Jefferson Proving Ground
Madison, Indiana

Volume I & II - Text

Draft Final
Phase II Remedial Investigation

Prepared for

U.S. Army Corps of Engineers
Louisville District
Louisville, Kentucky

Total Environmental Restoration Contract
DACW27-97-D-0015 Task Order 4008

February 2002

MWH
MONTGOMERY WATSON HARZA

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, LOUISVILLE
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March 21, 2002

Ms. Karen Mason-Smith (SRF-51)
U.S. Environmental Protection Agency, Region 5
Indiana Government Center - North
77 West Jackson Blvd
Chicago, IL 60604

Mr. Kevin Herron
Indiana Department of Environmental Management
Office of Environmental Response
100 N. Senate Ave.
Indianapolis, IN 46206-6015

Re: Draft Final Remedial Investigation
Jefferson Proving Ground,
Madison, IN

Dear Ms. Mason-Smith and Mr. Herron:

On behalf of the Department of Army, USACE along with its' contractor Montgomery Watson (MW) has prepared the enclosed Draft Final Remedial Investigation (RI) for the Jefferson Proving Ground. Additional copies (5 volumes in each set) are enclosed for your distribution, review and comment as follows: USEPA (5), and IDEM (4). The Draft RI submitted in August 1998 (EarthTech) has been revised to address comments from the United States Environmental Protection Agency (USEPA) and the Indiana Department of Environmental Management (IDEM). In addition, this document summarizes new work performed since the submittal of the Draft in 1998.

The Draft Final RI includes revised text, tables, figures, and an Appendix Addendum. Only new or revised Appendix material is included herein. One new appendix has been added to include relevant correspondence or meeting minutes from the meetings that occurred following the submittal of the comments on the Draft RI.

Included as the final document in the correspondence appendix (Appendix FF) is the Response to Comment (RTC) Table. The RTC table includes agency comments with their original comment number, initial EarthTech responses, and new MW responses. In addition, the table has been sorted to reflect comments by section number for easier review. Lastly, a column has been added for agency concurrence, to facilitate the face-to-face meeting to occur in June.

The following items should be noted for review of the document.

The following items should be noted for review of the document.

- The Draft RI used 1998 PRGs. The Draft Final RI does not update those PRGs for the analysis and screening of the old Phase I and II data. However, new data are compared to the current USEPA Region 9 PRGs and include the following:

  Confirmation Soil
  - Site 12A – Section 13
  - Site 12B – Section 14
  - Site 12C – Section 15
  - Site 13 – Section 16
  - Site 33 – Section 24

  Groundwater
  - Sites 3/4 – Section 8
  - Sites 7/21B – Section 10
  - Site 12A – Section 13
  - Site 12B – Section 14
  - Site 12C – Section 15

  Surface water and Sediments
  - Sites 9/10 (Middle Fork Creek) – Section 12

- The Baseline Risk Assessment was not revised to account for new risk assessment guidance that was issued since the original work plans were approved.

- The human health component of the Baseline Risk Assessment was revised to update the toxicity values used to estimate the human health risks. An attempt was made to get USEPA concurrence on these toxicity values but we were not able to get concurrence on the values before this report was issued. Note that this update was not done in response to any comment in the RTC table, rather MW and the USACE considered this update necessary.

- For risk related appendix material, a CD has been provided for changes to risk related tables. These includes the following:

  - An addendum to Appendix R – Air Emissions and Dispersion Modeling,
  - Complete replacement of Appendix V – Exposure Assessment Calculations for HHRA,
  - Complete replacement of Appendix W – Risk Characterization Calculations for HHRA,
  - Complete replacement of Appendix AA – Summary of Intakes and Risks for the DERA.

  This CD provides more documentation than the previous appendix materials provided. We hope this will aid in the technical review of these calculations.

- New analytical data collected since the Draft RI was reviewed and validated according to the USACE Louisville Chemistry Guideline, Revisions 1 and 3.

- Interim actions have been documented outside the Draft Final RI but are referenced within the appropriate sections. Additional investigations and evaluations are discussed and their results are presented within the Draft Final RI.

- Where interim measures occurred and confirmation sampling showed residual levels of contamination to be below Region 9 PRGs, the risk assessment was not updated. This is noted in the individual sections of the Draft Final RI report.

- The Army anticipates that USEPA and IDEM personnel will participate in the review and that additional comments by others will be reviewed by USEPA and IDEM project managers for applicability.

The preliminary schedule to complete the RI is as follows:

Army submits Draft Final RI to USEPA/IDEM	March 22, 2002
USEPA/IDEM perform their review (55 calendar days)	
Evaluation of RTC Table and Draft Final RI to Army	May 17, 2002
Army issues Response to USEPA/IDEM Evaluation	June 12, 2002
Face-to-face meeting in Madison, Wisconsin	June 24-26, 2002
Meeting to resolve issues, if needed, in Madison, IN	July 15-18, 2002
Last meeting, if needed, in Indianapolis, IN	July 30-Aug 2, 2002
Army issues Final RI (critical date)	**September 20, 2002**

To meet the critical September 20, 2002 Final RI submittal date, it is imperative that USEPA and IDEM's evaluation of the Draft Final RI be completed and sent to the Army by May 17, 2002. This 55-day review period should be sufficient if the review of the Draft Final RI focuses on the responses to the comments, the meeting minutes contained in Appendix FF, and the new information performed since the 1998 submittal of the Draft. It is the Army's understanding and anticipation that USEPA and IDEM will focus on the new information and responses that needed additional data. It is anticipated that issues that were resolved and/or comments that received concurrence no longer need addressing.

To expedite your review, the new and revised text within the report has been redlined to help focus your attention to that material. In addition, each change performed as a result of a comment has the comment number in parentheses following the text changes. With this redlining and the RTC table, USEPA and IDEM should be able to meet the May 17, 2002 review date.

If you have any questions, please feel free to call me at (502) 315-6335.

Sincerely,

Andrew B. Evens
Army Corps of Engineers

Enclosures: Draft Final RI (USEPA – 5 sets; IDEM – 4 sets)

cc: Paul Cloud – Army (1)
Brooks Evens – USACE (1)
Ken Knouf – Jefferson Proving Ground (2)

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Comment #	Section	Comment (EPA/IDEM as indicated in comment number)	Original Response to Comment (ET)	MW Revised Response (if applicable)	Agency Concur
IN6	01.2	**Section 1.2.2, Page 1-10, Paragraph 3:** "Since final closure of the facility in the fall of 1995, a local farmer has leased the area south of the firing line and is currently farming approximately 800 acres of the area that has no potential for UXO." As stated in previous comment letters IDEM staff do not agree that any area south of the firing line has no potential for UXO. UXO has been encountered in several areas previously classified by the Army as having no potential for UXO. This paragraph should be rewritten.	The sentence fragment ". . . that has no potential for UXO." will be deleted from Section 1.2.2.	Comment addressed per ET's response.	
IN18	1.2.2	**Section 12.1, Page 12-1:** This section covers some of the materials deposited in the Gate 19 Landfill. Asbestos, TCE, red lead and paint are the only special wastes mentioned. IDEM special waste disposal permits for chemicals, chemical warfare suits, test kits, and other items were also issued for this site. The site history should reflect this disposal of varied items rather than emphasize inert construction debris. A list of special wastes and their volumes, as listed in the permit files, should be added to the report.	The site history will be updated under Section 1.2.2, Installation History, as requested.	Comments addressed per ET's response.	
IN7	01.5 and Table 1-4	**Section 1.2.3, Page 1-16, Paragraph 2:** This paragraph describes the technical memorandums that have been completed and submitted for regulatory review to support a recommendation for no further action under CERCLA. IDEM staff have reviewed these technical memorandums and either agreed with the Army's rationale recommending the removal of the site from the RI/FS or have issues that are unresolved. This paragraph should be updated to include the current status of each technical memorandum.	This issue should be discussed in the upcoming comment resolution meeting. Many of the technical memoranda were submitted for regulatory review in November and December of 1995. Although comments were received from IDEM for all technical memoranda, USEPA comments and approvals were never received. A new Table 1-3 will be added to Section 1.2.3 to show the updated status of each technical memorandum.	Table 1-4 has been updated with the requested information, and is referenced in Section 1.5	
EPA28	02.6.3	**2. Section 2.6.3, Groundwater Flow Characteristics, Figures 2-16 and 2-17:** These figures present detailed contours, but only show a limited number of wells across the site. It is unclear if surface water features such as creeks or additional well measurements were used to better define the contours presented. If this is the case, it should be stated in the text and measurements presented on the figures, if possible. If not, the figures should depict areas of uncertainty accordingly.	Section 2.6.3, page 2-47, 2nd paragraph, describes how topographic data points were used in addition to monitoring well data to guide the placement of contours. Where there is uncertainty in the contours, dashed lines will replace solid lines. The note referring to Section 2.6.3 will be expanded to read: "See Section 2.6.3 regarding contour placement. Data points from creek drainages were used to supplement well data."	Comment addressed per ET's response.	
IN9	03.2.1	**Section 3.2.1, Page 3-17:** "Eight of the sites where fieldwork was conducted potentially contained UXO as a result of past activities." One of the sites included in these eight is the Yellow Sulfur Disposal Area. This contradicts the previous position of the Army which was this area had no potential for UXO. Please correct this section to properly document that the Yellow Sulfur Disposal Area was previously classified as an area with no potential UXO until UXO was encountered during excavation activities.	The sentence will be revised to read: "Sampling locations at eight sites were screened for potential UXO as a safety precaution." An additional sentence will be added that states: "Although archive searches and sample location screening did not identify potential UXO at Site 14, subsequent excavation activities resulted in the discovery of buried UXO."	Comment addressed per ET's response.	
IN10	03.2.1	**Section 3.2.1, Page 3-18, last bullet:** "UXO was found only at the Possible UXO at Airport (Site 45)." This is incorrect. Over 100 UXO items were found at the Yellow Sulfur Disposal Area, which is included in this section. This statement must be corrected.	Section 3.0 describes the RI field activities. The last bullet is correct when discussing the results of clearing of sampling locations during the Phase I and Phase II RI field investigations. The UXO found during interim measures was a result of excavation activities that occurred 3 to 4 years later. The bullet will be revised to clarify this sequence of events further: "UXO was found only at the Possible UXO at Airport (Site 45) during the screening of sampling locations for Phase I and Phase II RI field investigations." A discussion of the UXO items found during interim measures will be added to Section 17.3.3, which describes interim measures activities for Site 14.	Comment addressed per ET's response.	
EPA29	03.2.8.3	**3. Section 3.2.8.3, Well Development, Page 3-34:** The second paragraph states that development continued until the well water was "clear to the unaided eye." Page 61 of the Phase II Remedial Investigation Final Field Sampling Plan (Field Sampling Plan) states that the well development will continue until the turbidity readings for the well are less than 5 NTUs. A similar discrepancy between the Field Sampling Plan and the Draft RI Report was found regarding the purging of wells for sampling. Revise this section to include an explanation for not using the turbidity meter during well development and well purging. Uncertainties in the data due to the lack of turbidity data should be addressed in this explanation.	A discussion will be added concerning the uncertainties from the lack of turbidity meter measurements. The Phase I RI/FS Sampling Design Plan did not call for turbidity measurements due to the USATHAMA requirements of purging 5 bore volumes or pumping dry in the case of some wells. Phase II development did include turbidity measurements. However, 5 NTUs could not be achieved in many cases. Stabilization of pH, conductivity, and temperature, pumping of 5 bore volumes, and clarity to the unaided eye were used to ensure development and purging were complete. For metals analysis, both filtered and unfiltered data were collected. The text will be revised to clarify this issue.	Comment addressed per ET's response.	
IN11	04.2.3	**Section 4.2.3, Page 4-7, Last Paragraph:** "In surface water, 1,3,5-trinitrobenzene was detected in five of six samples at consistently low concentrations, which were similar to concentrations reported in laboratory method blanks for other lots analyzed during the same period. Because no other associated explosive compounds were detected in surface water and only one explosive compound (2,4-DNT) was detected in other media at JPG during the RI, the results for the surface water are considered probable artifacts of laboratory contamination." The lab results for this compound in the Gate 19 Landfill pond are above EPA PRGs. This is very high to be dismissed as a laboratory artifact. Resampling may be necessary?	The 1,3,5-trinitrobenzene was not dismissed and was carried through the risk assessment as a COPC. This fact will be added to the paragraph for clarification. The results indicate that the hazards to human health from ingestion and dermal contact with the 1,3,5-trinitrobenzene in the pond are insignificant. As a result, further sampling does not appear to be warranted.	Comment addressed per ET's response.	

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EPA3a	05.0	Generally, the methodology in the human health risk assessment for JPG is well organized and clearly presented. Discussions are succinct and unambiguous. The risk assessment tends toward a conservative basis and relies heavily on U.S. EPA guidance. With minor exceptions, where the methodology incorporates site-specific information, these determinations or exposure parameter values tend to be reflective of reasonable maximum exposures. Several broad procedural issues remain for U.S. EPA determination (selected issues are presented in the following bullet items), however, the comments in the enclosed deliverable are unlikely to significantly impact the results of the risk assessment, or those interim or remedial actions which may be predicated on the results of the risk assessment.	No response necessary.	No response necessary.	
EPA3b	05.0	Sites at JPG with total cancer risk estimates which did not exceed U.S. EPA's upper bound cancer risk threshold of 1.0E-04 were proposed for No Further Action (NFA) classification and were not carried forward to evaluation within the Feasibility Study (FS). Typically, risk estimates below 1.0E-06 are not considered indicative of significant concern, alternately, risk estimates in excess of 1.0E-04 generally require some amount of remedial action of interim measure to mitigate exposures. Within the range of 1.0E-04 to 1.0E6, U.S. EPA must make a judgement on whether exposures are acceptable based on the degree of conservatism inherent in the analysis. Many of the sites proposed for NFA exhibit total risk estimates in excess of 1.0E-05 and hazard estimates in excess of 1.0. Hazard exceedances do not span orders of magnitude and thus are not assumed to represent significant human health impacts. However, U.S. EPA Region 5 will review the estimates of cancer risk for sites proposed for NFA for final determination of acceptable risks and hazards and make preliminary determinations regarding potential remedial actions (where applicable).	Comment noted. Text will be modified to state that for all sites exhibiting potential risks/hazards above *de minimis*, the Army in consultation with USEPA Region 5 will decide if any remedial actions are necessary.	This has not been addressed within the Draft Final RI because de minimis risk is a risk management concern.	
EPA3c	05.0	These are risk management decisions which may need to be made at a later time. However, EPA wanted to bring these issues to the Army's attention since JPG has recommended no further action for each of the sites that fall within the risk range of 1.0E-04 to 1.0E-06. This issue is further discussed in General Comment 1.	See response above.	This is a risk management concern and therefore is not addressed in the Draft Final RI.	
EPA4a	05.0	A Detailed Ecological Risk Assessment (DERA) was conducted, and the results submitted as part of the Draft RI Report for <u>eight sites</u> located south of the Firing Line at JPG. The DERA was conducted and prepared based on a DERA Work Plan, dated January 23, 1998, and associated comments from U.S. EPA on the DERA Work Plan dated March 13, 1998 (the DERA Work Plan was apparently not revised to incorporate U.S. EPA's comments). The Army later provided a memo to address EPA's March 13, 1998 comment letter regarding the draft final DERA Work Plan (dated 23 January 1998). In general, the Army's memo stated that it would not address EPA's comments nor revise the draft final DERA Work Plan at that time, but would address EPA's comments in the Draft Phase II RI Report (August 1998).	No response necessary. This issue should be discussed in the upcoming comment resolution meeting.	No response necessary	
EPA120a	05.0	**5. Exposed, or Potentially Exposed Populations:** The risk assessment addresses only future on-site workers. Since all sites at JPG were evaluated under a future residential land use scenario and either a future industrial land use or agricultural land use, it is appropriate to consider additional receptor populations. Since a given site may undergo development as an industrial site it is appropriate to consider a future construction worker. This worker could be exposed under subchronic conditions to surficial and subsurface soil to a depth of 10 ft bgs, as well as shallow groundwater. At it's discretion, U.S. EPA may also consider the implementation of a future maintenance worker at such sites.	The receptors evaluated in the risk assessments are those specified in the Human Health Risk Assessment Work Plan (HHRAWP) (Rust E&I 1997). The construction worker would only be exposed typically at a site for less than one year, a short time frame in comparison to the 25 years used in the assessments for the industrial worker. This difference in exposure duration likely would offset any differences in other exposure parameters for the two groups of workers (e.g., skin surface area) and any difference in exposure point concentrations for surficial soils versus surficial/deep soils combined. At most of the JPG sites evaluated in the risk assessment, there are either no subsurface soil data, or there is little difference between the exposure point concentrations for surficial versus surficial/deep soil combined. Future maintenance workers would likely have exposure similar to that of the industrial worker evaluated in the assessments.	Response addressed per June 16 and 17, 1999 Final Meeting Minutes (Appendix FF).	
EPA120b	05.0	In addition, current as well as future agricultural activities necessitate contact with potentially impacted media. Although crops such as soybeans and silage are currently harvested from on-site areas and could be considered for additional areas in the future, the risk assessment addressed only ingestion of contaminated beef and milk from cattle's ingestion of these contaminated food sources. Tilling and planting necessitate contact (incidental ingestion, inhalation and dermal contact) with soil for an agricultural worker. In addition, future agricultural practices could be dependent upon the groundwater for watering stock as well as local crops.	For those sites designated agricultural, the soil pathways (incidental ingestion, dermal contact, inhalation) were evaluated for the on-site rural resident (assumed to be the same receptor as the agricultural worker mentioned by the reviewer). Groundwater data are available for only one of the potential agricultural sites (Sites 3/4); however, the USEPA did not request the evaluation of the use of groundwater for watering stock and crops in the approved HHRAWP.	Response addressed per June 16 and 17, 1999 Final Meeting Minutes.	

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EPA120c	05.0	While the risk assessment mentions that beef cattle are raised in on-site areas, they are assumed not to forage for food. Foraging activities would involve the incidental ingestion of soil by cattle. This is especially important as cattle tend to pull forage from the earth, roots and soil adhering, rather than clip off grass or shoots such as sheep do when foraging. If beef cattle are raised on-site, its should be specifically reiterated within the risk assessment that special conditions exist which do not allow for the foraging of the animals. None of these pathways have been considered within the risk assessment. These issues will be addressed in greater detail under the Specific Comments section of this review.	The reviewer is correct that the assessment did not evaluate on-site cattle ingesting soil via foraging activities. The risk assessment assumed that only silage would be grown at the various agricultural sites, such as is occurring today, not grassland. This was the scenario submitted and approved in the HHRAWP.	Response addressed per June 16 and 17, 1999 Final Meeting Minutes.	
EPA120d	05.0	Likewise, the risk assessment fails to address the potential for inhalation of volatile organic compounds (VOC) in ambient air stemming from shallow impacted groundwater. This pathway may be significant, especially as volatile intrusion may be contained indoors within overlying structures such as housing, offices or other storage or sheltering structures. VOCs contributed from impacted groundwater are evaluated only with respect to exposures incurred while bathing.	The volatilization of contaminants from groundwater into an on-site building such as a home or office was not evaluated because these pathways were not included in the HHRAWP, nor were they requested by the USEPA at that time. It is our opinion that the migration of volatile chemicals into indoor air from groundwater would not be a significant exposure pathway at JPG. Most of JPG is covered by Pleistocene glacial deposits (glacial till) that overlie Silurian and Devonian bedrock. The glacial deposits are 25 feet thick on average. The calcareous cement in the till makes it very hard (Illinoisan till lithostratigraphic horizon). Dry zones are reported below the water table within the glacial till in many site borings. The presence of such zones indicates that recharge water (precipitation) migrating from the ground surface to bedrock aquifers occurs through small hydraulically active fractures. Since evaporation and significant diffusion of contaminant vapors can take place only through these discrete active fractures, the contaminated vapor migration would be severely restricted. It is concluded, therefore, that volatile groundwater contaminants present in the bedrock aquifer are prevented from easily evaporating and migrating through the overlying glacial deposits. A qualitative discussion will be added to the uncertainty section of the applicable sites.	The potential for migration of volatile chemicals from groundwater into indoor air is limited to sites that have groundwater contaminated with VOCs. This actually only applies to Sites 12A, 12B, 12C, and 3 /4. Per June 16 and 17, 1999 Final Meeting Minutes, vapor intrusion modeling was performed for VOCs in groundwater and soil to indoor air at Sites 12A and 12B and incorporated into Sections 13 and 14. Modeling at Site 12C was not performed because the results of confirmation samples did not exceed EPA Region 9 PRGs. Sites 3 /4 will be carried forward to the FS for further evaluation.	
EPA122	05.0	7. **U.S. EPA Exposure Factors Handbook:** Several fundamental determinations in the risk assessment are predicated on values from a dated version of U.S. EPA's Exposure Factors Handbook (1995). Revisions to the report should attempt to take advantage of the most current version of this guidance document from August 1997. (a Science Advisory Board [SAB] review draft copy of this document was available in August of 1996.)	At the time the HHRAWP was developed for this project (finalized April 1997), the most recent version of the Exposure Factors Handbook was not available. The current risk assessment followed the approved work plan rather than using updating factors from the new handbook. A review will be conducted to identify changes that may impact the risk assessment conclusions, and an analysis will be conducted that will be added to appropriate site-specific uncertainty sections.	A limited number of exposure parameter values were revised for consistency with EPA Standard Default Exposure assumptions and EPA Exposure Factors Handbook (1997).	
EPA123	05.0	8. **Current Receptor Populations:** Although the text has presented the fact that all operations have ceased at JPG, it remains unclear whether or not the property is patrolled, guarded or whether or not routine maintenance activities must periodically be undertaken. Revisions to the risk assessment should address these questions.	The risk assessment will be updated to include a description of the current activities. Access is still controlled at the main gate. However, the entire facility is not routinely patrolled as in the past.	Comment has been addressed per ET's response.	
1EPA170b	05.0	A provision RfD value for the following chemicals have been developed by NCEA. These values should be used for the COPCs in the risk assessment. <u>Chemical</u> — <u>RfD</u> (mg/kg-day) Copper — 0.04 Iron — 0.5 DDE — 7E-04 1,2,-dichloroethane — 3E-02 Benzene — 3E-04 4-amino-2,6-DNT — 6E-05	The suggested provisional RfD values will be utilized in the revised Draft RI. However, any significant hazards associated with these chemicals will be specifically "flagged" to identify the fact that these criteria are provisional (not USEPA-verified values) and that, because of this, there is likely to be more uncertainty with the calculated hazards.	RfDs have been revised for consistency with values currently provided in IRIS, HEAST (1997), and in the absence of information in these sources, provisional values obtained in 2001 from NCEA (via an EPA toxicologist).	

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EPA180a	05.0	3. The presentation of the ecological risk assessment results does not include several primary elements needed to allow for an adequate review of the document. In addition, it is difficult to determine which data were used to perform statistical calculations, determine COPCs, and calculate the exposure point concentrations (EPCs). For example, the data from Phase I, Phase II, and Phase III investigations are described in the text, but from the complicated presentation of the data, it is not clear from the tables and other text which data were actually used to estimate an EPC. Therefore, this review did not include assessment of the accuracy of the statistical summaries. Also, sample locations used in this ecological risk assessment were not always discernable on the figures.	Clarity is requested regarding which primary elements are missing. The DERA contains all of the elements cited as critical by USEPA (1998, 1997, 1996, and 1995). These include problem formulation, analysis, and risk characterization. These guidance documents were followed closely in the development and preparation of the DERA. The methodology is presented in Section 5.3. The data are clearly presented as to Phase I, II, III, and IM in each section. The EPC is clearly marked on the summary statistics tables for each section. The reviewer is mistaken with regards to a toxicity assessment; it appears in Section 5.3.2.6 (page 5-128) and Appendix DD. The information requested by the reviewer is presented in succinct, tabular form in Tables 5.3-15 and 5.3-16 (pages 5-208 and 5-211, respectively), and in detail in Appendix DD. This allows a reader to rapidly assess the studies reviewed for each of the COPCs, what type of animal was used in the study, the uncertainty factors applied, and the final toxicity benchmark from which a hazard quotient was derived. While the same information could be provided in text form, it would be redundant as well as less informative to a technical reviewer. The DERA contains toxicity information for all COPCs, regardless of the resulting hazard quotient, if this information was obtained from a literature search. Text will be added to page 5-128 to indicate that consideration of Appendix DD is critical to the technical review of the toxicity section.	As agreed to in the June 16 and 17, 1999 Final Meeting with Earth Tech a site-specific Conceptual Site Model was provided for each site-specific ecological risk assessment, and a summary of all lines of evidence was provided. The lines of evidence for all sites were summarized on one easy to read table to help the reader focus in on the key lines of evidence for each site.	
EPA181a	05.0	4. Several ecological field studies (phytotoxicity tests, earthworm toxicity tests, soil fauna surveys, aquatic bioassessments/biometrics) were conducted in support of the ecological risk assessment. The results for all the sites included in the DERA indicate that field studies/toxicity tests are not significantly different for the impacted sites when compared to the results of the field studies/toxicity tests at the reference areas. It should be noted that chemical data for VOCs, SVOCs, pesticides, dioxins/furans which would indicate that results of the reference area studies are not impacted by anthropogenic compounds has not bee documented. In addition, according to the objectives stated in the report and in the meeting notes of the August 14, 1997 meeting, the sampling approach was to establish a semi-quantitative, quasi-PRG soil level to be used at all of the remaining sites. However, the results of these studies have been used as the sole rationale for elimination of a site from further actions and the results of the quantitative component of the risk assessment are either not discussed or dismissed.	The background locations and analytical suite were approved by the regulators (including EPA) following a 1995 site visit. Chemical analysis for the background locations was limited to metals. It was acknowledged by the regulators that metals were the COPCs for the DERA. The EPA stressed the importance of basing the DERA conclusions on the results of the Fall 1997 ecological sampling (Rust E&I 1997h). Due to schedule constraints at the time of the draft submittal, a more thorough discussion of the risk assessment results and conclusions could not be incorporated into the DERA. Further review of the data and the risk assessment results and conclusions will be undertaken for the next version of this report.	Response addressed per June 16 and 17, 1999 Final Meeting Minutes. It should be noted that toxicity profiles were not included in the ecological risk assessment as offered by EarthTech in the June meeting. Appendix DD provides the information used to assess the toxicity of COCs.	
EPA181b	05.0	It is agreed that these types of studies are appropriate for providing additional lines of evidence to support conclusions made in the risk assessment, but the results of the studies should not be considered conclusive, especially when quantitative risk estimates indicate exceedances of HQs. There are also many uncertainties associated with the on-site tests and they should not be regarded as conclusive evidence of the lack of adverse ecological impacts. The direct contact with the soil may not account for toxicity or adverse effects through the dietary food chain pathways. It is also not evident that it is justified to use the results of these tests as an assessment of potential long-term or chronic exposures. It is recommended that the results of these studies be reported and discussed in the summary sections along with ecotoxicological information associated with the multiple HQ exceedances reported for each of the sites. The limitations of these studies need to be expanded and include the uncertainties associated with the assumption that the toxicity tests are representative of all exposures to all receptors and the media used may not represent conditions across the site.	Field studies have always been an important component of ecotoxicology. According to USEPA guidance used during the DERA field effort (EPA 1997: Ecological Risk Assessment Guidance for Superfund), site-specific data are useful in the risk assessment. This is because the EPA recognizes that good site-specific data are likely to be more representative and less uncertain than HQs based on literature values derived from laboratory animals. For example, page 4-3 of EPA (1997) states ". . . some situations in which it might only be necessary or possible to compare estimated or measured contaminant exposure levels at a site to ecotoxicity values derived from the literature. . . . A bioassay using contaminated media from the site can suffice if the risk manager and risk assessor agree that laboratory tests with surrogate species will be taken as indicative of likely effects on the assessment endpoint." In a broader context, the term "bioassay" can represent the collection and analysis of any biological data not necessarily laboratory-derived data. As such, the collection of the ecological data (specifically the earthworm toxicity tests, soil fauna identification, and plant phytotoxicity data) constitute bioassays. Further statistical analyses will be provided as necessary to support the conclusions made from the field effort. While soil contact by lower trophic level receptors may not address biomagnification through the food chain, the dietary pathway was fully addressed in the DERA; HQs for the dietary pathway were modeled from BAFs/BCFs and are available for every section. The results of the field efforts are presented in the summary sections and will be expanded upon in the final version. HQs for every site were evaluated and presented in the DERA. The toxicity information is presented in the "Methods" section (Section 5). Presenting the toxicity information in every section of the "Results" would be redundant; therefore, the reader will be referred back to the toxicity table as necessary. A more complete uncertainty assessment will be provided; however, the results of the field efforts are more likely to be representative of exposures to receptors than are laboratory toxicity data, in part because sites were selected to be representative of the entire JPG in conjunction with the BTAG.	Response addressed per June 16 and 17, 1999 Final Meeting Minutes.	

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EPA182	05.0	5. A generic (e.g., non site-specific) Conceptual Site Model (CSM), that represents all possible exposures has been presented in the DERA. In addition, each of the sections associated with a particular site include an Exposure and Effects profile that indicates the receptors that may be exposed to COPCs for each site. However, the site-specific sources and migration pathways are not presented for each site. Without a site-specific CSM, it is difficult to determine whether data used to generate the EPCs can be considered complete and the appropriateness of the selected receptors for each site cannot be easily discerned. It is recommended that site-specific CSMs be included for each site.	The information that would be presented graphically is presented in more detail in the current text. The presentation of site-specific conceptual models could be performed although they would be repetitive. The site location is not going to affect the total inorganic or organic concentrations that make up the EPCs which appear in the DERA. All available data were used in the DERA and additional data collection is out of scope. Data gaps should have been identified during the work plan stage; comments regarding the need for additional aquatic sampling do not appear in EPA's comments on the work plan. All terrestrial receptors selected by the BTAG were evaluated at each site if soil data were available, and all aquatic receptors if surface water and/or sediment data were available; therefore, the appropriateness of the receptors at each site is irrelevant. The receptors were selected by the BTAG, of which EPA was a member, to adequately and conservatively represent all potential receptors occurring at JPG	No response necessary. Final DERA Work Plan followed.	
EPA183	05.0	6. Instead of revising the final DERA Work Plan, the Army agreed to include any changes made to the DERA based on comments made by U.S. EPA on the DERA Work Plan. However, it was noticed that the following Work Plan comments from U.S. EPA were not adequately addressed in the DERA: General Comments 1 (second paragraph) and 2; Specific Comments 1, 5, 7, 10, 11, and 13.	Clarity is requested from the reviewer - Are the comments that have not been adequately addressed those specific work plan comments (General Comments 1 and 2 and Specific Comments 1, 5, 7, 10, 11 and 13 -March 1998) or these new comments on the August 1998 RI report (January 1999)?	The DERA Work Plan, which was prepared with EPA concurrence, was followed.	
EPA180b	05.0 Figure 5.3-1	One of the primary elements of ecological risk characterization that was notably missing is the brief discussion of potential toxicological effects based on receptors and specific chemicals (also known as the toxicity assessment). The DERA does not include any information pertaining to potential toxicity for those COPCs with a hazard quotient (HQ) above 1. It is recognized that field studies were conducted to provide lines of evidence to support the ecological risk assessment; however, this information was incorporated in lieu of information typically associated with ecological risk assessment reporting. It is recommended that specific reference to data and locations for each site be incorporated within each section. It is also recommended that the ecological risk assessment follow a formal similar to the human health presentation and include necessary elements for review, such as the site-specific CSM and toxicological information. This would facilitate review and provide the information that is necessary to assess the validity of many of the statements made in the DERA.	The reviewer is mistaken with regards to the comments on the lines of evidence being used in lieu of the quotient method; both methods were applied. The DERA contains not only quantitative risk estimates based on literature toxicity values, but also the information derived from the field studies. The text will be clarified on page 5-131 and Figure 5.3-1 (page 5-151) to indicate all of the lines of evidence considered in the DERA. The statement regarding "specific reference to data and locations for each site" is unclear. Specific references to data and locations of each site are presented in each section. For example, for Section 7 (Site 2/27), Section 7.7.2.1 (page 7-84) refers to the use of Phase I data; the summary statistics used are in Table 7.7-1 (page 119). Section 7.7.2.2 (page 7-84) refers to the use of Phase II data, with summary statistics appearing in Table 7.7-5 (page 7-124). Section 7.7.2.3 (page 7-84) refers to the use of Phase III data; summary statistics for the data are in Table 7.7-11 (page 7-130). Each section regarding each DERA site (with the exceptions of Sections 31 and 32) is arranged the same way to facilitate ease of review. The DERA contains a CSM designed to represent JPG which received concurrence from the BTAG, of which EPA was a part (Rust E&I 1997h). During the development of the CSM, discussion involving each of the sites, the major contaminants, the exposure pathways, and the ecosystem took place. The site-wide CSM contains all potential exposure pathways for all receptors based on these discussions. Since each of the terrestrial pathways was evaluated for each of the terrestrial receptors at each location, and each of the aquatic at locations with surface water and/or sediment data, presentation of separate CSMs for each site would be repetitive; each would look identical. Text is included in each section under X.7.1 (Site Description) and X.7.3 (Exposure Profiles) that describes the habitat and other pertinent items for evaluation of the review of the DERA.	The data used to create these estimates is provided in Appendix AA.	
IN12	05.1	**Section 5.1.4.6.2, Page 5-46:** This discussion of the conceptual models for risk assessment of future residents deletes dust emissions because most residential sites were assumed to be covered by houses, concrete or paved driveways, and dense vegetation such as cultivated (grass) lawns. This is not acceptable. Flower gardens, vegetable gardens, landscaping, small construction projects, and children routinely penetrate vegetative cover and generate dust. An experienced risk assessor should evaluate this further.	Although we agree with the commentator that flower gardens, small construction projects, etc., would generate some dust on occasion, these activities typically involve small areas and short time periods. The flower and vegetable gardens are generally kept damp through watering, which minimizes dust emissions. The amount of dust generated annually is therefore expected to be relatively small compared to that generated from the larger agricultural areas, which were modeled for the residential scenarios. The discussion of this issue will be expanded in the site conceptual model.	Comment has been addressed per ET's response.	
EPA16	05.1	4. Table 3-1 indicates that background samples were collected for soil and groundwater during both the Phase I and Phase II investigations, but it does not appear that these results were included in the main body of the Draft RI Report. Since the background data were used for comparison purposes in the nature and extent of contamination discussions for several sites, the background sample locations and results need to be presented to allow for evaluation of the comparisons. Summarize the background sampling results and include this information in the main body of the report.	Background sampling results are presented in Section 5.1.4 (page 5-5) of the report.	No response necessary.	

Comment #	Section	Comment (EPA/IDEM as indicated in comment number)	Original Response to Comment (ET)	MW Revised Response (if applicable)	Agency Concur
EPA124	05.1	1. **Page 5-5, Section 5.1.4.1, Data Assembly:** CRL and SVOC acronyms have not been defined within the risk assessment methodology section. To the extent possible, the risk assessment should be a stand alone document so these acronyms should be defined.	All acronyms in the risk assessment will be defined and included where appropriate in Section 5.0.	Comment has been addressed per ET's response.	
EPA125	05.1	2. **Page 5-7, Section 5.1.4.2.1, Background Dioxin Sampling:** Please see General Comment No. 2.	See response to General Comment 2 (EPA117).	No response necessary.	
EPA126	05.1	3. **Page 5-11, Section 5.1.4.3.1, Soil:** This section reads, "At certain sites. . .where interim measures remediation has occurred, samples from the remediated areas were dropped from the data set. Confirmatory interim measures data were not used in the risk assessment because the interim measures areas have regulatory approval for closure." While it is appropriate to exclude data for media which has been removed, if any residual contamination remains and may be seen in the confirmatory sample results, regardless of whether it is at a level which was previously accepted for closure, it should be evaluated in the risk assessment. If contact with residual contamination, even from regulatory closed investigation areas, can occur it must be evaluated within the risk assessment. Regulatory closure levels can be driven by a host of issues other than a health basis. Revise the risk assessment to characterize potential exposure across the spectrum of contaminated areas where contact can occur.	Interim measures data were reviewed to determine if residual contamination exceeded residential PRGs or other risk-based criteria. In the case of Site 7, the review of confirmatory data lead to the hand removal of a small area of contaminants still exceeding the 400 ppm cleanup level for lead. Additional confirmation samples were then taken. The excavation was backfilled with clean borrow material. Since the excavation did not include three of the RI sample locations at Site 7, a risk assessment was performed on the contaminants located outside of the excavated area. Additionally, the groundwater pathway was evaluated in the risk assessment. The other interim measures sites were handled in a similar manner. The section will be revised to further clarify how the interim measures sites were evaluated.	The only site where an interim measure was used to exclude data was at site 7 (Red Lead Disposal Area). For other sites where interim measures were performed the risk assessment was not updated (Human Health Evaluation) or the IM data was evaluated separately (Ecological Risk Assessment)	
EPA127	05.1	4. **Page 5-12, Section 5.1.4.3.2, Groundwater:** Data from four sampling rounds within the Phase II RI groundwater sampling regime were averaged in the determination of monitoring well or location specific groundwater concentrations. Also, non-detect results were averaged only if the detection limit was less than the highest detected value. This is not entirely in keeping with the conservative basis of the risk assessment process. It would have been preferable for the maximum detected concentrations to have been used to represent each well at which it was collected. In addition, elevated detection limit results should have been tracked and addressed within the Uncertainty Section of the risk assessment. Use of the maximum detected concentration is supported more strongly if elevated detection limits for non-detects exceeded the maximum detected value.	The statement should read that nondetects were averaged only if one-half of the detection limit was higher than the highest detected value. A review of the groundwater exposure point concentration tables for the applicable sites reveals that for most groundwater contaminants the maximum value was used in the assessment. Where the 95% UCL value was used, generally all sample results were used in the calculation.	No response necessary.	
EPA128	05.1	5. **Page 5-13, Section 5.1.4.4.1, Quality of Data Reports:** The acronyms USAEC and IRDMIS were not previously defined within the risk assessment. To the extent possible, the risk assessment should be a stand alone document. Therefore, these acronyms should be defined.	See response to Specific Comment 1 (EPA124).	Acronyms have been defined.	
EPA129	05.1	6. **Page 5-14, Section 5.1.4.4.3, Completeness and Relevance of Data Sources:** Regarding the second bulleted item, please see Specific Comment No. 3.	See response to Specific Comment 3 (EPA126).	See response to EPA 126.	
EPA130	05.1	7. **Page 5-14, Section 5.1.4.4.4, Adequacy of Analytical Methods and Quantitation Limits:** The acronyms QC and DQA were not previously defined within the risk assessment. To the extent possible, the risk assessment should be a stand alone document. Therefore, these acronyms should be defined.	See response to Specific Comment 1 (EPA124).	Acronyms have been defined.	
EPA131	05.1	8. **Page 5-15, Section 5.1.4.4.4, Adequacy of Analytical Methods and Quantitation Limits:** The acronyms DQL and MDL were not previously defined within the risk assessment. To the extent possible, the risk assessment should be a stand alone document. Therefore, these acronyms should be defined.	See response to Specific Comment 1 (EPA124).	Acronyms have been defined.	
EPA132	05.1	9. **Page 5-15, Section 5.1.4.4.4, Adequacy of Analytical Methods and Quantitation Limits:** Second paragraph. In the determination of whether an elevated detection limit exists, the risk assessment makes mention that a value "had to substantially exceed the DQL." "Substantially" is never properly defined, however, assuming that the DQLs are derived based on the Region IX Preliminary Remediation Goals (PRG), anytime the reported detection limit or sample quantitation limit (please see General Comment No. 4) exceeded a DQL, the resultant datum should have been considered an elevated detection limit and as such warrants discussion within the risk assessment, specifically within the Uncertainty Section of the risk assessment. In addition, it is unclear what difference exists between the second and third criteria discussed in the evaluation of elevated non-detect results.	Professional judgment was used regarding the term "substantially" with respect to whether or not an elevated CRL warranted specific comment for a site, and was used in conjunction with other criteria, such as number of elevated CRLs compared to the total number of samples. The rationale will be more clearly defined in the revised text. The distinction between the second and third criteria is that the former refers to intrawell events and the latter refers to interwell events. This will be clarified in the revised text.	Comment has been addressed per Final Meeting Minutes (June 16 and 17, 1999).	

Comment #	Section	Comment (EPA/IDEM as indicated in comment number)	Original Response to Comment (ET)	MW Revised Response (if applicable)	Agency Concur
EPA133	05.1	10. **Page 5-16, Section 5.1.4.5, Identification of Chemicals of Potential Concern:** All tentatively identified compounds (TICs) should be retained and discussed within the Uncertainty Section if detected above a health-based screening criterion. In addition, all TICs which could be considered possible breakdown products of known site COPCs should be retained for discussion within the risk assessment Uncertainty Section. Subjective and unqualified language such as "significant levels" provides no tangible information to the reader and is out of context in all sections of the risk assessment with the exception of the Uncertainty Section or potentially the risk assessment conclusions.	The word "significant" in the second bullet item in Section 5.1.4.5 will be deleted and replaced with "above a health-based screening criterion." All chemicals in the available database that had health criteria were included in the risk assessment.	Comment has been addressed per Final Meeting Minutes (June 16 and 17, 1999).	
EPA134	05.1	11. **Page 5-17, Section 5.1.4.5, Identification of Chemicals of Potential Concern:** A discussion of the data quality objective (DQO) levels associated with field data is not apparent. It is generally not appropriate to average data analyzed in the field (typically, DQO level 1 or 2) with laboratory results (typically DQO level 3 or 4). Data with DQO levels less than 3 are not appropriate for use in quantitative risk assessment. JPG should define what is meant by the term "field duplicate" and provide assurance that the data used in the risk assessment is DQO level 3 or 4.	Field duplicates refer to a second sample collected in the same location as the original sample and analyzed in the laboratory using the same analytical methods. This term will be defined in the text, as requested. All of the analytical data used in the risk assessment had DQO level 3 or 4.	Comment has been addressed per ET's response.	
EPA135	05.1	12. **Page 5-19, Section 5.1.4.5.2, Background Screening - Inorganics: Soil -** Regarding the discussion of SQLs in fourth paragraph, please see General Comment No. 4.	See response to General Comment 4 (EPA119).	Comment has been addressed per ET's response.	
EPA136	05.1	13. **Page 5-33, Section 5.1.4.5.5, Screening with Region IX Preliminary Remediation Goals: Soil -** Please see General Comment No. 4. For example, one-half the SQL should be substituted for one-half the CRL.	See response to General Comment 4 (EPA119).	Comment has been addressed per ET's response.	
EPA137	05.1	14. **Page 5-33, Section 5.1.4.5.5, Screening with Region IX Preliminary Remediation Goals: Groundwater -**The text should mention that the Region IX PRGs do not account for dermally absorbed doses and this associated uncertainty should be addressed within the risk assessment Uncertainty Section.	This uncertainty in the screening methodology used will be itemized in the Uncertainty Section of the Revised Draft RI.	Comment has been addressed per ET's response.	
EPA138	05.1	15. **Page 5-34, Section 5.1.4.5.5, Screening with Region IX Preliminary Remediation Goals: Sediment –** There appears to be a typographical error in the first paragraph, third sentence. It is assumed that this sentence is meant to read, ". . .the residential PRG (*not EPC*) are presented in. . ."	EPC will be changed to PRG.	Comment has been addressed per ET's response.	
EPA141	05.1	18. **Page 5-38, Section 5.1.4.6.1, Facility-Wide Conceptual Site Model: Current Land Use Scenario –** Although the text has presented the fact that all operations have ceased at JPG, it remains unclear whether or not the property is patrolled, guarded or whether or not routine maintenance activities must periodically be undertaken. Revisions to the risk assessment should address these questions.	See response to General Comment 8 (EPA123).	No additional response necessary.	
EPA142	05.1	19. **Page 5-39, Section 5.1.4.6.1, Facility-Wide Conceptual Site Model: Trespassers** This receptor population could conceivably be exposed to VOC emissions from subsurface soil and groundwater. In addition, the risk assessment should make mention of whether groundwater seeps occur on-site which could contribute to dermal contact for this as well as many other receptor populations.	Exposure to VOCs and dusts from soil were modeled and evaluated for this trespasser receptor (see Section 28.1.1.2.1 on page 28-1). Exposure to groundwater VOCs in air was not evaluated; however, this is not expected to be a significant pathway at the site (see response to General Comment 4). Exposure from groundwater seeps was evaluated for the off-facility residents recreating in Middle Fork Creek (ingestion of and dermal contact with surface water contaminated from groundwater discharge based on modeling described in Appendix S). Mention of the possibility of this pathway for other receptors will be added.	Comment has been addressed per Final Meeting Minutes (June 16 and 17, 1999).	
EPA143	05.1	20. **Page 5-40, Section 5.1.4.6.1, Facility Wide Conceptual Site Model: Off-Facility (Nearby) Rural Residents -** It is agreed that current exposures from groundwater to this receptor group are likely to be negligible, however, downgradient groundwater users have been identified within one mile of JPG. In the future, groundwater users could be located much closer. The text should point out that future on-site residential exposures to groundwater are indicative of future potential groundwater users at the downgradient property boundary.	The reviewer is correct that the off-site residential exposures to groundwater are assumed to be at the property boundary. Text will be added in the appropriate sections to clarify this.	Comment has been addressed per ET's response.	
EPA144	05.1	In addition, this section's last paragraph on page 5-40 reads, "There is the potential for this pathway to be complete for off-site residents under the future land use scenarios; however, exposure to contaminated off-site groundwater in the future was addressed quantitatively [sic], as described in Section 5.1.4.6.3." This is confusing. It is unclear if the author means that these exposures were addressed qualitatively. This is doubly problematic because Section 5.1.4.6.3 does not exist within this document.	The text will be modified to read, "therefore, exposure to contaminated off-site groundwater in the future was addressed quantitatively, as described in Section 5.1.5".	Comment has been addressed per ET's response.	

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EPA145	05.1	21. **Page 5-41, Section 5.1.4.6.1, Facility-Wide Conceptual Site Model: Current On-Site Tenant Employees/Residents -** The text should identify whether groundwater seeps exist which could allow dermal or other contact and that impacted shallow groundwater does not underlie these areas. If contaminated groundwater does underlie areas where these receptors live and work, the risk assessment should evaluate exposures due to inhalation of VOCs volatilizing to ambient air and enclosed structures (homes).	It is assumed that access to surface water drainages containing seeps is restricted for the current on-site resident. See response to General Comment 5 (EPA120) regarding VOCs in homes.	Comment has been addressed per Final Meeting Minutes (June 16 and 17, 1999).	
EPA146	05.1	22. **Page 5-42, Section 5.1.4.6.1, Facility-Wide Conceptual Site Model: Future Land Use Scenario: Hunters -** The risk assessment should address potential inhalation of VOCs volatilizing from contaminated groundwater to ambient air. If the authors believe this exposure to be negligible due to the transient nature of this receptor population, it should not be quantified and instead should be addressed qualitatively in the Uncertainty Section of the risk assessment.	See response to Specific Comment 19 (EPA119).	Comment has been addressed per Final Meeting Minutes (June 16 and 17, 1999).	
EPA147	05.1	23. **Page 5-43, Section 5.1.4.6.1, Facility-Wide Conceptual Site Model: Future Land Use Scenario: Hunters –** Although a hunter's exposure due to ingestion of contaminated wild game may or may not be negligible, this exposure need not be quantified but must be qualitatively addressed within the Risk Characterization and the Uncertainty Section of the risk assessment.	Ingestion of wild game by the on-site hunter is not believed to be significant at the site. This information will be added to the uncertainty section in the revised Draft RI.	Comment has been addressed per ET's response.	
EPA149	05.1	25. **Page 5-44, Section 5.1.4.6.2, Site-Specific Conceptual Site Models: Future Land Use Scenarios -** Where an industrial future land use is considered for a specific site at JPG, the risk assessment should address more than the typical on-site worker; it should include at a minimum an on-site construction worker exposed subchronically to surface as well a subsurface contamination. This should include the following exposure pathways: • Surface Soil - Incidental Ingestion, Inhalation of VOCs and Particulates, Dermal Contact • Subsurface Soil - Incidental Ingestion, Inhalation of VOCs and Particulates, Dermal Contact • Groundwater - Inhalation of VOCs, Dermal Contact (if shallow depth to groundwater)	See response to General Comment 5 (EPA120).	No additional response necessary.	
EPA150	05.1	26. **Page 5-44, Section 5.1.4.6.2, Site-Specific Conceptual Site Models: Off-Facility Agricultural Consumers -** Under the future agricultural land use scenario, JPG areas are leased to off-facility farmers. The risk assessment currently considers only off-site individuals who consume beef and milk from cattle who are fed crops such as soybeans and corn (as silage) raised on the property. There is no mention of the farmer's actual exposure. A better basis for risk management decisions may be the farmer or agricultural family. It may be assumed that a farmer has contact with the soil and VOCs from the subsurface during planting and tilling in addition to ingestion of beef and milk. Homegrown vegetables may also be a consideration. Likewise, beef and dairy cattle raised on-site may have a greater contaminant intake than cattle raised off-site and fed crops raised on-site. It is unclear whether cattle are currently raised on-site or are simply proposed as part of the future land use. Section 5.1.5.2.9 (Comment No. 34) addresses cattle raised on-site.	Every site was evaluated for an on-site resident who consumed locally grown vegetables. For sites designated as agricultural, beef and milk consumption were additionally included.	Comment has been addressed per Final Meeting Minutes (June 16 and 17, 1999).	
EPA151	05.1	27. **Page 5-45, Section 5.1.4.6.2, Site-Specific Conceptual Site Models: On-Site Workers -** Please see previous comments regarding future construction worker exposures.	See response to General Comment 5 (EPA120).	No additional response necessary.	
EPA152	05.1	28. **Page 5-45, Section 5.1.4.6.2, Site-Specific Conceptual Site Models: On-Site Workers -** Please see previous comments regarding exposure to volatile emissions from shallow groundwater.	See response to General Comment 5 (EPA120).	No additional response necessary.	
EPA153	05.1	29. **Page 5-46, Section 5.1.4.6.2, Site-Specific Conceptual Site Models: On-Site Workers -** The third bulleted item mentions a production groundwater well. Typically, production groundwater wells are only associated with inhalation or dermal contact exposures at an industrial site. Previous references to a future on-site groundwater well have referred to a supply well for ingestion of drinking water. These terms may be interchangeable as long as the same exposure parameter values are applied to the receptor populations at issue. Revise the document to ensure that the water well on-site represents a drinking water supply well.	The text will be revised to indicate that the on-site well represented a hypothetical future drinking water well; there are currently no drinking water wells at the site.	Comment has been addressed per ET's response.	
EPA154	05.1	30. **Page 5-46, Section 5.1.4.6.2, Site-Specific Conceptual Site Models: On-Site Rural Residents -** The text referring to this receptor population should make transparent the point that exposures are quantified to both surface soil and a combination of surface and subsurface soil, as is outlined in the accompanying bulleted items on Page 5-47. The text initially leads the reviewer to conclude that all exposures are based on a combined data set of surface and subsurface soil only.	The text will be modified to point out that for the on-site rural residents, direct contact exposures were calculated for both surface soil only and a combination of surface/subsurface soil.	Comment has been addressed per ET's response.	

Comment #	Section	Comment (EPA/IDEM as indicated in comment number)	Original Response to Comment (ET)	MW Revised Response (if applicable)	Agency Concur
EPA155	05.1	31. **Page 5-46, Section 5.1.4.6.2, Site-Specific Conceptual Site Models: On-Site Rural Residents -** The text indicates that future residents were assumed to install groundwater supply wells at each site where monitoring wells currently exist. It is unclear whether there are developable areas at any sites where monitoring wells do not exist. If this is the case, it should be presented within the text. It may then be explained that exposures from these areas may draw upon conclusions from nearby or upgradient areas which are assumed to be closer to potential source areas and thus represent a more conservative basis for the risk assessment.	The text will be modified to indicate that at sites where monitoring wells do not exist the groundwater exposure pathways were not quantified. This uncertainty will be addressed in the uncertainty section.	Comment has been addressed per ET's response.	
EPA156	05.1	32. **Page 5-47, Section 5.1.4.6.2, Site-Specific Conceptual Site Models: On-Site Rural Residents -** Please see General Comment No. 5 and previous comments on the relevance of VOC emissions from groundwater to ambient air and indoor areas.	See response to General Comment 5 (EPA120).	No additional comment necessary.	
EPA157	05.1	33. **Page 5-51, Section 5.1.5, Exposure Assessment:** An environmental transport mechanism is not a necessity for a complete or potentially complete exposure pathway, however, a receptor population is. An exposure pathway must consist at a minimum of the following four basic factors: a source or mechanism of pollutant release to the environment, a potential point of contact, a route of exposure and a receptor population. The risk assessment should be revised to reflect this more accurate statement.	The text in Section 5.1.5 will be modified as requested.	Comment has been addressed per ET's response.	
EPA158	05.1	34. **Page 5-59, Section 5.1.5.2.9, Bioaccumulation in Beef:** This section addresses cattle being raised on or off the facility. Earlier sections of the risk assessment deal only with cattle raised off-site but fed on-site grown crops. The risk assessment should present the future potential land use assumptions. It is unclear whether on-site livestock farming is a future potential land use. Cattle raised on-site may ingest site-related contamination from media apart from contaminated crops, including ingestion of soil, ingestion of contaminated groundwater (if used as a watering source) and ingestion if contaminated forage. These issues affect predicted beef and milk concentrations. Currently, the risk assessment only addresses contaminant intake associated with cattle ingesting contaminated crops.	See response to General Comment 5 (EPA120).	No additional response necessary.	
EPA159	05.1	35. **Page 5-62, Section 5.1.5.3.1, Inhalation of Contaminated Air:** This section addresses contaminant air concentrations but does not address ambient or indoor air VOC concentrations attributable to impacted shallow groundwater. Please see previous comments and General Comment No. 5.	See response to General Comment 5 (EPA120).	No additional response necessary.	
EPA162	05.1	38. **Page 5-68, Section 5.1.5.3.3, Skin Surface Area Available for Contact:** Adolescent trespassers are assumed to have a skin surface area of 1,333 cm^2 available for contact with impacted soil or sediments. This value accounts for the hands and forearms only. It is more appropriate to account for the exposed skin of the feet and a percentage of the exposed skin of the lower leg. The authors are invited to select another appropriate value from U.S. EPA's Exposure Factors Handbook (U.S. EPA 1997).	The revised risk assessment will address an increased skin surface area to include lower legs.	The exposed skin of the feet is not included in the revised skin surface area (per Final Meeting Minutes, June 16-17, 1999); comment addressed accordingly.	
EPA163	05.1	39. **Page 5-72, Section 5.1.5.3.5, Dermal Contact with Groundwater: Chemical-Specific Normalized Dermal Permeability Constant -** The text cites U.S. EPA Risk Assessment Guidance for Superfund (RAGS) (1989) as the source for applying the default value for water (8.4E-04 cm/hr) as the permeability constant for inorganic analytes. However, U.S. EPA's 1992 Dermal Exposure Assessment: Principles and Application Guidance actually provides the default permeability coefficient of 1.0E-03 as a recommended value. It is suggested that this default value be applied for inorganic analytes, as it is obtained from dermal-specific guidance.	The value of 8.0E-04 cm/hr was presented in the approved HHRAWP. Dermal contact with groundwater is not a significant exposure pathway and this change would result only in a small increase (20%) in the risks calculated for this pathway and approximately a 1% increase in the overall risk/hazard associated with exposure to groundwater via all pathways. Therefore, no change is proposed since the risk assessment conclusions would remain the same.	Comment has been addressed per EPA's comments on initial Response to Comment Table (5/26/1999).	
EPA164	05.1	40. **Page 5-78 and 5-79, Section 5.1.5.3.7, Exposure Time and Table 5-18:** The exposure time for surface water exposures presented for current adolescent trespassers and future hunters is given as 0.25 hr/day. Given the habits of adolescent trespassers to frequent biologically rich areas such as wetland and waterway borders and the frequency with which hunters travel in these same areas, 15 minutes per day does not seem an appropriately conservative estimate. The authors should propose additional (longer) exposure times for contact with surface water and provide reference for such appropriate values.	The 15-minute exposure time for surface water contact was presented in the approved HHRAWP and, therefore, was used in the assessment. In addition, exposure to surface water was evaluated in the risk assessment for only one surface water body—the pond at an abandoned quarry at Sites 9/10 (all chemicals detected in Harberts Creek surface water screened out). There were no carcinogenic COPCs in the pond surface water , and the total HI associated with pond surface water exposure was <0.005 for both the child and the adult, and < 0.0001 for the hunter. Therefore, modifying the exposure time would not have a significant impact on the risk assessment.	No response necessary.	
EPA165	05.1	41. **Page 5-81, Section 5.1.5.3.10, Dermal Contact with Contaminated Sediment:** Sediment to skin adherence factor (AF) values are assumed within the risk assessment to be the same as those used for soil. However, it is reasonable to assume that sediment adherence factors would be significantly greater than those associated with dry soil. The risk assessment should be revised to include additional AF values reflective of sediment contact. These values should be accompanied by appropriate references.	The sediment-to-skin adherence factor used in the assessment is the value proposed in the approved HHRAWP.	Comment has been addressed per Final Meeting Minutes (June 16 and 17, 1999).	

Comment #	Section	Comment (EPA/IDEM as indicated in comment number)	Original Response to Comment (ET)	MW Revised Response (if applicable)	Agency Concur
EPA166	05.1	42. **Page 5-85, Section 5.1.5.3.12, Ingestion of Contaminated Beef:** Please see previous comments associated with the sequestration of contaminants in beef. Please see General Comment No. 5.	See response to General Comment 5 (EPA120).	No additional response necessary.	
EPA167	05.1	43. **Page 5-87, Section 5.1.5.3.13, Ingestion of Contaminated Milk:** Please see previous comments associated with the sequestration of contaminants in beef and milk. Please see General Comment No. 5.	See response to General Comment 5 (EPA120).	No additional response necessary.	
EPA168	05.1	44. **Page 5-89, Section 5.1.6.2, Non-Carcinogenic Chemicals of Potential Concern:** Language provided in this section of the report should be revised to excise subjectivity and outline the inherent uncertainty associated with toxicological studies and resultant toxicity criteria. Toxicological criteria, like a reference dose (RfD), is considered a safe level for even sensitive receptors within the population at large. It is not "guaranteed to be safe for everyone."	The text in Section 5.1.6.2 will be revised as requested and "guaranteed to be safe for everyone" will be deleted.	Language removed as requested.	
EPA169	05.1	45. **Page 5-90, Section 5.1.6.2, Non-Carcinogenic Chemicals of Potential Concern:** Route to route extrapolation from oral toxicity criteria in the derivation of dermal toxicity criteria to evaluate dermal contact exposures cannot be supported for contaminants which exhibit a direct toxic effect in the skin. Noncarcinogenic COPCs: the exclusion of liver toxicity as an indication of systemic toxicity is not appropriate. While the dose-response for liver effects may differ between the oral and dermal pathways, the exclusion of GI and liver effects as endpoints for evaluating toxicity from the dermal pathway is not acceptable. The impact of this statement on the risk assessment needs to be discussed.	We disagree with the reviewer's comment. From a toxicological point of view, the delivered dose to the liver and the gastrointestinal tract is considerably different for the oral and dermal routes of exposure. The derived health criteria for effects on these tissues by the oral route are based on this delivered dose (i.e., a more bolus dose versus a uniform dose). This observation will be addressed in the uncertainty section.	Comment has been addressed per EPA's comments on initial Response to Comment Table (5/26/1999).	
EPA148	05.1 Figure 5-3	24. **Page 5-43, Section 5.1.4.6.1, Facility-Wide Conceptual Site Model: Future Land Use Scenario: Residents -** If impacted shallow groundwater is assumed to underlie residential homes, exposures due to inhalation of VOCs volatilizing to ambient air and inside homes must be considered. Although this section outlines potential inhalation of VOCs arising from subsurface soil for this receptor population, this exposure pathway is not presented in Figure 5-3, the Facility-Wide Conceptual Site Model.	See response to General Comment 5 (EPA120). Figure 5-3 will be modified to include VOC emissions from soil.	Figure has been modified as requested.	
EPA171	05.1	47. **Page 5-97, Section 5.1.6.3.1, Toxicity Equivalency Factors (TEF):** The polynuclear aromatic hydrocarbons (PAH) do not meet the requirements for the TEF as applied to the dioxins. Instead, U.S. EPA applies relative potency factors (RPF) to the carcinogenic PAHs based on the toxicity of benzo(a)pyrene (BaP). The TEFs used in this section for the PAHs are equivalent to the U.S. EPA RPFs, but the authors should refer to U.S. EPA's <u>Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons</u> (1993) for the methodology supporting the RPFs for the carcinogenic PAHs.	Comment noted.	No response necessary.	
EPA184	05.2	1. **Section 5.2, Detailed Ecological Risk Assessment Background and Program Status, Page 5-109, Paragraph 1:** The text states that "Due to the rapid transition under BRAC towards privatization, many of the Areas south of the Firing Line, which had originally been planned for ecological studies, have since been plowed and planted in food crops. For this reason, no habitat maps are included as part of the DERA." It is understood that there may be physical alterations to certain areas of the site, but it is not clear how an ecological risk assessment can be conducted if all habitats are being eliminated as part of the closure plan. Many of the sites included in this DERA appear to have current viable habitats that were assessed. Habitat maps are considered an essential part of the ecological risk assessment process and should be included as documentation of the habitats that were evaluated at the time of base closure. These figures may also assist in making risk management decisions associated with remedial alternatives. It is recommended that habitat figures that document the general habitat conditions be considered for all sites, especially those that include unique or sensitive habitats.	The DERA is required regardless of the BRAC transition and the loss of habitat occurring at JPG south of the Firing Line. It is the Army's position that habitat maps for JPG south of the Firing Line are of limited value when the habitats are in such an accelerated state of transition into cropland. A statement will be added to Section 5.2 (page 5-109) that references a U.S. Fish & Wildlife Service letter to the U.S. Army regarding the presence of Federally-listed species or habitat within the cantonment area of JPG.	Comment addressed per ET's response. The U.S. Fish and Wildlife letter is included in Appendix Z.	
EPA185	05.2	2. **Section 5.2.4.2, Characterization of Ecological Effects, Page 5-113, Paragraph 2:** The text states that tissue sampling was not conducted since "the JPG contaminants typically are not bioaccumulative." The statement is not clear since many of the BCFs used in the exposure assessment component of this report indicate fairly elevated bioaccumulation. In addition, for several of the COPCs (i.e., mercury, cadmium, lead) ecotoxicological studies in literature indicate that these compounds do bioaccumulate in certain species. The statement should be revised or removed.	Tissue sampling was not performed; this was agreed upon by the BTAG (Rust E&I 1997f, 1997h). As a matter of technical information, standard definitions for a BCF indicate this only refers to the uptake of chemical from water and typically applies to aquatic animals; a BCF demonstrates bioconcentration, not bioaccumulation. The term BAF is more general, and is used for uptake from food and water. A high BCF for an aquatic animal does not necessarily mean that terrestrial animals will also exhibit contaminant uptake and accumulation. For example, mercury BCFs in fish range from about 4 to 3400, whereas in terrestrial animals, mercury BAFs range from 0.1 to 7.7 due to the different fate processes in sediments versus soils (RI Report, Rust E&I 1998). The bioaccumulation potential was addressed in the DERA by modeling the dietary pathway.	Comment has been addressed per Final Meeting Minutes (June 16 and 17, 1999).	

Comment #	Section	Comment (EPA/IDEM as indicated in comment number)	Original Response to Comment (ET)	MW Revised Response (if applicable)	Agency Concur
EPA186	05.2	3. **Section 5.2.5, Facility Habitats, Page 5-114, Paragraph 1:** The text states that a major portion of JPG is wooded and the remainder is open grassland. The document then list five primary habitats, but open grassland is not one of the five primary habitats (unless "Old Field" areas are considered open grassland). The U.S. Fish and Wildlife Service (FWS) indicates that grasslands are preferential breeding areas for the Henslow's sparrow (*Ammodramus henslowii)*, a species of Federal concern. The FWS indicates that the breeding population of this species within the airport area is the largest known within this species range. They recommend that open grassland areas be included as a primary habitat and documented on site habitat figures (also see Specific Comment No. 1).	The text will be revised accordingly to indicate that open grassland is included in the category of "Old Field". A substantial portion of the remaining open grassland has already been plowed and planted in agricultural crops. No such restrictions on grassland usage have been placed on the current lessee (and future owner).	Comment has been addressed per ET's response.	
EPA187	05.3	4. **Section 5.3.3.2.1, Data Incorporation - Incorporate Phase I, II and Interim Measures (IM) Confirmation Sampling Data into the DERA, Page 5-133, second bullet**: It is indicated that if a site had Interim Measures (IM) confirmation data, then those data were used in comparison to Phase I and Phase II results. It is stated that all IM surface soil data were evaluated regardless of depth. It was difficult to determine from the presentation what data were actually used to conduct the risk assessment or whether the depth of the surface soil samples used for each site were from depth that are related to ecological exposures. It is recommended that each section be revised to clarify the specific data used in the calculation of EPCs. Specific identification and locations of the samples should be presented for each of the eight DERA sites.	At the time of the draft RI submittal, the IM confirmation data were not segregated by depth or location since the maps and information provided by that contractor lacked sufficient detail. The IM data will be updated since IM data for Site 25 have recently been obtained. If the depths can be verified for the existing data, then this information will be provided in the next version of this report. The reviewer is referred to Tables 5-29 (page 5-110) and 5.3-4 (page 5-168), Figure 5.3-4 (page 5-154), and the individual site sections (Sections 8.7 (page 8-137), 10.7 (page 10-50), 12.7 (page 12-100), 17.7 (page 17-48), 20.7 (page 20-44), 22.7 (page 22-37), 31 (page 31-1) and 32 (page 32-1) for the data sets included for each site. The DERA utilized the very same surface soil, sediment, and surface water sample locations as shown in site figures for the human health risk assessment (HHRA) except that no soil depths greater than 2 feet were included. Since the RI report is already so voluminous, it was decided that any additional site figures with sampling locations other than the Fall 1997 Phase III ecological sampling locations would be redundant	Comment has been addressed per ET's response.	
EPA188	05.3	5. **Section 5.3.3.2.1, Data Incorporation - 5-134, Paragraph 2:** It is indicated that new analytical data for soils collected at the DERA study areas and reference areas co-located with biological field data were incorporated into the DERA. The text does not specifically reference the data tables and figures that were incorporated for determination of background conditions. It is recommended that this information be specified in this section.	The referenced paragraph was associated strictly with a comparison of Fall 1997 soil analytical data collected at the DERA terrestrial study sites (3/4, 9, 11, 14/15, 25, 28/29/39, and Cobbsfork, Rossmoyne, Avonburg reference areas) without comparison to the JPG Phase II background. This comparison had nothing to do with screening for COPCs. The text will be revised accordingly for clarity where appropriate.	Comment has been addressed per ET's response.	
EPA189	05.3	6. **Section 5.3.3.3.1, Reference Area Selection, Page 5-137, Terrestrial Ecosystem Reference Areas:** It is indicated that the selected reference areas are presumed to not be impacted by the Base activities. However, it is not clear how this presumption was made. Information has not been presented to indicate why the on-site areas selected for reference sites are considered unimpacted. It is of particular interest since all of the results indicate that there are no significant differences between sites with known sources and contaminants and these unimpacted sites. It is noted that the areas of the background samples may be near the end of the runway, near roadways, railways, or near drainages/discharges from other sites (difficult to interpret on the figure presented). It is recommended that the location and justification that the reference areas are representative of unimpacted areas be discussed or referenced in this section. In addition, it is not clear whether the sample locations used for chemical analyses were the same as the locations used for toxicity testing.	Additional clarification will be added to the text in Section 5.3.3.3.1 (page 5-136) that provides the justification for the choice of reference areas. It is noted that the background locations were selected with the concurrence of the regulatory agencies following a 1995 field visit to those locations. The last paragraph on page 5-138 states clearly that the same locations selected for earthworm and plant phytotoxicity testing were also used for soil collection for chemical analysis. Please also refer to the individual subsections on study design located on pages 5-138 through 5-139 for this information. The text on page 5-137 under Section 5.3.3.3.2 also clearly states that the studies were co-located with one another. In addition, each site map where DERA field studies were conducted shows the ecological sampling locations	Comment has been addressed per Final Meeting Minutes (June 16 and 17, 1999).	
EPA190	05.3	7. **Section 5.3.3.3.1, Reference Area Selection, Page 5-137, Aquatic Ecosystem Reference Areas:** It is stated that a section of Harberts Creek upstream of the Site 2/27 study area (apparently not impacted by the Base) was chosen as the aquatic reference area and sampled in the same manner as the study area. It is not clear what parameters were used to determine that the reference area should be comparable to the study site, or why the on-Base reference area is considered unimpacted. It is noted that the selected reference area may be impacted by other discharges from the base activities. It is recommended that justification and rationale for selection of the reference area be provided.	Additional text can be added to provide justification for the selection of the aquatic reference area. It is noted that the aquatic studies were proposed to assess the impacts of the Sewage Treatment Plant (Site 2/27) on Harberts Creek; therefore, any site upgradient of Site 2/27 would be considered unimpacted by effluent from that site.	Comment has been addressed per Final Meeting Minutes (June 16 and 17, 1999).	
EPA191	05.3	8. **Section 5.3.3.3.2, Terrestrial Field Studies to Support the DERA - In-Situ Earthworm Toxicity Testing, Page 5-138:** The text indicates that, except for manganese, only weak relationships were observed between earthworm mortality and any given COPC. The comparison of terrestrial field studies and COPCs with HQ exceedances is not specifically discussed within the individual DERA site sections. It is recommended that the COPCs with HQ exceedances be correlated to the field results in each of the individual sections.	Additional analysis will be performed as appropriate and edits made to the text for clarification.	Comment has been addressed per Final Meeting Minutes (June 16 and 17, 1999).	

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EPA192	05.3	9. **Section 5.3.3.3.2, Terrestrial Field Studies to Support the DERA- Plant Toxicity Testing, Page 5-139:** It is stated that pH and total organic carbon (TOC) are important parameters when interpreting earthworm and plant toxicity data. However, the individual sites do not discuss these parameters with regard to the comparability of the reference areas and whether there are any potential influences to the tests based on the pH and TOC. It is recommended that this information be specifically addressed when discussing each of the sites.	Additional analysis will be performed as appropriate and edits made to the text for clarification.	The additional comparisons for TOC and pH were performed as requested, and they are discussed in the Draft Final Report in the appropriate Site sections. A correlation matrix, as suggested in the June 1999 meeting by EarthTech, did not appear to be appropriate to address this comment.	
EPA193	05.3	10. **Section 5.3.3.3.3, Aquatic Field Studies to Support the DERA - Aquatic Macroinvertebrate Sampling of Harberts Creek, Page 5-141:** It is stated that diversity was to be calculated as identified in the DERA Work Plan, but these evaluations were deemed unnecessary following review of the overall risk assessment results. It is not clear what risk assessment results were reviewed to deem the diversity measure to be unnecessary or how it was determined that there were no significant differences in community structure without this information. The specific risk assessment results that were used to conclude that diversity measures were not necessary should be provided.	Diversity and community structure indices for the aquatic studies will be included in the next version of this report if the data allow, and if these indices provide more information than already provided in the RPB indices.	Community similarity indices were calculated for the aquatic studies according to the Rapid Bioassessment Protocols for Use in Streams and Rivers. A community loss index, which was calculated for the DERA, was also calculated.	
EPA194	05.3	11. **Section 5.3.4, Risk Characterization, Page 5-143:** The description for the risk characterization phase indicates that an HI or HQ above 1 for an ecological receptor may indicate the potential for risk and that additional field data collected would provide lines of evidence with which to describe and estimate risk. The individual DERA site sections include a discussion of HI and HQ exceedances but focus on the results of the field studies. It is recognized that the field studies may provide more representative site-specific conditions, however, these tests can also offer a high level of uncertainty. For example, it must be documented that the testing was done on soils that represent the exposure to the COPCs and that the comparison to reference areas that are documented to be unimpacted is essential to the proper interpretation of these results. It is recommended that the method for interpretation of the quantitative risk assessment results in addition to the field studies be presented in this section and applied to the site-specific risk characterization sections.	The risk characterization section will be revised to more clearly indicate that all lines of evidence were considered. Further documentation of the statistical evaluation and results at each site will be provided. In addition, a more in-depth uncertainty analysis will be included. These expanded discussions should address the reviewers' concern that testing occurred at sites that were representative of JPG exposure, and that HQs as well as field data were used as equal lines of evidence. Further detail will be added to the Risk Estimation and Risk Description sections for each site to show the comparisons.	The identified statistical evaluation for each site was not performed; however, lines of evidence were prepared.	
EPA119	5.1.4.4.4	**4. Quantitation Limits:** The methodology does not provide a transparent understanding of how quantitation limits were used within the risk assessment. The methodology makes a passing reference to practical quantitation limits (PQL), but never discusses their use within the document as a whole. CRLs are never defined within the risk assessment, but it has been assumed that these represent Contract Required Quantitation Limits (CRQL). CRLs are used within the document in determination of site-specific Chemicals of Potential Concern (COPC) lists as well as derivation of exposure point concentrations. CRQLs are not necessarily the lowest detectable levels achievable, but are rather levels that a Contract Laboratory Program (CLP) laboratory should routinely and reliably detect and quantify in a variety of sample matrices. A specific sample may require adjustments to the preparation or analytical method in order to be analyzed. In these cases the reported quantitation limit (QL) must in turn be adjusted. Therefore, Sample Quantitation Limits (SQL), not CRQLs are the QLs or interest for most samples. SQLs are mentioned on Page 5-19 in a discussion of the background soil concentrations, but the acronym is not defined earlier in the document. SQLs should be used in the derivation of EPCs and in comparison to screening levels for use in evaluating non-detect results. Because SQLs take into account sample characteristics, sample preparation, and analytical adjustments, these values are the most relevant QLs for evaluating non-detected chemicals.	Text will be added to Section 5.0 that details the specific use of the quantitation limits in the risk assessment, specifically regarding whether these are CRQLs or SQLs. Specific details will be added to Section 5.1.4.4.4, and the database sections for the sites will be edited to be consistent	Per the Final Meeting Minutes (June 16 and 17, 1999), text was added in Section 5.1.4.4.4 to clarify the acronyms CRLs, CRQL, and SQL. Final meeting minutes are included in Appendix FF.	
EPA3d	5.1.4.6.1	JPG has not evaluated all exposed, or potentially exposed populations that are typically addressed in a human health risk assessment. Potential exposure routes and receptor populations which are recommended by TechLaw for inclusion in the Draft RI Report are further discussed in General Comment 5 and Specific Comments 16 and 17 (among other specific comments).	Comment noted. See response to General Comment 5 (EPA120a) and Specific Comments 16 and 17 (EPA139 and 140, respectively).	With the exception of the construction worker and agricultural worker (i.e., farmer) quantitative risk estimates were prepared for all human receptors in each of the scenarios identified in the conceptual site model. Given the exposure parameter values used for the residential scenario, potential risks attributable to an on-site construction worker or an agricultural worker are no greater than the risk quantified for the on-site residential scenario. This is discussed in Section 5.0 of the Draft Final RI Report.	

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EPA30	06.4.3	4. **Section 6.4.3, Background Screening, Page 6-5:** The results for dioxins and furans are evaluated based on the relative amounts of lower and higher chlorinated congeners. The text does not discuss the degradation rates that were used to support the conclusion that the lower chlorinated congeners are comparable to anthropogenic background. Given the long period of operation of the incinerator (1941-1978), the residence times may have been long enough to create the current ratios of congeners. Provide additional discussion regarding the potential for these ratios to be associated with the incinerator operating period, rather than anthropogenic effects. In addition, discuss how the “anthropogenic background” sites were established. Describe the prevailing wind direction relative to the background sites and the incinerator, and include any applicable Wind Rose diagrams and/or modeling results.	Specific congener degradation rates were not considered in the background screening analysis. The qualitative (i.e., visual) comparison was made directly between all congener concentrations in the site samples and those in the background samples, not just the lower chlorinated congeners as stated in the comments. For the quantitative, statistical comparison, all congener data were converted to TCDD equivalents before analysis. If the incinerator contributed to the dioxin/furan concentrations at the site, a statistically significant increase in the congeners would be present irrespective of the degradation rates. It is unnecessary, therefore, to account for degradation rates in this type of analysis. Additional discussion will be provided in the text concerning this issue, as requested. The selection criteria for the “anthropogenic background” sites will also be added.	Text is added to refer the reader to Section 5.1.4.5.3 where the response to EPA 30 is noted in regard to how the background soil samples were selected. This background explanation is also added to Section 6.4.3. The conversion of dioxin concentrations to TCDD equivalents is mention in the uncertainty section of Section 6 (i.e., 6.6.3.3).	
IN13	07.2	**Section 7.2, Page 7-2:** Two additional incidents occurred at the Sewage Treatment Plan (Site 2) and Sewage Sludge Application Areas (Site 27) that should be documented in this section. First, mercury contamination was discovered and removed in the sewage treatment plant system in 1996. Second, planting and harvesting of tobacco occurred on environmentally contaminated Sites 2 and 27 in 1997. Subsequently, a Commissioner’s Order was issued by IDEM on October 31, 1997, preventing any movement of the tobacco until it had been determined, through scientific analysis, whether there had been uptake of contaminants. IDEM staff determined that uptake of heavy metals from the contaminated soil had occurred and determined the tobacco was disposed in an environmental safe and lawful manner. On April 20, 1998, the tobacco was disposed in an appropriate manner and IDEM staff considered the Commissioner’s Order to be satisfied.	The information discussed in this comment was not previously made available to the authors. Upon receipt, the referenced incidences will be incorporated into the discussion in Section 7.2, Previous Investigations.	Section 7.2: The text in this section has been revised to include a discussion of these incidents.	
EPA31	07.4	5. **Section 7.4.1.2, Rejected Results, Pages 7-10 through 7-11:** All of the PCB results were rejected for Sites 2 and 27. Section 7.1, Site Characteristics, states that “PCBs were also considered a potential contaminant at the sludge disposal areas because of their presence in sewage sludge at older treatment plants.” The rejected data creates a data gap. Discuss the potential for the release of PCBs to the environment from the sewage treatment plant and revise the recommendations for further investigation, as appropriate.	A data gap does not exist since Phase II samples were collected to replace the rejected results from Phase I. As stated in the text, only one compound (kepone) was rejected in one sample from Phase II. All PCB data were acceptable. Text will be reviewed for clarity on this issue.	Text is added per ET’s response.	
IN14	07.5.1	**Section 7.5.1, Page 7-28, Paragraph 2:** The text at the end of this paragraph states “(see Figure 7-2).” This should read “(see Figure 7-3).”	Reference in Section 7.5.1 will be corrected to “(see Figure 7-3).”	Comments addressed per ET’s response.	
EPA32	07.5.1	6. **Section 7.5.1, Surface Soils, Page 7-28, Paragraph 4:** This paragraph states that one sample near the satellite accumulation area contained 90 parts per million (ppm) TPH and 0.28 ppm DDD. These results indicate that the nature and extent of contamination in this area may not be completely defined. Discuss the data surrounding this area in more detail and revise the recommendations for further investigation, as appropriate.	Since neither the TPH or DDD concentrations exceeded cleanup standards and residential PRGs, additional sampling was not recommended. However, since the Phase I SVOC results were considered to be suspect, an additional sample was collected during Phase II at this location for SVOC analysis. No contaminants were detected in the Phase II sample. No further investigation is recommended.	Comments addressed per ET’s response.	
EPA200	07.7	17. **Section 7.7.5.1, Ecological Risk Assessment Summary, Aquatic Ecosystem, Page 7-101:** The summary states that as a result of the RBP, the aquatic habitat at Site 2 is not negatively impacted by former site activities and no further studies of the stream are recommended at this time. The conclusion is based solely on the results of the RBP. While the results of the RBP may be used to support a conclusion, they should also be considered as limited and should not be used as the sole source for determining potential impacts to the creek. In addition, the results of the RBP are highly dependent on the proper selection of locations used in the comparison. The summary is considered inadequate since it does not discuss the types of contamination that caused the exceedances of the HQ or the potential toxicity to aquatic organisms associated with these compounds. The summary should be revised to include a discussion of the results of the potential for adverse effects from the contaminants detected in the creek. In addition, it is not clear whether the nature and extent of contamination in Harberts Creek has been adequately documented. Only three downstream sediment samples were collected from the creek at a total distance of 150 feet downstream and were only analyzed for metals (some of these samples do not appear to have been analyzed for cyanide). Based on the review of the data for this site, it appears that additional sampling to document the nature and extent of contamination in the creek may be warranted.	Additional discussion concerning the potential effects associated with the COPCs will be provided in the next version of the report. The scope of the DERA was agreed upon by the BTAG and did not include additional analytical sampling of Harberts Creek.	Addition discussion is provided in Appendix FF.	

Comment #	Section	Comment (EPA/IDEM as indicated in comment number)	Original Response to Comment (ET)	MW Revised Response (if applicable)	Agency Concur
EPA196	07.7.3	13. **Section 7.7.3, Exposure and Ecological Effects Profile, Page 7-85:** The text presents the receptors for aquatic and terrestrial and their associated exposure pathways to be evaluated. The receptors and pathways appear to be adequate, however, it is not clear whether these exposure pathways were actually used in the quantification of risk. For example, the great blue heron exposure pathway is shown to include surface water and sediment ingestion, dietary ingestion of fish crayfish and aquatic plants, but the corresponding tables of Exposure Point Concentrations (Tables 7.7-2, 7.7-4, 7.7-6) do not include the concentrations for fish, crayfish, and aquatic plants. The text should clarify the exposure pathway that was calculated for each receptor. In addition, the conceptual site model for this area should indicate whether there is the potential for groundwater to discharge to surface water.	The text will be corrected to remove aquatic plants from the diet of the great blue heron. The risk estimates are correct, however. The BCFs for aquatic plants, invertebrates, fish or frogs are very limited (i.e., only cadmium, copper, lead, mercury, selenium, and zinc). If there are either no surface water data or BCFs for a particular COPC, then that dietary exposure cannot be estimated. A literature search remains ongoing for additional BAF/BCF data with which to update the dietary exposures. The text will be revised for clarity to identify what exposure pathways were evaluated, and the potential for groundwater exposure will be assessed.	Comment has been addressed per Final Meeting Minutes (June 16 and 17, 1999).	
EPA197	07.7.3.1	14. **Section 7.7.3.1, Selection of COPCs, Page 7-85:** The text lists the COPCs for surface water and sediment and references Tables 7.7-1 through 7.7-6. The tables referenced present exposure point concentrations for the selected COPCs, but does not indicate the value that the COPC compared to in order to be eliminated or retained. Thus, the process for the selection of COPCs is difficult to follow. It is recommended that the selection of ecological COPCs be documented as in Table 7-8 of the human health risk assessment.	Due to the length of the current document, all statistical comparisons of site concentrations versus JPG Phase II background for inorganics for COPC screening were provided in Appendix CC. The tables in the appendix indicate the basis for inclusion or exclusion of an analyte as a COPC. If an analyte was removed as a result of a central tendency comparison, then the mean concentrations of the analytes were the basis for the test. A conservative approach was maintained in that analytes were generally retained as COPCs when the number of samples or detected values was not optimal for statistical testing. The COPC screening generally followed recommendations provided in Region VIII technical guidance for this process and is detailed in Section 5.3.2.1 (page 5-118) of the DERA. The inclusion of tables such as those provided in the HHRA will be evaluated for usefulness and redundancy. The approach used for the HHRA differed from the process used for the DERA.	EarthTech explained in the June 1999 face to face meeting that a comparison to background was not made to select COPCs for surface water. Statistical comparisons to background that were performed for other media are provided in Appendix CC, and a reference to this particular comment was placed next to the reference to this appendix in the text to document this comment response, since no additional text was required. This was done instead of a statistical summary table.	
EPA198	07.7.3.2	15. **Section 7.7.3.2, Comparison of the Site Data to Reference Area Concentrations, Page 7-86:** The text states that a comparison of site soil concentrations was not performed due to time constraints. It is recommended that the text indicate how COPCs were selected for soil.	The text states that comparison of Phase I or II site data to reference areas was not done. As stated in the text, the Phase I and II data were collected during earlier sampling events, and often had a different analyte list; at many sites, there is no way to compare the older data to the current Phase III data. All site data collected during Phase III were compared to the reference area data collected during Phase III. To select COPCs at all locations, regardless of sampling event, the data were compared to the JPG Phase II background set. Note that analyte lists differed based on the sampling results and agreements made between the regulators and the Army. The statistical comparison to reference areas was performed as part of characterizing the DERA ecological study sites, and to identify potential biologically-significant differences that could affect the outcome of the ecological field sampling efforts. This will be more clearly stated in the text.	Statistical comparisons were not performed for site data (Phases I and II) versus reference soil area soil concentrations. However, risks based on the Phase I and II soil concentration data were compared to Cobbsfork, Rossmoyne, and Avonburg reference area sample data. These data were collected in 1997. Phase III data were not included in this comparison.	
EPA76b	08.1	This site does not appear to have the minimal 1 well up gradient and 3 wells down gradient required under RCRA. The groundwater data plotted in figures 8-3 and 8-4 never records 1 foot of difference in the groundwater. Is there enough data to make a "no further action" decision?	Due to identified hazards exceeding risk-based criteria associated with the groundwater at Sites 3 and 4, the "No Further Action" decision isn't feasible. At a minimum, restrictions on groundwater usage at these sites will be recommended. Sufficient data exists, however, to make remedial action decisions.	Additional wells were installed and discussion is included in Section 8.1	
EPA33	08.1	7. **Section 8.1, Site Characteristics, Page 8-2, Paragraph 3:** This paragraph states that monitoring well MW95-06 was installed directly downgradient of the landfill trench. While this monitoring well provides downgradient information for the Explosives Burn Area and Abandoned Landfill, it does not provide downgradient information for the New Burn Site (Figure 8-1, Well Locations and Figures 8-3 and 8-4, Groundwater Gradient Direction). It will be necessary to place a monitoring well downgradient of the New Burn Site to determine downgradient contaminant migration. Also, a second monitoring well may be required between the Landfill Trench and the Explosives Burning Area to determine if contamination is migrating from the Landfill Trench toward the Explosive Burning Area.	The collection of additional subsurface soils data would be warranted prior to recommending the installation of another monitoring well downgradient of the New Burn Site. These additional soils data could be provided during the remedial design phase for remedial action at Sites 3/4. No additional RI sampling is recommended. This issue should be addressed in the upcoming comment resolution meeting.	New downgradient wells were installed in 2001. Discussion was added to text.	
EPA199	07.7.3.3	16. **Section 7.7.3.3, Rapid Bioassessment of Harberts Creek, Page 7-86:** The text indicates that Rapid Bioassessment Procedures (RBP) of Harberts Creek were conducted to evaluated whether actual negative impacts (due to elevated concentration of COPCs) could be observed when compared to an unimpacted reference area. The rationale and justification for the selection of the impacted site and reference site is not discussed. The conclusions of the RBP cannot be assessed without this information. For example, Figure 7-1, Aquatic Sampling Locations for Site 2, shows that the RBP was conducted upstream of Site 2 (the STP outfall) in an area apparently unimpacted by the outfall. Figure 7.7-2, Aquatic Sampling Locations for Reference Sites, was upstream, on the Base, and appears to be near several sites that may have impacted the upstream area. It is recommended that the text indicate how and why the impacted and unimpacted locations were selected.	See response to specific comment No. 7 (EPA190).	Comment has been addressed per Final Meeting Minutes (June 16 and 17, 1999).	

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EPA34	08.3	8. **Section 8.3.1.3, Geoprobe Field Screening Survey, Page 8-12:** The last sentence refers the reader to Figure 8-1 for 22 probehole locations. However, Figure 8-5 should be the figure referenced.	The reference will be corrected to read "(Figure 8-5)."	Comments addressed per ET's response.	
EPA37	08.3.1.3	11. **Section 8.5.3.1, Geoprobe Field-Screening Survey, Page 8-75, Paragraph 1:** This paragraph states that "22 soil samples and 17 groundwater samples were collected from 22 probeholes." However, in Section 8.3.1.3, page 8-12, the text states "A total of 21 soil samples and 17 groundwater samples were collected from 22 probeholes." Clarify if 22 or 21 soil samples were collected and make the appropriate corrections to the text.	The 21 referenced in Section 8.3.1.3 on page 8-12 will be corrected to read 22.	Comments addressed per ET's response.	
EPA76a	08.3.1.4	7. **Section 8, Page 8-12, Section 8.3.1.4 Monitoring Wells:** In sentences 6 and 7, when reading this paragraph, a well was installed to the south of the burn area and was identified as being "up gradient." Two other wells were installed to the north of the burn area and identified as "down gradient." In fact, Figures 8-3 through 8-4, show the groundwater to be flowing to the west so none of these wells are up gradient or down gradient. They were installed lateral to the groundwater flow.	Paragraph will be revised. The original well locations were based on the fact that the glacial till groundwater flow is topographically controlled and the top of the bedrock surface slopes to the northeast. If the wells had been screened in the till as originally proposed, these statements would have been correct. Since the wells were screened in the Laural Dolomite, the flow is to the west.	Comments addressed per new information collected in 2001.	
EPA97	08.4.2	3. **Section 8.4.2 Data Quality Summary Sites 3 & 4 - Antimony, p. 8-24/25** Text and Table 8-1 indicate that antimony is not well characterized in the trench area. How will this data gap be addressed?	Several other metals detected in the trench area resulted in estimated human health hazards significantly exceeding the USEPA hazard index goal of 1. Additional antimony data would likely add to the overall hazard but would not likely impact the remedial action decision. Additional waste characterization would be required during the remedial design phase if treatment and disposal alternatives are selected.	Text has been added to Section 8.4.2 to address this comment.	
EPA35	08.5.2.1	9. **Section 8.5.2.1, Surface Soils, Page 8-71, Paragraph 2:** The last sentence of this paragraph states that ". . .either the compounds were completely combusted, degraded, or washed away. . ." The text should explain the theory regarding the contaminants being "washed away." It should include a discussion of the investigation/verification techniques used, such as collecting surface soil and/or sediment samples downslope from the site.	The sentence will be revised to simply state that "No explosive compounds were detected in any of the samples collected from the area suspected to be the former burning area." The unsupported theories of the washing away of contaminants will be removed.	Comments addressed per ET's response.	
EPA36	08.5.2.2	10. **Section 8.5.2.2, Borehole Soils, Page 8-72, Paragraph 1:** The first sentence states that solvent contamination (trichloroethene) was present in the subsurface. Revise the Draft RI Report to indicate concentrations of trichloroethene in the text at each subsurface interval. Also, the text refers the reader to Table 8-4 for organic contaminant concentrations. Table 8-4 contains metal concentrations in soil. Table 8-5 provides data for organics concentrations. This reference should be corrected.	The concentrations will be added to the text for each sample interval. Reference will be corrected.	Comments addressed per ET's response.	
EPA202	08.7	19. **Section 8.7.3, Exposure and Ecological Effects Profile, Page 8-138:** The text indicates that there are terrestrial exposure pathways expected for this site. However, based on review of the site description in Section 8.1, there appears to be a groundwater to surface water migration pathway. In addition, the land slopes toward Harberts Creek which may constitute an overland flow migration pathway. The potential for migration of COPCs into the creek has not been evaluated. It is recommended that surface water and sediment samples be collected from the creek and used in the DERA for this site.	If groundwater data are available for a site, and the potential for a pathway to the surface is apparent, those data will be incorporated into the DERA as a potential drinking water source for ecological receptors. Potential loading to streams will be modeled with a surface runoff equation; predicted concentrations will then be compared to TRVs to determine potential risks.	Additional sampling will be performed during the FS, if necessary, based on potential remedial options.	
EPA201	08.7.1 Figure 8.7-1	18. **Section 8.7.1, Ecological Site Description, Page 8-137:** the text states that the Explosive Burn Area and Abandoned Landfill consist of infrequently maintained grassland. It should be noted that the site appears to contain grassland habitats which may be used by the federal species of concern. Please refer to Specific Comment No. 3.	From an ecological standpoint, it is unfortunate that the leaseholder may plow all or most of the remaining old-field habitats referred to in this comment. At present, the area near the abandoned landfill is fenced, and the area has been left relatively undisturbed. A statement will be added to the site description in this section that refers to the grassland as potential habitat for the Henslow's sparrow. Please also refer to response to specific comment No. 6 (EPA189). The Henslow's sparrow is not a Federally listed T&E species, and the grassland habitat north of the Firing Line represents its preferred nesting habitat. The rapid change of habitats, as well as the future (now current) use, is the reason that habitat maps were not included in the DERA. It is also the reason that the DERA focuses mainly on receptors that can tolerate extensive human disturbance, such as mice, foxes, and rabbits. These agricultural activities are beyond the Army's control, and are what is to be expected when privatization of DOD facilities occurs.	No response needed.	

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EPA203	08.7.3	20. **Section 8.7.3, Exposure and Ecological Effects Profile, Page 8-138:** It is not clear what exposure point concentrations are used in the dietary exposure assessment for wildlife receptors. For example, Table 8.7-2, Summary of COPC Exposure Point Concentrations by Medium for Site 3, does not include concentrations for several of the food resources expected to be consumed by the wildlife receptors. This requires clarification.	The dietary concentrations are the product of the BAF or BCF for the receptor (Table 5.3-11, page 5-203) and the soil EPC. The dietary concentrations are presented in Table 7.7-2 (page 7-121); a zero appears in the cell if no BAF or BCF was available for that particular media/receptor combination. When only soil data were available at a site, only terrestrial dietary items contain values. When only surface water data were available, only the aquatic dietary items contain values. If both surface water and soil data were available, all types of dietary items potentially have values. Uptake into tissue was not predicted from sediment data since sediment-tissue partition coefficients are not readily available for many of the COPCs. These tables will be revised for clarity to reflect that the zero is due to either lack of a partition coefficient (BAF or BCF) or to lack of data for the particular exposure medium.	Appendix AA has been expanded to include the complete ecological risk assessment spreadsheets so that the reviewer can determine what the EPC was that was used to calculate a given risk estimate. In addition, the BAF and BCF data are provided in these spreadsheets as well. An explanation sheet has been included for Appendix AA to describe where this particular information can be found in these spreadsheets.	
IN15	09.8	**Section 9-8, Page 9-29, last Paragraph:** "Based on the human health and ecological risk assessment results, it is recommended that a No Further Action technical memorandum be prepared for Sites 5 and 6 that the site be removed from the RI/FS process." A technical memorandum for no further action for Sites 5 and 6 was produced in October 1998. Please update this section.	Text in Section 9.8 will be updated to read: "Based on the human health and ecological risk assessment results, a No Further Action technical memorandum for Sites 5 and 6 was produced in October 1998 for regulatory and public review so that these sites can be removed from the RI/FS process."	Text has been added to summarize the Decision Document, which was reviewed and approved by the agencies.	
EPA10	09.8	6. **Section 9.8, Page 9-29, Sites 5 and 6 - Wood Storage Pile and Wood Burning Area, Last Paragraph.** Please update this section. A Technical Memo for Sites 5 and 6 were submitted in August 1998, prior to our receipt of this Draft Phase II RI Report. Also, a public meeting was held in October 1998 for the "No Further Remedial Action Planned (NFRAP) Tech Memo and Draft Decision Document for NFRAP at Sites 5 and 6" in late October 1998.	Paragraph will be updated. It should be noted that due to ongoing BRAC reuse activities, the Phase II RI will never be 100 percent current.	Text in Section 9.8 has been updated (see response to comment IN15).	
IN16	10.1	**Section 10.1, Page 10-1, Paragraph 2:** It should be noted that the excavated soil was placed in roll-off boxes. One roll-off box was disposed as a special waste and one roll-off box was disposed as a hazardous waste. Additionally, one roll-off box exceeded the Resource Conservation and Recovery Act (RCRA) 90 day storage requirement.	This information will be incorporated into Section 10.1.	Comments addressed per ET's response.	
EPA98	10.4.2	4. **Section 10.4.2 Data Quality Summary Sites 7 & 21B, p. 10-17** Text states that no Phase II soil samples were analyzed for SVOCs nor metals. Why not? Considering that lead is a contaminant of concern at this area, how will this data gap be addressed?	Since the Site 7 area was scheduled for a removal action where lead-contaminated soils (and any other associated contaminants) were to be excavated and properly disposed of at an off-site disposal facility, additional RI sampling was not warranted. Confirmation sampling of the walls and floor of the excavated area was performed. Therefore, no data gap exists.	Comments addressed per ET's response.	
IN17	10.8	**Section 10.8, Page 10-58:** "Further investigation into the source of arsenic in groundwater may be warranted." The arsenic at this site is up to 13 times background and far exceeds the EPA Region 9 PRGs. Additionally, results indicate that carcinogenic risk and chronic health hazard estimates exceed EPA risk management criteria due almost entirely to ingestion of arsenic in groundwater. Further investigation into the source of arsenic is definitely necessary at this site.	Arsenic concentrations detected in the sampled Red Lead Disposal Area (Site 7) wells ranged from 16.8 ug/L to 32.4 ug/L. These concentrations are notably higher than those detected in background wells (2.6 ug/L) although they are within the range of natural concentrations commonly observed in groundwater. These natural concentrations range from < 1.0 ug/L to 30 ug/L (Dragun 1988). The higher arsenic concentrations in Site 7 monitoring wells may be the result of man-induced changes in the natural environment and site contamination. It may also be the result of different geological environments of the two sites. All the Site 7 wells are screened at the contact between glacial till and Laurel Dolomite. Background wells are screened in Louisville Limestone or at the contact between glacial till and Louisville Limestone. Background well MW-93-7 is screened in Laurel Dolomite like Site 7 wells. However, unlike Site 7, Laurel Dolomite in that area is covered by Waldron Shale. That may constitute a significantly different hydrogeochemical environment. Percolating through glacial till water may be more acidic than groundwater migrating through carbonate rocks. If an acidic solution enters soils containing a relatively high background concentration of arsenic in soil minerals, a mineral dissolution can result in elevated arsenic concentrations in groundwater (Dragun 1988). Periodical recharge of a bedrock aquifer by percolating through the glacial till water may create pulses of elevated concentrations. Arsenic concentrations will be monitored, and comparisons between Site 7 and background wells will be periodically made and interpreted.	Text has been added to say that arsenic concentrations will continue to be monitored and compared to background levels. Additional studies of the possible source of arsenic in groundwater and potential remedial technologies will be evaluated as part of the FS.	

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EPA38	11.3.1	12. **Section 11.3.1, Phase I RI Field Activities, Page 11-2, Paragraph 2:** Include a short discussion of the asbestos results presented in the *Jefferson Proving Ground, South of the Firing Line, Final Asbestos Survey Report.*	A brief discussion of the asbestos results will be added to Section 11.3.1 as requested.	Comments addressed per ET's response.	
EPA174	11.3.3.7, 11.4.4, 11.8, and Figure 11-2.	50. **Page 11-11, Section 11.8, Conclusions and Recommendations:** Site 8 has been recommended for NFA status pending the removal of sand and soils from bullet traps inside range and cleaning of concrete and inside steel surfaces. Confirmatory post-remediation samples results were not available at the time this determination was made and are not presented within the discussion of Site 8. Any subsequent revisions of this risk assessment should include the post remediation confirmatory sampling results to defend the selection of this site for no further action.	Data were just recently made available to the authors. The confirmatory results will be added to the revised report.	Confirmation sampling results are in the April 2000 Technical Memorandum, No Further Action is Planned at Site 8. Sampling locations are added to Figure 11-2 and a discussion is included throughout the Section.	
EPA172	11.5 Table 11-1	48. **Page 11-5, Section 11.5, Nature and Extent of Contamination:** This section reports cadmium as a COPC, yet none of the accompanying tables provide an indication that any wipe samples were ever analyzed for cadmium. Revise the tables to include results of cadmium analyses.	Cadmium was inadvertently omitted from the table and will be added in the revised report.	Comments addressed per ET's response.	
EPA173	11.5 Table 11-2	49. **Page 11-9, Section 11.5, Nature and Extent of Contamination:** Selenium is reported as having been detected in three surface soil samples from the Small Army Firing Range (Site 8) which exceeded it's screening criterion. Table 11-2 does not present any analytical results for selenium. Revise the risk assessment to resolve the discrepancy between the text and table.	Selenium was inadvertently omitted from the table and will be added in the revised report.	Comments addressed per ET's response.	
EPA13d	12.1	In Section 12.1 Site Characteristics, the text notes that 20 monitoring wells had been installed prior to 1993. This section does not include the screened intervals for each well or cross-sections using each of these wells. In addition, the logs for these wells are not provided in Appendix H.	A summary table will be provided showing Appendix H will be revised to contain the missing logs for wells installed by ESE. Information about other wells in this area installed by the facility or other contractors is unavailable. It should be noted that many of the early wells were abandoned prior to capping the landfill. Text has been added to this section which provides more detail on the earlier well installations.	Comments addressed per ET's response.	
EPA20	12.1	8. Section 12.0 does not include information about the potential depth of fill at the Gate 19 Landfill (Site 10). Given the number of wells drilled in the area including several within the fill area, any information about the volumes or depths of fill at the landfill should be discussed in the text.	A search for volumes or depths of fill at Site 10 will be conducted, and information will added as available.	No additional information is available to document the depth of fill materials at the Gate 19 Landfill.	
EPA39	12.1	13. **Section 12.1, Site Characteristics, Page 12-2, Paragraph 6:** The third sentence states that water level data from the 1993 series wells could not be combined with other monitoring wells because of the difference in screened interval depths. The screened intervals of the 1993 series wells should be provided to allow for a comparison between the two sets of wells.	Text has been added to this section which provides greater detail regarding earlier well installations. Appendix H will be revised to contain the missing logs for wells installed by ESE. Information about other wells in this area installed by the facility or other contractors is unavailable.	Comments addressed per ET's response.	
EPA204	12.1, Figure 2-1	21. **Section 12.1, Site Characteristics, Page 12-1, Paragraph 4:** The text indicates that surface water runoff appears to flow toward a small pond and the pond also receives runoff from a ditch that flows west along the Firing Line from as far away as Building 602. It also states that the pond discharges to the west via a drainage ditch and ultimately enters Middle Fork Creek and references Figure 2-1. The surface water pathway is not clearly documented on Figure 2-1 or any other figure found in this report. It is recommended that the surface water ecosystems be clearly presented .	Figure 2-1 will be revised to show the drainage of the pond to the perimeter fence, beyond which is private property. The area eventually drains into Middle Fork Creek to the northwest.	Comments addressed per ET's response.	
EPA205	12.3	22. **Section 12.3.1.4, Surface Water and Sediments, Page 12-16, Paragraph 1:** Surface water and sediment samples were collected from within the pond adjacent to the burning ground. It is also indicated that groundwater discharges into Middle Fork Creek along horizontal bedding planes and vertical fractures. It appears that the nature and extent of contamination associated with ecological receptors has not been adequately documented. It is recommended that Middle Fork Creek be included in the ecological risk assessment for this site. It is also recommended that the nature and extent of contamination associated with surface water migration and runoff and groundwater migration be evaluated and data included in the risk assessment.	The scope of the DERA was agreed upon by the BTAG and did not extend to including Middle Fork Creek, which does not course through JPG south of the Firing Line.	Sampling performed in 2001 indicated no organic contaminants were detected. Discussion added to text.	
EPA99	12.4	5. **Section 12.4.2 Data Quality Summary Sites 9 & 10, p. 12-24** Text states that all Phase I antimony soils results were rejected, and no analysis for antimony was performed on these sites' Phase II soil samples. However, Table 12-5 shows antimony values with an LT prefix. If these are Phase I data, why is there no indication in the table that all antimony data was rejected? If Phase II antimony data was not obtained, how will this data gap be addressed?	Unusable data (R coded) were discussed in detail in the text of Sections 6 through 27, but the qualifiers were not included in the summary data tables. The R codes assigned during the data validation process will be added to all summary analytical data tables in Sections 6 through 27. Please note that rejected data were not used during the risk assessment. Other metals detected for these sites resulted in estimated hazard indices exceeding the USEPA goal of 1. The addition of antimony would likely increase this exceedance but would not likely impact the final risk management decision. The potential impact of the lack of antimony data will be discussed in the uncertainty section.	Text has been added to refer to the reader to the uncertainty section in the human risk assessment (Section 5).	

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EPA206	12.4.3.3	23. **Section 12.4.3.3, Pond Surface Water, Page 12-29:** It is indicated that mercury was eliminated as a preliminary COPC since it was less than background in pond water. However, on Page 12-107, it is stated that "at this time no comparison to reference area conditions can be made since the Phase III reference area samples were all from terrestrial habitat." The text should specify what background site was used for the surface water and sediment comparison.	As mentioned in response to specific comment No. 14 above, the HHRA COPC screening was different from the DERA COPC screen (Section 5.3.2.1, page 5-118). No comparisons to background were made for the sediment or surface water due to schedule constraints. The COPCs in surface water will be compared to the AWQC or 1993 data collected by USACHPPM. Sediment COPCs will be compared to the sediment quality criteria (SQC) or other available screening benchmarks.	Comparison was made, and discussion was added to text.	
EPA40	12.5.6	14. **Section 12.5.6, Groundwater, Page 12-54, Paragraph 2:** The last sentence of this paragraph concludes that there is "fairly widespread solvent-related contamination" in groundwater. In order to better delineate where groundwater contamination exists, it would be helpful to provide one or more contaminant concentration maps for groundwater. Also see General Comment 1.	Additional contaminant distribution maps will be added as necessary. Emphasis will be placed on those contaminants that were identified as COPCs evaluated in the human health risk assessment.	Figure and discussion has been added per ET's response.	
EPA207a	12.7	24. **Section 12.7.5, Ecological Risk Assessment Summary, Page 12-109, first bullet:** The statement "Based on the ecological effects data, there are no adverse ecological effects at this site" is questioned since the data presented do not appear to support this statement. For example, sediment data show that manganese is significantly elevated in the pond. No information regarding the toxicity of the detected contaminants have been presented and it appears that the nature and extent of contamination has not been documented. Other bullets in this section rely solely on the field studies/toxicity test performed and do not adequately discuss the potential uncertainty associated with the results of these tests. Also see General Comments.	The whole purpose of risk assessment is not to define what COPCs are elevated in the environment, but to define what concentrations present a potential hazard to human health or the environment. Given this, it should be clear that merely because an element is elevated does not imply that there is a risk. Manganese sediment and surface water concentrations were compared to chronic surface water and sediment TRVs; the HI (sum of the sediment and surface water exposure pathway) for aquatic life was less than 10. Furthermore, the maximum sediment concentration was approximately that of the EPA NEC (Table 5.3-15, page 5-208). Major impacts to the aquatic ecosystem are not to be expected from these low risks based on chronic toxicity values.	The text was revised per EPA comments on initial Response to Comments Table (5/26/99). An attempt was made to address whether hazard indices greater than 1 were likely to present an ecological concern based on comparisons to reference area HIs. Another factor taken into account was the multiple lines of evidence evaluated for a particular assessment endpoint.	
EPA207b	12.7.2.4	It is noted that this area represents significant ecological habitats and aquatic resources are likely to have been impacted by the activities on the Base. It is recommended that additional sampling be conducted within the ecological exposure pathway and determinations be made regarding the need for identifying sources that are causing exceedances of the Ambient Water Quality Criteria and other sediment TRVs. This information may be needed for the FS and risk management decisions regarding remedial actions associated with this and other contributing sites.	The nature and extent of contamination is documented in 12.7.2 (page 12-100), where data for each phase are summarized by media along with the predicted concentrations in tissue. Furthermore, DERA ecological study site data are statistically compared to reference area data and the results discussed in this section. Further discussion of the statistical analyses will be provided along with data summaries for the site-specific toxicity tests and population evaluations. Uncertainty, however, is more appropriately discussed under the Uncertainty Analysis section (12.7.4.3, page 12-108) of the Risk Characterization. It is unclear what "See General Comments" refers to, since the site tests and HIs are discussed in 12.7.4.2 (page 12-106) and 12.7.5 (page 12-109). However, the statement that apparently was not clear to the reader will be revised to read "Based on the site-specific field data collected to document potential ecological effects....". Data gaps should have been identified during the work plan stage; comments regarding the need for additional aquatic sampling do not appear in EPA's comments on the work plan. However, an attempt will be made to link the COPCs in the pond to a terrestrial source and this effort will be documented.	Additional surface water and sediment sampling were collected in Middle Fork Creek and is discussed in Section 12.7.2.4.	
EPA79d	13.0 and 13.1.1	There seems to be a component of groundwater flowing to the north from the solvent pits, and there seems to be a lack of wells to the north of the buildings.	MW93-47, MW93-45, and MW96-1 are all located north of the solvent pit. Minor detections of 1,1,1-trichloroethane in MW93-45 and MW96-1 confirm that some contaminant migration has occurred to the north. The existing wells appear to be sufficient to monitor the northern component of flow. As the data indicate, however, the primary contaminant flow is to the south.	Comment addressed per ET's response.	

Comment #	Section	Comment (EPA/IDEM as indicated in comment number)	Original Response to Comment (ET)	MW Revised Response (if applicable)	Agency Concur
IN19 and EPA19	13.1 and 13.1.1.3	**Section 13.1.1.3, Pumping Test Results:** The drawdown cone should be plotted on a map, not just given as a tabular representation.	The requested information is presented in Appendix B. A reference to the appendix will be added to Section 13.1.1.3 as follows: "(see Appendix B, page 207)."	Comments addressed per ET's response.	
EPA14d	13.1	The plume shown in Figure 13-13 raises some questions based on its apparent movement to the southeast. Groundwater flow in the bedrock tends to be towards the west or northwest based on the potentiometric contour maps presented in Figures 13-6 and 13-7. A more detailed evaluation of the data should be conducted to provide an explanation for these discrepancies.	The potentiometric contour maps will be re-evaluated and revised as necessary. Text will be revised to provide additional interpretation concerning the apparent discrepancies. For all of the site-specific groundwater potentiometric contour maps, modifications will be made to consistently use 0.5-foot contour intervals. Consistent sets of maps will help in the comparison of hydraulic conditions between the sites. Some maps will not show any contours at all because gradients are so flat. Showing 0.2-foot or 0.1- foot intervals often create a confusing picture. The jagged picture reflects a "snapshot," changing configuration of a potentiometric surface. That configuration is influenced by a complicated pattern of laterally varying recharge rates (fractures in glacial till) that take place during discrete recharge events. Low porosity of bedrock formations and varying aperture of fractures result in laterally varying head distribution during recharge events, before heads equilibrate throughout the site. **This pattern of varying heads may obscure the picture of dominant-average gradient in areas of flat hydraulic gradients and close to a regional groundwater divide.** It is true that using data from a very small area does not help to discern the predominant direction of ground water flow. Groundwater flow in fractured rock is governed by hydraulics of individual fractures. Regional flow direction is apparent if the wells cover an area that is larger than a "representative elementary volume" (REV) for a given fractured medium. Analysis of a groundwater flow pattern at a smaller scale may reveal flow directions inconsistent with a larger scale picture. **The RUST (ET) interpretation of groundwater flow directions is based on all available information including a pattern of regional groundwater flow.**	A discussion has been added to Section 13.1.1 and subsections, describing interpreted groundwater flow.	
EPA21	13.1	9. The information provided on the underground storage tanks (USTs) at Site 12A (Section 13.0) does not clearly identify the status and background of each UST located at the site. Figure 13-1 identifies one tank as a former UST while the other tank is labeled simply as UST. Section 13.5.1.1, which describes the Geoprobe™ Field-Screening Survey, refers to many former USTs, but only describes a former 25,000-gallon fuel oil tank. Revise the text and figure to clarify the number and status of any existing or former USTs at Site 12A.	The text and figure will be revised to clarify the number and status of the former USTs at Site 12A.	Comments addressed per ET's response.	
EPA77	13.1 and 13.1.1	8. **Section 13, Page 13-2, Paragraph 2:** "Phase II wells. . .suggest groundwater flow is primarily to the southwest (see Figures 13-7). All these figures show ground water flow, from the solvent pit area of Building 602, to be flowing to both to the north and the south from the area of the solvent pit. Please explain this.	Explanations are presented in Section 13.1.1.2, page 13-20 for this phenomenon. As stated throughout the section, the groundwater flow directions appear to be variable and reflect seasonal variations. However, the statement that the primary flow direction is to the southwest remains valid.	The text of the section has been revised to include a more comprehensive discussion of groundwater flow.	
EPA81	13.1 and 13.3.2.3	7. **Page 13-20, Section 13.1.1.2:** This more detailed section indicates that a northwest flow for the bedrock aquifer is present, which is contrary to the statement provided in Section 13.1.1, Groundwater, which state that the flow is to the southwest. There is a lack of consistency in these statements. It appears that the plumb has not been delineated and more wells must be emplaced to further understand what is going on in both the perched aquifer and the bedrock aquifer.	Again, the statement in Section 13.1.1 was simply meant to convey that the primary flow direction is to the southwest, which is consistent to facility-wide and regional flow direction. Subsequent sections provide detailed descriptions of localized exceptions to this primary groundwater flow direction. Additional evaluation of existing well data will be performed and interpretations reevaluated before additional work is recommended. Any additional work would be conducted during the remedial design phase.	The text of the section has been revised to include a more comprehensive discussion of groundwater flow. Additional wells were installed and data collected in 2001.	
EPA80	13.1.1.2	6. **Page 13-2, Section 13.1.1:** Solvent contamination has been found in wells in both the perched and bedrock aquifers in directions which are lateral to the inferred direction of the groundwater flow for the perspective aquifer. Bedrock well, MW93-46, south east of the building is contaminated, yet, it is lateral to the inferred southwest groundwater flow. Also, bedrock well (MW 95-10), east of the building is also contaminated and it is up gradient of the groundwater flow. Contamination has been found as far out as well WP96-7 for the perched water table. This is down gradient for this groundwater flow.	As stated in the text, groundwater flow direction at this site is variable and the southeast and northern components are discussed in more detail in later sections. The statement that the primary groundwater flow direction is to the southwest remains valid.	Text has been added to Section 13.1.1.2	
EPA13f	13.3	Section 13.3.1, Phase I RI Field Activities, identifies the field activities completed during Phase I as collection of four surface soil samples, eight subsurface soil samples, and installation and sampling of four wells. The soil sample locations and sample intervals are not identified in the text. The borehole numbers (necessary for referencing the associated field logs and records in the appendices) were also absent from the text. Finally, the Geoprobe™ field screening survey was not described in this section.	Soil sample locations, sample intervals, borehole numbers, and a description of the Geoprobe™ field screening survey will be added to this section.	Text has been added to this section which references the Phase I RI Report.	

Comment #	Section	Comment (EPA/IDEM as indicated in comment number)	Original Response to Comment (ET)	MW Revised Response (if applicable)	Agency Concur
EPA13g	13.3.2.3 and 13.5.2	Section 13.3.2.3 states that four monitoring wells were installed at the top of bedrock, while one well was installed as a (deep) bedrock well. Table 13-6 contains data for all of these wells except for well MW96-7. If no contaminants were detected in this well, then that needs to be stated in the text.	A statement will be added to the text and table indicating that no contaminants were detected in well MW96-7.	Comments addressed per ET's response.	
EPA41	13.5.1.1 and Figure 13-13	15. **Section 13.5.1.1, Geoprobe™ Field-Screening Survey, Page 13-39:** The last sentence in this paragraph states that "the distribution of 1,1,1-trichloroethane contamination is illustrated in Figure 13-12." Figure 13-12 only depicts the data associated with the well points installed at Site 12A. Revise this section and Figure 13-12 to state that Figure 13-12 depicts only data from the well points. Also see General Comment 1.	An additional figure will be added showing the Phase I Geoprobe screening results.	Figure 13-13 has been added and referenced in Section 13.5.1.1.	
EPA43	13.5	17. **Section 13.5.1.1., Geoprobe™ Field-Screening Survey, Page 13-45, Paragraph 2:** The fourth sentence in this paragraph states "examination of the chromatograms reveal that the PH-07 compounds are from solvents, while those in PH-08 are primarily chlorinated compounds." Solvents may be chlorinated compounds (as is the case with TCE), therefore, it is unclear how the distinction was made between the PH-07 and PH-08 results. Revise the text to clarify this issue.	The referenced sentence will be deleted and the following sentence will be revised to state that "Examination of the chromatograms reveal that contamination in PH-07 is a combination of SVOCs from fuel oil and chlorinated solvents from the solvent pit, whereas those in PH-08 are chlorinated solvent compounds."	Comments addressed per ET's response.	
EPA44	13.5	18. **Section 13.5.2, Groundwater, Page 13-46:** The second paragraph refers to Table 13-2 for the results of the Phase I groundwater sampling results. However, Table 13-2 contains the pumping test results for Site 12A. Revise the text to reference the appropriate table.	The reference will be changed to Table 13-6 for Phase I groundwater sampling results.	Comments addressed per ET's response.	
EPA45	13.5.1.1 and 13.5.3	19. **Section 13.5.3, Summary of Contamination, Page 13-47:** The fourth sentence refers to Figure 13-12 for the perched groundwater results from the probeholes (installed during Phase I) at Site 12A. Figure 13-12 displays the results for VOCs in groundwater at the well point locations (installed during Phase II). Revise the text to reference the appropriate table or figure.	An additional figure will be added to show probehole results from Phase I.	Comments addressed per ET's response.	
IN20	13.5.1.1	**Section 13.5.1.1, Page 13-39:** This section mentions 18 Geoprobe borings and discusses the results, but does not contain a map to show where the samples were taken. Figure 13-12 is referenced, but does not contain the borehole locations. A map showing the borehole locations is necessary.	New Figure 13-12 showing the Geoprobe borings will be added to Section 13.5.1.1.	Comments addressed per ET's response.	
EPA14c	13.5.3	The conclusions for contaminant distribution in groundwater at Site 12A are also questionable. One conclusion is that ". . .a dense non-aqueous phase liquid (DNAPL) plume has formed in the glacial till groundwater above the bedrock." However, the only wells screened in the till are well points WP96-7, WP96-8, and WP96-26. There are several other monitoring wells at Site 12A screened across both the glacial till and bedrock, and a few of these wells contain chlorinated hydrocarbons. Therefore, based on the data presented, it is not clear whether the DNAPL is contained without the glacial till, or whether DNAPL has migrated into the bedrock.	The well points, screened entirely in the glacial till, contain DNAPLs supporting the interpretation of a DNAPL plume above the bedrock. The presence of DNAPLs in the wells screened in the bedrock may represent either the glacial till plume or a bedrock plume. As shown on the conceptual model (Figure 13-11), the hydrologic model is fairly complex. Clarification of both possibilities will be added.	Additional text has been added to Section 13.5.3. It should be noted that MWH has found no evidence to support existence of DNAPL in the existing site data, groundwater samples or in soil examined during soil excavation activities, particularly at the solvent pit sites (12A, 12B, and 12C).	
EPA14b	13.5.3	In order to provide JPG with an example of why the conclusions could not verified, Site 12A was reviewed in detail and several issues related to the conclusions for that section were found. The following points illustrate the problems associated with the current summaries: The Summary of Contamination section for Site 12A (Section 13.5.3) concluded that the soil contamination was limited to the shallow soils near the solvent pit. The Geoprobe™ field screening data collected from the solvent pit appears to contradict this conclusion based on the measurements of total VOCs in the range of 100 to over 1,000 ppb. The depths of these results were not identified and the media was not identified as soil or groundwater, however, the test suggests the contaminants were more likely chlorinated solvent compounds than BTEX compounds. The text also suggests that the solvent pit may be the source of these contaminants.	The limited extent refers to lateral migration and not vertical. The borehole soils adjacent to the solvent pit were contaminated from the surface to 22 feet. The lateral extent was confined to the immediate vicinity of the solvent pit based on surrounding probeholes that had nondetects the entire length of the boring. Additional information will be provided on the field screening results. These were presented in two previous reports and were not included in the draft Phase II RI. Reference to these two previous reports will also be added.	Additional text has been added to Section 13.5.3.	
IN21	13.8	**Section 13.8, Page 13-67, Last Paragraph:** "Sufficient data were collected during the Phase I and Phase II RI to evaluate potential cleanup technologies. Therefore, no further remedial investigation activities are warranted." This is contradicted by Section 13.5.1.1, Page 13-45, Paragraph one, which states . . .it was impossible to determine the southerly extent of contamination from the available data." Also, Figure 13-13, the contaminant distribution map, shows no data control for the contours east of WP96-21 and WP96-7. In these areas, the contours are guesses only, and need to be redrawn as dashed lines. It may be necessary to investigate further in the southwest section to adequately define the extent of contamination before preparing a remediation plan.	Section 13.5.11 is a discussion of the Phase I screening investigation, and the statement that the extent of contamination was not determined during Phase I is correct when taken in context. It is agreed that the figure should show some of the lines as dashed. The statement that sufficient data were collected to evaluate potential cleanup technologies is correct. However, as pointed out, further definition may be required during remedial design activities depending on the preferred remedial action alternative selected following completion of the FS.	Section 13.8 has been revised to say that sufficient data were collected during the Phase I and Phase II RI and the installation of new wells in 2001 to evaluate potential cleanup technologies. Additional data was also gathered during soil remediation activities performed in 2000. Therefore, no further remedial investigation activities are necessary at this time, but may be needed during remedial design activities.	

Comment #	Section	Comment (EPA/IDEM as indicated in comment number)	Original Response to Comment (ET)	MW Revised Response (if applicable)	Agency Concur
EPA82	14.1, 14.1.1, 14.1.2, 14.5.2, 14.5.3, and 14.5.4	8. **Section 14.1.1.2, Page 14-25:** Much can be said of site 617 and the changing nature of the flow of the bedrock aquifer. The wells with consistent contamination are MW93-39, MW93-40, MW95-01 and MW95-01, which are to the southwest, yet, the groundwater flow changes from the southwest to the southeast from map to map. There should be wells to the southeast that are contaminated as well, which should be recorded in this section.	Additional contaminant distribution maps will be added if required. The overall objective in preparing the draft Phase II RI Report was to provide representative examples of contaminant distribution for primary risk-driving contaminants of concern to keep the document to a manageable size while still providing sufficient information to base subsequent risk management decisions.	Additional discussion have been added in Sections 14.1.1, 14.5.2, 14.5.3, 14.5.4, and drawings. Additional wells and sampling were performed in 2001.	
EPA86	14.4, 15.4	3. In Sections 14.4.1 and 15.4.1, Data Validation Results, the text states that the CRL for MNBK exceeded the DQL. However, only the abbreviation of the compound name is presented. To ensure clarity in the report, revise the text throughout the Draft RI Report to include the full chemical name.	MNBK will be replaced with "methyl-N-butyl ketone" throughout the RI Report. Text will also be reviewed for the presence of other chemical abbreviations and, if found, will be replaced with the full chemical name as presented in Appendix N.	Comments addressed per ET's response.	
EPA47	14.5	21. **Section 14.5.2, Groundwater, Page 14-42, Paragraph 1:** The fourth sentence references Table 14-1 for Phase I groundwater sampling results. Table 14-1 contains groundwater elevation measurements only. Revise the text to reference the appropriate table.	Reference will be changed to Table 14-7	Comments addressed per ET's response.	
EPA48	14.5	22. **Section 14.5.2, Groundwater, Page 14-42:** This section references Table 14-1 for groundwater sampling results for VOCs. Table 14-1 only contains groundwater elevation data. Revise the text to reference the appropriate table or remove the reference.	Reference will be changed to Table 14-7.	Comments addressed per ET's response.	
IN22	14.8	**Section 14.8, Page 14-66, 1st Paragraph:** "A groundwater plume has migrated approximately 200 feet in a southerly direction." The plume is located mostly due west and to some extent to the southwest, according to the contaminant plume mapped on Figure 14-13.	As indicated on Figure 14-12, no contaminants were detected in temporary wellpoint WP96-11 to the west. Contaminants were detected in temporary wellpoint WP96-27 much further to the southwest. Hence the conclusion of a southerly flow.	Section 14.8 has been revised based on information obtained during the Phase I and Phase II RI, coupled with data obtained with new well installations in 2001.	
EPA83	15.1	9. **Section 15, Figures 15-4 through 15-7:** Again the bedrock groundwater potentiometric maps are showing southwest flow for the majority of the time, yet, there are two months (September and December) where groundwater flow is to the north. Section 15.1.1.1 states that interpretation of this phenomenon is unwarranted. Explain why these maps are included without a full explanation.	As stated in Section 15.1.1.1, the solvent contamination is primarily found in a single well screened in the Illinoisan till. No bedrock contamination has been detected. Additional study of the temporary change in flow direction was unwarranted since it would have no bearing on the conclusions and recommendations for remedial action management decisions.	No additional response necessary.	
EPA13i	15.3.2.3 and 15.5.2	Section 15.1.1 suggests that six well points were drilled at Site 12C. However, the text in Section 15.2 Previous Investigations, Section 15.3 Study Area Investigations, and Section 15.5, Nature and Extent of Contamination, does not discuss the installation of these well points.	A discussion of the installation of well points will be added.	Comments addressed per ET's response.	
EPA50	15.5	24. **Section 15.5.1, Soil, Page 15-38, Paragraph 2:** The groundwater data from two probeholes are presented in this paragraph, and a reference is made to Figure 15-11 for the distribution of 1,1,1-trichloroethane. However, Figure 15-11 presents the concentrations of VOCs detected in the temporary well points at Site 12C. Revise the text to reference the appropriate figure or remove the reference.	The reference for distribution of 1,1,1-TCE will be removed.	Comments addressed per ET's response.	
EPA49	15.5.1	23. **Section 15.5.1, Soil, Page 15-38, Paragraph 1:** The last sentence of this paragraph states that the probehole information is in Table 15-1. Table 15-1 only contains groundwater elevation data for the monitoring wells and well points. Additional data should be provided regarding the sampling locations, depths, and dates. Also, see General Comment 1.	An additional table and figure will be added to present the Phase I probehole results. This information was presented in detail in two previous documents and was omitted from the Phase II RI Report.	The text has been revised to reference probehole information included in Appendix G.	
EPA51	15.5.2	25. **Section 15.5.2, Groundwater, Page 15-38:** The second paragraph of this section states that no detections were found for the "two parent solvents." The introductory section for Site 12C states that trichloroethene was disposed of in the solvent pit but does not specifically name any other solvents. Identify the two parent solvents and provide any additional information about the nature of the solvents disposed of in the solvent pit. This information should be presented in the Site Characteristics section.	The "two parent solvents" will be deleted and replaced with the "the same solvents."	Comments addressed per ET's response.	
EPA52	15.5.2	26. **Section 15.5.2, Groundwater, Page 15-38:** One conclusion drawn in this section is that "groundwater contamination appears to be confined to the glacial till and the associated groundwater near the former solvent pit." The paragraph also suggests that there is poor communication between the till and bedrock groundwater based on a lack of detected contaminants in the bedrock well near the solvent pit. These conclusions do not appear to be substantiated by the data presented in Table 15-6. Although the bedrock well nearest the solvent pit had only a single detected concentration of TCE, a bedrock well southwest of the solvent pit had numerous detected concentrations of VOCs. In addition, Section 15.1.1.3.2, Bedrock Aquifer Test, notes clear evidence from the aquifer test that there is communication between groundwater in the till and groundwater in bedrock. Revise the conclusions in this section or provide additional discussion to resolve these discrepancies.	As stated, the conclusion of poor communication was based on the fact that concentrations of VOCs (up to 71,500 µg/L for 1,1,1-trichloroethane) were present in the till at MW88-15 but not detected in the bedrock wells immediately adjacent to and below MW88-15. Although some communication is indicated by the pump tests and minor contamination in other bedrock wells, it is the absence of high concentrations in bedrock wells adjacent to the Solvent Pit that led to the conclusion.	Section 15.5.2 has been revised.	

Comment #	Section	Comment (EPA/IDEM as indicated in comment number)	Original Response to Comment (ET)	MW Revised Response (if applicable)	Agency Concur
EPA100	16.4.2.1	6. **Section 16.4.2 Data Quality Summary Site 13, p. 16-15** Text states that all Phase I antimony soils results were rejected, and no analysis for antimony was performed on this site's Phase II soil samples. However, Table 16-3 shows antimony values with an LT prefix. If these are Phase I data, why is there no indication in the table that all antimony data was rejected? If Phase II antimony data was not obtained, how will this data gap be addressed?	See response to Volume IB, comment No. 5. The potential impact of the lack of antimony data will be evaluated in the uncertainty section of the human health risk assessment.	Confirmation sampling of residual soils during the removal action in 2000 met PRGs. Therefore, antimony has successfully been removed.	
IN23	16.8	**Section 16.8, Page 16-55**: The summation for Site 13 finds the only risk to be from metals in the soil. This is inadequate. As in many superficial risk evaluations, hydrocarbon contamination is not considered. Soils at this site tested up to 59,000 ppm (close to 6%) TPH. This is not only a potential health threat but possibly an immediate danger if ignited.	There are no human health criteria for TPH. Any PAHs detected in the soil were evaluated in the risk assessment. Potential ignitability is not a chemical risk assessment issue.	The removal action performed in 2000 is summarized in Section 16.8. Section 16.6 discusses that risk assessment calculations were not modified because of the successful removal action.	
EPA208	17.1, Figure 17-1	25. **Section 17.1, Site Characteristics, Page 17-1, Paragraph 2:** The text states that an intermittent drainage and a ditch receiving discharge from the site ultimately discharge into Middle Fork Creek, and the text references Figure 2-1. The surface water pathway cannot be discerned on the figure. The figure should be clarified to show surface water drainage pathways to Middle Fork Creek.	Figure 17-1 will be revised to show that the drainage continues into Middle Fork Creek to the northwest. Figure 2-1 cannot be revised since it is not available in an electronic format.	Figure 17-1 and 2-1 were revised to indicate surface water pathways.	
EPA53	17.3	27. **Section 17.3.3, Interim Measures Activities, Page 17-12, Paragraph 2:** The 24 SAIC confirmatory samples appear on Figure 17-5 (page 17-29). However, no map is available to indicate the location of the 43 soil samples. A map showing the locations of the 43 soil samples collected during excavation activities would aid the reader in determining contaminant distribution. Provide a map that shows the location of each of the 43 soil samples.	A map showing the excavation soil samples collected by Sverdrup will be added.	Comments addressed per ET's response.	
IN24	17.3.3	**Section 17.3.3, Page 17-12 1 st Paragraph:** The number and type of UXO discovered and excavated should be discussed in this section. The fact that additional anomalies were discovered in this area during UXO clearance, but not excavated, should also be added.	Discussion of UXO will be expanded in Section 17.3.3 as requested.	Comments addressed per ET's response.	
EPA209	17.3, Figure 17-1	26. **Section 17.3.1.3, Surface Water and Sediments, Page 17-11:** It is indicated that four sediment samples were collected during Phase I. However, the locations of these samples do not appear to have been presented on any of the corresponding figures in this section. It is recommended that sediment sample locations be presented on a figure.	Figure 17-1 (page 17-3) will be revised to show the sediment sampling locations.	Comments addressed per ET's response.	
IN25	17.5	Section 17.5.5, Page 17-25: This section reviews the data gathered from the Geoprobe investigation. Adequate locations are not given. A map showing the borehole locations is necessary.	New Figure 17-5, showing probehole locations, will be added to Section 17.5.5.	Comments addressed per ET's response.	
EPA54	17.5	28. **Section 17.5.1, Soil, Page 17-15:** A map showing the locations of Boreholes A through E would aid the reader in determining contaminant distribution. Revise the Draft RI Report to show these locations. Also, Table 17-3 (page 17-19) contains references to Borehole F. Revise the Draft RI Report to clarify whether an additional borehole (Borehole F) was drilled, but is not mentioned in Section 17.5.1.	A map showing the location of the Phase I boreholes and probeholes will be added. A reference to Borehole F will be added to the discussion in Section 17.5.1	Comments addressed per ET's response.	
EPA55	17.5.5	29. **Section 17.5.5, Geoprobe Field-Screening Survey, Page 17-25, Paragraph 1:** A map showing the locations of the five boreholes (YSA-PH01 through YSA-PH05) should be included.	The locations of the five boreholes—YSA-PH01 through YSA-PH05—will be added to Figure 17-1.	Comments addressed per ET's response.	
EPA210	17.7	27. **Section 17.7.5, Ecological Risk Assessment Summary, Page 17-56:** The text states that based on the ecological effects data, there are no adverse effects at the site. It appears that the Interim Measures may have been adequate to prevent unacceptable exposures to terrestrial receptors. However, the documentation of the nature and extent of contamination within the drainage pathway to Middle Fork Creek has not been adequate. Therefore it is not clear whether contamination in the sediment will result in a continuing source of contamination for the receiving surface water ecosystems. It is recommended that sediment (and surface water, if appropriate) samples be collected to document the contamination within the migration pathway associated with this site.	A reasonable attempt will be made to link the COPCs in soil prior to remedial activities to potential current concentrations in the sediment with a surface runoff/stream loading equation. This effort will be documented. Predicted concentrations in sediment will then be compared to sediment TRVs.	Modeling was not performed because surface water samples have been collected. This information is provided in Section 12 of the RI.	
IN26	17.8	**Section 17.8, Page 17-57:** Is a UXO clearance planned to address the presence of additional UXO in this area?	A statement will be added that additional UXO clearance of Site 14 will be included as part of the ongoing interim measures activities.	Section 17.8 has been revised to say that it is recommended that additional UXO clearance of Site 14 be included as part of the ongoing IM activities. Comments addressed per ET's response.	

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IN27	20.8	**Section 20.8, Page 20-53, Last Paragraph:** This paragraph should be updated to state the removal action was completed and a technical memorandum was submitted to the regulators in October 1998.	Please clarify. The Closure Report for Site 25 was not received by Rust E&I until December 1998. A draft Technical Memorandum for this site will likely be submitted for regulatory review in early February 1999.	Text has been updated with removal action information.	
EPA56	21.3.3	30. **Section 21.3.1.1, Surface Soils, Page 21-2:** Provide sample depth information to clarify the term "near-surface-soil samples."	The sample depth of 0-6 inches will be added to clarify the term near-surface.	Comments addressed per ET's response.	
EPA101	21.5.1	7. **Section 21.4.2 Data Quality Summary Site 26, p. 21-5/6** Text in Section 21.4.1 states that Phase I antimony soils results were not useable, and Table 21-1 has no antimony data, and seems to indicate that no analysis for antimony in soil was performed on this sites' confirmatory soil samples. If confirmatory soil antimony data was not obtained, how will this data gap be addressed?	The contaminated areas, based on the analysis of several other metals, were excavated and disposed of at an off-site facility. Confirmatory samples for all other metals show that residual metals are at or near background concentrations. If antimony contamination were present, removal would have occurred along with other metals-contaminated soils.	The comment was addressed in Section 21.5.1 indicating that the removal action performed also removed the antimony.	
EPA212	22.1	29. **Section 22.1, Site Characteristics:** It should be noted that the site description of this area indicates that it may be succeeding to an open grassland area that could attract the Henslow sparrow. It is recommended that the use of the area by potentially threatened species be addressed in the DERA.	As mentioned in response to specific comment No. 3 (EPA186) deed restrictions limiting use of the open grasslands have not been placed on the current lessor. Henslow's sparrow is not a listed T&E species.	Comment resolved per Final Meeting Minutes (June 16 and 17, 1999).	
EPA211	22.1, Figure 22.7-1	28. **Section 22.1, Site Characteristics, Page 22-1, Paragraph 1:** The text states that a surface water drainage is directed via ditches along the roadways to the south into Harberts Creek, which borders the mine test area (Site 39) on the south, and the text references Figure 2-1. The surface water pathway cannot be discerned on the figure. The figure should be clarified to show surface water drainage pathways from each of the sites to Harberts Creek.	Figure 22.7-1 (page 22-51) provides the requested information. As stated in response to specific comment No. 25 (EPA208), Figure 2-1 (page 2-3) cannot be revised.	Comment has been addressed per ET's response.	
IN28	22.1.1	**Section 22.1.1, Page 22-2, 1 st Paragraph:** This paragraph should mention the unresolved issue regarding the potential creation of a RCRA waste pile during interim removal actions.	Paragraph in Section 22.1.1 will be revised to include the requested information.	Comments addressed per ET's response.	
EPA57	22.4	31. **Section 22.4.3.1, Surface Soil, Page 22-13:** The statement "although the surface soil samples at this site were collected up to 1000 feet apart" does not easily lead to the conclusion that "there did not appear to be any hot spots of contamination." Explain how this conclusion was reached when soil samples were collected of up to 1,000 feet apart.	Sentence will be reworded to read: "None of the samples collected appear to represent a "hot spot". We agree that a firm conclusion cannot be reached from the available data. Both the fact that the same activity occurred throughout the entire area of this site and that the 95% UCL concentrations were similar to the maximum concentrations, suggest that the contamination in this area is more likely than not to be uniform. We believe our statement "there did not appear to be hot spots of contamination" is still valid.	Comment has been addressed per ET's response.	
EPA102	22.4	8. **Section 22.4.2 Data Quality Summary Sites 28, 29 & 39, p. 22-12.** Text states that Phase I antimony soils results were rejected, and no Phase II soil samples were analyzed for antimony. Table 22-3 for Site 28 has no antimony data, and seems to indicate that no analysis for antimony in soil was performed on this site's confirmatory soil samples. If confirmatory soil antimony data was not obtained, how will this data gap be addressed? For the other sites, since all soil antimony data is rejected, how will this data gap be addressed?	See response to comment 7 (EPA 101) above. For Site 39 the hazard indices for future residents may be underestimated due to the lack of antimony data. This uncertainty will be addressed in the uncertainty section of the risk assessment.	Section 22.4.2 has been revised to say that uncertainty involving the presence of antimony at Site 39 will be discussed further in the uncertainty section of the human risk assessment for the site.	
EPA213	22.7	30. **Section 22.7.3, Exposure and Ecological Effects Profile, Page 22-38:** It appears that Site 39 is adjacent to either a tributary to, or Harberts Creek. However, the exposure scenarios for Site 39 do not include aquatic receptors. Please clarify. It is apparent that there are no surface water or sediment data from Harberts Creek. It is recommended that sampling to address nature and extent of contamination and DERA activities be included for receptors in the creek.	The stream at this point is intermittent, and a bona fide aquatic community is not present. Data gaps should have been identified during the work plan stage; comments regarding the need for additional aquatic sampling do not appear in EPA's comments on the work plan. However, attempts will be made to link the COPCs in soil prior to remedial activities to potential current concentrations in the sediment with a surface runoff/stream loading equation and this effort will be documented. Predicted concentrations in sediment will then be compared to sediment toxicity benchmarks.	Modeling was not performed because surface water samples have been collected. A discussion of the aquatic habitat is included in the ecological risk assessment.	
EPA214	22.7	31. **Section 22.7.3.2, Comparison of Site Data to Reference Area Concentrations, Page 22-40:** The comparison of Phase II COPCs to reference areas is not referenced and the data used in this comparison cannot be verified.	Phase II COPCs were based on comparison to JPG Phase II background as were the Phase III data. The comparison referenced here is ambiguous as identified in response to specific comment No. 5 (EPA188).	Comparisons of site data to reference area concentrations were performed, but this is not related to screening for COPCs.	
EPA216	22.7	33. **Section 22.7.5, Ecological Risk Assessment Summary, Page 22-48:** The text states that based on the ecological effects data, there are no adverse effects at the site. It appears that the Interim Measures may have been adequate to prevent unacceptable exposures associated with Site 29, however, the documentation of the nature and extent of contamination within the surface water pathway for Harberts Creek has not been adequate. Therefore, it is not clear whether contamination in the sediment will result in a continuing source of contamination for the receiving surface water ecosystems. It is recommended that sediment and surface water samples be collected to document the contamination within the migration pathway associated with this site.	Data gaps should have been identified during the work plan stage; comments regarding the need for additional aquatic sampling do not appear in EPA's comments on the work plan. The stream at this point is intermittent, and a bona fide aquatic community is not present. However, attempts will be made to link the COPCs in soil prior to remedial activities to potential current concentrations in the sediment with a surface runoff/stream loading equation. This effort will be documented. Predicted concentrations in sediment will then be compared to sediment TRVs.	Harberts Creek was not sampled per agreement with USEPA, notes contained in Appendix FF.	

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EPA215	22.7.4.2	32. **Section 22.7.4, Risk Description, Page 22-45:** The text indicates that the Phase II data collected at Site 39 were intended to be representative of Sites 28 and 29. It is not clear how or why this assumption was made since this approach has not previously been discussed. Please clarify.	During discussions with the regulators concerning the scope of the DERA work plan, it was acknowledged that picking one of three locations at the Gator Z area would be sufficient to represent all three locations (which include 28 and 29). A statement to this effect will be added to the text of the report.	Text revised per Final Meeting Minutes (June 16 and 17, 1999).	
IN29	22.8	**Section 22.8, Page 22-49, Paragraph 2:** "Due to the cleanup of the pond and the reestablishment of the aquatic environment that existed in the pond prior to the removal action, it is concluded that no further investigation of Site 29 is warranted under the RI." IDEM staff agree with this statement, however, it should be stated that additional UXO clearance and removal may be necessary at this site.	The following statement will be added to Section 22.8: "However, additional UXO clearance and removal may be necessary at this site."	UXO clearance was performed and residual soils were tested. Results indicated soils met PRGs. (Draft Technical Memorandum UXO Soil Testing for the NE and SE Parcels, February 2002.)	
EPA58	23.1 Figure 23-1	32. **Section 23.1, Site Characteristics, Page 23-1, Paragraph 1:** Figure 23-1 does not indicate the location of Shed 11. Revise this figure to include Shed 11.	Shed 11 is shown in the figure but was not labeled. A label will be added.	Comments addressed per ET's response.	
EPA59	23.1	33. **Section 23.1, Site Characteristics, Page 23-1, Paragraph 4:** The statement "all cleaning agents were handled appropriately and containerized on site" does not indicate how this conclusion came about. Provide rationale or facts to back up the statement that all cleaning agents were handled appropriately and containerized on site given that Section 23.3.11 identified a "stained area."	Statement will be deleted and replaced with the following: "Site personnel placed waste solvents and oils in waste drums that when full, were picked up by the DRMO contractor for off-site disposal. Minor spillage reportedly occurred during handling of the drums (USEPA 1990)". These spills were cleaned as they occurred by wiping or picking up the stained materials. Laboratory data was collected by DRMO to support the spill cleanup results.	Comments addressed per ET's response.	
EPA60	23.3.1.1	34. **Section 23.3.1.1, Soil, Page 23-2:** Identify the rational for not sampling for volatile organic compounds. Section 23.1 (page 23-1, paragraph 1) identified the storage of stoddard solvents at Shed 11.	Text will be added stating that field screening with a photoionization detector (PID) was performed for all samples collected and based on the results, analysis for VOCs was determined to be not required.	Comments addressed per ET's response.	
EPA103	23.4.2	9. **Section 23.4.2 Data Quality Summary Site 31, p. 23-5** Text states that Phase I antimony soils results were rejected, and no Phase II soil samples were analyzed for antimony. Antimony soil contamination has not been characterized. How will this data gap be addressed?	The potential impact of the lack of antimony data will be addressed in the uncertainty section of the risk assessment.	Comments addressed per ET's response.	
IN30	23.8	**Section 23.8, Page 23-32, Last Paragraph:** The technical memorandum should include the rationale used to determine elevated manganese represents background conditions.	The requested discussion on background manganese will be included in Section 23.8 as recommended.	This is moot since manganese is no longer a risk driver and Section 23.8 has been revised accordingly.	
EPA175	23.8	51. **Page 23-32, Section 23.8, Conclusions and Recommendations:** For the future resident scenario at Site 31 (Building 227 Former Storage Pad), the hazard index for the child resident exceeds 1.0 at 1.7, primarily due to ingestion of manganese in home grown produce. Given the inherent conservatism associated with this future potential receptor population and the generally slight exceedance of the hazard criterion of 1.0, it does not appear likely that significant health impacts are of concern.	Comment noted.	Revised wording in Section 23.6.3.1.1 and 23.8 to address EPA comment.	
EPA61	24.3.1	35. **Section 24.3.1, Phase I RI Field Activities, Page 24-2:** Provide sample depth information to clarify the term "near-surface-soil samples."	The sample depth of 0-6 inches will be added as recommended.	Comments addressed per ET's response.	
EPA104	24.4.1.2	10. **Section 24.4.1.2-Rejected Results: Section 24.4.2-Data quality Summary Site 33, p. 24-5** Text states that Phase I antimony soils results were rejected, and no Phase II soil samples were analyzed for antimony. Antimony soil contamination has not been characterized. How will this data gap be addressed?	The potential impact of the lack of antimony data will be addressed in the uncertainty section of the risk assessment.	Confirmation sampling performed during the soil removal action in 2000 indicated residual soils met PRG. Therefore, antimony was removed.	
EPA62	25.3.1	36. **Section 25.3.1, Phase I RI Field Activities, Page 25-2, Paragraph 2:** Please provide sample depth information to clarify the term "near-surface-soil samples."	The sample depth of 0-6 inches will be added as recommended.	Comments addressed per ET's response.	
EPA105	25.4.2	11. **Section 25.4.2 Data Quality Summary Site 34, p. 25-5: Section 26.4.2-Data Quality Summary Site 38, p. 26-2:** Is antimony a potential C.O.C. for these sites? If so, a data gap exists due to rejected Phase I soil antimony data.	The potential impact of the lack of antimony data will be addressed in the uncertainty section of the risk assessment.	The comment has been addressed in Sections 25.4.2 and 26.4.2 indicating that the potential effect of rejecting the antimony results will be discussed further in the uncertainty section of the human risk assessment for the site.	

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EPA176	25.5.2 and Table 25-1	52. **Page 25-6, Section 25.5.2, Sand:** Although surface soil analytical data are presented in Table 25-1, it does not appear that data from the analysis of sand samples were reported in a similar table. Summary results are shown in Table 25-2. Data from the analysis of sand samples should have been presented in tabular format similar to the manner in which soil samples were reported for consistency within the evaluation of Site 34 (Building 136 Sandblasting Area).	Sand results will be added as requested.	Sand results were added to Table 25-1.	
EPA63	26.3	37. **Section 26.3.2, Phase II RI Field Activities, Page 25-2, Paragraph 2:** Justify the conclusion that one surface soil composite sample can adequately characterize an area with dimensions of "approximately 150 feet wide and several hundred feet long." A surface soil sampling program utilizing a grid pattern with regular interval samples would provide more representative site characterization. Also, using grab samples rather than composite samples would better define low concentrations and the distribution of contamination.	Agreement was reached with USEPA and IDEM during the planning of Phase II field investigations that further sampling under the RI/FS was not required at Site 38. As noted in Section 26.3.2 (on page 26-2), the potential UXO areas were evaluated further under a separate Army program. A future Technical Memorandum for No Further Action is Planned will incorporate the findings of the additional UXO evaluation under the different program. As a result, no further investigation under the RI/FS is planned.	Comments addressed per ET's response.	
EPA106	27.1 and throughout entire section	12. **Section 27.1 Site Characteristics Site 43, p. 27-1:** Text states that confirmatory sample data were not yet available; is there a projected date for this data and report to be submitted?	A draft report was just received from the contractor conducting the decontamination work at Site 42. A summary of the results will be presented in the next revision of this document.	Comments addressed per ET's response.	
IN31	28.3	**Section 28.3, Page 28-22, Paragraph 2:** "For the current facility-wide trespasser, estimates of chronic health hazards indicate that there are no hazards that exceed risk management criteria." This may be true, but the risks of UXO still remain and should be mentioned.	The potential for encountering potential UXO will be mentioned as requested. A paragraph will be added as follows: "The facility-wide trespasser or hunter could come in contact with UXO. However, the Army conducted an archive search report, which identified areas of potential UXO concerns. These areas are being cleared to a 4-foot depth as agreed upon by the Army. Other areas in which UXO are discovered by either Interim Removal Actions, frost heave, or accidental discovery will be handled by the Army on a site- by-site basis and will include access restrictions. The Army intends to handle its responsibility with regards to UXO issues as they arise. Deed restrictions will also be included in future land transfer in relation to UXO concerns. These deed restrictions will be incorporated in the FOST and land transfer deed documents.	No additional response necessary.	
EPA217	32.0	34. **Section 32.0, Terrestrial Reference Areas and JPG Phase II Background:** The text provides a brief area description for the selected reference areas. However, there are three selected reference areas in apparently different locations on the Base. It is not clear which of the areas are being described in the text provided. In addition, the text does not provide any information regarding why these areas are considered unimpacted by Base activities. The text should be revised as indicated in Specific Comment Nos. 5 and 6.	A reference to Figure 5-1 (page 5-9), which shows the JPG background sample locations, will be added to Sections 5.3.2.1.1 (page 5-118) and 32 (page 32-1). The text will be revised for clarity. Further documentation of the selection process for the reference areas will be provided, along with statistical comparisons to background to ascertain that the reference areas are indeed unimpacted.	Statistical comparisons to background to ascertain the reference areas are impacted were not performed.	
EPA218	32.3	35. **Section 32.3.1, Selection of COPCs, Page 32-2:** The text indicates that the reference area data were used to document risks to the receptors due to exposure to naturally occurring inorganics. The results are presumed to represent the adverse effects to the test species when exposed to naturally occurring or unimpacted concentrations of inorganic compounds. However, sampling and analyses data of anthropogenic contaminants (pesticides, dioxins, etc) to characterize exposure to the test species have not been presented. Therefore, it is not clear whether the results of the reference area tests can be used to represent inherent risks from naturally occurring inorganics. The text should be revised as indicated in General Comment No. 4.	If there are no statistically significant differences associated with the effects data, then no apparent site-related effects are expected to occur whether due to organics or inorganics.	Comment addressed per Final Meeting Minutes (June 16 and 17, 1999).	

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IN32	App B	**Appendix B, Page 181, Aquifer Tests:** This gives the results for observation well MW96-01 during a pump test of well MW93-46. The drawdown results for this well are very unusual. Drawdown continued for about twelve hours after pumping stopped and the well did not completely recover after five days. This is particularly unusual as this well is screened about twenty-five feet deeper than the pumping well. Please explain.	Monitoring well MW96-01 is about 100 feet NW of the pumping well MW93-46. It is slightly down gradient relative to the pumping well in vertical direction. The NW - SE orientation of the distance between these wells coincides with the orientation of one of the major two fracture sets (as inferred from radial plots of root K). MW96-01 is completed in Louisville Limestone, thirty feet below MW93-46, which in turn is completed in Jeffersonville Limestone. Aquifer test data reveal some hydraulic resistance to groundwater flow between the two geologic formations. This resistance can be evaluated using leaky conditions Hantush model, or Moench model. Moench model also considers partial penetration effect. The aquifer test data was also evaluated using fractured flow model - Moench w/slab blocks. All these models (except Moench w/slab blocks model) produce only approximate results since they assume porous medium (equivalent porous medium approach). In reality ground water flow at the site takes place in a complicated, heterogeneous, fractured environment. The results obtained, using Moench w/slab blocks are also approximate. The site investigators found it difficult to collect adequate data to quantitatively characterize the site's fractured system. This resistance to flow in vertical direction explains a delay in the monitoring well response. The longer recovery period in the monitoring well can be interpreted as a result of down gradient location relative to the pumping well. Recovery of depleted storage around the pumping well slows ground water flow and recharge from the direction of up gradient pumping well to the down gradient monitoring well. This, in turn, results in longer recovery period in monitoring well compared with the recovery rate in the pumping well. Other factors associated with this complicated fractured flow system may also contribute to this phenomenon.	No response required.	
EPA19	App B	7. The description of the aquifer tests performed at Sites 12A, 12B, and 12C is very brief. Additional information that should be provided in the report includes: pumping rates during step-draw down tests, length of time for each pumping rate, methods used for measuring flow rates and draw down at the pumping well. A discussion of any unusual field conditions or other factors potentially affecting the test results such as weather conditions or possible boundaries should also be included. Finally, the text should also state which of the "steps" was used to calculate the hydraulic conductivity values.	The Army draft of the RI Report originally contained more detail on the results of the aquifer testing, but in an effort to reduce the size of the document to a manageable size it was felt that those interested in the detailed results could consult the corresponding appendix (Appendix B), which includes all of the requested information.	No response required.	
EPA13c	App G	Well points were installed at several of the sites for the purpose of collecting shallow groundwater samples. The analytical data was presented on figures for many of the sites, but other data such as the depths and dates of the samples were not provided.	Additional data, such as depths and dates of the samples, will be provided and references to the Appendix G - Field Screening Surveys - will be added.	Comments addressed per ET's response.	
EPA87	App N	4. **Appendix N, General Comment:** The Appendix N data tables are not flagged according to the Functional Guidelines for Organic and Inorganic Data Review. Data which are qualified as LT (less than) are not qualified with the corresponding EPA data qualifier for a non-detected result (U). Revise Appendix N data tables so that data is flagged according to the Functional Guidelines.	No changes are proposed for the tables. If changes were made, any result associated with an LT or ND result in the "Meas Bool" column would be assigned a U code. Rather than revise the individual tables, we propose providing a table explaining data qualifiers at the front of Appendix N. This table would include a definition for each qualifier in the various columns as well as the corresponding EPA data qualifier, when applicable. For example, the LT and ND qualifiers would be linked with the EPA data qualifier for non-detected results (U).	Tables that define the various laboratory and data validation qualifiers, are included in Appendix N.	
EPA88	App N	5. **Appendix N, General Comment:** The data flagging procedures used in Appendix N are unclear. Four categories of qualifiers are included in the tables (Meas Bool, Flag Code, Data Qual, and EPA Qual), but no explanation of these categories is provided. To ensure clarity in the Draft RI Report, revise Appendix N to include an explanation of Meas Bool, Flag Code, Data Qual, and EPA Qual. Additionally, provide a table at the beginning of Appendix N which lists each of the data flags and their definitions.	Explanations of Meas Bool, Flag Code, Data Qual, and EPA Qual will be added to Appendix N.	Tables that define the various laboratory and data validation qualifiers, are included in Appendix N.	
EPA93	App N, O	10. **GENERAL COMMENT (APPENDIX N & O):** It was noted in Volume 1A, Section 3.4.3 Presentation and Interpretation of Data Tables, p. 3-58 does explain the LT, GT, and ND qualifiers, but for the interests of clarity, a table reiterating these definitions should be included here. Normally, US-EPA reviewers look for the "U" flag to denote undetects, and the lack of the utilization of this indication makes examination of tables for non-detects somewhat confusing.	A table reiterating these definitions will be added to the front of Appendix N and Appendix O. This table will include a definition for each qualifier in the various columns as well as the corresponding EPA data qualifier, when applicable. For example, the LT and ND qualifiers would be linked with the EPA data qualifier for non-detected results (U).	Tables that define the various laboratory and data validation qualifiers, are included in Appendix N.	

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EPA2a	App P	During the review of Appendix P it was noted that a number of pages were out of order and others may be missing. This deficiency is noted in General comment 6.	Appendix P has been placed in the correct order for reissuance.	Appendix has been corrected and resubmitted. In addition, the Quality Control Summary Reports for supplemental groundwater monitoring and surface water and sediment samples have also been added to the Appendix (New Work).	
EPA89	App P	6. **Appendix P, General Comment:** During the review of Appendix P it was noted that a number of pages were out of order and others may be missing. For example, in the Fall 1995 Sampling, Page AVKS-3 is followed by the Data Qualifier Summary Table for Lot AVKS. The next page in Appendix P is a Data Qualifier Summary Table for Lot AVNQ. However, no discussion section appears prior to this data table. Revise Appendix P as necessary to ensure that all pages are presented in the correct order.	Appendix P will be reviewed and corrected.	Appendix has been corrected and resubmitted. In addition, the Quality Control Summary Reports for supplemental groundwater monitoring and surface water and sediment samples have also been added to the Appendix (New Work).	
EPA90	App P	7. **Appendix P, General Comment:** The metals data presented in Appendix P was not flagged according to the Functional Guidelines for Inorganic Data Review. Throughout Appendix P (both Phase I and Phase II tables and discussions), it states that metals data was flagged due to a QC failure in the field duplicates. However, the Functional Guidelines for Inorganic Data Review states that data is not to be flagged based upon field duplicate results. Revise Appendix P (discussions and tables) to remove qualifiers from this data.	The *Final Facility-Wide Quality Assurance Project Plan for Phase II Remedial Investigation Studies and RCRA Interim Measures for Sites South of the Firing Line, Jefferson Proving Ground, Madison, Indiana* (QAPP) dated April 1996 requires qualification, based on field duplicate results, in Section 3. The QAPjP and the Functional Guidelines are not in conflict. While the Functional Guidelines do not require qualification, neither does it prohibit qualification. The action specified in the Functional Guidelines is “Any evaluation of the field duplicates should be provided within the data reviewer’s narrative comments”. More specific guidance for qualifying data based on field duplicate results is provided by EPA Region 5 in the “Region 5 Standard Operating Procedure for Validation of CLP Inorganic Data” dated September 1993. Section 3.2.3.6 of this document states: “Field duplicates are evaluated with the same acceptance criteria as the laboratory generated duplicates. If duplicate analysis results for a particular analyte fall outside the appropriate control limits, qualify the results for that analyte in all associated samples of the same matrix as estimated (J).” Although the QAPP offers more site-specific information/procedures than the Functional Guidelines require, no change to Appendix P is proposed.	No response necessary based on ET’s response and Final Meeting Minutes, dated November 23, 1999. Final Meeting Minutes are included in Appendix FF.	
EPA91	App P	8. **Appendix P, General Comment:** The graphite furnace (GFAA) data presented in Appendix P was not flagged according to the Functional Guidelines for Inorganic Data Review. Throughout Appendix P (both the Phase I and Phase II), it states that GFAA data was flagged due to failing matrix spike/matrix spike duplicate (MS/MSD) recoveries. According to SW-846 Method 7000 (section 8.6.2) and the Functional Guidelines for Inorganic Data Review, GFAA data is to be evaluated according to the analytical spike recovery. There are no criteria listed in either reference for recovery of the MS/MSD. Furthermore, Method 7000 states that if the analytical spike recovery does not meet the QC (85-115% recovery) criteria, all samples in the affected batch must be analyzed by the method of standard additions. However neither the analytical spike nor the method of standard additions was evaluated in Appendix P. Revise Appendix P to remove all data flags issued because of failing MS/MSD for GFAA analysis. Additionally, reevaluate all GFAA data and flag according to the analytical spike recovery. If the analytical spike data is not available, provide an explanation as to why the appropriate QC procedures were not followed.	According to SW-846 Method 7000 (Section 8.4), a matrix spike/matrix spike duplicate is required. Further, qualification requirements for GFAA MS/MSDs are specified in Section VII, Part E items 4 through 7 of the Functional Guidelines for Inorganic Review, dated February 1994. Thus, no changes are proposed to data qualifiers for samples associated with out-of-control MS/MSD results. As discussed in Method 7000, method of standard additions is only required if the recovery test in Section 8.6.2 of the method results in recoveries outside the 85-115% window. This recovery test is only required if results from the dilution test, described in Section 8.6.1 of the method, fail. This dilution test and the recovery tests are required at a frequency of one sample per analytical batch. The “Final Facility-Wide Quality Assurance Project Plan for Phase II Remedial Investigation Studies and RCRA Interim Measures for Sites South of the Firing Line, Jefferson Proving Ground, Madison, Indiana” (QAPP) dated April 1996 specifically itemizes QC parameters to be evaluated during the validation process in Section 9.2.2.2.2. This list of parameters does not include furnace QC. However, review of the individual validation reports shows that during Phase II, furnace QC results were evaluated for 26 out of the 38 reports with generally acceptable results. Since review of furnace data is not required by the approved QAPP and since the review of furnace results performed did indicate generally acceptable results for Phase II, no further action is proposed for the Phase II data. The validation reports provided for Phase I did not indicate whether a review of the furnace QC results did or did not occur. GFAA validation reports and, if necessary, available data packages will be reviewed to assess the analytical spike recovery results. Review of the individual validation reports in Appendix P shows that during Phase II, furnace QC results were evaluated for 26 out of the 38 reports with generally acceptable results.	No response necessary based on ET’s response and Final Meeting Minutes, dated November 23, 1999. Final Meeting Minutes are included in Appendix FF.	

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EPA92	App P AVIF-2A	9. **Appendix P, Fall 1995 Sampling, Page AVIF-1, Blank Section:** This section states that the levels of some analytes were detected in several blanks at concentrations ranging from -519.97 ug/L to 3.33 ug/L. Additionally, it states that metals results in the associated samples less than the action levels were qualified as non-detected at the PQL. However, no explanation was provided as to how data above the action levels were flagged. Revise this section (page AVIF-1, section Blanks) to include a discussion of how results above the action levels were flagged and how action levels were determined, particularly for the negative results.	Information will be added. For negative results the action level was established at 4x the absolute value of the blank concentration. No qualifiers were assigned to sample concentrations exceeding the 4x value. Positive concentrations less than the action level were qualified as estimated (J) and for nondetected results the detection limits were qualified as estimated (UJ). Action levels for positive samples were established at 5x the blank concentration. No action was taken for results above the action level. Results below the action level were qualified as not detected (U).	Information has been added to Appendix P as AVIF-2a.	
EPA94	App P	11. **GENERAL COMMENT (APPENDIX P):** It was noted throughout the sampling phases, that MEK was consistently rejected due to calibration problems. Will the missing MEK data have an adverse impact upon the risk assessment of these areas? For the Fall 1995 Phase II Sampling, GFAA Metals/Antimony Soil Lot AVKT; Spring 1996 Phase II Sampling, GFAA Metals Soil Logs AXIJ, AXIK, AXIL, AXIZ and AXJA. It was repeatedly noted in the text of Volume 1A and 1B that no Phase II soil samples were analyzed for antimony, yet the above Lots are listed here as Phase II GFAA Antimony soil results. Please explain.	Sections 6 through 27 identify rejected data and discuss what, if any, impacts the rejected data will have on the risk assessment. These discussions are generally included in the section entitled "Data Quality Summary". For some sites, Phase II sampling was conducted for SVOC analysis only to replace suspect Phase I SVOC data, and additional metals data were not collected. For other sites additional metals data were collected and antimony data were obtained. A careful review of all sections of the report identified instances in the text where antimony in soil was not determined during Phase II for some sites, and in those instances, antimony in soil was not characterized. Antimony in soil results were obtained for Sites 3, 20, 25 and 27 during the Phase II field investigations, and included in both the human health and ecological risk assessments.	No response necessary based on ET's response and Final Meeting Minutes, dated November 23, 1999. Final Meeting Minutes are included in Appendix FF.	
EPA107	App P	13. **Fall 1995 Phase II Sampling - Explosives/Water Lot AVGX, p. 2** Section 7.0 states no Laboratory Duplicate Sample Analysis was performed. Why was this not done? Was any reason given?	A matrix spike/matrix spike duplicate was performed rather than a laboratory duplicate. Explosive results are often non-detect and a comparison of a laboratory duplicate pair, which has concentrations below the detection limit, does not provide information regarding precision at concentrations above the detection limit. The mention that a laboratory duplicate was not performed should be viewed as additional information rather than a QC problem. Since the overall assessment of the data has not changed, no changes to the reports are proposed.	No response necessary based on ET's response and Final Meeting Minutes, dated November 23, 1999. Final Meeting Minutes are included in Appendix FF.	
EPA108	App P	14. **Fall 1995 Phase II Sampling - ICP Metals/Water Lots** The text states that in several Lots, no field blanks or field duplicates (Lots AVID, AVIF, AVIP) were taken. Cumulatively, these lots consisted of over 21 water samples. Why not?	Cumulatively, 35 water samples, 10 equipment blanks, and 3 field duplicates were collected for ICP metals analyses during the Fall 1995 Phase II sampling. Thus, while field blanks were not included with each lot, the overall collection frequency was greater than 10 percent. The field duplicates were collected at a cumulative frequency of 8.6 percent. While this is slightly lower than the 10 percent requirement for the fall event, a frequency of 20 percent was met for the winter 1996 event (based on review of the sample index provided in Appendix A of the report). The reduced frequency in field duplicate precision for the fall event should not affect data quality. No changes to the reports are proposed.	No response necessary based on ET's response and Final Meeting Minutes, dated November 23, 1999. Final Meeting Minutes are included in Appendix FF.	
EPA109a	App P	15. **Fall 1995 Phase II Sampling/Winter 1996 - GFAA Metals/Antimony & Total and Dissolved Metals/Mercury** It was noted in Lots AVIM, AVIK, AVIS for Antimony there were no field duplicates, and this also occurred in the Winter 1996 sampling round. Why were so many lots submitted without a field duplicate sample?	The winter 1996 event included a sample index, listing all samples collected for the event. Review of this index showed that 64 investigative samples and 8 duplicates were analyzed for antimony; thus, while field duplicates were not included with each lot, the overall field duplicate frequency was greater than 10 percent. A similar evaluation could not be completed for the fall 1995 event because the sample index was not available.	No response necessary based on ET's response and Final Meeting Minutes, dated November 23, 1999. Final Meeting Minutes are included in Appendix FF.	

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EPA109b	App P	For Mercury Lots (AVGL, AVIA, AVIB, AVOG, AVOH, AVOJ) no laboratory duplicates were submitted, and this also occurred in most of the Mercury lots in the Winter 1996 sampling round. Why is this considered acceptable for this many lots of samples not to have a single laboratory duplicate submitted? Was any corrective action taken? It is understood that MS/MSDs are required. The text stated that the LCS was acceptable. Was an LCS sample run for each of these analytical batches?	The mercury method, 7470, requires a spike duplicate to verify precision rather than a laboratory duplicate. This was done through the use of a matrix spike/matrix spike duplicate (MS/MSD). The individual validation reports were misleading by indicating a QC noncompliance due to the lack of a laboratory duplicate. Laboratory duplicates are discussed in the QAPjP; however, they are not specifically required for the mercury test. MS/MSD samples are required. Section 3.2.1.2 of the QAPjP states: "MS/MSDs will be required for all analytical lots of RI and confirmatory samples. Laboratory and blank spike duplicates are required in a few methods, as discussed in Section 7.0, *Analytical Procedures*." There is no requirement for laboratory duplicates for the mercury test in Section 7.0. The mention that a laboratory duplicate was not performed should be viewed as additional information rather than a QC problem. Since the overall assessment of the data has not changed, no changes to the reports are proposed. Yes. The Data Quality Assessment report for each batch lists the QC parameters reviewed and identifies problem areas with an asterisk. Each report indicated that the LCS results had been reviewed and were found to be acceptable. Additionally, each report contained the section "Overall Assessment" which stated that "Accuracy was acceptable, as demonstrated by the laboratory control sample (LCS) and MS/MSD percent recovery values".	No response necessary based on ET's response and Final Meeting Minutes, dated November 23, 1999. Final Meeting Minutes are included in Appendix FF.	
EPA110	App P	16. **Winter, 1996 Phase II Sampling - Explosives Lots, Metals/Water Lots** Field blanks, field duplicates, and laboratory duplicates missing in various lots. See comments above.	The sample index was reviewed for the Winter 1996 event and showed that the following number of samples, blanks, and field duplicates were collected and analyzed: Sample Event / Samples / No. of Investigative Analyses / Field Samples / Field Duplicates Winter 1996 / Explosives / 18 / 2 / 2 Winter 1996 / ICP Metals / 30 / 9 / 4 Winter 1996 / ICP Metals-Filtered / 30 / 4 / 0 The above numbers show that field duplicates were cumulatively collected at a frequency greater than 10%. The field blanks were also analyzed at a frequency of 10% for the explosives and ICP metals tests. No field blanks were collected for filtered ICP metals because both a filtered and non-filtered sample were collected at each location and the non-filtered sample was used to assess procedural contamination for metals. Based on this review, and responses to comments 14, 15, and 18, it appears that while field duplicates and field blanks were not included with every lot of samples submitted for explosives, metals, antimony and mercury tests, the overall field duplicate/field blank frequency for each event was approximately 10 percent of the investigative samples. A 10% frequency, rather than one per lot is required by the QAPP, thus, the project requirements were fulfilled. No changes are proposed to the document.	No response necessary based on ET's response and Final Meeting Minutes, dated November 23, 1999. Final Meeting Minutes are included in Appendix FF.	
EPA111	App P	17. **Spring, 1996 Phase II Sampling - GFAA Antimony Lots (AXFO, AXGE, AXGJ, AXIJ, AXIK, AXIL, AXIZ, AXJA), Mercury Lots (AXFB, AXGF, AXGW, AXGX, AXIG, AXIH, AXII, AXIW)** Laboratory duplicates were missing or duplicate analysis not done, as in two earlier sampling sessions. Why? Why weren't corrective actions taken previously? It is understood that MS/MSDs are required. The text stated that the LCS was acceptable. Was an LCS sample run for each of these analytical batches.	MS/MSD samples are required by both methods 7041 (see reference to method 7000) and method 7470. Neither method requires a laboratory duplicate. The individual validation reports were misleading by indicating a QC noncompliance due to the lack of a laboratory duplicate. The mention that a laboratory duplicate was not performed should be viewed as additional information rather than a QC problem. Since the overall assessment of the data has not changed, no changes to the reports are proposed. See the response to comment 16 regarding the field duplicate collection frequency. See response to EPA 109b.	No response necessary based on ET's response and Final Meeting Minutes, dated November 23, 1999. Final Meeting Minutes are included in Appendix FF.	

Comment #	Section	Comment (EPA/IDEM as indicated in comment number)	Original Response to Comment (ET)	MW Revised Response (if applicable)	Agency Concur
EPA112	App P	18. **Summer, 1996 Phase II Sampling - Mercury Analysis Lots (AXRM, AXRW, AXUE, AXUF)** Text indicates for all Mercury lots, with approximately 72 environmental samples), there was no ICV, no field duplicates, and no laboratory duplicates run. What is the basis for stating that "all data is acceptable for use?" Response states that the LCS was utilized as the ICV for these batches. Text states that initial calibration verification was acceptable; what was the actual values obtained for the initial calibration verification utilizing the LCS samples vs the initial calibration verification QC limits.	A response is be provided for each QC parameter questioned. ICVs: Quality control (QC) requirements for method 7470 specify a calibration curve, which is verified with an independently prepared check standard every 15 samples. No further requirements for check standards (either ICVs or LCSs) are mentioned. Text indicates the initial calibration for each lot was reviewed and was acceptable. Text also indicates that the laboratory control sample (LCS) was used in lieu of the ICV; thus, an independently prepared check sample was analyzed in accordance with the method. Since the method QC requirements were met, the replacement of the LCS for the ICV is deemed acceptable. Field Duplicates: Review of Appendix A, the sample index, shows that of the 72 environmental samples listed for each lot, 8 were field duplicates. For each lot, the section entitled "Overall Assessment" includes the statement "Precision was acceptable, as demonstrated by the relative percent difference values of the matrix spike/matrix spike duplicate (MS/MSD) and field duplicate analyses". Thus, field duplicate results were acceptable and analyzed at a frequency of 1 per 10 investigative samples. Laboratory Duplicates: Method 7470 requires a spike duplicate rather than a laboratory duplicate. No changes to the text are proposed. Acceptance limits used for the mercury LCS were 80-120% recovery (see Data Quality Assessment Report for spring 1996, mercury batch AXGX). According to the National Functional Guidelines, the initial calibration verification limits for mercury are 80-120%. Recoveries for the LCS results were reported as acceptable; thus the initial calibration verification limits were also met. Actual LCS results were not obtained since the Data Quality Assessment Reports indicated the results were acceptable for the ICV.	No response necessary based on ET's response and Final Meeting Minutes, dated November 23, 1999. Final Meeting Minutes are included in Appendix FF.	
EPA113	App P	19. **September 1997 Phase II Sampling - Antimony, Mercury, and Cyanide Lots.** Text indicates that for a substantial number of these lots, there were no field duplicates, and/or laboratory duplicate sample analysis done. Sometimes, MS/MSD analysis was utilized to demonstrate precision (see Antimony Lot BGWT, Cyanide Lot BGZK as examples). Isn't the MS/MSD QC test performed to determine if a matrix interference is present, and is not a normally utilized indicator of laboratory precision? Why no laboratory duplicates? MS/MSD question answered in previous comments. Meeting Minutes: ET could not address Mr. Chrystof's concerns and ET representatives indicated that they would get back to Mr. Chrystof regarding the issue brought out in the comment.	Review of the text indicates that lots with no field duplicates only included field or equipment blanks. Field duplicates are only required for investigative samples. Comment 17 addresses the reason for using MS/MSDs rather than laboratory duplicates for the antimony and mercury tests. Rationale is the same for cyanide (method 9012). MS/MSDs are used to determine if a matrix interference is present, but they are also commonly used to assess laboratory precision. Precision information cannot always be obtained through the use of laboratory duplicates because the compounds of interest are not present in the duplicate sample. Unsure what issue is outstanding. Initial comment response was adequate	No response necessary based on ET's response and Final Meeting Minutes, dated November 23, 1999. Final Meeting Minutes are included in Appendix FF.	
EPA114	App P	20. **New Burn Site, September 1997 Phase II Sampling - Dioxin/Furan Analysis, Lot BHTW** It was noted in text that this Lot consisted of one sample re-extracted and re-analyzed from Lot BHTV. There was no initial/daily calibration data, MS/MSD, or LCS data submitted for Lot BHTW; all were referenced back to Lot BHTV. Were Lots BHTV and BHTW both run on the same day, with the same calibration? Also, no LCS was performed for either Lot; instead, Lot BHTV referred to the MS/MSD results as being a substitute for the LCS. Lot BHTW then states that "severe matrix interferences were noted for 2378-TCDD and 2378-TCDF, which would indicate problems with Lot BHTV's MS/MSD, and yet the MS/MSD text for BHTW stated that the MS/MSD data utilized from Lot BHTV was "acceptable," and indicates no problem. Please explain. Understood that BHTV/BHTW run data will be investigated and added to validation report.	The analytical data packages will be reviewed to determine if lots BHTV and BHTW were both run on the same day, and information will be added to the validation report. Accuracy information was specifically obtained for each sample through the use of isotopically labeled internal standards for each compound of interest. The analytical method, 8290, does not require the use of an LCS. MS/MSD results were used to evaluate the precision of the method. Matrix interferences for method 8290 are determined on a sample- specific basis rather than only through the use of batch MS/MSD results. These interferences can be identified through review of the labeled internal standards, lock masses which may have shown a drop off, or ion ratios outside criteria. Thus, severe matrix interferences could be noted for an individual sample in Lot BHTW, while the MS/MSD results for the batch could be acceptable. Response: I believe I need data - our original response indicated the analytical data packages would be reviewed to determine if lots BHTV and BHTW were both run on the same day (or, with the same initial calibration) **See CMMcom.wpd** Lot BHTW Data assessment report states " no data for the initial calibration were submitted with this data package. Data were present in the data package for Lot BHTV. As the data in Lot BHTV were acceptable, no action was taken.	No response necessary based on ET's response and Final Meeting Minutes, dated November 23, 1999. Final Meeting Minutes are included in Appendix FF.	

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EPA115	App P	21. **New Burn Site, September 1997 Phase II Sampling - Dioxin/Furan Analysis, Lot BHTY, BHTX.** It was noted from the text that there were multiple problems with QC parameters. No LCSW was performed, yet the MS/MSD was deemed to be an acceptable substitute, even with OCDD %R and RPD values significantly exceeding QC limits. Also, non-confirmational 2378-TCDF results, and poor resolution on "several compounds." Please elaborate on how this set of data was deemed estimated, and not rejected? Understood that internal standards were run and found to be acceptable, with the exception that several samples had <40% recoveries. Were the recovery values significantly less than 40%?	Further detail for the QC issues in question for lots BHTY and BHTX are provided below to justify why data was qualified as estimated and not rejected. No LCS -- Accuracy information was specifically obtained for each sample through the use of labeled internal standards for each compound of interest. The analytical method 8290 does not require the use of an LCS. MS/MSD results were used to evaluate the precision of the method. MS/MSD Results -- The OCDD %R and RPD values did significantly exceed QC limits; however, the sample concentration was 25 times the spike concentration. As a comparison, the Functional Guidelines states that for metals, if the sample concentration is greater than 4 times the spike concentration, the recovery limits do not apply. Since accuracy information is available for every compound and every sample due to the labeled internal standards, the MS/MSD results outside control limits should not affect data quality. Non-Confirmation of 2378-TCDF -- Non-confirmation of 2378-TCDF results simply show that 2378-TCDF was not present in the sample and does not indicate a QC problem. Second column confirmation is used because compounds other than 2378-TCDF may elute within the same retention time window as 2378-TCDF. If 2378-TCDF cannot be verified on a second, different column (DB-225), the original peak was something other than 2378-TCDF. **Need data for BHTY.** Section states "Several samples had one or more percent recovery (%R) values that were less than the lower control limit of 40%. Positive results and reporting limits that were associated with outlying labeled standard recoveries were qualified as estimated. Nothing further needed for **BHTX**. Section states " Ten (of sixteen) labeled compound percent recovery (%R) values were less than the lower control limit of 40% in the method blank. Qualifiers are not issued to QC analyses; no action was taken. One labeled compound %R value was slightly greater than the 130% upper control limit in the sample (at 133%), no action was taken for this outlier	No response necessary based on ET's response and Final Meeting Minutes, dated November 23, 1999. Final Meeting Minutes are included in Appendix FF.	
EPA66a	App S	1. The description of the Multimedia Exposure Assessment Model (MULTIMED) presented in the Appendix S text is incomplete, and documentation for this model has not been provided as an attachment to the Appendix S. Based on the limited discussion provided in Appendix S, it is not possible to fully evaluate the adequacy of the screening model. Most importantly, it is not possible to determine the adequacy of the treatment of the source term used in the screening model. Appendix S indicates that the MULTIMED semi-analytical saturated zone transport model was used without the vadose zone module. Appendix S (pg. 5) further states that "when using this module alone (without using the vadose zone module), the contaminant source is assumed to lie directly in contact with the top of the aquifer." Appendix S (pg. 7) also states that "source contaminant loading to the aquifer is computed in MULTIMED by multiplying three model parameters: infiltration rate, area of the disposal unit, and initial contaminant concentration at the sources," and that "this initial contaminant concentration represents the contaminant concentration measure in site wells."	Only the semi-analytical saturated zone transport module in MULTIMED was used for modeling JPG sites. Complete documentation of that module is included in Section 5 of: Multimedia Exposure Assessment Model (MULTIMED) for Evaluating the Land Disposal of Wastes - Model Theory (Salhotra, et al., 1990). The model's practical implementation is documented in: A Subtitle D Landfill Application Manual for the Multimedia Exposure Assessment Model (MULTIMED), to which the Agency reviewer is directed (Sharp-Hansen, et al., 1990). These references represent several hundred pages of documentation. MULTIMED documentation can be accessed from the USEPA Center for Exposure Assessment Modeling (CEAM) ftp site: ftp://ftp.epa.gov/epa_ceam/wwwhtml/ceamhome.htm.	Comment addressed by ET's response. However, new internet site for MULTIMED is: www.epa.gov/ceampubl/multimed.htm	
EPA66b	App S	While not explicitly stated, it appears that since MULTIMED considers a source immediately above the water table and not within the saturated zone itself, that the source parameters must be manipulated so that the resulting concentration in the upper aquifer mixing zone is equivalent to that observed in monitoring wells. This would explain why the ground water specific discharge was used as the infiltration rate and the area of the flow (plume width times plume thickness) was assigned to the area disposal unit. While such an approach may be appropriate, it requires that the model not consider the surface infiltration rate when computing the quantity of groundwater used to dilute the contaminant loading computed in the above manner.	MULTIMED simulates a uniform flow field and contaminant transport in a way similar to other popular, screening level models such as AT123D or SOLUTE. Application to the site of the three models listed above was presented in Section 3.4 of the modeling report: Comparative Simulations Using Other Modeling Software. This section should provide assurance that calculations from the MULTIMED approach are reasonable. When using the saturated zone transport module alone (without using the vadose zone module), the contaminant source is assumed to lie directly in contact with the top of the aquifer; that is, no vadose zone transport is simulated. In general, the contaminant source was configured to recreate contaminant flux (mass balance) from the site and not contaminant concentrations at the site. Therefore, the source infiltration term must be used in the model.	Comment addressed by ET's response.	

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EPA66c	App S	A detailed description should be provided of the computations used in MULTIMED to determine contaminant concentrations in groundwater immediately beneath the source areas. In addition, since the adsorption phenomena considered by the model may influence the contaminant concentrations computed in groundwater immediately below and downgradient of the source area, a detailed analysis of how adsorption influences the contaminant concentration computed in groundwater below the source area should be provided. To provide adequate assurances that initial contaminant concentrations in groundwater immediately downgradient from the source area have been correctly computed, these concentrations of contaminants in groundwater as computed by the model should be presented for review.	The contaminant source parameters were manipulated in such a way as to simulate the mass flux of contaminants assumed to be leaving the downgradient edge of the source. The mass flux from the downgradient edge of the source was calculated from the assumed plume width, plume depth, calculated aquifer specific discharge, and the 95% upper confidence limit of the mean (or the highest detected concentration -whichever was the lower). Plume depth was assumed equal to well screen length - a conservative assumption of one-third aquifer depth. This is a much greater plume thickness than would be expected at the downgradient edge of the source site. The MULTIMED source infiltration rate was set equal to the aquifer specific discharge. A realistic recharge by precipitation of 0.064 m/year was set outside of the source area. This recharge was estimated from a regional groundwater mass balance presented in Table 2, Appendix S. The MULTIMED source planar area was adjusted so that the mass flux was equivalent to that calculated above. This equivalent mass flux was equal to the mass flux calculated as explained above. Adsorption onto the soil matrix of vadose zone phenomenon is not part of the model. Groundwater concentrations beneath the source were those measured at the site as described above. The model assumed infinite source so that the groundwater contaminant concentrations in groundwater beneath the site are assumed constant.	Comment addressed by ET's response.	
EPA67a	App S	2. Appendix S (page 4) indicates that the screening model include the effects of three-dimensional dispersion when computing downgradient contaminant concentrations. However, the dispersivity values used have not been clearly identified in Appendix S. Clearly identify the dispersivity values used, and provide sufficient justification for these values to indicate that they are conservatively representative of the bedrock fracture flow at JPG.	Default MULTIMED values were used for longitudinal, transverse, and vertical dispersivities (Sharp-Hansen et al., 1990). Default values are calculated as one-tenth of the transport distance for longitudinal dispersivity, one-third of the longitudinal dispersivity for transverse dispersivity, and 0.056 of longitudinal dispersivity for vertical dispersivity. The use of default parameter values was considered a reasonable approach considering the overall conservative approach of the model (see the answer to comment 6).	Comment addressed by ET's response.	
EPA67b	App S	In addition, the description of the model does not indicate if there is a natural boundary to vertical spreading of groundwater contamination (e.g., an aquitard) and, if so, how this boundary is accounted for in the model. The treatment of vertical dispersion (spreading) within the bedrock aquifer should be clearly explained and justified.	Aquifer thickness was set to 9.14 m (30 feet). This is considered conservative since the actual thickness of the aquifer system is much greater than 30 feet. The bottom of the aquifer represents a natural boundary to vertical spreading of groundwater contamination.	Comment addressed by ET's response.	
EPA67c	App S	The screening model has apparently included both the effects of longitudinal dispersion and degradation. However, it is does not appear that the effects of longitudinal dispersion has been considered when computing travel times. Although it smears the contaminant front and reduces the concentrations at the leading edge of the plume, longitudinal dispersion can also significantly reduce the travel times and, consequently, may reduce the impact of degradation. In addition, due to the effect of smearing the contaminant front, contaminant concentrations computed by the model at the travel time based on plug flow may underestimate the peak concentrations that eventually arrive at the potential receptor. Additional analysis should be provided to clearly demonstrate that peak concentrations predicted by the model at receptor locations predicted by the model at receptor locations have actually been used in the screening analysis.	MULTIMED computation of contaminant concentration at the receptor point accounts for the effect of the plume dispersion (smearing). The model reported concentrations represent the highest (peak) concentration at the receptor point regardless of time. The reported concentrations are not the plume leading edge concentrations at the receptor point, but rather are equilibrium concentrations at the receptor point. This is conservative because the source was modeled as continuous. The maximum equilibrium contaminant concentration at the receptor point was used in the exposure analysis. MULTIMED does not simulate contaminant transport as plug flow.	Comment addressed by ET's response.	
EPA68	App S	3. The screening model has included the effects of retardation based on the partitioning (sorption) of groundwater contaminants onto the aquifer matrix. These computations have apparently been based on equations normally used to compute such effects in porous media. However, contaminant migration at the JPG is considered to occur primarily through fractures in bedrock materials. The surface area of the solid matrix available for sorption under such conditions generally is significantly less than that in porous media. Consequently, traditional approaches for evaluating sorption and associated retardation of contaminant migration in porous media may not be appropriate at JPG and may significantly overestimate the amount of retardation that may occur in the bedrock aquifer. Unless a reliable basis for determining retardation coefficients in the fractured bedrock aquifer can be developed and presented, retardation should not be considered in the screening model.	The point that the "surface area of the solid matrix available for sorption under site conditions is less than that in porous media" is well taken. Limestone and dolomite may contain a small amount of organic carbon. Laboratory experiments have documented that hydrophobic organic compounds (contaminants) may be sorbed to inorganic aquifer material surfaces. This additional adsorption increases the value of the distribution coefficient and contaminant retardation (Certain 1996). In the face of this uncertainty, contaminant retardation was simulated using a low value of organic carbon content. Using the low value of this parameter is conservative since it results in less contaminant adsorption and retardation. This subsequently results in faster transport with less degradation and dilution due to spreading (dispersion). Computed retardation values are small. The option of not using retardation at all was considered too conservative in view of the conservative nature of the model. Model sensitivity to a reasonable range of retardation values was found to be low.	Comment addressed by ET's response.	

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EPA69	App S	4. The screening model has also included the effects of degradation. Appendix S (page 9) indicates that "the largest values of contaminant half-life in ground water found in (the) literature were used in model simulations." While these numbers may be appropriate for use in the screening model, an evaluation of these degradation rates with the degradation currently observed on site should be undertaken to verify the applicability of these rates. One possible approach for such an evaluation is to compare downgradient contaminant concentration distributions observed on site with that predicted by the screening model using the specified parameters.	More monitoring wells would need to be installed and far more chemical data would need to be periodically collected to provide the basis for model verification (including verification of the assumed degradation rates). Uncertainty associated with the selected degradation rates is offset by the overall conservatism of the screening level model.	Comment addressed by ET's response.	
EPA70	App S	5. According to the introduction of Appendix S, this modeling effort was undertaken to "estimate the concentrations of on-site contaminants at off-site ground water receptor points." It is unclear from the text in Appendix S how the exposure point concentrations were used in the human health or ecological risk assessments in the RI Report. Revise Appendix S or the appropriate report sections to explain how receptors A, B, and C were chosen and the purpose of their associated exposure point concentrations.	Requested discussion will be added to Appendix S. Each of these receptor points represent an area in which groundwater flow converges toward an erosional valley: Point A (Harberts Creek), Point B (Middle Fork Creek), and Point C (Middle Fork Creek). Sites were selected or assigned as contributing to one or more of those receptor points based on their configuration relative to each point. For the assessment, all assigned sources were assumed to contribute simultaneously to each receptor point, at their maximum (i.e., equilibrium) concentrations. The receptors at each point were residential people at Points A and B, and a recreational user of the creek at Point C.	Comment addressed by ET's response. Explanation was not provided in Appendix S, but the comment was addressed in ET's 1999 Technical Memorandum, Model Sensitivity Analysis and Alternative Modeling Scenarios Evaluation.	
EPA71	App S	6. The model incorporates a factor for degradation of organics. It is unclear whether the products of the degradation process have been accounted for in the model. If it is assumed that TCE breaks down into its daughter products, then these products should be included in the appropriate input concentrations of these daughter products. If not, the reason for excluding the daughter products should be explained in the text.	No daughter products were evaluated in the presented screening level model. Evaluating daughter products would require a much more extensive and complex modeling effort, and larger database of concentration data than is available for the site. This is an area of uncertainty of the risk assessment and will be noted as such in the revised RI draft.	Comment addressed by ET's response.	
EPA72	App S Section 3.1	**1. Section 3.1, Model Assumptions, Page 4, Bullet 3:** The text references Figure 1, which was not included in Appendix S. Revise the appendix to include the referenced Figure.	Section 3.1 - We will include the groundwater contour map listed as Figure 1.	The referenced figure was not included in Appendix S; however, the appropriate figure is presented in Section 2 as Figure 2-15.	
EPA73	App S Section 3.3	**2. Section 3.3, Model Input Parameters, Page 7, Bullet 2:** One assumption for the model was that the length of the well screen would represent the thickness of the plume at each site. The reasoning provided includes the claim that the aquifer recharge rate, the areas of the evaluated sites, annual water level fluctuations, and ground water velocity make this assumption conservative. An explanation of the relationship between these factors and the assumed plume thickness needs to be included to justify this assumption. Sites 12A and 12B provide some evidence that the well screen lengths may not be adequate as an estimate of plume thickness. At these two sites, monitoring wells have been installed in bedrock at two different intervals. In each case, contamination has been detected in the well(s) screened lower in the bedrock, suggesting that the plume exists over a greater vertical extent than 10 to 15 feet. Reevaluate the assumed plume thicknesses based on well placement and analytical results, or provide additional support for the original assumption.	The requested explanation will be included in the text of Appendix S to provide justification of the assumption used. The presence of contamination detected at two sites with monitoring wells installed at different depths can be explained as a result of: • leakage along the well column (imperfect well construction); • groundwater mixing caused by pump tests; • presence of inhomogeneities - local variations in the fracture network, and associated variations in the distribution of preferential pathways for contaminant movement; • migration of the source downward through the aquifer as DNAPL (dense non-aqueous phase liquid). In this case the source depth might be larger than that assumed in the model; however, the source area would likely be much smaller than that assumed in the model. This is because DNAPL tends to migrate along discrete flowpaths and, unless a major spill took place, aquifer zone DNAPL sources have a limited area. DNAPL pooling at the bottom of the aquifer usually occurs in the case of major spills. However, there is no indication that any major spills took place at JPG-contaminated sites of interest. The near-source plume thickness - 'source depth' - was set to one-third of the modeled aquifer thickness. If the source is somehow deeper than assumed then this underestimation is offset by using the conservative contaminant concentration. The 95% upper confidence limit of the mean or the highest detected concentration (whichever is the lower) is used for each contaminant concentration detected in the site's bedrock wells (Table 6). It is conservative to assume that this concentration represents the average concentration across the entire estimated plume width. The 95% upper confidence limit is often over three times the average concentration across the assumed plume width. Text will be added to discuss these points.	It should be noted that MWH has found no evidence to support existence of DNAPL in the existing site data, groundwater samples or in soil examined during soil excavation activities, particularly at the solvent pit sites (12A, 12B, and 12C). If DNAPL were present, it would be more likely to occur at the solvent pit locations than at the other identified sites. An important distinction exists between the presence of DNAPL and the presence of chlorinated solvents in solution. MWH has clarified the distinction between DNAPL and solubilized chlorinated solvents in the text. Explanation was not provided in Appendix S, but the comment was addressed in ET's August 1999 Technical Memorandum, Model Sensitivity Analysis and Alternative Modeling Scenarios Evaluation.	
EPA74	App S Section 3.5	**3. Section 3.5, Model Simulations, Page 10:** The first paragraph refers to Appendix 1 for printouts of input data and output files. However, the referenced appendix is not attached to Appendix S. Revise the document to include the referenced appendix.	Section 3.5 - We will include the referenced Attachment 1.	Attachment 1 is no longer available from ET.	

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EPA177	App T	53. **Appendix T, Page T-1:** Please provide a reference for the input values for k (=0.14 hr^{-1}) ($t_{1/2}$=4.9 hrs; 0.005 m^3/hr). Table T-1 presented on page T-4 references this value as a personal communication with an industrial hygienist. Provide a more definitive reference for this contact/communication, cite a date for the exchange, and add this reference to the References for Shower Model section of Appendix T.	A more definitive reference will be provided.	ET was unable to locate additional information regarding the "Personal communication - Industrial Hygienist" citation for the air exchange rate in shower stall parameter value (0.14 hr^{-1}).	
IN5	ES	**Executive Summary, Page ES-17, Paragraph 1:** It should be stated that a public notice is required under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 117 before sites can be removed from the Remedial Investigation/Feasibility Study (RI/FS).	The following statement will be added as requested: "However, before sites can be removed from the RI/FS, a public notice will be issued as required under CERCLA Section 117."	Comments addressed per ET's response.	
EPA9	ES	5. **Executive Summary, Page ES-17.** Please add a statement to the text in this section regarding the requirement of a public notice under CERCLA, Section 117, before sites can be removed from the RI/FS.	The following statement will be added as requested: "However, before sites can be removed from the RI/FS, a public notice will be issued as required under CERCLA Section 117."	Comments addressed per ET's response.	
EPA27	ES	1. **Executive Summary, Site 7 - Red Lead Disposal Area, Page ES-7, Paragraph 3 and Page ES-17, Paragraph 3:** These two paragraphs provide conflicting information regarding recommendations for carrying Site 7 forward to the feasibility study (FS). Resolve the discrepancy and correct the text accordingly.	The following statements will be added to the third paragraph on Page ES-17: "For all these sites except Site 7, No Further Action under CERCLA is being recommended and removal from the RI/FS process is warranted. Because additional investigation of arsenic in the groundwater at Site 7 may be warranted (to determine if the arsenic is naturally occurring or related to site activities), it is recommended that this site be carried forward to the FS."	The last five paragraphs of the ES have been revised to clarify recommendations for all of the sites.	
EPA8	ES – Site 2/27	4. **Executive Summary, Page ES-5, Sites 2 and 27 - Sewage Treatment Plant and Sewage Sludge Application Areas.** This paragraph provides conflicting information regarding recommendations for carrying Sites 2 and 27 forward to the Feasibility Study (FS). Resolve the discrepancy and correct the text accordingly.	The last sentence will be revised to indicate no further RI field investigations are warranted.	Comments addressed per ET's response.	
EPA5	ES – Site 8	1. **Executive Summary - Site 8/Small Arms Firing Range, Page ES-7.** EPA concurs with the Army's decision for NFA at Site 8. Site 8 should be documented in a NFA Proposed Plan or Draft Decision Document and public noticed for citizen's input via comment/review.	Now that the confirmation sampling data are available, a Draft Decision Document will be prepared.	Comments addressed per ET's response.	
EPA95	ES – Site 8	1. **Executive Summary - Site 8/Small Arms Firing Range, p. ES-7** Text states that contaminated soils were removed; were confirmatory samples taken and analyzed to confirm cleanup goals?	Confirmatory samples were collected but the results were not available for inclusion into the draft Phase II RI. Results were recently received from the contractor who conducted the work, and we will incorporate the sample data as appropriate.	Comments addressed per ET's response.	
IN2	ES – Site 12	**Executive Summary, Page ES-9, Paragraph 2:** "The Phase II results indicate that the primary solvent plume at each site is located in the immediate vicinity of the former solvent pit. At Buildings 602 and 617, contamination has migrated approximately 300 feet in a southerly direction at both sites." In other places it is referred to as "immediately downgradient." At this scale, three hundred foot distance is not in the "immediate vicinity" of the pit. This contradictory statement needs to be removed here and in other places where it is reported, such as Sections 13.5.1.1, and 13.8, and 14.8.	The text will be revised in the Executive Summary and in Section 13 and 14, as suggested, to remedy this contradiction. Although migration of contaminants has occurred, the "primary solvent plume" was meant to describe that portion of the plume exceeding tap water PRGs. The sentence on page ES-9 will be revised to read: "The Phase II results indicate that the solvent contaminants exceeding tap water PRGs are located in the immediate vicinity of the former solvent pit."	Comment was addressed through redrafting of affected sections while incorporating new data gathered in 2001.	
IN3	ES – Site 14	**Executive Summary, Page ES-10, Paragraph 4:** This paragraph states that unexploded ordnance (UXO) was encountered and excavated at the Yellow Sulfur Disposal Area. It should also state that this area was previously classified by the Army as an area with no potential UXO and not subject to a UXO survey. Additionally, it should state over 100 UXO items, including High Explosive (HE) ordnance, were found at the Yellow Sulfur Area and additional UXO is likely in this area.	An additional sentence will be provided that states that additional screening for UXO will be conducted as part of the ongoing interim action at Site 14. The following wording concerning the UXO found at Site 14 during the interim removal action will be added to the Executive Summary: "This area was previously classified by the Army as an area with no potential UXO and was not subject to a UXO survey. However, more than 100 UXO items (including high explosive (HE) ordnance) were discovered at the Yellow Sulfur Disposal Area during interim action. It is possible that additional UXO is in this area."	Comment addressed per ET's response.	
EPA7	ES – Site 14	3. **Executive Summary, Page ES-10, Paragraph 2, Site 14 - Yellow Sulfur Disposal Area.** Please add to the text the following: "*this area was previously classified by the Army as an area with no potential UXO, and therefore, was not subjected to a UXO survey. Additionally, more than 100 UXO items (including high explosive (HE) ordnance) were discovered at the Yellow Sulfur Disposal Area - Site 14. It is possible for additional UXO to be in this area.*"	Suggested wording will be added to page ES-10 as requested.	Comment addressed per ET's response.	

Comment #	Section	Comment (EPA/IDEM as indicated in comment number)	Original Response to Comment (ET)	MW Revised Response (if applicable)	Agency Concur
IN4	ES – Site 25	**Executive Summary, Page ES-12 and Page ES-13, Site 25:** The summary for Site 25 states that proposed interim measures are planned for the near future. Interim remedial action has already occurred at Site 25 and the text should be updated to reflect this.	The Closure Report for Site 25 was just recently prepared and submitted by TolTest, Inc. (December 1998). The Phase II RI Report will be updated to incorporate the interim remedial action results. The results were not available while the draft RI report was being prepared.	The interim action has been included.	
EPA6	ES – Site 25	2. **Executive Summary - Site 25/Papermill Road Disposal Area, Page ES-12.** Please update this section. EPA's contractor (TechLaw) provided field oversight during the soil excavation and confirmation sampling at this site in September 1997. EPA has provided several comment and comfort letters regarding the remaining data gaps at this site. Data validation and field quality control (QC) was not performed by the Army's field contractor (TolTest, Inc.) This updated documentation needs to be included in the revised Phase II RI Report.	Our understanding is that the excavation activities and confirmation sampling were conducted from January 1998 through April 1998 rather than September 1997. The referenced correspondence was not made available to the authors. Once received, the appropriate information will be incorporated.	Excavation confirmation sampling performed in January through April 1998 are summarized.	
EPA96	ES – Site 25	2. **Executive Summary - Site 25/Papermill Road Disposal Area, p. ES-12** Text states that following proper removal of contaminated soils, "confirmation sampling will be performed." When will this data become available?	The data were just recently issued in a draft closure report (December 1998). A summary of these results will be incorporated in the next version of this document.	Comments addressed per ET's response.	
IN1	ES Table ES-2	**Executive Summary, Page ES-1, Last Paragraph:** Nine sites have undergone or are in the process of undergoing interim remedial actions. A table should be produced to summarize the status of the interim remedial action sites. This summary should include what action was taken and when it occurred and/or what future action is planned and if the confirmatory sampling and closure reports were concurred with by the regulators. Additionally, the pending issue of stockpiled soils derived from removal actions at Sites 14, 15, 26, 28, and 29 should be discussed.	Table ES-2, Sites Scheduled for Interim Remedial Action, will be produced in the Executive Summary as recommended. The issue of stockpiled soils will be described in the next revision of the Phase II RI Report.	Table ES-2 has been added.	
EPA139	Figure 05-3	16. **Page 5-36, Figure 5-3, Facility-Wide Conceptual Model:** Based on a review of the entire risk assessment methodology, this model lacks the following: All Current and Future Receptors: • Subsurface Soil - Inhalation of VOCs • Groundwater - Inhalation of VOCs Current Security Guard or Maintenance Worker contact with (tentative) • Surface Soil - Incidental Ingestion, Inhalation of VOCs and Particulates, Dermal Contact • Subsurface Soil - Inhalation of VOCs • Groundwater - Inhalation of VOCs	See response to General Comment 5 (EPA120) for the inhalation of VOCs and the maintenance worker.	No additional response necessary.	
EPA195	Figure 05.3-6	12. **Figure 5.3-6, JPG Conceptual Site Model, Page 5-157:** The conceptual site model does not show the representation of the potential migration of contamination through groundwater discharging to surface water. This pathway should be included by adding a connecting arrow from the groundwater block to the surface water. Where applicable, the individual DERA sites should include a CSM with a discussion of the likelihood for the potential groundwater to be discharging to surface water.	The general conceptual site model will be revised to include this potential exposure pathway	Comments addressed per ET's response.	

Comment #	Section	Comment (EPA/IDEM as indicated in comment number)	Original Response to Comment (ET)	MW Revised Response (if applicable)	Agency Concur
EPA140	Figure 05-4	17. **Page 5-37, Figure 5-4, Site Specific Conceptual Model:** Based on a review of the entire risk assessment methodology, this model lacks the following: Future Construction Worker contact with: • Surface Soil - Incidental Ingestion, Inhalation of VOCs and Particulates, Dermal Contact • Subsurface Soil - Incidental Ingestion, Inhalation of VOCs and Particulates, Dermal Contact • Groundwater - Inhalation of VOCs, Dermal Contact (and ingestion should a water supply well be installed - this is considered when evaluating the future on-site worker scenario) All Current and Future Receptors contact with: • Subsurface Soil - Inhalation of VOCs • Groundwater - Inhalation of VOCs Future Maintenance Worker contact with: • Surface Soil - Incidental Ingestion, Inhalation of VOCs and Particulates, Dermal Contact • Subsurface Soil - Inhalation of VOCs • Groundwater - Inhalation of VOCs Current/Future Agricultural Worker contact with (assumed to already have contact with contaminated beef and milk): • Surface Soil - Incidental Ingestion, Inhalation of VOCs and Particulates, Dermal Contact • Subsurface Soil - Inhalation of VOCs, Inhalation of VOCs and Particulates, Dermal Contact • Groundwater - Inhalation of VOCs, Dermal Contact Future Beef and Dairy Cattle (milk) concentrations could be influenced by surface soil concentrations as well as groundwater if used for stock watering.	See response to General Comment 5 (EPA120). The future agricultural worker is identified in the assessment as the rural resident at each site and the rural resident was evaluated for the pathways specific for surface soil and subsurface soil. At every site where groundwater data were available, inhalation of shower VOCs and dermal contact with groundwater were evaluated if the concentration exceeded the tap water PRG.	Comment addressed as discussed at EPA 120a.	
EPA78	Figure 13-5	9. **Page 13-13, Figure 13-5:** April of 1996, show the groundwater elevation at MW-93-47 to be 848.23, which is lower than any of the monitoring wells at the site yet the "inferred groundwater flow direction" is away from this well. How can this be explained?	The data and contouring for all potentiometric contour maps will be re-evaluated and revised as necessary. See comment EPA14d response, page 23.	The figure was revised to correct the erroneous water elevation.	
EPA79c	Figure 13-5	Figure 13-5, June 1996, shows the groundwater contours to the south of Building 602 meeting at a trough, (water is flowing to the east from the left side of the figure and water is flowing to the west from the right side of the figure). Shouldn't the inferred ground water flow then be drawn going to the northeast where monitoring wells are located indicating a deeper piezometric surface? This appears to be half finished work.	Potentiometric contour maps will be reviewed for consistency and revised as necessary. See comment EPA14d response, page 23.	Comment addressed per ET's response. Additional data and explanation are provided.	
EPA46	Figure 13-12, Figure 13-13	20. **Figure 13-13, Distribution of 1,1-Dichloroethylene, Page 13-49:** Figure 13-13 depicts the contaminant concentrations map for Site 12A (for 1,1-dichloroethylene). Based on comparisons with Table 13-6, the analytical data are from Round 4 of the groundwater sampling at the site. No values are labeled for the well points that had concentrations of 1,1-dichloroethylene. Revise the figure to include the data from the well points or provide an explanation in the text for limiting the data used to monitor well data. Also, see General Comment 1.	The title of the figure will be changed to "Distribution of TCE in Bedrock Groundwater from June 1996 Sampling Round". The well point contamination in the Illinoisan Till is shown in Figure 14-12. The caption of Figure 13-12 will be revised to read: "Volatile Organic Compounds in Illinoisan Till Groundwater at Building 602 Solvent Pit (Site 12A).	Figure 13-13 was revised to show monitoring well and probe hole groundwater data. Figure 13-14 shows well point data. Other additional data is presented as appropriate.	
EPA79a	Figures 13-xx	5. **Section 13:** Most of the figures in Section 13 show what appears to be computer generated groundwater contours which make no sense at all. They almost look like military maneuver maps, i.e., Figure 13-5, June 1996; Figure 13-6, June and November of 1996; and Figure 13-7, December of 1996. Almost all of these maps show groundwater flow north from Building 602, which is opposite of the statement of page 13-2, which states "groundwater flow primarily to the southwest." How can this all be explained?	Further explanation is provided in Section 13.1.1.2. Facility-wide and regional groundwater flow is to the southwest and although there are localized variations in flow, the data from Building 602 support a primary flow direction to the southwest. The data and contouring for all potentiometric maps will be reviewed and revised as necessary. However, downhole flow meter measurements generally support the interpretations derived from the potentiometric maps.	Comment is addressed per ET's response.	
EPA79b	Figures 13-xx	Contour intervals are inconsistent on some maps (e.g., Figure 13-4 June 1996, and Figure 13-5, October 1996). Please be consistent.	Potentiometric contours maps will be reviewed and revised as necessary. See comment EPA14d response, page 23.	Comment addressed per ET's response.	
IN8	Table 01-4	**Table 1-4, Page 1-28:** This table provides a summary of previous findings and the rationale for removing sites from the RI/FS. As stated in the previous comment, it should be stated that a public notice is required prior to the site being removed from the RI/FS. Additionally, the current status (concurrence by regulators or unresolved issues pending) should be included in Table 1-4. (now Table 1-5)	The table (now Table 1-5) will be revised to include the current status. A statement will be added indicating that public notice will be required prior to formal removal from the RI/FS. The following footnote will be added to Table 1-4 in Section 1.5: "Note.—Before sites are removed from the RI/FS, a public notice will be issued as required under CERCLA Section 117."	Table 1-4 has been updated as indicated in ET's response.	
EPA160	Table 05-11	36. **Page 5-64, Table 5-11, Variable Values for Inhalation Pathway:** The off-site resident category (at Middle Fork Creek) appears to be a recreational type exposure scenario, rather than a residential scenario. Labeling these individuals as "residents' is misleading.	See response to General Comment 5 (EPA120).	Table revised as requested.	

Comment #	Section	Comment (EPA/IDEM as indicated in comment number)	Original Response to Comment (ET)	MW Revised Response (if applicable)	Agency Concur
EPA161	Table 05-12	37. **Page 5-67, Table 5-12, Variable Value for Ingestion:** Soil ingestion is not limited to just direct contact with outdoor soil, but also included soil-derived dust. Therefore, the exposure frequency for soil ingestion should be the entire work period (i.e., 250 days per year).	As specified in the HHRAWP, the soil ingestion rate due to dust in the three winter months is assumed to be negligible. Therefore, soil ingestion was only modeled for 9 months of the year for the worker. Since the ingestion rates for the residents already account for seasonal variation, these receptors were modeled to be exposed to soil 350 days/year.	The exposure frequency was adjusted from 189 days/year to 250 days/year for the on-site worker as requested.	
EPA170a	Table 05-25	46. **Page 5-91, Table 5-25, Chronic Oral Toxicity Values:** The footnotes for the lead toxicity should cite the EPA Integrated Exposure Uptake and Biokinetic (IEUBK) Model and the EPA Adult Lead Exposure Model as the methods for assessing lead exposure, rather than citing no data.	The footnote will be changed to cite the sources of the lead screening values used in the assessment. .	Table revised as requested.	
EPA13e	Table 12-9	In Section 12.3.2.4, Groundwater, the text notes that 11 monitoring wells were sampled during the Phase II investigation at Sites 9 and 10, however, the specific wells are not identified. In addition, it is unclear why groundwater monitoring results are presented for Phase I and Phase II sampling only. Table 12-9 identifies the well numbers for each detected concentration, but does not provide the sampling rates. The specific wells sampled and the dates of sample collection are critical to the determination of contaminant distribution and concentration variation over time (i.e., trends).	Text will be updated to include a discussion of the wells sampled during Phase II. Earlier historical data were not presented due to unknown data quality. A column will be added to Table 12-9 indicating the sampling date.	Text has been added to this section to provide more detail on the sampling.	
EPA42	Table 13-6	16. **Table 13-6, Analytical Results for Groundwater Samples from the Building 602 Solvent Pit (Pit 12A), Page 13-40:** This table identifies the individual sampling rounds, but does not state when each round was completed. For clarification purposes, revise the text in the table or add a key to identify the month and year of each round.	A footnote will be added to the table that identifies the sampling dates (month and year) for each round.	Footnotes have been added to tables to identify groundwater sampling rounds.	
EPA13h	Table 15-5	Section 15.0 identifies three wells installed as part of the 1989 ESE RI, however, Table 15-5 only contains analytical data from well MW88-15 and not wells MW88-14 and MW88-16. Analytical results for wells MW88-14 and MW88-16 should be added to Table 15-6.	Results for wells MW88-14 and MW88-16 were all less than the reporting limit or non detects for VOCs. This information will be added as a footnote to Table 15-5.	Comment was addressed with a revised table incorporating new data.	
IN33	General	1. As stated at the beginning of this letter, the Human Health Risk Assessment portion of the Draft Phase II Remedial Investigation was not evaluated and comments pertaining to the HHRA will be deferred to EPA's review of this document.	No response required.	No response required.	
IN34	General	2. Although there are numerous corrections needed, the general conclusions and recommendations of this document are acceptable. The sites planned for no further action technical memorandums are adequately characterized and suitable for deletion from the RI/FS. Sites which exceed risk management criteria are recommended to be carried forward to this Feasibility Study.	No response required.	No response required.	
IN35	General	3. A major deficiency in the general base characterization is the lack of an evaluation of the area south of the firing line, but directly north of the firing positions. Cannon sites in these 268 positions have fired many millions of rounds of munitions over the fifty-four years of active testing. In spite of the fact that explosives and metals residues have undoubtedly accumulated in front of the guns, no testing in these areas has been reported. The fact that such contamination exists, and in significant amounts, can be seen in Section 12.5.5, where explosives contamination in the Gate 19 Landfill pond is attributed directly to "surface-water runoff from the nearest firing position located about 2,000 feet east of the pond." If run-off from 2,000 feet away can raise the concentrations in a pond (after dilution) to above Region 9 PRGs, then the contaminated area must be investigated and evaluated.	This comment will require additional discussion during the upcoming comment resolution meeting. During all previous investigations it was agreed that everything south of Firing Line Road was to be included in the RI/FS. The area described is north of the area previously defined.	Comment was clarified in the Final Meeting Minutes (June 16 and 17, 1999). Topography indicates surface water flow north of the firing line does not flow south of the firing line.	

Comment #	Section	Comment (EPA/IDEM as indicated in comment number)	Original Response to Comment (ET)	MW Revised Response (if applicable)	Agency Concur
IN36	General	4. As stated in previous comment letters and throughout this letter, IDEM staff have concerns regarding UXO safety issues south of the firing line. Several areas south of the firing line previously classified by the Army as areas with no potential UXO and not subject to a UXO survey have had UXO discovered on them. With the potential for UXO to be anywhere on base, no area of JPG should be classified by the Army as areas with no potential UXO.	Comment noted. References to areas having no potential for UXO will be deleted. Additional wording will be added as necessary that describes the Army's ongoing UXO surveys that have cleared many areas to a depth of 4 feet. The Army conducted an archive search report, which identified areas of potential UXO concerns. These areas are being cleared to a 4-foot depth as agreed upon by the Army. The UXO investigations consist of identifying all metal hits with flagging of various colors. The colors indicate the size or intensity of the measurement indicating buried metal. All flagged hits are excavated and observed. Potential HE UXOs are detonated in place. Scrap metal is collected and removed off-site for disposal at a recycling facility. Surveys that have been or are in the process of being conducted include an area east of Shun Pike Road (800 acres), the Airport Parcel (500 acres), an area west of Tokyo Road (400 acres), an area along the Firing Line Road in the NE portion of the Cantonment Area (49 acres), and an area east of Engineers Road (100 acres). Other areas in which UXO are discovered by either Interim Removal Actions, frost heave or accidental discovery will be handled by the Army on a site-by-site basis. The Army intends to handle its responsibility with regards to UXO issues as they arise. Deed restrictions will also be included in future land transfer with relation to UXO concerns. These deed restrictions will be incorporated in the FOST and land transfer deed documents.	No additional response needed.	
IN37	General	5. Remediation by excavation, disposal off site and backfilling with clean fill has occurred at a number of sites. However, the confirmational sampling after remediation and the health risk evaluation indicated a number of remaining problems in the soil below the backfill at Sites 28, 31 and 39. These sites are recommended for no further action. These sites should have deed restrictions that forbid unprotected excavation and residential use. Without deed restrictions, these sites pose a human health risk due to the possible inhalation of wind blown dust and the ingestion of soil and garden fruits and vegetables. The sites typically have high metal concentrations such as Manganese in the soils below the backfill.	Of the sites referenced, only Site 28 was included for interim remedial action, and the confirmation results for Site 28 show that no remaining contaminants exceed risk-based cleanup criteria and that cleanup was complete. For sites 31 and 39, manganese is once again the major contributor to potential health hazards for hypothetical future residents. As described for several other sites, there appear to be high background concentrations of manganese in soils at JPG. Further evaluation of manganese may be warranted before deed restrictions are considered for these sites.	No additional response needed.	
IN38	General	6. The status (concurrence by regulators or unresolved issues pending) of the technical memorandums that have been completed and submitted for regulatory review to support a recommendation for no further action under CERCLA should be provided. Additionally, the sites that were not carried forward from the Phase I RI to the Phase II RI should be public noticed before removal from the CERCLA process.	The status of the technical memoranda should be discussed during the upcoming comment resolution meeting. Once the status is determined, the requested information can be included.	Section 1 and the Executive Summary have been modified to address this comment.	
IN39	General	7. Nine sites have undergone or are in the process of undergoing interim removal actions. The current status of the removal actions should be summarized. This summary should include what action was taken, when the confirmatory sampling and closure reports were completed, and what future action, if any, is required at each site. Additionally, the pending issue regarding stockpiling of hazardous waste at several interim removal sites should be mentioned.	A summary of the interim removal actions will be included as requested. However, it should be noted that the Phase II RI Report represents a snapshot in time and should be treated as such. Since cleanup activities continue at JPG, the RI Report can never be 100 percent current especially in light of the review cycles involved.	Comment addressed per ET's response.	
EPA1a	General	The presentation of analytical data and associated sampling locations in Section 6 through 27 is inadequate. These data do not provide a complete picture of the investigation results or the nature and extent of contamination. There are numerous places in the draft RI Report where analytical results are discussed, but locations and dates of sampling are not identified. In addition, in several sections the analytical data are presented for only one contaminant, and data presentations are limited to the monitoring wells or groundwater well points only. Thus, the reader cannot determine the distribution of contamination in different media at each of the sites. General Comment 1 addresses this issue, and provides the Army with a select number of examples of these deficiencies.	Where missing, location maps will be added or revised to include all previous sampling. Discussions of analytical results will be revised to include all media sampled. In terms of contaminant distribution maps, the emphasis will continue to be placed on showing those contaminants identified as potential contaminants of concern. This will keep the document to a manageable size while still presenting the critical information necessary to make informed remedial action decisions. Additionally, a large amount of detailed initial screening information (i.e., probehole data) was previously provided in two documents (*Summary of Field Screening: Jefferson Proving Ground* (Rust E&I 1993a) and the *Jefferson Proving Ground South of the Firing Line Final Draft Remedial Investigation* (Rust E&I 1994). A synthesis of these results will be provided. Additional references to these previous documents will also be added as required to further support the appropriate nature and extent discussions.	Refer to response to EPA13a.	
EPA1b	General	The incomplete presentation of the nature and extent of contamination is also addressed under the "Ecological Risk Assessment Comments."	Comment noted.	Refer to response to EPA13a.	
EPA1c	General	Because the nature and extent of contamination has not been adequately presented in the Draft RI Report, the conclusions presented in the Summary of Contamination sections are not well substantiated. This issue is addressed in General Comment 2.	Comment noted.	Comment noted.	

Comment #	Section	Comment (EPA/IDEM as indicated in comment number)	Original Response to Comment (ET)	MW Revised Response (if applicable)	Agency Concur
EPA2b	General	Many of the samples collected during the Phase I RI investigation were analyzed using U.S. Army Corps of Engineers (ACOE) test methods. The procedure within these methods are different than those in U.S. EPA's SW-846 methods.	Comment noted. The methods used for Phase I were required by USATHAMA rather than the COE. In some cases, QA/QC requirements for USATHAMA-Certified Methods were not as stringent as SW-846 methods. However, the laboratory met the requirements for USATHAMA when performing the analyses. Problems in meeting EPA functional guidelines resulted in the change to using only EPA methods for Phase II investigations. Phase II samples were designed to replace questionable Phase I results.	No additional response needed.	
EPA4b	General	The Draft RI Report states that the eight sites were identified in a Technical Memorandum (June 1997) which was submitted to regulators for approval. According to the Draft RI Report, following a meeting between the U.S. Army Corps of Engineers (ACOE), U.S. EPA and the Indianan Department of Environmental Management (IDEM) on August 14, 1997, a final Technical Memorandum was submitted and a final Preliminary Ecological Risk Assessment (PERA) was revise, reportedly based on direction provided by U.S. EPA. Our comments do not include an assessment of the validity or appropriateness of eliminating sites prior to the DERA. Based on the review of information provided in our files, we agree that the elimination of sites was previously reviewed and approved by U.S. EPA.	No response necessary.	No response needed.	
EPA4c	General	There were several significant issues identified during the review of the DERA, including insufficient characterization and assessment of surface water bodies at JPG, lack of site-specific conceptual site models and the lack of a toxicity assessment (among many other deficiencies) that have not been addressed in the Draft Phase II RI Report (August 1998). It appears that the DERA may require major revisions.	Comment noted. This issue should be discussed in the upcoming comment resolution meeting.	This comment has been addressed by specific responses addressed in this table.	
EPA11	General	1. **UXO Issues.** EPA has cited in several comment and comfort letters (past and present) many concerns regarding UXO safety issues and potential contamination threats to human health and the environment. As proven by Site 14 - Yellow Sulfur Disposal Area, Site 49 - Explosives Pit Area, etc., there is a potential for UXO to be found anywhere at JPG (including north and south of the firing line). This should be included in the revised Phase II RI Report, as appropriate.	Additional text will be added that describes the potential for UXO and the Army's on-going efforts to identify and remedy the areas with UXO hazards. The Army conducted an archive search that identified areas of potential UXO concerns. These areas are being cleared to a depth of 4 feet as agreed upon by the Army. The UXO investigations consist of identifying all metal hits with flagging of various colors. The colors indicate the size or intensity of the measurement indicating buried metal. All flagged hits are excavated and observed. Potential HE UXOs are detonated in place. Scrap metal is collected and removed off-site for disposal at a recycling facility. Surveys that have been or are in the process of being conducted include an area east of Shun Pike Road (800 acres), the Airport Parcel (500 acres), an area west of Tokyo Road (400 acres), an area along the Firing Line Road in the NE portion of the Cantonment Area (49 acres), and an area east of Engineers Road (100 acres) Other areas in which UXO are discovered through interim removal actions, frost heave, or accidental discovery, will be handled by the Army on a site-by-site basis. The Army intends to fulfill its responsibility with regards to UXO issues as they arise. This information will be added to the revised RI Report. Deed restrictions will also be included in future land transfer with relation to UXO concerns. These deed restrictions will be incorporated in the FOST and land transfer deed documents.	Comment addressed per ET's response.	
EPA12	General	2. **9 RCRA Interim Measures Sites, South of the Firing Line.** All updated information regarding RCRA regulations (including stockpiled soils, 90-day storage exceedance sites, etc.) must be included in the revised Phase II RI Report.	Much of the interim measures information was still outstanding at the time these comments were received. The next version will contain as much updated information as possible. It should be noted that activities continue to be ongoing (i.e., Yellow Sulfur Area) and the report will never be 100 percent current.	Interim measures have been added throughout.	

Comment #	Section	Comment (EPA/IDEM as indicated in comment number)	Original Response to Comment (ET)	MW Revised Response (if applicable)	Agency Concur
EPA13a	General	1. The presentation of analytical data and associated sampling locations in the sections on individual sites (Sections 6 through 27) does not provide a complete picture of the investigation results or the nature and extent of contamination. All dates, locations, depths, and analyses performed for each sample should be presented for all investigations at the site. The results should then be summarized for all samples and presented in tables and maps as appropriate. The information provided should include all detected concentrations of organic constituents and concentrations of all inorganic constituents that exceed background concentrations. This information is critical for establishing contaminant distribution within the sites. Several examples of incomplete data presentation are presented below. Please note that these are a selected number of examples, and several other areas of incomplete data presentation exist. Therefore, Jefferson Proving Ground (JPG) should revise each applicable section of the Draft Remedial Investigation (RI) Report to ensure all investigative data are properly presented.	Additional information will be added as practical. With the exception of the screening-level probehole data collected during Phase I, the sample data for detected organics and inorganics above background are already provided in the existing draft. In an effort to keep the document to a manageable size, the emphasis has been placed on presenting contaminant distribution information for only those contaminants that impact the assessment of potential risks to human health and the environment and the subsequent remedial action decisions. Additional contaminant distribution maps will be provided for groundwater contamination at the solvent pit sites to provide a more complete picture of the contaminant distribution. Additionally, Phase I probehole results will be added where appropriate. For metals, contaminant distribution maps will continue to be limited to those contaminants that exceed risk-based concentrations and are major contributors to potential risks to human health and the environment. Otherwise, each site would contain 26 individual distribution maps for metals that would add little value to the conclusions and recommendations.	During the June 16 and 17, 1999 face-to-face meeting, EarthTech agreed to update contaminant distribution maps for each analyte that exceeded Region IX PRGs for the Human Health Risk Assessment to show all analytical data on a map when the analyte had one or more PRG exceedances. In addition, they agreed to develop the same type of distribution maps for the ecological risk assessments for analytes that have HQ greater than 1. The first task was not performed, because there was not considered to be enough added value to justify the cost of producing these updated maps. The primary reason for this is that the PRGs are a "preliminary" screening benchmark, and do not necessarily earmark a location of human health concern. It is rather more appropriate to focus on analytes that are considered to pose a risk based on the results of the risk assessment. In terms of the ecological risk assessment, a more detailed discussion of the risk drivers and an overall summary of the lines-of-evidence has been included instead of ecological distribution maps. Distribution maps which were already available for the key drivers are cross referenced in the ecological risk assessment when a particular risk driver exceeds reference area HIs.	
EPA13b	General	Geoprobe™ field-screening surveys were performed at several sites and both soil sampling and groundwater sampling data were generated. While the text in some sections includes descriptions of the number of boreholes, other related information such as the probehole locations, depth and number of samples, and sample dates frequently are not presented.	Detailed summaries of Geoprobe results were provided in two previous documents and were not included in this draft. However, as requested, information concerning probehole location and depth, number and date of samples, etc. will be added in the next version.	Comment addressed per ET's response.	
EPA13j	General	In addition, the Nature and Extent of Contamination sections contain very limited mapping of contaminant concentrations. In several sections, the analytical data are presented for only one contaminant and data presentations are usually limited to the monitoring wells or well points only. Given that several contaminants and numerous monitoring points are present at some of these locations, it would be helpful to present additional maps of other contaminants. A map showing total VOCs may also be applicable at selected sites.	Every effort was made to present the contaminant distribution maps for primary contaminants of concern to keep the document to a manageable size. Additional contaminant maps will be added as required to provide a more complete picture of contaminant distribution. However, we will continue to focus on primary contaminants of concern. Each section will be reviewed for data presentation completeness and additional information will be added as necessary.	See response to EPA13a.	
EPA14a	General	2. The conclusions presented in the Summary of Contamination sections are not well substantiated based on the information provided. The lack of adequate data presentation (as described in General Comment 1) does not allow for a complete evaluation of the characterization of the nature and extent of contamination at each site, and therefore the conclusions could not be verified by the reviewers.	Data presentations will be revised to address the reviewers' concerns. Primarily, data presented in detail in previous documents will be synthesized and presented in the Phase II report to provide a more complete picture of contaminant nature and extent. Additional maps will be prepared that include this information. Additional individual contaminant distribution maps will be added when they are important to support the conclusions.	See response to EPA13a.	
EPA14e	General	In addition to data presentation issues, a significant amount of data were rejected as part of the data evaluation for many of the sites. Although there may be valid reasons for the rejected data, the remaining data set may be limited due to the rejections. This raises questions as to whether the nature and extent of contamination has been adequately defined at all of the sites.	Phase II characterization activities were designed to fill data gaps identified following Phase I as a result of suspect or rejected data. The use of USEPA methods versus USATHAMA methods significantly reduced the amount of problematic data. Sufficient data exist to allow risk management decisions to be made. Additional data may be required to complete remedial action design at some sites. No further investigation under the RI is recommended.	Comment has been addressed on a site by site basis.	

Comment #	Section	Comment (EPA/IDEM as indicated in comment number)	Original Response to Comment (ET)	MW Revised Response (if applicable)	Agency Concur
EPA14f	General	The characterization of contamination at each site needs to be reevaluated after the data collected has been more completely analyzed and presented. Any conclusions drawn should be clearly supported by analytical results. At sites where data were rejected, the potential data gap created by the rejected data should also be evaluated.	Revised data presentations will be used to better support the conclusions of contamination. As discussed in detail in Section 5 (i.e., Section 5.1.4.1 and Section 5.1.4.4.4) sites with rejected data from Phase I were resampled during Phase II and the Phase II results were used to replace the rejected data. As a result, data gaps are considered to no longer exist.	The data used to characterization the extent of contamination is presented in the data validation section for each site.	
EPA15	General	3. An RI was conducted by ESE and documented in a 1989 report. In several sections of the current RI report, the ESE investigation is summarized by listing the contaminants that were found in the soil samples collected. The results showed several contaminants present in soil, but the locations, depths and concentrations of these samples were not provided. For each site investigated as part of the 1989 ESE report, summary tables and/or maps should be generated to present the data collected and conclusions drawn from the data collected at that time. When appropriate, these data should also be included in the human health and ecological risk assessments.	ESE data, such as sample locations, depths, and concentrations, will be shown on figures when appropriate. Use of the data in the risk assessment is not appropriate without proper validation unless used only in a qualitative context.	Comment addressed per ET's response.	
EPA17	General	5. The introductory sections to the human health risk assessment do not provide sufficient information regarding the data sets used in the risk assessments. In the sections for some sites, the text does not state which analytical data were used for the risk assessment or why those data were chosen. For example, groundwater samples were collected in temporary well points at several locations. It is unclear why these data were not included in the risk assessment. Include a discussion of the analytical data used and provide the reasoning for excluding any data that were not used. Reference(s) to applicable sections of the risk assessment will address this deficiency.	A new subsection will be added to each Study Area Investigation Section for each site, identifying the specific data sets that were used in the risk assessments. This section will also identify which data were not used and why.	Within each site-specific section of the human health and ecological risk assessment, cross-references have been added to alert the reader where they can find a summary of the samples used in the risk assessment. For the human health risk assessment, the reader is referred back to the Data Evaluation section of the report. For the Ecological Risk Assessment, the reader is referred to tables in Appendix AA that were developed to address this specific comment.	
EPA18	General	6. Throughout the Draft RI Report (and particularly in the Data Evaluation section for many of the sites), the analytical results are listed by sample number. These numbers are extremely cumbersome when trying to determine the locations, depths, and dates associated with these samples. In some cases, the sampling location is listed on the same figure or table, for example, figure 13-12 on page 13-43. However, only the sample number is listed in several cases, for example in Sections 13.4.1 and 13.4.2. In these cases, it is not readily apparent when or where these samples were collected. Provide pertinent location and sampling date information in addition to, or in place of, the sample numbers.	This request requires further discussion in the upcoming comment resolution meeting. A footnote will be added to tables where multiple rounds of sampling occurred to clarify sampling dates. For wells, both the well ID and corresponding sample number will be shown on figures and tables. For borings, boring ID, depth, and corresponding sample number will be shown. For surface samples, only the sample ID will be included and the term “surface” will be defined on the figure or table. These changes will aid in the interpretation of the sample data and discussions.	Comment addressed per ET's response.	
EPA22	General	10. Several figures depicting contaminant concentrations identified some concentrations as zero. These results are not actually zero, but indicate that the contaminant was not detected at the detection limits. Revise figures to indicate that the contaminant of interest was below detection limits.	The figures will be revised to indicate that contaminants were not detected at the detection limits (i.e., were below detection limits).	Figures were not revised however, it is recognized that "zero" denotes results less than detection limits.	
EPA23	General	11. Several figures throughout the report provide analytical results with Installation Restoration Data Management Information System (IRDMIS) abbreviations. These figures note that IRDMIS abbreviations are not standard. For clarification purposes, either provide a key to the abbreviations or use standard abbreviations.	A key to abbreviations will be provided	A key to abbreviations is provided in Appendix N.	
EPA24	General	12. Analytical results tables should contain all information necessary to determine if identified contaminants are below, at, or above regulatory levels. It is suggested that all analytical results tables contain regulatory levels for contaminants identified at each site.	The requested information is already presented in the screening tables that are presented in the risk assessment sections.	No additional response needed.	
EPA25	General	13. Several sites contain information concerning geophysical surveys. It would be helpful if a short paragraph were inserted to discuss results of these surveys. Also, figures containing the survey grid and any survey anomalies would greatly enhance the geophysical survey discussion.	Discussions of geophysical survey results will be added as requested.	Comment addressed per ET's response.	
EPA26	General	14. Tables throughout the report utilize “LT” for results of analytical analyses below the detection limit. The qualifiers “U” and “UJ” are also presented within the report. In order to assist the reader in evaluating flagged data for non-detected results, revise the Draft RI Report to provide a definition of each qualifier within Sections 6 through 27, preferably at the beginning of each section.	Definitions will be added to individual tables as requested.	Qualifier definitions have been added to Appendices N, O, and P.	
EPA64	General	1. Several of the figures that present analytical data do not clearly state the hydrostratigraphic units associated with the contaminant concentrations. Revise the appropriate figures to include the hydrostratigraphic unit being mapped.	The unit being mapped is identified in the titles of the figure (i.e., bedrock or Illinoisan Till) both at the top and bottom of the page.	Comment addressed per ET's response.	
EPA65	General	2. Numerous references throughout the text direct the reader to a figure or table that does not provide the indicated information. Review all references to ensure the appropriate figure or table is cited.	Figure and table references will be reviewed throughout the report and corrected as necessary.	Comment addressed per ET's response.	

Comment #	Section	Comment (EPA/IDEM as indicated in comment number)	Original Response to Comment (ET)	MW Revised Response (if applicable)	Agency Concur
EPA75a	General	6. **General Comment:** Overall, it appears that a good job was done regarding well construction. There were times during well development when the Army's contractor didn't follow through until 5 NTUs were achieved. Also, during sampling, 5 NTUs or a non-turbid state were not always achieved. However, the overall job regarding well construction seems to be very good.	No response required.	Refer to Comment EPA29.	
EPA75b	General	It seems that many of the ground water contour maps were constructed using data from a very small area with very little variation in the wells. This makes the maps look more like battle maps of troop movements instead of a good piezometric map. Perhaps it was the program that was used to draw the contours, as suggested in the subject report. A good example of this is located in Section 15.	The contour maps will be revisited and improved where possible. Since the surface is essentially flat, contouring of the data is somewhat problematic. This problem was recognized following the Phase I investigation and that is why downhole flow meter data were collected to verify the inferred flow directions based on the potentiometric contour maps. See EPA comment 14d, Page 23 for a description of the proposed changes for the revised maps.	Comment addressed per ET's response.	
EPA84	General	1. Throughout Sections 6 to 27 the text states that practical quantitation limits (PQLs) were rejected due to insufficient calibration or low response in the calibration. From this statement it is unclear if the results were rejected or reported at a higher PQL. Additionally , rejection of the PQL is not part of the Functional Guidelines for Organic Data Review. Revise these sections to provide an explanation of how samples with rejected PQLs were reported. In addition, Sections 6 to 27 should describe how these rejected PQLs were used in the human health and ecological risk assessments. This issue also merits discussion within the risk assessments.	Information in the text is misleading. The results, not the PQLs, were rejected. Text will be revised to state that the results were rejected rather than the PQLs in Section 8 and Sections 12 through 16. The comment is not applicable to other sections.	Text has been revised to indicate which analytes were considered unusable (rejected) and qualified "R".	
EPA85	General	2. The data from Phase I of the RI was not flagged according to the procedures outlined in the Functional Guidelines for Inorganic and Organic Data Review. For example, in the Phase I DQA Summary (Appendix P, page 11) it states that numerous target analytes (metals) were detected in the soil method blank, but that laboratory contamination was not evaluated with this blank. Instead laboratory contamination was evaluated from the calibration blanks. According to the Functional Guidelines for Inorganic Data Review, method blank contamination must be taken into account, and detected analytes must be flagged in any associated samples. Additionally, no interference check samples were submitted with the Phase I ICP data, therefore the calibrations cannot be verified according to the Functional Guidelines. Since the validation of the Phase I RI data using the Functional Guidelines for Inorganic and Organic Data Review should not affect the overall usability of the data, this comment has been included for informational purposes only.	The results, not the PQLs, were rejected and were not used in either risk assessment. Text currently states that rejected data were not used and no further changes are proposed.	Text has been revised to indicate which analytes were considered unusable (rejected) and qualified "R".	
EPA116	General	1. **Jefferson Proving Ground (JPG) Cancer Risk Point of Departure:** Sites at JPG with total cancer risk estimates which did not exceed U.S. EPA's upper bound cancer risk threshold of 1.0E-04 were proposed for No Further Action (NFA) classification and were not carried forward to evaluation within the Feasibility Study (FS). Typically, risk estimates below 1.0E-06 are not considered indicative of significant concern, alternately, risk estimates in excess of 1.0E-04 generally require some amount of remedial action of interim measure to mitigate exposures. Within the range of 1.0E-04 to 1.0E-06, U.S. EPA must make a judgement on whether exposures are acceptable based on the degree of conservatism inherent in the analysis. Many of the sites proposed for NFA exhibit total risk estimates in excess of 1.0E-05 and hazard estimates in excess of 1.0. Hazard exceedances do not span orders of magnitude and thus are not assumed to represent significant human health impacts. U.S. EPA Region 5 will review the estimates of cancer risk for sites proposed for NFA for final determination of acceptable risks and hazards.	The reviewer is correct in stating that USEPA must review the results of the risk assessment and determine if the site should go towards NFA or not. These statements will be deleted from the appropriate sections in the risk assessment.	This is a risk management decision.	
EPA117	General	2. **Anthropogenic Background:** Although the risk assessment makes pointed mention that Remedial Investigation (RI) activities were designed to evaluate potential background anthropogenic contamination (specifically, dioxins), it also specifically mentions that any and all detections of these contaminants would be carried through the risk assessment process and would not be removed from consideration of total risk attributable to exposed receptor populations. Ubiquitous anthropogenic contamination, like dioxin, can result from a host of non-point sources such as automobile exhaust. It is extremely difficult to conclusively demonstrate that such chemicals are present at the site due to operations not related to the site or the surrounding area. In any case, all anthropogenic sources of contamination should be considered in an estimation of the total indices of carcinogenic risk and non-carcinogenic hazard attributable to all exposed or potentially exposed receptor populations.	All anthropogenic background data (i.e., dioxin data) were included in the risk assessment; however, if the dioxin exposure point concentration was less than the risk-based screening criterion, dioxins were not further evaluated in the assessment.	The explanation from EarthTech in their response to comment was incorporated into Section 5.0. In addition, it should be noted that because of the small number of dioxin samples collected, the exposure point concentration for dioxins was by default the maximum concentration detected. .	

Comment #	Section	Comment (EPA/IDEM as indicated in comment number)	Original Response to Comment (ET)	MW Revised Response (if applicable)	Agency Concur
EPA118	General	3. **Groundwater Data:** The risk assessment groups groundwater data by investigation area, or site, and advances quantitative analysis on an upper-bound estimate of the mean, the 95% Upper Confidence Limit (UCL), as the exposure point concentration (EPC). Typically, U.S. EPA prefers to group all groundwater data relevant to a particular facility together and advance quantitative analysis on the maximum detected concentrations for an estimate of reasonable maximum exposures (RME) and also on the mean concentrations for an estimate of central tendency exposures (CTE). Groundwater data are more frequently divided by impacted aquifer. Site- or area-specific groundwater data may sometimes be divided on the basis of perched and localized groundwater. The JPG risk assessment methodology, through this division of groundwater by individual site, may propose a more conservative basis for evaluating exposures, assuming equal exposures under future residential use. However, this methodology with it's EPC basis on the 95% UCL may tend to imply a greater level of detail or knowledge about localized groundwater concentrations than is presently known or may be surmised. This is not, however, an entirely inappropriate approach, but must be evaluated carefully within the Uncertainty Section of the risk assessment.	The comment by the reviewer is noted. A discussion of this point will be added to the uncertainty section.	Comment addressed per ET's response.	
EPA121	General	6. **Subjective or Other Statements Made on the Basis of Professional Judgement:** An effort should be made by the authors to remove professional judgement statements and subjective determinations from the body of the text of the risk assessment. Generally speaking, these statement or discussions are appropriate only for the Uncertainty Section. Statements such as, ". . .this scenario is unlikely to ever occur. . ." (page 5-45) or ". . .guaranteed to be safe for everyone. . ." (page 5-89) are particularly troublesome. In some instances, this information, while not entirely presented upon the basis of fact at the particular site in question, is still relevant. In these cases, the author should make an effort not to proffer or present interpretation as known or highly certain fact.	An attempt will be made to remove all professional judgment statements and subjective determinations from the body of the text in the revised draft RI.	Comment addressed per ET's response.	
EPA178	General	1. The site description indicates that there are ten lakes ranging in size from one acre to 165 acres associated with JPG. In addition, there are three surface water systems that drain the area south of the Firing Line. The surface water ecosystems associated with JPG are inadequately described and/or investigated. Future use of the site appears to be recreational and apparently will be used to support wildlife. Surface water and sediment samples to characterize the significant water bodies within the watershed that are influenced by the activities at JPG have not been adequately discussed or presented on figures. Supplemental surface water and sediment sampling from the creeks and lakes should be considered since the Base will be transferred for public use and appropriate characterization of these water bodies has not been documented at this time. It is recommended that the Army document the status of these aquatic ecosystems upon transfer. In addition, surface water and sediment should be samples at the Base boundary to determine if there are any concerns regarding off-site discharges.	The area south of the Firing Line is most likely to be used for industrial and agricultural purposes. The current lessee (also the future owner) has already planted extensive crops and has proceeded to lease many of the existing buildings for a variety of commercial activities. Recreational use is expected to be a minor component. JPG north of the Firing Line (some 51,000 acres) will remain under Federal ownership. The scope of the DERA was agreed upon by the EPA, IDEM, USAEC, and the USACE in the form of a BTAG. The field sampling activities were based upon specific direction from the EPA (Rust E&I 1997f through I). The regulators visited the DERA sites and agreed upon their inclusion in the ecological assessment. The DERA is restricted to the area south of the Firing Line. Harberts Creek is the primary stream associated with the facility south of the Firing Line and was included in the DERA.	No response needed.	
EPA179	General	2. The Detailed Ecological Risk Assessment (DERA) indicates that all sites are considered to have sufficient sampling to either proceed to a feasibility study or no further action and no additional sampling is planned. However, the majority of chemical data included for the DERA sites are primarily metals, although many of the sites would indicate that volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and dioxins would be expected to be present based on the activity at the site. The documentation of the nature and extent of contamination within the ecological exposure pathway is not adequately described and it appears that some chemical data (i.e., dioxins) have not been used in an estimation of the total ecological risk attributable to all potentially exposed receptor populations. Therefore, it is not clear whether the FS and corresponding remedial action would adequately address potential adverse effects to ecological exposures. The site-specific DERA sections should specifically discuss the completeness of sampling and analyses associated with each of the sites and use all available data in the calculation of risk. If existing data suggest that the documentation of the nature and extent of contamination has not been adequate, then it is recommended that additional sampling be conducted to document the nature and extent of contamination within the ecological exposure pathways.	The scope of the DERA was agreed upon as identified in general comment No. 1 (EPA178). Dioxins were not included in the DERA other than for the New Burn site since they were associated with sites not identified for inclusion in the DERA. Where not already provided, additional text can be supplied which specifically identifies the COPCs for each DERA site.	The Final DERA workplan was followed.	

Resolution of USEPA Comment and Army Reponses
Draft Final Remedial Investigation dated March 2002
Jefferson Proving Ground (JPG)

Comment #	Section	EPA 31 May 2002 Comment	Army Response Submitted 21 June 2002	EPA Evaluation of Response	Resolved (yes/no)
GENERAL COMMENTS					
EPA 1	Sec 2.3.1	**Bedrock Geology:** Paragraph 2, Figures 2.3, 2.4 And 2.5 do not provide information, they are unreadable.	These figures were intended to be included as color figures, however your copy of the Draft Final RI inadvertently included black and white copies. We apologize for this and the color copies are included for replacement.		Yes – Sent 6/21/02
EPA 2	Sec 2.3.1	**Bedrock Geology:** :Paragraph 5, Figure 2-7 do not information on Till and Bedrock units, they are unreadable.	These figures were intended to be included as color figures, however your copy of the Draft Final RI inadvertently included black and white copies. We apologize for this and the color copies are included for replacement.		Yes – Sent 6/21/02
EPA 3	Sec 2.4	**Soils:** Figure 2.10, does not provide information, it is unreadable.	These figures were intended to be included as color figures, however your copy of the Draft Final RI inadvertently included black and white copies. We apologize for this and the color copies are included for replacement.		Yes – Sent 6/21/02
EPA 4	Sec 2.6.2.1	**Unconsolidated Glacial Deposits:** End of 7th paragraph, 8th paragraph discussion of "threshold gradient effect."	The comment is unclear. Statement noted.		
EPA 5	Sec 2.6.2.1	**Unconsolidated Glacial Deposits:** Reading this section can be confusing. Recommend that this section be boiled down to: "Groundwater flow in the till is slow due low hydraulic conductivity and relatively flat hydraulic gradients. When there is flow, the regional groundwater flow is roughly in the same direction as the surface water drainage. However, it is likely that groundwater flow in the glacial till is concentrated in fractures and in sand an[d] gravel lenses, with the bulk of the matrix experiencing very little groundwater movement. When the matrix is devoid of fractures, root channels, and worm bores the conductivity [is]in the range of 3.4 x 10-8 cm/sec to 9.8 x 10-8 cm/sec. When fractures are present, the conductivity is far greater with downward movement most prevalent.	All of the above-recommended text is already contained in the paragraphs within Section 2.6.2.1. However, the section can be rewritten as noted.		
EPA 6	Sec 2.6.2.2	**Silurian and Devonian Limestones and Dolomites**: Second paragraph, 1st sentence, 'bedrock" aquifer recharged by infiltration of precipitation along fractures within the till. The absence of fractures in the till extending to the bedrock, the groundwater will appear to be confined... Comment: Isn't this one way of saying this is a confined aquifer?	The text will be modified to clarify and will read as follows: "The bedrock aquifer is locally confined in areas where there is an absence of fractures in the till. The artesian potentiometric head rises to a maximum of 10 feet below ground surface in the monitoring wells screened within the glacial till." This text will replace the last sentence in paragraph 2 of Section 2.6.2.2.		
EPA 7	Sec 2.6..3.1	**Aquifer test results:** Louisville L.S., 9.38×10^{-54} ? Please clarify	The correct value is 9.38×10^{-5}. This will be modified in the Final RI.		
EPA 8	Sec 2.6.3.1.2	**Section 2.6.3.1.2 pumping test:** Where till zones didn't recover after the pumping tests is fine for the fracture till model, but for an area where ESE 1989 did two slug tests in the till suggests that there is a till aquifer. (See Section 2.6.2.1)	MWH has reviewed the slug test information from the 1989 ESE Report. It appears that the head changes that were induced during the slug/bail tests were very small (some were less than one foot). Therefore, the recharge to the wells may have been due to filter pack storage, not recharge from the surrounding aquifer.		

Resolution of USEPA Comment and Army Reponses
Draft Final Remedial Investigation dated March 2002
Jefferson Proving Ground (JPG)

Comment #	Section	EPA 31 May 2002 Comment	Army Response Submitted 21 June 2002	EPA Evaluation of Response	Resolved (yes/no)
EPA 9	Sec 2.3.3.1.2	**Pumping tests at sites 12A 12B and 12C:** Last sentence, ...through the till would occur quite slowly. Vertical Groundwater Gradients.	This comment is unclear. However, the last paragraph in Section 2.6.3.1.2 will be modified to clarify the slow recharge phenomenon. The modification to be made is based on a comment from IDEM, and subsequent discussions with IDEM Hydrogeologist. A descriptive discussion of the slow recharge will replace the discussion of a "tension-saturated zone". The discussion will explain how the fine-grained, low permeability material that compose the glacial till retard the infiltration of precipitation and percolation to the water table. The result could be a slowly downward migrating saturated zone within the vadose zone as a result of a precipitation event.		
EPA 10	Sec 2.6.3.2.2	**Background Well Cluster B:** 3rd paragraph does not make sense at all ... "the bedrock groundwater at BKB is locally unconfined in the absence of fractures in the underlying till" Two major questions. "Locally unconfined in the absence of fractures" Please explain the concept, and "underlying till." Please explain. General Comment: It seems to the reader that a case of not perched aquifer exists at JPG. The till is fractured and is in communication with the bedrock aquifer system. However, there is enough doubt in the writing, such recharge is quite slow (the till in absence of fractures is 3.4 to 9.8 x 10 - 8) that the JPG model, as it is understood, seems to be too dependent on a bedrock aquifer recharged by the fractured till. We believe that there are still sites where the groundwater flow in the till is an important conduit of contamination.	The sentence was misstated and should read "As with the bedrock groundwater at BKA, the bedrock groundwater at BKB is locally <u>confined</u> in the absence of fractures in the <u>overlying</u> till."		
EPA 11	Sec 3.2.7.2.1	**Groundwater sampling:** 2nd paragraph, 3rd sentence, "controlled vacuum..." Used for VOC sampling? Not proper.	Section 3.2.7.2.1 discusses groundwater sampling of temporary wells for the specific purpose of collecting screening level data. Furthermore, the description of the complete sampling method includes collection of the groundwater from the bottom of the tubing at the end opposite from where the "controlled vacuum" was applied. While this method may not be ideal, it was used in 1993 as part of the Phase I investigation to provide information to guide the placement of permanent monitoring wells. Permanent monitoring wells were sampled using bailers or positive-displacement pumps as described in Section 3.2.8.4.		
EPA 12	Sec 13.0	**Building 602 solvent pit Site 12A; Section 13.1.1 Groundwater:** Figures 13-7a, 13-7b, 13-15a do not show data for two of the three wells added in 2001 for the Data Gap Investigation (MW01-09 and MW01-11) The wells are essentially the same for Figures 13-5, 13-6, 13-7, 13-8, 13-9, 13-10 and figure 13-15. Why would one interpret the data on 13-7a and 13-7b any different than "normal" variation?	All new wells, including MW01-09 and MW01-11, are shown with data on Figure 13-15a. These wells were installed in November 2001. Figure 13-7a reflects the potentiometric surface from data collected before the wells were installed. Figure 13-7b reflects the potentiometric surface from data collected in November 2001. The new wells are shown on Figure 13-7b but were not used in the contouring because wells MW01-09 and MW01-10 were screened in a deeper bedrock unit, and MW01-11 was not static at the time of sampling.		

Comment #	Section	EPA 31 May 2002 Comment	Army Response Submitted 21 June 2002	EPA Evaluation of Response	Resolved (yes/no)
EPA 13	Sec 13.1.1.1	**(Perched) Shallow Groundwater:** Again, it appears that the Army is disregarding the existence of a "perched" zone. The groundwater model is made up of a fractured till in communication with a bedrock aquifer. There has been TCE disposed in the solvent pit over so many years. TCE being a DNAPL, and using mass balance calculations, can all of the TCE be accounted for over the duration of the use of the pits? There has been no DNAPL detected, but has the site been characterized properly using the new model? Is there contamination in place under the building? Did the removal remove the total source area? This site is being carried through to the FS, it is believed that the possibility of the source being still under a portion of Building 602 due to groundwater flow. The FS may look at removal of the building for additional source removal.	As stated in the Draft Final RI, a perched zone does not exist at JPG. Based on the groundwater data collected in temporary wells during the Phase II Investigation and the direct response to the pumping tests conducted at Sites 12A and 12B, we have determined that the glacial till is often saturated from the bedrock/till interface to some depth below the ground surface within the glacial till. Therefore, a "perched aquifer" does not exist in the glacial till. IDEM and MWH agreed upon this concept during a telephone conversation. A TCE mass balance calculation has not been performed because the quantity of TCE disposed is not available. There is contamination under the building, however the soil vapor intrusion modeling performed in the Draft Final RI concludes that the residual contaminated soil at the building foundation do not present a potential health risk under the industrial future use scenario. Currently, it is not the Army's intent to remove the building as part of the remedial action at the site, however the property will have a deed restriction against residential use.		
EPA 14	Sec 14.0	**Building 617 Solvent Pit (Site 12B):** Due to the availability of all well data, the November 2001, Figure 14-10b is more current than the June 2001, figure 14-10a. It is noted that in the November 2001, Figure 14-10b, the only well that has been added to this figure is MW01-13 when comparing this figure with November, 1996. The groundwater flow is only 90 degrees off. With the variation seen earlier, can it be stated that the November 2001 is any better than the 1996 figure, with the addition of only one well? It appears that the November 2001 Figure is highly biased in over all conclusion of the groundwater flow direction. There has been little addition of data from 1996.	Six wells were added during November 2001, MW01-12 through MW01-17. All of these wells appear on Figure 14-10b, which represents the November data. However only 2 wells (MW01-15 and 01-17) are used in the contouring of the potentiometric surface on this Figure. The other four wells were not used because they are screened in a deeper bedrock unit.		
EPA 15	Sec 14.8	**Conclusions and Recommendations:** It is agreed that this site be carried through to the FS, however, it is believed that the possibility of the source is still under a portion of Building 617 due to groundwater flow. The FS may need to look at removal of the building for additional source removal	Site 12B will be carried forward into the FS as stated in the Draft Final RI. There is the possibility of contamination under the building, however the soil vapor intrusion modeling performed for the Draft Final RI concludes that the residual contaminated soils at the building foundation do not present a potential health risk under the industrial future use scenario. Currently, it is not the Army's intent to remove the building as part of the remedial action at the site, however the property will have a deed restriction against residential use.		
EPA 16	Sec 15	**Section 15. Building 279 Solvent Pit (Site 12C):** Figure 15-10a does not contain any more wells than the June 1996 yet the results are 180 degrees different. Figure 15-10b does not contain any more well than November 1996. Again we see 180 degree difference. It is believed that no new useful information has been presented 15-10a and 15-10b? We believe that this should be carried into the FS.	Figures 15-10a and 15-10b reflect the results of the June and November 2001 sampling events – no additional wells were installed. It is not uncommon for changes in direction to occur when the contoured data is relatively flat. Site 12C will be carried forward to the FS for groundwater.		

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EPA 17	Sec 7.0	**Sewage Treatment Plant (Site 2) and Sewage Sludge Applications Areas (Site 27);** Section 7.6.2.2.2 Soil: There are two areas or "sub areas" of potential concern at site 27 where concentrations of COPCs are elevated, and these areas are assumed to used as a residential so the site can be used to grow corn?. Is this good science or common sense? How will this be enforced? More consideration of this site should be made.	Concentrations of all COPCs at Site 27 were used in an evaluation of potential risks to human health (i.e., lifetime residential scenario). This evaluation included the consumption of homegrown fruits and vegetables (including corn), beef, and milk. It was assumed that beef cattle and milk cows would be fed corn silage.		
EPA 18	Sec 7.6.2.2.4 Sec 7.6.2.3.5	**Fruits, Vegetables, and Crops and Ingestion of Contaminated Beef and Milk:** Did you look at livestock eating both corn and silage grown in this area when looking at the ingestion pathway? You seem concerned about the silage pathway only. Site 3/4 appears to have an inconsistent groundwater thesis, Section 8.1, Phase II, paragraph 3, talks of groundwater flow in the till. Two additional wells were placed at the till bedrock interface (MW01-03 and MW01-04). Section 8.3.1.4 states there was little to no groundwater in the glacial till at these sites, and these were wells screened at the glacial bedrock interface 93-23, 93.	Section 7.6.2.2.4. The model that was used to estimate the uptake of soil contaminants by livestock was based on an assumption that cattle would be fed only silage. Sections 8.1 and 8.3.1.4 will be modified to clarify groundwater flow in the till.		
EPA 19	Sec 8.0	**Explosive Burn Area (Site 3) and Abandoned Landfill (Site 4);** Section 8.3.2.3 Groundwater: MW01-03 and MW01-04 were installed "downgradient." But Figures 8-3, 8-4, 8-4a, 8-4b have them as lateral wells, to the north of the Groundwater Flow to the west.	Figures 8-3 and 8-4 reflect historic data used to prepare the bedrock potentiometric surface maps. Although wells MW01-03 and MW01-04 are shown on Figures 8-4a and 8-4b, they were not included for contouring of the potentiometric surface because these wells are screened in the shallow interface, which flows in a different direction than the potentiometric surface. Thus the locations of wells MW01-03 and MW01-04 are described as downgradient with respect to the shallow flow direction.		
EPA 20	Sec 10.0	**Red lead Disposal area (Site 7) and Temporary Methylene Chloride Storage Area at Building 211 (Site 21b);** Section 10.8 Conclusions and Recommendations: Paragraph 5, last sentence. "It appears that sites 7/21b ...ecological risk is acceptable..." When reading this sentence, it appears that not enough information is known for a definite statement to be made. Should move to the FS, doesn't appear there is enough information available.	As stated in the Draft Final RI, Sites 7/21B will be brought forward to the FS for groundwater. The ecological risk assessment was performed before the interim removal action. The Draft Final RI paragraph 5 of the Conclusions and Recommendations goes on to say: "Utilizing the interim measures sampling results, the estimated HIs for ecological receptors are now within the same order of magnitude, or lower than those of the reference areas." The next sentence will be modified to read "As a result, Sites 7/21B have been remediated to a point that ecological risk is acceptable for these sites especially considering the sites intended future use is industrial in nature.		
EPA 21	Sec 19.0	**Building 204 Temporary Storage Area (Sites 21A and 30):** It is agreed that this should be moved to the FS. Perhaps one soil boring is not enough information on Horizontal extent of contamination.	No response needed. Sites 21A/30 will be brought forward to the FS.		

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Comment #	Section	EPA 31 May 2002 Comment	Army Response Submitted 21 June 2002	EPA Evaluation of Response	Resolved (yes/no)
DATA QUALITY COMMENTS				**Received 15 July 2002**	
EPA 1		**General Comment:** Please be advised that this review is as complete as can be expected, provided the following caveats: The RI Data Validation for supplemental sampling (surface water/sediment/soils, June and November, 2001) incorporated the Louisville Chemical Guidelines, Versions 1.0 and 3.0. Be advised that the Louisville Chemical Guidelines (LCG) are a "work in progress", and that it has not been finalized, nor received final approval (as yet), by this Region. Furthermore, the LCG is now at Version 4.0, which incorporated changes from our last round of comments, has just undergone our review, and will incorporate some additional changes. These changes may directly impact data quality, and will contain inconsistencies in acceptance criteria/data qualification between LCG Versions (1.0, 3.0) and 4.0.	Samples were analyzed and the data was subsequently reviewed according to the LCG versions 1 and 3 in use at that time. Because LCG version 5 is now available the data will re-reviewed using the most current version of the LCG.	Understood that data will be re-reviewed utilizing the LCG Version 5.0. EPA requests that the results of this review be submitted to our office for review and comment.	Yes
APPENDIX P: QUALITY CONTROL SUMMARY REPORT (QCSR) COMMENTS:				**Received 15 July 2002**	
EPA 1	Sec 1.0	**Introduction:** Text states that the Louisville Chemical Guidelines Version 1.0 and 3.0 was utilized. Be advised that the Louisville Chemical Guidelines (LCG) are a "work in progress", and that it has not been finalized, nor approved as yet, by this Region. Furthermore, the LCG is now at Version 4.0, which incorporated changes from our last round of comments, and has just undergone our review. These changes may directly impact data quality, and will contain some inconsistencies in acceptance criteria and related data qualification between Versions (1.0- 3.0) and 4.0.	See response to comment 1.	Understood that data will be re-reviewed utilizing the LCG Version 5.0. EPA requests that the results of this review be submitted to our office for review and comment.	Yes
EPA 2	Sec 1.0	**Introduction:** Text states that only 10% of the groundwater data was validated. Why only 10% of groundwater?	MWH reviewed (equivalent to Level 3) 100% of the groundwater data. In addition, LDC fully (comprehensive) validated 10% of the groundwater data. If significant analytical problems were noted, LDC would have validated additional data. Full validation of 10% of the data was stated in the approved QAPP and QAPP Addendums and is a generally accepted alternative to 100% validation, particularly when it is done in conjunction with 100% data review.	Above statement clarifies what validation was performed. Understood	Yes
EPA 3	Sec 1	**Introduction:** Text in second paragraph states that there were two data reviews/validation. One, a 100% definitive data review by MWH, and the second, a 100% of surface water/sediment data, and 10% of groundwater data, comprehensive data validation by LDC. These have been "combined" in the QCSR (Quality Control Summary Report). This is not acceptable. Much more thorough documentation is required.	The LDC data validation reports will provided in an Appendix of the RI document. There were no significant discrepancies between the MWH data review and LDC validation. The substance of the QCSR will not change if we say the MWH review and LDC validation were both used in the QCSR. Only one QCSR will be provided.	EPA awaits receipt of LDC data validation reports for review and comment.	Yes – Sent 7/24/02
EPA 4		There are no comprehensive Data Validation Reports submitted. If the LCG Version 3.0 was utilized, it clearly states the requirements for data validation and reporting. US-EPA also has clear, long established requirements for data validation and data reporting. Neither set of requirements are satisfied here.	LDC validation reports and MWH verification/review reports will be provided in an Appendix of the RI report. These will supplement the information provided in the QCSR.	EPA will begin review/comment of these reports upon receipt.	Yes – Sent 7/24/02

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Comment #	Section	EPA 31 May 2002 Comment	Army Response Submitted 21 June 2002	EPA Evaluation of Response	Resolved (yes/no)
EPA 5		Separate reports should be provided, with detailed findings, for both the 100% MWH data review, and the (100% surface water/sediment, and groundwater) LDC Data validation. This was not done. They should not be "combined".	LDC validation reports and MWH verification reports will be provided in an Appendix of the RI report. These will supplement the information provided in the QCSR.	Understood.	Yes – Sent 7/24/02
EPA 6		Providing only data tables with the absolute minimum of Data Validation Comments is not sufficient.	See response to comment 5.	Understood.	Yes – Sent 7/24/02
EPA 7		U.S. EPA does not consider the QCSR to be either complete, nor satisfactory.	See response to comment 5.	Understood.	Yes – Sent 7/24/02
TOXICOLOGICAL (HUMAN HEALTH RISK ASSESSMENT) COMMENTS					
EPA 1		During U.S. EPA's Toxicologist's May 13, 2002 visit of Jefferson Proving Ground, he noticed that some of the buildings which he could walk into, had asbestos containing materials inside. It is recommended that asbestos be included in the human health risk assessment (HHRA) scenarios as warranted.	The buildings in questions are under the Lease in Furtherance of Conveyance (LIFC) between the Army and the Ford Lumber and Building Supply Company (Ford). The LIFC was entered into by Ford in an "as is, where is" condition. As parcels are proposed for transfer from the Army to Ford, a notification of any potential asbestos liability and/or cleanup is identified by the Army to Ford and Ford will assume this responsibility along with the title of the parcel.	Concur with response. Because asbestos is a hazardous waste that is not specifically regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Army is correct in stating that as parcels are proposed for transfer, disclosure/notification of any potential asbestos liability and/or cleanup must be made to the buyer (Ford Lumber Company) and any restrictions on the use of the property related to those hazards are required to be included in the deed. No further response is needed.	Yes
EPA 2		The firing points, burn and mortar pits were used to fire or explode/burn ordnance. This will carry material (from the current or past burns/explosions) skyward and downwind. The sampling plan will detect UXO contaminants of concern that may be present at the source (burn/mortar pit) but there was no attempt to characterize the extent of atmospheric transport of these contaminants.	With only minor exceptions, residual soil sampling of areas in which UXO clearances have been conducted within the cantonment area at JPG have not shown any levels of concern for explosives or metals. Because these areas would have had a much greater potential to have any actionable levels for these contaminants, additional generic sampling in areas that were not identified as having a potential for UXO is not warranted.	Response is noted. EPA has not been able to resolve many issues related to UXO residual soil sampling at JPG with the Army. EPA has submitted several nonconcurrence comments in the past regarding surface and subsurface soil sampling depths at the JPG UXO sites. The UXO residual soil sampling approach used and the issue regarding characterizing the extent of atmospheric transport of UXO contaminants is a very complex issue and may need to be deferred as a "parking lot" issue at our upcoming meeting in Madison, Wisconsin, during the week of July 29, 2002. I recommend that we discuss this as a separate topic via a conference call during the week of August 12, 2002. If during the conference call, we do not resolve this issue, the team would still have the planned August 21-22, 2002 DF RI Report meeting at JPG in Madison, Indiana to discuss this further. EPA is suggesting this so that the team can try to initially resolve all issues that can be easily resolved. This would save some time, money and assure that the July 30-August 1, 2002 is productive.	No
EPA 3		There were approximately 268 Firing Positions which fired munitions for over 50 years and therefore contamination would occur in the firing positions, downwind, and surface water runoffs paths. It is recommended that in order to disprove contamination in these areas the appropriate samples should be taken.	See response to comment #2 above.	See our comment #2 above in reply to the response for UXO contaminants.	No
EPA 4		Since the Human Health Risk Assessment (HHRA) addresses present and future residential, agricultural, hunting/fishing, gardening, worker, construction worker and trespasser scenarios it is recommended that adequate sampling be performed throughout the various sites and surrounding areas south of the Firing Line which should include top soil, sediments, water, and soil samples deeper than 4 feet to protect construction workers.	Site soil sampling was performed per USEPA Region 5 approved sampling work plans (e.g., Pre-QAPjP Meeting Minutes, August 15 - 16, 1995). The sampling methodology was also discussed at several other meetings with USEPA and IDEM. Therefore, soil sampling performed to date is considered to be adequate to evaluate the nature and extent of contamination for each of the risk assessment scenarios evaluated at this site.	After reviewing the approved Pre-QAPjP Meeting Minutes, the minutes do not appear to address the original comment regarding sampling various environmental media at depths deeper than 4 feet to protect construction workers. Is there any reference on this issue in the approved basewide human health risk assessment (HHRA) for JPG South of the Firing Line? If so, please reference the specific section of the HHRA that addresses this issue.	No

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Comment #	Section	EPA 31 May 2002 Comment	Army Response Submitted 21 June 2002	EPA Evaluation of Response	Resolved (yes/no)
EPA 5		The presentation of analytical data and associated sampling locations on individual sites does not provide a complete picture of the investigation results or the nature and extent of contamination, for example the extent of the solvent plumes before and after the remediation effort on sites 12A, 12B and 12C, or the extent of the atmospheric transport of UXO contaminants at sites 3, 9, 11, 28, 39 or any firing point.	Site soil sampling was performed per USEPA Region 5 approved sampling work plans (e.g. Pre-QAPjP Meeting Minutes, August 15 - 16, 1995). The sampling methodology was also discussed at several other meetings with USEPA and IDEM. Therefore, soil sampling performed to date is considered to be adequate to evaluate the nature and extent of contamination for each of the risk assessment scenarios evaluated at this site. Where appropriate, such as for the fugitive dust scenario, data from multiple sites have been evaluated to provide an evaluation of site-wide risk. See response to comment #2 above for UXO contaminants.	The response does not fully address the comment. EPA has expressed concerns with Sites 12A and 12B not being fully characterized during evaluation of the Draft Final Construction Completion Report for Sites 12A, 12B, 12C and 33 (CCR) and on the UXO Work Plan. Also, in the Indiana Department of Environmental Management's (IDEM) recent comment letter (dated May 21, 2002) on the CCR several references are made regarding soil samples with contamination detected at levels above EPA Region 9 Preliminary Remediation Goals (PRGs). EPA has also requested that the Army define and characterize the full extent of groundwater contamination, including the plume which is beneath the buildings near the solvent pit RI sites. EPA concurs with the Army's proposal to carry some of the RI sites into the Feasibility Study (FS). EPA will review the FS once we receive it. The approved August 15-16, 1995 Pre-QAPjP Meeting Minutes and sampling work plans stated that field changes/modifications would be brought to the attention of the Army, IDEM and USEPA for concurrence and/or approval. The Army has not received concurrence or approval on the field modifications from USEPA. See our above Comment #2 in reply to the response regarding UXO contaminants. At Site 12A, it appears that the Army is doing a HHRA on a hot-spot rather than on the Building 602 area that would include Sites 12A, 24, 35, the culvert and any other site which would fall within the defined boundaries of this sub-site, which later would be included in the whole site HHRA as the JPG site in Madison, IN. Realistically a resident, worker or trespasser scenario in Site 12A would be affected by more than just the solvent pit's toxic pollutants and EPA wold recommend doing the HHRA with that in mind. At Site 12B, the solvent pit which is close to Building 617 had three steel USTs removed which were located south of the building. At probe hole PH11, it was noted that a free product which was black and viscous was present, but that no sample was collected. For the same reasons as stated above at Site 12A, EPA recommends that the Building 617 area be included in the HHRA which would mean sampling the material in PH11. It is stated that surface soil samples, subsurface soil samples and groundwater samples at Site 12B were not analyzed for inorganic constituents. EPA recommends that inorganic constituents be analyzed for all sites, including Site 12B. Site 12B, as well as Sites 12A and 12C were assessed as candidates for natural attenuation using the BIOCHLOR model. EPA wonders if the free product noted in PH11 would have any affect on the natural attenuation by reductive dechlorination at the same site and if it was even considered. In order to know what the risks are from the solvent pit contaminants, EPA recommends that the whole plume be defined including that which goes under the building. All sample results should be included in the HHRA At Site 12C, Building 279 as well as the solvent pit known as Site 12C is located north of the firing line. Therefore, UXO screening around Building 279 should be considered. It was noted that each site will be screened for UXO prior to the start of any intrusive activities, which meant only the solvent pits (Sites 12A, 12B, and 12C), and not the larger building areas. Since no samples were analyzed for chemical parameters as part of the UXO clearance activities around the Building 279 area, EPA recommends that this be done and included in the HHRA. In order to know what the risks are from the solvent pit contaminants, EPA recommends that the whole plume be defined including that which goes under the building.	No

Comment #	Section	EPA 31 May 2002 Comment	Army Response Submitted 21 June 2002	EPA Evaluation of Response	Resolved (yes/no)
EPA 6		The UXO screening process remains a problem because of the utility or construction worker scenario in the HHRA which is done deeper than 4 feet below ground.	The Army is the lead Federal agency for ordnance and explosives issues. The Army has conducted UXO clearance actions at those sites within the cantonment area that have been identified as having a potential for UXO. Subsequent to the UXO clearance actions, a statement of clearance for those areas cleared is issued by the Army and identifies any excavation restrictions applicable to that parcel if warranted. During the transfer of any parcel upon which a UXO clearance was performed the following (or substantially equivalent) language is required to be placed in the FOST and deed title transfer documents: The Grantor completed a comprehensive records search and based upon that search, has undertaken and completed statistical and physical testing of areas on the Property where the presence of unexploded ordnance ("UXO") was considered possible. Based upon said search and testing, the Grantor represents that, to the best of its knowledge, no UXO is currently present on the Property. Notwithstanding the records search and testing conducted by the Grantor, the parties acknowledge that, due to the former use of the Property as an active military installation, there is a possibility that UXO may exist on the Property. Upon due notice, the Grantor agrees to remove any such remaining UXO discovered on the Property, as required under applicable law and regulations, as expeditiously as is reasonable and practicable, subject to the availability of funds. If the Grantee, any subsequent owner, or any other person should find any UXO on the Property, they should not move or disturb the item and shall immediately call the local police or local fire authorities and U.S. Army Corps of Engineers, Louisville District, P.O. Box 59, Louisville, Kentucky 40201, (502) 315-6963.	Concur with response. No further response is needed.	Yes
EPA 7		Old lead paint could be a concern, recommend that sampling be performed to eliminate this concern in buildings	The Army is following the requirements DOD and EPA approved Lead-Based Paint Guidelines for Disposal of Department of Defense Residential Real Property – A Field Guide, regarding this issue. The Army performs a lead-based paint inspection and risk assessment for those structures identified as having a potential residential reuse and provides that information to Ford. Ford, upon transfer of the property, assumes the Army's liability and responsibility for this issue.	Concur with response. Has the Army identified any structures at JPG, as of to date, that have potential residential reuse?	Yes
EPA 8		Compositing is a process in which contaminant concentrations are essentially averaged based on the subsamples that are composited (i.e., spatially or vertically). Composite samples are not recommended for use when doing human health risk assessment.	Site soil sampling was performed per USEPA Region 5 and IDEM approved sampling work plans. Based on our experience, compositing of soil samples can be used in a risk assessment, and does not invalidate the use of the data in the risk assessment.	The sampling work plans that EPA has concurred with do not include composite sampling. EPA, IDEM and the Army agreed in the basewide QAPP and Field Sampling Plans that JPG would not do composite sampling, but would take all surface soil samples at a depth of 6 inches and subsurface soil samples at a depth of 1 foot intervals. In some instances, the Army has implemented field modifications that deviate from the concurred upon sampling work plans, and have not received concurrence from EPA. Our original comment remains the same.	No

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Comment #	Section	EPA 31 May 2002 Comment	Army Response Submitted 21 June 2002	EPA Evaluation of Response	Resolved (yes/no)
REVIEW OF TOXICOLOGICAL VALUES TABLE FOR JPG					
EPA		U.S. EPA's Toxicologist has looked over the Tox Values for JPG and after consulting with Dr. Mark Johnson (ATSDR) and folks at STSC in Cincinnati, we have come up with the following recommendations: We do not support or recommend using withdrawn values from IRIS or HEAST. The Superfund Health Risk Technical Support Centers provisional papers, IRIS, and HEAST do not have inhalation reference dose values, they all have inhalation reference concentrations instead and IRIS does not have any subchronic or dermal values, therefore, I would recommend that the footnotes be changed to reflect the fact that these are conversions.	Footnotes in Tables 5-25 and 5-26 will be revised to reflect the fact that the inhalation RfDs from IRIS and HEAST are based on conversions. Many of the retired NCEA provisional values can still be used and can be found on the web site listed below.	Concur with response. EPA requests to review the revised footnotes before finalizing the DF RI Report.	Yes
EPA		Incorrect values listed for these chemicals: 1,1,1-Trichloroethane - RfD incorrect and possibly inhalation RfD if the old RfC was used for conversion.	The old RfC value was used in the Draft Final RI. The oral chronic RfD for 1,1,1-Trichloroethane is not posted on the suggested NCEA Internet site.	After doing a literature search and reading the Risk Assessment Issue Papers for the Derivation of Provisional Chronic and Subchronic RfCs for 1,1,1-Trichloroethane, EPA recommends using an oral chronic RfD of 2.8E-1 mg/kg-day and oral subchronic RfD of 2.8E+0 mg/kg-day. Since the toxicity value obtained from the hepatotoxicity data in rats is more conservative than that from the neurotoxicity data in gerbils, it is recommended that the above values be assumed for the provisional subchronic and chronic oral RfDs for 1,1,1-trichloroethane based on the possible hepatotoxicity of 1,1,1-trichloroethane. Confidence in these RfDs is medium to low, reflecting medium confidence in the database.	Yes
EPA		Trichloroethylene - use the values found in the draft assessment on the NCEA website instead of previous provisional values, web address is http://oaspub.epa.gov/eims/eimsapi.detail?deid=23249&partner=ORD-NCEA	The chronic oral and inhalation RfDs from NCEA will be revised in Tables 5-25 and 5-26, respectively.	Concur with response. EPA requests that the revised tables be submitted to our office for review and comment prior to finalizing the DF RI Report.	Yes
EPA		Zinc - sRfD in HEAST (left blank in the table)	The oral subchronic RfD for zinc is shown in the master table in Appendix W. However, only chronic RfDs were used in this risk assessment.	Concur with response. No further response is needed.	Yes
EPA		Footnote discrepancies: Antimony sRfD - footnote should reference NCEA provisional paper instead of IRIS Barium sRfD - footnote should reference HEAST Dieldrin sRfD - footnote should reference HEAST Manganese sRfD - footnote should reference HEAST Molybdenum sRfD - footnote should reference HEAST Pentachlorophenol sRfD - footnote should reference HEAST Silver sRfD - footnote should reference HEAST Thallium sRfD - footnote should reference HEAST	Suggested revisions will be made to the footnotes in the master table in Appendix W.	Concur with response. EPA awaits receipt of revised footnotes in the Appendix W Master Table for review and comment prior to finalizing the DF RI Report.	Yes

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Comment #	Section	EPA 31 May 2002 Comment	Army Response Submitted 21 June 2002	EPA Evaluation of Response	Resolved (yes/no)
EPA		The following chemicals have provisional values that can be used whether they are retired or current: 1,1,1-Trichloroethane - RfD, sRfD, **RfC**, **sRfC** 1,2-Dichloroethane - RfD, RfC, sRfD can be derived by removing the UF of 10 (for use of a subchronic study) from the chronic RfD Aluminum - RfD and RfC Benzene - **RfD**, sRfD, RfC, sRfC Chloroform - RfC and sRfC Silver - RfC and sRfC Iron - RfD Toluene - sRfD Antimony - sRfD	Current or retired provisional values will be used as available. A revised table of toxicity values will be provided when completed for USEPA review before the Final RI is produced. NCEA values, where available on the NCEA's Internet site (highlighted in bold above), have been used. Provisional toxicity information for all other toxicity values requested in this comment will be used upon the provision of these values by EPA Region 5.	Concur with response. EPA awaits receipt of the revised table of toxicity values for review/comment/concurrence prior to finalizing the DF RI Report.	No

REVIEW OF ECOLOGICAL RISK ASSESSMENT

Comment #	Section	EPA 8 July 2002 Comment	Army Response Submitted 22 July 2002	EPA Evaluation of Response	Resolved (yes/no)
EPA 1	Sec 5.3.4.1 Vol I	**Risk Estimation:** The document states "A total HI (HITOTAL) was calculated by summation of HQs across all chemicals to facilitate comparison of one site to another. However, since all of the toxicological effects are not additive, it is recommended that risk decisions be made on the HQ and HI and not the total HITOTAL." Many of the risk characterizations and descriptions are based on the use of Hazard Indexes (HIs): the sum of the Hazard Quotients (HQs) for a particular receptor (the white-footed mouse or red fox, for example). HIs are generally not good tools for risk calculations as they are totals of HQs for chemicals and compounds that often have unrelated toxicological effects. Metals and organic compounds typically have different toxicological effects; and each specific compound or chemical within those categories can vary in its respective toxicological effect(s). Furthermore, although HIs are calculated from HQs based on No Adverse-Effect Levels (NOAELs) or Lowest Adverse Effect Levels (LOAELs), there are no NOAELs or LOAELs for HIs. Thus, there is no possibility of comparisons against benchmarks, leaving only comparisons against reference data. On the other hand, individual HQs might suggest that the Contaminants of Potential Ecological Concern (COPECs) might pose ecological risk, where simply comparing against data from reference sites might underestimate that risk or not indicate any risk at all.	The use of the HI approach was approved as part of the work plan for the DERA, and the use of this approach was not commented upon by USEPA at the Draft stage. Therefore this approach was carried through in the Draft Final even though it is not commonly used today in Region V for ecological assessments. The approach was commonly used at the time that the draft document was produced, and was considered conservative because the assumption was made that each analyte affected a receptor additively, whereas the HQ approach does not assume this. The purpose of the note that was quoted above was to alert the reader to this limitation of this approach. Under the former approach there can be situations where all HQs are less than one, but the overall HI is greater than the threshold of one. With the HQ method, this situation does not occur. Many of the tables and figures summarize the results of the HI, and at this point in the project it would take a great deal of resources to remove all references to the HI approach altogether. Within the Draft Final version of the ERA there are tables that summarize the ecological risks by HQ (refer to Appendix AA). In addition, the analytes having the largest HI over the threshold of one are also discussed in the Draft Final RI by site. In the Final RI, the use of the HI can be supplemented by comparing the HQs for key analytes in the investigative area that exceed the threshold value of 1 to their HQ in the reference area. We believe this additional comparison would address the USEPA's primary concern with the HI approach. In addition, we can put a historical note to the effect that the HI approach though once used commonly for ecological risk assessment, is not currently used within USEPA Region V.		

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Comment #	Section	EPA 8 July 2002 Comment	Army Response Submitted 22 July 2002	EPA Evaluation of Response	Resolved (yes/no)
EPA 2		For some receptors, the HIs are very high (over 100). This suggests that there could be ecological problems, even if the HIs are not statistically different from those calculated from data from the reference area. Some COPECs contribute different amounts to the HIs calculated for each receptor, and thus are likely responsible for differing amounts of potential risk. In some cases one or two COPECs, aluminum or vanadium for example, can contribute substantially more than the other COPECs represented in a particular HI. Each COPEC should be examined individually to help elucidate the potential contributions to risk by those COPECs and not dismissed because the HIs are not statistically higher than those from reference areas.	Refer to response to comment 1. In addition, we would like to clarify that not all COPECs would be examined on an individual basis. Only those COPECs that have an HQ greater than 1 in investigative samples would be examined further. In addition, if there were many COPECs with an HQ greater than 1, the focus of the discussion in the text would be on those that have the largest HQs.		
EPA 3		All of the lines of evidence utilize comparisons with data from the reference site. Risk characterization should not be based solely on comparisons against reference data, as the media in the reference area might contain contaminants as well that could potentially cause ecological risk. Because there are several lines of evidence concerning ecological risk at Jefferson Proving Ground, the use of these comparisons is not necessarily problematic. However, additional lines of evidence that do not involve comparisons with reference data should be included. The reference area should be examined to determine if the media present (surface water, sediment, or soil) have COPECs, what they are, and at what levels. If the levels are high enough to potentially cause ecological risk, then comparisons with data from the contaminated areas might not illuminate any potential ecological risk at the contaminated areas.	The lines of evidence that were collected as part of the RI field investigation were summarized, and most rely on comparisons to the reference areas, because this was how the ERA was designed. This is a common design for ecological risk assessment investigations. The exception to this approach would be the observations on soil fauna made in investigative areas. Please specify what other lines of evidence the USEPA is suggesting that could be provided beyond those already collected in the Final RI that would not entail additional field data collection. The specific analytes requested for characterization of the reference samples were analyzed during the RI. These included metals and dioxins. The reference areas were selected to specifically collect samples in three representative soil series for the JPG facility in areas that were not expected to be contaminated. The reference sampling was planned with USEPA and IDEM input, and these reference data were to supersede the Phase 1 background data (refer to Section 5.1.4.2 of the Draft Final RI). We would propose to address the issue of other analytes potentially being present in the reference samples in the uncertainty section of the Final RI. It could be stated that because some analytes were not tested for in the reference samples, there would be the potential for toxicity due to the presence of contaminants that were not accounted for in the reference samples. This would limit the use of the comparisons between investigative and reference samples. However, it should be noted that the results of the toxicity tests for the reference samples indicate that toxicity was not generally apparent in these samples, so it is unlikely comparisons to these reference data are greatly limited by this lack of characterization.		
EPA 4	Sec 5 Volume I pg. 5-88	Although it was specifically stated that Appendix DD was critical to a technical evaluation of the risk assessment, Appendix DD was not included in the document. Appendix BB (a summary of DERA COPECs), Appendix CC, and Appendix EE (with the data on fish communities, including Indexes of Biotic Integrity (IBIs)) were also missing.	As indicated in the cover submittal letter, only appendices that have changed or contain new information were included with the Draft Final RI submittal. Appendix BB, CC, DD, and EE were submitted previously with the Draft RI.		

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Comment #	Section	EPA 8 July 2002 Comment	Army Response Submitted 22 July 2002	EPA Evaluation of Response	Resolved (yes/no)
EPA 5		Because U.S. EPA was not able to review the data from the missing appendices, and the lines of evidence are lacking in analyses that do not involve comparisons to reference data, U.S. EPA cannot concur with conclusions concerning ecological risk at Jefferson Proving Ground.	Refer to the response to Comment 4 above.		

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Comment #	Section	IDEM 30 May 2002 Comment	Army Response Submitted 21 June 2002	IDEM Evaluation of Response	Resolved (yes/no)
GENERAL COMMENTS:					
IDEM 1		IDEM staff have reviewed all historical comments and agree that they have been adequately addressed in the DF RI.	No response needed.		N/A
IDEM 2		There has been some concern over the selection of background locations due to the elevated levels of several contaminants being detected in the samples collected from these locations. Some of these background contaminants exceed cleanup standards. Additional studies are needed to explain these levels and justify their continued use as acceptable background sample locations.	Background locations were chosen and sampling was performed under the approved workplan and QAPP. Meeting minutes for the August 15 and 16, 1995 meeting indicate that the regulators concurred with the selection of the background locations and the sampling plan. In addition, a letter dated June 13, 1997 from the USEPA indicates that all the background data were reviewed and were acceptable.	The response to general comment 2 failed to meet the intent of the comment. Arsenic is a problem contaminant for the JPG site. Even though the Environmental Protection Agency (EPA) and IDEM approved the locations, IDEM staff feel that the Army has failed to adequately present documentation to explain the presence of the Arsenic at levels exceeding drinking water standards or preliminary remediation goals in background groundwater monitoring wells. Documentation could be in the form of research papers, geological survey research papers, or peer scientific research papers. There is information in the form of these items that should be incorporated into the DF RI to make it complete and eliminate an area of concern for local residents and future individuals that would review this document.	No
IDEM 3		The discussions of the shallow groundwater for sites 12A and 12B in Sections 13.1.1.1 and 14.1.1.1 are questionable. All original references to a perched aquifer have been removed. The text now states that the apparent water table rise after rainfall is not just due to the rain water being slow to percolate down through the low permeability till layers, but is instead caused by a “high tension head following precipitation events” which “slows the potential for recharge.” The statement is also made that “[t]he area in the aquifer where this occurs is also known as a tension-saturated zone.” IDEM staff believe there has been a misapplication of concepts. IDEM staff believe there is confusion between the capillary fringe with recharge, and the term “pressure head” with “tension-saturated zone.”	Response to comments 3, 4, 5, and 6 are combined after comment 6.	Response is adequate.	Yes
IDEM 4		The reference quoted to attempt validation of this concept is Freeze and Cherry (1979), whose discussion on page 44 concerns the “tension-saturated zone,” which is their name for the more common term, “capillary fringe.” The capillary fringe is defined as the part of the aquifer water held above the normal zone of saturation by capillarity in matrix interstices acting against gravity. This concept concerns water moving up from the aquifer, not rainwater recharge moving down. The RI also states that the tension-saturated (or capillary fringe) zone is “… the area in the aquifer … ” Conversely, recharge, slowed by various factors (including pressure head), is discussed on pages 213 and 214 of Freeze and Cherry. As a small part of this discussion, the statement is made that “… the upper few centimeters of surface saturation … must be tension-saturated” (page 213). Freeze and Cherry do not call this a tension-saturated zone, which by their definition comes up from the aquifer below. This is not the same as the zone discussed on page 44 (Freeze and Cherry, 1979). This section of the RI presents a combination of two completely different concepts (one up from below and one down from rainwater). IDEM staff request an explanation and clarification of combining the two differing groundwater concepts.		Response is adequate.	Yes

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Comment #	Section	IDEM 30 May 2002 Comment	Army Response Submitted 21 June 2002	IDEM Evaluation of Response	Resolved (yes/no)
IDEM 5		The RI must provide complete references. For example, the statement that "[t]he decline in head observed after the pump test is a characteristic response to a reduction in tension head in the till (Freeze and Cherry, 1979)" must include the exact page and paragraph for this reference.		Response is adequate.	Yes
IDEM 6		Despite the confusion of concepts, IDEM staff request discussion and explanation on the reason why a single factor (pressure head) is given precedence over other effects on recharge. The previous text concerning an ephemeral perched aquifer due to slow recharge was accurate and also in agreement with current hydrogeological concepts and nomenclature.	These comments concern the same topic that is presented in Sections 13 (Site 12A) and 14 (Site 12B) in the Draft Final RI. **General comment 3** noted that the term "perched aquifer" was removed from the discussions regarding the glacial till. Because of groundwater data collected in temporary wells during the Phase II Investigation and the direct response to the pumping tests conducted at Sites 12A and 12B, we have determined that the glacial till is often saturated from the bedrock/till interface to a depth below the ground surface within the glacial till. Therefore, a "perched aquifer" does not exist in the glacial till. IDEM and MWH agreed upon this concept during a May 30, 2002 telephone conversation (meeting minutes are response to those minutes are attached). **General comments 3 and 4** indicate that there is confusion about what is being expressed by the discussion in Sections 13.1.1.1 and 14.1.1.1 regarding a "tension-saturated zone." The concept was introduced to explain how the fine-grained, low permeability material that compose the glacial till retard the infiltration of precipitation and percolation to the water table. The result could be a slowly downward migrating saturated zone within the vadose zone as a result of a precipitation event. We believe that this is the situation that General comment 6 is describing as "an ephemeral perched aquifer." Furthermore, because of the very flat potentiometric surface across both sites, the slow recharge phenomenon may lead to temporary hydraulic gradients that vary from the predominant groundwater flow direction. IDEM and MWH agree that in these situations the observed groundwater contaminant plume becomes an excellent indicator of the predominant groundwater flow direction. Because IDEM and MWH agree in principle on these hydrogeological conditions occurring at JPG, we agreed, to dispel confusion, that the discussion regarding the "tension-saturated zone" will be replaced with a descriptive discussion of the slow recharge phenomenon. **General comment 5** requests detailed references, including exact page and paragraph. This comment was directed to the discussion of the "tension-saturated zone" only and not a general comment to be implemented throughout the Draft Final RI. Because the discussion regarding the "tension-saturated zone" is being replaced, these detailed references will not be necessary.	Response is adequate.	Yes

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Comment #	Section	IDEM 30 May 2002 Comment	Army Response Submitted 21 June 2002	IDEM Evaluation of Response	Resolved (yes/no)
IDEM 7		There are many temporary wells that have been installed during the RI. These wells need to be properly closed according to Indiana Department of Natural Resources regulations. IDEM staff recommend that any of these temporary wells that have experienced detectable levels of contaminants need to be replaced with a permanent groundwater monitoring well of compliant construction.	Temporary wells at sites 12A, 12B, and 12C are being abandoned during June 2002 as a separate scope of work unrelated to RI activities. The Work Plan for the Well Abandonments has been submitted for review by IDEM. The Work Plan does specify that the wells will be abandoned in compliance with Indiana State Statutes and Rules IC 25-39, 312 IAC 12, 312 IAC 13, and 329 IAC 9; combined with some clarifications reflected in the Indiana Office of Land Quality – Geological Services Technical Memorandum titled "Drilling Procedures and Monitoring Well Construction Guidelines," dated May 14, 2001. The temporary wells were installed to provide screening level groundwater data to determine locations for permanent well installations. They have fulfilled that purpose and are no longer needed because permanent wells have been installed to monitor the groundwater plume. If additional permanent wells are determined to be needed, they will be installed in the future.	Response is adequate.	Yes
SPECIFIC COMMENTS:					
IDEM 1		**Executive Summary, Page ES-7:** DEM staff agree with the statement presented in the last paragraph discussing Site 7/21B that arsenic in the groundwater pathway needs further study, particularly as it relates to background sample locations. There is a definite misconnection in background levels of arsenic in groundwater. IDEM staff suggest it may be necessary to install monitoring wells outside the property boundary as part of the additional studies.	Land outside the property boundary of JPG is private property. Any additional study of arsenic in groundwater does not warrant installation of groundwater wells on private property. The Army will not be pursuing the installation of monitoring wells outside the property boundary to further define background levels of arsenic in groundwater.		No
IDEM 2	Executive Summary	**Page ES-9:** In the first paragraph on Sites 12A, 12B, 12C, the word "extensive" is used to describe additional activities necessary to define the extent of contamination at these sites. IDEM staff believe that the word "additional" is more appropriate and should be substituted.	Comment will be incorporated.		Yes
IDEM 3	Sec 2.5	**Surface Water Hydrology:** "JPG has an extensive system of surface-water resources, including ponds, lakes, streams, and wetland areas, along with numerous ephemeral streams, ponding sites, and wet areas. These drainages appear to have developed along major fracture lineaments." Ponds, wetlands, lakes, ponding areas, and wet areas are not "drainages." They exist because of the lack of adequate drainage. Also, except for the streams and perhaps some of the lakes, these features are not lineament-controlled. This paragraph needs revision.	The paragraph will be revised to accurately describe the surface water bodies at JPG.	Response is adequate.	Yes
IDEM 4	Sec 2.6.3.1	**Slug Test:** The hydraulic conductivity for the Louisville Limestone is given as 9.38 X 10^{-54} cm/sec. Please check the conductivity value and assure that it is correct.	The correct value is 9.38 x 10^{-5} cm/sec. The RI will be revised for this.	Response is adequate.	Yes
IDEM 5	Sec 2.6.3.2.2	Background Well Cluster B: The text states, "[a]s with the bedrock groundwater at BKA, the bedrock groundwater at BKB is locally unconfined in the absence of fractures in the underlying till." This sentence needs clarification as to why the groundwater would be unconfined with no fractures in the till. There also must be an explanation of how till could be deposited underneath the bedrock.	Based on our review of the Section 2.6.3.2.1, Background Well Cluster A and Section 2.6.3.2.2, Background Well Cluster B, we conclude that the sentence was misstated and should read "[a]s with the bedrock groundwater at BKA, the bedrock groundwater at BKB is locally confined in the absence of fractures in the overlying till."	Response is adequate.	Yes

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Comment #	Section	IDEM 30 May 2002 Comment	Army Response Submitted 21 June 2002	IDEM Evaluation of Response	Resolved (yes/no)
IDEM 6	Sec 2	**Figures: Figures 2-3, 2-4, 2-5, 2-6, and 2-10 are unreadable.** Figure 2-10 is a mass of black with white lines in it. They need to be replaced with legible figures in order for IDEM staff to properly interpret the information they are presenting.	These figures were intended to be included as color drawings. We have learned that a number of report copies were distributed with illegible black and white copies. We apologize for this oversight and attached are color copies as replacements.	Response is adequate.	Yes
IDEM 7	Sec 3	**Figures 2-16 and 2-17:** These maps are suppose to identify groundwater flow direction on two separate sampling events, however, there are no arrows present to show the flow direction being illustrated or discussed in the text in the section.	Groundwater flows from points of high to low equipotentials. Although the regional groundwater flow direction is from east to west, the local groundwater flow directions range through all compass directions. Therefore, to avoid confusion, arrows indicating groundwater flow directions have not been placed on these drawings; however, groundwater flow at any location is perpendicular to the equipotential contours moving from high to low equipotentials. A note to this affect will be added to the figures.		Yes
IDEM 8	Sec 3.2.7.2.1	**Groundwater Sampling:** This section mentions sampling groundwater using a "controlled vacuum" and a peristaltic pump. These are invalid methods for volatile organic compound (VOC) sampling.	Section 3.2.7.2.1 discusses groundwater sampling of temporary wells for the specific purpose of collecting screening level data. Furthermore, the description of the complete sampling method includes collection of the groundwater from the bottom of the tubing at the end opposite from where the "controlled vacuum" was applied. While this method may not be ideal, it was used in 1993 as part of the Phase I investigation to provide information to guide the placement of permanent monitoring wells.	Response is adequate.	Yes
IDEM 9	Sec 3.2.8	**Monitoring Wells:** "In May and November 2001, seventeen additional monitoring wells were installed at four sites…based on the results from supplemental monitoring conducted at these sites and historical data from earlier monitoring rounds." IDEM staff have not seen a justification or rational submitted for the location selection of these 17 wells. A detailed narrative explaining the rationale for the selection of each well location and what data the well is expected to provide needs to be submitted.	Information regarding potential well locations was provided in Work Plan documents reviewed by IDEM. Specific rationale was not provided because final locations were to be determined in the field by mutual agreement of the USACE, IDEM, and EPA. Although EPA did not send a representative to participate, the locations of the seventeen additional monitoring wells were agreed upon by representatives from the USACE and IDEM. During the telephone conversation with IDEM, we concluded that the well locations were determined in the field by mutual agreement between USACE and IDEM. However, for the sake of documenting the purpose for each monitoring well, a table will be added to Section 3 that briefly summarizes the rationale for each monitoring well location.	Response is adequate.	Yes
IDEM 10	Sec 3.2.8.7	**Monitoring Well Water Level Measurements:** "No indication of the presence of LNAPLs or DNAPLs was observed…" This is incorrect. Perhaps it was intended to state that "[n]o indication of the presence of LNAPL or DNAPL free product was observed." Clarification is needed.	The comment is in regards to the use of the terms "LNAPL" and "DNAPL". Given the intent and definition of the terms, the usage is correct as stated. After discussion with IDEM, we believe that adding the term "free product" parenthetically will dispel confusion, for example, "…the presence of LNAPL or DNAPL (i.e., free product) was…".	Response is adequate.	Yes
IDEM 11	Table 3-7	**Summary of Data Quality Objectives:** The data usage column for site #13 states "[c]onfirm presence of absence…" The word "of" should be changed to "or."	Concur. Table 3-7 will be revised accordingly.	Response is adequate.	Yes
IDEM 12	Sec 4.1.1.2	**Groundwater Processes:** The text states that "…fracture flow may affect groundwater movement at JPG." In this draft, "affect" has been substituted for the word "dominate." "Dominate" is more correct and should be retained.	Concur. Section 4.1.2 will be revised accordingly.	Response is adequate.	Yes

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IDEM 13	Sec 6.5.1	The extent of contamination at Site 1 has not been defined. Aluminum, arsenic, beryllium, and manganese results exceeded United States Environmental Protection Agency (USEPA) Residential Region 9 Preliminary Remediation Goals (PRGs) in samples INC01SF001 and INC01SF002. Chromium results exceeded Region 9 Residential PRG in sample INC01SF001. The concentrations of dioxin "OCDD" when converted to "TCDD" equivalent concentrations "were found to exceed the USEPA Region 9 criteria of 4.5 E –07." However, dioxin "OCDD" was found to exceed this criterion in background samples. IDEM staff agree that this site be carried forward to the Feasibility Study (FS). Additional sampling may be needed around the two previous samples in all directions to adequately develop a remedial alternative. Please explain and identify the acronyms OCDD and TCDD.	This site will be carried forward to the FS. The acronyms are defined in the Acronym section at the front of each volume of the Draft-Final RI. OCDD stands for octachlorodibenzodioxin and TCDD stands for 2,3,7,8-Tetrachlorodibenzo-p-dioxin.		Yes
IDEM 14		The extent of contamination in the soil at Site 2 (sewage treatment plant [STP]) was not defined. Two samples were collected, which showed aluminum, arsenic and manganese results exceeding the Residential Region 9 PRGs. Additional sampling is needed at the STP. IDEM staff agree that this site be carried forward to the FS.	Comment noted.	Several of IDEM's comments were in regard to the extent of contamination not being completely defined. IDEM requested that additional investigation be performed. The Army has responded that the comment was noted. It is unclear whether the Army will continue with additional investigations in the feasibility study or not. This issue needs to be clarified.	No
IDEM 15	Sec 7.5.1	The extent of contamination in the surface soil at Site 27 (sewage sludge application areas) has not been defined. Aluminum, antimony, arsenic, barium, beryllium, copper, chromium, lead, vanadium, and thallium results exceeded the Region 9 Residential PRGs. The samples with the maximum concentrations were samples SSA27SF022 and SSA27SF024. IDEM staff agree that this site be carried forward to the FS. Additional sampling may be warranted to adequately develop a remedial alternative or restricted reuse would be necessary.	Comment noted.	Several of IDEM's comments were in regard to the extent of contamination not being completely defined. IDEM requested that additional investigation be performed. The Army has responded that the comment was noted. It is unclear whether the Army will continue with additional investigations in the feasibility study or not. This issue needs to be clarified.	No
IDEM 16	Sec 7.5.2	The vertical extent of contamination in the subsurface soil at Site 27 (sewage sludge application areas) has not been defined. Soil samples were collected at depths of 2, 5, and 10 feet. Sample results from all three depths exceeded the Residential Region 9 PRGs for aluminum, arsenic, beryllium, manganese, and thallium. IDEM staff agree that this site be carried forward to the FS. Additional sampling may be warranted to adequately develop a remedial alternative or restricted reuse would be necessary.	Comment noted.	Several of IDEM's comments were in regard to the extent of contamination not being completely defined. IDEM requested that additional investigation be performed. The Army has responded that the comment was noted. It is unclear whether the Army will continue with additional investigations in the feasibility study or not. This issue needs to be clarified.	No
IDEM 17	Sec 7.5.3	The extent of contamination in the sediment along Harberts Creek has not been defined. Additional samples are needed upstream and downstream of the current sample locations. Arsenic, beryllium, and manganese results exceeded the Residential Region 9 PRGs in all five samples. Vanadium and iron results exceeded the Region 9 Residential PRG in sample STP02SD004, chromium results exceeded the criteria level in sample STP02SD003 and STP02SD004, and aluminum results exceeded the criteria level in STP02SD003 and STP02SD005.	Harberts Creek sediment samples contained aluminum, arsenic, beryllium, chromium, iron, manganese, and vanadium at concentrations above their respective USEPA Region 9 PRGs. However, the human health risk assessment results indicate that there is no risk associated with Harberts Creek sediments (Table 7-15). In addition, the ecological risk assessment results indicate that Harberts Creek has not been negatively impacted by site activities. Therefore no further studies are necessary.		No

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Comment #	Section	IDEM 30 May 2002 Comment	Army Response Submitted 21 June 2002	IDEM Evaluation of Response	Resolved (yes/no)
IDEM 18	Sec 7.5.4	Silver was detected in Harberts Creek surface water above the Residential Region 9 PRG. The nature and extent and potential source of the arsenic contamination needs to be further investigated. One possible source that was not mentioned could be from runoff associated with contaminated soils due to the incinerator and the land applied sewage treatment plant sludge.	Silver was detected in surface water at Harberts Creek, however the concentrations were less than the PRG for silver in tap water (Section 7.5.3). As a result of screening against PRGs, no chemicals were retained as COPCs for surface water (Section 7.6.1.5.4). The arsenic concentrations detected in sediments of Harberts Creek were determined to be consistent with elevated background levels identified for the entire JPG area. In addition, the ecological risk assessment results indicate that Harberts Creek has not been negatively impacted by site activities. Therefore, no further studies of the stream are necessary.		No
IDEM 19	Sec 10.3.2.3	Supplemental Groundwater Monitoring: "Additional groundwater sampling was performed in June 2001 (the seven wells)…" IDEM staff believe that this statement is incorrect and it should read that eight wells instead of seven wells. Please confirm the accurate well number and correct as necessary.	The statement is correct. A total of eight wells were sampled at Site 7/21B. However, only seven of the wells were sampled in June 2001. The eighth well was sampled in November 2001.	The response to specific comment 19 needs further explanation of why the eighth monitoring well was sampled several months later during a totally different seasonal timeframe. The reason for the delay in sampling needs explained and documented in the DF RI.	No
IDEM 20	Sec 10.5.1.2	Arsenic results at Site 7/21B exceeded the Residential Region 9 PRG (0.045 μg/L) in MW93-10 (16.8 μg/L), MW93-11 (23.7 μg/L), MW93-44 (31.6 μg/L) and MW95-04 (33.5 μg/L). The nature and extent of the arsenic contamination is unknown. Additional sampling is needed.	Concur. Sites 7/21B will be addressed in the FS for groundwater.		No
IDEM 21	Sec 10.5.1.3	The red lead disposal area (Site 7/21B) had two samples that still contained lead above the Residential Region 9 PRG. It was stated that in these two areas the contaminated soil was removed by hand, but it is confusing as to whether additional sampling was performed to confirm that contamination was actually removed to levels below Region 9 criteria. IDEM staff agree that this site be carried forward to the FS. Additional sampling to confirm cleanup criteria has been met may be necessary.	Sites 7/21B will be carried forward to the FS for groundwater. The risk assessment concluded that the only risks were for the groundwater pathway.	The response to specific comment 21 fails to adequately answer whether confirmation soil samples were collected or whether they were necessary based on the risk assessment calculations.	No
IDEM 22	Sec 10.5.2.1	The two metals at Site 7/21B were found to exceed the Residential Region 9 PRG are cadmium in sample 1B and lead in samples 1B and 2B. Dieldrin was found to exceed the Residential Region 9 PRG. Additional sampling may be warranted to adequately develop a remedial alternative or restricted reuse would be necessary.	Dieldrin was a sample result from Site 21A that was mistakenly grouped with Site 21B data. The text will be revised accordingly. The soils contaminated with cadmium and lead were removed during an interim removal action (Sverdrup, 1997b).		Yes
IDEM 23	Sec 10.5.2.1	There is no reference to a map identifying sampling locations for Site 21B. Therefore, the extent of contamination could not be determined. Please provide this map.	Figure 10-5 contains the sample locations.		Yes
IDEM 24	Sec 10.5.2.1 Sec 10.8	On page 10-12, it states the only metals exceeding the Residential Region 9 PRGs at Site 21B were cadmium and lead. However, on page 10-29 and 10-30 it states that aluminum, barium, beryllium, and manganese were found to exceed Residential Region 9 PRGs for Site 21B. There is an inconsistency that needs to be clarified.	Page 10-12 is in error and will be corrected.		Yes

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Comment #	Section	IDEM 30 May 2002 Comment	Army Response Submitted 21 June 2002	IDEM Evaluation of Response	Resolved (yes/no)
IDEM 25	Sec 12.5.2 Sec 12.5.3 Sec 12.5.4	In the surface soil samples at Site 9 and 10, aluminum, beryllium, and manganese results exceeded the EPA Region 9 PRGs. In the subsurface soils, arsenic, barium, beryllium, manganese, and vanadium results exceeded the Region 9 PRGs. For the middle location of borehole B, benzo[a]anthracene, benzo[a]pyrene, 3,4-benzofluoroanthene, benzo[k]fluoranthene, and 1,2,5,6-dibenzoanthracene results exceed Region 9 PRGs. In sediment samples, aluminum, beryllium, and manganese results exceeded Region 9 Criteria. Based on the information and data provided, it appears that the extent of contamination has not been defined at Site 9 and 10. Additional sampling data are needed to define the two sites.	Site 10, the Gate 19 landfill has been capped in accordance with an IDEM approved closure plan, which significantly reduces the risks associated with the site. Based on the risk assessment performed for Site 9, Burning Area, this site will be carried forward to the FS.		No
IDEM 26		The surface soil in the new burn area (Site 9) had several semi-volatile organic compounds (SVOCs), polyaromatic hydrocarbons (PAHs), dioxins/furans, and lead above the Residential Region 9 PRG. IDEM staff agree that this site be carried forward to the FS. Additional sampling may be necessary in order to define the extent of contamination.	Concur.	Several of IDEM's comments were in regard to the extent of contamination not being completely defined. IDEM requested that additional investigation be performed. The Army has responded that the comment was noted. It is unclear whether the Army will continue with additional investigations in the feasibility study or not. This issue needs to be clarified.	No
IDEM 27	Sec 12.5.6	The groundwater at Site 9 and 10 contained arsenic, beryllium, copper, lead, and manganese above the Region 9 PRG. IDEM staff believe that these sites should be carried forward to the FS.	Sites 9/10 will be addressed in the FS.		Yes
IDEM 28	Sec 13.1	The text discusses the remedial removal action to remove source contaminated materials through excavation and off-site disposal. Confirmation samples were collected and residual contamination was detected in the confirmation samples. Even though there is reference to the Draft Final Completion Report for Sites 12A, 12B, 12C, and 33, more detail needs to be added to explain that only the confirmation samples directly under the building foundation had residual contamination above PRGs and all other locations were acceptable.	The Draft Final RI, Section 13.1 will be revised to include this information.		Yes
IDEM 29	Sec 13.1.1.2	The text refers to Figures 2-16 and 2-17 as illustrating regional groundwater flow to the southwest in the bedrock system. However, these figures lack any identifying markings that show regional groundwater flow. IDEM staff request this information be added to the figures.	Refer to response to Specific Comment 7.		Yes
IDEM 30	Sec 13.3.2.3	The text discusses the installation of additional groundwater monitoring wells. However, it does not explain the reason the specific locations were selected for installation and what information was to be gained. Please include this information.	Refer to response to Specific Comment 9.	Response is adequate.	Yes
IDEM 31	Sec 13.3.3	Explain in more detail where confirmation samples were collected and identify which sample(s) exceeded PRGs. Please be more specific.	Section 13.3.3 will be revised to summarize confirmation sampling results contained in the Draft-Final Construction Completion Report		Yes
IDEM 32	Sec 13.5.2	The value for the USEPA Region 9 criteria for 1,1,1-trichloroethane (790 μg/L) has been marked for removal. Please explain the reasoning for removal of this value. IDEM staff believe this value should be retained.	The values of the Region 9 PRGs are listed in the tables that are referenced within the text, thus the duplication is not needed.		Yes

Resolution of IDEM Comment and Army Reponses
Draft Final Remedial Investigation dated March 2002
Jefferson Proving Ground (JPG)

Comment #	Section	IDEM 30 May 2002 Comment	Army Response Submitted 21 June 2002	IDEM Evaluation of Response	Resolved (yes/no)
IDEM 33	Sec 14.1	The text discusses the remedial removal action for source removal of contaminated materials through excavation and off-site disposal. Confirmation samples were collected and residual contamination was detected in the confirmation samples. Even though there is reference to the Draft Final Completion Report for Sites 12A, 12B, 12C, and 33, more detail needs to be added to explain that only the confirmation samples directly under the building foundation had residual contamination above PRGs and all other locations were acceptable.	The Draft Final RI, Section 14.1 will be revised to include this information.		Yes
IDEM 34	Sec 14.3.2.3	The text discusses the installation of additional groundwater monitoring wells. However, it does not explain the reason the specific locations were selected for installation and what information was to be gained. Please include this information.	Refer to response to Specific Comment 9.	Response is adequate.	Yes
IDEM 35	Sec 14.3.3	Explain in more detail where confirmation samples were collected and identify which sample(s) exceeded PRGs. Please be more specific.	Section 14.3.3 will be revised to summarize confirmation sampling results.		Yes
IDEM 36	Sec 15.3.3	IDEM staff are aware that a field drainage tile was encountered during excavation of the contaminated soils. Please include this information in the report and identify any significance it had relative to contamination migration.	During the interim removal action, field personnel recorded activities in a field logbook. There is no reference in the logbook regarding the presence of a drainage tile in the excavation at Site 12C. Confirmation testing indicated that the contaminated soils at Site 12C were removed and the site will go forward to the FS for groundwater.	The response to specific comment 35 **(actually 36)** is inadequate. IDEM staff was present during removal operations and observed the presence of the field tile and took digital photographs. See the following photograph and area identifier.	No
IDEM 37	Sec 17.5.1 Sec 17.5.4	The soil and groundwater contamination at Site 14 has not been defined. Additional investigations are needed to define the extent of contamination. In addition, unexploded ordnance (UXO) discovered at this site must be addressed.	Soil has been addressed by the interim removal action. Remaining soil and groundwater contamination will be addressed in the FS. UXO support will be included as a component in the remedial actions performed at the site.		Yes
IDEM 38	Sec 19.5.1	The extent of contamination at Site 21A and 30 is undefined to the east. Additional sampling is needed in this area.	The extent of contamination to the east is defined by samples 14 and 15.	Agreed.	Yes
IDEM 39	Sec 19 Table 19-1	The report for Site 21A and 30 failed to mention that chlordane results exceeded the Residential Region 9 PRG in samples STA21SF010, STA21SF012, and STA21SF014 (see Table 19-1). This needs to be addressed in future reports.	Sample results for Site 21A may have been mistakenly crossed with Site 21B results. This will be evaluated and Tables 19-2 and 19-3 will be revised and the section modified accordingly.		Yes
CONCLUSIONS					
IDEM 1		The conceptions concerning groundwater recharge and the difference in capillary fringe and pressure head must be addressed. The inclusion of these concepts, references, and terminology need evaluated.	This is addressed in the response to general comments 3, 4, 5, and 6. Please refer to that discussion. The Draft Final RI will be revised accordingly.	Response is adequate.	Yes
IDEM 2		Site background locations and concentrations have been a point of concern for the site throughout the RI. Several contaminants (i.e., aluminum, arsenic, beryllium, chromium, manganese, dioxins/furans) need further investigation and information collected to clarify and address concerns. IDEM staff believe that a separate and detailed section needs to be developed and included in this document. IDEM staff believe that further sampling may also be needed.	Concern noted. Please refer to the response to General Comment 2.		No

Resolution of IDEM Comment and Army Reponses
Draft Final Remedial Investigation dated March 2002
Jefferson Proving Ground (JPG)

Comment #	Section	IDEM 30 May 2002 Comment	Army Response Submitted 21 June 2002	IDEM Evaluation of Response	Resolved (yes/no)
Conclusions IDEM 3		It was determined that the extent of contamination at Sites 1, 2, 27, 3, 4, 7, 21B, 9, 10, 12A, 12B, 12C, 14, 21A, 30, and 26 was not defined and these sites will be carried forward to the feasibility study (FS). Additional investigations are needed. In addition, the comments above need to be addressed. It was determined that the extent of contamination was defined at Sites 5, 6, 8, 13, 15, 25, 28, 29, 39, 31, 33, 34, 38, 42. These sites may proceed with a No Further Action (NFA) Technical Memorandum as suggested.	We disagree with the assessment of Site 26. Site 26 has been defined and will not go forward to the FS. Contaminated soils were removed in the areas south of the DRMO Storage Area during a 1997 interim removal action. Contaminated soils were removed in the DRMO Storage Area during a 1998 interim removal action. Confirmation sample results indicated residual soils at both locations within Site 26 met PRGs. Sites 5, 6, 8, 13, 15, 25, **26**, 28, 29, 31, 33, 34, 38, 39, and 42 will not go forward to the FS.		Yes

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ABBREVIATIONS AND ACRONYMS LIST

AEHA	U.S. Army Environmental Hygiene Agency
AF	adherence factor
AHERA	Asbestos Hazard Emergency Response Act
ANOVA	analysis of variance
AOC	areas of concern
ARAR	Applicable or Relevant and Appropriate Requirement
AREE	Areas Requiring Environmental Evaluation
ASTM	American Society for Testing Materials
ATEL	Aqua Tech Environmental Laboratories, Inc.
AT	averaging time
ATEL	Aqua Tech Environmental Laboratories
ATV	all-terrain vehicle
AUF	area use factor
AWQC	ambient water quality criteria
BAFs	bioaccumulation factors
BCFs	bioconcentration factors
bgs	below ground surface
BKA	Background Site A
BKB	Background Site B
BKC	Background Site C
BRAC	Base Realignment and Closure
BTEX	benzene, toluene, ethylbenzene, and xylene
BTF	biotransfer factor
BW	body weight
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERFA	Community Environmental Response Facilitation Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
cm	centimeters
CoC	chain of custody
COC	contaminant of concern
COPC	contaminant of potential concern
CPOM	coarse particulate organic material
CRL	certified reporting limit
CT	central tendency
CTI	Commonwealth Technologies, Inc.
DDD	1,1-Dichloro-2,2-bis(*p*-chlorophenyl)ethane
DDE	2,2-Bis(*p*-chlorophenyl)-1,1-dichloroethene
DDT	2,2-Bis(*p*-chlorophenyl)-1,1,1-trichloroethane

DERA	detailed ecological risk assessment
DF	detection frequency
DIR	dietary ingestion rate
dL	deciliter
DNAPL	dense non-aqueous phase liquid
DNT	Dinitrotoluene
DOD	Department of Defense
DSG	DERA Scoping Group
DQA	data quality assessment
DQL	desired quantitation limit
DQO	data quality objectives
DQST	data quality screening tool
DRMO	Defense Reutilization and Marketing Office
DTW	depth to water
DU	depleted uranium
ED	exposure duration
EF	exposure frequency
EIS	Environmental Impact Statement
EM	electromagnetic
EO	explosive ordnance
EOD	explosive ordnance disposal
EODT	EOD Technologies, Inc.
EP	extraction procedure
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
EPIC	Environmental Photographic Interpretation Center
EP&T	Ecological Planning and Toxicology, Inc.
EPT	Ephemeroptera, Plecoptera, Trichoptera
ERL	effects range low
ESE	Environmental Science and Engineering, Inc.
ET	exposure time
FDF	field data form
FE	federal endangered species
FS	feasibility study
FSAP	Field Sampling and Analysis Plan
FT	federal threatened species
GC	gas chromatograph
GIS	Geographical Information System
GSA	Geological Society of America
GT	greater than
HBI	Hilsenhoff Biotic Index
HEAST	Health Effects Assessment Summary Table

HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
HQA	habitat quality assessment
HR	home range
HRS	Hazard Ranking System
HSA	hollow-stem auger
IAP	Installation Action Plan
IBI	Index of Biotic Integrity
ICP	inductively coupled plasma
ID	inside diameter
IDEM	Indiana Department of Environmental Management
IDNR	Indiana Department of Natural Resources
IE	Indiana endangered species
IM	interim measures
IR	ingestion rate
IRDMIS	Installation Restoration Data Management Information System
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
IT	Indiana threatened species
JPG	Jefferson Proving Ground
LCS	laboratory control sample
LNAPLs	light non-aqueous phase liquids
LOAEL	lowest observed adverse effect level
LQL	lower quantifiable limit
LSD	least significant difference
LT	less than
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MDL	method detection limit
MDRD	minimum detectable relative difference
MEK	Methyl ethyl ketone
MF	modifying factor
µg/g	micrograms per gram
µg/L	micrograms per liter
mg/D	milligrams per day
mg/L	milligrams per liter
mg/kg	milligrams per kilogram
mL	milliliter
MRL	method reporting limit
MS/MSDs	matrix spike/matrix spike duplicates
MSL	mean sea level

NA	not analyzed
NAA	no action alternative
NCEA	National Center of Environmental Assessment
NCP	National Contingency Plan
ND	non-detect
NEC	no effects concentration
NEIC	National Enforcement Investigations Center
NEPA	National Environmental Policy Act
NFA	no further action
NOAEL	no observed adverse effect level
NPDES	National Pollutant Discharge Elimination System
NPL	National Priority List
NRC	Nuclear Regulatory Agency
NTU	nephelometric turbidity units
NWI	National Wetland Inventory
OCDD	octachlorodibenzodioxin
OCP	organochlorine pesticide
OD	outside diameter
OSWER	Office of Solid Waste and Emergency Response
PA	preliminary assessment
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated byphenol
pCi/L	picocuries per liter
PCP	pentachlorophenol
PCs	permeability constants
PERA	preliminary ecological risk assessment
PFO	palustrine forested
PH	probehole
PID	photoionization detector
POL	petroleum, oil, and lubricants
ppb	parts per billion
ppm	parts per million
PQL	practical quantitation limit
PR	preliminary review
PRG	preliminary remediation goal
psi	pounds per square inch
PSI	preliminary site inspection
PSS	palustrine scrub shrub
PVC	polyvinyl chloride
QA/QC	Quality Assurance/Quality Control
QAP	Quality Assurance Program
QAPjP	Quality Assurance Project Plan

QC	Quality Control
RA	risk assessment
RAGS	Risk Assessment Guidance for Superfund
RBP	Rapid Bioassessment Protocol
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RDA	recommended daily allowance
RFA	RCRA Facility Assessment
RfC	reference concentration
RfD	reference dose
RI/FS	Remedial Investigation and Feasibility Study
RI	remedial Investigation
RME	reasonable maximum exposure
RPD	relative percent difference
RUF	root uptake factor
Rust E&I	Rust Environment and Infrastructure, formerly SEC Donohue, Inc.
SAIC	Science Applications International Corporation
SARA	Superfund Amendment and Reauthorization Act
sec	seconds
SFD	sediment fraction in diet
SHSP	Site Health and Safety Plan
SIR	soil ingestion rate
SMDPs	scientific management decision points
SOP	standard operating procedure
SOW	statement of work
SQC	sediment quality criteria
SQL	sample quantitation limit
SSA	sewage sludge application area
SSSA	Site-Specific Sampling and Analysis
STP	Sewage Treatment Plant
SVOC	semivolatile organic compound
SWMU	Solid Waste Management Units
TCDD	2,3,7,8-Tetrachlorodibenzo-*p*-dioxin
TCE	Trichloroethane
TCLP	Toxicity Characteristic Leaching Procedure
TDS	total dissolved solids
T&E	threatened or endangered
TEF	toxicity equivalency factor
TEQ	toxicity equivalency
TIC	tentatively identified compound
TM	technical memorandum
TNT	Trinitrotoluene

TPH	total petroleum hydrocarbons
TRVs	toxicity reference values
UA	uncertainty analysis
UCL95	upper 95 percent confidence level
UFs	uncertainty factors
UR	unit risk
USACE	U.S. Army Corps of Engineers
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
USAEC	U.S. Army Environmental Center
USAEHA	U.S. Army Environmental Hygiene Agency
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USCS	Unified Soil Classification System
USEPA	U.S. Environmental Protection Agency
USFWS	U. S. Fish and Wildlife Service
USRADS	Ultrasonic Ranging and Data Acquisition System
UST	underground storage tank
UXO	unexploded ordnance
VOC	volatile organic compound
WIR	water ingestion rate
WLE	water level elevation

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EXECUTIVE SUMMARY

Jefferson Proving Ground (JPG) is a former munitions and weapons testing facility located near Madison, Indiana, which was closed in 1995 under the Army's Base Realignment and Closure (BRAC) program. As part of this closure process, the Army conducted environmental studies in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) designed to characterize the nature and extent of possible contaminant releases at JPG and to determine their potential impacts on human health and the environment. A Remedial Investigation/Feasibility Study (RI/FS) was conducted to fulfill the CERCLA requirements as well as other federal, state, and local laws and to facilitate the cleanup and transfer of JPG properties for reuse following facility closure. Rust Environment and Infrastructure (Rust E&I), under a U.S. Army Environmental Center (USAEC) contract (Contract No. DAAA15-90-D-0007, Task Order 0005), was tasked with conducting the RI/FS for the area referred to as South of the Firing Line at JPG. Initially, there were 50 potential contaminant-release sites identified for investigation under the RI/FS. Rust E&I conducted record searches, personnel interviews, reviews of previous environmental investigations, and field investigations in 1992 and 1993 to determine the possible extent of environmental contamination at JPG. Rust E&I then prepared and submitted the Final *Draft Remedial Investigation Report for Jefferson Proving Ground, South of the Firing Line* (Rust E&I 1994) which presents the results of a Phase I field investigation program. On the basis of the conclusions and recommendations within the report and comments received from the U.S. Environmental Protection Agency (USEPA) and Indiana Department of Environmental Management (IDEM), it was determined that data gaps still existed following Phase I and that additional investigation was required for 23 of the 50 sites located south of the Firing Line.

A Phase II field investigation, designed to fill the data gaps identified on the basis of the Phase I results, was conducted from October 1995 through June 1996. A supplemental field investigation was conducted in September 1997 to provide data determined to be necessary to evaluate potential risks to ecological receptors south of the Firing Line at JPG. In addition, sampling was also conducted in September 1997 at a new burn site discovered during an unexploded ordnance (UXO) survey by another contractor. The *Draft Phase II Remedial Investigation Report for Jefferson Proving Ground, South of the Firing Line* (Draft RI) was submitted August 1998 to detail the Phase II investigation objectives, the technical approach and procedures used, the results of previous and Phase II field investigations, an evaluation of the nature and extent of contamination, an assessment of data quality, the determination of risks to human health and the environment, and the conclusions and recommendations. This Draft Final Phase II RI addresses the agencies' comments on the Draft RI and incorporates additional work performed since the submittal of the Draft RI. The results of the Phase II RI study, combined with previous results, will subsequently be used in the completion of the FS where various remedial-action alternatives will be screened, analyzed, and recommended for each of the remaining sites.

There are 30 sites (23 with Phase II sampling and 7 carried forward from Phase I without Phase II sampling) associated with the area South of the Firing Line that are the subject of this report (Table ES-1). Of these sites, fourteen have undergone interim remedial action through the U.S. Army Corps of Engineers (USACE), Louisville District, since completion of the Phase II RI field investigation activities (Table ES-2) (IN1). For these sites, the cleanup actions are described and confirmatory results are summarized, where available, which help document that the risks to human health and the environment have been reduced to levels that are below all applicable state and federal cleanup goals. For these and other sites where the human health and ecological risks are at acceptable levels, technical memoranda will be prepared that recommend No Further Action (NFA) resulting in the removal of these sites from the RI/FS process.

Work plans for the Phase II data gap sampling were prepared and submitted in the spring of 1995. These plans provided the details of the proposed field investigation activities for each of the sites. Activities included additional surface and subsurface soil sampling and analysis, field screening surveys, and groundwater sampling. Additionally, addendum work plans were prepared and submitted in the fall of 1997 to provide details of ecological field surveys and sampling and soil sampling at a new burn site identified adjacent to Sites 3 and 4. Work plans were also submitted for additional monitoring and installation of new monitoring wells at Sites 3/4, 7/21B, 12A, 12B, 12C, and Middle Fork Creek.

Chemical analyses for Phase II, supplemental groundwater and surface water and sediment, and confirmation samples were performed using USEPA SW-846 methods. Analytical data were screened and validated through the use of an independent third party specializing in data validation. Additional screening was performed by Rust E&I according to USEPA risk assessment guidance to determine contaminants of potential concern (COPCs) for each of the sites. The analytical suite selected for each sample was based on a review of all previous investigation results and past facility activities reported for each site. Where possible, previous and Phase II results were combined prior to screening. Part of the screening process involved the establishment of background concentrations for metals and dioxins to allow a comparison of site-specific concentrations with background levels found at JPG. To determine the background levels, additional soil and groundwater sampling was conducted during Phase II in areas unlikely to be contaminated from previous JPG facility operations. For soils, background concentrations were determined according to major soil types. Other screening involved the comparison of Phase I and Phase II RI data with corresponding field and laboratory quality control (QC) data, including the screening for common laboratory contaminants. The data were also screened for frequency of detection. A final screening was performed to determine if any contaminants exceed the applicable state or federal cleanup standards or drinking water standards.

The screened data deemed to be valid and usable were then evaluated to determine the nature and extent of contamination at each site. Following the nature-and-extent analysis, a quantitative human health risk assessment (HHRA) was performed to determine whether any adverse effects to human health could occur as a result of past activities. Potential

adverse effects to the local ecology and environment were also evaluated using data from Phase I and Phase II field investigations and data collected specifically for the ecological risk assessment in the fall of 1997. The HHRA evaluated several potential exposure scenarios including both current and future exposure scenarios. These scenarios included residential, industrial, agricultural, trespassing, and hunting scenarios. The detailed ecological risk assessment (DERA) included site-specific and facility-wide exposure scenarios for key ecological receptors at JPG. Both the HHRA and DERA were conducted according to work plans developed in conjunction with USEPA, IDEM, U.S. Fish and Wildlife Service (USFWS), and Army personnel.

The following summarizes the findings of this Phase II RI for each site.

SITE 1—BUILDING 185 INCINERATOR

Phase I and Phase II sampling results for metals and dioxins/furans in surface soils located downwind of the incinerator indicate that no significant contaminant releases have occurred as a result of burning activities. However, aluminum, arsenic, beryllium, chromium, manganese, and dioxins/furans were retained throughout the contaminant screening process as COPCs. A comparison of dioxins/furans from site samples with background contaminant levels indicates that the dioxins/furans may or may not be related to previous site activities. The human health assessment results indicate that under the hypothetical future residential scenario, adult and child residents may be at risk from exposure to dioxins and metals in soils. No ecological risks were identified for Site 1 due to the small area of contamination, lack of ecological contaminants of concern, and the highly disturbed nature of the area (recent agricultural activity).

Since future residential risks exceed the USEPA risk-based criteria, it is recommended that Site 1 be carried forward to the FS. No additional investigations under the RI appear to be warranted.

SITES 2 AND 27—SEWAGE TREATMENT PLANT AND SEWAGE SLUDGE APPLICATION AREAS

Phase I and Phase II results of surface soil, subsurface soil, sediment, and surface water sampling indicate that metals contamination exists in the sludge application areas and in the sediments of Harbert's Creek. The sludge application areas consist of several broad areas where sewage sludge was previously removed from the sewage treatment facility and spread across the ground surface. Harbert's Creek was contaminated by discharges to an outfall located downstream from the sewage treatment plant. Of particular concern was the presence of elevated silver originating from the former photographic laboratory. During Phase II, the entire Site 27 area was gridded and sampled resulting in the identification of at least one "hot spot" area of contamination in addition to broad areas of above-background concentrations of metals. The primary contaminants in soils are

aluminum, arsenic, beryllium, chromium, manganese, silver, and thallium. The primary contaminants in sediments of Harbert's Creek are aluminum, arsenic, beryllium, chromium, iron, manganese, and vanadium. No COCs were found to be present in surface water from Harbert's Creek.

The results of the human health risk assessment for Site 2 indicate potential chronic health hazards exceeding the USEPA hazard index goal of 1.0 that are associated with the inhalation of manganese in fugitive dust. For Site 27, hazards to the hypothetical future resident also exceed the goal of 1.0 as a result of potential incidental ingestion of surface soil and ingestion of home-grown produce contaminated with arsenic and manganese. Hazards associated with the ingestion of silver through the milk pathway also exceed the goal of 1.0 for the future resident. Estimated carcinogenic risks for future residents and future on-site workers are all within the USEPA target range of 1E-04 to 1E-06.

Results of the ecological risk assessment indicate that Harbert's Creek has not been adversely impacted by contaminant releases from the Sewage Treatment Plant and that no further studies of the stream are warranted. An assessment of ecological risk from contaminants in soils at Sites 2/27 indicates that risks to plants, soil fauna, white-footed mouse, and eastern cottontail are slightly elevated when compared to the reference areas at JPG. However, after all lines of evidence are considered, it appears that contamination at Sites 2/27 does not pose a threat to ecological health.

Due to the chronic health hazards associated with the future residential land use scenario, it is recommended that this site be carried forward to the FS. Due to the large amount of data collected during the Phase I and Phase II RI, it appears that Sites 2 and 27 have been adequately characterized and no further RI field investigations (EPA8) are warranted.

SITES 3 AND 4—EXPLOSIVE BURNING AREA, ABANDONED LANDFILL, AND NEW BURN SITE

Phase I and Phase II surface soil, subsurface soil, and groundwater sample results indicate that there are three distinct areas of contamination at these sites. The first area (Site 3) consists primarily of metal contaminants in surface soils that exceed USEPA Region 9 cleanup goals as a result of surface burning activities. The second area consists of a former disposal trench within the Abandoned Landfill (Site 4), which was found to contain aluminum, barium, cadmium, chromium, and lead as contaminants in soils that exceed the cleanup goals. The third area consists of a narrow burn trench discovered in 1995 immediately west of Site 3 where metals, semi-volatile organic compounds (SVOCs), dioxins/furans, and explosives were found to be present. Of these contaminants, barium, chromium, lead, manganese, several SVOCs, the pesticide DDE, and dioxins/furans were all retained as COPCs for the human health risk assessment.

Groundwater downgradient of Sites 3 and 4 was found to contain several metals exceeding their respective background concentrations. Additionally, low concentrations of

solvent-related contaminants and one explosive compound were also detected. Of these contaminants, aluminum, arsenic, cobalt, iron, lead, manganese, molybdenum, and the explosive compound 4-amino-2,6-dinitrotoluene were retained as COPCs for the human health risk assessment. Additional monitoring well installations and supplemental groundwater monitoring performed in 2001 provided additional information about the nature and extent of contamination downgradient of Sites 3/4. The results confirm the previous groundwater results for metals and SVOCs. Explosives compounds were not detected. The results also indicated shallow groundwater contamination for VOCs downgradient of the Abandoned Landfill trench and shallow groundwater flow at the till bedrock/interface towards Harberts Creek, located to the north. Groundwater flow in the bedrock remains generally to the west-southwest.

Results of the risk assessment indicate that all three areas contain estimated carcinogenic and/or chronic health hazards exceeding USEPA risk management criteria. The primary contaminants and exposure pathways for the Site 4 trench include ingestion of metals in soil, ingestion of metals in homegrown produce, ingestion of metals in groundwater, and inhalation of volatile organic compounds (VOCs) and metals in fugitive dust. For the surface area containing the Site 3 burn area, chronic health hazards exceed USEPA risk management criteria primary due to ingestion of metals in soil, ingestion of metals in groundwater, and inhalation of VOCs and metals in fugitive dust. The new burn area had the highest carcinogenic risks primarily due to exposure to SVOCs in soils, SVOCs and dioxins in homegrown produce, and metals in groundwater. Chronic health hazards exceeded criteria due to ingestion of metals in homegrown produce, ingestion of metals in groundwater, and inhalation of metals in fugitive dust.

The results of the ecological survey at Sites 3/4 indicate that the contaminated soils did not produce levels of mortality in earthworms and did not affect the soil fauna diversity. The highest hazard indices were estimated for the white-footed mouse, eastern cottontail, plants, and soil fauna at Sites 3/4. However, the estimated risks fall within the same order of magnitude as those estimated for the reference areas at JPG. This indicates that relative risk to ecological receptors is not significantly elevated at Sites 3/4. One exception appears to be at one grid location where barium was found to be elevated. This location would result in higher risks to ecological receptors than other locations within the sites.

Since all three areas appear to pose future human health risks and hazards exceeding USEPA risk management criteria, it is recommended that Sites 3/4 be carried forward to the FS process. Due to the large amount of data collected during the Phase I and Phase II investigations, it appears that no further investigations are warranted under the RI.

SITES 5 AND 6—WOOD STORAGE PILE AND WOOD BURNING AREA

Surface soil sample results for these two sites indicate that both SVOCs and dioxins/furans are present in soils adjacent to Sites 5 and 6. The wood storage and wood burning areas are located on the concrete of the abandoned airport runways at JPG. Before base closure in

1995, all wood had been removed from these sites and was being stored at another on-site location for proper off-site disposal. Contaminants identified during Phase I and Phase II were generally at levels below all regulatory cleanup criteria. However, dioxins were found to be present at concentrations exceeding USEPA Region 9 risk-based criteria and were therefore retained as COPCs. Results of the HHRA indicate that there are no carcinogenic risks or chronic health hazards exceeding USEPA risk management criteria. The Phase I preliminary ecological risk assessment concluded that Sites 5 and 6 do not pose a significant risk to ecological receptors.

On the basis of the human health and ecological risk assessment results, a No Further Action (NFA) Decision Document was finalized in March 1999 proposing NFA for industrial use of Sites 5/6. An Addendum to the Decision Document was finalized in August 2001 proposing NFA for residential use. These sites will not be carried forward to the FS process.

SITES 7 AND 21B—RED LEAD DISPOSAL AREA AND TEMPORARY METHYLENE CHLORIDE STORAGE AREA

Phase I and Phase II soil sample results indicate that the primary COC was lead exceeding the cleanup goal of 400 μg/g. Red lead was found to be present in an area located adjacent to the southwest corner of Building 211. Based on the Phase I results, which included lead in concentrations exceeding the USEPA cleanup goal, an interim remedial action was conducted in 1997. This action consisted of the excavation and proper off-site disposal of lead-contaminated soils. Confirmatory samples collected from within the excavation indicated that a small area of contamination exceeding criteria still remained. This small area was then hand-excavated resulting in the determination by IDEM that further site remediation was not required.

Soil samples collected for Site 21B indicated the presence of low concentrations of several pesticides and several metals exceeding their respective background concentrations. Due to the low concentration of the pesticides, only the metals were found to exceed USEPA Region 9 preliminary remediation goals (PRGs). Aluminum, barium, beryllium, and manganese were retained as COPCs for Site 21B and the remainder of Site 7 (samples collected outside of the excavated area).

Groundwater samples from Sites 7 and 21B show that aluminum, arsenic, barium, mercury, molybdenum, and zinc are present in concentrations exceeding their respective background levels. Of these metals, arsenic and barium were found to exceed USEPA Region 9 PRGs. Additional monitoring well installations and supplemental groundwater monitoring performed in 2001 provided additional information about the nature and extent of contamination downgradient of Sites 7/21B. The results confirm the previous groundwater results for metals. VOC compounds were not detected. The results indicated that arsenic continues to be detected at concentrations above background at the site. Furthermore, the

highest concentration of arsenic was detected in the upgradient well, located northeast of the Sites.

Rust E&I, on the basis of Phase I and Phase II results, determined the potential risks to human health and the environment from Site 21B and from residual contamination left in the areas outside of the excavation at Site 7. The results indicate that carcinogenic risk and chronic health hazard estimates exceed USEPA risk management criteria for the future on-site worker and future on-site resident due almost entirely to ingestion of arsenic in groundwater. Excluding the groundwater ingestion pathway, the remaining risks from exposure to site soils would not exceed USEPA risk management criteria. The source of the arsenic in groundwater is unknown since arsenic was present in upgradient groundwater as well.

Results of the ecological risk assessment at Sites 7/21B indicate that, on the basis of Phase I data, there was a risk to ecological receptors from Site 21B contaminants. However, following the removal action conducted as part of the interim measures program, the estimated risks are at acceptable levels, indicating the removal action was successful in reducing ecological risks.

Due to the estimated risks exceeding USEPA risk management criteria, it is recommended that this site be carried forward to the FS. Additional studies of arsenic in the groundwater pathway may be warranted to determine if the arsenic is naturally occurring or related to site activities. No additional investigations are warranted.

SITE 8—BUILDING 295 SMALL ARMS FIRING RANGE

Building 295 was the site of an indoor small arms firing range that consisted of four firing lanes in a building several hundred feet long. Analytical results from Phase I surface soil samples collected outside of the building indicated that metals contamination was present in site soils but at levels below risk-based concentrations. The suspected source of these metals was the roof vent system for the building. Wipe samples from the interior walls of the firing lanes also indicated the presence of several metals on the concrete surface. However, no risk criteria exists for wipe sample data. On the basis of the Phase I results, no HHRA was performed. The site was also found to lack suitable habitat for ecological receptors. Additionally, no Phase II sampling was conducted for this site.

To allow release of this building for reuse, however, interim measures work was conducted at this site in 1997. The contaminated soils were excavated and removed, and the interior surfaces of the building were washed using water and detergent followed by a water rinse. The waste water was collected and properly disposed of off-site. Following the washing, the walls were sprayed with a sealant to encapsulate any potential residual metals. Confirmatory samples were collected and results have been incorporated into the Phase II RI Report. As a result of the interim measures at Site 8, no further evaluation under the RI/FS appears to be required and a No Further Remedial Action decision is warranted. A

Draft Decision Document will be prepared and public noticed for citizens input via comment/review (EPA95). The site will not be carried forward to the FS.

SITES 9 AND 10—BURNING GROUND SOUTH OF GATE 19 LANDFILL AND GATE 19 LANDFILL

Phase I sampling of soils at Sites 9 and 10 resulted in the detection of SVOCs, VOCs, and metals with the primary COPCs being the metals. Low levels of VOCs were detected in groundwater samples but at concentrations below risk-based standards. Phase II sampling consisted of an additional five rounds of groundwater sampling and additional soil sampling for SVOC analysis due to Phase I SVOC results being considered suspect. The Phase II results confirmed that low levels of SVOCs and VOCs as well as metals are present in groundwater at Sites 9 and 10. Only metals were found to be at levels exceeding risk-based criteria.

During the Phase II RI, interim action was performed at the Gate 19 Landfill with the placement of a cap on the landfill. Monitoring wells located within the landfill were properly abandoned prior to capping. For the Phase II RI, assessments of residual risk to human health and the environment were made for the contaminated groundwater and for the soils contamination located outside of the landfill cap.

The results of the human health risk assessment indicate that the chronic health hazard estimates for the future on-site resident exceed the USEPA hazard index goal of 1.0 for Site 10 primarily due to the ingestion of manganese in home-grown produce. The hazard indices for the future on-site worker also exceed the USEPA goal of 1.0 due primarily to inhalation of manganese in fugitive dust.

Estimates for cancer risk indicate that all of the risks for the future on-site resident and future on-site worker are within the USEPA target range of 1E-04 to 1E-06.

Based on the ecological risk assessment results, it appears that there are no adverse ecological effects resulting from contamination at Sites 9/10. Metals were found to be elevated when compared to the metals concentrations at the reference areas. The hazard indices estimated on the basis of Phase I data are within the same order of magnitude as those estimated for the reference areas. With the addition of the Phase II and supplemental data from 1997 (Phase III), the hazard indices are still within the same order of magnitude as those of the reference areas. As a result, it was concluded that there are no significant ecological risks at Sites 9/10.

Due to the chronic health hazard estimates that exceed USEPA risk management criteria, it is recommended that Site 9 be carried forward to the FS process. The interim measures at Site 10 appear to have adequately reduced potential risks to human health and the environment. In addition, it appears that sufficient data have been collected to characterize the nature and extent of contamination at both sites and that no further investigation under the RI/FS is warranted.

SITES 12A, 12B, AND 12C—BUILDINGS 602, 617, AND 279 SOLVENT PITS

Phase I field screening for VOC contamination, surface and subsurface soil sampling, and groundwater sampling resulted in the identification of a plume of solvent-contaminated groundwater at each of the three sites. Soil contamination was confined to the immediate area of each former solvent pit. Because the extent of contamination was not defined by the Phase I results, extensive Phase II groundwater sampling and aquifer testing activities were conducted at the three sites. The resulting data provided the information needed to define the nature and extent of contamination and provided sufficient groundwater flow information to evaluate potential remedial action alternatives.

Interim Removal Actions were performed at all three sites in the summer of 2000. The solvent pits and contaminated soils were were excavated and disposed off-site at a regulated facility. Confirmation soil sampling was performed to evaluate the completeness of the source removal action. Sampling at Sites 12A and 12B indicated that although most of the contaminated soils were removed, residual contamination above the PRGs existed beneath the building foundation beyond the practical ability to excavate. Therefore, excavation was terminated adjacent to the buildings to preserve their integrity. These excavations were backfilled with clean fill material that was compacted, and 10-10-10 fertilizer was added to the backfill to promote biological activity in the soils. In addition, perforated PVC pipe was also added along the footprint of buildings so that additional fertilizer could be added to the soil if needed to promote biodegradation. Confirmation sampling at Site 12C indicated that residual soils met PRGs. A detailed description of the construction activities and sample results is contained in the *Draft-Final Construction Completion Report, Remedial Removal Actions, Sites 12A, 12B, 12C, and 33* (Montgomery Watson, February 2002).
Solvent contamination identified in the groundwater at all three sites during Phase I was monitored four times during Phase II. The Phase II results indicate that the solvent contaminants exceeding tap water PRGs are located in the immediate vicinity of the former solvent pit (IN2). At Buildings 602 and 617, contamination has migrated approximately 300 feet in a southerly direction at both sites. At Building 279, the contaminant plume does not appear to be migrating since no contamination was detected in downgradient wells. Contamination was restricted to the well located adjacent to the former solvent pit. For all three sites, the primary COPCs are 1,1,1-trichloroethane, 1,1-dichloroethylene, and 1,1-dichloroethane.

Additional monitoring well installations and supplemental groundwater monitoring performed in 2001 provided additional information about the nature and extent of VOC contamination at Sites 12A, 12B, and 12C. The results generally confirmed the previous groundwater results for the nature and magnitude of contamination at each site. In addition, natural attenuation parameters were collected, and a preliminary evaluation of the potential for the occurrence of natural attenuation of the VOC contaminants was

performed. In general, natural attenuation appears to be occurring at all three sites and may be a viable remedial alternative.

The results of the human health risk assessment indicate that risks under the future land use scenarios exceed USEPA risk-based criteria for all three sites primarily as a result of exposure to contaminated groundwater through ingestion, dermal contact, and inhalation (VOCs during showering). During the Phase I RI, it was determined that there were no potential ecological risks at Sites 12A, 12B, and 12C due to the fact that the COPCs detected at the three sites were located in the subsurface soils and groundwater. The primary pathways for ecological exposure at these sites would be direct contact, ingestion, and inhalation of soil particles. The contaminants, generally at a depth of 4 feet or greater, would only become exposed if the sites are excavated or disturbed. Screening-level groundwater fate and transport modeling showed that contaminated groundwater would not migrate to potential surface water discharge areas, and this was confirmed by surface water sampling conducted in Middle Fork Creek, the likely local groundwater discharge point.

Due to the elevated risks to potential future residents and industrial workers, it is recommended that this site be carried through the FS process. Sufficient data were collected during the Phase I and Phase II investigations to evaluate potential cleanup technologies as required. As a result, no further remedial investigation activities are warranted.

SITE 13—OLD FIRE TRAINING PIT

Data from the Phase I field investigation indicated that fuel-related and solvent-related soil contamination exists at the site and that groundwater also contained low concentrations of the same contaminants. In addition, several metals were also present at elevated concentrations in both the soil and groundwater at Site 13. Phase II field investigation results confirmed that low concentrations of SVOCs and VOCs are present in the Site 13 groundwater. In addition, the metals contamination was also confirmed with several metals exceeding USEPA Region 9 criteria.

The human health risk assessment shows that there are no carcinogenic risks or chronic health hazards exceeding USEPA's risk management criteria for future on-site industrial workers. For the future hypothetical resident, chronic health hazards due to ingestion of zinc in homegrown produce were estimated to exceed USEPA criteria. However, using surface and subsurface soil combined (mixed), these hazards would be below the criteria.

The preliminary ecological risk assessment conducted during the Phase I RI determined that arsenic, cadmium, barium, and zinc are COPCs for Site 13. However, it was determined that because the area of contamination is small, exceedances of toxicity criteria are slight and, based on maximum detected values and the fact that the area surrounding the site incorporates concrete airport runways, it was determined that ecological receptors are not likely to be impacted by Site 13 contaminants.

Sufficient data were collected during the Phase I and Phase II investigations to characterize the nature and extent of contamination and to evaluate potential remedial action alternatives. A Removal Action was performed at Site 13 and documented in the *Final Position Paper-Site 13*, dated March 2001. Based on confirmation sampling performed on residual soils in the excavation, the removal action was successful in removing contaminated soils and Site 13 is recommended for NFA for residential use.

SITE 14—YELLOW SULFUR DISPOSAL AREA

The presence of scattered chunks of yellow sulfur in Site 14 soils resulted in soil pH measurements as low as 1.4. These acidic conditions appeared to have affected the concentrations of several metals within the sulfur-contaminated area. Phase I surface and subsurface soil samples contained numerous metals that exceeded both background and USEPA Region 9 criteria. Sediment samples from the drainage area adjacent to Site 14 also contained metals exceeding background and USEPA Region 9 criteria that likely have been leached from the contaminated soils. Arsenic, cobalt, and lead were found to be present in concentrations exceeding USEPA Region 9 criteria in both Phase I and Phase II groundwater samples. No organic contaminants were detected.

Following Phase II field activities, the USACE began interim remedial action at Site 14. The action involved the excavation and removal of the yellow sulfur and associated contaminated soils. During excavation activities, however, UXO was encountered and excavation activities were halted until further UXO surveys could be conducted. All excavated soils were hauled to a storage area located north of the firing line where additional screening for potential UXO was conducted. As a result, additional items of UXO were found and destroyed. This area was previously classified by the Army as an area with no potential UXO and was not subject to a UXO survey. However, more than 100 UXO items (including high explosive (HE) ordnance) were discovered at the Yellow Sulfur Disposal Area during interim action. It is possible that additional UXO is in this area. Currently, the excavation remains open pending Army and regulatory review of confirmation sampling results (IN3, EPA7).

A review of the confirmation sampling data shows that chromium levels exceed USEPA Region 9 PRGs and that soil pH indicates that acidic conditions still exist within the site. In addition, there is evidence that additional UXO may exist at Site 14. As a result, it is recommended that this site be carried forward to the FS. Any additional work required, however, will be conducted under the ongoing interim measures program being conducted by the USACE. Therefore, no additional remedial investigation activities appear to be warranted.

Results of a limited human health risk assessment (air and groundwater exposure pathways only) indicate that the overall hazard indices for chronic health risks for the future on-site resident and worker exceed the USEPA goal of 1.0. For both future scenarios, the critical

exposure pathway is ingestion of groundwater contaminated with arsenic. The cancer risk for both scenarios also exceed the USEPA target range of 1E-04 to 1E-06 as a result of ingestion of groundwater contaminated with arsenic.

Results of the ecological risk assessment at Site 14 indicate that, based on ecological effects data, there are no adverse ecological effects at this location. Of the contaminants in the soils at Site 14, only barium and lead were elevated in comparison with levels found in the soils at the reference areas. There were no effects observed on earthworm mortality and no effects on soil fauna at Site 14. Using all lines of evidence, it was concluded that there is no significant ecological risk at this location.

Due to the presence of additional UXO, the presence of chromium in soils exceeding USEPA Region 9 PRGs, the presence of arsenic in groundwater resulting in potential future human health risks, and the presence of an acidic environment in remaining site soils, it is recommended that this site be carried forward to the FS process.

SITE 15—BURN AREA SOUTH OF NEW INCINERATOR

Phase I soil sample results indicated that several metals, including lead ranging from 1,900 µg/g to 23,000 µg/g, were present at concentrations exceeding both background and USEPA Region 9 risk-based concentrations. Wipe samples from the surface of the concrete pad also indicated that metals contamination was present. In addition, total petroleum hydrocarbons (TPH) were present in the soils and on the concrete surface but at concentrations below cleanup criteria.

An interim remedial action was performed in 1997 at Site 15, including the removal of the concrete pad and excavation of the near-surface contaminated soils for off-site disposal. Confirmation samples were collected from the excavation and, on the basis of the results, it was determined that no further remedial action was necessary. The excavation was then backfilled with locally derived borrow material.

Due to the completion of interim measures and collection of confirmation samples showing contaminant levels below USEPA risk management criteria, no human health risk assessment was conducted. The ecological risk assessment for Site 14 also applied to Site 15. As a result, no adverse effects to ecological receptors were identified. It is recommended that a No Further Action technical memorandum be prepared for Site 15 and the site be removed from the RI/FS. No additional investigation is warranted.

SITES 21A AND 30—BUILDING 204 TEMPORARY STORAGE AREA AND PESTICIDE STORAGE AREA

Building 204 was used as a storage building for a variety of pesticides and herbicides. A small metal shed southeast of Building 204 was used for mixing and rinsing of pesticides

and herbicides. Phase I surface soil sample results indicated that pesticide contamination is present in the soils surrounding Building 204. Phase II surface soil sample results further defined the extent of pesticide contamination. Although a variety of pesticide contaminants were present, only dieldrin was present at concentrations exceeding USEPA Region 9 risk-based criteria.

The human health risk assessment results indicate that there are no carcinogenic risks or chronic health hazards that exceed USEPA risk management criteria for the future on-site worker. For the hypothetical future resident, exposure to dieldrin in surface soil through ingestion of homegrown produce is estimated to result in cancer risks exceeding the USEPA target range of 1E-04 to 1E-06 and hazard index of 1.0. However, if the surface soil is mixed and dispersed with subsurface soil, the risks and hazards would not exceed USEPA risk management criteria.

The preliminary ecological risk assessment conducted during the Phase I RI indicated that dieldrin in soil could have an impact on vegetation in one surface soil location. However, due to the small size of this contaminated area, the high amount of human activity, and lack of suitable habitat, it was determined that no further ecological risk analysis was required.

As a result of the potential risks to future on-site residents, it is recommended that this site be carried forward to the FS. Sufficient data were obtained during the Phase I and Phase II investigations to characterize the nature and extent of contamination at Sites 21A and 30. No additional remedial investigation activities are warranted.

SITE 25—PAPERMILL ROAD DISPOSAL AREA

A variety of organic contaminants and metals were detected at Site 25 during the Phase I field investigation. To further define the extent of this contamination, additional surface and subsurface soil samples were collected during Phase II. The Phase II results confirmed the presence of low concentrations of numerous SVOCs that are consistent with contaminants that would be associated with the tar-like substance observed on the ground surface at Site 25. Several metals were also found to exceed background levels but only arsenic, beryllium, and thallium were found to be present at concentrations exceeding USEPA Region 9 criteria.

Interim remedial action was completed for this site in early 1998 where near surface soils (from the surface to a depth of 2 feet) were excavated from a 200-by-200 foot area and removed for proper off-site disposal. Following removal of contaminated soils, confirmation sampling was conducted, and the results of the sampling based on a draft closure report (Toltest Inc., December 1998) have since been incorporated in this Draft Final RI report (IN4, EPA96).

Human health and ecological risk assessments were performed pending completion of the proposed interim action. The results of the human health risk assessment indicate that

chronic health hazard estimates for future on-site residents exceed the USEPA hazard index goal of 1.0. For the child resident, the critical pathways were ingestion of thallium in soils and inhalation of manganese in fugitive dusts. For the future off-site consumers of milk and beef, the estimated hazard indices are below the goal of 1.0. Cancer risk to future on-site residents were all within the USEPA target range of 1E-04 to 1E-06.

The ecological risk assessment concluded that there are no adverse ecological effects for this site. Beryllium in soil was the only COPC that was elevated above those of the reference areas. Using Phase I data, the hazard indices are within the same order of magnitude as those of the reference areas. With the addition of the Phase II and the supplemental data (Phase III) collected in September 1997, the resulting hazard indices are still consistent with those observed at the reference areas. Effects on earthworm mortality and effects on soil fauna diversity were not observed. Plant reproduction and growth were also not effected. Based on all lines of evidence, it was concluded that there is no significant ecological risk at Site 25.

The confirmation sample results indicated that the contamination has been successfully removed, therefore it is recommended that a No Further Action technical memorandum be prepared and that the site be removed from the RI/FS (EPA6). This site will not be carried forward to the FS.

SITE 26—DRMO STORAGE AREA AND POSSIBLE DISPOSAL SITES SOUTH OF DRMO

Phase I soil samples collected in the storage area adjacent to Building 189 indicated that, although lead contamination was present from the previous storage of lead acid batteries, none of the contamination exceeded the USEPA cleanup level of 400 µg/g. No other contaminants were present in the storage area.

To the south of the DRMO Storage Area, surface soil samples were collected from a bare spot of soil surrounded by areas of abundant vegetation. The sample results indicated the presence of detectable amounts of TPH but at levels well below the state action level of 100 µg/g. A number of metals were detected at concentrations exceeding both background and USEPA Region 9 risk-based criteria. Phase II sampling was not conducted due to planned interim remedial action for the bare spots south of the DRMO.

In 1997, interim remedial action was conducted at the bare spots south of the DRMO Storage Area that included the excavation and removal of near-surface contaminated soil for proper off-site disposal. Confirmation samples were collected and based on the results, it was determined that no further remedial action was required. The excavation was backfilled with locally derived borrow material. In April 1998 soils were excavated from an area within the fenced DRMO Storage Area. Confirmation samples confirmed that residual soils met PRGs. As a result of the interim action, no human health or ecological risk assessments were conducted.

It is recommended that a No Further Action technical memorandum be prepared for this site. No further investigation under the RI/FS process is warranted.

SITES 28, 29, AND 39—GATOR Z OPEN BURN AREA, GATOR Z MINE SCRAP DISPOSAL AREA, AND GATOR Z MINE TEST AREA

These three areas are all associated with the previous testing of explosive mines. Testing activities were conducted at Site 39. Open burning of debris associated with this testing occurred at Site 28. Disposal of scrap metal in an open pit near the burn area occurred at Site 29. Phase I soil sampling at Site 28 indicated that ash and underlying soils associated with the open burn area contained metals at levels exceeding USEPA Region 9 risk-based criteria. Although metals were also found to exceed background concentrations at Sites 29 and 39, no contaminants were present at concentrations exceeding USEPA risk-based criteria.

In 1997, interim remedial action was conducted at Site 28. Ash and contaminated soils were excavated and removed for proper off-site disposal. Confirmation samples collected from the excavation indicate that the metals in soils were below risk-based criteria and that no further remedial action is required. As a result, a human health risk assessment was not conducted for Site 28. Based on a review of the confirmation sample results for Site 28, it was concluded that no ecological risks remain. It is recommended that a No Further Action Technical Memorandum be prepared for this site and that the site be removed from the RI/FS process.

Interim remedial action was also performed within the pond (pit) of Site 29. Debris and contaminated sediment were excavated from the pond floor and properly disposed of off-site. Confirmation sampling shows that no contaminants exceed USEPA cleanup goals. As a result, no further investigation of this site is warranted. The excavation is to remain open to restore the aquatic environment that was present at the site prior to the remedial action. Due to the remedial action conducted, human health and ecological risk assessments were not conducted for this site. It is recommended that a No Further Action technical memorandum be prepared for Site 29 and that the site be removed from the RI/FS process.

Human health and ecological risk assessments were conducted for the Gator Z Mine Test Area (Site 39). Results of the human health risk assessment indicate that carcinogenic risks and chronic health hazards to future on-site workers and on-site residents are at acceptable levels when compared to the USEPA risk management criteria.

The results of the ecological risk assessment also indicate that there are no adverse ecological effects at this site. As a result of both assessments, it is recommended that a No Further Action technical memorandum be prepared for Site 39 and the site be removed form the RI/FS process.

SITE 31—BUILDING 227 FORMER STORAGE PAD

Numerous metals were found to exceed background concentrations in both surface and subsurface soils at Site 31. In addition, TPHs were detected in surface soils. Of the metals, arsenic, barium, beryllium, and manganese were present at concentrations exceeding USEPA Region 9 risk-based criteria. TPH concentrations were all below the state cleanup standard of 100 µg/g.

Results of the human health risk assessment indicate that there are no risks or hazards exceeding USEPA risk management criteria for the future on-site worker. For the hypothetical future on-site child resident, the total chronic health hazard estimates show that the USEPA hazard index goal of 1.0 is exceeded primarily due to the ingestion of manganese in home-grown produce. This assumes produce grown in surface soils. If subsurface soil is mixed with the surface soil, the resulting hazard index is below the goal of 1.0. No other exceedances of USEPA risk management criteria were noted.

The preliminary ecological risk assessment conducted during the Phase I RI determined that the COC for ecological receptors at Site 31 is barium. The maximum site concentration could be potentially harmful to site fauna. However, since Site 31 is surrounded by a frequently mowed lawn, has a small area of contamination, and is in an area with high human activity, no adverse ecological impacts were identified. As a result, no further ecological investigations appear to be warranted.

Although the USEPA goal of 1.0 was exceeded for the future child resident, none of the chemical-specific hazard indices exceeded the criteria. When it is assumed that the surface soil will be mixed with subsurface soil during gardening, the resulting produce would not contain levels of metals that would result in a hazard index greater than 1.0. For this reason, it is recommended that a No Further Action technical memorandum be prepared for Site 31 and that the site be removed from the RI/FS. This site will not be carried forward to the FS.

SITE 33—BUILDING 333 NEW INCINERATOR

Phase I and Phase II surface sample results from locations downwind of the incinerator indicate that metals are present at concentrations above background. These levels, however, are below the corresponding USEPA Region 9 risk management criteria with the exception of aluminum and manganese. In addition, dioxins/furans were detected in above-background concentrations.

Results of the human health risk assessment indicate that no risks or hazards exceed USEPA risk management criteria for future on-site workers or residents. The contaminant levels detected in soils were evaluated during Phase I for potential impacts on ecological

receptors. None of the contaminants were found to exceed toxicity criteria for ecological receptors. As a result, no further ecological risk analysis is required.

A Removal Action was performed at this site in 2000. Confirmation sampling was performed on remaining soils in the excavation. Results indicated that dioxin contamination exceeded background. However, a risk calculation for that level was performed, which indicated that exceedance was below the USEPA's target risk range. Therefore no additional excavation was necessary. A detailed description of the removal and sample results are contained in the *Draft Final Construction Completion Report, Remedial Removal Actions, Sites 12A, 12B, 12C, and 33* (Montgomery Watson, February 2002).

No further remedial investigations are warranted and it is recommended that a No Further Action technical memorandum be prepared for Site 33. Site 33 will not be carried forward to the FS process.

SITE 34—BUILDING 136 SANDBLASTING AREA

Sampling of surface soil around the asphalt pad formerly used for sandblasting operations resulted in the identification of several metals exceeding their respective background concentrations. Evaluation of the sample results against USEPA Region 9 risk-based criteria resulted in only beryllium being carried forward as a COPC at Site 34.

Human health risk assessment results indicate that there are no carcinogenic risks or chronic health hazards that exceed USEPA risk management criteria.

During the Phase I preliminary ecological risk assessment, lead was identified as a COC in one sample. However, due to the small area of contamination, the presence of pavement and mowed grass around the building, and the high amount of human activity in the area, no adverse impacts to ecological receptors were identified and no additional ecological analysis was warranted.

From the human health and ecological risk assessment results, it is recommended that a No Further Action technical memorandum be prepared and that Site 34 be removed from the RI/FS. This site will not be carried forward to the FS.

SITE 38—NORTHWEST-SOUTHEAST RUNWAY FLARE TEST AREA

Geophysical surveying of Site 38 indicated that no significant accumulation of buried metal, which might represent UXO, was present. In addition, analysis of a surface soil sample at the site indicated that no explosives contamination is present. The soil sample did contain beryllium, boron, cobalt, copper, nickel, and silver in concentrations exceeding background. Of these metals, however, only beryllium was found to exceed USEPA

Region 9 risk-based criteria and was the only COPC evaluated in the human health risk assessment.

Results of the risk assessment indicate all carcinogenic risk and chronic health hazard estimates are below or within the allowable range for USEPA risk management criteria. Based on the protocols established for the preliminary ecological risk assessment, there were no potential ecological risks identified for Site 38. From the results of the human health and ecological risk assessments, it is recommended that a No Further Action technical memorandum be prepared for Site 38. This site will not be carried forward to the FS.

SITE 42—BUILDING 281 INDOOR RANGE

Soil samples collected from the dirt floor of the firing range were analyzed for metals by the toxicity characteristic leaching procedure (TCLP) to determine if metals in the soils exceeded RCRA standards for leachable metal. In addition, wipe samples from the firing lane walls were collected to determine the presence or absence of lead dust. The results indicate that lead and other metals do not exceed RCRA hazardous waste criteria.

Although no further characterization was recommended for this site, the USACE conducted an interim remedial action at Site 42 to allow future reuse of the building. This action consisted of removal and disposal of dirt from the floor and washing of the walls followed by spraying with a sealant. Since the contamination at Site 42 is contained within the building, no potential ecological risks were identified. Also, due to the interim measures at Site 42, no human health risk assessment was required. Confirmation sampling was conducted to verify that the interim measures were effective in reducing the potential for human exposure within the building. Results of this sampling indicate that the remediation goals were met. It is recommended that a No Further Action technical memorandum be prepared for Site 42. No further investigation under the RI/FS is warranted and the site will not go to the FS stage.

In addition to the sites listed above, Rust E&I conducted an assessment of potential risks to current and future off-facility residents, current facility-wide trespassers and future facility-wide hunters, and current on-site residents from exposure to contaminants from multiple contaminated sites at JPG. This assessment resulted in the conclusion that there is no current receptor risk that exceeds USEPA risk management criteria. Of the future scenarios, the future off-site resident could be at risk from the hypothetical exposure to solvent-related contamination in groundwater.

In summary, many sites do not pose a risk to human health and the environment and are being recommended for No Further Action under CERCLA and removal from RI/FS process.However, before sites can be removed from the RI/FS, a public notice will be

issued as required under CERCLA Section 117 (IN5, EPA9). Refer to Table ES-3 for a quick reference of each site's RI result and recommendation (EPA27).

Several sites, on the basis of the human health and/or ecological risk assessment(s), were found to pose an unacceptable risk. These sites will be included in the FS for the screening and development of remedial action alternatives, which will reduce these risks to acceptable levels (refer to Table ES-3).

Current and future receptors of facility-wide contamination through the air, groundwater, or surface water pathways were estimated to not be at risk from JPG contaminants with the exception of those potentially exposed to future solvent-related groundwater contamination. The solvent pit sites (Sites 12A and 12B) that would be the source of this contamination are to be carried forward to the FS process and will likely be recommended for some type of remedial action to ensure that these hypothetical future risks do not occur.

TABLE ES-1

Sites Evaluated During The Phase II RI

Site No.	Site Name
1	Building 185 Incinerator
2	Sewage Treatment Plant
3	Explosive Burning Area
4	Abandoned Landfill
5	Wood Storage Pile
6	Wood Burning Area
7	**Red Lead Disposal Area**
8	**Building 295 Small Arms Firing Range**
9	Burning Ground South of Gate 19 Landfill
10	**Gate 19 Landfill**
12A	Building 602 Solvent Pit
12B	Building 617 Solvent Pit
12C	Building 279 Solvent Pit
13	Old Fire Training Pit
14	**Yellow Sulfur Disposal Area**
15	**Burn Area South of New Incinerator**
21A	Building 204 Temporary Storage Area
21B	Temporary Methylene Chloride Storage Area
25	**Papermill Road Disposal Area**
26	**DRMO Storage Area and Possible Sites South of DRMO**
27	Sewage Sludge Application Areas
28	**Gator Z Open Burn Area**
29	**Gator Z Mine Scrap Disposal Area**
30	Building 204 Pesticide Storage Area
31	Building 227 Former Storage Pad
33	Building 333 New Incinerator
34	Building 136 Sandblasting Area
38	Northwest-Southeast Runway Flare Test Area
39	Gator Z Mine Test Area
42	Building 281 Indoor Range

Note: Bolded sites are those that have had interim remedial removal actions completed by the Army.

TABLE ES-2

Sites Having Interim Remedial Removal Action

Site No.	Site Name	Description of Remedial Action	Characterization/ Confirmation Sampling	Completion Date	Closure Report	Regulatory Concurrence	Recommendation
7	Red Lead Disposal Area	Action consisted of excavation and proper off-site disposal of lead-contaminated soils.	8 soil samples collected and analyzed for TAL metals (SW-846 6010 and 7000s) and VOCs (SW-846 8260A) (Sverdrup). 8 soil samples collected and analyzed for TAL metals (SW-846 6010 and 7000s) and VOCs (SW-846 8260A) (SAIC).	1996	Sverdrup 1997b	Pending	Based on HHRA exceedances and arsenic levels in ground water include in FS; no additional soil-related investigations are warranted; however arsenic in ground water may require further investigation.
8	Building 295 Small Arms Firing Range	Action consisted of lead dust, soil and sand removal and disposal.	30 wipe samples for lead (SW-846 6010),	1998	Ferguson -Harbour 1998	Concurrence based on USEPA comment No. 5. - JPG Draft Phase II RI Report (Rust E&I 1998).	This site was considered as No Further Action (NFA). A draft Decision Document is being prepared.
10	Gate 19 Landfill	Landfill cap applied at Site 10.	None	1995?	None	??	Recommend no NFA for Site 10.
12A	Building 602 Solvent Pit	Soils removal and disposal	23 Samples contamination still present below foundation wall	2000	MW 2002	Pending	Site will go to FS for groundwater
12B	Building 617 Solvent Pit	Soils removal and disposal	18 samples contamination still present below foundation wall	2000	MW 2002	Pending	Site will go forward to FS for groundwater
12C	Building 279 Solvent Pit	Soils removal and disposal	13 samples confirmed PRGs were met	2000	MW 2002	Pending	Site will go forward to FS
13	Old Fire Training Pit	Soils removal and disposal	14 samples confirmed PRGs were met	2000	2001	Approved	Position paper for NFA approved by EPA and IDEM

TABLE ES-2

Sites Having Interim Remedial Removal Action

Site No.	Site Name	Description of Remedial Action	Characterization/ Confirmation Sampling	Completion Date	Closure Report	Regulatory Concurrence	Recommendation
14	Yellow Sulfur Disposal Area	Excavation and disposal of 640 cubic yards of contaminated soils	24 confirmation samples for metals (TAL SW-846 6010 & 7000s), total sulfur and pH (SAIC)	Ongoing	Sverdrup 1997	Pending results of current remediation and RI.	Based on HHRA exceedances, include Site 14 in FS
15	Burn Area South of New Incinerator	Removal and disposal of concrete pad, and excavation and disposal of near-surface contaminated soils	8 confirmation samples + 1 field duplicate for metals (TAL SW-846 6010 & 7000s) (SAIC)	1997	Sverdrup 1997	Pending confirmation sampling of stockpiled soil	Based on IM remedial actions and confirmation sampling, Site 15 was not included in HHRA for JPG Draft Phase II RI. Ecological risks were negligible. Site is being addressed in an NFA TM.
25	Papermill Road Disposal Area	Excavation and disposal of near-surface soils from a 200'x200' x 2' area.	24 confirmation samples for TAL metals (SW-846 6010b), SVOCs (SW-846 8270) and VOCs (SW-846 8260).	1998	Toltest	Pending confirmation sampling of stockpiled soil	IM confirmation sampling data are included in this version of the Phase II RI report.
26	DRMO Storage Area and Possible Sites South of DRMO	Excavation and disposal of approx. 45 cubic meters (59 cubic yards) of soil from an area 40' x 40' x 1'.	DRMO storage site: 5 characterization samples analyzed for lead (SW-846 6010) (Toltest). For site south of DRMO Storage: 9 characterization soil samples for TCLP metals (SW-846 6010 & 7470), TCLP SVOCs(SW-846 8270), and TCLP VOCs(8240) (Toltest) For site south of DRMO Storage: 9 confirmation soil samples for TAL metals (SW-846 6010 and 7000s) (SAIC)	1997	Toltest	Pending confirmation sampling of stockpiled soil	IM Confirmation sampling data are included in this version of the Phase II RI report.

TABLE ES-2

Sites Having Interim Remedial Removal Action

Site No.	Site Name	Description of Remedial Action	Characterization/ Confirmation Sampling	Completion Date	Closure Report	Regulatory Concurrence	Recommendation
28	Gator Z Open Burn Area	Removal and disposal of ash and contaminated soils and backfilled with clean soil.	3 characterization soil samples analyzed for TCLP metals (SW-846 6010), TCLP VOCs (SW-846 8240), and TCLP SVOCs (SW-846 8270) (Toltest). 10 confirmation soil samples for TAL metals (SW-846 6010 & 7000s) including boron and molybdenum (SAIC).	1997	Toltest	Pending confirmation sampling of stockpiled soil	Site should be addressed in a NFA TM.
29	Gator Z Mine Scrap Disposal Area	Removal and disposal of sediment and debris from a small pond	4 characterization samples - 1 water sample for total metals, 1 water sample for explosives, 1 water sample for oil & grease and TPH, and 1 water sample for BOD. 2 confirmation sediment samples for total metals (SW-846 6010 & 7471) and explosives (SW-846 8330A).	1997	Toltest	Pending confirmation sampling of stockpiled soil and UXO clearance	IM Confirmation sampling data are included in this version of the Phase II RI report. Site should be addressed in a NFA TM.
33	Building 333 New Incinerator	Soils Removal and Disposal	11 samples, dioxin exceeded background. Risk calculated was below USEPA target risk range	2000	MW 2002	Pending	Draft-Final CCR is submitted and summary included in this report. Site is recommended NFA.

Note: Post excavation characterization samples.

TABLE ES-3

Summary of Phase I and Phase II RI Results and Recommendations for Remaining Sites South of the Firing Line

Site No	Site Name	Human Health Risk Exceeding Criteria ?	Ecological Risks Exceeding Criteria ?	Forward to Feasibility Study	Prepare NFA Tech Memo ?
1	Building 185 Incinerator	Yes	No	Yes	No
2 & 27	Sewage Treatment Plant Area	Yes	No	Yes	No
3 & 4	Explosive Burning Area, Abandoned Landfill, and new burn site	Yes	No	Yes	No
5 & 6	Wood Storage Pile and Wood Burning Area	No	No	No	Yes
7 & 21B	Red Lead Disposal Area & Temporary Storage Area at Building 211	Yes	No	Yes	No
8	Small Arms Firing Range	No	No	No	Yes
9 & 10	Burning Ground South of Gate 19 Landfill and Gate 19 Landfill	Yes	No	Yes	No
12A	Building 602 Solvent Pit	Yes	No	Yes	No
12B	Building 617 Solvent Pit	Yes	No	Yes	No
12C	Building 279 Solvent Pit	Yes	No	Yes	No
13	Old Fire Training Pit	Yes	No	No	Yes
14	Yellow Sulfur Disposal Area	Yes	No	Yes	No
15	Burn Area South of New Incinerator	No	No	No	Yes
21A and 30	Building 204 Temporary Storage Area and Pesticide Storage Area	Yes	No	Yes	No
25	Papermill Road Disposal Area	Yes	No	No	Yes
26	DRMO Storage Area and Possible Sites South of DRMO	No	No	No	Yes
28	Gator Z Open Burn Area	No	No	No	Yes
29	Gator Z Scrap Disposal Area	No	No	No	Yes
31	Building 227 Former Storage Pad	No	No	No	Yes
33	Building 333 New Incinerator	No	No	No	Yes
34	Building 136 Sandblasting Area	No	No	No	Yes
38	Northwest-Southeast Runway Flare Test Area	No	No	No	Yes
39	Gator Z Mine Test	No	No	No	Yes
42	Building 281 Indoor Range	No	No	No	Yes

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

The Base Realignment and Closure (BRAC) Commission, established by the Secretary of Defense in 1988, recommended the closure of Jefferson Proving Ground (JPG) in Madison, Indiana. Closure activities at JPG were completed in 1995. Appropriate cleanup and reuse is being expedited in accordance with President Clinton's July 2, 1993, five-point program. This program called for the establishment of cleanup teams to conduct "bottom-up" reviews of cleanup plans and schedules, accelerating the National Environmental Policy Act (NEPA) process, involving the public, preparing Suitability to Lease documentation, and implementing the Community Environmental Response Facilitation Act (CERFA) for identification of uncontaminated real estate. In support of the BRAC process, the Army proposed and is currently implementing a Remedial Investigation/Feasibility Study (RI/FS) to evaluate the area south of the Firing Line and recommend cleanup activities as required. Initiation of RI/FS activities north of the Firing Line was deferred pending more definitive land reuse planning. As part of the RI/FS for the sites south of the firing line, a Final *Draft RI Report* was prepared and submitted for regulatory review in July 1994. That document summarizes results of field investigation activities conducted in 1992 and 1993. Based on comments received and a re-evaluation of existing data, it was determined that additional investigation was required for 23 of the sites. This report summarizes the results of this additional (Phase II) investigation and provides conclusions and recommendations on the basis of estimated risks to human health and the environment. The Army, based in part on the results presented in the Final *Draft RI Report*, has initiated and completed several voluntary interim cleanup actions to mitigate risks to human health and the environment and to facilitate reuse of the property. Additional cleanup actions, if required, will be primarily based on the investigative results presented in this document.

The RI was conducted in accordance with Army BRAC requirements, which have their basis in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended in 1986 by the Superfund Amendments and Reauthorization Act (SARA) and other federal, state, and local laws that pertain to hazardous materials such as asbestos, radon, and PCBs or permitted operations such as open burn/open detonation units, sewage treatment plants, landfills, and underground storage tanks (USTs).

The two primary objectives of the RI portion of the RI/FS for sites located south of the Firing Line at JPG are to define extent and magnitude of environmental contamination within ~~each of~~ the 50 identified sites (54 locations) at JPG and to assess the potential risks to human health and the environment posed by this contamination.

This report summarizes the results of the investigations designed to meet these objectives. The Army expects to submit the FS in 2003. Figure 1-1 schematically illustrates the work process for completing the RI/FS for JPG sites south of the Firing Line.

To meet the RI objectives, the results of the previous environmental investigations at JPG were reviewed and evaluated. The RI Work Plans for identified sites south of the Firing Line were prepared. These plans identified data quality objectives, data gaps, data-collection rationale and strategies, and methods and procedures for subsequent sample analysis and data evaluation activities. From these work plans, the initial field investigation phase of the RI (herein referred to as Phase I) was conducted in November and December of 1992 and March through July of 1993 at JPG. The subsequent sample analysis and data-evaluation activities were completed, and the *Jefferson Proving Ground South of the Firing Line Final Draft Remedial Investigation Report* (Rust E&I 1994) was prepared.

The report summarized the previous environmental investigations conducted at JPG, presented and evaluated the data collected during the Phase I RI field investigation, provided results of the baseline human health and ecological risk assessments, and provided subsequent conclusions and recommendations. From this document, the U.S. Army Corps of Engineers (USACE), Louisville District, prepared and implemented work plans for voluntary cleanup actions at several of the sites that were identified as posing a potential threat to human health and the environment.

Following regulatory review of the Final *Draft Phase I RI Report*, it was determined that data gaps still existed for 23 of the ~~50~~ sites south of the firing line. To address these data gaps, a Phase II RI was initiated in the fall of 1995 and completed in the spring of 1996. The Phase II RI was designed to meet the following objectives:

- Verify and further define the nature and extent of previously identified contamination
- Provide data of a sufficient quality for direct comparison with applicable State of Indiana and Federal regulatory criteria
- Collect a sufficient quantity of data to support a baseline risk assessment and FS
- Address regulatory comments and concerns based on previous investigation results, including issues of data quality, potential contaminants not previously assessed, pathways not adequately evaluated, and background conditions not adequately defined.

This Phase II RI document has been prepared to summarize the results of the Phase II investigations, to present and evaluate the data collected during both Phase I and Phase II field investigations, to assess potential risks to human health and the environment on the basis of these data, and to provide conclusions and recommendations. Also included, where available, are results from recently completed interim remedial actions and a re-evaluation of risks to human health and the environment from ~~any~~ residual contamination that remains following the interim action. This document does not include information for the 23 sites that were recommended for NFA by the Phase I RI. Those sites are identified with an asterisk in Table 1-1.

This Section 1 – Introduction includes the following subsections:

- Section 1.2 describes the JPG installation, history, and previous environmental investigations conducted;
- Section 1.3 describes the environmental regulatory conditions under which this RI/FS is being conducted;
- Section 1.4 presents a summary of the RI report organization; and
- Section 1.5 provides a summary of sites recommended for removal from the RI process following the Phase I RI. The recommendation for removing these sites from the RI/FS was documented ~~for each site~~ in technical memoranda that have been submitted for regulatory review and approval.

1.2 INSTALLATION BACKGROUND

1.2.1 Installation Description

JPG occupies approximately 55,265 acres of land along U.S. Highway 421 north of Madison, Indiana, as illustrated in Figure 1-2. The facility is located in portions of Ripley, Jennings, and Jefferson Counties. The installation is approximately 18 miles long (north to south) and varies from 3 to 6 miles wide (east to west). There are 481 buildings located throughout JPG. A major portion of JPG is wooded and the remainder is open grassland or recently cultivated farmland. Industrial buildings, workshops, administrative buildings, and personnel housing are located in the southern portion of the facility. A line of 268 gun positions ran east to west across the southern portion. Weapons were fired at targets located to the north of these gun positions. The immediate area of the gun positions is referred to as the Firing Line. The Firing Line can be approximated by Firing Line Road as shown in Figure 1-3. In addition to the gun positions, the facility consisted of 50 impact areas, 13 permanent test complexes, and 7 ammunition assembly plants. The locations of investigated sites are presented in Figure 1-3 and are referenced by the RI site numbers listed in Table 1-1.

1.2.2 Installation History

JPG was used as a proving ground from 1941 through 1995. A wide assortment of conventional munitions and weapons were tested at the facility. These include propellants, projectiles, cartridges, mortars, grenades, fuses, primers, boosters, rockets, tank ammunition, mines, and weapon components. The mission of JPG was primarily to plan and conduct production acceptance tests, reconditioning tests, surveillance tests, and other studies of ammunition and weapons systems.

Past activities at JPG have included detonation, burning, and disposal of many types of waste propellants, explosives, and pyrotechnic substances at the facility. Many of these activities

resulted in residual risks to public health and the environment. Safety concerns involving possible unexploded ordnance (UXO) also remain. Potentially hazardous substances identified at JPG include various explosive compounds, waste propellants, lead, chlorinated solvents, wood preservatives, sulfur, silver, photographic development wastes, sanitary wastes, and petroleum products. Landfill items also included construction debris, metal, concrete, wood, red lead paint, trichloroethylene (TCE), and methylene chloride-contaminated polyurethane (Pelron A&B). In the past, JPG generated other hazardous wastes which included used paint thinners (i.e., mineral spirits, xylene, and Stripeze®), paint sludge, Stoddard solvent, pentachlorophenol (PCP)-treated wood boxes, and 1,1,1-trichloroethane (TCA) (IN18). Some of these substances are known to have been released to the soil as a result of waste disposal activities. Subsequently, groundwater was also contaminated through contaminant migration.

North of the Firing Line at JPG are numerous impact areas that are comprised of high impact targets, asphalt- and sediment-bottom ponds for testing proximity fuses, a gunnery range, mine fields, and a depleted uranium (DU) impact area. Surrounding the impact areas are safety fans where wide, long, or short rounds could fall. These areas are ~~all~~ considered to contain unexploded ordnance.

Prior to facility closure in 1995, impact areas were routinely kept clear of vegetation by disc plowing and infrequent herbicide application. None of the impact areas, including the DU impact area, are included in this RI/FS because they are located north of the Firing Line. Environmental investigation of the DU impact area was previously conducted in accordance with the Nuclear Regulatory Agency required permit to address the potential radiological hazards associated with the use of DU at JPG. Groundwater was routinely sampled at the site, and the data were transmitted to the Indiana Department of Environmental Management (IDEM). The results from this routine sampling and analysis indicate that ~~there is no~~ DU contamination in the groundwater at the area was not detected.

The Defense Secretary's Commission on BRAC recommended JPG among other bases for closure and/or realignment in December 1988. The Congress mandated JPG be closed and its mission be realigned with Yuma Proving Ground in April 1989. As a result, USACE was given the responsibility for managing and conducting environmental investigations at JPG in association with the BRAC Program. Under the BRAC program, the testing mission was realigned to Yuma Proving Ground and operational closure occurred on September 30, 1994. Final closure of JPG occurred on September 30, 1995. Since that time a caretaker has assumed the day-to-day maintenance and compliance duties for those portions of JPG that have not been turned over to another organization for reuse. ~~All m~~Munitions testing by the U.S. Army at JPG ceased by September 30, 1994.

Since final closure of the facility in the fall of 1995, a local farmer has leased the area south of the firing line and is currently farming approximately 800 acres of the area. ~~that has no potential for UXO~~ (IN6). He, in turn, has subleased a number of the buildings to private companies as described in Table 1-2. About 32 private individuals under the farmer’s subleases currently occupy the previous military housing area, which includes Buildings 1, 3, 4, 7, 8, 11, 12, 15, 16, 17, 20, 21, 23, and 33. Ownership of the entire area south of the firing line will eventually be transferred to the farmer following completion of remedial action

activities required to clear the areas of contamination exceeding cleanup goals and to clear the areas of UXO (EPA11). Interim cleanup actions are currently being conducted by the USACE, Louisville District, for sites previously identified as posing a risk to human health and the environment. On the basis of the results of the current Phase II RI, additional cleanup actions may be required before the property south of the firing line can be released. It is estimated that the transfer of ownership will occur around the year 2000.

The 51,000-acre area north of the firing line will remain under Army ownership with the Indiana Air Guard utilizing the range under license for training exercises. The U.S. Fish and Wildlife Service (USFWS) has assumed responsibility for the management of JPG's natural resources through a memorandum of agreement. The agreement provides an opportunity for the USFWS to conduct an enhanced level of ecosystem management and study and to address long-term natural resource management at JPG. Over the next 3 years, tThe USFWS will evaluate the status of fish, wildlife, and habitats over the 51,000-acre area north of the firing line utilizing funding provided by the Army. Public use of the area will continue to be limited due to the potential for coming in contact with UXO (EPA11).

1.2.3 Previous Investigations

This section provides a sequential overview of pertinent environmental investigations that have been conducted at the JPG site. Results from these studies have been evaluated and used in planning and conducting the RI for sites south of the Firing Line at JPG. Additional environmental studies, data, and reports in support of regulatory requirements such as permit applications were also considered in the RI as described in Section 1.3.

Numerous reports describing various environmental investigations conducted at JPG from 1978 to the present were available to support planning and implementation of the RI. Some were site-specific, while others were facility-wide investigations. Some of the earlier facility-wide investigations included an *Environmental Impact Assessment of JPG* (O'Neill 1978), *Installation Assessment of JPG* (USATHAMA 1980), *Update of the Initial Assessment* (ESE 1987), and a report to the Governor (IDEM 1989). Another significant report dealing with environmental practices at JPG was a *Resource Conservation and Recovery Act (RCRA) Part B Permit Application for Open Burning/Open Detonation* (USACE 1988).

In 1988, the U.S. Army Environmental Hygiene Agency (USAEHA) completed the *Interim Final Report of Ground Water Contamination and Evaluation of Solid Waste Management Units (SWMUs) at JPG*. This evaluation included visual site inspections of several SWMUs and recommendations for sampling to characterize potential chemical contamination at the base. In addition, information on the presence of polychlorinated biphenyls (PCBs), the installation's use of pesticides, wastewater treatment, and groundwater analysis were included (USAEHA 1988).

In January 1989, Environmental Science and Engineering, Inc., completed an RI/FS that defined the nature and extent of groundwater contamination by volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides and PCBs, and lead in

monitoring wells around the Gate 19 Landfill and suspected contamination in the vicinities of the solvent disposal areas at Buildings 279, 602, and 617. Additionally, the hydrogeologic setting of the investigated areas was evaluated to estimate the rate and direction of groundwater flow and consequent contaminant migration. Soil-gas investigations, installation of 15 monitoring wells, groundwater sampling and analysis of the 15 new wells and 3 existing wells, and slug testing at 5 monitoring wells at the Gate 19 Landfill and Building 279 were ~~all~~ part of the characterization of the 4 sites (ESE 1989).

In September 1989, a working document of the Installation Assessment Relook Program was completed. This document is a supplement to the USEPA's original Environmental Photographic Interpretation Center (EPIC) photographs. Eighteen sites were re-photographed and analyzed. The original EPIC study provided a summary of ~~all~~ possible past disposal areas at JPG identifiable through evaluation of historical aerial imagery. A reassessment of possible CERCLA sites was conducted under this program.

In August 1989, the U.S. Environmental Protection Agency (USEPA) National Enforcement Investigations Center (NEIC) conducted a comprehensive multimedia assessment of JPG. This NEIC report published in April 1990 was requested by the Environmental Review Branch, Planning and Management Division, USEPA Region 5 in support of the USEPA Region 5 environmental review of military installations proposed for closure. The purpose of the report was to determine the compliance status of the JPG operations with the applicable environmental laws, regulations, permits, consent decrees, and other related requirements and conditions. This investigation was accomplished through review and evaluation of data from USEPA Region 5 and JPG files, and implementation of an on-site inspection (USEPA 1990).

In October 1989, Ebasco Environmental began an Enhanced Preliminary Assessment (PA) through Argonne National Laboratory to support the BRAC Program. The purpose of the Enhanced PA was to assess the environmental quality of JPG. Topics considered in the *Enhanced PA Report* included:

- Regulatory Compliance Status
- Asbestos
- PCBs
- Radon
- Lead-based paint
- USTs
- Current or potential restraints on facility utilization
- Environmental issues requiring resolution

- Other environmental concerns that might present impediments to the expeditious transfer and/or release of JPG

The Enhanced PA Report was based on (1) visual inspection of the facility; (2) review of existing information from JPG records, related regulatory agency files at the local, state, and federal levels, previous reports, and current property owners; (3) interviews with available current and former personnel associated with the facility; and (4) aerial photographs. Through review and analysis of previous data, 53 areas requiring environmental evaluation (AREEs), 36 SWMUs, and 17 areas of concern (AOCs) were identified and evaluated. Additionally, potential pathways for contaminant migration were defined; potential receptors of contamination were identified; and recommendations for further study were provided (Ebasco 1990a).

Ebasco prepared the *Master Environmental Plan* for JPG in November 1990, as a follow-on to the *Enhanced PA Report*. This plan was completed to (1) support the BRAC process by providing additional information required to characterize AOCs at JPG, (2) support Installation Restoration Program (IRP) activities, (3) prioritize site actions, and (4) assist in the development of cost-effective response actions. The *Master Environmental Plan* detailed the existing conditions at the 36 SWMUs from the Enhanced PA, 10 AREEs, additional general environmental concerns at JPG, additional data requirements, and proposed activities to provide the required data (Ebasco 1990b).

In 1991, the USACE prepared an Environmental Impact Statement (EIS) to identify and address the environmental impacts of the closure of JPG and relocation of its mission of ammunition acceptance testing to Yuma Proving Ground, Yuma, Arizona. Considered in this report were the consequences of closure, relocation, and future use of JPG (USACE 1991).

Rust E&I (formerly SEC Donohue) performed a Site-Specific Sampling and Analysis (SSSA) program from November 1991 through January 1992. The scope of this program included sampling at the Gate 19 Landfill, the Depleted Uranium Impact Area, and entrance and exit streams at JPG. The results were published in a *Letter Report* in August 1992 (SEC Donohue 1992).

In February 1992, A.T. Kearney, Inc., completed the *RCRA Facility Assessment* (RFA) for JPG. This report included the results of the visual site inspection and the preliminary review (PR) of ~~all~~ available relevant documents. The RFA identified 86 SWMUs and AOCs and included functional and physical descriptions of 67 of the 86 SWMUs and AOCs, their dates (or suspected dates) of operation, waste management practices, and release controls.

The remaining 19 AOCs identified in the RFA were not described in detail because they existed under conditions where the release potential was extremely low (A.T. Kearny 1992).

The Preliminary Site Inspection (PSI), completed in August 1993 by Advanced Sciences, Inc., is the revised edition to the June 1992 Draft PSI. The PSI presented the necessary data and information to score JPG on USEPA's revised Hazard Ranking System (HRS). Sites

considered sources of contamination or sites with actual or suspected releases of hazardous constituents to the environment were evaluated, including 16 sites in the southern cantonment area and 6 sites north of the Firing Range.

In June 1992, Mason & Hanger, Battelle, and ARS completed the Cleanup and Reuse Options Study. The purpose of this study, which encompassed the entire installation, was to document environmental responses and corrective actions within a range of potential reuse options. The study (1) documented the UXO situation, identified existing and emerging sites potentially appropriate for cleanup, and estimated costs for unrestricted surface reuse; (2) documented alternatives for remediation and associated range of costs for SWMUs; and (3) provided a range of potential generic reuse options and methodology to rapidly develop associated costs (Mason & Hanger 1992).

In April 1993, Vail Research and Technology summarized results of a radon-monitoring investigation conducted at JPG in the *Radon Monitoring Results for the Army Radon Reduction Program, JPG*. This report documents a radon-monitoring program in which 25 structures at JPG were monitored for radon in early 1993. The resulting radon concentrations measured levels ranging from 0.5 picocuries per liter (pCi/L) to 1.9 pCi/L, which were ~~far~~ below the USEPA action level of 4 pCi/L (Vail R&T 1993).

The Installation Action Plan (IAP) was completed in March 1993 by the USACE. This report summarizes the 103 previously identified sites at JPG. The 1993 status and contaminants of concern (COCs) are listed for ~~each~~ the sites in relation to further environmental work (if any) to be accomplished.

The Community Environmental Response Facilitation Act (CERFA) Report, completed by TETC in December 1993, identified real property where no known CERCLA-regulated hazardous substances or petroleum products were stored, released, or disposed ~~of~~ at BRAC properties, specifically at JPG. The identified real property would offer the greatest opportunity for immediate reuse and redevelopment (TETC 1993).

In September 1992, Rust E&I completed RI/FS Work Plans and on Addenda in June 1993 that described the procedures to conduct the initial RI/FS investigation of 50 sites located south of the ~~F~~firing ~~L~~line at JPG. The RI objectives were to define the extent and magnitude of environmental contamination and assess human health and environmental risk associated with contamination at these sites. The 1992 work plans outlined the overall approach and defined the activities required to provide a comprehensive study of 25 previously identified sites (22 SWMUs and 3 other sites) at JPG. In June, 1993, these work plans were modified by addenda to incorporate an additional 29 sites. The work plans were prepared in accordance with CERCLA and included the investigative approach as stated by the USACE. The following documents were prepared as part of the work plan development effort:

- *The Technical Plan (Volume I)*
- *Sampling Design Plan (Volume II)*
- *Quality Control Plan (Volume III)*

- *Health and Safety Plan (Volume IV)*
- *Addendum to the Technical Plan (Volume I)*
- *Addendum to the Sampling Design Plan (Volume II)*
- *Addendum to the Health and Safety Plan (Volume III)*

These plans were submitted to the IDEM, USEPA Region 5, and USACE for review and approval.

The investigative approaches described in the Work Plans were based on an initial evaluation of the results of previous investigations, wherein data gaps were identified. Individual work tasks were described along with the specific rationale, objectives, and technical approach to be used to fill these data gaps. ~~All w~~Work tasks were designed to provide information that would satisfy standard requirements, criteria, or limitations promulgated under Federal or State of Indiana environmental laws applicable to JPG.

Phase I RI field sampling, as prescribed in the Work Plans, was completed in July 1993. Data analysis was completed in January 1994. *The Final Draft Remedial Investigation Report for Sites South of the Firing Line, Jefferson Proving Ground, Indiana* was completed in July 1994. The report included baseline human health and ecological risk assessments and conclusions and recommendations. This document was submitted for Army, USEPA, and IDEM review and comment. Following receipt of review comments, it was determined that data gaps existed for 23 of the 50 sites evaluated during the Phase I RI.

To address these data gaps, Rust E&I prepared and submitted *Phase II RI Work Plans* that provided requirements and procedures for field investigation activities and laboratory analyses to fill the identified data gaps. In addition, requirements and procedures to be used by the USACE during interim remedial action activities at select sites were included in the *Phase II RI Work Plans* by Science Applications International Corporation (SAIC). Phase II Field investigation activities were conducted from October 1995 to June 1996. By May 1997, the USACE had completed interim removal actions at five sites and closure reports were prepared and submitted for regulatory approval. In addition to the Phase II field activities performed in 1995 and 1996, work plans were prepared for additional ecological surveys that were conducted in September 1997 to fill data gaps identified from the *Preliminary Ecological Risk Assessment* (PERA) presented in the *Final Draft RI Report*. The 1997 ecological field investigation activities provided data needed to complete the *Detailed Ecological Risk Assessment* (DERA) presented in this report. In addition, field investigation activities at a new burning/disposal site identified during a UXO geophysical survey in the area of the abandoned landfill (Sites 3/4) were also completed in September 1997.

For the sites not included in the Phase II RI, 8 technical memoranda were completed and submitted for regulatory review to support a recommendation for no further action (NFA) under CERCLA as follows:

- *Technical Memorandum for No Further Action under CERCLA - Site 17, August 1995.*

- *Technical Memorandum for No Further Action under CERCLA - Site 20 A, September 1995.*

- *Technical Memorandum for No Further Action under CERCLA - Sites 32, 43, 48, and 50, September 1995.*

- *Technical Memorandum for No Further Action under CERCLA - Sites 18, 19, 24, 35, 36, 37, 40, 41, and 44, November 1995.*

- *Technical Memorandum for No Further Action under CERCLA - Sites 22 and 23, November 1995.*

- *Technical Memorandum for No Further Action under CERCLA - Sites 16, 45, 46, 47, and 49, December 1995.*

- *Technical Memorandum for No Further Action under CERCLA - Site 11, January 1996*

- *Technical Memorandum for No Further Action under CERCLA - Site 20B , January 1997*

Refer to Section 1.5 for a discussion of these NFA sites. (IN7)

Since the start of Phase II RI activities in 1995, interim remedial action has been conducted at several sites. Closure reports have been prepared and submitted to USEPA Region 5 and IDEM for review and approval. These reports include:

- *Closure Report, Building 211, Site 7-Red Lead, Jefferson Proving Ground, Madison Indiana:* prepared by Sverdrup Environmental, Inc., for the U.S. Army Corps of Engineers, Louisville, Kentucky, July 1997.

- *Closure Report, Yellow Sulfur Area and Small Burn Area, Sites 14 and 15, Jefferson Proving Ground, Madison, Indiana:* prepared by Sverdrup Environmental, Inc., for the U.S. Army Corps of Engineers, Louisville, Kentucky, July 1997.

- *Closure Report, Jefferson Proving Ground, Site 26 DRMO Storage Area, Madison, Indiana:* prepared by TolTest, Inc., for the U.S. Army Corps of Engineers, Louisville, Kentucky, July 1997.

- *Closure Report, Jefferson Proving Ground, Site 28 Gator Z Open Burn Area, Madison Indiana:* prepared by TolTest, Inc., for the U.S. Army Corps of Engineers, Louisville, Kentucky, July 1997.

- *Closure Report, Jefferson Proving Ground, Site 29 Gator Z Scrap Disposal Area, Madison Indiana:* prepared by TolTest, Inc., for the U.S. Army Corps of Engineers, Louisville, Kentucky, July 1997.

- *Final Report, Jefferson Proving Ground Site 8 - Indoor Firing Range Decontamination, Madison, Indiana,* prepared by Ferguson Harbour, Inc., 1998 December.

- *Construction Completion Report, Jefferson Proving Ground, Sites 12A, 12B, 12C, and 33*, prepared by Montgomery Watson for the U.S. Army Corps of Engineers, Louisville, Kentucky, March 2001.

- *Position Paper, Jefferson Proving Ground, Site 13*, prepared by Montgomery Watson for the U.S. Army Corps of Engineers, Louisville, Kentucky, March 2001.

At the time of this report, the above-referenced documents were in various stages of review and approval.

1.3 REGULATORY SETTING

Guidelines for the remediation of hazardous constituents released from federal facilities are provided in Section 120 of the CERCLA. Essentially, ~~all~~ guidelines, rules, regulations, and criteria carried out under CERCLA apply to federal facilities. In that context, environmental studies and current and future remediation activities conducted at JPG are governed by CERCLA under the review and approval of the USEPA, Region 5, and the State of Indiana. The U.S. Army, through USACE and USACE, is responsible for the study and cleanup of waste sites at JPG.

As stated in Section 1.2.2, JPG was recommended for closure by the BRAC and closure activities were conducted in compliance with President Clinton's July 2, 1993, five point program to expedite economic recovery at communities where military bases are slated to close. This program created guidance and procedures (1) to establish base realignment and closure teams, (2) to accelerate the National Environmental Policy Act (NEPA) process, (3) to increase public involvement in the cleanup program, (4) to guide the Suitability to Lease decision process, and (5) to implement CERFA for identification of uncontaminated real estate.

The CERCLA process specifies that site cleanups must attain standards from federal and state environmental programs that are "applicable or relevant and appropriate" under the circumstances. These standards, known as ARARs, have been developed for JPG. Table 1-3 presents a preliminary list of ARARs for the RI/FS activities.

Generally, these ARARs represent federal requirements except those areas where state requirements are more stringent than the federal requirements. In addition to federal or state

requirements, there are also USACE and Department of Defense (DOD) requirements that must be met (i.e., regulations governing UXO). Where the potential for UXO exists, site work must comply with the following regulations:

- Department of Defense 6055.9-STD Ammunition and Explosive Safety Standards
- AR 385-64 Ammunition and Explosive Safety Standards
- AR 50-6 Chemical Surety Program
- AR 75-15 Responsibilities and Procedures for Explosive Ordnance Disposal (EOD) (EPA11)

State of Indiana regulations are also presented in Table 1-3. During the FS, a detailed evaluation of State of Indiana ARARs will be conducted and the State of Indiana regulations that are more stringent will supersede federal regulations.

While in operation, JPG was required to maintain the following permits:

- RCRA Permit (Part A Interim and Part B Application)
- NPDES Permit (State Permit)
- Fire Training Permit (State Variance)
- Open Burning/Open Detonation Permit (State Variance)
- Air Permit (State Variance)

The RCRA Interim Permit (Part A) was required because pyrotechnics, explosives, and propellants were stored and thermally treated at the facility. These items were also detonated on open ground. A RCRA Subpart X Hazardous Waste (Part B) Permit application was also required.

A National Pollutant Discharge Elimination System (NPDES) Permit was required at JPG to discharge the effluent from the sewage treatment plant.

A local Fire Training Permit was required for JPG to provide fire-fighting training to JPG personnel. This training was conducted under the supervision of state and local fire-fighting agencies.

An Open Burning Permit from the IDEM was required for JPG to burn excess propellants, explosives, vegetation, and scrap wood. The permit was renewed annually.

An air permit would normally be required to operate an incinerator. In the case of JPG, local regulations required an air permit only if at least 10 tons per day of solid wastes were incinerated. JPG's new incinerator capacity was only 4 tons per day. Consequently, ~~no~~an air permit was not required to operate the incinerator. JPG did have a permit from the IDEM for the open burning of excess propellants and explosives.

Since ~~all~~ Army industrial operations south of the firing line have ceased, these permits are not ~~longer~~ required or maintained.

1.4 REPORT ORGANIZATION

The organization of this Phase II RI report generally follows the suggested format provided in *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (USEPA 1988c).

In addition, the report is organized to fulfill USACE requirements for reporting geotechnical and analytical results (USATHAMA 1987 and USATHAMA 1990).

The following sections are included in this report:

- Section 2.0 describes the physical characteristics of JPG, including the physiography, climate, demographics and land use, geology, hydrogeology, background water quality, soils, vegetation, and wildlife.

- Section 3.0 discusses the field, laboratory analysis, and data evaluation procedures that were used during Phase I and Phase II of the RI.

- Section 4.0 describes the contaminant assessment methodologies used to characterize contaminant fate and transport at JPG, contaminant behavior, and determination of background characteristics.

- Section 5.0 presents the human health and ecological risk assessment methodologies used, including hazard identification, exposure assessment, toxicity assessment, risk characterization, and uncertainty analysis.

- Sections 6.0 through 27.0 present the following site-specific RI results: (1) site characteristics, (2) a description of previous investigations, (3) the study area investigations, (4) data evaluation, (5) the nature and extent of contamination, (6) the human health risk assessment, (7) ecological risk assessment, and (8) conclusions and recommendations.

- Sections 28.0 through 30.0 provide the results of human health risk assessments for current facility-wide trespassers, current off-site rural residents, and future facility-wide hunters.

- Section 31.0 present the ecological risk assessment for Site 11, and Section 32.0 provides the assessment for the three terrestrial reference areas.
- Section 33.0 provides references used during the completion of the RI.

1.5 SUMMARY OF SITES REQUIRING NO FURTHER INVESTIGATION

Based on the results of previous investigations, as presented in the *Final Draft RI Report for Jefferson Proving Ground sites south of the Firing Line* (Rust 1994), a total of ~~24~~ 23 sites (24 locations) were identified as requiring no further action under the RI/FS. To document these findings, eight Technical Memorandum documents were prepared and submitted to the regulatory agencies for review and approval. These documents provided information necessary to support the recommendation for no further action. Table 1-4 provides a summary of the previous findings, the rationale for removing the ~~each of the 24~~ 23 sites (24 locations) from the RI/FS, and the current status of the NFA documents. (IN9, IN7)

TABLES

TABLE 1-1

Sites South of the Firing Line
Jefferson Proving Ground
Madison, Indiana

Site No.	Site Name
1	Building 185 Incinerator
2	Building 177 Sewage Treatment Plant and Water Quality Laboratory
3	Explosive Burning Area
4	Abandoned Landfill
5	Wood Storage Pile
6	Wood Burning Area
7	Red Lead Disposal Area
8	Small Arms Indoor Range
9	Burning Ground South of Gate 19 Landfill
10	Gate 19 Landfill
11*	Burning Area for Explosive Residue
12A	Building 602 Solvent Pit
12B	Building 617 Solvent Pit
12C	Building 279 Solvent Pit
13	Old Fire Training Pit
14	Yellow Sulfur Area
15	Burn Area South of New Incinerator
16*	Potential Ammo Dump Site
17*	Asbestos Containing Materials
18*	Underground Storage Tanks
19*	Off-Site Water Supply Wells
20A*	Building 279 Temporary Waste Storage
20B*	Building 305 Temporary Waste Storage
21A	Building 204 Temporary Storage
21B	Building 211 Temporary Storage
22*	Building 216 Locomotive Maintenance Pit
23*	Building 216 Potential Solvent Disposal Pit
24*	Building 602 Soil Staging Area
25	Paper Mill Road Disposal Area
26	DRMO Storage Area
27	Sewage Sludge Application Area
28	Gator Z Mine Open Burn Area
29	Gator Z Mine Scrap Disposal
30	Building 204 Pesticide Storage Area
31	Building 227 Former Storage Pad
32*	Building 105 Locomotive Maintenance Pit
33	Building 333 New Incinerator
34	Building 136 Sandblasting Area
35*	Building 602 Former Leaking Underground Storage Tank
36*	No. 2 Oil Spill at Building 103
37*	Gasoline Station, Building 118
38	Northwest-Southeast Runway Test Area
39	Gator Z Mine Test Area
40*	Discharge/Fill Pipe at Building 259
41*	Building 281 Fuel Oil from Former UST
42	Building 281 Indoor Range
43*	Possible USTs or Wells at Artillery and Infantry Roads
44*	Underground Concrete Vault near Airport Rail Tracks
45*	Possible UXO at the Airport
46*	Old Flare Test Sites (2) at South End Airport
47*	Wooded Area South of the Airport (possible test area)
48*	Ammunition Storage Igloos South of the Firing Line
49*	Explosive Ordnance South of the Firing Line
50*	Building 186 Wash Rack

General Note:

* = Sites were recommended for No Further Action by the Phase I RI and therefore are not included in this Phase II RI.

TABLE 1-2

Current Industrial Tenants
Jefferson Proving Ground
Madison, Indiana

Building No.	Company or Individual	Current/Proposed Usage
105	J & R Stamping	Metal Stamping (also uses Building 136)
106	Tri-State Laminates	Laminating
108	American Directory Service	
110	Firetac Systems, Inc.	
114	J. Trapp	
115	T. Hammock	Storage
119	VMV	Injection mold fabrication
121	Rust Environment & Infrastructure	Storage/Field Office
125	U.S. Army Jefferson Proving Ground	Site Management Team
138	Ford Development/ Prairie Farms	Office
144	G. Storrs/ R. Davidson	
146	G. Cole/ D. Stephens	
149	D. Colvin/ Jeffersonian Cafe	Cafe
156	Banner Distribution	Pallet Repair (Bldgs 148 & 202 for storage)
184	Sewage Treatment Plant Office	Office
202	Gymnastics World, Inc	Storage and Light Assembly
205	Stephan Machine Shop	Machine Shop (pending)
211	Pietrykowski Products	Shipping Containers
212	Dave O’Mara Contractors	
215	Hydra-Tach	
216	Madison Port Authority	Management
226	Jones Environmental Drilling	Well Drilling
227	Rotary Lift/Dover Corporation	
241	K. Bruner	
322	Stephan Machine Shop	Machine Shop
534	Southeastern Indiana Solid Waste	Management
567	R. Hudson	Storage
569	A.B.C Construction Company	Storage
578	Madison Precision Industries	Storage
711	F. Collins	Storage

TABLE 1-3

Preliminary ARARS [(a)]
Jefferson Proving Ground
Madison, Indiana

Standard Requirements, Criteria, or Limitations	Citation	Description	Potentially Applicable/Relevant and Appropriate
CLEAN WATER ACT	33 U.S.C. 1251-1376		
National Pollutant Discharge Elimination System (NPDES)	40 C.F.R. Parts 122 and 125	Requires permits for discharge of NPDES pollutants from any point source into waters of the United States	Relevant and Appropriate - Chemical Specific, Location Specific
Water Quality Standards	40 C.F.R. Part 131	Sets criteria for water quality based on toxicity to human health.	Applicable - Chemical Specific
Ambient Water Quality Criteria	40 C.F.R. Part 131 Subpart D	Sets criteria for ambient water quality based on toxicity to aquatic organisms.	Applicable - Chemical Specific
Dredge or Fill Requirements	40 C.F.R. Parts 230-231	Requires discharges to address impact of discharge or dredge or fill material on the aquatic ecosystem.	Relevant and Appropriate - Action Specific
Effluent Guidelines and Standards for the Point Source Category	40 C.F.R. Part 414	Require specific effluent characteristics for discharge under NPDES permits.	Relevant and Appropriate Chemical Specific, Location Specific
General Pretreatment Regulation for Existing and New Sources of Pollution	40 C.F.R. Part 403	Sets standards to control pollutants that pass through or interfere with treatment processes in public treatment works or that may contaminate sewage sludge.	Relevant and Appropriate - Chemical Specific
SAFE DRINKING WATER ACT	42 U.S.C. 300f et seq.		
National Primary Drinking Water Regulations	40 C.F.R. Part 141	Establishes health-based standards for public water systems (maximum contaminant levels (MCLs)).	Applicable - Chemical Specific

TABLE 1-3

Preliminary ARARS
Jefferson Proving Ground
Madison, Indiana

Standard Requirements, Criteria, or Limitations	Citation	Description	Potentially Applicable/Relevant and Appropriate
National Secondary Drinking Water Regulations	40 C.F.R. Parts 144-147	Provides for protection of underground sources of drinking water.	Relevant and Appropriate - Chemical Specific, Action Specific
RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)	40 C.F.R. Parts 260-272		
Standards Applicable to Generators of Hazardous Waste	40 C.F.R. Part 262	Establishes standards for generators of hazardous waste.	Relevant and Appropriate - Action Specific, Location Specific
Standards Applicable to Transporters of Hazardous Waste	40 C.F.R. Part 263	Establishes standards that apply to transporters of hazardous waste within the U.S. if the transportation requires a manifest under 40 C.F.R. Part 262.	Relevant and Appropriate - Action Specific
Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal (TSD) Facilities	40 C.F.R. Part 264	Establishes minimum national standards, which define the acceptable management of hazardous wastes for owners and operators of facilities that treat, store, or dispose.	Relevant and Appropriate - Action Specific
Groundwater Protection	40 C.F.R. Part 264.90 - 264.101	Establishes standards for pollutants that will, or are likely to, enter into groundwater.	Applicable - Chemical Specific
Use and Management of Containers	40 C.F.R. Part 264 Subpart I	Provides standards for the condition, compatibility, management, inspection, containment, and closure for containers used in hazardous waste related activities.	Relevant and Appropriate - Action Specific
Waste Piles	40 C.F.R. Part 264 Subpart L	Provides containment, design closure, and post-closure care requirements for facilities that treat or store hazardous wastes in piles.	Relevant and Appropriate - Action Specific

TABLE 1-3

Preliminary ARARS
Jefferson Proving Ground
Madison, Indiana

Standard Requirements, Criteria, or Limitations	Citation	Description	Potentially Applicable/Relevant and Appropriate
Land Disposal Restrictions	40 C.F.R. Part 268	Identifies hazardous wastes that are restricted from land disposal and describes those circumstances under which an otherwise prohibited waste may be land disposed.	Applicable - Chemical Specific, Action Specific
RCRA/SOLID WASTE	40 C.F.R. 240-258		
Criteria for Classification of Solid Waste Disposal Facilities and Practices	40 C.F.R. Part 257	Establishes criteria for use in which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on public health or the environment, and thereby constitute prohibited open dumps.	Relevant and Appropriate - Location Specific, Chemical Specific
CLEAN AIR ACT	42 U.S.C. 7401		
National Primary and Secondary Ambient Air Quality Standards	40 C.F.R. Part 50	Establishes primary and secondary standards for six pollutants to protect public health and welfare.	Applicable - Chemical Specific
National Emission Standards for Hazardous Air Pollutants	40 C.F.R. Part 61	Establishes standards for air pollutant emissions to protect public health and welfare.	Applicable - Chemical Specific
TOXIC SUBSTANCES CONTROL ACT (TSCA)	15 U.S.C. 2601 et seq.		
(PCB) Storage and Disposal	40 C.F.R. Part 761 Subpart D	Requirements for storage and disposal of PCBs including incineration	Applicable - Chemical Specific
PCB Waste Disposal Records and Reports	40 C.F.R. Part 761 Subpart K	Requirements for PCB waste disposal records and reports	Applicable - Chemical Specific
PCB Spill Cleanup Policy	40 C.F.R. Part 761 Subpart G	Criteria for determining adequacy of PCB spill cleanup	Applicable - Chemical Specific, Action Specific

TABLE 1-3

Preliminary ARARS
Jefferson Proving Ground
Madison, Indiana

Standard Requirements, Criteria, or Limitations	Citation	Description	Potentially Applicable/Relevant and Appropriate
Fish and Wildlife Coordination Act	166 U.S.C. 661-666	Requires consultation when a federal department or agency proposes or authorizes any modification of any stream or other water body, and adequate provision for protection of fish and wildlife resources.	Applicable - Location Specific, Action Specific
Endangered and Threatened Wildlife and Plants (1992)	50 C.F.R. 17.11 and 17.12	List of endangered and threatened plants and wildlife.	Applicable - Location Specific
Protection of Bald and Golden Eagles	16 U.S.C. 668-668d	Protects identified species.	Applicable - Location Specific
Protection of Migrating Game and Insectivorous Bird	16 U.S.C. 701-718h	Protects identified species.	Applicable - Location Specific
Migration Bird Treaty Act of 1918	16 U.S.C. 703	Prohibits the taking, capture, killing, and processing of any migratory bird, their parts, or eggs.	Applicable - Action Specific
Endangered Species Act	U.S.C. 1531 50 C.F.R. Parts 200 and 402	Requires action to conserve endangered species within critical habitats upon which endangered species depend (includes consultation with the U.S. Department of the Interior).	Applicable - Location Specific
Archeological and Historical Preservation	16 U.S.C. 469 40 C.F.R. 6301(c)	Establishes procedures to provide preservation of historical and archeological data which might be destroyed through alteration of terrain as a result of a federal construction project or a federally licensed activity or program.	Applicable - Location Specific
Historic Sites, Buildings and Antiquities Act	16 U.S.C. 461-467 40 C.F.R. 6301(a)	Requires federal agencies to consider the existence and location of landmarks on the National Registry of Natural Landmarks to avoid undesirable impacts on such landmarks.	Applicable - Location Specific
American Indian Religious Freedom Act	42 U.S.C. 1996 43 C.F.R. 7	Protection of sites or artifacts associated with current Indian or other traditional, religious practices, rites, or ceremonies.	Applicable - Location Specific

TABLE 1-3

Preliminary ARARS
Jefferson Proving Ground
Madison, Indiana

Standard Requirements, Criteria, or Limitations	Citation	Description	Potentially Applicable/Relevant and Appropriate
National Historic Preservation Act	49 U.S.C. 470 40 C.F.R. 6301(b) 36 C.F.R. Part 800	Establishes standards for designating and maintaining structures of historical importance.	Applicable - Location Specific
OCCUPATIONAL SAFETY AND HEALTH ACT	29 C.F.R. 1900-1999		
OSHA Worker Safety	29 C.F.R. 1910.120	Worker Safety.	Applicable - Action Specific
OSHA Excavation	29 C.F.R. 1926 Subpart P	Excavation	Applicable - Action Specific
Hazardous Materials Transportation Act	49 C.F.R. parts 107, 171-177	Regulates transportation of hazardous materials.	Applicable - Action Specific
USACE GUIDELINES AND POLICIES:			
Department of the Army Ammunition and Explosives Safety Documents	USAT CESP 385-02	UXO safety guidelines for explosives and ammunition.	Applicable - Action Specific
Department of the Army Ammunition of Explosives Safety Standards	AR 385-64	UXO safety guidelines for explosives and ammunition.	Applicable - Action Specific
Department of Defense Explosives Safety Board Directives	#6055.9	UXO safety guidelines for explosives and ammunition.	Applicable - Action Specific
USEPA Guidance on Remedial Actions for Superfund Sites with PCB Contamination	OSWER Directive No. 9355.4-01 (USEPA/540/G-90 007) August 1990	Recommends approach for evaluation and remediation of PCB contaminated sites and suggests PCB cleanup goals.	To Be Considered - Chemical Specific
INDIANA WATER			

TABLE 1-3

Preliminary ARARS
Jefferson Proving Ground
Madison, Indiana

Standard Requirements, Criteria, or Limitations	Citation	Description	Potentially Applicable/Relevant and Appropriate
Indiana Water Pollution Control Law, Water Pollution Control Board	Indiana Code, Title 13, Article 1, Chapter 3	Establishes standards and rules for the control and prevention of pollution in waters of the state.	Applicable - Action Specific
Indiana Water Pollution Control Law, Waste Water Treatment Control	Indiana Code, Title 13, Article 1, Chapter 6	Classification of water treatment plants, wastewater treatment plants, and water distribution systems. Certification of persons to operate water treatment plants.	Applicable - Action Specific
Indiana Wastewater Management Law	Indiana Code, Title 13, Article 7, Chapter 8.8	Regulates persons who provide wastewater management services.	Relevant and Appropriate - Action Specific
Indiana Groundwater Protection Act	Indiana Code, Title 13, Article 7, Chapter 26	Establishes rules for prevention of ground water pollution. Registry of sites with ground water contamination. Establishes ground water quality standards. Provides rules for construction and monitoring of surface impoundments.	Applicable - Action Specific
Indiana Wastewater Treatment Facilities Regulations, Wastewater Treatment Facilities; Issuance of Permits; Construction and Permit Requirements	Indiana Administrative Code, Title 327, Article 3	Establishes procedures and criteria for issuance of permits for the construction of water pollution treatment/control facilities; agency approval of completed construction prior to use; and the issuance of permits for the operation of water pollution treatment/control facilities.	Applicable - Action Specific
Indiana Wastewater Treatment Facilities Regulations, Wastewater Treatment Facilities; Overload Condition	Indiana Administrative Code, Title 327, Article 4	Prevents excessive hydraulic and/or organic overloading of publicly owned treatment works and the subsequent discharge or bypassing of insufficiently treated sewage due to new sewer connections to such overloaded POTWs.	Applicable - Action Specific
Indiana Industrial Wastewater Pretreatment Regulations, Industrial Wastewater Pretreatment Programs (NPDES)	Indiana Administrative Code, Title 327, Article 5	Provides policies, procedures, and criteria for the issuance of discharge permits under the national pollutant discharge elimination system, and implementation of a program for the pretreatment of industrial wastewaters to be discharged into municipal sewage treatment facilities.	Applicable - Action Specific

TABLE 1-3

Preliminary ARARS
Jefferson Proving Ground
Madison, Indiana

Standard Requirements, Criteria, or Limitations	Citation	Description	Potentially Applicable/Relevant and Appropriate
Indiana Water Quality Standards	Indiana Administrative Code, Title 327, Article 1 and 2	Establishes goals to restore and maintain the chemical, physical, and biological integrity of the waters of the state. Provides water quality standards applicable to all waters of the state.	Applicable - Chemical Specific
Indiana Drinking Water Standards	Indiana Administrative Code, Title 327, Article 8	Provides inorganic, organic, biological, and radioactive maximum contaminant levels and goals for drinking water.	Relevant and Appropriate - Chemical Specific
INDIANA GUIDANCE FOR VOLUNTARY CLEANUP PROGRAM			
Indiana Voluntary Cleanup Program	Indiana Administrative Code, Title 13, Article 7, Chapter 8.9	Establishes technical guidelines and instructions for applying the Voluntary Cleanup Program (VCP) and preparing and reviewing VCP work plans. Provides specific standards for cleanup criteria.	To be Considered - Action Specific
INDIANA SOLID AND HAZARDOUS WASTE			
Indiana Solid Waste Management Laws	Indiana Code, Title 13, Article 7, Chapters 10.5 and 22	Establishes requirements concerning solid waste management and procedures and requirements to permit construction or operation of a landfill.	Applicable - Action Specific
Indiana Hazardous Waste Law	Indiana Code, Title 13, Article 7, Chapter 8.5	Establishes requirements for the proper and safe transportation, treatment, storage, and disposal of any hazardous waste that is generated in or transported into the state.	Applicable - Action Specific
Indiana Hazardous Waste Facility Siting Law	Indiana Code, Title 13, Article 7, Chapter 8.6	Establishes procedures for effective public participation in the siting process for hazardous waste facilities.	Applicable - Action Specific
Indiana Superfund Law	Indiana Code, Title 13, Article 7, Chapter 8.7	Superfund program.	Relevant and Appropriate - Location Specific

TABLE 1-3

Preliminary ARARS
Jefferson Proving Ground
Madison, Indiana

Standard Requirements, Criteria, or Limitations	Citation	Description	Potentially Applicable/Relevant and Appropriate
Indiana Underground Storage Tank Act	Indiana Code, Title 13, Article 7, Chapter 20	Provides requirements and certifications associated with installation, testing, retrofitting, removal and closure of underground storage tanks.	Applicable - Action Specific
Indiana Environmental Hazardous Disclosure and Responsible Party Transfer Law	Indiana Code, Title 13, Article 7, Chapter 22.5	Establishes requirements for environmental disclosure documents associated with property transfers.	Relevant and Appropriate - Action Specific
Indiana Hazardous Waste Reduction Law	Indiana Code, Title 13, Article 7, Chapter 27	Establishes a hazardous waste reduction program.	Applicable - Action Specific
Indiana Hazardous and Solid Waste Landfills Act	Indiana Code, Title 13, Article 7, Chapter 32	Requirements for financial responsibility for the costs of closure and postclosure monitoring and maintenance of the hazardous waste landfill, solid waste landfill, or transfer stations.	Applicable - Action Specific
Indiana Solid Waste Incineration Law	Indiana Code, Title 13, Article 7, Chapter 21	Establishes rules for construction and operation of incinerators.	Applicable - Action Specific
Indiana Industrial Pollution	Indiana Code, Title 13, Article 9	Pollution prevention program.	Relevant and Appropriate - Action Specific
Indiana Petroleum Releases Law	Indiana Code, Title 7, Chapter 20.1	Establishes provisions to require an owner or operator or a responsible person to undertake removal or remedial action with respect to a release of petroleum at a petroleum facility.	Applicable - Action Specific, Location Specific
Indiana Solid Waste Management Facilities Siting Act	Indiana Code, Title 13, Article 9.5	Establishes administrative solid waste management requirements including solid waste management plans and fees.	Applicable - Action Specific
Indiana Solid Waste Management Permit Regulations	Indiana Administrative Code, Title 329, Articles 1 and 2	Establishes procedures and requirements for solid waste permits. Provides rules and requirements for solid waste disposal. Establishes requirements for pre-operational, operational and closure of solid waste land disposal facilities and incinerators. Provides requirements for generations of special wastes.	Applicable - Action Specific, Location Specific

TABLE 1-3

Preliminary ARARS
Jefferson Proving Ground
Madison, Indiana

Standard Requirements, Criteria, or Limitations	Citation	Description	Potentially Applicable/Relevant and Appropriate
Indiana Hazardous Waste Management Rules	Indiana Administrative Code, Title 329, Article 3.1	Establishes a hazardous waste management program consistent with RCRA. Establishes standards for identifying hazardous waste as well as standards for hazardous waste management procedures for generators, transporters, and owners and operators of hazardous waste facilities.	Applicable - Action Specific
Indiana Hazardous Substance Response Sites Regulation	Indiana Administrative Code, Title 329, Article 7	Provides criteria and procedures for establishing a priority ranking of hazardous substance response sites not on the National Priorities List of those sites believed to pose significant threat to human health and the environment.	Relevant and Appropriate - Location Specific
Indiana Hazardous Waste Facility Siting Rules	Indiana Administrative Code, Title 323	Describes the policies and procedures to be followed in the issuance or denial of certificates of environmental compatibility for hazardous waste disposal facilities.	Relevant and Appropriate - Action Specific
INDIANA AIR POLLUTION CONTROL REGULATIONS			
General Provisions	Indiana Administrative Code, Title 326, Article 1	Establishes primary and secondary ambient air quality standards.	Applicable - Chemical Specific, Action Specific
Permit Review Rules	Indiana Administrative Code, Title 326, Article 2	Establishes criteria that identifies when construction and operating permits are required and procedures associated with permits.	Applicable - Action Specific
Monitoring Requirements	Indiana Administrative Code, Title 326, Article 3	Establishes requirements and procedures associated with air monitoring.	Applicable - Action Specific
Burning	Indiana Administrative Code, Title 326, Article 4	Establishes standards for open burning, air curtain destructors, and incinerators.	Applicable - Action Specific, Chemical Specific
Opacity Regulations	Indiana Administrative Code, Title 326, Article 5	Establishes standards that apply to all visible emissions.	Applicable - Action Specific, Chemical Specific

TABLE 1-3

Preliminary ARARS
Jefferson Proving Ground
Madison, Indiana

Standard Requirements, Criteria, or Limitations	Citation	Description	Potentially Applicable/Relevant and Appropriate
Particulate Rules	Indiana Administrative Code, Title 326, Article 6	Establishes particulate emission standards for sources in attainment and nonattainment areas. Provides fugitive dust standards.	Applicable - Action Specific, Chemical Specific
Sulfur Dioxide Rules	Indiana Administrative Code, Title 326, Article 7	Establishes sulfur dioxide emission limitations and reporting requirements	Applicable - Action Specific, Chemical Specific
Volatile Organic Compound Rules	Indiana Administrative Code, Title 326, Article 8	Establishes volatile organic compound emission standards.	Applicable - Action Specific, Chemical Specific
Carbon Monoxide Emission Rules	Indiana Administrative Code, Title 326, Article 9	Establishes carbon monoxide emission standards.	Applicable - Action Specific, Chemical Specific
New Source Performance Standards	Indiana Administrative Code, Title 326, Article 12	Establishes performance standards for new stationary sources.	Applicable - Action Specific, Chemical Specific
Emission Standards for Hazardous Air Pollutants	Indiana Administrative Code, Title 326, Article 14	Establishes emission standards for asbestos, beryllium, vinyl chloride, benzene and volatile hazardous air pollutants.	Applicable - Action Specific, Chemical Specific

Footnotes:
(a) Applicable or Relevant and Appropriate Requirements

TABLE 1-4

Summary Of Sites Removed From The RI/FS[(a)] Process
Jefferson Proving Ground
Madison, Indiana

Site No.	Site Name	Previous Findings	Rationale for Removal From RI/FS and Status of NFA[(b)] Document
11	Burning Area for Explosive Residue	Metals, two herbicides, and one SVOC were present in site soils. Human health risk assessment indicated no current risks or hazards exceeding criteria.	Site 11 is being monitored and closed under a RCRA Subpart X permit. Because further investigations will be conducted during closure and post-closure activities under RCRA, it was recommended the site be removed from the RI/FS. A Technical Memorandum supporting this recommendation was submitted to the regulatory agencies in January 1996.
16	Potential Ammo Dump Site	Visual inspections, review of historical aerial photographs, and geophysical surveys provided no evidence of UXO disposal at this site.	No further investigation under the RI/FS was recommended due to the lack of evidence of UXO disposal at this site. A Technical Memorandum summarizing these findings was submitted to the regulatory agencies in Dec 1995 and comments were addressed and submitted July 1996. Finalization is postponed until UXO removal activities are resolved. UXO Removal in progress for western portion , which included Site 16.
17	Asbestos-Containing Materials	Many buildings contained asbestos materials including pipe insulation, wall board, roofing, siding, and floor tiles. The Phase I RI included a comprehensive survey of the facilities including a detailed inspection of 345 buildings and a sampling and analysis program. A separate document was produced and submitted to the regulatory agencies.	The asbestos survey conducted under the RI/FS met the objectives of identifying and quantifying hazards associated with asbestos-containing materials south of the firing line at JPG. Corrective action will be conducted under the facility's asbestos abatement program regulated under TSCA. Therefore, no further investigation is required under the RI/FS. A Technical Memorandum was submitted Sept. 1995 and response to Agency comments in December 1995. Waiting for agency approval.

TABLE 1-4

Summary Of Sites Removed From The RI/FS[(a)] Process
Jefferson Proving Ground
Madison, Indiana

Site No.	Site Name	Previous Findings	Rationale for Removal From RI/FS and Status of NFA[(b)] Document
18	Underground Storage Tanks	Twenty-five tanks that were removed or out of service during the Phase I RI were evaluated through a records search, previous data, field screening, and soil sampling and analysis. The USACE remediated 18 locations where releases to soils occurred under an ongoing UST remediation program.	It was recommended that all of the UST sites included in Site 18 be removed from the RI/FS and be addressed by the USACE under the UST program. This program is being overseen by the IDEM LUST/UST branch; cleanup, verification sampling, and monitoring will comply with IDEM requirements. A Tech Memo was submitted November 1995 and comments were received from IDEM in January 1996. No comments have been received from USEPA. The Army has received approval from IDEM for all UST Sites with the exception of Site 27 - Former Fire Station House.
19	Off-Site Water Supply Wells	Field screening and soil boring sampling detected no VOC contamination and only low levels of VOCs were detected in field screening samples. All detected contaminants were below state action levels.	The contaminated soil adjacent to the former USTs was remediated as part of the ongoing UST program being overseen by the IDEM LUST/UST branch. A report documenting the cleanup was submitted to IDEM. No further investigation was recommended because remediation was completed following state guidance. A Tech Memo was submitted November 1995 and comments were received from IDEM in January 1996. No comments have been received from USEPA. UST closed in accordance with IDEM UST regulations. Closure letter received from IDEM. Property has been transferred.
20A	Building 279 Temporary Storage Area	Site 20A was used for temporary storage of hazardous wastes from 1981 to 1982. The site was mistakenly reported on the facility's Part A Application under RCRA. A closure plan was submitted to the state and USEPA while the Phase I RI was being conducted.	A letter from the State of Indiana stating approval of the closure of Site 20A was received during the Phase I RI. As a result, it was recommended that the site be removed from the RI/FS. Supporting documentation was presented in a Technical Memorandum submitted to the regulatory agencies in September 1995. Responses to comments were submitted in December 1995. Waiting for agency approval.

TABLE 1-4

Summary Of Sites Removed From The RI/FS[(a)] Process
Jefferson Proving Ground
Madison, Indiana

Site No.	Site Name	Previous Findings	Rationale for Removal From RI/FS and Status of NFA[(b)] Document
20B	Building 305 Temporary Waste Storage Area	Closure plans were prepared under RCRA at the time of the Phase I RI. Visual inspections, records searches, personnel interviews, and soil boring sampling and analysis resulted in the identification of pesticide-related contamination and metals contamination. No current risks to human health exceed regulatory criteria.	Since site closure is being conducted under RCRA, cleanup, verification sampling, and monitoring will be performed in accordance with RCRA requirements. As a result, it was recommended that no further investigation be performed under the RI/FS. A Technical Memorandum was prepared and submitted to the agencies in January 1997. Comments have not been received.
22	Building 216 Locomotive Maintenance Pit	A site inspection resulted in the conclusion that no contaminant releases to the environment have occurred from the concrete pit.	No evidence for contaminant releases exists. Therefore, no further investigation under the RI/FS is warranted. This recommendation was submitted to the regulatory agencies in a Technical Memorandum in November 1995. IDEM and USEPA concluded that this site does not represent a threat to human health or the environment.
23	Potential Solvent Disposal Pit	Results of RI drilling and sampling and a field screening survey indicate that no VOC contamination is present and personnel interviews indicate that a disposal pit never existed at this site.	Since characterization of this site resulted in a determination that no contaminants are present and that the disposal pit never existed, it was recommended that the site be removed from the RI/FS as a No Further Action site. A Technical memorandum was prepared and submitted to the regulatory agencies in November 1995. IDEM and USEPA concluded that this site does not represent a threat to human health or the environment.
24	Soil Staging Area at Building 602	A surface soil sample collected in a drainage immediately adjacent to the former soil staging area indicated total petroleum hydrocarbon (TPH) contamination exceeding State of Indiana action levels is present. A second sample in the drainage was non-detect for TPH. Contamination appears to be limited.	Due to limited extent of contamination, previous removal of the stockpiled soils, and low estimated risks to human health and the environment, this site was recommended for no further investigation and removal from the RI/FS as a No Further Action site. A Tech Memo was submitted November 1995 and comments were received from IDEM in January 1996. No comments have been received from USEPA.

TABLE 1-4

Summary Of Sites Removed From The RI/FS[(a)] Process
Jefferson Proving Ground
Madison, Indiana

Site No.	Site Name	Previous Findings	Rationale for Removal From RI/FS and Status of NFA[(b)] Document
32	Building 105 Locomotive Maintenance Pit and Former Lead Casting Area	Inspection of the locomotive maintenance pit revealed that the pit was completely enclosed by concrete and contained no drain. No visible cracks or evidence of a release was identified. The former lead casting area was found to contain lead in the vent hood. The Army subsequently dismantled and properly disposed of the vent hood eliminating this potential hazard to human health.	Since no evidence of contamination exists for Building 105 after removal of the vent hood, it was recommended that the site be removed from the RI/FS as a No Further Action site. A Technical Memorandum was prepared and submitted to the regulatory agencies in September 1995. Responses to agency comments were submitted in January 1996. Waiting for agency approval. Property has been transferred.
35	Former Leaking UST	Reports of a spill caused by the removal of a UST prompted a cleanup of this site. Near-surface soil samples in the surface water pathway were collected to evaluate if the cleanup was complete. Additionally, a field survey for VOCs was performed. TPHs were found to be present in the soils but at levels below state action criteria.	Contamination at Site 35 is surrounded from contamination from Site 12A (Building 602 Solvent Pit). It was recommended that further investigation of the site be performed as part of the Site 12A investigation and that Site 35 be removed from the RI/FS. A Tech Memo was submitted November 1995 and comments were received from IDEM in January 1996. No comments have been received from USEPA. Received IDEM approval letter for UST Closure.
36	No. 2 Oil Spill at Building 103	Facility personnel conducted a cleanup of the spill but confirmatory samples were not collected. A records search, personnel interviews, site inspection, a screening survey, and soil boring sampling were conducted at the spill site. Soil samples collected during the Phase I RI indicate TPH contamination in near-surface soils remains in a small area.	Due to the small size of the contaminated area exceeding IDEM cleanup levels (one sample), no further investigation was determined to be warranted. It was recommended that Site 36 be removed from the RI/FS and that any future investigation, if required, be conducted by the Army under the direction of the IDEM LUST/UST program. A Tech Memo was submitted November 1995 and comments were received from IDEM in January 1996. No comments have been received from USEPA. Building 103 received closure approval from IDEM.

TABLE 1-4

Summary Of Sites Removed From The RI/FS[a] Process
Jefferson Proving Ground
Madison, Indiana

Site No.	Site Name	Previous Findings	Rationale for Removal From RI/FS and Status of NFA[b] Document
37	Gasoline Station Building 118	Four tanks were removed from this site in 1990. A water sample collected from each of the four tank excavations indicated the presence of petroleum hydrocarbon contamination. During the Phase I RI, a field screening survey for VOCs was performed and groundwater monitoring wells were installed. Contamination was found to be present only in the immediate area of the tank excavations. Cleanup of these contaminated soils was completed in 1994.	A 25,000-gallon diesel UST remained in place during the Phase I RI. Additional investigation of this tank should be completed at the time of tank removal. Therefore, it was recommended that Site 37 be removed from the RI/FS and placed under the ongoing UST remediation program being conducted by USACE in accordance with IDEM requirements. A Tech Memo was submitted November 1995 and comments were received from IDEM in January 1996. No comments have been received from USEPA. Received IDEM approval letter for closure.
40	Discharge/Fill Pipe at Building 259	A records search and site inspection of the building and piping system indicated little likelihood of contaminant releases. A black tar-like substance on the ground adjacent to a pipe inlet was removed and a soil sample was collected immediately below the location of the substance. TPH contamination was present but confined to small area. Remediation of the soils was documented in a report to the IDEM.	The site was recommended for elimination from the RI/FS because the site has been remediated under the UST program being overseen by the IDEM LUST/UST branch. This is the agency responsible for monitoring regulatory compliance and establishing environmental procedures for USTs at JPG. A Tech Memo was submitted November 1995 and comments were received from IDEM in January 1996. No comments have been received from USEPA. Received IDEM approval letter for closure.
41	Building 281 Fuel Oil from former UST	Samples collected at the time of tank removal indicated residual TPH contamination in the excavation. Phase I RI soil boring sampling indicated that only one sample contained detectable TPH. Field screening for VOCs indicate that the contamination is localized near the excavation. The contaminated soil was subsequently remediated as part of the UST program.	Remediation was conducted under the ongoing UST program at JPG according to IDEM guidance and documentation of cleanup was submitted to the IDEM LUST/UST branch. As a result, it was recommended that Site 41 be removed from the RI/FS. A Tech Memo was submitted November 1995 and comments were received from IDEM in January 1996. No comments have been received from USEPA. Received IDEM approval letter for closure

TABLE 1-4

Summary Of Sites Removed From The RI/FS[a] Process
Jefferson Proving Ground
Madison, Indiana

Site No.	Site Name	Previous Findings	Rationale for Removal From RI/FS and Status of NFA[b] Document
43	Possible USTs or Wells at Artillery and Infantry Roads	A site inspection, utility survey and field scan for VOCs was conducted at this suspected UST site. No evidence of a UST could be found and it was thought that the lines in question were steam lines for a building heating system.	No further investigation of this site appeared to be warranted and a recommendation was made to remove Site 43 from the RI/FS as a No Further Action site. A Technical Memorandum was prepared and submitted to the regulatory agencies in September 1995. Responses to agency comments were submitted in January 1996. Waiting for agency approval.
44	Underground Concrete Vault Near Airport Rail Tracks		A Tech Memo was submitted November 1995 and comments were received from IDEM in January 1996. No comments have been received from USEPA. Received IDEM approval letter for closure.
45	Possible Unexploded Ordnance at the Airport	A records search, personnel interviews, and geophysical surveys were conducted for the suspected UXO at the airport. Although flares were known to have been tested at the site, the geophysical survey results indicate no buried UXO is present at this site.	Due to a lack of evidence that UXO is present, it was recommended that Site 45 be removed from the RI/FS as a No Further Action site. A Technical Memorandum summarizing these findings was submitted to the regulatory agencies in Dec 1995 and comments were addressed and submitted July 1996. Finalization is postponed until UXO removal activities are resolved. UXO clearance surveys occurred 1999 and site has been cleared for unlimited use. Residual soil sampling occurred on the airport property and a sampling report was submitted in the Airport FOST.
46	Possible Flare Test Sites at South End of Airport	Personnel interview failed to yield any information on past flare testing at the south end of the airfield. A site inspection showed there was no evidence of previous testing activities.	It was recommended that Site 46 be removed from the RI/FS due to the lack of evidence of previous testing. Future UXO-related issues at JPG will be addressed by the USACE as part of their facility-wide UXO surveys and studies. A Technical Memorandum summarizing these findings was submitted to the regulatory agencies in Dec 1995 and comments were addressed and submitted July 1996. Finalization is postponed until UXO removal activities are resolved. UXO clearance surveys occurred 1999 and site has been cleared for unlimited use. Residual soil sampling occurred on the airport property and a sampling report was submitted in the Airport FOST.

TABLE 1-4

Summary Of Sites Removed From The RI/FS[(a)] Process
Jefferson Proving Ground
Madison, Indiana

Site No.	Site Name	Previous Findings	Rationale for Removal From RI/FS and Status of NFA[(b)] Document
47	Wooded Area South of Airport	A visual site inspection, magnetometer scan, records search, and personnel interviews indicated that the surface area had been previously cleared for UXO. The magnetometer survey revealed no detectable buried metal associated with any of the crater-like pits in the area. It is unknown whether the depressions are even related to testing activities.	Because there was no evidence of testing and no indication of buried debris, Site 47 was recommended for removal from the RI/FS. The USACE also found no evidence of ordnance during a site survey conducted for the Archives Search Report. A Technical Memorandum summarizing these findings was submitted to the regulatory agencies in Dec 1995 and comments were addressed and submitted July 1996. Finalization is postponed until UXO removal activities are resolved. UXO clearance surveys occurred 1999 and site has been cleared for unlimited use. Residual soil sampling occurred on the airport property and a sampling report was submitted in the Airport FOST.
48	Ammunition Storage Igloos South of the Firing Line	All igloos south of the firing line were located and an inventory listing of stored items was obtained from facility personnel. A visual inspection of each igloo was conducted for evidence of any contaminant releases. There was no evidence from these inspections that indicated that a release had occurred and the potential for a release was determined to be low.	It was concluded that no further investigation of the storage igloos was required and a recommendation was made to remove Site 48 from the RI/FS as a No Further Action site. A Technical Memorandum was prepared and submitted to the regulatory agencies in September 1995. Responses to agency comments were submitted in January 1996. Waiting for agency approval.
49	Possible Explosive Ordnance South of the Firing Line	Three possible sites for UXO were identified from a previous records search. A file search, personnel interviews, and a visual inspection failed to yield evidence of UXO.	Since there was no evidence of UXO at the three areas that make up Site 49, it was recommended the site be removed from the RI/FS. Future UXO-related issues will be addressed by the USACE as part of a facility-wide UXO study. A Technical Memorandum summarizing these findings was submitted to the regulatory agencies in Dec 1995 and comments were addressed and submitted July 1996. Finalization is postponed until UXO removal activities are resolved. UXO Removal Actions occurred in 2000 and clearance for limited use has been approved. Residual sampling at the southeast parcel was conducted in Fall 2001. Sampling report was issued to Regulators February 2002.

TABLE 1-4

Summary Of Sites Removed From The RI/FS[a] Process
Jefferson Proving Ground
Madison, Indiana

Site No.	Site Name	Previous Findings	Rationale for Removal From RI/FS and Status of NFA[b] Document
50	Building 186 Wash Rack and Oil/Water Separator	A site inspection of the wash rack sump and the oil/water separator revealed that both were in good condition and in good working order. There were no cracks in the concrete that would allow a contaminant release. Wash rack runoff water was found to be appropriately handled through the oil/water separator and wastewater treatment plant. Operations were monitored under an NPDES permit.	Since the facility was found to be in compliance with the NPDES permit and in good condition, it was recommended that no further investigation is necessary under the RI/FS. As a result, a Technical Memorandum was prepared and submitted to the regulatory agencies in September 1995. Responses to agency comments were submitted in January 1996. Waiting for agency approval. Property transferred.

General Note:
Before sites are removed from the RI/FS, a public notice will be issued as required under CERCLA Section 117. (IND 8)

Footnotes:
(a) Remedial Investigation/Feasibility Study.
(b) No Further Action.

FIGURES

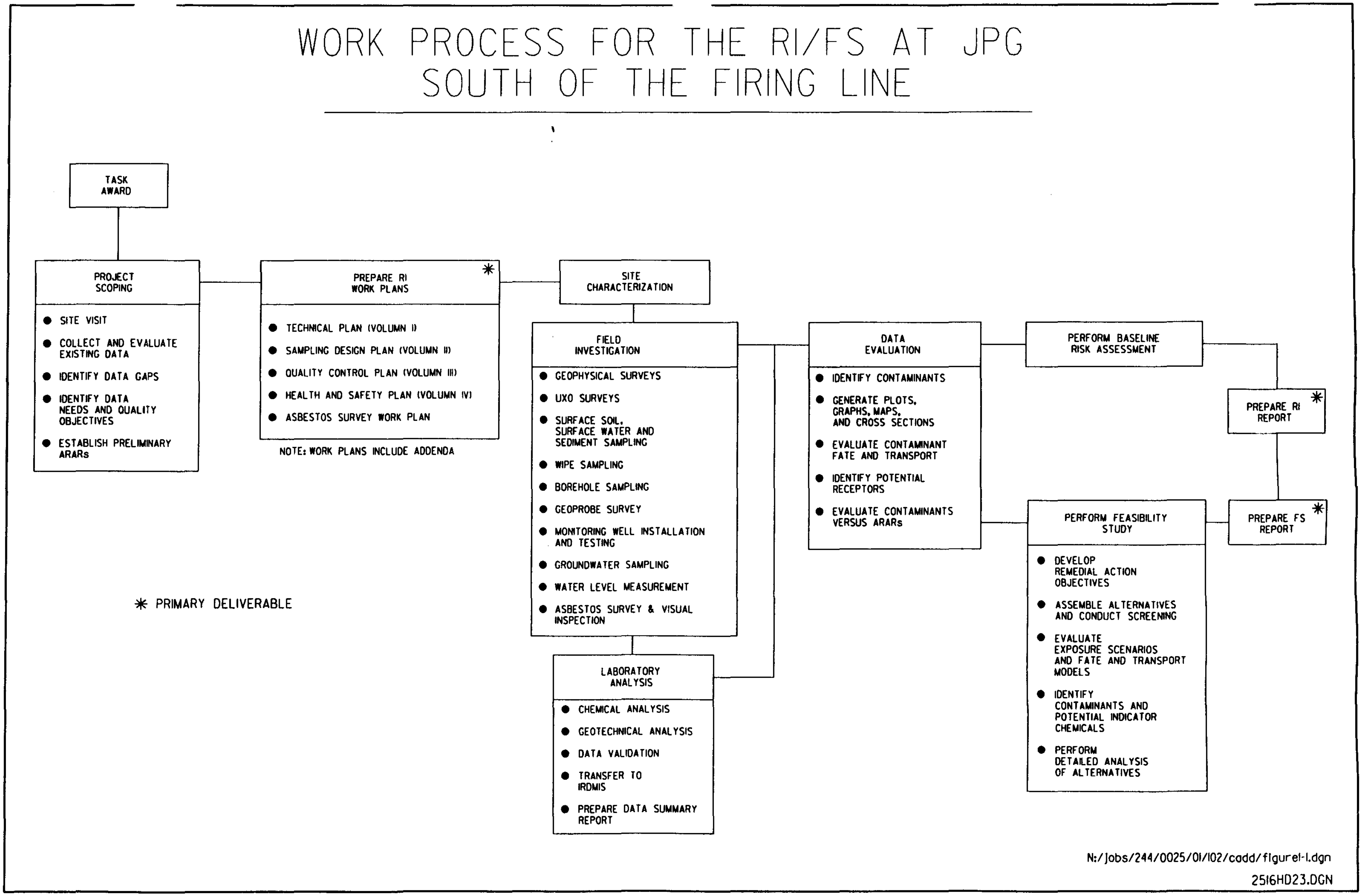


Figure 1-1. Work Process Diagram for the RI/FS

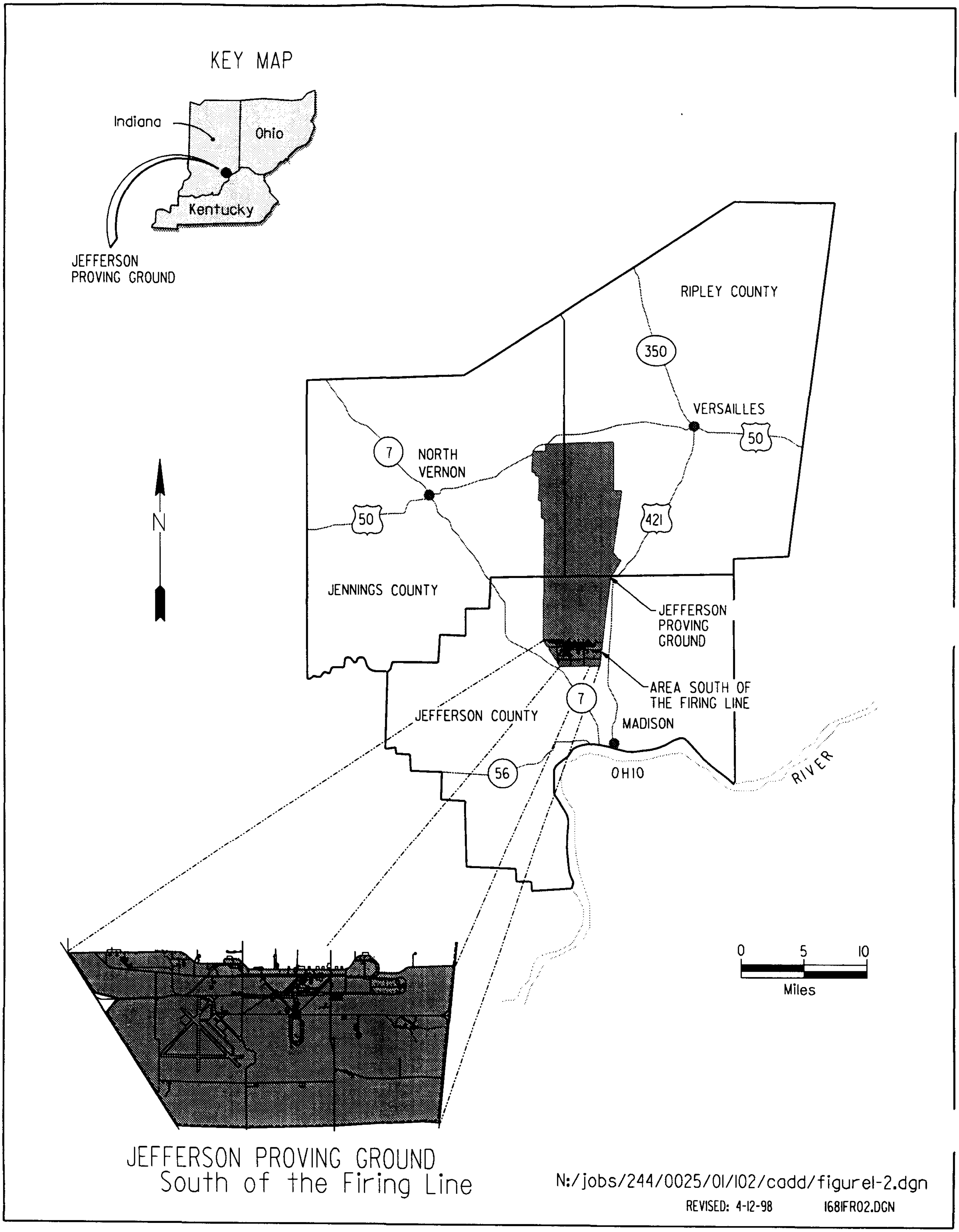
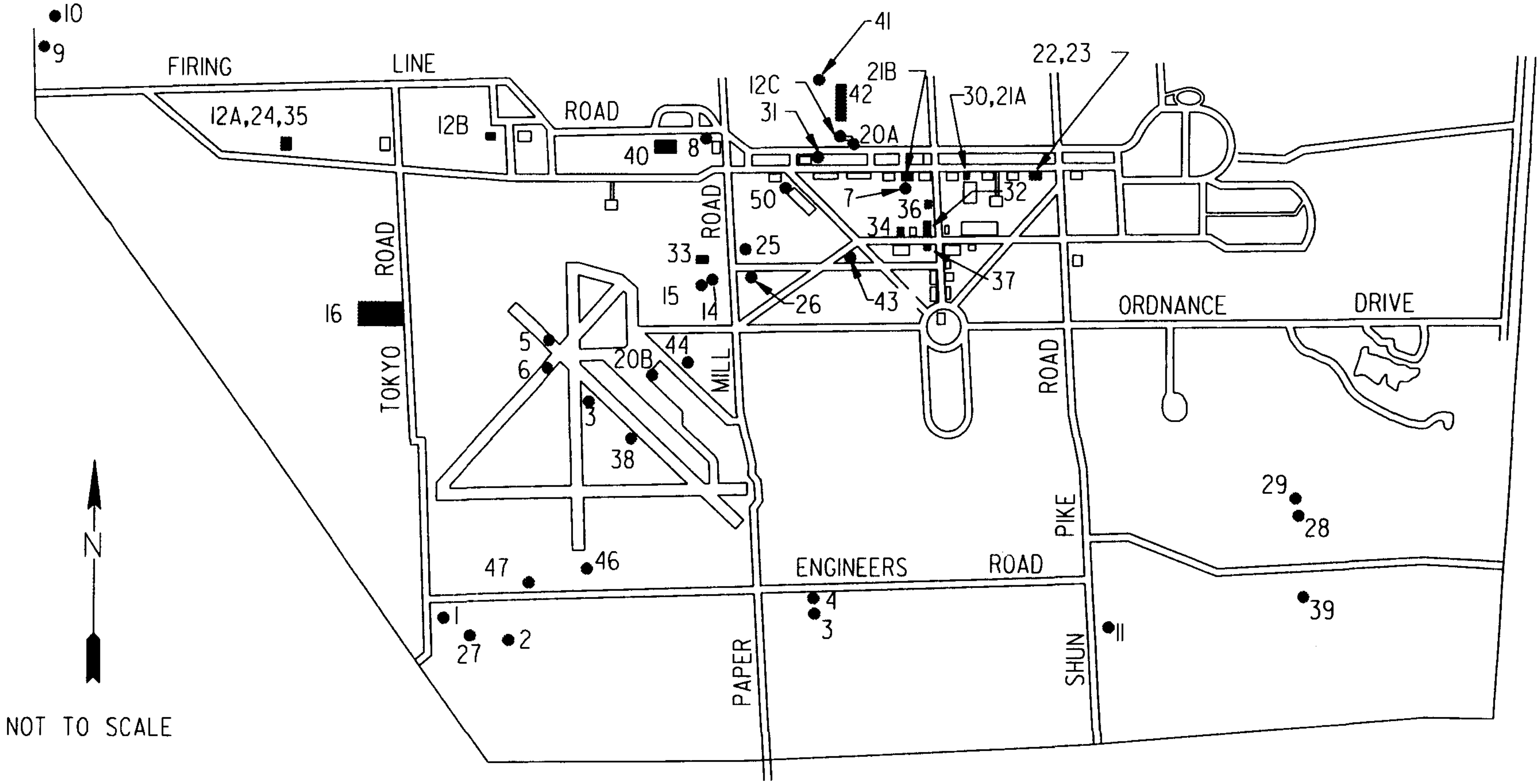


Figure 1-2. Location Map



Sites not identified on map:

17 Asbestos containing materials (potentially many locations)
18 Underground storage tanks (located at several sites)
19 Off-site water supply wells (not shown on map)
45 Possible explosive ordnance at airport (many locations)
48 Ammunition Storage Igloos south of the firing line (many locations)
49 Explosive ordnance south of the firing line (many locations)

N:/jobs/244/0025/01/102/cadd/figure1-3.dgn

NOTE: SITES NUMBER 30 & 21A BOTH REFER TO TEMPORARY STORAGE AREA (BUILDING 204)

REVISED: 5-6-98 1680FG02.DGN

Figure 1-3. RI/FS Sites South of the Firing Line

2.0 PHYSICAL CHARACTERISTICS OF JEFFERSON PROVING GROUND

2.1 PHYSIOGRAPHY

JPG is located along the southern fringe of the Central Lowlands Physiographic Province in the Till Plains section, which is characterized by young till plains without ~~no~~ pronounced morainic features. Topography of JPG is flat to rolling, with most relief due to stream incision. Seven streams and their tributaries drain the JPG area, generally coursing from northeast to southwest. The upland surface varies in elevation from approximately 840 feet above mean sea level (MSL) to 930 feet above MSL, with a slope of less than 1 degree to the southwest. The topography of the area south of the Firing Line is generally flatter than the area north of the Firing Line because of less stream incision (Figure 2-1). Three streams and/or their tributaries drain the area south of the Firing Line: Harberts Creek, Hensley Creek, and Middle Fork Creek.

2.2 CLIMATE

2.2.1 Precipitation

Precipitation at JPG is generally nonseasonal and varies from year to year. The fall months are usually the driest, and March and May are the wettest. The heaviest precipitation totals, as well as the rains of longest duration, are normally associated with low-pressure disturbances that generally move in a southwest-to-northeast direction through the Ohio Valley south of the installation. Snowfall usually occurs from November through March, though some snow has been observed in the months of October and April. As with rainfall, snow amounts vary considerably from year to year and from month to month. The average annual precipitation is 42 inches. Precipitation data are summarized in Table 2-1.

2.2.2 Seasonal Temperatures

Seasonal temperatures at JPG range from 100 degrees Fahrenheit (°F) or higher in the summer to 0^{o}F or lower in the winter. The average date in the spring for the last occurrence of temperatures as low as 32°F is late April, and the first occurrence in the fall is generally in late October. The average annual temperature is 54°F. Temperature data are summarized in Table 2-1.

2.2.3 Weather Patterns

The climate of extreme southeastern Indiana is of a variable nature because of the characteristic path of the low- and high-pressure systems that routinely pass through the vicinity and the occasional influx of warm, humid air from the Gulf of Mexico. Thunderstorms—occurring as separate air-mass cells, or squall lines, or widespread storm complexes with high rainfall intensities and damaging winds—are common during the spring

and summer months. Heavy fog, reducing prevailing visibility to 1/4 mile or less, occurs an average of 18 days a year. Such occurrences are rather evenly distributed from early spring through late summer. The prevailing direction of surface winds is southerly, and the velocity averages under 10 miles per hour.

The climate at JPG is mid-continental with frequent changes in temperature and humidity. During the summer, the temperatures average from the mid-70s to the mid-80s (^oF). On an average, the temperature exceeds 90^oF for 39 days a year. Winter temperatures generally range from 22 to 35^oF. The total annual precipitation is approximately 42 to 44 inches with nearly 50 percent of it occurring during the growing season. On the average, 28 days of the year have precipitation greater than or equal to 0.5 inch. The region of JPG is subject to tornadoes and severe thunderstorms. In 1974, tornadoes reportedly caused nine deaths and many injuries in the communities of Madison and Hanover. No damage was reported for JPG from these storms.

2.3 GEOLOGY

The JPG is located on the western flank of the Cincinnati Arch, a broad structural ~~feature~~ dome that separates the Illinois and Appalachian Basins (Figure 2-2). Most of JPG is covered by a veneer of Pleistocene glacial deposits that overlies Silurian and Devonian bedrock. Pleistocene and Holocene drainage systems have breached and eroded the Paleozoic bedrock across the regional outcrop patterns, particularly along the Ohio River drainage.

2.3.1 Bedrock Geology

Southeastern Indiana's position within the stable interior craton results in a relatively simple surface geologic expression. The Ordovician through Devonian sedimentary rocks in the JPG area were deposited on the eastern flank of the Illinois Basin. Subsequent uplift of the Cincinnati Arch has caused the beds to dip to the west-southwest at 20 to 25 feet per mile. Numerous unconformities are present within the section as a result of erosional events along the Cincinnati Arch.

Figure 2-3 shows the interpreted bedrock geology subcropping beneath the base of the glacial till. This map is based on bedrock cores collected by Rust E&I during drilling of the 1993 series of monitoring wells, cores collected by ESE during drilling of the 1988 series of monitoring wells, and lithologic data and natural gamma-ray logs from two U.S. Geological Survey (USGS) monitoring wells drilled in 1978. Also shown on this map are the locations of two cross sections, A-A' and B-B' (Figures 2-4 and 2-5). Both cross sections show the westerly dip of the bedrock formations and the highly variable thickness of the overlying glacial deposits. A noticeable feature near the middle of both cross sections is a steepening of the westward dip. The Louisville Limestone, which is about 50 feet thick in both well MW93-1 at location BKA and well MW93-4 at location BKB, thins and pinches out near this flexure.

Similar thickness variations in the Louisville Limestone have been documented in the outcrop west of JPG (Dawson 1940).

The monitoring well locations, total depths, and natural-gamma log traces are shown on the cross sections. Except for the USGS wells, the deepest formation penetrated is the Osgood Shale. Previous investigations had incorrectly stated that the monitoring wells at the Gate 19 Landfill and the Building 279 Solvent Pit encountered the Brassfield Limestone beneath the glacial till and that the Brassfield was the primary bedrock aquifer at JPG. The Brassfield is a thin (0 to 10 feet) limestone which underlies the Osgood Shale. The formations actually encountered beneath the glacial till at the Gate 19 Landfill and the Building 279 Solvent Pit were the North Vernon Limestone and the Laurel Dolomite, respectively.

The fence diagram shown in Figure 2-6 gives a three-dimensional perspective of glacial till and bedrock units encountered at the various sites. Noticeable features are the highly variable thickness of the glacial till and the pinching out of the Louisville Limestone.

The bedrock stratigraphy is summarized on the stratigraphic column shown in Figure 2-7. The Salamonie Dolomite is comprised of the Osgood and Laurel members. The Osgood Member consists of a medium to dark gray calcareous shale with dolomite and siltstone interbeds. The Osgood is conformably overlain by the Laurel Member, which consists of light gray to tan dolomite and dolomitic limestone with some thin shale beds in the upper half, especially near the contact with the overlying Waldron Shale. Chert nodules and chert beds occur in the upper part of the Laurel, and brachiopods and crinoids are locally common in the lower part of the Laurel (e.g., MW93-7). The Waldron Shale is predominantly ~~a greenish~~greenish-~~-~~gray calcareous shale with thin siltstone and limestone interbeds. The Waldron is mostly nonfossiliferous, but crinoid fragments are locally abundant. The Louisville Limestone is the uppermost Silurian formation in the JPG area, except in those places where it is absent beneath an unconformity. The Louisville consists of fine-grained, light gray to tan dolomitic limestone with some chert zones. The Louisville is mostly nonfossiliferous, except for a crinoid zone in the lower part. In monitoring well MW93-7, brachiopods were abundant in the lower part.

The Geneva Dolomite is the oldest Devonian formation in the JPG area. This formation is comprised of buff to medium brown, nonfossiliferous dolomite with minor wispy shale laminae. Large, white, secondary calcite crystals are randomly distributed through the fine-grained dolomite matrix. Overlying the Geneva Dolomite is the Jeffersonville Limestone, a light brown to tan fossiliferous limestone with minor chert nodules. Corals and stromatoporoids are common in the lower part, and brachiopods are common in the upper part. The youngest formation that is present south of the Firing Line is the North Vernon Limestone of Devonian age. The North Vernon is a medium gray to blue gray, fossiliferous limestone. Crinoids and stromatoporoids are the most common fossils.

Older rocks that were not encountered during drilling of the monitoring wells, but that are exposed along some stream drainages north of the Firing Line, are the Ordovician Dillsboro, Saluda, and Whitewater formations and the Silurian Brassfield Limestone. The Dillsboro consists of gray calcareous shale and thin limestone interbeds that form easily erodible slopes.

The Dillsboro is overlain by the Saluda Formation, a cliff ~~former~~ forming unit up to 60 feet thick. The Saluda is comprised primarily of fine-grained, silty dolomites with interbedded limestones.

The Whitewater Formation, which consists of limestone interbedded with thin shales and dolomites, is the uppermost Ordovician formation in the JPG area. The Brassfield Limestone, which ranges in thickness from 0 to 10 feet, overlies the unconformity at the Ordovician-Silurian boundary. Where the Brassfield is absent, the unconformable contact is picked at the base of the Salamonie Dolomite. The Brassfield is a coarsely crystalline, grayish-orange dolomite containing clasts and reworked fossils derived from the underlying Whitewater.

Fracturing of bedrock formations is noticeable in outcrops and in surface drainage patterns. Outcrops in the JPG area commonly have straight, near-vertical faces typical of fracture-controlled weathering. Fracture-controlled stream drainages are indicated by numerous straight segments with near right-angle meanders. Bedrock fractures are also indicated by lineaments detectable on aerial photographs. In his study of lineaments and fracture traces in the JPG area, Greeman (1981) found a strong west-southwest fracture-set orientation and a secondary northwest fracture-set orientation (Figure 2-8). The fracture orientation is consistent with the dip direction of the Cincinnati Arch, and is also consistent with the direction of compressional stress imparted to the bedrock during formation of the Cincinnati Arch.

2.3.2 Glacial Geology

~~The bedrock in the JPG area is covered by Pleistocene glacial deposits that range in thickness from a few feet to greater than 40 feet and average about 25 feet in thickness~~Pleistocene glacial deposits cover the bedrock in the JPG area. The thickness of the glacial deposits range from a few feet to greater than 40 feet and average about 25 feet. ~~The JPG area was covered by continental ice sheets~~Continental ice sheets covered the JPG area several times during Illinoian and pre-Illinoian stages of glaciation (Totten and Hay 1987). The Ohio River is considered to be the southern margin of continental glaciation in southeastern Indiana. The Wisconsinian ice advance did not reach as far south as JPG, but about 2 to 4 feet of Wisconsin loess mantles the Illinoian drift (Totten and Hay 1987).

Figure 2-9 shows a generalized profile of the glacial deposits encountered during the drilling of the soil borings and monitoring wells. This profile is typical of areas where the glacial thickness is about 25 feet or greater. In areas with thinner glacial cover, all or parts of the lower units are missing. Overlying the bedrock in most places is ~~a greenish~~greenish-~~-~~gray clay that commonly contains numerous chert, dolomite, and limestone rock fragments. Small (1/4-inch) limonite spherules are also common. Overlying the clay is ~~a greenish~~greenish-~~-~~gray silt that also contains numerous limonite spherules. A thin (< 1 inch), highly organic zone comprised of plant fragments overlies the greenish-~~-~~gray silt. This organic layer marks the boundary from noncalcareous below to calcareous above. A light to medium gray clay and/or very fine silt zone overlies the organic zone. Well preserved twigs, leaves, and other plant material are commonly found in this zone. The absence of coarse-grained material in this unit

contrasts strongly with ~~all~~ the other glacial deposits encountered. This unit was probably deposited in an ice-margin lake.

Overlying the gray clay and/or silt zone is a silt deposit with some gravel. The color of the unit grades from gray in the lower part to an oxidized brownish yellow to brown in the upper part. This unit is probably the Illinoian age till described by Totten and Hay (1987). Rare sand and gravel lenses are discontinuous, even between closely spaced wells. The top of the silt with gravel unit marks a boundary from calcareous below to noncalcareous above. The uppermost zone is typically a mottled brownish yellow and light gray silt with variable clay and sand content. A saturated zone of 1 to 2 feet commonly occurs at the base of this unit just above the contact of the silt with the gravel. This zone appears to be related to the supraglacial pond deposits and the Wisconsinian loess deposits mantling the Illinoian drift.

2.4 SOILS

The soils covering most of JPG south of the Firing Line belong to the Cobbsfork-Avonburg map unit (Figure 2-10). These soils are present on upland glacial drift plains that are characterized by smooth topography. Slopes range from 0 to 4 percent. Along the drainages of the upland plains are soils of the Cincinnati-Rossmoyne map unit. The slopes of this soil group range from 0 to 45 percent. The relationship of these soil groups to parent material and topography is illustrated in Figures 2-11 and 2-12. Both soil groups are formed in a thin mantle (up to 13 feet) of Wisconsinian loess and in the underlying Illinoian glacial drift.

2.4.1 Cobbsfork-Avonburg Soil Group

The nearly level, poorly drained Cobbsfork soils have a seasonal high water table and are located on the broadest tabular divides, where the glacial drift is thickest. An example of areas covered by this soil group is the airport and areas northwest and east of the airport. Typically, these soils have surface and subsurface layers composed of grayish-brown silt loam; both layers are about 6 inches thick. The upper part of the subsoil is a light gray to light brownish gray, mottled silt loam; the middle part is a light brownish gray, mottled, firm silt loam; and the lower part is a yellowish brown, mottled silt loam and strong brown clay loam.

The nearly level to gently sloping, somewhat poorly drained Avonburg soils have a seasonal high water table and are located on relatively broad tabular divides and upper back slopes. Examples of areas that are covered by this soil group are the areas flanking the Harberts Creek and Middle Fork Creek drainages. These soils have a very low permeability fragipan in the subsoil. Commonly, they have a dark grayish brown silt loam surface layer about 10 inches thick. The upper part of the subsoil is a yellowish brown, mottled, friable silt loam and a light brownish gray, mottled, friable silty clay loam. The middle part of the subsoil is a light brownish gray, mottled, very firm silt loam fragipan; and the lower part is a light brownish gray, mottled, friable silt loam.

2.4.2 Cincinnati-Rossmoyne Soil Group

The nearly level and gently sloping, moderately well drained Rossmoyne soils are located on summits, shoulder slopes, and upper back slopes. Examples of areas that are covered by this soil group are areas flanking the Harberts Creek and Middle Fork Creek drainages. They have a low permeability fragipan in the subsoil. Typically, they have a dark brown silt loam surface layer about 8 inches thick. The upper part of the subsoil is yellowish brown, mottled, friable silt loam; the middle part is a yellowish brown, mottled, very firm and brittle clay loam fragipan; and the lower part is a strong brown, mottled, firm silty clay loam.

The gently sloping to moderately sloping, well drained Cincinnati soils are located on summits, shoulder slopes, and back slopes. They have a low permeability fragipan in the subsoil. Typically, they have a dark brown silt loam surface layer about 6 inches thick. The upper part of the subsoil is yellowish brown, mottled, firm clay loam; the middle part is a yellowish brown, mottled, very firm and brittle clay loam fragipan; and the lower part is a strong brown, mottled, firm silty clay loam.

The Holton soils are a minor soils series present in the Cincinnati-Rossmoyne-Hickory Soil Group. This series consists of deep, somewhat poorly drained, moderately permeable soils on flood plains. These soils formed in alluvium derived from soils that formed in glacial drift. Examples of areas that are covered by this soil group are the bottoms of the Harberts Creek and Middle Fork Creek drainages. Slopes range from 0 to 2 percent. The Holton soils generally are adjacent to Cincinnati soils. In a typical profile, the surface layer is about 8 inches of grayish brown loam. The subsoil is about 24 inches thick. The upper part is dark brown, friable loamy sand and the lower part is a dark gray, friable fine sandy loam.

2.4.3 Geotechnical Soil Analyses

Geotechnical soil analyses (physical testing) were performed on 40 borehole and monitoring well samples during Phase I field activities. The results of these analyses are presented in Appendix A. The samples ranged in depth from 0.3 foot to 38.5 feet. Monitoring wells installed at the Burn Area for Explosive Residue (Site 11) and the Building 118 Gas Station (Site 37) were screened in the glacial till. Biased samples from sandy zones were collected from the monitoring wells at these sites to help evaluate the hydraulic conductivity of glacial till aquifers. Table 2-2 shows the grain-size distribution for each of the 40 samples, the mean grain size of all samples, and the mean grain size of the sample population excluding the biased sandy and gravelly samples. Sand and gravel lenses within the glacial till are rare and discontinuous, even between closely spaced wells. Therefore, the mean grain size of the sample population excluding the sandy and gravelly samples is most representative of the glacial till composition. The glacial till is comprised predominantly of silt (52 percent) with subequal amounts of sand (26 percent) and clay (21 percent). Gravel is a minor constituent (1 percent).

2.4.4 Unified Soil Classification System

~~All s~~Soil samples were logged according to the Unified Soil Classification System (ASTM D 2487-90) Standard Test Method for Classification of Soils for Engineering Purposes. This classification system identifies three major soil divisions: coarse-grained soils, fine-grained soils, and highly organic soils. These three divisions are further subdivided into a total of 15 basic soils groups as follows:

- Course-Grained Soils
  - GW—Well graded gravels or gravel-sand mixtures
  - GP—Poorly graded gravels or gravel-sand mixtures
  - GM—Silty gravels, gravel-sand-silt mixtures
  - GC—Clayey gravels, gravel-sand-clay mixtures

- Fine-Grained Soils
  - SW - Well graded sands or gravelly sands
  - SP - Poorly graded sands, sand-silt mixtures
  - SM - Silty sands, sand-silt mixtures
  - SC - Clayey sands, sand clay mixtures
  - ML - Inorganic silts and very fine sands, rock flour, silty or Clayey sands or clayey silts with slight plasticity
  - OL - Organic silts, silt-clays of low plasticity
  - MH - Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
  - C - Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
  - OH - Organic clays of medium to high plasticity, organic silts
  - CH - Inorganic clays of high plasticity, fat clays

- Highly Organic Soils
  - PT - Peat or other highly organic soils

Soil samples were classified on the borehole logs according to one of the above groups and descriptive observations were noted.

2.5 SURFACE WATER HYDROLOGY

JPG has an extensive system of surface-water resources, including ponds, lakes, streams, and wetland areas, along with numerous ephemeral streams, ponding sites, and wet areas. These drainages appear to have developed along major fracture lineaments (Greeman 1981).

Surface water in the vicinity of JPG is not used for domestic drinking water. The primary uses of surface water are for recreation and livestock watering. The surface-water quality is somewhat better than the groundwater quality, but the supply is limited as many streams are

quite small and have intermittent flows. The surface water, similar to the groundwater, is classified as a calcium-magnesium-bicarbonate water; however, the total dissolved solids (TDS) content is less than 200 parts per million (ppm) as compared to the average groundwater TDS of over 600 ppm. This reflects the dilution of the groundwater base flow contribution by relatively pure rainwater.

This discussion of surface-water features is focused on the drainages that are related to the area south of the Firing Line at the facility even though there are seven major streams that drain JPG. Surface water at JPG flows along northeast-to-southwest-trending stream drainages, which eventually join the Muscatatuck River west of JPG. Figure 2-13 shows the major stream drainages at JPG. The streams are part of the White River Basin (a sub-basin of the Wabash River Basin, which is a sub-basin of the Ohio River). From the northern end to the southern end of JPG, these streams are: (1) Otter Creek, (2) Graham Creek, (3) Little Graham Creek, (4) Marble Creek, (5) Big Creek, (6) Middle Fork Creek, (7) tributaries to Hensley Creek, and (8) Harberts Creek. The streams crossing JPG are not part of the National Wild and Scenic River System and ~~have no~~ do not have segments that are listed in the Nationwide Rivers Inventory.

South of the Firing Line, Hensley and Harberts Creeks flow with an average of less than 25 cubic feet per second (cfs). The very southern portion of JPG, including the airfield, the residential area, igloo loop, and the Kreuger lake area, is drained by Harberts Creek. Hensley Creek drains the wooded area south of Firing Line Road and west of Tokyo Road.

Just north of the Firing Line is Middle Fork Creek, which has an approximate average flow of 50 cfs. The majority of surface-water runoff associated with the Gate 19 Landfill and other sites located near the Firing Line is eventually carried by Middle Fork Creek.

Hensley, Harberts, and Middle Fork Creeks flow to the west-southwest. The channels created by these creeks are incised into the till or bedrock, or both. At some locations along these creeks, the depth of channel incision is deep enough that groundwater intercepts the creek. At these locations, the creek is gaining water from the discharge of groundwater to the creek. At other locations along the creek, the ~~ground~~water table remains below the creek and the creek may lose water to the groundwater system. The interaction of the incised creek channels on the groundwater system is discussed in more detail in Section 2.6.3.

There are at least 10 ponds or lakes on the installation, varying in size from less than 1 acre to 165 acres. Most are stocked with various kinds of game fish by the Indiana Department of Natural Resources (IDNR). The largest lake is Old Timbers Lake in the northeastern corner of JPG at the headwaters of Little Otter Creek, which drains into Otter Creek. This lake is approximately 165 acres in size. The second largest lake is Krueger Lake, which covers some 8 acres of the Harberts Creek drainage basin in the southeastern portion of the installation. Krueger Lake is stocked with fish and used for recreation. Even though it is south of the Firing Line, it is not near any of the RI/FS sites. Several smaller ponds and surface impoundments are also present on the installation.

2.6 HYDROGEOLOGY

2.6.1 Groundwater Use

The groundwater under JPG is generally of poor quality and is not used for drinking purposes or for other purposes in any significant capacity. The drinking water at JPG is obtained from the City of Madison Municipal Supply Systems and the Canaan Water System. The City of Madison withdraws its drinking water from the alluvial deposits in the Ohio River Valley approximately 5 miles south of JPG.

The ambient groundwater quality throughout Indiana is variable and dependent on the aquifer system, geologic setting, and depth of the water bearing formation. In general, the incidence of mineralized or saline groundwater increases rapidly at bedrock depths below 300 feet. The chemical quality of the potable water being used is adequate to meet the basic needs for household, municipal, industrial, and irrigation uses; however, the water is normally very hard, exceeding 180 ppm hardness. Other constituents which often impact natural water quality include iron, manganese, sulfate, fluoride, and hydrogen sulfide. Most of Indiana's groundwater contains more than the 0.3 ppm aesthetic threshold for iron. Sulfate levels are dependent on the sulfide mineral content of the bedrock and the redox potential of the groundwater, with the highest sulfate concentrations occurring where abundant sulfide minerals such as pyrite come in contact with oxygenated groundwater.

In the vicinity of JPG, most of the potable water is obtained from the alluvial aquifer along the Ohio River Valley. The S~~s~~tate of Indiana reports that there are 21 municipal water supply wells in Jefferson County, 6 in Ripley County, and 0 in Jennings County, the 3 counties associated with JPG (IDEM 1989). The State of Indiana also reports that the non-community water supply wells in the 3 counties number 7 in Jefferson County, 10 in Ripley County, and 3 in Jennings County. ~~They also report that t~~There are less than 4,000 wells per county in these 3 counties, including ~~all~~ drilled or hand dug wells. It is assumed that only the wells tallied as water supply wells above are used for potable water supplies. There are very few wells in the vicinity of JPG that are used for domestic water supplies, thus limiting the potential for the groundwater contamination pathway to be completed for the human ingestion scenario. A review of state well records identified only one well within 1 mile downgradient from the area south of the Firing Line at JPG. This well is located 100 feet west of the east boundary and 1,700 feet south of north boundary of section 36 of township T5N, R9E.

The bedrock aquifer in the southern portion of JPG appears to contain a calcium-magnesium-bicarbonate type groundwater with a TDS content of over 600 ppm. Sodium and sulfate are the other two predominant dissolved species. The average iron content is 0.5 ppm. In general, the water is relatively high in TDS, is of poor quality, and would be marginal as a potable water source.

The groundwater ~~perched~~ in the glacial till also appears to contain a calcium-magnesium-bicarbonate-type groundwater with TDS over 400 ppm. Sodium and sulfate are the ~~other~~ two

predominant dissolved species. The iron content is 0.08 ppm. In general, the glacial till groundwater is relatively high in TDS, is of poor quality and low productivity, and would be marginal as a potable water source.

2.6.2 Hydrostratigraphic Units

There are three hydrostratigraphic units in the area of JPG: (1) the unconsolidated glacial deposits, (2) the underlying Silurian and Devonian limestones and dolomites, and (3) the alluvial deposits in the Ohio River Valley south of the installation.

2.6.2.1 Unconsolidated Glacial Deposits. The unconsolidated glacial deposits range in thickness from 4 to 43 feet thick and are comprised predominantly of till. Groundwater movement within the till is characteristically slow because of the low hydraulic conductivity of the till and the relatively flat hydraulic gradients.

Slug tests completed from recently installed wells screened within the till resulted in hydraulic conductivities ranging from 2.89×10^{-5} to 8.40×10^{-5} cm/sec. Previous slug test data (only two tests were completed) set the hydraulic conductivity range for the till at 1.08×10^{-5} to 3.47×10^{-5} cm/sec (ESE 1989). The water table within the till loosely conforms to the configuration of the surface topography. The regional groundwater flow in the till, therefore, is in roughly the same direction as the surface water drainage, which is toward the west-southwest over most of the installation. Locally, ~~however,~~ the groundwater flow in the till can move toward the nearest surface-water drainage, or toward the nearest vertical fractures or joints in the till that transmit the water to the bedrock aquifer.

The glacial deposits can be divided into three distinct units based on soil type and cementation. Overlying the bedrock is an older (Kansan), noncalcareous till that is characterized by limonitic spherules (called pisolitic geothite by Totten and Hay 1987). This unit ranges in thickness from 2 to 9 feet depending on the location. The thickness of the older till can vary dramatically at ~~each~~ JPG~~site~~, and is dependent on the irregular top-of-bedrock surface. Overlying the older till is the Illinoian till, a calcareous till that can often be divided into two units, an upper unit, which is an orange-brown color, and a lower unit, which is a gray color. The orange-brown color is attributed to oxidation, whereas the gray color is attributed to reducing conditions. The calcareous cement in the Illinoian till makes it very hard; Geoprobe holes from the Phase I RI often encountered refusal near the top of the till. The range of thickness of the Illinoian till across the area south of the Firing Line at JPG is from approximately 4 to 25 feet with an average thickness of 15 feet. The top of the Illinoian till is typical from 5 to 12 feet below ground surface. Overlying the Illinoian till are noncalcareous clayey silts that are interpreted to be supraglacial pond deposits and Wisconsinian loess deposits mantling the Illinoian till. A saturated zone approximately 1 to 2 feet commonly occurs at the base of this unit just above the contact with the Illinoian till. The contact between the Illinoian till and the overlying glacial deposits can be easily picked by the abrupt change from calcareous to noncalcareous materials.

Results of sieve analysis indicate that there ~~is~~ are no apparent textural differences between the Illinoian and older tills. In rare instances, sand layers of variable thickness are encountered in the tills. These sand layers are discontinuous and usually not laterally extensive. Vertical and subvertical fractures, which are stained yellow-brown to dark red-brown and purplish-brown by oxides, are found to be common throughout the till. Two fracture sets were identified in the weathered till: small-scale fracturing (range of fracture spacing is typically 10 mm) and large scale fracturing (range of fracture spacing is 20 mm to over 630 mm). Both types of fractures appear to impart a secondary permeability to the till as evidenced by the presence of free water.

Matrix hydraulic conductivity, often termed intergranular hydraulic conductivity, is the hydraulic conductivity of a material devoid of fractures, root channels, and worm bores. Results indicate that the intergranular hydraulic conductivity of the tills at JPG are in the range of 3.4 x 10^{-8} cm/sec to 9.8 x 10^{-8} cm/sec. Small-scale fractures have an apparent hydraulic conductivity of approximately 5 x 10^{-7} cm/sec, and large-scale fractures have an apparent hydraulic conductivity of approximately 2 x 10^{-5} cm/sec. The till that is devoid of fractures has a similar hydraulic conductivity as the weathered till matrix (approximately 1 x 10^{-8} cm/sec). Hendry's investigation (1988~~2~~) shows that random testing of tills without detailed field inspection may lead to erroneous conclusions regarding the hydraulic conductivity of a till. In many instances, detailed hydrogeologic studies may be required to determine the bulk hydraulic conductivity of tills.

Studies by Sharp (1984) in dissected till plains in North-Central Missouri, which are similar to the glacial till at JPG (dissected till plains covered by glacial drift and loess), show that drift hydraulic conductivities are in two distinct groupings. Laboratory tests of cuttings and cored material averaged between 1 x 10^{-8} and 1 x 10^{-9} cm/sec, while the 14 field-measured values averaged 6.9 x 10^{-5} cm/sec. This four to five order of magnitude increase is caused by joints and sand or gravel lenses within the clay-rich till. The actual permeability of the sand lenses or joints cannot be directly estimated by means of slug testing since such a test gives only an average value and, thus, the lowest possible value for the permeable portion. If only 10 percent of the piezometer penetrates permeable zones, then transmissivity of these zones must be an order of magnitude greater, so the 1 x 10^{-4} to 1 x 10^{-3} cm/sec is a conservative hydraulic conductivity for these zones. This fact has significant implications for groundwater movement in the glacial till at JPG. It is likely that groundwater flow in the glacial till is concentrated in fractures and in sand and gravel lenses, with the bulk of the matrix experiencing very little groundwater movement.

Groundwater flow within the glacial till may also be affected by the threshold gradient effect. The threshold gradient is the gradient that is required to initiate water movement in saturated media. In sands and gravels, the threshold gradient is zero. The threshold gradient in clayey deposits may be greater. From laboratory experiments on clays collected from Ontario, Tavenas (Tavenas et al. 1983) found the threshold gradient to be 0.07. The threshold gradient effect can significantly affect groundwater flow rates, and is why previous investigators at JPG assumed that perched groundwater existed at JPG. ~~(this is, among other factors, why perched conditions may develop with variably saturated conditions down the soil profile). An example~~

~~of such a perched zone is the saturated zone overlying the top of the calcareous Illinoian-age till at JPG.~~

2.6.2.2 Silurian and Devonian Limestone~~s~~ and Dolomite~~s~~. The shallow bedrock groundwater in the vicinity of JPG is primarily stored in the bedrock hydrostratigraphic unit comprised predominantly of Silurian and Devonian limestone~~s~~ and dolomite~~s~~ members. Of the seven units shown in Figure 2-7, the Louisville Limestone and the Laurel Member of the Salamonie Dolomite are the principal shallow-bedrock groundwater-producing units south of the Firing Line at JPG. Thicknesses of these deposits range from 0 to 43 feet and 25 to 45 feet thick, respectively. Separating the Louisville and the Laurel is the Waldron Shale, which ranges from 4 to 12 feet thick and acts as an aquitard.

The ~~groundwater in the~~ bedrock aquifer is unconfined to semi-confined (USGS Open File Report 90-151) and is recharged by ~~surface flow~~infiltration of precipitation to the bedrock aquifer concentrated along fractures within the glacial till, and in areas where the creek channels are losing water to the groundwater system. Groundwater in the bedrock beneath JPG shows a direct and rapid response to changing climatic conditions as evident by the hydrograph for USGS monitoring well MW-5 (Figure 2-14). This well is an open-hole completion in bedrock and is cased and grouted through the glacial till. In the absence of fractures in the till extending to the bedrock, the groundwater will appear confined, with artesian potentiometric head rising in monitoring wells to within 10 feet or less ~~of~~ below the ground surface ~~after a well is completed.~~within the glacial till.

Theoretical network flow modeling suggests that important patterns of selective enlargement occur even during the very early laminar flow (bedding plane) stages of aquifer development (Groves 1993). In the absence of variations in initial fracture size, major flow paths develop along the most direct path between entrance and exit, and those passages most closely aligned with the hydraulic gradient are also favored. Thus, at JPG the primary fracture set oriented from the northeast to southwest is probably the preferred -local flow path for shallow bedrock groundwater because these fractures most closely align with the apparent horizontal~~lateral~~ hydraulic gradient (Figures 2-8 and 2-15).

Groundwater movement in the Louisville Limestone and Laurel Dolomite is ~~largely~~ likely dependent upon secondary permeability features, including the density and size of fractures. The most productive wells in the JPG area are located at intersections of regional fracture lineaments, indicating that groundwater flow in the bedrock aquifer is primarily controlled by fractures (Greeman 1981). Theoretical modeling investigations recently performed on the early stages of karst aquifer development (Groves 1993) reveal that under the influence of geologically reasonable carbon dioxide pressures and head gradients, the minimum diameter of flow paths (fractures) that will form into conduits are on the order of 100 µm, while those only a few times larger will form conduits easily. Competition for flow between potential flow paths is, thus, a strong function of initial fracture size. Many of the fractures observed in the limestone core obtained from monitoring well borings at JPG were 100 µm or larger and showed evidence of solutioning.

Outcrops of the limestone bedrock show vertical joints and fractures, which must result in some downward migration of water from the glacial till. For instance, a roadcut west of JPG, which exposes the entire section of Jeffersonville Limestone, revealed horizontal bedding planes, fractures separated by approximately 3 feet, and vertical fractures on 10-foot spacings.

Based on information gained from this roadcut, groundwater probably movement is likely controlled s downgradient by a combination of lateral flow along bedding planes and vertical flow along fracture zones.

Karst features such as sinkholes have been recognized along the Otter Creek and Big Graham Creek drainages a few miles west of JPG; however, no karst features have been mapped on JPG (Greeman 1981). Observations made by field personnel during the RI indicate that some minor karst features aremay -have developing developed in and near some of the sites. For example, frequent encounters with voids and lost circulation zones were encountered during bedrock drilling, and solutioned out fractures were observed in the rock core recovered from some well borings.

2.6.2.3 Ohio River Alluvial Deposits. The third hydrostratigraphic unit does not underlie JPG. This unit consists of the alluvium of the Ohio River Valley and is significant because it is the only major source of groundwater in the region that is available for domestic use. However, the nearest occurrences of this hydrostratigraphic unit are 5 miles south of JPG. Because the bedrock groundwater flow direction at JPG is generally to the west-southwest, and the north-south stream drainages are located west of JPG, it is very unlikely that any potential contamination present in groundwater at JPG could ever reach the Ohio River alluvial aquifers.

2.6.3 Groundwater Flow Characteristics

Geographically, theThe –east boundary of JPG is situated on a north-south trending topographical high that roughly coincides with the trace of Highway 421. This is evident by the lower topographic elevations east and west of the east property margin. This topographic high divides the drainage of surface water and groundwater. On the west side of the high, local groundwater flow is toward the west to Middle Fork, Hensley, and Harberts Creeks, and -then south to the Ohio River. On the east side of the high, local groundwater flow is toward the east to West Fork then south to the Ohio River. The topographic high located along the east boundary of JPG is the only identified upland area also indicates in the vicinity of JPG that could provide the recharge to the local bedrock aquifergroundwater system is from surface infiltration., since there are no other highlands that could supply groundwater to the system. However, regional groundwater flow is likely toward the southwest, eventually discharging into the Ohio River, the dominant hydrologic feature in the region.

The water-level elevations of wells screened in bedrock (Table 2-3) loosely conform to the configuration of the surface topography. Surface water elevations from creek drainages were used to supplement well data. (EPA28) Two potentiometric surface maps compiled from water level elevation data measured in November 1995 and December 1996 indicate the apparent direction of bedrock groundwater flow to generally be west-southwest, which coincides with

the direction of surface drainage and regional dip of the bedrock (Figures 2-16 and 2-17). A strong fracture-set orientation is also directed to the southwest (see Figure 2-8). Groundwater elevations near the east boundary are typically around 890 feet, while the elevations along the western boundary of JPG are typically around 820 feet. This gives an average linear groundwater gradient from east to west across JPG of approximately 0.003 ft/ft.

The groundwater potentiometric contour maps were developed using groundwater elevation data from ~~all~~ the monitoring wells at JPG, and the topographic data shown on the map. In areas where ~~no~~ groundwater elevation data were not available~~, the~~, the elevation of the bottom of incised creek channels were ~~used as an indication of~~assumed to coincide with the top of the water table. ~~where the groundwater table may be if a well were located near the creeks.~~ It is understood that Figures 2-16 and 2-17 are not entirely accurate given the number of assumed data points used in the creek drainages to construct the maps. However, the creeks are perennial streams, which indicates groundwater interaction between the streams and the underlying aquifer.~~it is known that the creeks do contain water even during dry parts of the season. Since there is no topographic high to the east that could supply this water, it is assumed that the creeks receive water from the groundwater system. The groundwater may discharge to these creeks where the regional dip of the groundwater surface is less than the gradient of the creek, causing the bottom of the creek bed to intercept the groundwater table. At these locations, groundwater may discharge to the creek.~~

Generally, the groundwater flow direction at JPG is to the ~~west~~ southwest, which is in ~~good~~ agreement with the regional groundwater flow direction documented in *USGS Open File Report 90-151* (Figure 2-18).

2.6.3.1 Aquifer Test Results. Slug and pumping tests performed on wells throughout JPG have provided information on the hydraulic conductivity of the bedrock aquifer and the overlying glacial till.~~perched groundwater.~~ Slug tests were performed on the majority of the wells following installation. Specifically, a total of 56 wells were slug tested, and of these, 51 were screened in bedrock and 5 were screened ~~entirely~~ in till deposits. Slug tests were performed on 6 wells screened in the North Vernon Limestone, 10 wells screened in the Jeffersonville Limestone, 1 well screened in the Geneva Dolomite, 12 wells screened in the Louisville Limestone, 22 wells screened in the Laurel Dolomite, and 5 wells screened in the till deposits. Three pumping tests were performed~~; these tests were performed~~ at the former solvent pit sites, Building 602 (Site 12A), Building 612 (Site 12B), and Building 279 (Site 12C). The hydraulic conductivity results derived from the slug and pumping tests are presented below.

2.6.3.1.1 Slug Test. The results of the slug tests performed on individual wells place the range of hydraulic conductivity values between 3.30×10^{-6} cm/sec and 3.86×10^{-3} cm/sec. These values can be further divided by grouping them according to formation. The range of hydraulic conductivity results derived from slug tests are presented in Table 2-4, and include 2.89×10^{-5} to 8.40×10^{-5} cm/sec for the clayey silt deposits above the Illinoian till; 5.89×10^{-5} to 1.61×10^{-3} cm/sec for the North Vernon Limestone; 3.3×10^{-6} to 3.45×10^{-3} cm/sec for the Jeffersonville Limestone; 1.73×10^{-5} cm/sec for the Geneva Dolomite (only one value); 1.25 x

10^{-5} to 4.4 x 10^{-4} cm/sec for the Louisville Limestone; and 2.02 x 10^{-5} to 2.75 x 10^{-3} cm/sec for the Laurel Dolomite. From these range of values, the average value for ~~each~~ the rock units based on slug test results are as follows:

- Clayey Silt—~~6.1~~5.79 x 10^{-5} cm/sec
- North Vernon Limestone—~~5~~3.55~~.5~~ x 10^{-4} cm/sec
- Jeffersonville Limestone—~~5.8~~1.39 x 10^{-4} cm/sec
- Geneva Dolomite—1.73 x 10^{-5} cm/sec (only one well screened in the Geneva was slug tested)
- Louisville Limestone—~~1.5~~9.38 x 10^{-54} cm/sec
- Laurel Dolomite—~~3.3~~1.43 x 10^{-4} cm/sec

2.6.3.1.2 Pumping Tests. The results of pumping tests indicate a range of hydraulic conductivity values for the bedrock units underlying the site. At the three sites where pumping tests were performed (Building 602, Building 617, and Building 279), the values for hydraulic conductivity ranged from 9.7 x 10^{-5} to 1.67 x 10^{-2} cm/sec. The results of these tests are applicable to the Jeffersonville Limestone, Geneva Dolomite, Louisville Limestone, and the Laurel Dolomite. Based on the pumping tests, the following average hydraulic conductivity values were derived for the corresponding rock unit(s):

- Jeffersonville Limestone (Bldg 602)—5.5 x 10^{-4} cm/sec
- Jeffersonville Limestone (Bldg 617)—6.0 x 10^{-3} cm/sec
- Laurel Dolomite (Bldg 279)—1.4 x 10^{-4} cm/sec

The pumping tests were performed on existing wells, using one centrally located well for the pumping well and the remaining wells for observation wells. Wellpoints installed in the ~~perched groundwater zone above the Illinoian~~ glacial till were also monitored during the tests.

The extraction of groundwater from the bedrock aquifer ~~did~~ produced drawdown in the ~~perched groundwater zone~~glacial till wells, indicating a hydraulic connection between the till and bedrock hydrostratigraphic units. This ~~The drawdown in the perched zone from the pumping test in the bedrock aquifer further~~ supports the conceptual model that the till and bedrock are hydraulically ~~two zones are inter~~connected, probably through small vertical fractures in the till, and that recharge to the bedrock system occurs through the till. Hydraulic conductivity values for the ~~perched groundwater zone~~bedrock/till zone, based on the drawdown produced by the pumping test, are presented below.

- Building 602 (Site 12A): Average K value - 4.0 x 10^{-3} cm/sec

- Building 617 (Site 12B): Average K value - 4.7×10^{-3} cm/sec
- Building 279 (Site 12C): Average K value - 1.6×10^{-4} cm/sec

Drawdown in the perched zonetill was measured up to 140 feet from the pumping well. The drawdown in the perched zonetill did not fully recover to pre-test conditions following completion of the pumping test, suggesting that tension-saturated conditions (Freeze and Cherry, 1979) exist in the till, and that recharge to the perched zone and, ultimately, the bedrock aquifer through the till would occur quite slowly.may be very dependent on precipitation.

2.6.3.2 Vertical Groundwater Gradients. At six locations south of the Firing Line, two or three wells were installed within an 8-foot radius feet of each other to form a well cluster (Figure 2-19). The purpose of these well clusters was to determine the vertical potential groundwater gradients at different locations within JPG. The well cluster containing wells MW93-1, MW93-2, and MW93-3 (Background Site A) is located at the western end of Firing Line Road. Another well cluster (Background Site B) consists of wells MW93-4, MW93-5, and MW93-6, and is located southeast of the intersection of Tokyo and Engineers Roads. The third cluster (Background Site C) contains wells MW93-7, MW93-8, and MW93-9, located at the northwestern corner of the East Perimeter and Minefield Roads. The fourth cluster contains two wells, MW93-47 and MW95-1, and is located at Building 602. The fifth and sixth well clusters are located at Building 617 and are comprised of wells MW93-41 and MW96-2 and wells MW96-4 and MW96-5. The locations of each of the six clusters are shown in Figure 2-19 as BKA (Background Site A), BKB (Background Site B), BKC (Background Site C), 602 (Building 602), N617 (Building 617 North), and S617 (Building 617 South). The deepest wells at each site areis screened exclusively in the bedrock, while the shallow well is screened at the bedrock-glacial till contact. The vertical potential groundwater gradient at each of these nested well sites is discussed below.

2.6.3.2.1 Background Well Cluster A. Based on the boring logs, the bedrock surface at BKA is located approximately 9 feet bgs. Well MW93-1 (screened 75 to 95 feet bgs) is screened in the Louisville Formation, and MW93-2 (screened 42 to 52 feet bgs) is screened in the Geneva Dolomite. The top foot of the screen in MW93-3 (screened 8 to 18 feet bgs) is located in the overlying glacial till, with the remainder of the screen set in the North Vernon Limestone.

Slug tests performed on the wells showed little variability in the bedrock hydraulic conductivity (K values) at different depths. The test for MW93-3, which was completed at the base of the glacial till and had a screened interval that extended 8 feet into the bedrock, resulted in a calculated K value of 5.89×10^{-5} cm/sec. This value is in contrast to the calculated slug test K values of 1.25×10^{-5} cm/sec for well MW93-1 and 1.73×10^{-5} cm/sec for well MW93-2 where the wells were screened in fractured bedrock.

Regionally, the bedrock groundwater at this location is unconfined; however, locally, in the absence of fractures in the overlying till, groundwater will rise to a level that is higher than where it is encountered, giving the appearance of confining conditions. Table 2-5 presents ~~all~~ the water-level data collected since June 1993 through December 1996 at BKA. Based on this water-level data, there appears to be an average downward gradient of 0.15 foot/foot, indicating that the bedrock aquifer is receiving recharge at this location.

2.6.3.2.2 Background Well Cluster B. At this location, the glacial till-bedrock interface is located approximately 15 feet bgs. Well MW93-4 is screened from 78 to 98 feet bgs in the Louisville Limestone, and MW93-5 is screened from 38 to 48 feet bgs in the Louisville Limestone and the Geneva Dolomite. The shallowest well, MW93-6 (screened from 13 to 23 feet bgs), has the bottom 8 feet of the screen in Jeffersonville Limestone and the top 2 feet screened in the glacial till. Voids were encountered in the bedrock in MW93-4 at 18 to 19 feet bgs and in MW93-5 at 23 to 24 feet bgs, indicating that some solutioning or weathering of the limestone ~~is taking~~has taken place in the shallow bedrock.

According to slug test data, the hydraulic conductivity of the bedrock based on the two deep wells is 6.80 x 10^{-5} and 3.79 x 10^{-5} cm/sec (from MW93-4 and MW93-5, respectively). The hydraulic conductivity of the bedrock near the glacial till-bedrock interface was calculated to be 3.30 x 10^{-6} cm/sec (from MW93-6), which is the lowest hydraulic conductivity calculated from ~~any of~~ the wells at JPG. The fact that MW93-4 and MW93-5 are an order of magnitude higher than MW93-6 may be attributed to the presence of fractures and secondary porosity development in the two deeper wells.

As with the bedrock groundwater at BKA, the bedrock groundwater at BKB is locally unconfined in the absence of fractures in the underlying till. Table 2-5 presents water-level data collected from the wells between June 1993 and December 1996. Based on this water-level data, there is an average upward gradient of 0.10 foot/foot at the site, indicating that this location has an area of groundwater discharge from the bedrock aquifer. BKA wells are located within the drainage of Harberts Creek, one of the larger creek drainages south of the Firing Line and one that flows year round.

2.6.3.2.3 Background Well Cluster C. At this location, the glacial till-bedrock interface was encountered during ~~the~~ drilling ~~of the three wells~~ at approximately 14 feet bgs. Well MW93-7 was screened 75 to 95 feet bgs in the Laurel Dolomite, and Well MW93-8 was screened from 22 to 32 feet bgs in the Louisville Limestone. Well MW93-9 was screened 12 to 17 feet bgs, mostly in the Louisville Limestone.

Slug test results revealed that the bedrock at the three different depths had close to the same hydraulic conductivity. At this location, the bedrock hydraulic conductivity ranged from 2.32 x 10^{-4} (MW93-7) to 2.0 x 10^{-4} cm/sec (MW93-9).

Groundwater levels collected between June 1993 and December 1996 are shown in Table 2-5. Because of the presence of the Waldron Shale (encountered 36 to 46 feet bgs), the major aquitard unit encountered at JPG, the downward vertical gradient was the highest of the three

background locations (0.36 foot/foot). BKC is located in a recharge area at the east property boundary of JPG very near the regional groundwater divide shown in Figures 2-16 and 2-17.

2.6.3.2.4 Building 602 Well Cluster. Wells MW93-47 and MW96-1 form the shallow and deep well cluster at Building 602. At this location, the glacial till-bedrock interface was encountered approximately 30 feet bgs. Well MW96-1 is screened from 58 to 68 feet bgs in the Louisville Limestone and Geneva Dolomite. The shallow well, MW93-47 (screened from 29 to 39 feet bgs), has the bottom 9 feet of the screen in Jeffersonville Limestone and the top 1 foot screened in the glacial till. Well MW93-47 is adjacent to the former solvent pit at Building 602. The hydraulic conductivity of the bedrock based on drawdown data of these two wells during the pumping test was 7.62×10^{-4} and 2.85×10^{-4} cm/sec (from MW93-47 and MW95-1, respectively).

Water levels collected between June 1993 and December 1996 are shown in Table 2-5. These data show a consistent downward vertical gradient with an average value 0.02 feet/feet. Water levels indicate that the bedrock aquifer is receiving recharge~~d~~ in the vicinity of Building 602.

2.6.3.2.5 Building 617 Well Clusters. Wells MW93-41 and MW96-2 (N617), adjacent to the former solvent pit at Building 617 (Site 12B), form one of two well clusters at Building 617. At this location, the glacial till-bedrock interface was encountered at approximately 19 feet bgs. Well MW96-2 is screened from 39 to 49 feet bgs in the Louisville Limestone. The shallow well, MW93-41, (screened from 18 to 28 feet bgs), has the bottom 9 feet of the screen in Jeffersonville Limestone and the top 1 foot screened in the glacial till. The second well cluster at Building 617 is comprised of wells MW96-4 and MW96-5 located approximately 520 feet southwest of Building 617 (S617). At this location, the glacial till-bedrock interface was encountered at approximately 17 feet bgs. Well MW96-4 is screened from 42 to 52 feet bgs in the Louisville Limestone and Geneva Dolomite. The shallow well, MW96-5, is screened from 17 to 27 feet bgs in the Jeffersonville Limestone.

The vertical groundwater gradient at both well clusters N617 and S617 indicate recharge to the bedrock aquifer at these locations. The average vertical gradients at these well clusters were 0.50 feet/feet at N617, and 0.39 feet/feet at S617.

The hydraulic conductivity of the bedrock near wells MW93-41 and MW96-2 based on the pumping test results from well MW93-41 was estimated at 2.31×10^{-3} cm/sec. The hydraulic conductivity at wells MW96-4 and MW96-5 is not known since these wells were not slug tested and did not show ~~any~~ drawdown influence from the pumping test.

2.6.3.3 Horizontal Hydraulic Gradients. The potentiometric surface of the groundwater at JPG south of the Firing Line is shown in Figures 2-16 and 2-17 for November 1995 and December 1996. The change in groundwater elevation from the east boundary to the west boundary of JPG was approximately 60 feet, and appears to generally mimic topography. The distance from the east perimeter fence to the west perimeter fence near the center of JPG is approximately 4 miles (21,120 feet), which gives an average hydraulic gradient of 0.003 feet/feet. As shown in Figures 2-16 and 2-17, the horizontal hydraulic gradient is not

consistent across JPG. Steeper gradients may exist near the incised stream channels and flatter gradients may exist near the interior of JPG where the ground surface is relatively flat.

Generally, the approximate hydraulic gradient within the interior of JPG was between 0.003 and 0.005 feet/feet. Using a range of effective porosities between 1 and 30% for fractured rock (Fetter 1988), the average linear velocity, or seepage velocity, of the groundwater can be estimated (Table 2-6). As evident by Table 2-6, the travel time for groundwater at JPG may vary significantly based on the effective porosity alone, with a range of values between 1 and 1,800 feet per year (ft/yr).

~~The vertical potential groundwater gradient at both well clusters N617 and S617 indicate recharge to the bedrock aquifer at these locations. The average vertical gradients at these well clusters were 0.50 feet/feet at N617, and 0.39 feet/feet at S617.~~

2.6.4 Background Groundwater Flow Characteristics

As discussed in the preceding section, ~~all of~~ the well clusters except for background wells BKB were located in recharge areas (i.e., a downward gradient was present between the deepest and shallowest wells). At location BKB an upward gradient is present, representing a discharge area. Cluster BKB is located adjacent to Harberts Creek drainage, one of the larger incised creek drainages south of the Firing Line. The average vertical gradients for the three background well clusters are presented in Table 2-5. It is important to note the strongest calculated gradient occurs where the Waldron Shale is present between two different screened intervals, typical of the conditions resulting from the presence of a confining unit. In addition, water-level data collected from well pairs installed during the previous investigation at the Gate 19 Landfill showed a downward gradient of 0.096 foot/foot.

2.7 VEGETATION

2.7.1 Indigenous Plants

Although ~~no~~ a systematic survey of indigenous plants has ~~ever~~ not been conducted, JPG is believed to contain a wide assortment of plants that are common to the southeastern portion of the State of Indiana. The dominant shrubs and vines in the area include the river alder, flowering dogwood, hawthorn, honeysuckle, smooth sumac, and blueberry. Native grasses (bluegrass, redtop, timothy, and clover) are well established in the open areas. Fescue has been planted in areas where seeding was needed.

2.7.2 Threatened/Endangered Plant Species

Although the mission of JPG has precluded regular systematic surveys by state or federal biologists, two plant species known or expected to occur on the installation are on the Federal or State of Indiana list of threatened species. JPG is ~~also~~ within the range of the federally listed endangered species called the running buffalo clover (trifolium stoloniferum), which has

been found in Switzerland County to the southeast of JPG. In addition, ~~T~~the smooth white violet or red stem violet (viola blanda) is listed by the State of Indiana as a threatened species and is known to occur within the boundaries of JPG. The IDNR completed a literature survey and a field survey of threatened and endangered plant species and natural areas on the installation in 1993. ~~In addition~~Furthermore, the USFWS conducted field surveys in the spring and summer of 1993. Copies of those reports are provided in Appendix FF.

2.7.3 Forests

JPG is heavily forested. Of the total JPG land area (55,265 acres), more than 75 percent is covered by a variety of tree species. The most abundant tree on JPG is the red maple, which is associated with the wetland areas. White oak and yellow poplar dominate the northern end of the installation, while red cedar predominates in the well drained areas. Less dominant or locally dominant tree species include the hickory, pin oak, red oak, sweetgum, beech, elm, ash, sugar maple, sycamore, walnut, black cherry, and sassafras. Very little acreage of coniferous forest exists. The largest stand, consisting of some 43 acres of white pine, can be found near Old Timbers Lodge.

Timber is harvested north of K Road and in the south end of JPG along the perimeter. Timber harvests include saw timber and high quality veneer of white oak and black walnut. By-products from timber harvesting include hardwood pulpwood, firewood, and fence posts. Annual timber sales have been regulated and controlled by the Louisville Corps of Engineers District since 1982. Annual harvests have ranged from 300,000 to 400,000 board feet, with an annual allowable cut estimated to achieve a sustained yield of 442,000 board feet. Fifteen-thousand acres of unharvested woodlands are managed for production of quality hardwood timber.

2.7.4 Wetlands

Wetland resources present at JPG are not well defined. The current estimate of wetland acreage is 6,470 acres. A wetland resources investigation using the *U.S. Fish and Wildlife Service Draft National Wetland Inventory*, estimated that JPG had more than 2,900 acres of wetlands. In a separate study, based upon Landsat imagery, the total wetland areas on JPG were estimated to exceed 6,000 acres. In addition, narrow bands of wetlands associated with streams were measured in terms of linear distance. The total linear distance of these wetlands was determined to be 68.75 miles. Most of these wetlands (2,090 acres and 5.0 linear miles) are palustrine forested (PFO) wetlands, which are dominated by broadleaf, deciduous wood vegetation, 6 meters tall or taller with 30 percent aerial coverage. The second most common type of wetland, with 632 acres, is palustrine scrub-shrub (PSS) wetlands, which are dominated by young PFO wetland specimens or species that will remain as shrubs, less than 6 meters tall.

Three major wetland complexes were identified using the National Wetland Inventory (NWI) maps. These complexes are concentrated on the eastern side of JPG. One complex is associated with headwater streams of Little Graham Creek and accounts for 480 acres of PFO

and PSS wetlands. Another complex is associated with the headwaters of Marble Creek, which empties into Big Creek. This complex accounts for 524 acres of PFO and PSS wetlands. The third complex is associated with one of the headwater streams of Big Creek just inside the eastern boundary of JPG and accounts for 175 acres of PFO and PSS wetlands.

2.7.5 Leasing Activities and Woodlands

It is estimated that approximately 10 percent of the land was forested when JPG was formed, the remaining 90 percent having been cleared for agriculture. Today, about 75 percent of the land is forested.

Between WWII and the Korean conflict, approximately 5,000 acres of land were leased in the airport area. Several thousand acres in other parts of the base were leased for agriculture. During various inactive time periods, JPG leased land for grazing and local municipal/commercial airport operations. Buildings have also been leased to private companies as indicated in Table 2-7.

2.8 WILDLIFE

2.8.1 Indigenous Fauna

Despite the frequent test firing of numerous rounds of a wide variety of conventional munitions, JPG provides an excellent habitat for wildlife. There have been systematic surveys of indigenous animals on the installation. Available data for the surrounding area indicate that 44 species of mammals are known to occur. These species include whitetail deer, red fox, grey squirrels, opossum, shrews, rabbits, groundhogs, beavers, bats, raccoons, skunks, muskrats, weasels, and chipmunks.

JPG and the surrounding area have a diverse avian community, with a total of 121 breeding bird species reported for the area. This rich avian diversity is supported by the variety of cover types interspersed with riparian corridors. Some of the species at JPG are doves, songbirds, pheasant, herons, loons, quail, and grebes. Favorable habitat exists for the bluebird, including two bluebird trails that have been created on the installation.

A few sampling sites have been surveyed for reptiles and amphibians by Karns (1993). This report indicated that the Big Graham Creek site (mature hardwood forest with an associated creek) was the richest herpetological site in Ripley County. Reptiles and amphibians with geographical ranges that overlap JPG include 7 species of turtles, 3 species of lizards, 16 species of snakes, 18 species of salamanders, 3 species of toads, and 12 species of frogs. In the summer of 1993, the USFWS conducted breeding bird surveys in 11 areas at JPG. That initial study reported a total of 102 species of birds breeding on JPG. Also at that time, the USFWS conducted bat surveys and threatened and endangered (T&E) surveys. The results of the Karns and USFWS surveys are provided in Appendix FF.

2.8.2 Hunting/Fishing Areas

The hardwood forests, mature pine stands, open fields, riparian corridors, scrub-shrub/old field, wetlands, ponds, lakes, and streams on JPG provide an almost ideal habitat for the wide variety of game animals and fish that are harvested on the installation. Some stocking of game birds, fish, and other creatures has been accomplished to maintain stable populations of some species. Hunting is allowed on approximately 30,000 acres of designated land for employees of JPG and their guests, and for a small number of state hunters drawn by lottery. Bag and creel checks are required before hunters and fishermen are allowed to leave the installation. The remaining 25,000 acres of land provide habitat for small game. This land is closed to hunters because of the danger of UXO.

Mammals and fowl harvested on JPG include whitetail deer, fox squirrel, eastern gray squirrel, eastern cottontail rabbit, and wild turkey. According to the Natural Resource Manager at JPG, Mr. Ken Knouf, from 550 to 750 whitetail deer are harvested annually. The wild turkey harvest averages 50 birds per year. The USFWS conducted fish surveys of the streams within the boundaries of JPG in June of 1993. According to their observations, at least some reaches of Otter Creek contained excellent fish diversity. An incomplete listing of the fish species identified in that survey may be found in Appendix FF.

2.8.3 Unique Habitats

In the northeastern section of JPG along Big Graham Creek near the Old Timbers Lodge, there is a rookery for the great blue heron. Since this rookery is located in a relatively undisturbed area of JPG, the great blue heron appears to be thriving, unaffected by the previous munitions-testing activities to the south. The USFWS and IDNR have identified grassland areas near the airport that provide suitable habitat for the Henslow's sparrow (State of Indiana threatened specie)~~. (Figure 2-20).~~ There are even larger tracts of open grassland that exist north of the firing line providing ideal habitat. There may be other unique habitats on the installation; however, the more than 50 years of artillery, mortar, tank, grenade, mines, and air drop munitions testing have made a systematic survey impractical.

2.8.4 Threatened/Endangered Animal Species

There are five federally endangered animals (four birds and one mammal) that may occur within the boundaries of JPG. The four bird species are transients that may occur during migration, including the American peregrine falcon (Falco peregrinus), bald eagle (Haliaeetus leucocephalus), arctic peregrine falcon (Falco peregrinus tundrius), and Kirtland's warbler (Dendroica kirtlandii). In the summer of 1993, the Indiana bat (Myotis sodalis) was documented to exist at JPG. Kirtland's snake (Natrix kirtlandi), a candidate species, is present within the boundaries of JPG.

2.9 LAND USE AND DEMOGRAPHY

JPG is surrounded by several small rural towns including New Marian, Holton, Nebraska, Rexville, Grantsburg, Belleview, Middlefork, San Jacinto, and Wirt. The area immediately adjacent to the installation is farmland. Approximately 100 farmhouses and other dwellings are located within 1 mile downgradient of JPG south of the Firing Line. The topographic map shown in Figure 2-1 gives an indication of dwelling density near JPG (the small black squares represent dwellings).

Most of JPG is wooded with the exception of impact areas and clear areas surrounding building complexes. As a result, the installation has an active forest and wildlife management program. Over the years, the installation has generated income through sale of timber and hunting and fishing permits. Employment at JPG ranged from 1,774 in 1953 to 386 in 1990.

Since the early 1800s, the land surrounding JPG has been used predominantly for small family farms. The major local crops are tobacco, corn, and soybeans, and little change is expected in the foreseeable future. There are several light industrial manufacturing companies in the more urbanized areas such as Madison.

TABLES

TABLE 2-1

Temperature and Precipitation Data
Jefferson Proving Ground
Madison, Indiana

	Temperature						Precipitation				
				2 Years in 10 Will Have				2 Years in 10 Will Have			
Month	Average Daily Maximum	Average Daily Minimum	Average	Maximum Temperature Higher Than --	Minimum Temperature Lower Than --	Average Number of Growing Degree Days*	Average	Less Than --	More Than --	Average Number of Days With 0.10 Inch or More	Average Snowfall
	°F	°F	°F	°F	°F	Days	Inches	Inches	Inches	Days	Inches
January	42	24	33.	67	-3	**33**	3.21	1.8	4.36	7.36	5.4
February	46.7	26.7	36.7	69	1	74	3.34	1.52	4.82	7	2.3
March	55.4	33.7	44.5	80	14	231	4.48	2.48	6.1	9	2.9
April	68.4	43.5	55.8	86	25	474	4.03	2.02	5.66	9	0.1
May	77.5	52.8	65.2	93	33	781	4.48	2.59	601	8	0
June	85.3	62.2	73.8	97	45	1014	4.01	2.36	5.46	7	0
July	88.1	65.9	77	98	51	1147	3.76	2.18	5.03	7	0
August	87.3	64.2	75.8	98	50	1110	2.61	1.18	3.78	5	0
September	82.3	57.9	70.1	97	40	903	3.15	1.49	4.49	6	0
October	71.4	46.5	59	88	27	589	2.6	1.27	3.68	5	0
November	56.3	36.5	46.4	79	14	216	3.25	1.78	4.44	6	0.6
December	44.7	26.8	35.7	70	2	75	3.05	1.54	4.29	6	1.8
Yearly:											
Average	67.1	45.1	56.1	---	---	---	---	---	---	---	---
Extreme	---	---	---	102	-5	---	---	---	---	---	---
Total	---	---	---	---	---	6647	41.97	35.46	48.16	82	13.1

General Note:

1. Data were recorded in the period 1951-1976 at Madison, Indiana. Source: USDA Soil Conservation Service.
   A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (40°F).

TABLE 2-2

Grain Size Distribution of Borehole Soil Samples
Jefferson Proving Ground
Madison, Indiana

		Grain Size Distribution (%)			
Site ID	Depth	Gravel	Sand	Silt	Clay
ALF04BHD02	4.7	2.1	22.2	56.7	19
BGG09BHA02	4.5	0.6	22	62.8	14.6
BGG09BHF01	0.3	3	22.4	52.9	21.7
GLF10BHB01	0.9	0.3	25.3	53.9	20.5
GLF10BHE02	4.9	0.7	19.9	64.6	14.8
SPB11BHB03	9.6	0.6	29.1	40.5	29.8
SPB11GWA*	28.7	1.4	58.1	31.5	9
SPB11GWA	36.7	1.5	25.1	47.7	25.7
SPB11GWB*	25	20.4	73.4	4.4	1.8
SPB11GWB	38.5	3	39.2	24.7	33.1
SPB11GWC*	23.7	1.7	76.2	8.6	13.5
SPB11GWC	38.5	0	2.4	76.5	21.1
SVA12BHC03	9.3	5.6	37.7	34.3	22.4
FTA13BHA02	4.6	1	19.6	60.4	19
FTA13BHA03	9.6	0.3	32.5	49.4	17.8
YSA14BHC02	4.6	0.5	27.6	50.8	21.1
YSA14BHF01*	0.6	52.6	33.5	10.5	3.4
OSW19BHB03	9.3	0.2	2.5	85.3	12
HZS20BHC03	2	0	17.2	63.9	18.9
HZS20BHE05	3	0.3	19.4	65.1	15.2
SVT23BHC03	9.9	0.5	39.7	39.5	20.3
PMR25BHC03	9.6	1	29.9	34.4	34.7
FSP31BHB05	19.2	0.9	26.9	52.2	20
OSP36BHD01	0.2	0.1	21	65.5	13.4
GST37GWA	7	0.1	17.1	60.2	22.6
GST37GWA*	12	5.1	68.8	19.4	6.7
GST37GWA	17	10.5	33.6	37.8	18.1
GST37GWB*	8	1.4	48.4	23.6	26.6
GST37GWB	12	0.9	35.7	44.9	18.5
GST37GWB	17	0.9	33.1	45.1	20.9
GST37GWC	7	0.2	21.7	57.6	20.5
GST37GWC*	12	1	46.4	37.5	15.1
GST37GWC	17	0.9	35.4	41.4	22.3
GST37GWD	5	0	19.4	58.5	22.1
GST37GWD	10.2	2.3	37.1	43.4	17.2
GST37GWD	15	1.3	33.7	43.5	21.5
GST37GWE	4	0.1	17.6	59.3	23
GST37GWE	9.2	0.6	33.4	47.9	18.1
GST37GWE	14	2.6	34.3	41.3	21.8
UFR41BHC02	4.6	0.2	11.1	58.1	30.6
MEAN - ALL	11.7	3.2	31.2	46.4	19.2
MEAN - NO *	10.9	1.3	25.6	52.1	21

General Notes:
1. SPB11 and GST37 samples were collected from monitoring well soil cores to help evaluate glacial till hydraulic conductivity.
2. Table 3-1 correlates Site ID to monitoring well number.
3. * - biased sample of sandy or gravelly zone.

TABLE 2-3

Groundwater Elevations South of the Firing Line
Jefferson Proving Ground
Madison, Indiana

AREA	WELL NO.	WELL ELEV.	29-Jun-93 DTW	29-Jun-93 WLE	AUG. 13, 1993 DTW	AUG. 13, 1993 WLE	SEPT. 13, 1993 DTW	SEPT. 13, 1993 WLE	NOV. 19, 1995 DTW	NOV. 19, 1995 WLE	FEB. 2, 1996 DTW	FEB. 2, 1996 WLE
BKA CLUSTER	MW93-1	833.58	13.5	820.08	14.42	819.16	13.36	820.22	13.63	819.95	11.74	821.84
	MW93-2	834.28	13.81	820.47	14.4	819.88	13.72	820.56	13.96	820.32	11.91	822.37
	MW93-3	834.02	5.5	828.52	3.99	830.03	5.66	828.36	3.75	830.27	3.84	830.18
BKB CLUSTER	MW93-4	846.18	13.99	832.19	15	831.18	14.42	831.76	15.2	830.98	12.54	833.64
	MW93-5	846.35	15.98	830.37	16.52	829.83	15.96	830.39	16.2	830.15	14.48	831.87
	MW93-6	846.55	20.41	826.14	18.69	827.86	20.06	826.49	20.64	825.91	20.56	825.99
BKC CLUSTER	MW93-7	901.82	35.15	866.67	35.74	866.08	35.6	866.22	36.02	865.8	34.31	867.51
	MW93-8	901.97	6.12	895.85	6.96	895.01	6.16	895.81	6.19	895.78	3.83	898.14
	MW93-9	902.05	6.06	895.99	6.17	895.88	6.7	895.35	6.09	895.96	3.7	898.35
BKD BACKGROUND	MW95-5	900.13	Installed in 1995		Installed in 1995		Installed in 1995		6.1	894.03	3.64	896.49
BKE BACKGROUND	MW83-4	900.47	N		N		N		10.38	890.09	3.97	896.5
RED LEAD AREA	MW93-10	872.68	15.04	857.64	15.85	856.83	14.74	857.94	15.41	857.27	14.03	858.65
	MW93-11	871.35	14.75	856.6	15.57	855.78	14.49	856.86	15.18	856.17	13.72	857.63
	MW93-44	872.79	16.03	856.76	16.83	855.96	15.76	857.03	16.43	856.36	14.96	857.83
	MW95-4	868.86	Installed in 1995		Installed in 1995		Installed in 1995		12.77	856.09	11.29	857.57
FIRE TRAINING PIT	MW93-12	850.7	10.38	840.32	11.16	839.54	10.74	839.96	10.89	839.81	8.81	841.89
	MW93-13	850.55	10.42	840.13	11.42	839.13	10.91	839.64	11.16	839.39	9.1	841.45
	MW93-14	850.07	9.05	841.02	9.8	840.27	8.45	841.62	9.27	840.8	7.95	842.12
GATE 19 LANDFILL	MW93-15	820.58	6.3	814.28	4.04	816.54	6.24	814.34	4.47	816.11	2.61	817.97
	MW93-16	827.8	9.9	817.9	9.01	818.79	10.14	817.66	9.52	818.28	8.01	819.79
	MW93-17	829.08	11.96	817.12	10.42	818.66	11.47	817.61	10.96	818.12	9.55	819.53
	MW93-18	831.14	12.46	818.68	11.65	819.49	12.4	818.74	11.98	819.16	9.6	821.54
	MW93-19	829.18	12.96	816.22	11.67	817.51	13.19	815.99	12.11	817.07	10.34	818.84
	MW88-1	824.82	N		12.81	812.01	11.14	813.68	13.94	810.88	10.04	814.78
	MW88-2	829.72	15.45	814.27	15.47	814.25	14.54	815.18	16.2	813.52	13.26	816.46
	MW88-3	832.17	N		14.64	817.53	13.16	819.01	Capped		Capped	
	MW88-4	833.68	12.55	821.13	13.33	820.35	12.39	821.29	13.44	820.24	10.69	822.99
	MW88-5	828.04	N		13.55	814.49	12.96	815.08	14.64	813.4	11.46	816.58
	MW88-7	830.62	17.68	812.94	17.38	813.24	17.02	813.6	17.79	813.6	15.69	814.93
	MW88-9	833.4	N		14.41	818.99	15.29	818.11	14.97	818.43	13.43	819.97
	MW88-10	830.37	N		13.51	816.86	12.13	818.24	Capped		Capped	
	MW88-11	826.65	N		13.28	813.37	13.9	812.75	14.3	812.35	12.81	813.84
	MW88-12	828.8	N		N		10.42	818.38	Capped		Capped	

TABLE 2-3

Groundwater Elevations South of the Firing Line
Jefferson Proving Ground
Madison, Indiana

AREA	WELL NO.	WELL ELEV.	29-Jun-93 DTW	29-Jun-93 WLE	AUG. 13, 1993 DTW	AUG. 13, 1993 WLE	SEPT. 13, 1993 DTW	SEPT. 13, 1993 WLE	NOV. 19, 1995 DTW	NOV. 19, 1995 WLE	FEB. 2, 1996 DTW	FEB. 2, 1996 WLE
GATE 19 LANDFILL	MW88-13	830.97	N		13.52	817.45	12.34	818.63	Capped		Capped	
	MW88-17	828.76	N		6.92	821.84	4.37	824.39	Capped		Capped	
	MW81-1	831.96	N		N		N	831.96	Dry		Dry	
	MW81-3	828.29	N		N		Dry		13.92	814.37	12.44	815.85
	MW83-1	829.21	N		10.64	818.57	11.77	817.44	11.1	818.11	9.53	819.68
	MW83-2	828.58	N		12.05	816.53	11.86	816.72	13.37	815.21	6.66	821.92
	MW83-3	830.94	N		16.95	813.99	16.66	814.28	17.84	813.1	14.82	816.12
ABANDONED LF	MW93-20	864.78	19.13	845.65	19.56	845.22	18.89	845.89	18.81	845.97	16.98	847.8
	MW93-21	859.21	13.84	845.37	14.21	845	13.54	845.67	13.58	845.63	11.88	847.33
	MW93-22	856.29	10.2	846.09	10.55	845.74	9.86	846.43	9.93	846.36	8.28	848.01
	MW93-23	851.57	5.38	846.19	5.71	845.86	4.96	846.61	5.18	846.39	3.64	847.93
	MW95-6	861.83	Installed in 1995		Installed in 1995		Installed in 1995		9:21	845.44	16:04	847.16
YELLOW SULFUR	MW93-24	857.28	7.79	849.49	8.68	848.6	7.55	849.73	8.26	849.02	6.28	851
	MW93-25	856.08	6.56	849.52	7.5	848.58	6.36	849.72	7.13	848.95	5.06	851.02
	MW93-26	855.12	5.61	849.51	6.55	848.57	5.42	849.7	6.17	848.95	4.1	851.02
	MW95-03	852.84	Installed in 1995		Installed in 1995		Installed in 1995		21:21	848.95	19:55	851.01
CONCRETE VAULT	MW93-27	858.74	6.18	852.56	5.11	853.63	5.26	853.48	4.23	854.51	3.63	855.11
	MW93-28	857.62	5.39	852.23	5	852.62	5.07	852.55	4.61	853.01	4.59	853.03
	MW93-29	858.48	5.93	852.55	5.03	853.45	5.37	853.11	4.35	854.13	4.14	854.34
EXPLOSIVE BURN	MW93-30	885.1	21.22	863.88	21.98	863.12	21.53	863.57	22.36	862.74	20.1	865
	MW93-31	883.53	17.18	866.35	18	865.53	17.88	865.65	17.67	865.86	16.02	867.51
	MW93-32	884.34	6.41	877.93	4.68	879.66	6.11	878.23	4.38	879.96	3.97	880.37
BUILDING 617	MW93-38	855.2	5.83	849.37	6.8	848.4	5.63	849.57	6.39	848.81	4.32	850.88
	MW93-39	854.36	6.02	848.34	6.94	847.42	5.22	849.14	8.01	846.35	3.26	851.1
	MW93-40	855.62	7.14	848.48	8.4	847.22	6.61	849.01	9.41	846.21	4.57	851.05
	MW93-41	855.95	6.9	849.05	8.08	847.87	6.54	849.41	8.43	847.52	4.95	851
	MW95-1	854.27	Installed in 1995		Installed in 1995		Installed in 1995		8:09	844.93	5:45	851.03
	MW95-2	853.81	Installed in 1995		Installed in 1995		Installed in 1995		15:21	845.18	23:45	850.83
	MW96-2	856.17	Installed in 1996		Installed in 1996		Installed in 1996		Installed in 1996		Installed in 1996	
	MW96-3	853.82	Installed in 1996		Installed in 1996		Installed in 1996		Installed in 1996		Installed in 1996	
	MW96-4	856.04	Installed in 1996		Installed in 1996		Installed in 1996		Installed in 1996		Installed in 1996	
	MW96-5	856.41	Installed in 1996		Installed in 1996		Installed in 1996		Installed in 1996		Installed in 1996	
	MW96-8	855.75	Installed in 1996		Installed in 1996		Installed in 1996		Installed in 1996		Installed in 1996	

TABLE 2-3

Groundwater Elevations South of the Firing Line
Jefferson Proving Ground
Madison, Indiana

AREA	WELL NO.	WELL ELEV.	29-Jun-93 DTW	29-Jun-93 WLE	AUG. 13, 1993 DTW	AUG. 13, 1993 WLE	SEPT. 13, 1993 DTW	SEPT. 13, 1993 WLE	NOV. 19, 1995 DTW	NOV. 19, 1995 WLE	FEB. 2, 1996 DTW	FEB. 2, 1996 WLE
BUILDING 279	MW93-42	864.72	9.48	855.24	9.63	855.09	9.04	855.68	10.18	854.54	8.53	856.19
	MW93-43	867.4	12.56	854.84	13.61	853.79	12.54	854.86	13.48	853.92	11.63	855.77
	MW95-07	868.36	Installed in 1995		Installed in 1995		Installed in 1995		0:00	854.36	6:14	856.1
	MW95-08	867.78	Installed in 1995		Installed in 1995		Installed in 1995		3:21	854.64	11:45	856.29
	MW95-09	868.18	Installed in 1995		Installed in 1995		Installed in 1995		9:50	854.77	18:43	856.4
	MW88-14	867.3	11.29	856.01	12.08	855.22	11.02	856.28	12.2	855.1	10.67	856.63
	MW88-15	867.75	9.09	858.66	8.05	859.7	5.95	861.8	9.13	858.62	9.02	858.73
	MW88-16	867.56	12.39	855.17	10.23	857.33	9.64	857.92	12.53	855.03	9.22	858.34
BLDG 602	MW93-45	857.98	11.38	846.6	13.83	844.15	11.82	846.16	16.03	841.95	9.83	848.15
	MW93-46	858	11.38	846.62	13.84	844.16	11.46	846.54	16.04	841.96	9.82	848.18
	MW93-47	855.56	8.9	846.66	11.32	844.24	9.56	846	13.55	842.01	7.33	848.23
	MW93-48	857.64	20.21	837.43	13.51	844.13	11.34	846.3	16.25	841.39	9.62	848.02
	MW95-10	858.42	Installed in 1995		Installed in 1995		Installed in 1995		10:48	841.97	4:48	848.22
	MW95-11	857.14	Installed in 1995		Installed in 1995		Installed in 1995		13:12	841.61	22:48	848.21
	MW96-1	855.32	Installed in 1996		Installed in 1995		Installed in 1996		Installed in 1996		Installed in 1996	
	MW96-6	854.8	Installed in 1996		Installed in 1995		Installed in 1996		Installed in 1996		Installed in 1996	
	MW96-7	855.26	Installed in 1996		Installed in 1995		Installed in 1996		Installed in 1996		Installed in 1996	
GAS STATION	MW-93-33	874.45	13.32	861.13	12.83	861.62	13.29	861.16	N		13.48	860.97
	MW-93-34	873.94	7.24	866.7	6.93	867.01	6.97	866.97	N		8.38	865.56
	MW-93-35	873.53	11.08	862.45	9.92	863.61	11.44	862.09	N		11.48	862.05
	MW-93-36	873.32	6.91	866.41	6.94	866.38	6.82	866.5	N		6.46	866.86
	MW-93-37	873.28	8.62	864.66	8.2	865.08	8.43	864.85	N		8.36	864.92

General Notes:
1. * - monitoring wells installed during previous investigations
2. N - water level not recorded
3. DTW - depth to water
4. WLE - water level elevation in feet above sea level

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TABLE 2-4

Hydraulic Conductivity Values Computed from Slug Test Data
Jefferson Proving Ground
Madison, Indiana

		$K^{(a)}$	Rock Unit Average
Clayey Silt Above Bedrock			
Gas Station	MW93-33	$8.40E^{-5}$	
	MW93-34	$4.08E^{-5}$	
	MW93-35	$7.26E^{-5}$	
	MW93-36	$8.10E^{-5}$	
	MW93-37	$2.89E^{-5}$	
			$5.9E^{-5}$
North Vernon Limestone			
BKA	MW93-03	$5.89E^{-5}$	
Gate 19 Landfill	MW93-15	$1.61E^{-3}$	
	MW93-16	$4.32E^{-4}$	
	MW93-17	$3.89E^{-4}$	
	MW93-18	$2.20E^{-4}$	
	MW93-19	$5.72E^{-4}$	
			$3.6E^{-4}$
Jeffersonville Limestone			
BKB	MW93-06	$3.3E^{-6}$	
Building 617	MW93-38	$3.72E^{-5}$	
	MW93-39	3.14^{-4}	
	MW93-40	$2.0E^{-4}$	
	MW93-41	$2.17E^{-4}$	
	MW95-1	$1.3E^{-3}$	
	MW95-2	$2.5E^{-5}$	
Building 602	MW93-45	$1.5E^{-4}$	
	MW93-46	$3.48E^{-3}$	
	MW93-47	$9.4E^{-5}$	
			$1.4E^{-4}$
Geneva Dolomite			
BKA	MW93-02	$1.73E^{-5}$	
			$1.73E^{-5}$
Louisville Limestone			
BKA	MW93-01	$1.25E^{-5}$	
BKB	MW93-04	$6.8E^{-5}$	
	MW93-05	$3.79E^{-5}$	
BKC	MW93-08	$4.22E^{-4}$	
	MW93-09	$4.4E^{-4}$	
RLA	MW93-10	$7.85E^{-5}$	
	MW93-11	$9.40E^{-5}$	
VLT	MW93-27	$1.97E^{-4}$	
	MW93-28	$6.08E^{-5}$	
	MW93-29	$2.08E^{-4}$	
RLA	MW95-4	$1.0E^{-4}$	
East Perimeter Fence	MW95-5	$4.2E^{-5}$	
			$9.4E^{-5}$

TABLE 2-4

Hydraulic Conductivity Values Computed from Slug Test Data
Jefferson Proving Ground
Madison, Indiana

		K	Rock Unit Average
Laurel Dolomite			
BKC	MW93-07	$2.32E^{-4}$	
FTA	MW93-12	$1.78E^{-4}$	
	MW93-13	$2.35E^{-5}$	
	MW93-14	$2.82E^{-5}$	
ALF	MW93-20	$2.02E^{-5}$	
	MW93-21	$4.78E^{-5}$	
	MW93-22	$3.55E^{-5}$	
	MW93-23	$2.64E^{-5}$	
YSA	MW93-24	$2.95E^{-5}$	
	MW93-25	$1.14E^{-3}$	
	MW93-26	$2.75E^{-3}$	
	MW95-3	$4.7E^{-3}$	
Explosive Burn Area	MW93-30	$9.35E^{-5}$	
	MW93-31	$6.55E^{-5}$	
	MW93-32	$2.16E^{-5}$	
279	MW93-42	$1.10E^{-5}$	
	MW93-43	$5.63E^{-5}$	
	MW95-7	$6.0E^{-5}$	
279, contd.	MW95-8	$4.8E^{-4}$	
	MW95-9	$5.4E^{-5}$	
ABL	MW95-6	$2.7E^{-5}$	
RLA	MW93-44	$9.3E^{-5}$	
			$8.6E^{-5}$
JPG Average			**$1.2E^{-4}$**

Footnotes:
(a) Hydraulic conductivity

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TABLE 2-5

Vertical Gradients at Cluster Well Locations
Jefferson Proving Ground
Madison, Indiana

	Background Well Clusters											
	BKA				BKB				BKC			
	MW93-1	MW93-2	MW93-3	Gradient	MW93-4	MW93-5	MW93-6	Gradient	MW93-7	MW93-8	MW93-9	Gradient
Screen	75' - 95'	42' - 52'	8' - 18'	ft/ft	78' - 98'	38' - 48'	13' - 23'	ft/ft	75' - 95'	22' - 32'	12' - 17'	ft/ft
Date												
6/29/93	820.08	820.47	828.52	0.14(d)	832.19	830.37	826.14	0.09(u)	866.67	895.85	895.99	0.35(d)
8/13/93	819.16	819.88	830.03	0.19(d)	831.18	829.83	827.86	0.05(u)	866.08	895.01	895.88	0.36(d)
9/13/93	820.22	820.56	828.36	0.14(d)	831.76	830.39	826.49	0.09(u)	866.22	895.81	895.35	0.35(d)
11/19/95	819.95	820.32	830.27	0.176(d)	830.98	830.15	825.91	0.2(u)	865.80	895.78	895.96	0.36(d)
2/11/96	821.84	822.37	830.18	0.14(d)	833.64	831.87	825.99	0.1(u)	867.51	898.14	898.35	0.37(d)
4/24/96	822.42	822.96	831.12	0.15(d)	834.19	833.07	830.13	0.06(u)	867.24	898.73	899.11	0.38(d)
6/19/96	822.03	822.40	829.52	0.13(d)	833.68	831.89	827.22	0.1(u)	867.26	897.15	897.31	0.36(d)
9/11/96	819.39	820.05	828.26	0.15(d)	830.93	829.94	825.87	0.9(u)	865.81	893.46	893.88	0.34(d)
10/3/96	820.98	821.42	830.10	0.15(d)	831.73	830.70	827.19	0.07(u)	864.97	896.48	896.89	0.38(d)
11/25/96	821.32	821.85	830.82	0.15(d)	833.15	831.46	825.90	0.9(u)	867.16	897.68	898.38	0.37(d)
12/23/96	(3)	(3)	(3)	(2)	834.33	832.95	828.26	0.1(u)	867.50	898.32	898.59	0.37(d)
	Average Gradient = 0.15(d) Recharge				Average Gradient = 0.1(u) Discharge				Average Gradient = 0.36(d) Recharge			

TABLE 2-5

Vertical Gradients at Cluster Well Locations
Jefferson Proving Ground
Madison, Indiana

	Solvent Site Well Clusters								
	602			N617			S617		
	MW96-1	MW93-47	Gradient	MW96-2	MW93-41	Gradient	MW96-4	MW96-5	Gradient
Screen	58' - 68'	29' -39'	ft/ft	39' - 49'	18' - 28'	ft/ft	42' - 52'	17' - 27'	ft/ft
Date									
6/29/93	(1)	846.66	(2)	(1)	849.05	(2)	(1)	(1)	(2)
8/13/93	(1)	844.24	(2)	(1)	847.87	(2)	(1)	(1)	(2)
9/13/93	(1)	846.00	(2)	(1)	849.41	(2)	(1)	(1)	(2)
11/19/95	(1)	842.01	(2)	(1)	847.52	(2)	(1)	(1)	(2)
2/11/96	(1)	848.23	(2)	(1)	851.00	(2)	(1)	(1)	(2)
4/24/96	(1)	849.02	(2)	(1)	851.40	(2)	(1)	(1)	(2)
6/19/96	848.30	848.51	0.005(d)	835.22	850.73	0.50(d)	840.70	850.18	0.28(d)
9/11/96	842.21	843.75	0.04(d)	833.04	847.40	0.46(d)	NM	845.01	(2)
10/3/96	843.82	844.11	0.008(d)	832.94	848.95	0.52(d)	838.85	846.58	0.27(d)
11/25/96	845.02	(3)	(2)	834.05	850.02	0.51(d)	843.05	848.00	0.86(d)
12/23/96	847.54	848.25	0.02(d)	850.90	851.06	0.52(d)	847.79	850.81	0.14(d)
	Average Gradient = 0.02(d) Recharge			Average Gradient = 0.50(d) Recharge			Average Gradient = 0.39(d) Recharge		

Footnotes:

(1) Well was not installed at that date.
(2) Gradient cannot be calculated.
(3) Groundwater level was not measured.

TABLE 2-6

Sensitivity Analysis on Seepage Velocities by Varying Effective Porosity
Jefferson Proving Ground
Madison, Indiana

Location From – To	Hydraulic Conductivity	Effective Porosity	Hydraulic Gradient	Seepage Velocity	
				ft[b]/day	ft/year
VLT - West Boundary	$1.7x10^{-3}$ cm/sec[a]	0.01	0.005	2.4	879
	$1.7x10^{-3}$ cm/sec	0.15	0.005	0.2	59
	$1.7x10^{-3}$ cm/sec	0.30	0.005	0.1	29
Bldg. 617 - West Boundary	$5.96x10^{-3}$ cm/sec	0.01	0.003	5.1	1850
	$5.96x10^{-3}$ cm/sec	0.15	0.003	0.3	123
	$5.96x10^{-3}$ cm/sec	0.30	0.003	0.2	62
Bldg. 602 - West Boundary	$6.6x10^{-4}$ cm/sec	0.01	0.005	0.9	341
	$6.6x10^{-4}$ cm/sec	0.15	0.005	0.1	23
	$6.6x10^{-4}$ cm/sec	0.30	0.005	0.03	11
ABL - West Boundary	$3.1x10^{-5}$ cm/sec	0.01	.003	0.03	9.6
	$3.1x10^{-5}$ cm/sec	0.15	.003	0.002	0.6
	$3.1x10^{-5}$ cm/sec	0.30	.003	0.001	0.3

Footnotes:
(a) centimeter per second
(b) feet

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TABLE 2-7

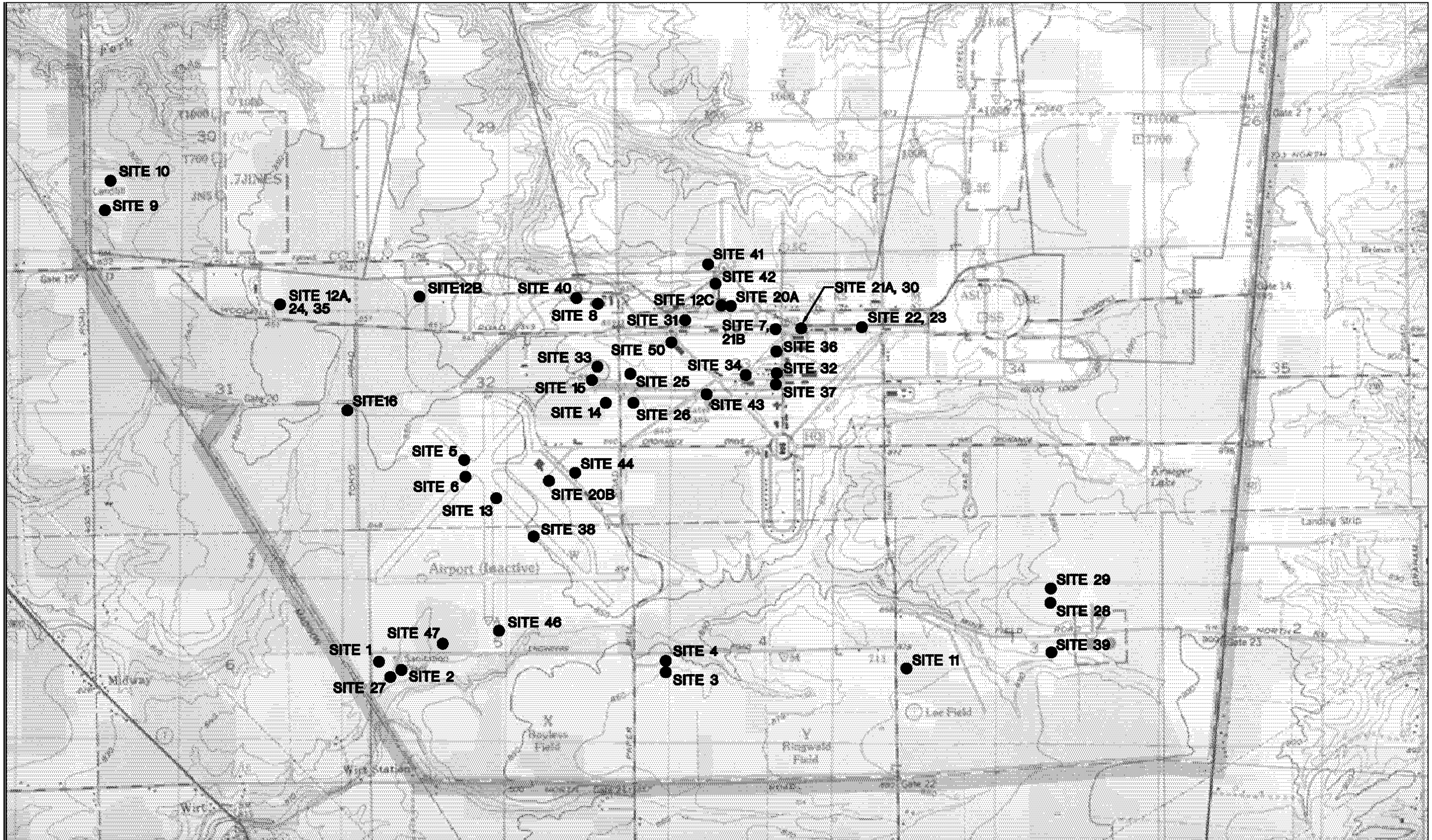
Current Tenants South of the Firing Line
Jefferson Proving Ground
Madison, Indiana

Building No.	Tenant	No. of People	Building Usage[a]
1	Resident	5	Residential
3	Resident	3	Residential
4	Resident	4	Residential
7	Resident	3	Residential
8	Resident	4	Residential
11	Resident	3	Residential
12	Resident	2	Residential
15	Resident	3	Residential
16	Resident	2	Residential
17	Resident	2	Residential
20	Resident	3	Residential
21	Resident	1	Residential
23	Resident	2	Residential
33	Resident	1	Residential
105	J & R Stamping	8	Metal Stamping (also uses Building 136)
106	Tri-State Laminates	6	Laminating
108	American Directory Service		
110	Firetac Systems, Inc.	6	
114	J. Trapp	1	
115	T. Hammock		Storage
119	VMV	8	Injection mold fabrication
121	Rust Environment & Infrastructure		Storage/ Field Office
125	U.S. Army Jefferson Proving Ground	10	Site Management Team
138	Ford Development/ Prairie Farms	2	Office
144	G. Storrs/ R. Davidson	2	
146	G. Cole/ D. Stephens	2	
149	D. Colvin/ Jeffersonian Cafe	5	Cafe
156	Banner Distribution	17	Pallet Repair (Bldgs 148 & 202 for storage)
184	Sewage Treatment Plant Office		Office
202	Gymnastics World, Inc		Storage and Light Assembly
205	Stephan Machine Shop		Machine Shop (pending)
211	Pietrykowski Products	10	Shipping Containers
212	Dave O'Mara Contractors		
215	Hydra-Tach		
216	Madison Port Authority	13	Management
226	Jones Environmental Drilling		Well Drilling
227	Rotary Lift/Dover Corporation		
241	K. Bruner	1	
322	Stephan Machine Shop	10	Machine Shop
534	Southeastern Indiana Solid Waste	5	Management
567	R. Hudson		Storage
569	A.B.C Construction Company		Storage
578	Madison Precision Industries		Storage
711	F. Collins		Storage

Footnote:

(a) Building usage is reported where known on the basis of information provided by the U.S. Army Site Management Office in March 1998.

FIGURES



LEGEND

● SITE 1 SITE LOCATION AND NUMBER

NOTE

BASE MAP DEVELOPED FROM A U.S.G.S. TOPOGRAPHIC QUADRANGLE MAP PREPARED FOR UNITED STATES ARMY: JEFFERSON PROVING GROUND, INDIANA, DATED 1986.

north

0 2000 4000

SCALE IN FEET

FIGURE 2-1

QUALITY CONTROL	
Graphic Standards DLF	2-19-02
Lead Professional	
Technical Review	
Project Manager TEM	2-19-02
Management Review	
Other	

This document has been developed for a specific application and may not be used without the written approval of Montgomery Watson Harza.

Developed By TAPB
Drawn By DLF
Approved By
Date
Reference
Revisions

TOPOGRAPHIC LOCATION MAP FOR SITES 1 THROUGH 42

SOUTH OF THE FIRING LINE
JEFFERSON PROVING GROUND
MADISON, INDIANA

Drawing Number
2440025
010102 B23

MWH MONTGOMERY WATSON HARZA

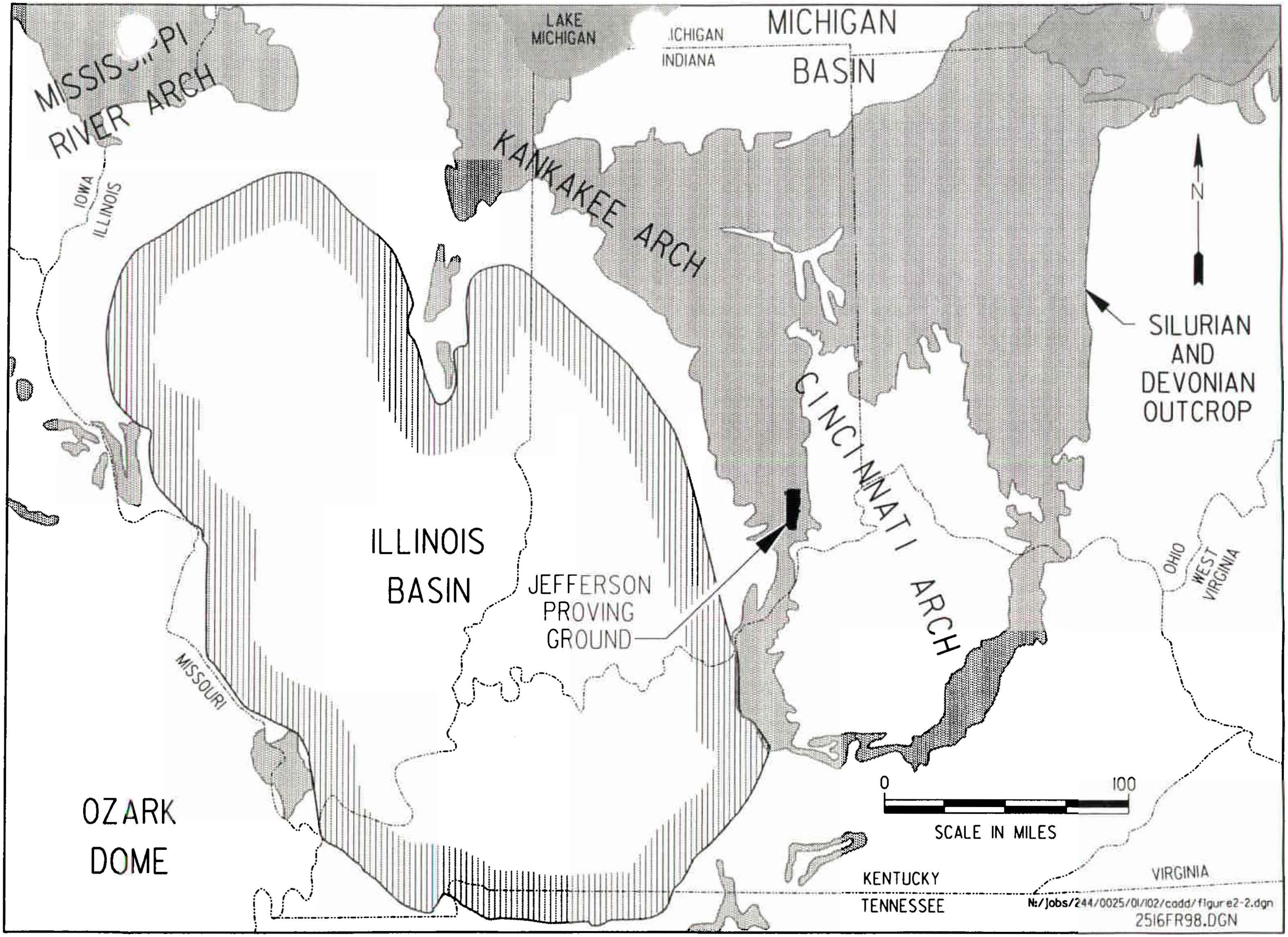


Figure 2-2. Regional Structural Setting of JPG

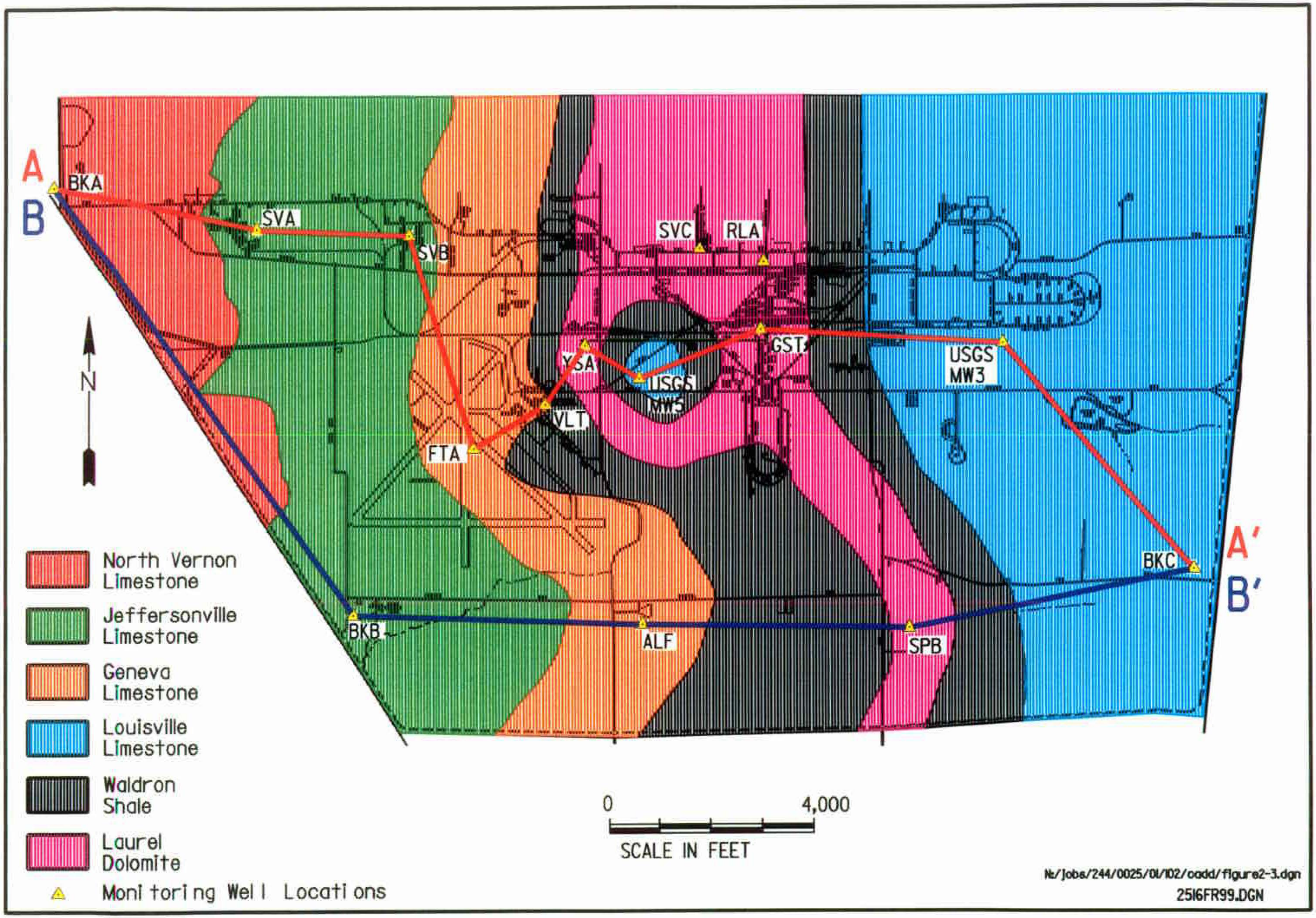


Figure 2-3. Interpreted Bedrock Geology Subcropping Beneath the Glacial Till Based on Monitoring Well Data

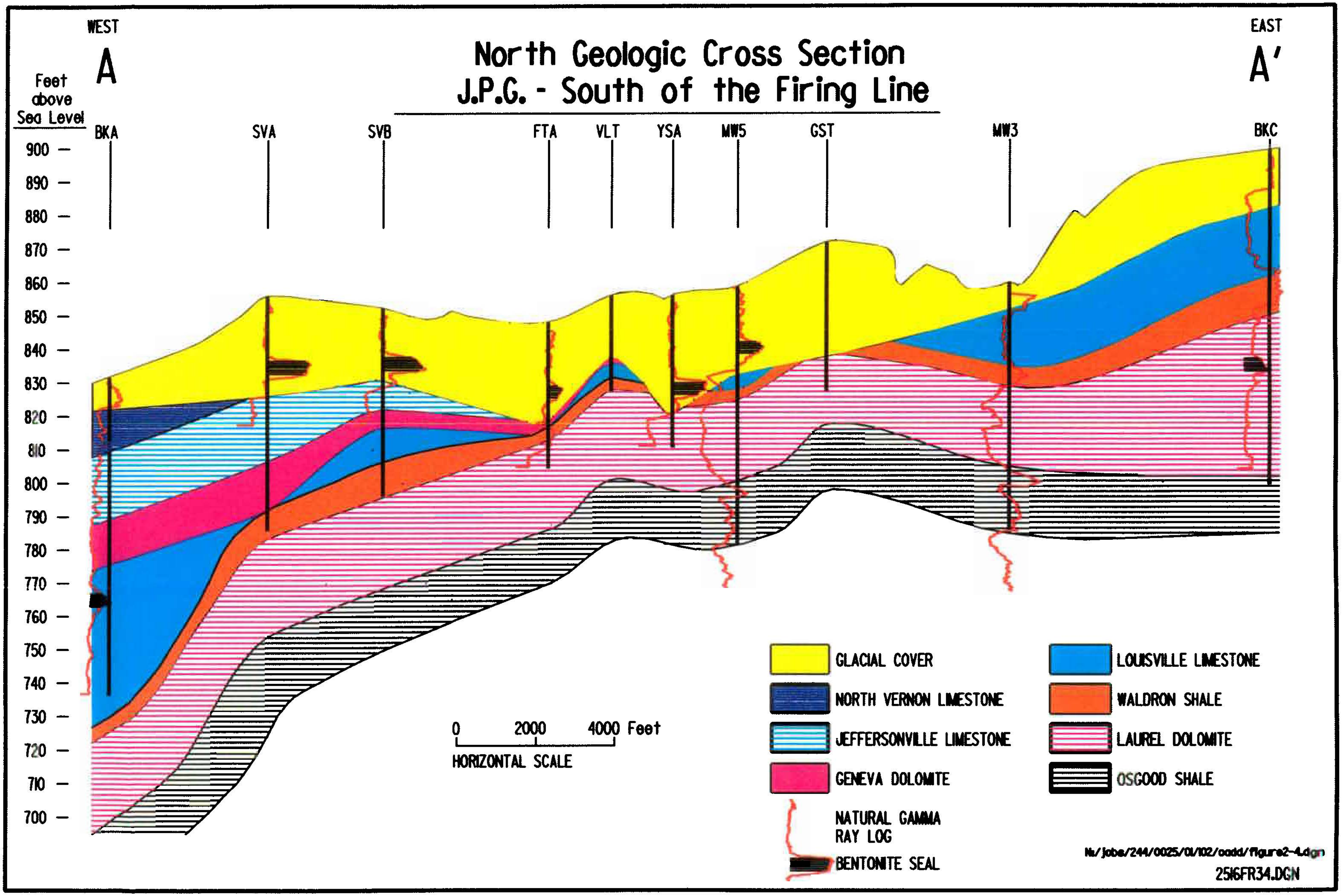


Figure 2-4. Geologic Cross Section Across the Southern Portion of JPG (A-A')

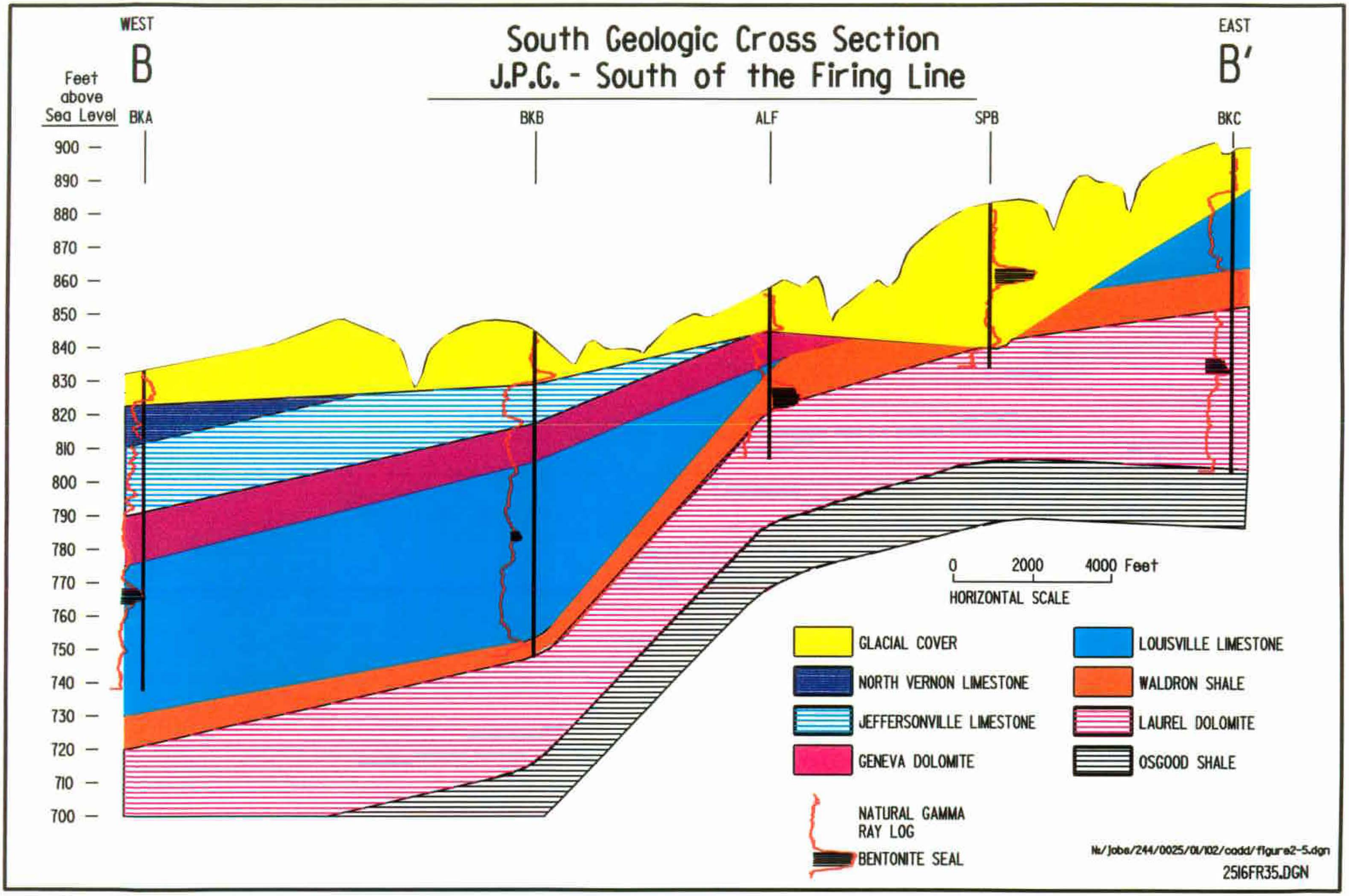


Figure 2-5. Geologic Cross Section Across the Southern Portion of JPG (B-B')

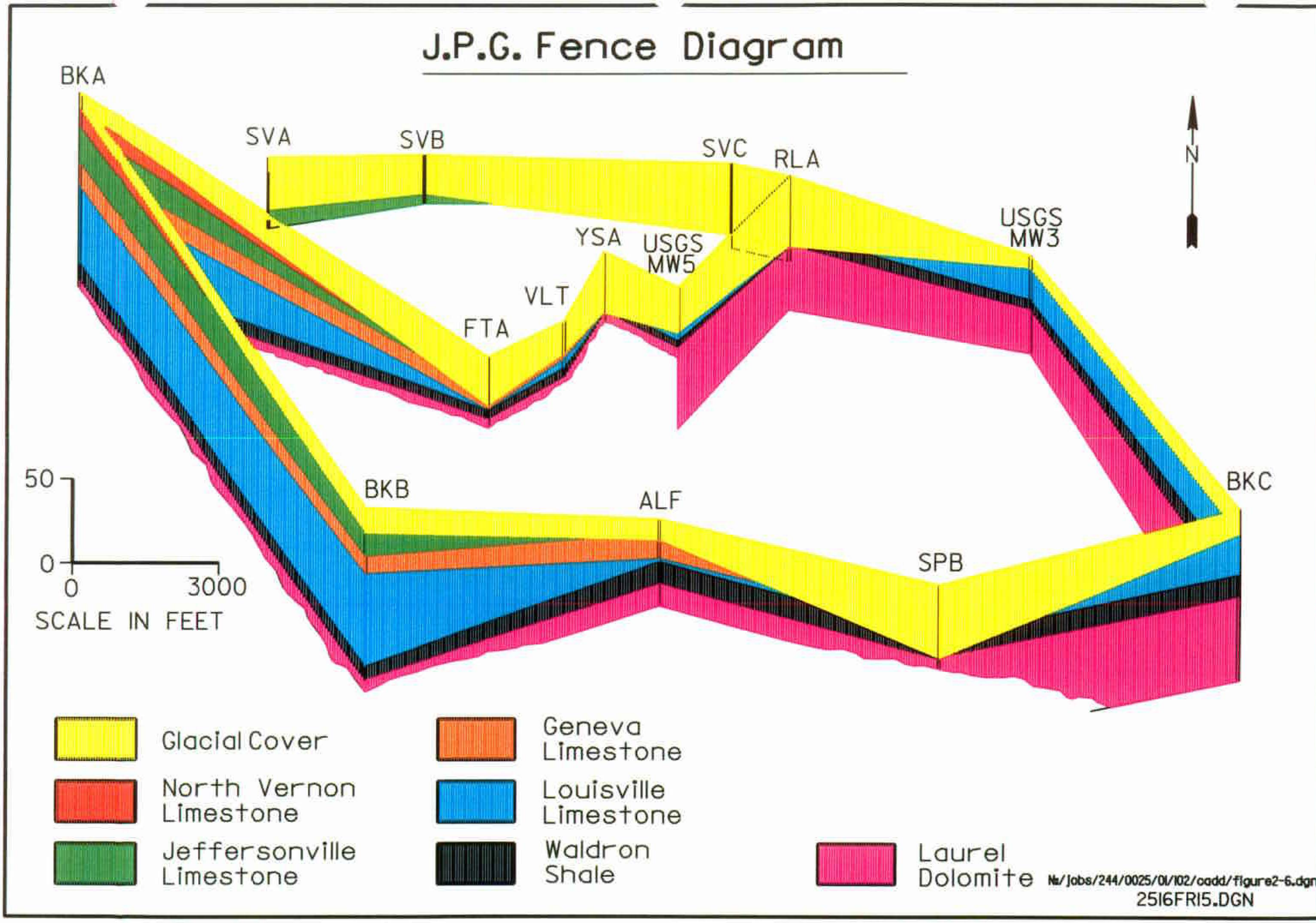
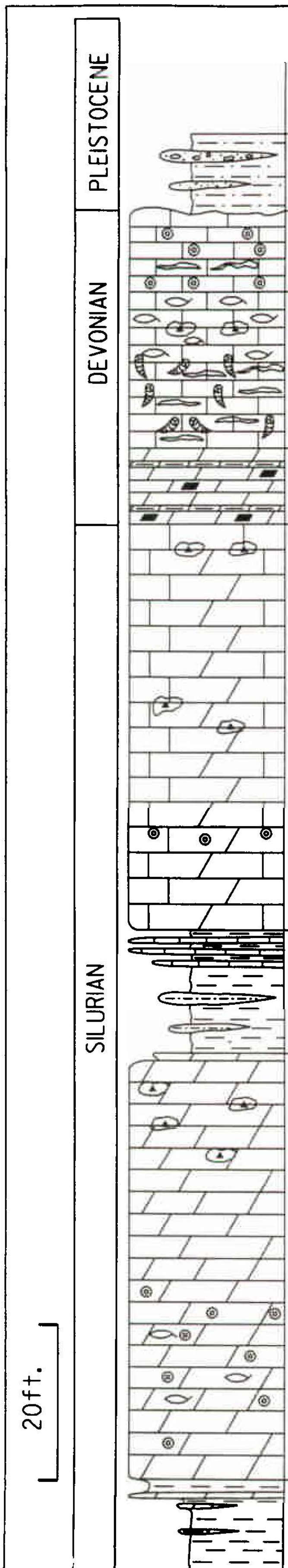


Figure 2-6. Monitoring Well Fence Diagram of the Southern Portion of JPG



Stratigraphic Unit	Hydrogeologic Characteristics
GLACIAL DEPOSITS (3.5-45ft.) Mostly silt and clay with minor san and gravel(see glacial deposit lithologic column - (Figure)	Poor aquifer, minor sand and gravel lenses are discontinuous and often have fines
NORTH VERNON LIMESTONE (>12ft.) Limestone, medium gray to blue gray , crinoids common, some stromatoparoids, skeletal grainstone beds, mostly low porosity	Generally poor aquifer due to low porosity and few fractures. Weathered styolite zones yield some water
JEFFERSONVILLE LIMESTONE (21ft) Limestone, light brown to tan, corals and stromatoparoids abundant in lower horizons, brachiopods in upper part, some cross-bedding, some skeletal grainstone beds, minor weathered chert nodules, orange weathered color near top of bedrock, especially along styloiltes, mostly low porosity	Generally poor aquifer due to low porosity and few fractures. Weathered styolite zones underlying glacial cover yield some water
GENEVA DOLOMITE (11-12ft.) Dolomite, buff to medium brown, few tan minor wispy shale laminae, large calcite crystal inclusions common	Poor aquifer. Very low porosity. Minor fracturing
LOUISVILLE LIMESTONE (0-43ft.) Dolomitic limestone and dolomite, tan to light gray, mostly non-fossiliferous except for crinoid zone in lower part, brachiopods abundant and crinoids common in MW93-7, some chert zones, mottling and irregular banding common	Highly variable water yielding characteristics. Mostly low porosity, but vuggy porosity common to very abundant, fracturing common in porous zones
WALDRON SHALE (4-12ft.) Shale, olive gray to dark greenish gray, mostly few to no fossils, but locally abundant crinoids	Only confining unit within ±150ft of carbonate strata
LAUREL MEMBER (SALAMONIE DOL.) (25-45 ft.) Dolomite and dolomitic limestone, light gray to tan, few fossils in upper part, brachiopods and crinoids common in lower part, chert nodules abundant in upper part, vuggy porosity well developed in fossiliferous lower part (MW93-7)	Highly variable water yielding characteristics. High yielding wells (e.g., Red Lead and Yellow Sulfur area) probably near fracture zones. Porosity generally low but well developed in fossiliferous zone in lower part (MW93-7)
OSGOOD MEMBER (SALAMONIE DOL.) Shale, medium to dark gray, no fossil, calcareous, some dolomite and siltstone interbeds, minor pyrite crystals	Confining Unit

- LARGE CALCITE CRYSTALS
- CHERT NODULE
- CORALS
- CRINOID
- STROMATOPAROIDS
- BRACHIOPOD

N:/jobs/244/0025/01/102/cadd/figure2-7.dgn
2516FR29.DGN

Figure 2-7. Stratigraphic Column for JPG South of the Firing Line

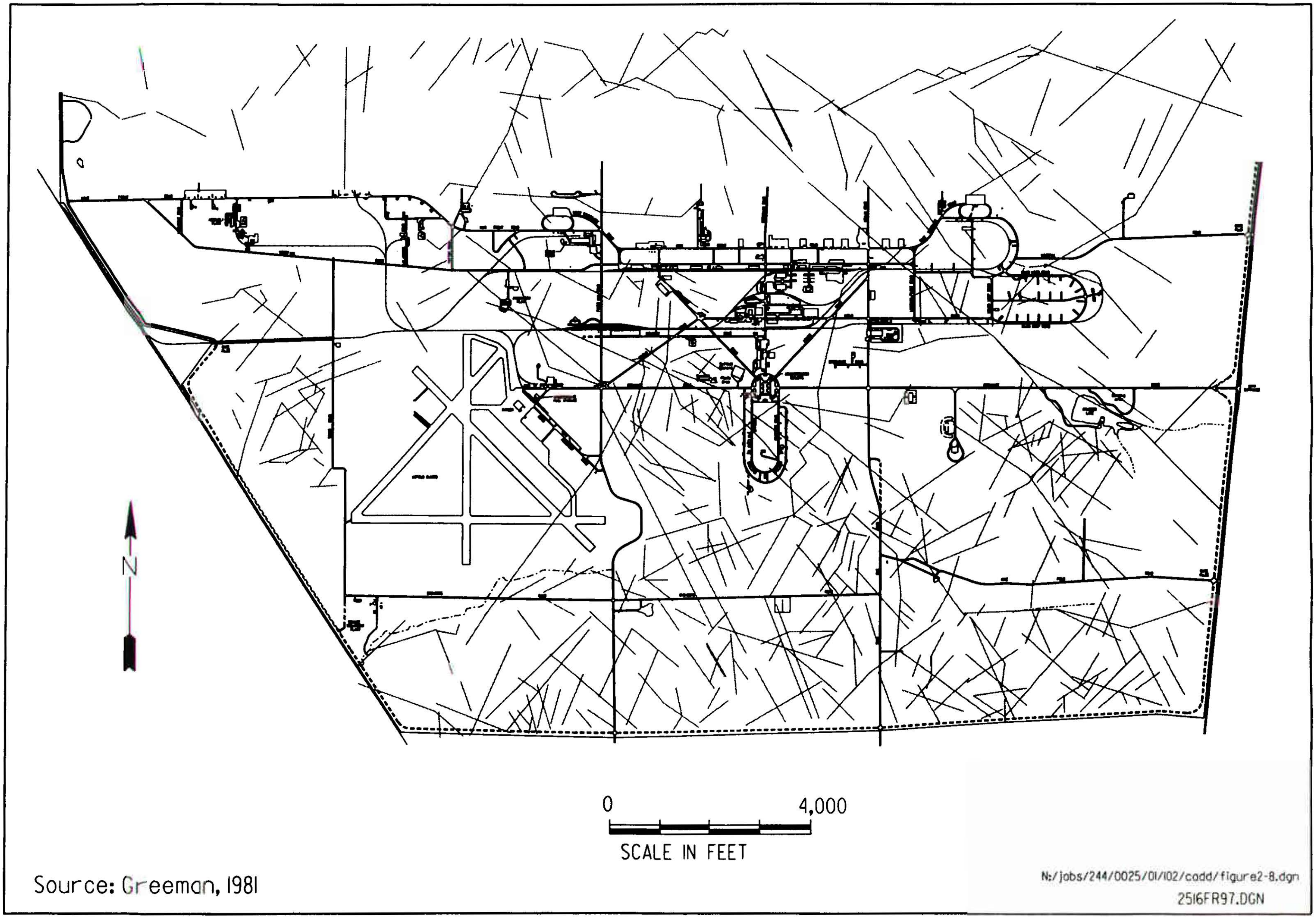


Figure 2-8. Lineament and Fracture-Trace Map

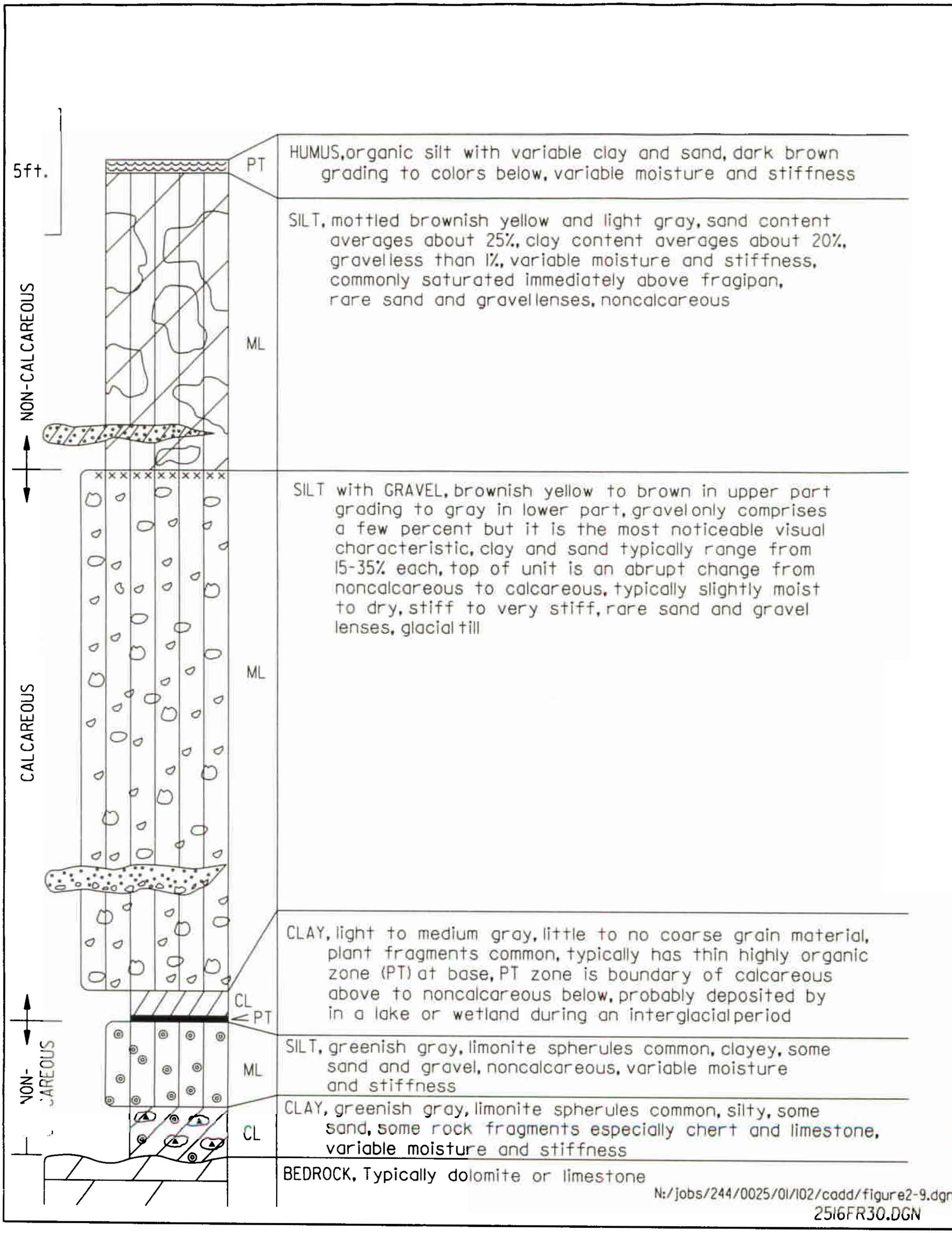


Figure 2-9. Glacial Deposit Stratigraphic Column

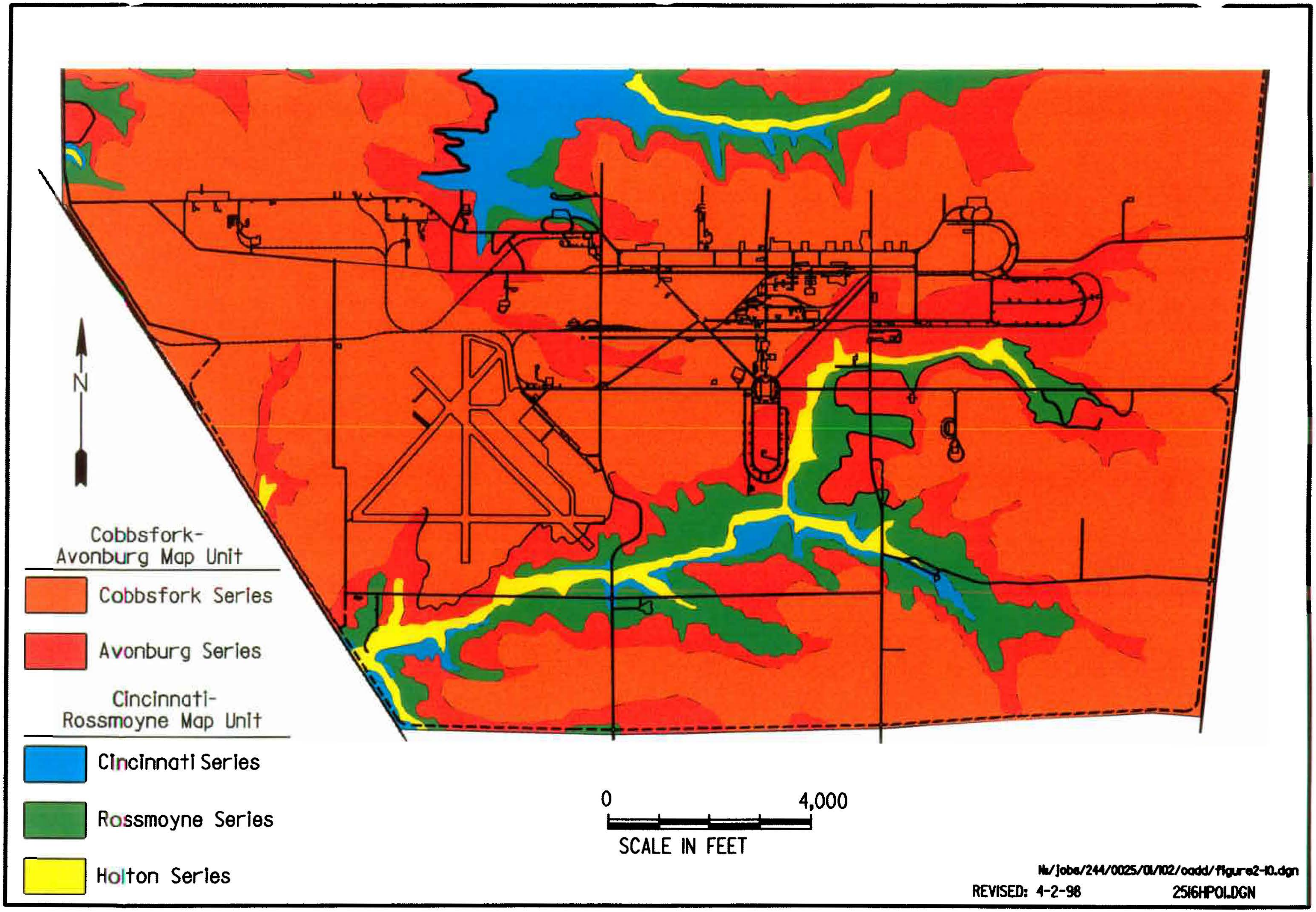
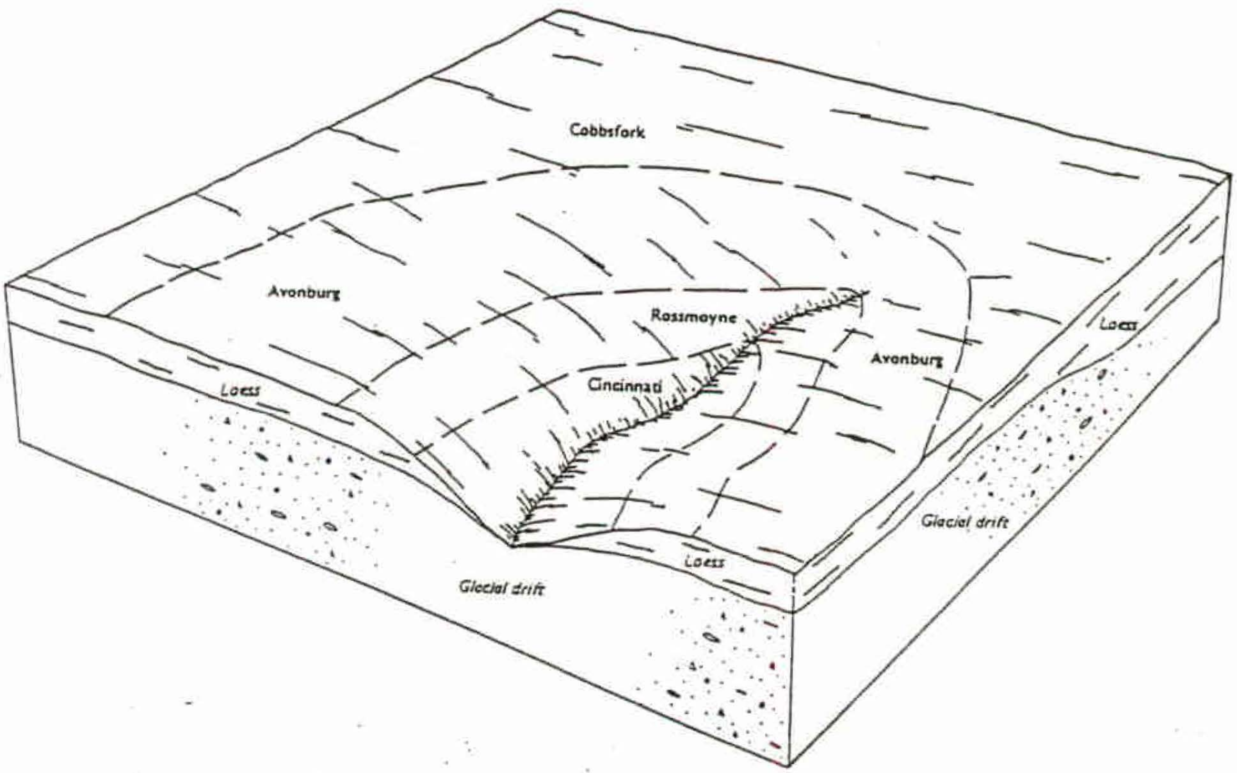
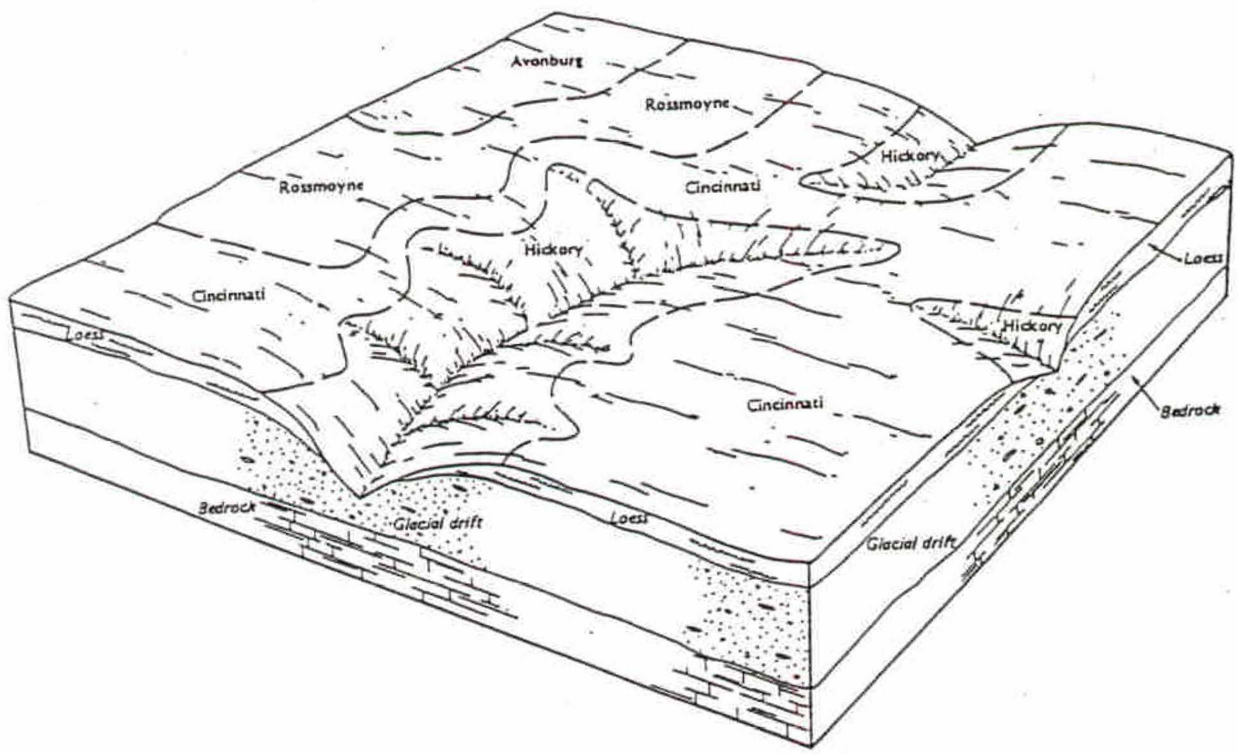


Figure 2-10. Soils Map



Source: U.S. Department of Agriculture and Soil Conservation Service, 1985a

Figure 2-11. Soil Relation to Topography and Parent Material for the Cobbsfork-Avonburg Map Unit (from USDA Soil Survey of Jefferson County)



Source: U.S. Department of Agriculture and Soil Conservation Service, 1985a

Figure 2-12. Soil Relation to Topography and Parent Material for the Cincinnati-Rossmoyne Map Unit (from USDA Soil Survey of Jefferson County)

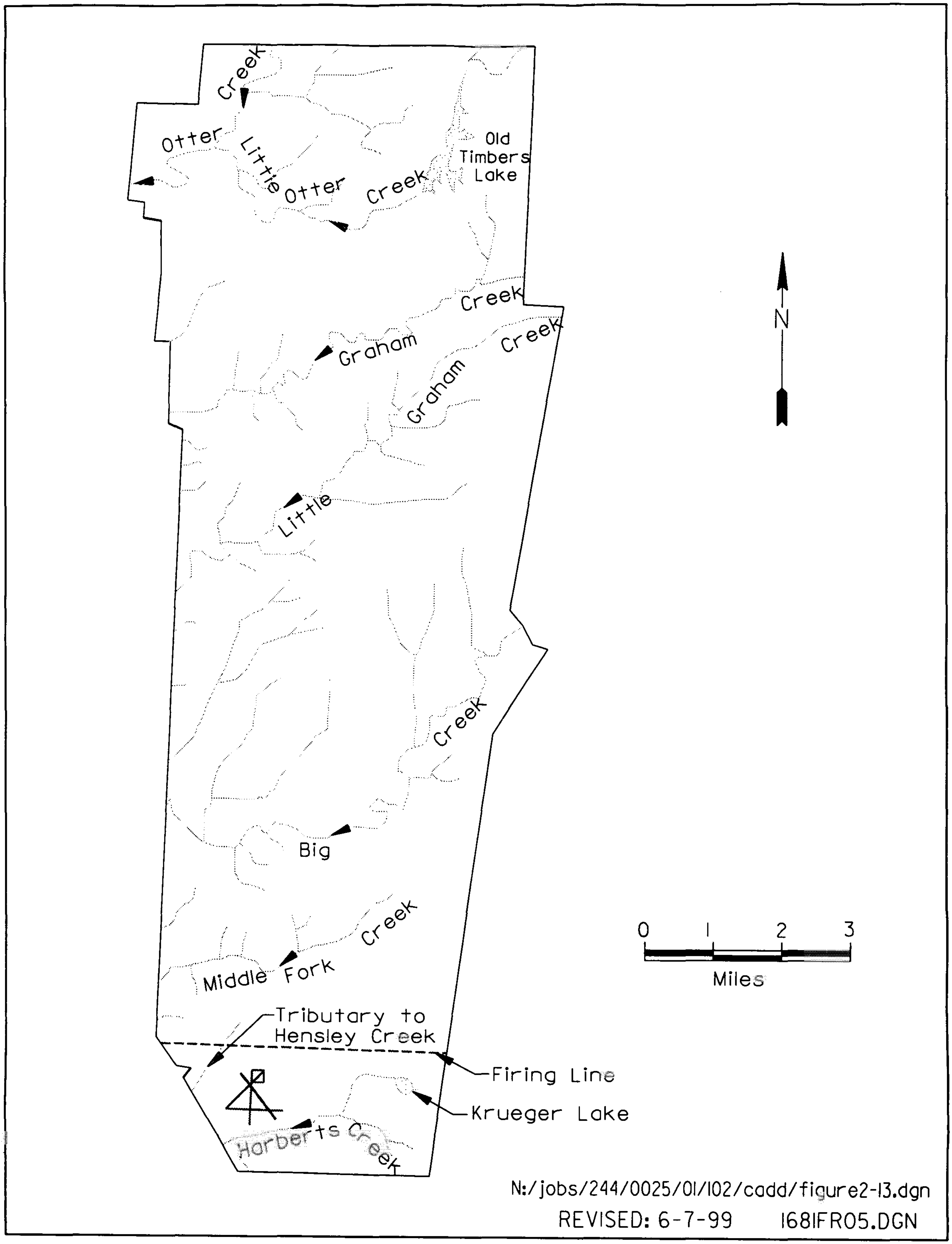
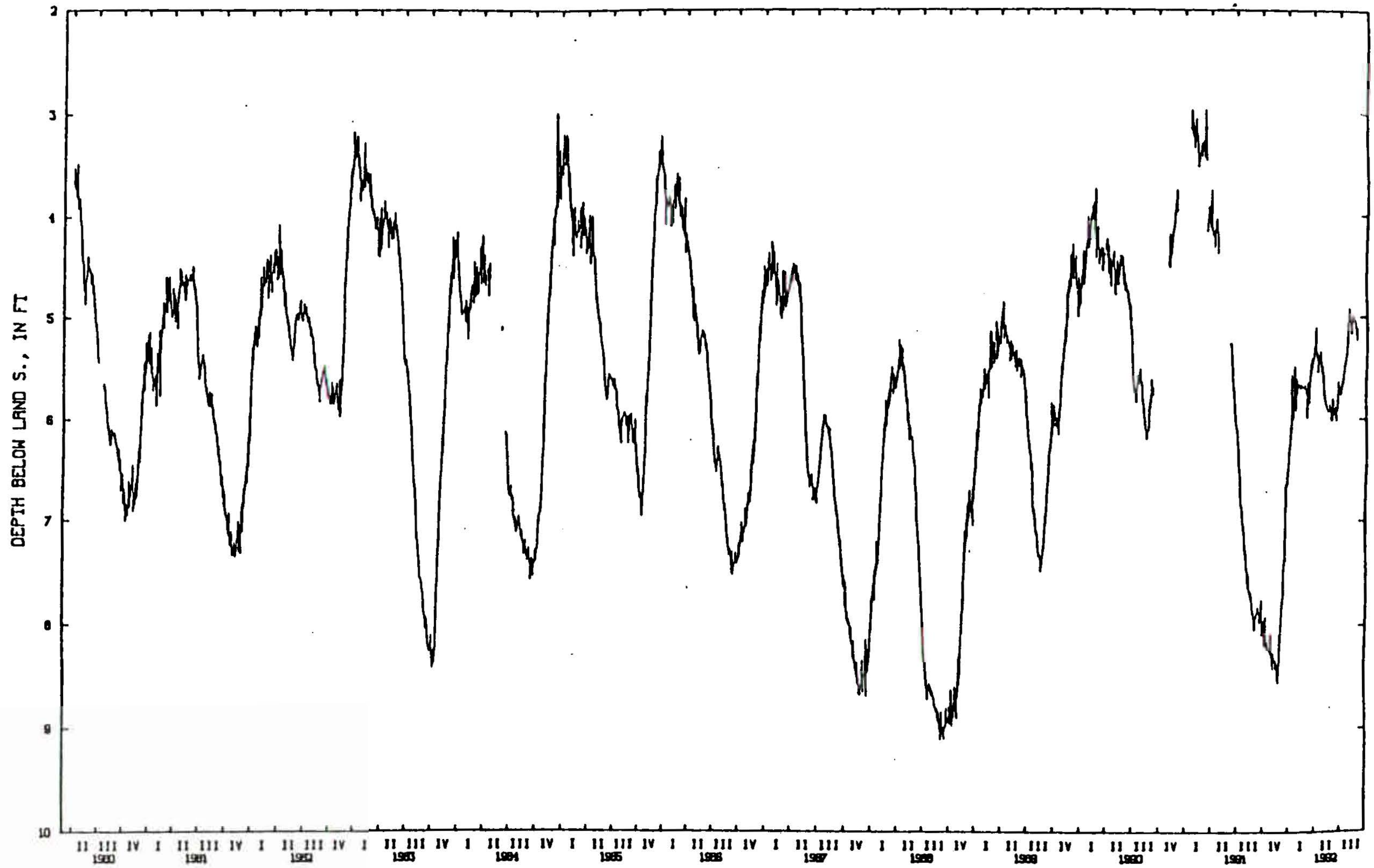


Figure 2-13. Stream Drainages at JPG



Note.—Location for Well MW-5 shown on Figure 4-3.

Figure 2-14. Hydrograph for USGS Monitoring Well MW-5

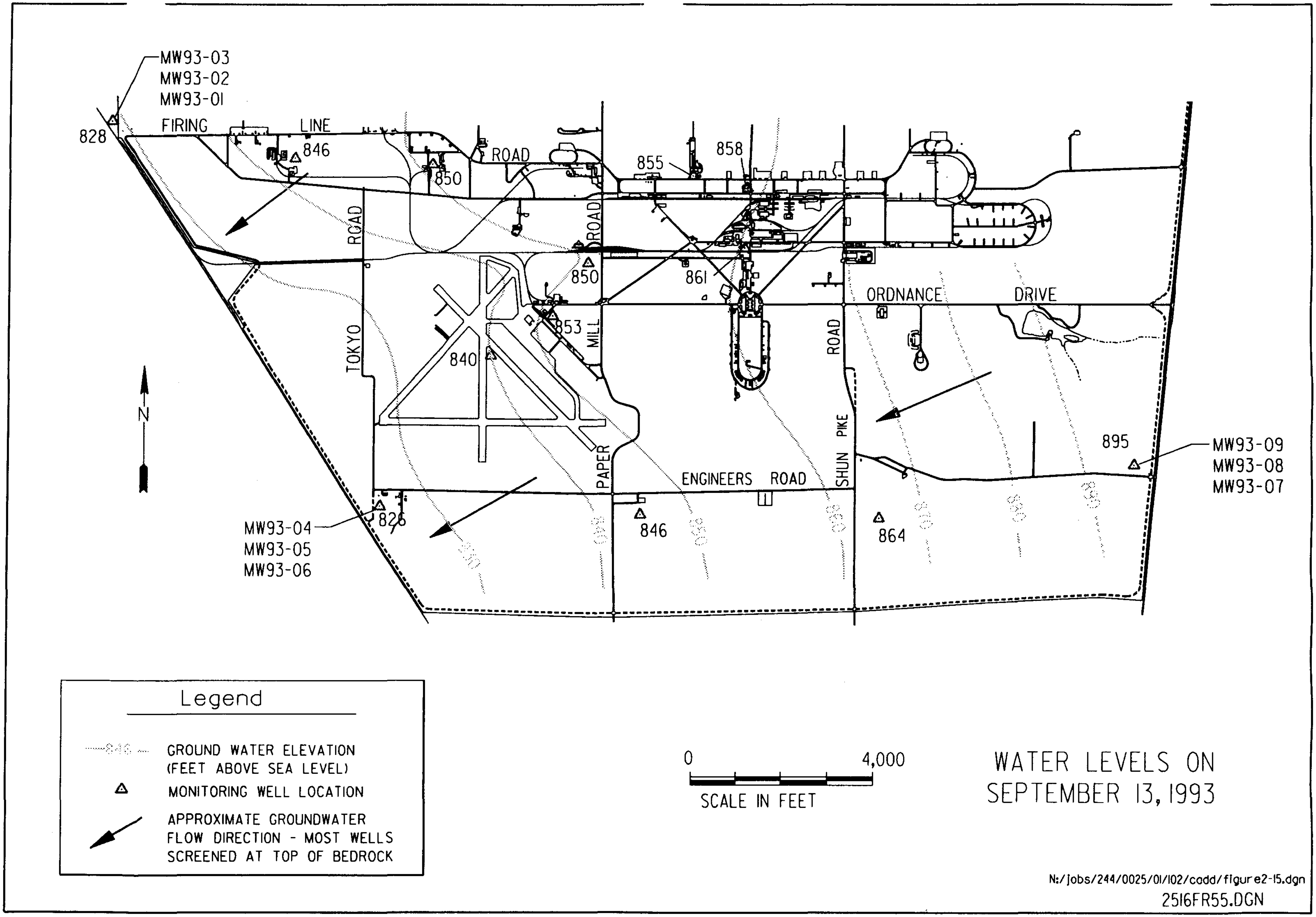


Figure 2-15. Groundwater Flow Direction, September 1993

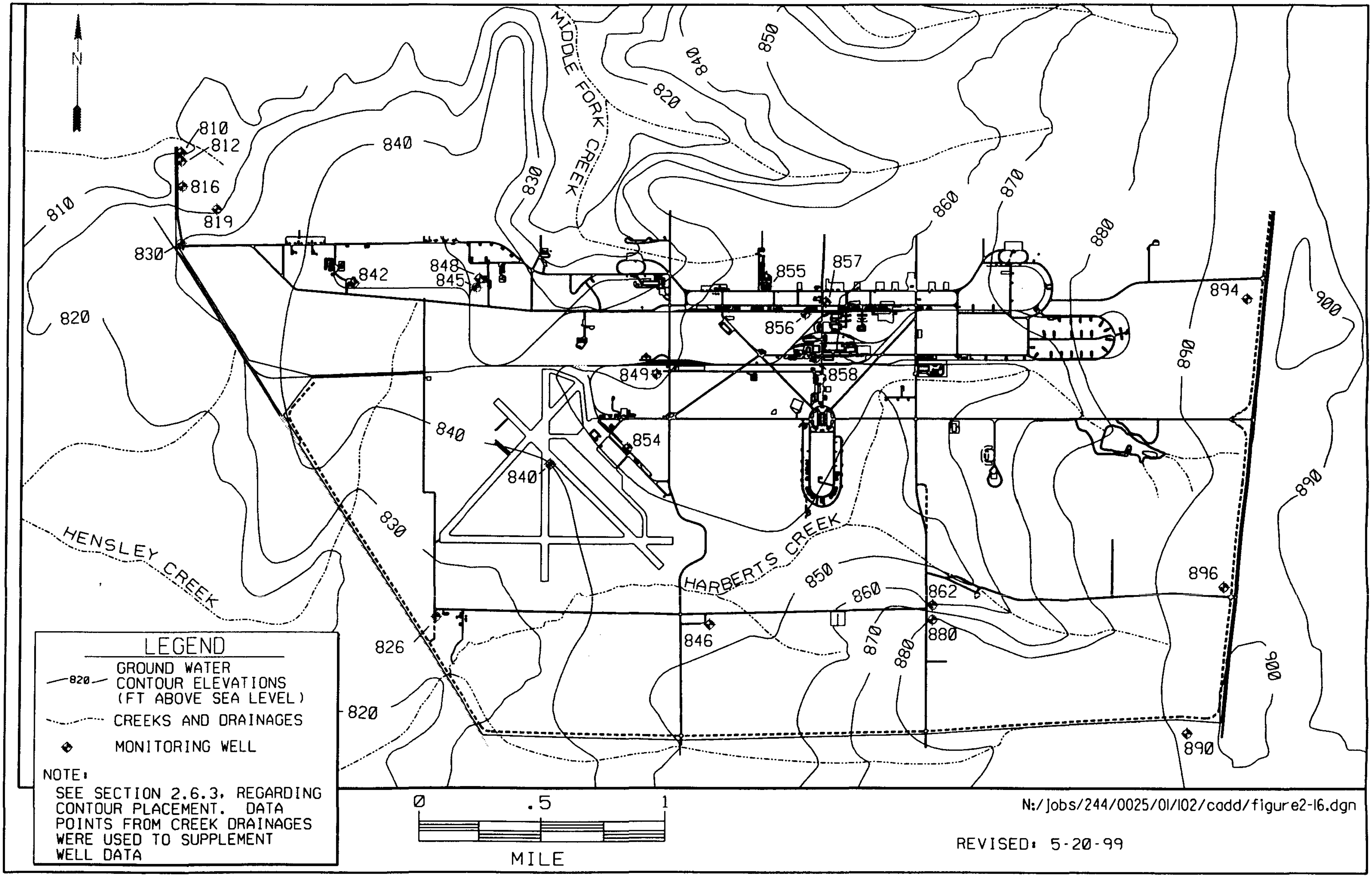


Figure 2-16. Groundwater Flow Direction, November 1995

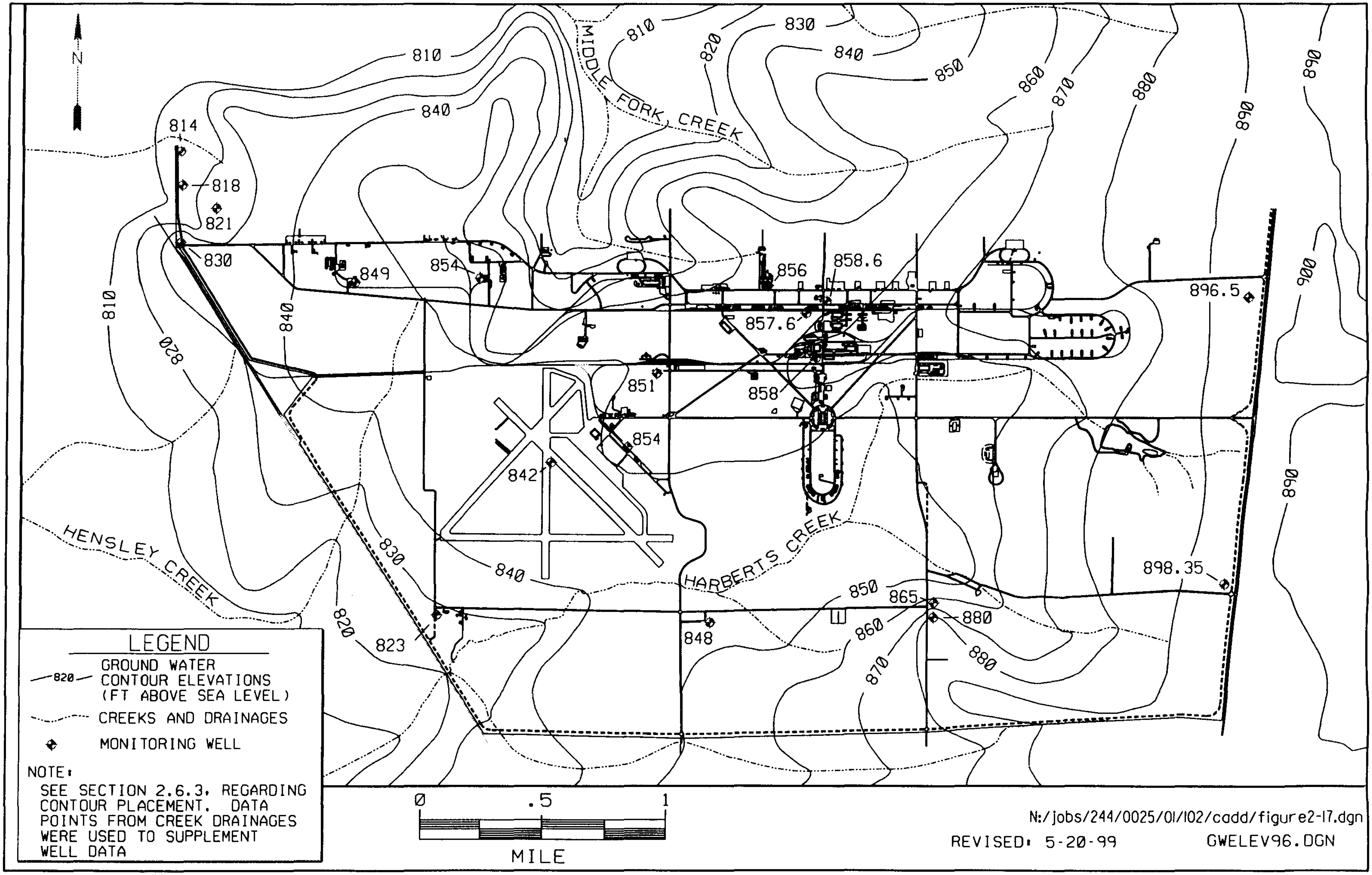


Figure 2-17. Groundwater Flow Direction, December 1996

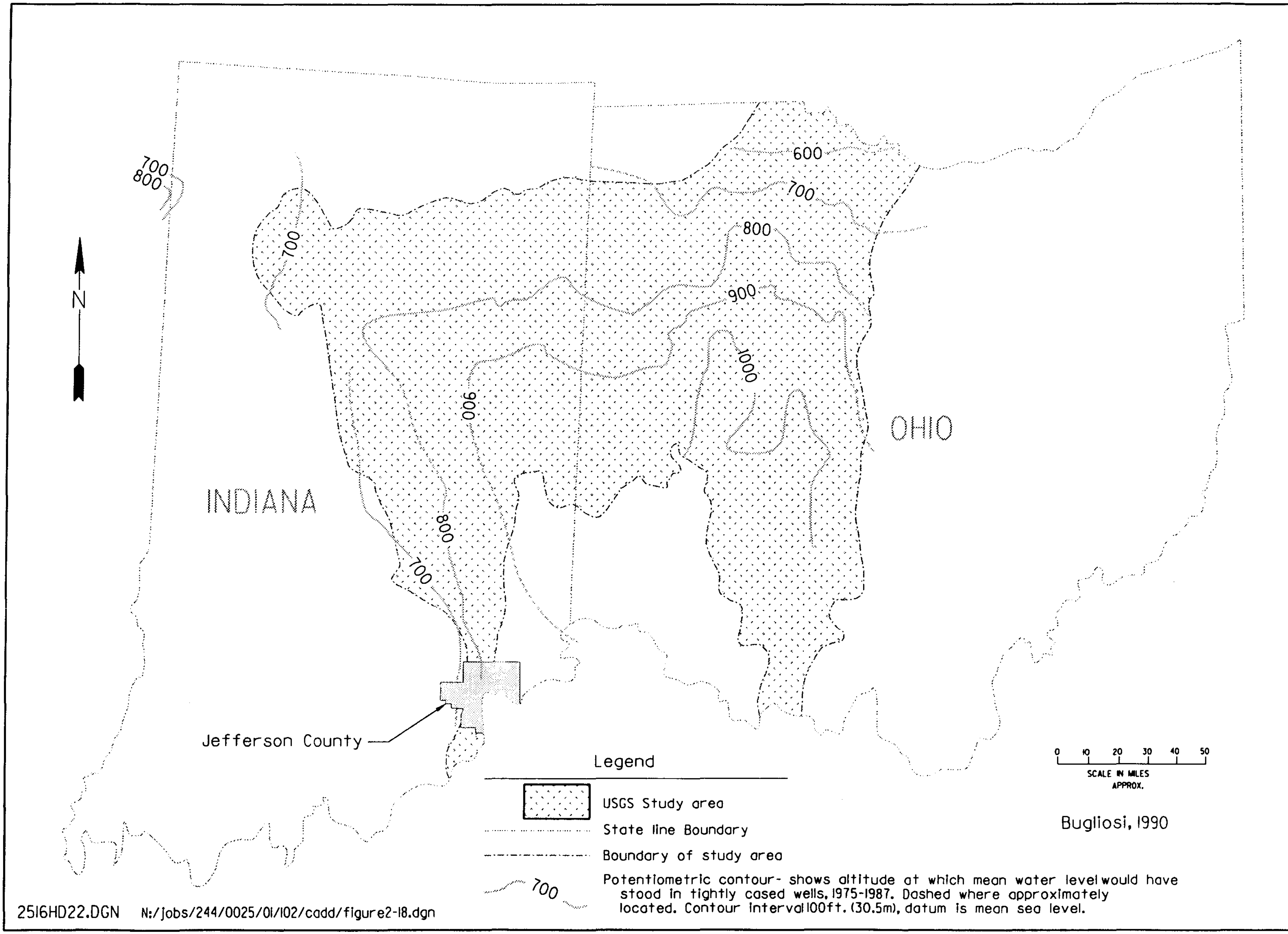


Figure 2-18. Regional Groundwater Flow ʻ ction for the Cincinnati Area

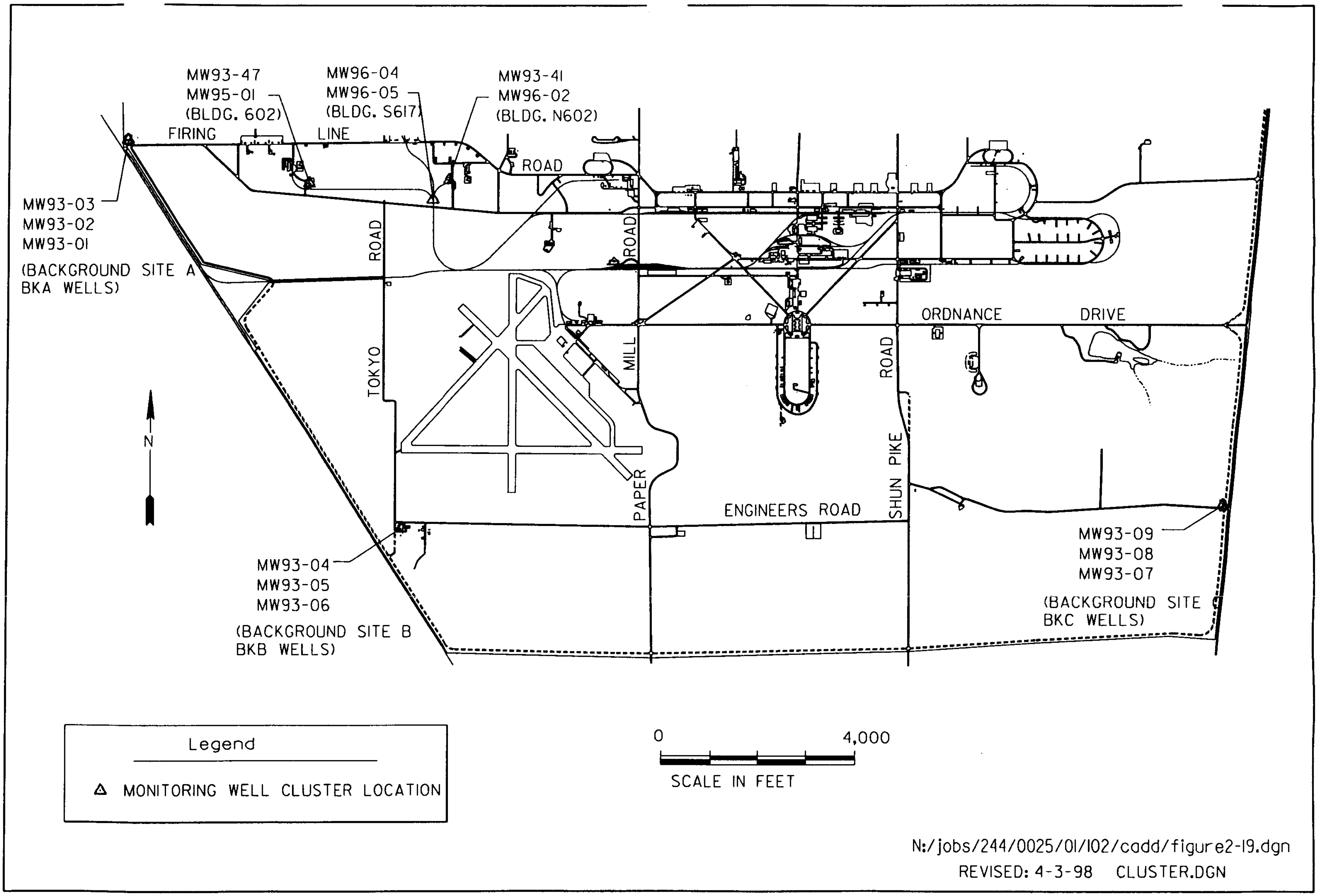


Figure 2-19. Well Cluster Locations to Determine Vertical Potential Gradients

3.0 SITE ASSESSMENT METHODOLOGY

3.1 CHRONOLOGICAL SUMMARY OF RI FIELD ACTIVITIES

3.1.1 Phase I RI Field Activities

Phase I RI fieldwork began on November 6, 1992, with three crews on site. One crew drilled and sampled soil borings; another performed surface soil, stream sediment, surface water, and other miscellaneous sampling activities; and the third performed geophysical surveys at selected sites. The drilling was performed by a subcontract crew and drilling rig from Burlington Environmental of Columbia, Illinois. They were assisted and supervised by Rust E&I personnel. Health and safety support for drilling and downhole explosive ordnance screening was provided by Rust E&I's teaming partner, EOD Technologies (EODT) of Knoxville, Tennessee. The geophysical surveys were also performed by EODT. This round of fieldwork was completed in December 1992.

Asbestos surveys and inspections were also conducted in November 1992 by a four-person team at every building south of the Firing Line. They gathered information that was included in the Asbestos Survey Work Plan, which was submitted to the Army in December 1992. Army comments were addressed in the *Final Asbestos Survey Work Plan*, which was submitted January 6, 1993. Detailed asbestos inspections began on January 11 and continued through February 12, 1993 (Rust E&I 1993a), utilizing four two-person teams from ~~. All of the inspectors were~~ Rust E&I.~~ personnel.~~ Approximately 1,700 samples were collected from 226 buildings, and the results were incorporated into a draft report submitted to the Army in June 1993. The Army's comments were incorporated, and a final report was submitted in September 1993.

The second round of Phase I RI work began in March 1993. The results of the first round of fieldwork (November-December 1992) were not available in time to perform an in-depth evaluation before starting the second round of fieldwork. However, enough information was available to determine that the soils at several sites were contaminated with VOCs. A Geoprobe field-screening program was proposed to delineate the approximate extent of contamination and to determine final monitoring well locations at these sites. This screening provided information on the extent of VOC and SVOC contamination in the soil and in shallow groundwater contained in the glacial till at a number of sites. Geoprobe field-screening activities began on March 23, 1993, by a team from Burlington Environmental, which used a van-mounted Geoprobe and a field portable gas chromatograph (GC). A Rust E&I hydrogeologist supervised the work. The Geoprobe field-screening results were obtained daily, and site maps were updated with the sample results. This information was used to place monitoring wells and to determine if a number of abandoned UST sites required additional site investigations. The field-screening results were documented in a report entitled *Final Summary Report of Field Screening at JPG*, which was submitted to the Army in August 1993 (Rust E&I 1993b). Portions of that report are included in the site-specific investigative results in Sections 6 through 28.

The installation of monitoring wells began in early April and was completed in early June 1993. Well development was completed about a week later, and sampling of the wells began at about the same time. Well drilling, installation, and development were performed by Burlington Environmental and supervised by Rust E&I personnel. Monitoring-well sampling was performed by Rust E&I personnel and was completed by July 10, 1993. The wells were surveyed for horizontal and vertical coordinates by McAllister Engineering of Madison, Indiana. Three complete sets of water level measurements were collected by Rust E&I personnel on June 29, August 13, and September 13, 1993. Slug tests were performed on ~~all~~ the wells during late July, and the field equipment was demobilized by July 27, 1993. Seven of the wells had to be resampled for explosives because the samples were accidentally contaminated with explosives spiking solution at the laboratory. One well had to be resampled for VOCs because the first sample was lost.

Other fieldwork performed during the second round of Phase I RI field activities included some additional surface soil, surface water, and wipe sampling. A ~~detailed inventory of plants and animals at each site was conducted by a team of local experts from Hanover College~~team of local experts from Hanover College conducted a detailed inventory of plants and animals at each site ~~in order~~ to provide data to support an ecological risk assessment. Additional record searches were completed on the ammunition storage igloos and several possible ordnance testing sites south of the Firing Line. Walkovers of several suspected test areas were also conducted.

The proposed versus actual Phase I RI field activities are summarized in Table 3-1.

3.1.2 Phase II RI Field Activities

As previously stated, the primary objective of the Phase II RI was to provide sufficient data to fill data gaps identified for specific sites south of the firing line at JPG following the Phase I RI. Identified data gaps and proposed field investigation activities were presented in Phase II RI Work Plans prepared in April 1996. Data collection for the Phase II RI consisted primarily of the collection of surface and subsurface soils and the installation and sampling of groundwater monitoring wells for laboratory analysis of COPCs. A total of 22 of the 50 sites required additional data collection under the Phase II RI. These sites and the activities conducted are summarized in Table 3-2.

Phase II RI fieldwork began in October 1995 and was completed in July 1996. Supplemental Phase II fieldwork was conducted in September 1997 to provide data to complete the ecological risk assessment and to collect information on potential contaminant releases associated with a new site located near the abandoned landfill (Sites 3/4). On October 18, 1995, Rust E&I field personnel and drilling personnel from Philip Environmental of Groveport, Ohio, began drilling and sampling activities at the three solvent pit sites (12A, 12B, and 12C). This included soil boring drilling and sampling, monitoring well drilling and sampling, groundwater flow meter measurements, and aquifer testing. These same activities continued at Sites 3/4, 7, 9/10, and 14 in November 1995.

In February 1996, groundwater sampling was conducted at previously installed (1983 through 1993) and newly installed (1995) wells. In April 1996, a third round of groundwater sampling

at existing well locations was conducted. In addition, a field screening investigation was conducted at the solvent pit sites (12A, 12B, and 12C) that consisted of the installation of temporary well points for collection of samples for VOC analysis using an on-site mobile laboratory. On the basis of previous Phase I results, November 1995 and February 1996 Phase II results, and April 1996 field screening results, additional monitoring wells were installed and sampled in April 1996 to fill data gaps at Sites 12B and 12C.

In May 1996, surface soil and soil boring sampling was conducted at sites 1, 2, 5, 9, 21, 25, 27, and 39. A fourth round of groundwater sampling was also conducted in June 1996. In addition, groundwater pumping tests were conducted at the three solvent pit sites (12A, 12B, and 12C located in Sections 13, 14, and 15 of this report, respectively).

In September 1997, ecological field investigation activities were conducted. These included macroinvertebrate sampling and fish counts in the surface waters of Harberts Creek, a rapid bioassessment for riparian habitat; collection of site soils for plant toxicity testing; collection of site soils for metals, pH, and organic matter content analyses; in-site earthworm toxicity testing; and identification and determination of relative abundance of soil microfauna.

Also in September 1997, additional soil sampling and analysis was conducted for a new site located adjacent to the abandoned landfill (Sites 3/4). Due to the unknown nature of buried materials at this site, a UXO survey was performed over the area by EODT, Inc., to better define the areal extent of buried debris and to support soil boring activities. Based on the results of the UXO survey, surface soil and subsurface soil samples (up to 5 feet in depth) were collected across the new site to determine the nature and extent of contamination (EPA11).

3.1.3 Phase II RI Activities Performed in 2001 [new work]

Phase II RI field activities were performed in 2001 and were to provide additional information to evaluate current groundwater conditions and the potential for natural attenuation following the Phase II field activities performed in 1997. Eight additional monitoring wells were installed, developed, and sampled in May and June 2001 at Sites 3/4 and 7/21B. In June 2001, the existing monitoring wells at Sites 12A, 12B, and 12C were also sampled. Based on the information collected during the May and June groundwater sampling event, the *Draft Work Plan, Additional Monitoring Wells, Sites 12A and 12B (Montgomery Watson)* was prepared and submitted in October 2001.

In November 2001, three additional monitoring wells (MW01-09, MW01-10, and MW01-11) were installed at Site 12A, and six additional monitoring wells (MW01-12, MW01-13, MW01-14, MW01-15, MW01-16, and MW01-17) were installed at Site 12B. The new wells at Sites 12A and 12B, and well MW93-10 at Site 7/21B were sampled in November 2001. For completeness in evaluating these sites, the information and results are included within the Phase II RI report and presented in detail in the appropriate sections for each site.

3.2 FIELD INVESTIGATION ACTIVITIES

3.2.1 Unexploded Ordnance Clearing

Sampling locations at the following eight sites plus one new site were screened for potential UXO as a safety precaution (IN9) (EPA11):

- Abandoned Landfill (Site 4)
- Gate 19 Landfill (Site 10)
- Yellow Sulfur Disposal Area (Site 14)
- Potential Ammo Dump (Site 16)
- Gator Z Mine Scrap Disposal Area (Site 29)
- Possible UXO at Airport (Site 45)
- Wooded Area South of the Airport (Site 47)
- Explosive Ordnance South of the Firing Line (Site 49)
- New Burn Site near Sites 3/4

Although archive searches and sample location screening did not identify potential UXO at Site 14, subsequent excavation activities resulted in the discovery of buried UXO (IN9) (EPA11). Prior to, during, and after UXO clearance activities, UXO personnel adhered to certain conditions that comply with the *U.S. Army Series 60 Manual* for handling ordnance items and followed current USAEC Safety Office guidance. The following conditions were required for the UXO personnel:

- Detailed Standard Operating Procedures (SOPs) were provided for ~~all~~ UXO procedures.
- Equipment to communicate with off-site emergency-response personnel was present at the site (i.e., cellular and/or radio telephones).
- UXO operations were conducted only during daylight hours.
- UXO operations ceased during thunder/lightning storms or other severe weather.
- UXO operations were conducted with a minimum of two UXO subcontractor personnel, who were equally qualified and knowledgeable of UXO.
- Arrangements were made prior to initiation of fieldwork with the responsible JPG EOD personnel for the safe disposal of UXO.

- Prior to conducting field geophysical survey activities at the Abandoned Landfill and the Gate 19 Landfill, UXO personnel assessed these sites to determine if UXO was potentially present.

- UXO personnel had stop-work authority at sites with potential UXO.

- UXO was found only at the Possible UXO at Airport Site (Site 45) during the screening of sampling locations for Phase I and Phase II RI field investigations (IN10). One fuse of unknown condition was found off to the side of the surveyed area. The fuse was marked with a flag, and JPG EOD was notified for its removal.

UXO personnel supported performance of the following specific field activities: site access, clearance of grid areas for geophysical surveys, and clearance of surface- and subsurface-sampling locations. To ensure safe and clear access through an area where the potential for UXO existed, a clearance team of two UXO personnel conducted a visual sweep of the proposed route, and cleared and marked a 10-foot-wide path. They maintained a line of sight with each other and were in continual communicationed with other field crew members. at all times.

3.2.2 Geophysical Surveys (EPA25)

Geophysical surveys were conducted during Phase I at the Abandoned Landfill (Site 4), the Gate 19 Landfill (Site 10), the Potential Ammo Dump (Site 16), the Gator Z Mine Scrap Disposal Area (Site 29), and the Possible UXO at Airport (Site 45). The geophysical surveys were designed to assist in locating and mapping individual areas where trenching may have occurred and/or where potentially hazardous materials may have been buried. The technique used at JPG was magnetometry and/or the use of an EM-31 Ground Conductivity Meter combined with an Ultrasonic Ranging and Data System (USRADS) that allowed real-time monitoring of the geophysical results. The EM-31 measures an induced magnetic field for measurement of ground conductivity.

Following the surface sweep of the area for UXO, the geophysical team established grid lines using a measuring tape, compass, and line-of-sight techniques. From a permanent, known location (i.e., bench mark and fence line), the team established corner points for the area to be surveyed using laths and high visibility flagging. Grid lines between these corner points were established using a measuring tape and line-of-sight. High visibility flagging and laths were placed at the appropriate grid spacing. Map coordinates were calculated for the corner points, and measurements were referenced to these points. Survey grids to be used at the sites varied according to the size of the area, but generally were at 20-by-20-foot or 50-by-50-foot spacings. The grids were laid out by first establishing a baseline through the central portion of the survey area using a compass and measuring tape. The baseline was a straight line with survey stakes placed a minimum of every 100 feet along its length. Using the baseline as a reference, the remainder of the survey grid was established. When utilizing the USRADS, any

geophysical anomalies encountered in the survey areas were better defined using more closely spaced measurements in a crisscross fashion across the originally identified anomaly.

The geophysical survey methodology and results are summarized in Appendix C.

3.2.3 Borehole Drilling and Sampling

3.2.3.1 Phase I Borehole Drilling and Sampling. A total of 87 boreholes were drilled and sampled during the November and December 1992 Phase I RI field activities. ~~All but eight~~Seventy-nine of the Phase I boreholes were drilled with a CME 550 ATV rig. The drilling rig was cleaned using a high-pressure, hot-water washer after arriving on site and was cleaned between auguring operations at each site. In addition, down-hole equipment such as augers and soil tubes were cleaned between each use. Cleaning operations took place at a dedicated equipment-cleaning facility at the Building 186 wash rack. The wash water was obtained from the domestic water supply at the side of Building 186. Used wash water flowed into the sump beneath the wash rack and then through an oil-water separator and into the sanitary sewer.

Several sites were screened for UXO as a precaution (EPA11). EODT personnel provided UXO clearance prior to moving onto the drill site and during ~~all phases of~~ drilling operations. The EODT personnel scanned the drill site with a magnetometer to find an area with no metal. After auguring began, the borehole was surveyed with a magnetometer every 5 feet until a depth of 15 feet or bedrock was reached.

The soil borings were drilled using 7-5/8-inch outside diameter (OD) by 4-1/4-inch inside diameter (ID) hollow-stem augers (HSAs). Continuous samples were ~~taken~~ collected from the surface to the bottom of the borehole using a combination of split-spoon samplers and continuous soil sampling tubes. To collect samples for laboratory analysis, the soil borings were split-spoon sampled at discrete intervals selected by the on-site Rust E&I geologist. During Phase I activities, samples were ~~taken~~ collected using a 3-inch OD by 24-inch-long split-spoon sampler containing four 2-1/2-inch by 6-inch-long brass sleeves. The split-spoon sampler was driven by a 140-pound drop hammer falling 30 inches into undisturbed ground beneath the lead HSA to its full length or until a blow count of 50 blows per 6 inches or less of penetration was reached. Fifty blows per 6 inches or less of penetration was considered refusal, and when these conditions were encountered no further attempt was made to sample that interval.

The full split-spoon was brought to the surface and opened. One of the four brass sleeves was selected for laboratory analysis by the Rust E&I geologist. The selected brass sleeve was separated from the others by slicing through the soil at both ends of the sleeve with a stainless-steel knife. The ends of the brass sleeve were then covered with a square of Teflon™ film, and a plastic cap was placed over both ends. The caps were sealed with silicon tape. The sample number, sample depth, analysis to be performed, and time sampled were recorded on the sample label, in the geologist's logbook, and on the soil sample data form (Appendix D). Sample material from an adjacent brass sleeve was placed in a zip-lock plastic bag and was

later tested for total VOCs using a photoionization detector (PID). The headspace total VOC values were recorded in the geologist's logbook.

Intervals not sampled by split-spoon were sampled with continuous soil-sampling tubes. A continuous sample was ~~taken~~ collected by running a 5-foot-long soil-core tube in advance of the cutting head of the HSAs. The tube was forced downward as the augers were rotated by a non-rotating A-rod connected to the top-head drive. The rods permitted the sampler to be retracted when full and replaced with a new tube.

Eight boreholes during Phase I were augured with a hand-operated, stainless-steel barrel auger. The hand auger was used where access for the truck-mounted rig was impossible, such as building interiors and underneath overhead steam lines. For boreholes inside of buildings, the building floor was first penetrated with an electric-powered, hand-operated concrete corer. The hand auger was then used to bore a hole to the desired depth, and sample material contained within the barrel was withdrawn. A stainless-steel spoon was used to remove the sample from the auger barrel. The sample was placed in a stainless-steel tray for thorough mixing prior to bottling. Samples for VOC analysis were collected before mixing to avoid loss of volatiles.

~~All s~~Sampling equipment was cleaned after each use by washing with scrub brushes in a pan containing Alconox and approved water. The equipment was moved to a second pan containing approved tap water for rinsing. The equipment was then sprayed with deionized water and placed in a rack for air drying.

The soil core was laid out on plastic sheets where it was described in detail by the field geologist. The soil samples were described on borehole logs using the Unified Soil Classification System (USCS), and colors were described using the Munsell Soil Color Chart. The borehole logs are presented in Appendix E. In addition to the lithologic description, the following items were documented on the boring log:

- Blow counts per 6 inches of penetration and percent recovery
- Depth and sample number of soil samples collected for laboratory and geotechnical analysis
- Drilling subcontractor, drillers, and rig type
- Depth water first encountered and water depth after boring completion
- Dates, times, and depths of drilling per shift
- An explanation of symbols used on the boring log
- Location sketch showing the position of wells relative to noticeable features at the site (e.g., buildings, roads, etc.)

Soil cuttings were containerized in 55-gallon drums. The drums were labeled and an inventory was kept in the geologist logbook.

3.2.3.2 Phase II Borehole Drilling and Sampling. A total of 13 soil borings were drilled and sampled during the Phase II field investigation conducted from November 1995 through July 1996 (see Table 3-2). Philip Environmental (purchaser of Burlington Environmental utilized during Phase I) of Groveport, Ohio, was subcontracted to conduct the Phase II drilling. Borehole drilling and sampling was performed using a CME 55 drilling rig, 4-1/4-inch-ID hollow-stem augers, a 5-foot-long continuous tube sampler, and a split-barrel sampler. Cleaning operations were the same as described for Phase I.

The hollow-stem auger rig was used to auger to the desired sampling depth(s). A 5-foot-long continuous soil sampling tube was placed inside the hollow-stem auger and was advanced ahead of the auger cutting head to obtain continuous core for lithologic logging. When the desired sample interval was reached, the sampling tube was removed and a 3-inch-OD by 24-inch-long stainless-steel split barrel sampler was inserted and driven for the full length of the sampler to obtain samples for chemical analysis.

Once the sampler was full, the sampler was carefully removed from the borehole and separated from the drive-rod assembly. The sampler was then laid flat on plastic sheeting, and the head and drive shoe were removed. One-half of the split-barrel was removed exposing the sample. The uppermost portion of the sample (i.e., the slough) was discarded. The sample was screened with a PID, and sample material to be analyzed for VOCs was removed immediately as-is and placed in the proper sample container. The remainder of the sample was placed in a stainless-steel pan and thoroughly mixed prior to bottling. Where a discrete section of core showed evidence of significant contamination, the material was removed and bottled prior to mixing of the remaining core.

Lithologic logging of the continuous core and sample cores was conducted as described for Phase I with the appropriate forms being completed. The completed borehole logs are presented in Appendix E. Decontamination of equipment between boreholes and samples was also completed as described for Phase I. Abandonment of the boreholes consisted of grouting with bentonite. The cuttings were screened with a PID for VOCs, and those meeting acceptable criteria were spread on the ground at the site. Cuttings not meeting the criteria were containerized, properly labeled, and stored at the site pending receipt of the analytical results for the drummed materials.

3.2.4 Surface-Soil and Sediment Sampling

Surface-soil samples for both the Phase I and Phase II RI were collected using a hand-operated stainless-steel auger or stainless-steel trowel. Sediment samples were collected using a stainless-steel scoop. The excavated soil and sediment were placed in a stainless-steel sampling pan. Samples for VOCs analysis were immediately placed in the sample containers to prevent loss of volatiles. ~~All other~~Remaining sample material was thoroughly mixed with

a stainless-steel spoon before bottling. The remaining sample material was placed in a zip-lock plastic bag, and the headspace was later tested for VOCs using a PID. The sample number, time of collection, sample depth, and the analysis to be performed were recorded on the sample label in the sampling logbook. Similar information was recorded on the soil/sediment sample data form (Appendix F). This record also contains the soil description, the sample container description, and a duplicate copy of the sample label. The sample location (measured from building corners, road intersections, or other landmarks) was recorded in the sampling logbook.

For sites with existing or suspected petroleum-based contamination, ~~all s~~sampling equipment was cleaned after each use by washing with scrub brushes in a pan containing Alconox and approved water. The equipment was then moved to a second pan containing approved tap water for rinsing. The equipment was then sprayed with deionized water and placed in a rack for air drying.

3.2.5 Surface-Water Sampling

The surface-water samples collected during Phase I at the Gate 19 Landfill and Gator Z ponds were collected by immersing the sample bottles. For VOCs samples, the bottles were capped beneath the surface of the water to avoid trapping air bubbles. The surface-water samples collected from Harberts Creek near the sewage treatment plant were collected using a peristaltic pump. Measurements of temperature, pH, and conductivity were made at the time of sample collection and recorded in the sample logbook. The sample number, water clarity and color, the analysis to be performed, and sample location were also recorded in the logbook and on the water sample data form. No surface water sampling was conducted during the Phase II field investigation.

3.2.6 Wipe Sampling

Wipe samples were collected during Phase I by wiping a sterile cotton gauze over a 10-centimeter-square area. A plastic template was used to delineate the wiped area. Wipe samples for metals and explosives analysis were collected by wiping a clean, sterile gauze pad moistened with distilled water over the designated area. The wipe was then placed inside the sampling jar.

The same procedure was followed for samples collected for other analyses, except that the following solvents were used to moisten the wipes for the corresponding compound analyzed:

- Methanol for total petroleum hydrocarbons (TPH)
- Methylene chloride for SVOCs
- Hexane for PCBs and pesticides

The sample number, sample location, solvent used, analysis to be performed, and chronology of the days activities were recorded in the sample logbook. The sample bottles were labeled with the sample number, time of collection, and analysis to be performed.

3.2.7 Field-Screening Surveys

3.2.7.1 Photoionization Detector and Organic Vapor Analyzer Screening. Both surface and subsurface soil samples were screened during Phase I using a PID or organic vapor analyzer (OVA) to determine which samples were to be analyzed for VOCs. During sample collection, a clean wide-mouth sample jar or a locking plastic bag was half-filled with sample material, sealed, and allowed to sit for approximately 1 hour at ambient temperature before a measurement for VOCs was ~~taken~~collected. For the jars, aluminum foil was placed over the jar opening and then the lid was screwed down tightly with the foil in place. The lid was removed from the jar and the probe of a calibrated PID or OVA was placed through the foil and a measurement of the headspace air was immediately ~~taken~~collected. For the plastic bag, the end was opened just enough to insert the probe and a measurement of the head space air was ~~taken~~collected. The results of these ~~head space~~headspace measurements were recorded in the field logbooks. Table 3-3 presents a summary of the head space measurements collected for the sites contained in this report.

During Phase II sampling, head space measurements were limited due primarily to the fact that a knowledge of site contaminants was obtained during Phase I. However, a PID was routinely used to screen core and cuttings as the material was removed in order to guide sample packaging, handling, and shipping. These measurements also were used for determining the proper handling and disposal of waste sample materials and cuttings. In addition to the head space analyses, discarded sample materials and cuttings were also scanned with a PID or OVA to determine the proper disposal requirements. If a positive PID reading was obtained, the material was drummed until further analysis of the waste material could be performed.

3.2.7.2 Phase I Geoprobe Field Screening Surveys. The results of the Phase I fieldwork performed in November and December 1992 indicated that Geoprobe field-screening surveys would be an effective field screening method for optimizing the sampling planned for the additional Phase I fieldwork conducted in 1993. The field screening for 25 sites at JPG was subcontracted by Rust E&I to Burlington Environmental during the second round of Phase I field investigations. The work performed involved the use of Burlington Environmental's RECON Geoprobe system to perform field screening for VOCs in soil and groundwater. The field screening was performed at some sites to determine the need for monitoring wells and, at others, to optimize the locations of monitoring wells. The Geoprobe hole locations were marked with pin flags, and utility clearances were obtained prior to start of work at each site. Probehole initiation and sampling were performed with a Geoprobe mounted on the back of a cargo van. Upon completion of ~~each~~ a probehole, the location was measured by tape to the nearest foot from reference locations such as building corners or road intersections, and recorded on a site map. The chemical compounds of interest included a variety of VOCs and SVOCs related to petroleum hydrocarbons and solvents. A field portable gas chromatograph was used to determine the presence of contamination in soil and groundwater samples. The

field gas chromatograph was calibrated for a suite of compounds sufficiently broad to provide some quantitative results for the suspected contaminants.

Notes were kept in a field logbook during the screening surveys. These notes include the location of ~~each~~ the probehole, the depth of ~~each~~ the intervals sampled for both soil and groundwater, and descriptions of the samples, such as color, texture, grain size, moisture content, and odors. ~~All p~~Probeholes were backfilled with bentonite upon completion of sampling.

The analysis results ~~and analysis~~ of the field-screening survey are presented in Appendix G.

3.2.7.2.1 Groundwater Sampling. A hydraulic probe driving unit (Geoprobe) was used to drive and withdraw the groundwater sampling probes. A hydraulic hammer was used where necessary to assist in driving probes through unusually hard or compacted soils. The probes consisted of 3-foot sections of 1-inch-diameter threaded steel pipes with a detachable drive point.

After the probe was inserted into the water-bearing zone, the drive rods were raised leaving the drive point in place. Then a section of polyethylene tubing was inserted through the drive rods into the void space between the drive point and the end of the rods. A controlled vacuum was applied to the tubing to draw the groundwater to the surface. When recharge was too slow to sample groundwater immediately after pushing down the rods, a peristaltic pump was used to collect the sample as soon as sufficient groundwater was available. The vacuum was then turned off, the tubing disconnected from the pump and removed from the rods, and the water in the tubing drained from the bottom into a 40-milliliter (mL) glass vial sealed with a Teflon™-lined septum screw cap. The sample was then given to the GC technician for on-site analysis.

The samples were prepared and analyzed using field modifications to USEPA SW-846 Method 3810 (static headspace screening) and Method 8010/8020. The field modifications provide USEPA Level II field screening data for establishing the identity and relative concentration of compounds detected.

The samples were prepared as follows: a 20-mL aliquot of the groundwater sample was placed into a headspace vial containing 3 grams of reagent grade potassium carbonate. The sample vial was heated at 70°C for 10 minutes to equilibrate the volatile components between the liquid and the air in the vial. An aliquot of up to 500 microliters of the headspace was collected by inserting a syringe through the septum of the vial and pulling the headspace sample into the syringe. The aliquot was then injected directly into the GC.

A Hewlett-Packard Model 5890A Series II GC was used for the analysis of the groundwater samples. Compound separation and detection were performed using a 30-meter wide-bore DB-VRX capillary column and a PID and flame-ionization detector in series. The analysis for benzene, toluene, ethylbenzene, and total xylenes was performed with an isothermal oven temperature of 75°C and a total analysis time of 10 minutes. Sample chromatograms, work

sheets, and analytical results for the groundwater samples are on file in the daily data-files summary packet provided to Rust E&I by Burlington Environmental.

The analysis for acetone, benzene, chloroform, 1,1-dichloroethane (1,1-DCA), 1,1-trichloroethylene (1,1-DCE), 1,2-dichloroethane (1,2-DCA), ethylbenzene, n-hexane, toluene, total 1,2-dichloroethylene (1,2-DCE), total xylenes, 1,1,1-trichloroethane (1,1,1-TCA), and 1,1,2-trichloroethane (1,1,2-TCA) was performed with an oven temperature profile of 35°C to 95°C and a total analysis time of 17.1 minutes. The reporting of 1,2-dichloroethylene (1,2-DCE) included the summation of cis- and trans-1,2-dichloroethylene. Total xylenes included the summation m-, p-, and o-xylene isomers. Benzene and 1,2-dichloroethane (1,2-DCA) were reported on data summary tables as a single value because of co-elution of the two compounds.

Sample component concentrations were measured based on an external standard calibration. Known concentrations of the above referenced compounds were injected as a calibration gas mixture into the GC. Compound peak area versus standard concentration was used to calculate sample concentrations. The computing integrator performs the calculation but will occasionally mislabel a peak, in which case the calculation must be checked by hand.

Compound identification was based on comparison of target compound retention times with sample retention times. A reference peak compound, α,α,α-trifluorotoluene (α,α,α-TFT), was added to each sample to aid in target compound identification. Compounds are considered as tentatively identified. Sample matrices and co-eluting compounds can make peak recognition and identification difficult.

Total VOC concentrations were calculated for ~~each~~ the sample by summing ~~all~~ the detected peaks from the first calibrated compound to the last calibrated compound, subtracting the area of the reference peak compound, and relating the value to the toluene response factor.

The lower quantifiable limit (LQL) is the lowest concentration of a compound that can be practicably measured relative to the calibration standard. Quantifiable limits are a function of the injection volume and the detector sensitivity. The LQL is calculated from the current target compound response factor, sample size, and the estimated peak area that would have been detected under the given conditions. The LQL for the target compounds appears in LQL data sheets included in the daily data files.

Analytical results for the groundwater samples analyzed by this technique will not necessarily be the same as those obtained by submitting the same groundwater sample for laboratory analysis. Different techniques are used in each case and, although method sensitivities and accuracies are comparable, different results are possible.

3.2.7.2.2 Soil Sampling and Analysis. A hydraulic probe driving unit was used to drive and withdraw the soil-sampling probe. A hydraulic hammer was used where necessary to assist in driving the probes through unusually hard or compacted soil. The soil sampling assembly

consisted of 3-foot sections of 1-inch-diameter threaded steel pipes, a retractable drive-point sample sleeve, and inner extension rods.

The soil sampler was driven to the desired initial sampling depth. The inner extension rods were inserted into the probe rods and threaded into the retractable drive-point piston stop, which was then removed. The piston stop prevents the retractable drive point from being pushed up into the sample sleeve prior to reaching the sampling depth. The soil sampler assembly was advanced 2 feet, pushing soil into the steel sample tube containing a disposable acetate liner. The probe rods and soil sampler were removed from the probehole and disassembled. The soil sample was extruded from the sample tube, and an aliquot was placed in a 40-mL sample vial sealed with a Teflon™-lined septum screw lid and then given to the GC technician for on-site analysis.

The samples were prepared and analyzed using field modifications to USEPA SW-846 Method 3810 (static headspace screening) and Method 8010/8020. The field modifications provide USEPA Level II field screening data for establishing the identity and relative concentration of compounds detected.

The samples were prepared for analysis as follows: 10 grams of soil and 10 mL of potassium carbonate (K_2CO_3) saturated aqueous solution were added to a 40-mL glass vial, after which the vial was capped. The sample was shaken to disperse the soil. The sample vial was heated at 70°C for 10 minutes to equilibrate the volatile components between the liquid and the air in the vial. An aliquot of up to 500 microliters of the headspace was collected by inserting a syringe through the septum of the vial and pulling the headspace sample into the syringe. The aliquot was then injected directly into the GC. The analysis continued as previously outlined in the Groundwater Sampling and Analysis section. Sample chromatograms, worksheets, and analytical results for the soil samples are on file in the daily data files summary packet provided to Rust E&I by Burlington Environmental.

Analytical results for the soil samples analyzed by this technique will not necessarily be the same as those obtained by submitting the same soil sample for laboratory analysis. Different techniques are used in each case and, although method sensitivities and accuracies are comparable, different results are possible.

3.2.7.2.3 Phase I Geoprobe Field Analytical Quality Control. Quality control was an essential part of the analytical test methodology. Quality control procedures increased the confidence in the analytical results and were used to evaluate the reproducibility of the data.

The GC was calibrated daily prior to sample analysis using a single-point external standard calibration procedure. Known concentrations of ~~each of~~ the target compounds were prepared as a gas-phase standard. The USEPA recommends instrument calibration be performed at least once every 12 hours. The calibration helps to evaluate the operating conditions of the GC and to calculate compound concentrations in samples.

A chromatographic system blank was analyzed at the beginning of each survey day, prior to calibration and analyzing samples. The system blank is used as a means of indicating that sample carry-over has not occurred. A probe rod blank was analyzed prior to sample collection to ensure that the sample probe was free of contamination. A system blank was analyzed after every 10 samples, or at least once daily for each survey. If sample carry-over had occurred, the concentration detected in the system blanks was subtracted from ~~any~~ subsequent samples containing that compound. Analytical results for blanks are presented in analytical results summary tables included in each site-specific description in Appendix G.

A duplicate sample analysis was performed after every 10 samples, or at least once daily for each survey. The duplicate analysis served to demonstrate analytical reproducibility. Duplicate sample results of plus or minus 20 percent of the original sample results were considered acceptable. Analytical results for duplicates are presented in the analytical results summary tables for each specific site in Appendix G.

A calibration check standard was analyzed periodically during the survey day. The check standard was used to validate target compound retention times and identification and to verify compound response factors. Calibration check standard concentration results of plus or minus 20 percent of the original calibration were considered acceptable. Chromatograms and results for daily check standards are located in the daily chromatogram files.

An internal reference peak compound, α,α,α-TFT, was added to ~~all~~ the samples to aid ~~in~~ with target compound identification. This reference compound served to increase the accuracy of target compound recognition and provided qualitative sample injection information. The α,α,α-TFT was used as an internal reference peak compound because of the unlikely detection of the compound in samples collected on-site.

3.2.7.2.4 Phase I Geoprobe Analytical Quality Assurance. Quality assurance was performed to evaluate and verify field gas chromatographic measurements. The verification included, but was not limited to, evaluation of data precision, accuracy, detectability, and other miscellaneous quantitative and qualitative parameters.

Quality assurance was performed by implementing the following procedures:

1. Review ~~all~~ the raw data sheets, chromatograms, and field sampling and analysis worksheets.

2. Note chromatographic abnormalities.

3. Correlate sample identification, injection volumes, and dilution multipliers on worksheets and chromatograms.

4. Review tentatively identified target compounds.

5. Reverse response factor evaluation to detect quantitation errors due to the computing integrator, target compound mismatch, manual calculations, or incorrect calibration parameters.

6. Archive raw data, including work sheets, chromatograms, and reports.

3.2.7.3 Phase II Temporary Well Point Field Screening Survey. During the April 1996 round of sampling for the Phase II RI, a field screening survey was conducted at Buildings 602, 617, and 279 Solvent Pit sites (Sites 12A, 12B, and 12C, respectively) to better define groundwater flow characteristics, to better characterize the nature and extent of groundwater contamination, and to help determine the number and location of additional permanent monitoring wells to be installed.

For ~~all~~ well point locations, borings were drilled to the top of the bedrock, to a point within the Illinoian Till, or ~~at~~ to the top of the Illinoian Till using a CME 55 ATV hollow-stem auger rig. A 5-foot section of 0.020-inch-wide slotted PVC screen was set at the bottom of the boring. Riser pipe above the screen consisted of 2-inch-diameter schedule 40 PVC pipe that was brought a level approximately 1 foot above ground surface. The annular space around the screen was backfilled with 10-20 clean silica sand to approximately 2 feet above the screened interval. A 5-foot bentonite seal was placed above the sand pack. The boring was then sealed with cement/bentonite grout to just above the top of the Illinoian till to prevent water in the ~~shallow perched zone~~glacial till from mixing with the bedrock aquifer. The remainder of the boring was left open. The temporary well points were removed following sampling activities using a winch on the drill rig. After the well materials were removed, hollow-stem augers were used to clean the hole followed by abandonment using a cement/bentonite grout. Each well point was developed, sampled, and slug tested using the same procedures utilized for the permanent monitoring wells.

An on-site mobile laboratory was used to analyze the field screening groundwater samples for VOCs. Aqua Tech Environmental Laboratories (ATEL) Inc. of Marion, Ohio, analyzed the field samples by USEPA SW-846 Method 8260 using a Hewlett Packard 5890 Series II Gas Chromatograph/5971 Mass Selective Detector. Surrogates, method blanks, matrix spike/matrix spike duplicate (MS/MSD), and laboratory control samples were utilized for mobile laboratory QC according to the Method 8260 requirements. The mobile laboratory provided a full Level IV/V data package following the completion of field activities. However, the analytical results were provided to Rust E&I as soon as possible after the analysis was completed to allow field determination of contaminant levels and to guide ongoing field activities.

A total of 32 temporary well points were installed and sampled at the three solvent pit sites. Appendix I presents the construction information for these well points. In addition to the sampling of the well points, a downhole flow meter was used to evaluate flow direction and rates in the ~~shallow perched zone~~glacial till and the bedrock aquifer. These results were used to help predict contaminant transport direction and rates. Water levels were also recorded to provide better water table surface mapping information at the three sites. Additional

information concerning the results of the field screening surveys is provided in the site-specific sections for sites 12A, 12B, and 12C (Sections 13.0, 14.0, and 15.0, respectively). Field screening analytical results and corresponding quality control results from ATEL are presented in Appendix G.

3.2.8 Monitoring Wells

A total of 48 monitoring wells were drilled and installed during the 1993 field activities. An additional 18 wells were drilled during the 1995 and 1996 field activities. There are 11 background wells (3 well clusters of 3 wells each, and 2 single completion wells) and 55 wells at 12 sites. Well locations for the Phase I RI wells were selected based on the results of soil-boring samples collected during November and December 1992, geophysical surveys performed in November 1992, and Geoprobe field-screening investigations conducted during March, April, and May 1993. Locations for the Phase II wells were based on data gaps identified from Phase I results. It should be noted that prior to the 1993 field activities, 3 wells had been installed at Building 279 and 20 wells had been installed at the Gate 19 Landfill. To the extent possible, these wells were also sampled during the RI field investigations. Many of the wells at the Gate 19 Landfill, however, have been abandoned due to the placement of a cover over the landfill during interim action activities.

In May and November 2001, seventeen additional monitoring wells were installed at four sites (12A, 12B, 7/21B, and 3/4). These monitoring wells were installed based on the results from supplemental monitoring conducted at these sites (plus site 12C) and historical data from earlier monitoring rounds.

~~Each m~~Monitoring wells drilled during Phase I and Phase II of the RI ~~was~~were assigned a sequential well number beginning with MW93 (e.g., the first well drilled was labeled MW93-1). Six monitoring wells installed by ESE during their remedial investigation of the Gate 19 Landfill and the Solvent Pit Buildings are labeled using their original well numbers with the prefix MW88 (e.g., ESE's MW-2 is designated MW88-2). The water samples collected from the monitoring wells were assigned a Site ID using the same scheme used for other types of samples. The first three characters of the Site ID are an abbreviation for the site (e.g., YSA for Yellow Sulfur Area); the fourth and fifth characters are the site number; and the sixth and seventh characters designate the type of sample (GW is used for the MW93 groundwater samples and MW is used for the MW88 groundwater samples). For the MW93 wells, the eighth character designates the sequence ~~each~~ the well was drilled at a given site. For example, YSA14GWA and YSA14GWB are the first and second wells drilled at the Yellow Sulfur Area. The last two characters indicate the round of sampling. For Phase I, this number is always 01 because only one round of sampling was performed (e.g., YSA14GWA01). For Phase II, the last two characters of 01, 02, 03, and 04 reflect four rounds of sampling. Table 3-4 lists each monitoring well and the corresponding Site ID numbers.

3.2.8.1 Drilling Procedure. The Phase I RI well drilling was performed with a Gus Pech 22-R rig. The monitoring wells were drilled with a combination of hollow-stem auguring through the glacial cover and down-hole air hammering into the bedrock section. For wells drilled

during Phase I, bedrock in the upgradient well at each site and the deep well at each of the background well clusters was continuously cored using a wireline coring method. The drilling procedure for each well, along with ~~any~~ significant events or problems, was recorded in the geologist's logbook. Well drilling during Phase II was performed using a modified CME 55 drilling rig. The Phase II wells and the additional monitoring wells were drilled using a combination of hollow-stem auguring and down-hole air hammering or air rotary drilling.

The drilling rig was cleaned using a high-pressure, hot-water washer after arriving on site and was cleaned between drilling operations at each site. In addition, down-hole equipment such as augers and soil tubes was cleaned between each use. Cleaning operations took place at a dedicated decontamination facility at the Building 186 wash rack. The wash water was obtained from the domestic water supply at the side of Building 186. Used wash water flowed into the sump beneath the wash rack, and from there through an oil-water separator and into the sanitary sewer.

Several sites had the potential for UXO and required EODT personnel for UXO clearance prior to moving onto the drill site and during ~~all phases of~~ drilling operations. The EODT personnel scanned the drill site with a magnetometer to find an area with no metal. After auguring began, the borehole was surveyed with a magnetometer every 5 feet until a depth of 15 feet or bedrock was reached.

3.2.8.1.1 Hollow-Stem Auguring. The glacial till was drilled using 7-5/8-inch OD by 4 1/4-inch ID hollow-stem augers. Continuous samples were ~~taken~~ collected from the surface to the top of bedrock using continuous soil sampling tubes or split-spoon samplers. A continuous sample was ~~taken~~collected by running a 5-foot-long soil-core tube in advance of the cutting head of the HSAs. The tube was forced downward as the augers were rotated by a non-rotating A-rod connected to the top head drive.

The rods permitted the sampler to be retracted when full and replaced with a new tube. The soil core was laid out on plastic sheets and described in detail by the field geologist. The soil samples were described on borehole logs using the Unified Soil Classification System. Colors were described using the Munsell Soil Color Chart. The borehole logs are presented in Appendix H~~E~~. In addition to the lithologic description, the following items were documented on the borehole log:

- Sampled interval and percent recovery
- Depth and sample number of representative soil samples collected as required by USAEC Geotechnical Requirements, Sec. III.A.12.d
- Drilling subcontractor, drillers, and rig type
- Depth water first encountered and water depth after boring completion
- Dates, times, and depths of drilling per shift

- An explanation of symbols used on the boring log
- Location sketch showing the position of wells relative to noticeable features at the site

After auguring to bedrock with the 7-5/8-inch-OD HSAs, the wells were reamed to bedrock with 12-inch-OD by 8-1/4-inch-ID HSAs. Soil cuttings from ~~all~~ auguring operations were containerized in 55-gallon drums, which were labeled and inventoried in the geologist's logbook. Down-hole air hammering and well installation were performed inside the 12-inch augers.

3.2.8.1.2 Bedrock Coring. Bedrock in the upgradient well at most sites and in the deep well at ~~each of~~ the three background well clusters was continuously cored using a 2.15-inch-ID wireline core barrel. Coring was performed inside the 7~~-~~5/8-inch HSAs, which were seated on the top of bedrock. At the end of a core run (a maximum of 10 feet), the inner core barrel was retrieved on a wireline, and the core was emptied from the barrel onto a core trough. The core was then reassembled, and the depth was written in indelible marker on each piece of core. The core was placed in wooden boxes, and intervals of lost core were identified with annotated wooden blocks. The boxes were marked inside and out with the well number, the box number, and the depth interval. Each box of core was photographed using color film. The field geologist description of the core was recorded on borehole logs and included the rock classification, lithologic characteristics, color (using the GSA Rock Color Chart), bedding characteristics, texture, hardness, fracturing, porosity, and degree of weathering. The borehole logs are presented in Appendix H~~E~~.

After coring was completed, the 7-5/8-inch-OD HSAs were pulled and the hole was reamed as described above using 12-inch-OD HSAs. Bedrock was then reamed to an 8-inch hole size using a down-hole air hammer.

3.2.8.1.3 Down-Hole Air Hammering. The bedrock portion of the monitoring wells was drilled using a down-hole air hammer. This method was very effective in drilling the dense limestones and dolomites that comprised the bulk of the bedrock lithologies. The air being blown downhole was filtered with two in-line filters and was checked periodically with an HNu PID (Model 101) for oil contamination. The air hammering was performed inside the 12-inch OD HSAs, which were seated at the top of bedrock. Rock cuttings, formation water, and water used for cuttings removal were discharged into a steel tank. After air hammering was finished, the tank contents were shoveled into 55-gallon drums. The drums were labeled, and an inventory was kept in the geologist's logbook.

3.2.8.2 Well Construction. The monitoring wells were constructed following USAEC Geotechnical Requirements guidelines. The well construction procedure and materials used were documented in the geologist's logbook and on well construction diagram. Completed well construction diagrams for ~~all~~ the wells installed for the RI are presented in Appendix I. Most wells were completed in an interval straddling the bottom of the glacial till and the top

of bedrock. Six of the background wells and ~~all~~ four of the Abandoned Landfill wells were screened only in bedrock. ~~All f~~Five of the Gas Station wells were screened ~~only~~ in the glacial till. Two wells, MW93-42 and MW93-47, were drilled in parking lots and were completed as flush-mounted wells. ~~All o~~Other wells were constructed with standard steel protective casings. The wells installed by Rust E&I during the Phase I and II were constructed of 4-inch-ID, schedule 40, flush-threaded PVC. The additional wells installed by Montgomery Watson during 2001 were constructed of 2-inch-ID, schedule 40 or 80, flush-threaded PVC. ~~All w~~Well screen and casing materials were steam cleaned prior to installation in the borehole. The well installation procedure is outlined below.

After the well was drilled to its total depth, the air hammer was pulled from the hole and the well depth was measured with a weighted measuring tape. The wells were screened with 0.01-inch milled slotted screen with a threaded PVC end cap. The casing above the screened interval extended to approximately 2.5 feet above ground surface where it was capped with a vented, threaded cap. The screen filter pack consisted of a USAEC-approved, 20-40 mesh silica sand and was poured to a minimum of 5 feet above the top of the screen, except in those instances where shallow well depth would have prevented an adequate seal above. Where well depth would allow, a minimum 5-foot-thick bentonite seal was poured above the sand pack using USAEC-approved bentonite pellets. The pellets were hydrated with groundwater in wells where the water level was sufficiently high. In wells where the water level was below the level of the seal, approved water was added to hydrate the pellets. The remaining annulus was grouted to near the surface with a mixture of 14 gallons of approved water per 50-pound bag of Enviroplug bentonite grout. During well installation, the HSAs were extracted in such a manner to ensure continuous placement of sand pack, bentonite pellets, and grout.

A 5-foot-long, 6-inch-square steel well protector was cemented in place over each above-ground completion. The well protectors were set approximately 2.5 feet into the ground and have hinged caps that lock with keyed padlocks. Additional protection was provided by four 3-inch-diameter steel posts erected radially 4 feet from each well. The well protectors and the well posts were painted high-visibility orange. A 6-inch-thick gravel blanket was placed around ~~each~~ the well, extending about 4 feet radially from the protective casing. A 1/4-inch-diameter drainage port was drilled through the protective casing above the gravel pad. ~~Each w~~Wells were ~~was~~ identified by a riveted brass plate stamped with the well number. For the two wells drilled in parking lots (MW-93-42 and MW-93-47), a water-tight valve box assembly was installed. The valve box cover was set flush with the pavement to protect the wells and to avoid interference with traffic.

~~All m~~Monitoring well locations and elevations were surveyed by a state licensed surveyor. The results of this survey are provided in Appendix J.

3.2.8.3 Well Development. ~~All w~~Wells installed by Rust E&I and Montgomery Watson were developed by surging and pumping. A well development record was maintained for each well documenting the water level before and after development; well volume and volume purged; water-quality parameters before, during, and after development; equipment used; and other

pertinent information (Appendix K). Similar information was also kept in the well development logbook, along with a chronology of the day's activities.

The well development procedure was as follows. Immediately following removal of the well cap, the well was checked with a PID and an initial water level measurement was takencollected. The well was then surged for approximately 10 minutes with a surge block, constructed of a steel pipe with rubber gaskets. Next, the well was pumped with a 2-inch Grundfos Rediflo submersible pump while the discharge water was monitored with a YSI pH/conductivity/ temperature meter. In cases where well production was sufficient, a 4-inch submersible pump was used. As development progressed, the volume of water removed and the water clarity were recorded. Well development continued until five well volumes were removed and the well water was clear to the unaided eye. Wells that recharged very slowly and/or wells in which the water remained turbid were considered developed after three development attempts. The *Phase I RI/FS Sampling Design Plan* (Rust E&I) did not call for turbidity measurements due to the USATHAMA requirements of purging five bore volumes or pumping dry in the case of some wells. Phase II development did include turbidity measurements. However, five normal turbidity units (NTUs) could not be achieved in many cases. Stabilization of pH, conductivity, and temperature, pumping of five bore volumes, and clarity to the unaided eye were used to determine when well development and purging were complete where turbidity measurements were lacking. (EPA29)

All dDischarge water was containerized in 55-gallon drums. The drums were labeled and an inventory was kept in the well development logbook. All wWell development equipment was cleaned using a hot-water washer prior to eachbefore its use.

3.2.8.4 Well Purging and Sampling. The 48 Phase I and 18 Phase II monitoring wells were purged and sampled no sooner than 2 weeks after well development. Additionally, six previously installed wells were purged and sampled (three at the Gate 19 Landfill and three at the Building 279 Solvent Pit). Wells that recharged more slowly were purged by using a 2-inch submersible pump powered by a generator. These wells were then sampled with a bladder pump within 48 hours after purging. Wells that recharged quickly were purged and immediately sampled with the bladder pump.

All eEquipment used for purging, measuring, and sampling was cleaned before each its use in each well to prevent avert potential cross contamination between wells. For sites with existing or suspected petroleum-based contamination, the electric submersible pump was cleaned by pumping at least three hose volumes of approved tap water and Alconox solution through the pump and hose assembly. The pump and hose were then rinsed by pumping at least three hose volumes of approved tap water. The pump and hose exteriors were cleaned using a high-pressure hot-water washer. The bladder pump was cleaned in the same manner as the electric submersible pump, with an additional final rinse of at least three hose volumes of deionized water that was pumped through the pump and hose. Also, the pump and hose exteriors were given a final rinse with deionized water.

The purging procedure for each well was documented on a purging form that provides a record of well headspace measurement, equipment used, water-level measurements, volume purged, water-quality parameter measurements, and other pertinent information (Appendix L). Immediately following removal of the well cap, the well was checked with a PID and an initial water level measurement was ~~taken~~collected. For the slower recharging wells purged with the submersible pump, the pump was lowered to about 2 feet above the bottom of the well. For the faster recharging wells purged with the bladder pump, the pump intake was lowered to the top of the screened interval. At least one well volume was purged from each of the wells. The pH, conductivity, and temperature of the discharge water were monitored during purging, as well as the water level and volume purged. Parameter stabilization was also a criterion used to determine when a well had been sufficiently purged in order for sampling to begin. Dissolved oxygen measurements were also ~~taken~~collected with a YSI dissolved oxygen meter. ~~All p~~Purged water was containerized in 55-gallon drums. The drums were labeled, and an inventory was kept in the well purging and sampling logbook.

The sampling procedure for each well was documented on a well sampling form that provides a record of equipment used, water-level measurements, water-quality parameter measurements, samples collected, preservatives used, and other pertinent information (Appendix M). Similar information was also recorded in the well sampling logbook along with a chronology of the day's activities. In the wells that recharged quickly, sampling was performed immediately after purging with the bladder pump. After taking a final set of water-quality parameter measurements, the pump-outlet hose was disconnected from the flow-through cell and used to fill the sample bottles. The water collected for dissolved metals analysis was filtered through a 0.45-micron in-line filter prior to collection. The slower recharging wells that had been purged with the submersible pump were sampled with the bladder pump within 48 hours after purging. The sampled water was clear in all but seven of the wells, where the water was slightly turbid to turbid.

In addition to the general care used in the Phase I and II sampling events, the supplemental groundwater monitoring performed by Montgomery Watson in 2001 used low-flow purging and sampling techniques. Dedicated Teflon tubing that was present in existing wells was used for sampling. New polyethylene (PE) tubing was used and then discarded at new well locations at Sites 12A, 12B, 3/4, 7/21B. Purging and sampling was conducted using Grundfos Redi-Flow 2 submersible pumps, with the exception of the four new 2-in wells constructed of Schedule 80 PVC, wherein a QED bladder pump was used. A Horiba U-22 multiprobe equipped with a flow through cell was connected to the discharge end of the pump tubing. The wells were then purged at a rate of approximately 200 to 300 mL/min. Depth-to-water measurements were also monitored and recorded during the well purging. Water quality parameters including temperature, pH, specific conductance, dissolved oxygen (DO), reduction-oxidation (redox) potential, and turbidity were recorded at 5-minute intervals on dedicated groundwater sampling data sheets.

Once water quality parameters stabilized within 10% over three consecutive readings, and depth-to-water measurements indicated that the water level was stable and above the screened interval, the well was considered to be stable and ready for sampling. If depth-to-water

measurements indicated that the water level was being drawndown steadily despite the low purge rate, then the water level was drawn down to the approximate depth of the top of the well screen to increase the head difference to induce more flow from the formation, and the recording of parameters continued. At three wells (MW93-48, MW96-04, and MW96-06) the water still appeared to be coming entirely from storage in the well screen. In these wells, the water level was drawn down to the level of the pump inlet and the groundwater samples were collected as soon as sufficient volume of groundwater had entered the well to fill the required sample containers.

Once stabilized, the multi-probe flow-thru cell was removed from the discharge tubing, and the sample was collected directly from the discharge tubing into the laboratory prepared containers. Sample bottles were filled without rinsing at the low flow rate that achieved stabilization. VOC vials were filled first, allowing the stream of groundwater to flow along the side of each vial to avoid aeration. VOC vials were completely filled with no headspace. The samples for analysis of the remaining parameters were collected following the VOC sample. In the seventeen new wells where PE tubing was used, VOC samples were collected using a stainless steel bailer.

3.2.8.5 Monitoring Well Slug Testing. ~~All m~~Monitoring wells installed during the RI were tested for determination of point-specific aquifer hydraulic conductivity using rising head and falling head slug tests. Groundwater elevation, in relation to the top of the screened interval, and the relative recharge rate determined during well development, were used as criteria to select the type of test completed on each well. When the static water level was well above the screen and the well recharged back to the static level within approximately 2 hours, both rising head and falling head tests were completed. If the groundwater elevation was within the screened interval, then only the rising head data were collected. If a well was very slow to recharge and the static water level was above the screened interval, only the falling head test was completed. The equipment used to complete these tests included a portable computer, an Aquastar data logger, NWI 5-pounds-per-square-inch (psi) pressure transducers, and a PVC slug. The slug was constructed from a capped 3-foot-by-3-inch section of PVC pipe filled with sand, used to displace water inside of the well.

The first step in the procedure was to record the static water level as measured below the top of the casing. Next, the pressure transducer was lowered inside the well approximately 6 feet below the static water level and secured with tape around the outside of the PVC casing in order to ~~prevent~~ minimize ~~any~~ movement of the transducer and cable during the test. A transducer depth of 6 feet below the static water level permitted slug movement in and out of the well without moving or interfering with the position of the transducer. Once the water level had stabilized according to readings collected on the data logger, the water level from the top of the casing was recorded again.

The data logger was pre-programmed to collect water levels from the transducer at 3-second intervals for the first 3 minutes, 5-second intervals up to 5 minutes into the test, 15-second intervals for the next 5 minutes, 30-second intervals up to 15 minutes into the test, and 2-minute intervals for the remainder of the test. For very slow recharging wells that required

several hours to return to static level, data were collected at 15- to 30-minute intervals after 2 hours into the test. These tests were often performed late in the day, so that data could be collected overnight. Once the data logger was activated to start the data collecting sequence, the slug was lowered into the well so that the top of the slug was just below the static water level. The data were recorded while the water level adjusted back to static level. In addition to the data collected with the transducer and data logger, intermittent water levels were measured from the top of the casing using a sounder. These measurements were necessary since the transducer only measures the height of water above the sensor. Once the water level returned to within 90 percent of the static water level, the data collection sequence was restarted, and the slug was quickly removed from the well to perform a rising head test. Data collection continued until the water level was again within 90 percent of the static level. The slug was steam cleaned between each use, and new nylon rope was used in each well test.

~~All d~~Data files were transferred from the data logger to a PC in LOTUS format. Using LOTUS, a data file was created containing water level versus the time difference since the beginning of the test. In turn, this file was converted into ASCII format and used as input for the program SLUGTX, a compiled FORTRAN code which utilizes the Bouwer and Rice equation for rising head and falling head data analysis. Table 2-4 lists each well and the associated hydraulic conductivity (in cm/sec) based on either the rising head or falling head data. Graphic plots of the edited data files used to derive the hydraulic conductivity values are included in Appendix B.

3.2.8.6 Monitoring Well Pumping Tests. Step drawdown pumping tests were used during Phase II at the three solvent pit sites (Sites 12A, 12B, and 12C) to evaluate the effects of pumping a well at various discharge rates. Information gained from these tests includes values for specific capacity, optimum discharge rates for pumping wells, the amount of well loss attributed to laminar and turbulent flow components, the effect of various discharge rates on turbulent flow, and estimated values for transmissivity, hydraulic conductivity, and storage coefficient.

A pressure transducer was placed in the well and connected to a datalogger for 24 hours to obtain background water level information prior to the start of the pumping test. A pressure transducer was inserted in the well at a depth below the maximum anticipated drawdown and at least 1 foot above the bottom of the well. The datalogger was programmed to record water levels on a logarithmic cycle. Once the logger was properly set, the pump was turned on and the initial drawdown was recorded. Once the drawdown had stabilized, the datalogger was reset and the pumping rate was increased. This step was repeated using various pumping rates. The results of the pumping tests are presented in Appendix B and the site-specific discussions for Sites 12A, 12B, and 12C.

3.2.8.7 Monitoring Well Water Level Measurements. During Phase I, three rounds of water-level measurement were performed for the monitoring wells at JPG. Water levels were measured for all Rust E&I monitoring wells during each of the three rounds. During the last two rounds, water levels were also measured for most of the monitoring wells installed during previous investigations at the Gate 19 Landfill (Site 10) and the Building 279 Solvent Pit

(Site 12C). Static-water levels were measured using an electronic water-level sounder or interface probe to the nearest 0.01 foot. The measurement was repeated three times to verify that the depth to water was correct. The interface probe was used for wells known or suspected to contain dense non-aqueous phase liquids (DNAPLs) or light non-aqueous phase fluids (LNAPLs). However, DNAPLs or LNAPLs have never been detected at the sites. The equipment was cleaned with a mild detergent and rinsed with deionized water before measurements in each well. The water-level data were used to construct prepare potentiometric surface maps that are presented in each of the site-specific sections that have monitoring well data. They were also used in determining hydraulic gradients. of the water-bearing formations and to determine the thickness of LNAPLs or DNAPLs, where present. During Phase II, six rounds of water-level measurements were collected (November 1995 and February, April, June, September, and December 1996) using the same procedures used during Phase I. The water-level data collected during each round by Rust E&I are summarized in Table 3-5.

During the supplemental groundwater monitoring, an oil/water interface probe capable of detecting NAPLs was used in wells which were considered to have the greatest potential for containing NAPLs. The probe was lowered slowly into each well to check the water surface for LNAPLs and to check for DNAPLs near the bottom of wells. The oil/water interface probe was used in wells MW93-47 (Site 12A), MW93-41, MW96-2, MW93-39, MW93-40, and MW95-01 (Site12B), and MW88-15 (Site 12C).

Clear disposable bailers were used to evaluate the presence of NAPLs in wells where the potential of encountering NAPLs was considered low, based on well locations with respect to identified sources, and based on historical groundwater quality results. The clear bailers were used in these wells instead of the oil/water interface probe to minimize the potential of introducing contaminants to otherwise clean wells from a probe which may have previously been in contact with pure product. The clear bailers were used in each of the wells at Sites 12A, 12B, and 12C.

No indication of the presence of LNAPLs or DNAPLs was observed in any of the wells at Sites 12A, 12B, or 12C.

3.3 CHEMICAL DATA ANALYSIS AND EVALUATION

All sSamples collected for this RI were analyzed using USAEC and/or USEPA analytical methodologies as prescribed in the *USAEC Quality Assurance Program* (QAP) (USATHAMA, 1990), and USEPA's *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods SW846,* Third Edition, and the USACE Louisville Chemistry Guideline (LCG), Revisions 1 and 3, 2001. Table 3-6 presents a list of USAEC performance demonstrated methods and USEPA analytical methods used for this RI. USAEC performance-demonstrated methods were used for all analyses performed during Phase I except for TPH and dioxins, for which USEPA approved methods were used. During Phase II, all analyses were performed using laboratory SOPs based upon USEPA SW846 methods as presented in Table 3-6. Details of these procedures can be found in the *Final Facility-Wide Quality*

Assurance Project Plan for Sites South of the Firing Line, Jefferson Proving Ground, Indiana (Rust E&I and SAIC 1996b).

~~All of the s~~Samples ~~collected~~ were analyzed by DataChem Laboratories, Inc., located in Salt Lake City, Utah. Sample analyses performed for this RI included VOCs, BTEX, SVOCs, total metals, TCLP metals, explosives, cyanide, anions, herbicides, TPH, PCB/pesticides, and dioxins/furans. The particular suite of analyses to which samples were subjected was based on historical information and previous environmental investigations for the specific site. The *Sampling Design Plan, the Final Addendum to the Remedial Investigation/Feasibility Study Sampling Design Plan, and the Phase II Remedial Investigation Field Sampling Plan* outline the rationale and proposed sampling plan for each site investigated at JPG. Historical information on potential contamination present at each site and analytical results from the sampling performed for this RI are presented by site in Sections 6.0 through 27.0.

Groundwater, sediment, and surface water samples collected during supplemental monitoring by Montgomery Watson in 2001 were analyzed by SW-846 methods by EMAX Laboratories located in Torrance, California. Samples were analyzed for one or more of the following: VOCs, SVOCs, polynuclear aromatic hydrocarbons (**PAHs**), explosives, TAL metals, dissolved gases (ethene, ethane, methane, carbon dioxide), and indicator parameters (chloride, sulfate, alkalinity, sulfide, total kjeldahl nitrogen, nitrate, and total organic carbon).

3.3.1 Explanation of Sample Site ID Designation

Analytical data for ~~each~~ samples collected at each site are provided in data tables in Sections 4.0 through 44.0 and in Appendix N. ~~Each s~~Samples were ~~was~~ assigned a 10-character Site ID. The first five characters consist of an abbreviation of the site and the site number. For example, the Yellow Sulfur Area (Site 14) is abbreviated as YSA14. The media abbreviations are the 6th and 7th characters of the sample Site ID. These abbreviations describe the type of sample collected:

- AH = Ash
- BH = Borehole Soil
- GW = Groundwater
- MW = Monitoring Well Groundwater
- SW = Surface Water (sample collected from well installed during a previous investigation) or from Middle Fork Creek **(during supplemental monitoring)**
- SD = Sediment
- SF = Surface Soil
- SN = Sand
- WL = Monitoring Well Soil
- WP = Wipe

For ~~all~~ the samples except borehole and monitoring-well samples, the last three characters are sequential sample numbers. For example, the 16 surface-soil samples at the Explosive Burning Area (Site 3) are assigned Site IDs of EBA03SF001 through -016. For borehole samples, the eighth character is a letter assigned to ~~each~~ the borehole, and the ninth and tenth characters are used to designate samples at different depths. For example, sample YSA14BHA02 was collected from the first borehole at the Yellow Sulfur Area (Site 14) from

the second depth sampled. For monitoring-well samples, the eighth character designates the sequence ~~each~~ in which the well was drilled at a given site. For example, YSA14GWA and YSA14GWB are the first and second wells drilled at the Yellow Sulfur Area. The last two characters indicate the round of sampling. Because only one round of sampling was performed, this number is always 01 (e.g., YSA14GWA01).

Sample identification used for supplemental groundwater monitoring and surface water and sediment sampling include:

- Site identifier = JPG (Jefferson Proving Ground)
- Site, Site 12A = S12A
- Sample location = SW01 - surface water sample at location 1

The sample results for each site in Appendix N are organized by media type. Within each media type, the sample results are then divided by Site ID number into groups of analytes. ~~All of the r~~Results, detections, and non-detections are printed out.

3.3.2 Chemical Data Quality Assurance/Quality Control

Analytical sample results obtained for this RI are compared to background conditions, other screening criteria, previous sampling results, and site histories in Sections 6.0 through 28.0 of this report. These comparisons allow identification and/or confirmation of contamination at the sites and are used in the selection of contaminants of concern (COCs). The COCs are then used in the ecological and human health risk assessment to determine if ~~any~~ adverse effects are associated with the site. Prior to comparison to background or site-specific conditions, analytical data were subjected to quality assurance/quality control (QA/QC) protocols specified by the USAEC QAP (USATHAMA 1990), ~~and~~ USEPA (USEPA 1994a and 1994b), or the LCG (USACE 2001). These programs are focused on ensuring precision, accuracy, representativeness, comparability, and completeness in the reported data. A flow chart detailing the data flow process for the Phase I and Phase II RI data is presented in Figure 3-1. The following sections describe these QA/QC protocols and how the results relate to the quality of the data used in this RI.

3.3.2.1 Laboratory Quality Assurance/Quality Control. USAEC, ~~and~~ USEPA, and USACE laboratory QA/QC procedures consist of creation and analysis of method blanks, laboratory quality control spikes, and MS/MSDs. These samples were analyzed with the actual field samples to evaluate the quality of the resulting analytical data. A discussion of the laboratory QC procedures used to evaluate the analytical data generated for this RI is presented below.

3.3.2.1.1 Method Blanks. For each chemical analysis conducted by the laboratory, method blanks were included in the sample lots to identify contamination that may have been introduced during sample preparation or analysis. Chemically pure deionized water was used

to collect these method blanks at the laboratory. The method blanks were then analyzed following the same procedures used to analyze field samples. Analytes detected above certified reporting limits (CRLs) in the method blank were used to delineate actual site contamination from potential laboratory contamination. Method blanks were analyzed for the following parameters: VOCs, BTEX, SVOCs, total metals, toxicity characteristic leaching procedure (TCLP) metals, explosives, cyanide, anions, herbicides, PAHs, indicator parameters, TPHC, PCB/pesticides, and dioxins.

For common laboratory contaminants (i.e., acetone, methyl ethyl ketone, methylene chloride, toluene, and the phthalate esters) found in method, trip, or rinse blanks, sample results were considered valid only if the concentration in the sample exceeded 10 times the amount detected in the corresponding method blank (USEPA 1989a). For analytes not considered to be common laboratory contaminants, sample results were considered valid only if the concentration in the sample exceeded 5 times the amount detected in the corresponding method blank (USEPA 1989a). Appendix O presents the compounds detected in method blanks that were used to evaluate the sampling results for this RI. For supplemental groundwater monitoring and surface water and sediment sampling blank results are discussed in the Quality Control Summary Reports (QCSR**s**) in Appendix P. Method blank data were compared with results from the field samples with which the blanks were associated to determine the contaminants of potential concern (COPCs) for the risk assessments. The field samples associated with the detections found in the method blanks are presented in Appendix O.

Common laboratory contaminants detected above CRLs in the method blanks were bis(2-ethylhexyl)phthalate, di-n-butylphthalate, and toluene. Detections of these contaminants in the corresponding field samples were considered laboratory artifacts unless the reported concentration exceeded 10 times the method blank concentration. Inorganic contaminants that were detected in method blanks were boron, barium, chromium, copper, manganese, lead, selenium, vanadium, and zinc. The anions, nitrite/nitrate, were present in one method blank. Organic contaminants, other than common laboratory contaminants, that were detected in the method blanks were benzo[a]anthracene, chrysene, and lindane. One dioxin, octachlorodibenzodioxin; one explosive, 1,3,5-trinitrobenzene; and several unknown compounds were also detected in method blanks. These compounds not considered to be common laboratory contaminants, with the exception of the unknowns, were used to screen field samples according to the "5-times rule." The unknown compounds could not be matched using USAEC's chemical response database.

3.3.2.1.2 Laboratory Quality Control Spikes. To verify method performance and provide information on analytical method accuracy and precision, the laboratory was required to analyze laboratory quality control spike samples (QC spikes). Three QC spikes were required for each analytical batch: one spiked at twice the concentration of the lower CRL for the method and the other two samples spiked at 10 times the concentration of the lower CRL for the method. Field samples were bracketed by the QC spikes during the actual analysis run; the low spike was analyzed initially, followed by analysis of the field samples, and then by analysis of the two high spikes. The spike recovery data were plotted on control charts to

determine if resulting recoveries were within acceptance tolerance ranges as set by USAEC and USEPA. The control charts were also used to record results from the evaluation of method-specific holding times. Results from the evaluation of these control charts in the data quality assessment performed by EcoChem, Inc., are presented in Appendix P.

Laboratory control sample recoveries for supplemental groundwater monitoring and surface water and sediment sampling are provided in the QCSRs in Appendix P.

3.3.2.1.3 Matrix Spike/Matrix Spike Duplicates. MS/MSDs were analyzed in conjunction with blanks and replicates to provide quality control for the analytical methods used. The MS/MSDs were used to provide information regarding sample matrix effects and the capability of different methods to efficiently extract analytes of interest. MS/MSDs were analyzed with every analytical batch. The MS/MSDs are actual field samples split three ways: one control sample and two duplicate samples. The control sample is analyzed, and the result is used to establish the amount of analyte actually present in the field sample. This concentration can then be used to subtract from the concentration obtained for the spiked samples in order to establish a percent recovery for that particular analyte in that matrix. In addition, the relative percent difference (RPD) for the two spikes can also be estimated. These two factors, the percent recovery and the RPD, are used to assess the precision of the analytical method.

Each USEPA analytical method has established ranges of performance, and laboratories under contract to USEPA are required to continually evaluate method-specific results of MS/MSDs to determine precision and accuracy criteria for utilized methods. Based on these results, laboratory and method-specific performance characteristics can be compared to USEPA method performance criteria. This approach is also utilized by USAEC for establishing upper and lower control chart limits.

Percent recovery values outside of established method-specific ranges may indicate matrix interference effects. For instance, when more than 100 percent of an analyte is recovered it is generally assumed that the sample matrix is contributing to the reported analyte concentration. Similarly, if percent recoveries are significantly less than 100 percent, the sample matrix may be influencing the analyte extraction process. Relative percent differences also provide information regarding possible matrix interference effects during analyses. If RPDs are outside of statistically significant ranges, then variability in sample results can be attributed to variability in the matrix or the capability of a method to extract a particular analyte from that matrix.

Under the IRDMIS system, the standard matrix control charts for each lot of data are reviewed by the USAEC Chemistry Branch. In addition to that review, EcoChem, Inc., performed a data quality assessment on sample data and the associated laboratory quality control samples from 12 of the 43 sites during Phase I. Thirty-seven lots, which were analyzed for a range of analytes including cyanide, metals, SVOCs, volatiles, explosives, PCBs, and TPH, were included in the EcoChem, Inc., evaluation. A few of these lots were over the holding time or were not within the acceptable range of percent recovery. Due to concerns over data quality,

EcoChem conducted additional evaluation of ~~all~~ the lots following Phase I. The results of this data quality assessment are presented in Appendix P. MS/MSD recoveries for ~~all of~~ the Phase II data were reviewed by EcoChem, Inc.

For supplemental groundwater monitoring and surface water and sediment sampling MS/MSD results refer to the QCSRs in Appendix P.

3.3.2.2 Field Quality Assurance/Quality Control. Field QA/QC procedures, outlined in USAEC's QAP, consist of the collection and analysis of field duplicates, rinse blanks, and trip blanks to provide information pertaining to the precision, accuracy, representativeness, comparability, and completeness of field data collected.

3.3.2.2.1 Field Duplicates. Field duplicate samples are duplicative samples collected at the same location, consisting of the same matrix, and analyzed for the same suite of analytes. Comparison of the results of field duplicates with collected sample results is indicative of the degree to which samples are homogeneous and assesses the laboratory precision for a particular method. Duplicate sample results are presented at the end of Appendix N.

3.3.2.2.2 Rinse Blanks. Rinse blanks are aqueous samples collected by running the water, which was used to rinse field sampling equipment, over or through the sampling equipment after sampling and decontamination. Results associated with these samples provide information on the effectiveness of field decontamination procedures and on the potential for sample contamination during sample collection; thus, providing critical information concerning potential cross-contamination between sampling locations.

Analytical results for the rinse blanks collected during the RI field sampling program are shown in Appendix O. Inorganics such as lead, copper, zinc, mercury, silver, and chromium were present in the rinse blanks. Nitrite/nitrate were also detected in the rinse blanks. Toluene, an organic compound and a common laboratory contaminant, was detected in a rinse blank. Several other organic contaminants—chloroform, bromodichloromethane, and dibromochloromethane—were also detected in rinse blanks. One explosive, 1,3,5-trinitrobenzene, was detected in both the rinse and method blanks, suggesting laboratory contamination as the probable source. The "5 and 10 times" rule was applied to evaluate the sample data associated with the rinse blank data and, thereby, determine the COPCs for use in the risk assessment.

3.3.2.2.3 Trip Blanks. Numerous trip blanks were shipped and analyzed under the RI field sampling program. Trip blanks are aqueous samples transported with the actual samples from the field to the laboratory and are used to identify potential sample contamination during transport. Trip blanks, VOC sample containers previously filled by DataChem, Inc., were analyzed for VOCs since contamination from the air is generally the only way field samples are contaminated during transport.

Analytical results for the trip blanks are shown in Appendix O (Table O-4). Several analytes were detected in the trip blanks such as toluene (a common laboratory contaminant),

chloroform, 1,1,1-trichloroethane, 1,1-dichloroethane, carbon tetrachloride, trichloroethene, and 1,1,2-trichloroethane. Toluene was detected at a low concentration (1 ppm) in both a trip blank and a method blank in lot ADEJ, which suggests that these detections are likely the result of laboratory contamination. The "5 and 10 times" rule was also applied to the trip blank results to evaluate the sample data associated with the contaminated trip blanks when determining the COPCs for use in the risk assessment.

Field duplicate, field blank, and trip blank data for supplemental groundwater monitoring and surface water and sediment sampling are provided in the QCSRs in Appendix P.

3.4 DATA QUALITY ASSESSMENT

This section presents an assessment of the field and laboratory data quality. In order to accurately evaluate the results of the assessment, it is important to first identify the data quality objectives (DQOs) established for the 23 sites presented in this report. Table 3-7 presents a summary of the DQOs for these sites.

~~All of the~~ The DQOs for ~~each of~~ the 23 sites were met by collecting, analyzing, and interpreting the soil, surface water, and groundwater samples and by successfully conducting the field surveys according to approved field procedures. Field and laboratory data completeness, accuracy, precision, and representativeness were also key to meeting the DQOs and are presented in the following sections.

DQOs for the supplemental groundwater monitoring and surface water and sediment sampling were equivalent to EPA Level IV data for each site sampled and Middle Fork Creek (MFC) sampling. DQO's are discussed in the *Sampling and Analysis Plan for Supplemental Groundwater Monitoring Sites 3/4, 7/21B, 12A, 12B, and 12C and Surface Water and Sediment Sampling Middle Fork Creek* (MWH, 2001).

3.4.1 Field Data

3.4.1.1 Field Audits and Surveillances. Prior to the start of field work, readiness reviews were conducted ~~to ensure~~ so that the ~~proper~~ appropriate procedures were in place, the ~~proper~~ appropriate equipment was available, training and training records were complete, and ~~that all~~ applicable work plans were available to each field team member.

During the course of each field investigation phase, an internal QA audit was performed of the field activities. A report of findings was issued and corrective action, where necessary, was taken. A record of the corrective actions was maintained. None of the observations or findings resulted in the loss or compromise of field data. The Field Leader was responsible for ensuring that procedures were being followed on a daily basis. As a result, surveillance of field activities was maintained. Where a field change was required to the written procedures or work plan scope, a field change form was completed documenting the change.

3.4.1.2 Field Calibration. The quality of field measurements was ensured through the daily execution of instrument calibrations or performance checks. Field procedures specify that instruments that fail the calibration or checks are not to be used until the instrument could be repaired or replaced. During both Phase I, and Phase II, and supplemental monitoring field investigation activities, the following instruments were calibrated or checked daily when in use:

- pH, oxidation/reduction potential, conductivity, temperature, and dissolved oxygen meter
- PID
- Turbidity meter

3.4.1.3 Completeness and Accuracy. Prior to the start of each round of field activities, a field database was established with all of the proposed samples and corresponding analyses entered. This database was monitored continuously for proposed versus actual results. This resulted in the early detection of missed samples or analyses. The chain-of-custody (CoC) records were also compared against the field database for completeness and accuracy. From the CoC record review and database monitoring, it was determined that no samples were lost as a result of improper field handling and shipping.

Field personnel strictly adhered to field decontamination procedures throughout the Phase I and Phase II investigations and strictly followed sample handling and shipping procedures to ensure the quality of the resulting data was maintained. Overall, tThe completeness goal of 90 percent for field data was achieved. In addition, field records were placed in project files that were locked when Rust E&I personnel were not present to provide security for the prevent the loss of any field records.

Accuracy of field data was evaluated primarily through the review of completed field records for completeness, accuracy, and legibility. The accuracy of data entry was also checked by comparing hard-copy printouts of the entered data with the original field data that had been entered. Calibration records were reviewed for any trends that would indicated instrument drift or failure.

3.4.1.4 Field QC Samples. To ensure that sample collection, handling, and shipping procedures resulted in quality results, several types of quality control samples were collected throughout Phase I and Phase II of the RI and the supplemental groundwater monitoring and surface water and sediment sampling at MFC. These included equipment rinse blanks, field blanks, trip blanks, and field duplicates. The results from these samples are addressed in site-specific sections (Sections 6.0 through 28.0) where the field QC sample results were compared against the resulting site sample results to ensure verify that no contamination was not introduced through sample collection and handling procedures. Data from these QC samples are presented in Appendix O.

The results of the QC sampling versus the sample data are presented in the data evaluation section for each individual site. A list of each sample ~~impacted~~ affected by blank contamination is provided where necessary.

3.4.2 Laboratory Data

3.4.2.1 Data Quality Assessment Methodology. Prior to the start of the field investigation phases of the RI, DQOs were established to define the project-specific goals for analytical precision, accuracy, representativeness, completeness, and comparability. On the basis of these goals, EcoChem, Inc., conducted a Data Quality Assessment (DQA) based on USEPA guidance documents that relate to the assessment of data quality and based on the DQOs established for the RI. EcoChem developed JPG-specific DQA work sheets that were used to review ~~all~~ JPG analytical data. These work sheets consisted of checklists that include requirements common to ~~all~~ data packages including custody documentation, deliverables checklists, and field QC and QA Status/Control Chart review. Also a project-specific corrective action form was created to track the discovery and resolution of ~~any~~ systematic problems.

The technical approach used by EcoChem to conduct the DQA consisted of Tier 1, a modified USEPA Level III DQA, and a Tier 2, consisting of USEPA Level IV/V DQA of critical lots. Tier 1 consisted of a 100 percent review of the data using a Data Quality Screening Tool (DQST) that was developed specifically for this project. The DQST provided the following information about each lot of analytical data:

- Sample index
- Holding times
- Blank contamination
- Reporting limit verification
- Blank spike percent recovery
- Surrogate percent recovery
- MS/MSD percent recovery
- MS/MSD RPD values
- Field duplicate RPD values
- Laboratory duplicate RPD values
- Target analyte list verification

The DQST results were reviewed by EcoChem, and appropriate data qualifiers were assigned to the data as a result of the review. A DQST computer printout and qualified sample result forms were reviewed by both a primary and secondary review chemist prior to being submitted to Rust E&I for incorporation into the RI Report.

The Tier 2 evaluation consisted of the identification of "critical lots," which were those data lots that had 5 percent of the data points outside the acceptance criteria, such as surrogate and spike recovery outliers, MS/MSD relative percent difference outliers, excessive blank contamination, etc. The presence of these outliers in a lot indicated that some external event had affected the data quality and that further investigation was ~~warranted~~necessary. Tier 2 DQA was performed on approximately 10 percent of the lots from Phase I and Phase II data. The Tier 2 DQA addressed the following items:

- Relative response factors
- % RSD values
- % D values
- Controlled compounds by SW-846 methods
- Compounds that were detected in the associated samples
- Compounds that, based upon a review of the raw data, appear to be non-linear or have a significantly different daily response

In addition, EcoChem recalculated a percentage of initial and continuing calibration data points when the calibration summary forms were found to be absent.

The results of the Tier 2 DQA indicate that the greatest number of data qualifiers were related to SVOC data. As a result, ~~all~~ the SVOC data were subjected to the Tier 2 DQA process. Laboratory Data Consultants (LDC), subcontracted by Montgomery Watson, performed a comprehensive data validation on 100% of the MFC surface water and sediment data and 10% of the groundwater data. Montgomery Watson performed a data review on 100% of the surface sediment and groundwater data. ~~Flagged~~ Qualified or rejected data based on the results of the DQA process are discussed in the following section and on a site-specific basis in Sections 6.0 through 28.0. The resulting DQA reports from EcoChem and QCSRs by Montgomery Watson are presented in Appendix P.

3.4.2.2 Data Quality Assessment Results.

3.4.2.2.1 Data Accuracy. Accuracy measures the bias in a measurement system. Accuracy is assessed by determining how close a measured value lies to its true value. Typical sources of bias or error include the following:

- Poorly designed sampling processes
- Field, laboratory, or container contamination
- Incorrect sample preservation
- Poor sample handling
- Sample matrix interferences and cross-contaminant interferences
- Poor or incorrect sample preparation and analysis

Sampling accuracy for the RI was evaluated by analyzing field QC samples—including field blanks, trip blanks, and rinse blanks—and by confirming the adherence to ~~all~~ sample handling, preservation, and holding time requirements. The goal for the field QC samples was no detectable analytes. The goal for holding times was no exceedence.

Based on a review of QC sample results and sample holding time information, sampling accuracy for the RI was good.

Laboratory accuracy is assessed through the use of sample spikes and QC samples. For example, a sample may be spiked with an organic or inorganic compound of known concentration and the average percent recovery (%R) calculated as a measurement of accuracy. A second procedure is to analyze a standard (e.g., standard reference materials, certified reference materials, continuing calibration standards) and calculate the percent difference (%D) between the measured value and the statistically determined value of the standard. The RI used the following quality samples to assess accuracy:

- Surrogate spikes for organic analyses
- Matrix pikes for organic, metal, and inorganic analyses
- Laboratory control samples
- Method blanks ~~(all)~~ and reagent/preparation blanks (metals)
- Standard reference materials for field calibration (i.e., the calibration verification standards for conductivity, turbidity, and PID)
- Continuing calibration check samples for organic, metal, and inorganic analyses

In addition to these QC samples, three additional checks were performed as part of the laboratory accuracy check:

- Interference check samples for inductively coupled plasma (ICP) methods
- Mass spectral tuning check for methods using a mass spectral detector
- Evaluation of chromatographic quality and check for the potential of breakdown products in various GC methods.

The accuracy DQOs established for surrogate recovery and matrix spike recoveries are provided in Appendix C of the QAPjP (Rust E&I 1996b). The accuracy DQOs for laboratory control samples, continuing calibration check samples, mass spectral tuning, and interference check samples are also given in Appendix C of the QAPjP.

Based on the EcoChem, Inc. DQA reports, many of the Phase I results for SVOCs were determined to be suspect resulting in additional sampling required for SVOCs at several locations during Phase II. In addition, results for antimony during Phase I were rejected. In most cases, additional metals data were collected during Phase II so that a data gap did not exist for antimony.

3.4.2.2.2 Precision. Precision is a measure of the reproducibility of an analytical result under a given set of conditions (i.e., to obtain the same or similar results of replicate measurements of samples from the same population). Reproducibility is affected by sample collection procedures, matrix variations, the extraction procedure, and the analytical method used. Limits of precision due to sampling factors are project-specific; they often include both project-specific effects (e.g., a particularly difficult or heterogeneous matrix) and laboratory-specific factors (e.g., poor volume measurement by the extraction chemist). In order to obtain "good" results, the sources of variability must be controlled so that the precision of the final result is adequate for its data use. Setting precision DQOs is an attempt to control sampling and analysis variability and understand inherent sample or field heterogeneity.

Field precision for the RI was assessed through the collection and measurement of field duplicates at a rate of 1 per 10 analytical samples. The best measurement of field precision is the RPD between field duplicate samples and matrix spike/matrix spike pairs. The DQO established for soil samples was an RPD less than 35 percent. For water samples, the DQO was an RPD of 25 percent for low turbidity water (less than 10 NTUs) and 35 percent of higher turbidity waters (greater than 10 NTUs). Findings of these comparisons are presented in Appendix P.

Analytical method precision was evaluated using laboratory duplicate pairs, blank spike duplicate pairs, and MS/MSDs. Laboratory precision using these duplicate pairs is assessed through the evaluation of the RPD. Criteria for laboratory precision is specified on a method-by-method basis. These criteria are presented in Appendix C of the QAPjP.

3.4.2.2.3 Completeness. Completeness is defined as the percentage of measurements that are judged to be valid for the use intended relative to the total number of measurements planned. The completeness goal is essentially the same for all data uses: a sufficient amount of data

must be obtained to make the necessary decision to take the necessary action. Nationally, USEPA's Contract Laboratory Program (CLP) has been found to be from 80 to 85 percent complete.

Objectives for completeness were not established for the Phase I RI. However, the analytical completeness for Phase I was estimated at greater than 95 percent. For the Phase II RI, two types of samples were identified for measuring completeness: (1) population samples and (2) unique, critical samples. Population samples are those samples that are collected with the intent to characterize the overall nature and extent of contamination, and no one sample is uniquely more important than another. Unique, critical samples are individual samples that are unique to a specific media, location, or time and on whose results specific decisions are made. The completeness goals established for the Phase II RI are as follows:

- Sample that is uniquely representative of conditions and an analyte that is also unique for that condition (e.g., endrin analysis for Site 21A); the goal is that 100 percent of the data be usable (but may be qualified).

- Sample that is uniquely representative of conditions and an analyte that is not unique for those conditions (e.g., one of several PAHs present); the goal is that 100 percent of the samples must have 80 percent completeness of analytes.

- Sample that is one of several equally representative samples and an analyte that is unique for those conditions; the goal is that 80 percent of the samples must have 100 percent usable data.

- Sample that is one of several equally representative samples and an analyte that is not unique for those conditions; the goal is that 90 percent of samples would have 90 percent completeness in the analyte list.

Based on the results of the DQA process, the completeness goals for Phase II data were met.

3.4.2.2.4 Representativeness. Representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter, or environmental condition. Representativeness is a measure of how closely measured results reflect the actual concentration or distribution of chemical compounds in a sampled media. Representativeness is a qualitative parameter that is most concerned with the proper design of the sampling program and proper laboratory protocol.

The field sampling designs for both the Phase I and Phase II RI were developed specifically to provide data representative of the conditions within each study area. The representativeness for the sampling was ~~ensured~~ maintained by strictly following sampling design and sampling procedures that were established for each type of sampling media. As described in Section 3.1, only minor deviations from the sampling designs and procedures were recorded during the Phase I and Phase II field investigations, and representativeness was maintained.

The representativeness of the laboratory data was maintained through the adherence to strict analytical procedures for each method used. The laboratory's conformance with these procedures was assessed through audits and data validation. Based on both the audit and DQA reports, laboratory conformance with established procedures was good.

3.4.3 Presentation and Interpretation of Data Tables

The purpose of this section is to provide a description of RI data reduction procedures performed subsequent to QA/QC evaluation described in the previous section. These data reduction steps provide a data set of valid results that can be assessed to determine the presence or absence of releases and the nature and extent of contamination at JPG sites located south of the Firing Line.

The evaluation of RI QA/QC results, as described in Section 3.3.1, was performed to generate a data set consisting of valid results and to identify data that were potentially problematic for use in the assessment of releases of contamination at JPG. Problematic data include data influenced by analytical interferences or less than tolerable analytical-method performance as measured by laboratory procedures. Problematic data also result from cross-contamination during sampling in the field or during laboratory analyses and are identified through evaluation of samples and blanks.

Analytical results were first evaluated against CRLs (USAEC methods) or method reporting limits (MRLs) (USEPA methods) to identify valid detections of analyzed compounds. Compound detections consisted of valid analytical results that exceed associated CRLs or MRLs. In general, CRLs and MRLs are accepted analytical method limits that are based on proven and well-documented analytical procedures that are continually reviewed and monitored. They reflect the lower limit of confident compound detection and are typically certified to detect contamination at or below regulatory levels. Therefore, concentrations reported above these limits, for valid data, were considered valid detections. Valid data that do not exceed CRLs or MRLs are identified in the IRDMIS database as "LT" (i.e., less than the CRL or MRL) and do not necessarily indicate that a particular compound did not exist in a sample. Rather, they indicate that the concentration of that particular compound was below the limit of statistical confidence and is not appropriate to report. Because CRLs and MRLs are generally below regulatory levels, concentrations below the reporting limits typically are treated as undetectable concentrations. Analytes that were not detected are identified in the IRDMIS database with an "ND". For Phase II analytical methods, an attempt was made to reach the USEPA Region 5 desired quantitation limits (DQL), including those that are below the laboratory SOP detection limits. Where possible, alternative methods were used to achieve the desired detection limits.

For supplemental groundwater, surface water, and sediment data not detected above the MRL, the MRL followed by a laboratory qualifier "U" is used.

During the Phase I data review, several samples were found to have been recorded as greater than or "GT" by the analytical laboratory. Most of these samples were groundwater samples

analyzed for VOCs. As a result, the groundwater was resampled and accurate values replaced the originals. There are a few sites that were not resampled where "GT" is still recorded in the measurement boolean field in Appendix N. Most of these sites were not resampled because the "GT" values were for analytes generally regarded as safe (e.g., calcium, magnesium) or estimated values were within 15 percent of the upper reporting limit.

Tables summarizing the analytical data for ~~all~~ the sites ~~for which~~where sampling was performed are presented in site-specific sections 6.0 through 28.0. The tables in ~~each~~ site-specific sections are arranged by media type. Within ~~each~~ the media type, the sample results are then divided into groups of analytes. ~~All of the r~~Results, detects and non-detects, for the total metals are printed out; however, for the rest of the analytes, only the detects are listed. Complete sets of analytical results for samples collected during the RI are presented in Appendix N.

3.4.3.1 Data Flags. The sample data were compared to several criteria in order to begin identifying data that indicated potential contamination. The different criteria that ~~each~~ samples ~~was~~were compared to and the results of that comparison are presented in the "Data Flag" field of the data tables. The data flags for method, rinse, and trip blanks are used to indicate that the flagged analyte was found in the method, trip, or rinse blank associated with the sample. ~~Each of these d~~Data flags ~~is~~are explained in Appendices N, O, and ~~x~~ P. For supplemental groundwater, surface water, and sediment samples qualifiers are included under the laboratory qualifier and/or data validation qualifier columns. Qualifier definitions are provided on the qualified data tables in Appendix N and the QCSRs in Appendix P.

TABLES

TABLE 3-1

Summary of Proposed Versus Actual Phase I RI[a] Field Activities
Jefferson Proving Ground
Madison, Indiana

Site		Geophysical Survey	UXO[b] Survey	Surface Soil	Soil Borings	Sediment	Surface Water	Groundwater Wells	Other	Geoprobe Survey
Site 1 Bldg. 185 Incinerator										
	Proposed	-	-	2	-	-	-	-	-	-
	Actual	-	-	2	-	-	-	-	-	-
Site 2 Bldg. 177 Sewage Treatment Plant										
	Proposed	-	-	2	-	5	-	-	-	-
	Actual	-	-	2	-	5	2	-	-	-
Site 3 Explosive Burning Area										
	Proposed	-	-	16	-	-	-	-	-	-
	Actual	-	-	16	-	-	-	-	-	-
Site 4 Abandoned Landfill										
	Proposed	2	1	-	4	-	-	3	-	-
	Actual	2	1	-	4	-	-	4	-	1
Site 5 Wood Storage Pile										
	Proposed	-	-	2	-	-	-	-	-	-
	Actual	-	-	2	-	-	-	-	-	-
Site 6 Wood Burning Pile										
	Proposed	-	-	2	-	-	-	-	-	-
	Actual	-	-	2	-	-	-	-	-	-

TABLE 3-1

Proposed Versus Actual Phase I RI Field Activities
Jefferson Proving Ground
Madison, Indiana

Site	Geophysical Survey	UXO Survey	Surface Soil	Soil Borings	Sediment	Surface Water	Groundwater Wells	Other	Geoprobe Survey
Site 7 Red Lead Disposal Area									
Proposed	-	-	2	4	-	-	3	-	-
Actual	-	-	2	4	-	-	3	-	-
Site 8 Small Arms Range									
Proposed	-	-	4	-	-	-	-	wipe 40	-
Actual	-	-	4	-	-	-	-	20	-
Site 9 Burning Ground									
Proposed	2	1	4	6	3	3	1	-	-
Actual	2	1	16	6	3	3	1	-	-
Site 10 Gate 19 Landfill									
Proposed	2	1	-	10	-	-	4	-	-
Actual	2	1	-	10	-	-	4	-	-
Site 11 Burning Area for Explosive Residue									
Proposed	-	-	10	4	-	-	3	-	-
Actual	-	-	10	4	-	-	3	-	1
Site 12 Bldg. 602 Solvent Pit									
Proposed	-	-	-	4	-	-	3	-	-
Actual	-	-	-	4	-	-	4	-	1

TABLE 3-1

Proposed Versus Actual Phase I RI Field Activities
Jefferson Proving Ground
Madison, Indiana

Site	Geophysical Survey	UXO Survey	Surface Soil	Soil Borings	Sediment	Surface Water	Groundwater Wells	Other	Geoprobe Survey
Bldg. 617 Solvent Pit									
Proposed	-	-	-	4	-	-	3	-	-
Actual	-	-	-	4	-	-	4	-	1
Bldg. 279 Solvent Pit									
Proposed	-	-	-	4	-	-	2	-	-
Actual	-	-	-	4	-	-	2	-	1
Site 13 Old Fire Training Pit									
Proposed	-	-	-	5	-	-	3	-	-
Actual	-	-	-	5	-	-	3	-	1
Site 14 Yellow Sulfur Area									
Proposed	-	1	-	6	4	4	3	-	-
Actual	-	1	-	6	4	-	3	-	1
Site 15 Burn Area South of New Incinerator									
Proposed	-	-	4	-	-	-	-	wipe 1	-
Actual	-	-	4	-	-	-	-	1	-
Site 16 Potential Ammo Dump									
Proposed	2	1	-	-	-	-	-	-	-
Actual	2	1	-	-	-	-	-	-	-

TABLE 3-1

Proposed Versus Actual Phase I RI Field Activities
Jefferson Proving Ground
Madison, Indiana

Site	Geophysical Survey	UXO Survey	Surface Soil	Soil Borings	Sediment	Surface Water	Groundwater Wells	Other	Geoprobe Survey
Site 17 Asbestos Survey									
Proposed	-	-	-	-	-	-	-	226 Bldgs.	-
Actual	-	-	-	-	-	-	-	329 Bldgs.	-
Site 18 USTs[(c)]									
Proposed	-	-	-	16	-	-	-	-	-
Actual	-	-	-	-	-	-	-	-	12
Site 19 Off-Site Water Supply									
Proposed	-	-	-	2	-	-	-	2 wipe	-
Actual	-	-	-	2	-	-	-	2 wipe	1
Site 20 Waste Storage Bldgs.									
Bldg. 279									
Proposed	-	-	-	8	-	-	-	wipe 16	-
Actual	-	-	-	10	-	-	-	-	-
Bldg. 305									
Proposed	-	-	-	6	-	-	-	wipe 16	-
Actual	`-	-	-	6	-	-	-	-	1
Site 21 Storage Bldgs.									
Bldg. 204									
Proposed	-	-	3	-	-	-	-	wipe 3	-

TABLE 3-1

Proposed Versus Actual Phase I RI Field Activities
Jefferson Proving Ground
Madison, Indiana

Site	Geophysical Survey	UXO Survey	Surface Soil	Soil Borings	Sediment	Surface Water	Groundwater Wells	Other	Geoprobe Survey
Actual	-	-	3	-	-	-	-	3	-
Bldg. 211									
Proposed	-	-	3	-	-	-	-	wipe 3	-
Actual	-	-	3	-	-	-	-	3	-
Site 22 Building 216 LMP									
Proposed	-	-	-	1	-	-	-	inspection	-
Actual	-	-	-	-	-	-	-	inspection	-
Site 23 Building 216 SDP									
Proposed	-	-	-	3	-	-	4	-	-
Actual	-	-	-	3	-	-	-	inspection	1
Site 24 Bldg. 602 Soil Staging									
Proposed	-	-	2	-	-	-	-	-	-
Actual	-	-	2	-	-	-	-	-	-
Site 25 Paper Mill Road Disposal Area									
Proposed	-	-	3	3	-	-	-	-	-
Actual	-	1	3	3	-	-	-	-	-
Site 26 DRMO Storage Area									
Proposed	-	-	6	-	-	-	-	-	-

TABLE 3-1

Proposed Versus Actual Phase I RI Field Activities
Jefferson Proving Ground
Madison, Indiana

Site	Geophysical Survey	UXO Survey	Surface Soil	Soil Borings	Sediment	Surface Water	Groundwater Wells	Other	Geoprobe Survey
Actual	-	-	9	-	-	-	-	-	-
Site 27 Sewage Sludge App. Areas									
Proposed	-	-	12	-	-	-	-	-	-
Actual	-	-	16	-	-	-	-	-	-
Site 28 Gator Z Mine Burn Area									
Proposed	-	-	3	-	-	-	-	1 ash	-
Actual	-	1	3	-	-	-	-	1 ash	-
Site 29 Gator Z Mine Scrap Disposal									
Proposed	1	-	-	-	3	3	-	-	-
Actual	1	-	-	-	3	3	-	-	-
Site 30 Building 204 Pesticide									
Proposed	-	-	3	-	-	-	-	wipe 3	-
Actual	-	-	3	-	-	-	-	3	-
Site 31 Building 227 Former Storage Pad									
Proposed	-	-	-	3	-	-	-	-	-
Actual	-	-	-	3	-	-	-	-	-

TABLE 3-1

Proposed Versus Actual Phase I RI Field Activities
Jefferson Proving Ground
Madison, Indiana

Site	Geophysical Survey	UXO Survey	Surface Soil	Soil Borings	Sediment	Surface Water	Groundwater Wells	Other	Geoprobe Survey
Site 32 Building 105 LMP									
Proposed	-	-	3	-	-	-	-	inspection	-
Actual	-	-	-	-	-	-	-	inspection + 1 wipe	-
Site 33 Building 333 New Incinerator									
Proposed	-	-	2	-	-	-	-	1 ash	-
Actual	-	-	2	-	-	-	-	1 ash	-
Site 34 Building 136 SBA									
Proposed	-	-	3	-	-	-	-	2 sand	-
Actual	-	-	3	-	-	-	-	2 sand	-
Site 35 Building 602 UST									
Proposed	-	-	3	-	-	-	-	-	-
Actual	-	-	3	-	-	-	-	-	1
Site 36 Bldg. 103 Oil Spill									
Proposed	-	-	-	4	-	-	4*	-	-
Actual	-	-	-	4	-	-	-	-	1
Site 37 Building 118 Gas Station									
Proposed	-	-	-	-	-	-	5	-	-

TABLE 3-1

Proposed Versus Actual Phase I RI Field Activities
Jefferson Proving Ground
Madison, Indiana

Site	Geophysical Survey	UXO Survey	Surface Soil	Soil Borings	Sediment	Surface Water	Groundwater Wells	Other	Geoprobe Survey
Actual	-	-	-	-	-	-	5	-	1
Site 38 NW-SE Runway Flare									
Proposed	1	1	1	-	-	-	-	File Search	-
Actual	1	1	1	-	-	-	-	File Search	-
Site 39 Gator Z Mine Test									
Proposed	-	-	6	-	-	-	-	-	-
Actual	-	-	6	-	-	-	-	-	-
Site 40 Bldg. 259 Discharge/Fill Pipe									
Proposed	-	-	1	-	-	-	-	inspection	-
Actual	-	-	1	-	-	-	-	inspection	-
Site 41 Bldg. 281 UST									
Proposed	-	-	-	3	-	-	4	-	-
Actual	-	-	-	3	-	-	-	-	1
Site 42 Bldg. 281 Indoor Range									
Proposed	-	-	3	-	-	-	-	10 wipe	-
Actual	-	-	3	-	-	-	-	10 wipe	-

TABLE 3-1

Proposed Versus Actual Phase I RI Field Activities
Jefferson Proving Ground
Madison, Indiana

Site	Geophysical Survey	UXO Survey	Surface Soil	Soil Borings	Sediment	Surface Water	Groundwater Wells	Other	Geoprobe Survey
Site 43 Artillery and Infantry Possible USTs									
Proposed	1	-	-	-	-	-	-	inspection	-
Actual	1	-	-	-	-	-	-	inspection	-
Site 44 Underground Concrete									
Proposed	1	-	-	3	-	-	-	1 product	-
Actual	1	-	-	3	-	-	3	1 product	1
Site 45 Airport UXO									
Proposed	-	1	-	-	-	-	-	file search	-
Actual	-	1	-	-	-	-	-	file search	-
Site 46 Flare Test Areas South									
Proposed	-	-	-	-	-	-	-	search and inspection	-
Actual	-	-	-	-	-	-	-	search and inspection	-
Site 47 Wooded Area South of									
Proposed	1	-	-	-	-	-	-	file search	-
Actual	1	-	-	-	-	-	-	file search	-

TABLE 3-1

Proposed Versus Actual Phase I RI Field Activities
Jefferson Proving Ground
Madison, Indiana

Site	Geophysical Survey	UXO Survey	Surface Soil	Soil Borings	Sediment	Surface Water	Groundwater Wells	Other	Geoprobe Survey
Site 48 Storage Igloos									
Proposed	-	-	-	-	-	-	-	search and inspection	-
Actual	-	-	-	-	-	-	-	search and inspection	-
Site 49 EO South of Firing Line									
Proposed	-	-	-	-	-	-	-	search and inspection	-
Actual	-	-	-	-	-	-	-	search and inspection	-
Site 50 Building 186 Wash Rack									
Proposed	-	-	-	-	-	-	-	inspection	-
Actual	-	-	-	-	-	-	-	inspection	-
Background Sampling									
Proposed	-	-	15	-	-	-	9	-	-
Actual	-	-	15	-	-	-	9	-	-

Footnotes:
(a) Remedial Investigation.
(b) Unexploded ordnance.
(c) Underground storage tank.

TABLE 3-2

Summary of Proposed Versus Actual Phase II RI [a] Field Activities
Jefferson Proving Ground
Madison, Indiana

Site	Geophysical Survey	UXO [b] Survey	Surface Soil	Soil Borings	Sediment	Surface Water	Groundwater Wells	Groundwater Samples	Geoprobe Survey
Site 1 Bldg. 185 Incinerator									
Proposed	-	-	2	-	-	-	-	-	-
Actual	-	-	2	-	-	-	-	-	-
Site 2 Bldg. 177 Sewage Treatment Plant									
Proposed	-	-	1	-	-	-	-	-	-
Actual	-	-	1	-	-	-	-	-	-
Site 3 Explosive Burning Area									
Proposed	-	-	20	4	-	-	-	-	-
Actual	-	-	20	4	-	-	-	-	-
Site 4 Abandoned Landfill									
Proposed	-	-	-	2	-	-	1	20	-
Actual	-	1	-	2	-	-	1	20	-
Site 5 Wood Storage Pile									
Proposed	-	-	2	-	-	-	-	-	-
Actual	-	-	2	-	-	-	-	-	-
Site 6 Wood Burning Pile									
Proposed	-	-	1	-	-	-	-	-	-
Actual	-	-	1	-	-	-	-	-	-

TABLE 3-2

Summary of Proposed Versus Actual Phase II RI Field Activities
Jefferson Proving Ground
Madison, Indiana

Site	Geophysical Survey	UXO Survey	Surface Soil	Soil Borings	Sediment	Surface Water	Groundwater Wells	Groundwater Samples	Geoprobe Survey
Site 7 Red Lead Disposal Area									
Proposed	-	-	-	-	-	-	1	16	-
Actual	-	-	-	-	-	-	1	16	-
Site 8 Small Arms Range									
Proposed	-	-	-	-	-	-	-	-	-
Actual	-	-	-	-	-	-	-	-	-
Site 9 Burning Ground									
Proposed	-	-	8	4	-	-	-	5	-
Actual	-	-	8	4	-	-	-	4	-
Site 10 Gate 19 Landfill									
Proposed	-	-	-	2	-	-	-	44	-
Actual	-	-	-	2	-	-	-	40	-
Site 12 Bldg. 602 Solvent Pit									
Proposed	-	-	-	-	-	-	2	24	-
Actual	-	-	-	-	-	-	5	24	1
Bldg. 617 Solvent Pit									
Proposed	-	-	-	-	-	-	2	24	-
Actual	-	-	-	-	-	-	6	32	1

TABLE 3-2

Summary of Proposed Versus Actual Phase II RI Field Activities
Jefferson Proving Ground
Madison, Indiana

Site	Geophysical Survey	UXO Survey	Surface Soil	Soil Borings	Sediment	Surface Water	Groundwater Wells	Groundwater Samples	Geoprobe Survey
Bldg. 279 Solvent Pit									
Proposed	-	-	-	-	-	-	3	32	-
Actual	-	-	-	-	-	-	3	32	1
Site 13 Old Fire Training Pit									
Proposed	-	-	-	2	-	-	-	15	-
Actual	-	-	-	2	-	-	-	12	-
Site 14 Yellow Sulfur Area									
Proposed	-	-	15	4	-	-	1	16	-
Actual	-	1	15	4	-	-	1	16	-
Site 15 Burn Area South of New Incinerator									
Proposed	-	-	8	4	-	-	-	-	-
Actual	-	-	8	4	-	-	-	-	-
Site 21A Bldg. 204 Temporary Storage									
Proposed	-	-	12	1	-	-	-	-	-
Actual	-	-	12	2	-	-	-	-	-

TABLE 3-2

Summary of Proposed Versus Actual Phase II RI Field Activities
Jefferson Proving Ground
Madison, Indiana

Site	Geophysical Survey	UXO Survey	Surface Soil	Soil Borings	Sediment	Surface Water	Groundwater Wells	Groundwater Samples	Geoprobe Survey
Site 21B Bldg. 211 Temporary Storage									
Proposed									
Actual									
Site 25 Paper Mill Road Disposal Area									
Proposed	-	-	10	2	-	-	-	-	-
Actual	-	-	10	2	-	-	-	-	-
Site 26 DRMO Storage Area									
Proposed	-	-	9	2	-	-	-	-	-
Actual	-	-	-	-	-	-	-	-	-
Site 27 Sewage Sludge App. Areas									
Proposed	-	-	20	4	-	-	-	-	-
Actual	-	-	20	4	-	-	-	-	-
Site 28 Gator Z Mine Burn Area									
Proposed	-	-	10	2	-	-	-	-	-
Actual	-	-	10	2	-	-	-	-	-

TABLE 3-2

Summary of Proposed Versus Actual Phase II RI Field Activities
Jefferson Proving Ground
Madison, Indiana

Site	Geophysical Survey	UXO Survey	Surface Soil	Soil Borings	Sediment	Surface Water	Groundwater Wells	Groundwater Samples	Geoprobe Survey
Site 29 Gator Z Mine Scrap Disposal									
Proposed	-	-	-	-	-	-	-	-	-
Actual	-	-	-	-	-	-	-	-	-
Site 30 Building 204 Pesticide Storage Area									
Proposed									
Actual									
Site 31 Building 227 Former Storage Pad									
Proposed	-	-	-	-	-	-	-	-	-
Actual	-	-	-	-	-	-	-	-	-
Site 33 Building 333 New Incinerator									
Proposed	-	-	2	-	-	-	-	-	-
Actual	-	-	2	-	-	-	-	-	-
Site 34 Building 136 Soundblasting Area									
Proposed									
Actual									

TABLE 3-2

Summary of Proposed Versus Actual Phase II RI Field Activities
Jefferson Proving Ground
Madison, Indiana

Site	Geophysical Survey	UXO Survey	Surface Soil	Soil Borings	Sediment	Surface Water	Groundwater Wells	Groundwater Samples	Geoprobe Survey
Site 38 NW-SE Runway Flare Test									
Proposed	-	-	-	-	-	-	-	-	-
Actual	-	-	-	-	-	-	-	-	-
Site 39 Gator Z Mine Test									
Proposed	-	-	-	-	-	-	-	-	-
Actual	-	-	-	-	-	-	-	-	-
Site 42 Bldg. 281 Indoor Range									
Proposed	-	-	-	-	-	-	-	-	-
Actual	-	-	-	-	-	-	-	-	-
New Burn Site near Sites 3/4									
Proposed	-	-	-	-	-	-	-	-	-
Actual	-	1	10	3	-	-	-	-	-
Background Sampling									
Proposed	-	-	25	-	-	1	20	-	-
Actual	-	-	25	-	-	1	15	-	-

Footnotes:
(a) Remedial Investigation
(b) Unexploded ordnance

TABLE 3-3

Summary of PID and OVA Head Space Measurements
Jefferson Proving Ground
Madison, Indiana

Site	Sampling Phase	Sample No.	Depth (feet)	Instrument Type	Headspace Reading (PPM) [d]
1	1	INC01SF001	0 - 0.5	PID [b]	ND[a]
	1	INC01SF002	0 - 0.7	PID	ND
2	1	STP02SF001	0 - 1.1	PID	ND
	1	STP02SF002	0 - 0.7	PID	ND
	1	STP02SD001	0 - 0.5	PID	ND
	1	STP02SD002	0 - 0.5	PID	ND
	1	STP02SD003	0 - 0.5	PID	ND
	1	STP02SD004	0 - 0.5	PID	ND
	1	STP02SD005	0 - 0.5	PID	ND
3	1	EBA03SF001	0 - 0.7	PID	ND
	1	EBA03SF002	0 - 0.9	PID	ND
	1	EBA03SF003	0 - 0.5	PID	ND
	1	EBA03SF004	0 - 0.4	PID	ND
	1	EBA03SF005	0 - 0.3	PID	0.1
	1	EBA03SF006	0 - 0.7	PID	ND
	1	EBA03SF007	0 - 0.8	PID	0.1
	1	EBA03SF008	0 - 0.7	PID	0.5
	1	EBA03SF009	0 - 0.5	PID	1.3
	1	EBA03SF010	0 - 0.5	PID	0.1
	1	EBA03SF011	0 - 0.5	PID	ND
	1	EBA03SF012	0 - 0.5	PID	0.2
	1	EBA03SF013	0 - 0.5	PID	0.2
	1	EBA03SF014	0 - 0.5	PID	0.2
	1	EBA03SF015	0 - 0.5	PID	0.2
	1	EBA03SF016	0 - 0.5	PID	0.2
4	1	ALF04BHA01	0.4 -1.4	PID	2
	1	ALF04BHA02	4.4 - 4.9	PID	1.2
	1	ALF04BHA03	9.4 - 9.9	PID	52
	1	ALF04BHA04	12.0 - 12.5	PID	8.5
	1	ALF04BHB01	0.5 - 1.0	PID	4.2
	1	ALF04BHB02	5.5 - 9.0	PID	60

TABLE 3-3

Summary of PID and OVA Head Space Measurements
Jefferson Proving Ground
Madison, Indiana

Site	Sampling Phase	Sample No.	Depth (feet)	Instrument Type	Headspace Reading (PPM)
4	1	ALF04BHC01	0.3 - 0.8	PID	55
	1	ALF04BHC02	4.5 - 5.0	PID	ND
	1	ALF04BHC03	9.4 - 9.9	PID	7
	1	ALF04BHC04	10.5 - 13.0	PID	ND
	1	ALF04BHD01	0.9 - 1.4	PID	ND
	1	ALF04BHD02	4.7 - 5.2	PID	ND
	1	ALF04BHD03	9.5 - 10.0	PID	60
5	1	WDP05SF001	0 - 0.8	PID	ND
	1	WDP05SF002	0 - 0.5	PID	0.1
6	1	BWP06SF001	0 - 0.6	PID	ND
	1	BWP06SF002	0 - 0.5	PID	0.1
7	1	RLA07SF001	0 - 0.8	OVA[c]	ND
	1	RLA07SF002	0 - 0.8	OVA	0.1
	1	RLA07BHA01	0.9 - 1.4	PID	ND
	1	RLA07BHA02	4.4 - 4.9	PID	2.5
	1	RLA07BHA03	4.9 - 5.4	PID	7
	1	RLA07BHB01	0.9 - 1.4	PID	5
	1	RLA07BHB02	4.5 - 5.0	PID	1
	1	RLA07BHB03	9.6 - 10.1	PID	1
9	1	BGG09SF001	0 - 0.5	OVA	ND
	1	BGG09SF002	0 - 0.5	OVA	ND
	1	BGG09SF003	0 - 0.5	OVA	ND
	1	BGG09SF004	0 - 0.5	OVA	ND
	1	BGG09SF005	0 - 0.5	OVA	ND
	1	BGG09SF006	0 - 0.5	OVA	ND
	1	BGG09SF007	0 - 0.5	OVA	ND
	1	BGG09SF008	0 - 0.5	OVA	3.0
	1	BGG09SF009	0 - 0.5	OVA	ND
	1	BGG09SF010	0 - 0.5	OVA	ND
	1	BGG09SF011	0 - 0.5	OVA	ND
	1	BGG09SF012	0 - 0.5	OVA	ND
	1	BGG09SF013	0 - 0.5	OVA	ND
	1	BGG09SF014	0 - 0.5	OVA	ND

TABLE 3-3

Summary of PID and OVA Head Space Measurements
Jefferson Proving Ground
Madison, Indiana

Site	Sampling Phase	Sample No.	Depth (feet)	Instrument Type	Headspace Reading (PPM)
9	1	BGG09SF015	0 - 0.5	OVA	ND
	1	BGG09SF016	0 - 0.5	OVA	ND
	1	BGG09SD001	0 - 0.5	OVA	ND
	1	BGG09SD002	0 - 0.5	OVA	ND
	1	BGG09SD003	0 - 0.5	OVA	ND
	1	BGG09BHA01	0.4 - 0.9	PID	2.4
	1	BGG09BHA02	4.5 - 5.0	PID	1.8
	1	BGG09BHA03	5.5 - 7.0	PID	1.0
	1	BGG09BHB01	0.4 - 0.9	PID	0.4
	1	BGG09BHB02	4.9 - 5.4	PID	4.5
	1	BGG09BHB03	6.9 - 7.4	PID	1.6
	1	BGG09BHC01	0.3 - 0.8	PID	1.0
	1	BGG09BHC02	4.7 - 5.2	PID	1.0
	1	BGG09BHC03	9.7 - 10.2	PID	1.8
	1	BGG09BHD01	0.7 - 1.2	PID	2.2
	1	BGG09BHD02	4.6 - 5.1	PID	7.0
10	1	GLF10BHA01	0.7 - 1.2	PID	4.0
	1	GLF10BHA02	5.0 - 5.5	PID	2.0
	1	GLF10BHA03	7.1 - 7.6	PID	2.5
	1	GLF10BHB01	0.9 - 1.4	PID	2.0
	1	GLF10BHB02	4.3 - 5.3	PID	2.7
	1	GLF10BHB03	6.3 - 6.8	PID	3.5
	1	GLF10BHC01	0.6 - 1.1	PID	2.0
	1	GLF10BHC02	4.9 - 5.4	PID	2.1
	1	GLF10BHC03	7.1 - 7.6	PID	3.4
	1	GLF10BHD01	1.4 - 1.9	PID	1.0
	1	GLF10BHD02	5.0 - 5.5	PID	ND
	1	GLF10BHD03	8.0 - 8.5	PID	ND
	1	GLF10BHE01	1.0 - 1.5	PID	ND
	1	GLF10BHE02	4.9 - 5.4	PID	ND
	1	GLF10BHE03	9.0 - 9.5	PID	ND
	1	GLF10BHF01	1.0 - 1.5	PID	ND

TABLE 3-3

Summary of PID and OVA Head Space Measurements
Jefferson Proving Ground
Madison, Indiana

Site	Sampling Phase	Sample No.	Depth (feet)	Instrument Type	Headspace Reading (PPM)
10	1	GLF10BHF02	5.0 - 5.5	PID	ND
	1	GLF10BHF03	9.2 - 9.7	PID	ND
	1	GLF10BHG01	0.9 - 1.4	PID	ND
	1	GLF10BHG02	4.9 - 5.4	PID	ND
	1	GLF10BHG03	9.4 - 9.9	PID	ND
	1	GLF10BHH01	0.9 - 1.4	PID	ND
	1	GLF10BHH02	4.9 - 5.4	PID	0.2
	1	GLF10BHH03	8.9 - 9.4	PID	ND
	1	GLF10BHI01	0.9 - 1.4	PID	ND
12A	1	SVA12BHA01	0.9 - 1.4	PID	54
	1	SVA12BHA02	4.3 - 4.8	PID	24
	1	SVA12BHA03	9.3 - 9.8	PID	42
	1	SVA12BHB01	0.9 - 1.4	PID	72
	1	SVA12BHB02	4.3 - 4.8	PID	64
	1	SVA12BHB03	9.3 - 9.8	PID	56
	1	SVA12BHC02	4.3 - 4.8	PID	60
	1	SVA12BHC03	9.3 - 9.8	PID	48
12B	1	SVB12BHA01	0.9 - 1.4	PID	50
	1	SVB12BHA02	4.3 - 4.8	PID	68
	1	SVB12BHA03	9.3 - 9.8	PID	48
	1	SVB12BHB01	0.9 - 1.4	PID	62
	1	SVB12BHB02	4.3 - 4.8	PID	52
	1	SVB12BHB03	9.3 - 9.8	PID	33
	1	SVB12BHC01	0.9 - 1.4	PID	200
	1	SVB12BHC02	4.3 - 4.8	PID	300
	1	SVB12BHC03	9.3 - 9.8	OVA	60
12C	1	SVC12BHA01	0.8 - 1.2	PID	0.4
	1	SVC12BHA02	4.3 - 4.8	PID	1
	1	SVC12BHA03	9.3 - 9.8	PID	0.4
	1	SVC12BHB01	0.4 - 0.9	PID	ND
	1	SVC12BHB02	4.2 - 4.7	PID	ND
	1	SVC12BHB03	9.3 - 9.8	PID	ND

TABLE 3-3

Summary of PID and OVA Head Space Measurements
Jefferson Proving Ground
Madison, Indiana

Site	Sampling Phase	Sample No.	Depth (feet)	Instrument Type	Headspace Reading (PPM)
12C	1	SVC12BHC01	0.3 - 0.8	PID	ND
	1	SVC12BHC02	4.3 - 4.8	PID	ND
	1	SVC12BHC03	9.3 - 9.8	PID	ND
	1	SVC12BHD01	0 - 1.0	PID	ND
	1	SVC12BHD02	4.0 - 4.5	PID	ND
	1	SVC12BHD03	9.0 - 9.5	PID	ND
13	1	FTA13BHA01	0.3 - 0.8	PID	27
	1	FTA13BHA02	4.6 - 5.1	PID	110
	1	FTA13BHA03	9.6 - 10.1	PID	90
	1	FTA13BHA04	14.6 - 15.1	PID	80
	1	FTA13BHB01	0.5 - 1.0	PID	60
	1	FTA13BHB02	4.6 - 5.1	PID	35
	1	FTA13BHB03	9.6 - 10.1	PID	32
	1	FTA13BHB04	14.3 - 14.8	PID	26
	1	FTA13BHC01	0.6 - 1.1	PID	25
	1	FTA13BHC02	4.6 - 5.1	PID	52
	1	FTA13BHC03	9.6 - 10.1	PID	25
	1	FTA13BHC04	14.6 - 15.1	PID	70
	1	FTA13BHD01	0.6 - 1.1	PID	45
	1	FTA13BHD02	4.6 - 5.1	PID	50
	1	FTA13BHD03	9.6 - 10.1	PID	40
	1	FTA13BHD04	14.6 - 15.1	PID	40
	1	FTA13BHD05	19.2 - 19.7	PID	32
	2	FTA13BHE01	0 - 1.0	PID	1.9
	2	FTA13BHE02	4.0 - 5.0	PID	0.6
	2	FTA13BHE03	9.0 - 10.0	PID	0.8
	2	FTA13BHE04	14.0 - 15.0	PID	4.2
14	1	YSA14BHA01	0.5 - 1.0	PID	ND
	1	YSA14BHA02	4.5 - 5.0	PID	ND
	1	YSA14BHA03	9.5 - 10.0	PID	ND
	1	YSA14BHB01	0.6 - 1.1	PID	ND
	1	YSA14BHB02	4.6 - 5.1	PID	ND

TABLE 3-3

Summary of PID and OVA Head Space Measurements
Jefferson Proving Ground
Madison, Indiana

Site	Sampling Phase	Sample No.	Depth (feet)	Instrument Type	Headspace Reading (PPM)
14	1	YSA14BHB03	9.6 - 10.1	PID	ND
	1	YSA14BHC01	0.6 - 1.1	PID	ND
	1	YSA14BHC02	4.6 - 5.1	PID	ND
	1	YSA14BHC03	9.6 - 10.1	PID	ND
	1	YSA14BHD01	0.3 - 1.0	PID	ND
	1	YSA14BHD02	4.6 - 5.1	PID	ND
	1	YSA14BHD03	9.6 - 10.1	PID	ND
	1	YSA14BHE01	0.6 - 1.1	PID	40
	1	YSA14BHE02	3.3 - 3.7	PID	2
	1	YSA14BHE03	4.6 - 5.1	PID	2
	1	YSA14BHE04	9.6 - 10.1	PID	60
	1	YSA14BHF01	0.6 - 1.1	PID	60
	1	YSA14BHF02	4.6 - 5.1	PID	50
	1	YSA14BHF03	9.6 - 10.1	PID	50
15	1	BAS15SF001	0 - 1.0	OVA	ND
	1	BAS15SF002	0 - 0.8	OVA	ND
	1	BAS15SF003	0 - 0.7	OVA	ND
	1	BAS15SF004	0 - 0.5	OVA	ND
21A	1	STA21SF001	0 - 0.8	OVA	0.1
	1	STA21SF002	0 - 0.5	OVA	ND
	1	STA21SF003	0 - 0.5	OVA	ND
21B	1	STB21SF001	0 - 0.5	OVA	ND
	1	STB21SF002	0 - 0.6	OVA	ND
	1	STB21SF003	0 - 0.5	OVA	ND
24	1	SST24SF001	0 - 0.5	OVA	ND
	1	SST24SF002	0 - 0.5	OVA	ND
25	1	PMR25SF001	0 - 0.5	PID	ND
	1	PMR25SF002	0 - 0.5	PID	ND
	1	PMR25SF003	0 - 0.5	PID	ND
	1	PMR25BHA01	0.3 - 0.8	PID	ND
	1	PMR25BHA02	4.6 - 5.1	PID	ND
	1	PMR25BHA03	9.6 - 10.1	PID	ND

TABLE 3-3

Summary of PID and OVA Head Space Measurements
Jefferson Proving Ground
Madison, Indiana

Site	Sampling Phase	Sample No.	Depth (feet)	Instrument Type	Headspace Reading (PPM)
25	1	PMR25BHB01	0.4 - 0.9	PID	ND
	1	PMR25BHB02	4.6 - 5.1	PID	ND
	1	PMR25BHB03	9.6 - 10.1	PID	ND
	1	PMR25BHC01	1.6 - 2.4	PID	ND
	1	PMR25BHC02	4.6 - 5.1	PID	ND
	1	PMR25BHC03	9.6 - 10.1	PID	1
26	1	DRM26SF001	0 - 0.5	PID	ND
	1	DRM26SF002	0 - 0.5	PID	ND
	1	DRM26SF003	0 - 0.5	PID	ND
	1	DRM26SF004	0 - 0.5	PID	ND
	1	DRM26SF005	0 - 0.5	PID	ND
	1	DRM26SF006	0 - 0.5	PID	ND
27	1	SSA27SF001	0 - 0.8	PID	ND
	1	SSA27SF002	0 - 0.8	PID	ND
	1	SSA27SF003	0 - 0.8	PID	ND
	1	SSA27SF004	0 - 0.75	PID	ND
	1	SSA27SF005	0 - 1.0	PID	ND
	1	SSA27SF006	0 - 0.8	PID	ND
	1	SSA27SF007	0 - 0.9	PID	ND
	1	SSA27SF008	0 - 1.0	PID	ND
	1	SSA27SF009	0 - 0.55	PID	ND
	1	SSA27SF010	0 - 0.58	PID	ND
	1	SSA27SF011	0 - 0.7	PID	ND
	1	SSA27SF012	0 - 0.5	PID	ND
28	1	GZO28SF001	0 - 0.5	PID	ND
	1	GZO28SF002	0 - 0.5	PID	ND
	1	GZO28SF003	0 - 0.5	PID	ND
29	1	GZS29SD001	0 - 0.5	PID	ND
	1	GZS29SD002	0 - 0.5	PID	ND
	1	GZS29SD003	0 - 0.5	PID	ND
31	1	FSP31BHA01	0.9 - 1.4	PID	ND
	1	FSP31BHA02	4.3 - 4.8	PID	ND

TABLE 3-3

Summary of PID and OVA Head Space Measurements
Jefferson Proving Ground
Madison, Indiana

Site	Sampling Phase	Sample No.	Depth (feet)	Instrument Type	Headspace Reading (PPM)
31	1	FSP31BHA03	9.3 - 9.8	PID	ND
	1	FSP31BHA04	14.3 - 14.8	PID	ND
	1	FSP31BHB01	0.9 - 1.4	PID	ND
	1	FSP31BHB02	4.3 - 4.8	PID	ND
	1	FSP31BHB03	9.3 - 9.8	PID	ND
	1	FSP31BHB04	14.3 - 14.8	PID	ND
	1	FSP31BHB05	19.2 - 19.7	PID	ND
	1	FSP31BHC01	0.2 - 0.7	PID	ND
	1	FSP31BHC02	4.5 - 5.0	PID	ND
	1	FSP31BHC03	9.5 - 10.0	PID	ND
	1	FSP31BHC04	14.2 - 14.7	PID	ND
39	1	GZM39SF001	0 - 0.5	PID	ND
	1	GZM39SF002	0 - 0.5	PID	ND
39	1	GZM39SF003	0 - 0.5	PID	ND
	1	GZM39SF004	0 - 0.5	PID	ND
	1	GZM39SF005	0 - 0.5	PID	ND
	1	GZM39SF006	0 - 0.5	PID	ND
40	1	PIP40SF001	0 - 0.5	PID	ND
42	1	FRB42SF001	0 - 0.5	PID	ND
	1	FRB42SF002	0 - 0.5	PID	ND
	1	FRB42SF003	0 - 0.5	PID	ND
46	1	FTS46SF001	0 - 0.5	PID	ND

Footnotes:

(a) No VOCs detected.
(b) Photoionization detector.
(c) Organic vapor analyzer.
(d) Parts per million.

TABLE 3-4

Monitoring Well Index Correlating Well Number To Site ID
Jefferson Proving Ground
Madison, Indiana

Site ID	Well Number	Well Number	Site ID
ALF04GWA	MW-93-20	MW-96-1	SVA12GWG
ALF04GWB	MW-93-21	MW-96-2	SVB12GWH
ALF04GWC	MW-93-22	MW-96-3	SVB12GWI
ALF04GWD	MW-93-23	MW-96-4	SVB12GWJ
ALF04GWE	MW-95-6	MW-96-5	SVB12GWK
BGG09GWA	MW-93-19	MW-96-6	SVA12GWH
BKA51GWA	MW-93-1	MW-96-7	SVA12GWI
BKA51GWB	MW-93-2	MW-95-1	SVB12GWE
BKA51GWC	MW-93-3	MW-95-2	SVB12GWF
BKB51GWA	MW-93-4	MW-95-3	YSA14GWD
BKB51GWB	MW-93-5	MW-95-4	RLA07GWD
BKB51GWC	MW-93-6	MW-95-5	BKE51GWA
BKC51GWA	MW-93-7	MW-95-6	ALF04GWE
BKC51GWB	MW-93-8	MW-95-7	SVC12GWC
BKC51GWC	MW-93-9	MW-95-8	SVC12GWE
BKC51GWD	MW-95-5	MW-95-9	SVC12GWD
FTA13GWA	MW-93-12	MW-95-10	SVA12GWE
FTA13GWB	MW-93-13	MW-95-11	SVA12GWF
FTA13GWC	MW-93-14	MW-93-1	BKA51GWA
GLF10GWA	MW-93-15	MW-93-2	BKA51GWB
GLF10GWB	MW-93-16	MW-93-3	BKA51GWC

TABLE 3-4

Monitoring Well Index Correlating Well Number To Site ID
Jefferson Proving Ground
Madison, Indiana

Site ID	Well Number	Well Number	Site ID
GLF10GWC	MW-93-17	MW-93-4	BKB51GWA
GLF10GWD	MW-93-18	MW-93-5	BKB51GWB
GST37GWA	MW-93-33	MW-93-6	BKB51GWC
GST37GWB	MW-93-34	MW-93-7	BKC51GWA
GST37GWC	MW-93-35	MW-93-8	BKC51GWB
GST37GWD	MW-93-36	MW-93-9	BKC51GWC
GST37GWE	MW-93-37	MW-93-10	RLA07GWA
RLA07GWA	MW-93-10	MW-93-11	RLA07GWB
RLA07GWB	MW-93-11	MW-93-12	FTA13GWA
RLA07GWC	MW-93-44	MW-93-13	FTA13GWB
RLA07GWD	MW-95-04	MW-93-14	FTA13GWC
SPB11GWA	MW-93-30	MW-93-15	GLF10GWA
SPB11GWB	MW-93-31	MW-93-16	GLF10GWB
SPB11GWC	MW-93-32	MW-93-17	GLF10GWC
SVA12GWA	MW-93-45	MW-93-18	GLF10GWD
SVA12GWB	MW-93-46	MW-93-19	BGG09GWA
SVA12GWC	MW-93-47	MW-93-20	ALF04GWA
SVA12GWD	MW-93-48	MW-93-21	ALF04GWB
SVA12GWE	MW-95-10	MW-93-22	ALF04GWC
SVA12GWF	MW-95-11	MW-93-23	ALF04GWD
SVA12GWG	MW-96-1	MW-93-24	YSA14GWA

TABLE 3-4

Monitoring Well Index Correlating Well Number To Site ID
Jefferson Proving Ground
Madison, Indiana

Site ID	Well Number	Well Number	Site ID
SVA12GWH	MW-96-6	MW-93-25	YSA14GWB
SVA12GWI	MW-96-7	MW-93-26	YSA14GWC
SVB12GWA	MW-93-38	MW-93-27	VLT44GWA
SVB12GWB	MW-93-39	MW-93-28	VLT44GWB
SVB12GWC	MW-93-40	MW-93-29	VLT44GWC
SVB12GWD	MW-93-41	MW-93-30	SPB11GWA
SVB12GWE	MW-95-1	MW-93-31	SPB11GWB
SVB12GWF	MW-95-2	MW-93-32	SPB11GWC
SVB12GWH	MW-96-2	MW-93-33	GST37GWA
SVB12GWI	MW-96-3	MW-93-34	GST37GWB
SVB12GWJ	MW-96-4	MW-93-35	GST37GWC
SVB12GWK	MW-96-5	MW-93-36	GST37GWD
SVC12GWA	MW-93-42	MW-93-37	GST37GWE
SVC12GWB	MW-93-43	MW-93-38	SVB12GWA
SVC12GWC	MW-95-7	MW-93-39	SVB12GWB
SVC12GWD	MW-95-9	MW-93-40	SVB12GWC
SVC12GWE	MW-95-8	MW-93-41	SVB12GWD
VLT44GWA	MW-93-27	MW-93-42	SVC12GWA
VLT44GWB	MW-93-28	MW-93-43	SVC12GWB
VLT44GWC	MW-93-29	MW-93-44	RLA07GWC
YSA14GWA	MW-93-24	MW-93-45	SVA12GWA

TABLE 3-4

Monitoring Well Index Correlating Well Number To Site ID
Jefferson Proving Ground
Madison, Indiana

Site ID	Well Number	Well Number	Site ID
YSA14GWB	MW-93-25	MW-93-46	SVA12GWB
YSA14GWC	MW-93-26	MW-93-47	SVA12GWC
YSA14GWD	MW-95-3	MW-93-48	SVA12GWD
GLF10MW2	MW-88-2	MW-88-2	GLF10MW2
GLF10MW4	MW-88-4	MW-88-4	GLF10MW4
GLF10MW7	MW-88-7	MW-88-7	GLF10MW7
SVC12MW14	MW-88-14	MW-88-14	SVC12MW14
SVC12MW15	MW-88-15	MW-88-15	SVC12MW15
SVC12MW16	MW-88-16	MW-88-16	SVC12MW16

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TABLE 3-5

Monitoring Well Water Level Measurements
Phase I and II Field Investigations
Jefferson Proving Ground
Madison, Indiana

		Well	Depth to Water (feet)								
Area	**Well No.**	**Elev.**	**6/93**	**8/93**	**9/93**	**11/95**	**2/96**	**4/96**	**6/96**	**9/96**	**12/96**
Background Cluster A	MW-93-1	833.58	13.50	14.42	13.96	13.63	11.74	11.16	11.55	14.19	----
	MW-93-2	834.28	13.81	14.40	13.72	13.96	11.91	11.32	11.88	14.23	----
	MW-93-3	834.02	5.50	3.99	5.66	3.75	3.84	2.90	4.50	5.76	----
Background Cluster B	MW-93-4	846.18	13.99	15.00	14.42	15.20	12.54	11.99	12.50	15.25	11.85
	MW-93-5	846.35	15.98	16.52	15.96	16.20	14.48	13.28	14.46	16.41	13.4
	MW-93-6	846.55	20.41	18.69	20.06	20.64	20.56	16.42	19.33	20.68	18.29
Background Cluster C	MW93-7	901.82	35.15	35.74	35.60	36.02	34.31	34.58	34.56	36.01	34.32
	MW93-8	901.97	6.12	6.96	6.16	6.19	3.83	3.24	4.82	8.51	3.65
	MW93-9	902.05	6.06	6.17	6.70	6.09	3.70	2.94	4.74	8.17	3.46
Background Well D	MW95-5	900.13	----	----	----	6.10	3.64	3.22	4.21	7.02	3.57
Background Well E	MW83-4	900.47	----	----	----	10.38	3.97	3.56	5.38	10.72	3.92
Read Lead Area	MW93-10	872.68	15.04	15.85	14.74	15.41	14.03	13.92	13.96	15.87	12.85
	MW93-11	871.35	14.75	15.57	14.49	15.18	13.72	13.62	13.68	15.62	12.66
	MW93-44	872.79	16.03	16.83	15.76	16.43	14.96	14.87	14.96	16.9	13.92
	MW95-4	868.86	----	----	----	12.77	11.29	11.21	11.30	13.26	10.26
Fire Training Pit	MW93-12	850.70	10.38	11.16	10.74	10.89	8.81	9.13	9.26	11.14	8.51
	MW93-13	850.55	10.42	11.42	10.91	11.16	9.10	9.50	9.62	11.91	9.07
	MW93-14	850.07	9.05	9.80	8.45	9.27	7.95	7.88	8.08	9.74	7.46
Gate 19 Landfill	MW93-15	820.58	6.30	4.04	6.24	4.47	2.61	1.96	3.14	4.61	2.10
	MW93-16	827.80	9.90	9.01	10.14	9.52	8.01	7.16	8.35	9.52	7.57
	MW93-17	829.08	11.96	10.42	11.47	10.96	9.55	8.60	9.99	11.04	9.13
	MW93-18	831.14	12.46	11.65	12.40	11.98	9.60	8.66	10.02	11.99	8.84
	MW93-19	829.08	12.96	11.67	13.19	12.11	10.34	9.16	10.90	12.29	9.76
	MW88-1	824.82	----	12.81	11.14	13.94	10.04	9.23	9.42	12.95	9.14
	MW88-2	829.72	15.45	15.47	14.54	16.20	13.26	12.05	12.98	14.56	11.71
	MW88-4	833.68	12.55	13.33	12.39	13.44	10.69	9.73	10.60	13.65	10.02

TABLE 3-5

Monitoring Well Water Level Measurements
Phase I and II Field Investigations
Jefferson Proving Ground
Madison, Indiana

Area	Well No.	Well Elev.	Depth to Water (feet)								
			6/93	8/93	9/93	11/95	2/96	4/96	6/96	9/96	12/96
	MW88-7	30.62	7.68	17.38	17.02	17.79	15.69	13.74	15.51	17.00	13.91
	MW88-5	828.048	----	13.55	12.961	14.64	11.46	10.25	11.10	12.71	10.21
	MW88-9	33.40	----	14.41	5.29	14.97	13.43	12.56	13.78	5.01	12.48
	MW88-11	826.65	----	13.28	13.90	14.30	12.81	10.20	12.62	14.41	10.50
	MW83-1	829.21	----	10.64	11.77	11.10	9.53	8.51	9.84	11.03	9.16
	MW83-2	828.58	----	12.05	11.86	13.37	6.66	5.88	9.36	13.91	7.17
	MW83-3	830.94	----	16.95	16.66	17.84	14.82	13.07	14.86	16.41	13.51
Abandoned Landfill	MW93-20	864.78	19.13	19.56	18.89	18.81	16.98	17.84	18.26	19.44	16.76
	MW93-21	859.21	13.84	14.21	13.54	13.58	11.88	12.58	12.99	14.15	11.56
	MW93-22	856.29	10.20	10.55	9.86	9.93	8.28	9.05	9.38	10.48	7.88
	MW93-23	851.57	5.38	5.71	4.96	5.18	3.64	4.35	4.58	5.66	3.16
	MW95-6	861.83	----	----	----	16.39	14.67	15.35	15.80	16.98	14.34
Yellow Sulfur Area	MW93-24	857.28	7.79	8.68	7.55	8.26	6.28	6.61	6.76	8.81	----
	MW93-25	856.08	6.56	7.50	6.36	7.13	5.06	5.35	5.52	7.67	----
	MW93-26	855.12	5.61	6.55	5.42	6.17	4.10	4.40	4.58	6.73	----
	MW95-3	852.84	----	----	----	3.89	1.83	2.10	2.30	4.44	----
Concrete Vault	MW93-27	858.74	6.18	5.11	5.26	4.23	3.63	2.92	4.26	5.77	3.61
	MW93-28	857.62	5.39	5.00	5.07	4.61	4.59	3.67	4.62	5.59	4.38
	MW93-29	858.48	5.93	5.03	5.37	4.35	4.14	3.12	4.45	5.92	3.84
Explosives Burn Area	MW93-30	885.10	21.22	21.98	21.53	22.36	20.10	20.34	20.88	22.71	19.76
	MW93-31	883.53	17.18	18.00	17.88	17.67	16.02	16.18	17.00	----	15.81
	MW93-32	884.34	6.41	4.68	6.11	4.38	3.97	3.49	4.84	6.54	3.71
Building 617	MW93-38	855.20	5.83	6.80	5.63	6.39	4.32	3.90	4.42	6.88	4.26
	MW93-39	854.36	6.02	6.94	5.22	8.01	3.26	2.98	3.94	8.15	3.17
	MW93-40	855.62	7.14	8.40	6.61	9.41	4.57	4.24	6.16	9.35	4.56
	MW93-41	855.95	6.90	8.08	6.54	8.43	4.95	4.55	5.22	8.55	4.89
	MW95-1	854.27	----	----	----	9.34	3.24	2.96	4.06	9.02	3.18
	MW95-2	853.81	----	----	----	8.64	2.99	2.63	3.76	9.57	2.91
	MW96-2	856.17	----	----	----	----	----	20.95	23.13	21.30	

TABLE 3-5

Monitoring Well Water Level Measurements
Phase I and II Field Investigations
Jefferson Proving Ground
Madison, Indiana

		Well	Depth to Water (feet)								
Area	**Well No.**	**Elev.**	**6/93**	**8/93**	**9/93**	**11/95**	**2/96**	**4/96**	**6/96**	**9/96**	**12/96**
	MW96-3	853.82	----	----	----	----	----	----	4.46	8.76	3.86
	MW96-4	856.04	----	----	----	----	----	----	15.34	17.67	8.25
	MW96-5	856.41	----	----	----	----	----	----	6.23	11.40	5.60
	MW96-8	855.75	----	----	----	----	----	----	5.16	8.91	4.69
Building 279	MW93-42	864.72	9.48	9.64	9.04	10.18	8.53	8.30	8.61	9.52	7.46
	MW93-43	867.40	12.56	13.61	12.54	13.48	11.63	11.44	11.26	13.25	10.27
	MW95-7	868.36	----	----	----	14.00	12.26	12.03	11.86	13.98	11.08
	MW95-8	867.78	----	----	----	13.14	11.49	11.40	11.20	13.27	10.36
	MW95-9	868.18	----	----	----	13.41	11.78	11.70	11.50	13.51	10.61
	MW88-14	867.30	11.29	12.08	11.02	12.20	10.67	10.65	10.44	12.43	9.52
	MW88-15	867.75	9.09	8.05	5.95	9.13	9.02	8.72	9.01	8.97	8.94
	MW88-16	867.56	12.39	10.23	9.64	12.53	9.22	9.17	8.72	10.17	8.08
Building 602	MW93-45	857.98	11.38	13.83	11.82	16.03	9.83	9.04	9.53	15.46	9.86
	MW93-46	858.00	11.38	13.84	11.46	16.04	9.82	9.03	9.55	15.46	9.82
	MW93-47	855.56	8.90	11.32	9.56	13.55	7.33	6.54	7.05	11.81	7.78
	MW93-48	857.64	20.21	13.51	11.34	16.25	9.62	8.78	8.90	15.01	9.79
	MW95-10	858.42	----	----	----	16.45	10.20	9.44	9.95	15.88	10.31
	MW95-11	857.14	----	----	----	15.55	8.95	8.21	8.65	14.55	8.96
	MW96-1	855.32	----	----	----	----	----	----	7.02	13.11	7.31
	MW96-6	854.80	----	----	----	----	----	----	4.97	11.42	5.61
	MW96-7	855.26	----	----	----	----	----	----	6.76	12.72	6.92
Gas Station	MW93-33	874.45	13.32	12.83	13.29	----	13.48	12.90	13.32	13.29	13.09
	MW93-34	873.94	7.24	6.93	6.97	----	8.38	4.88	6.35	8.12	5.31
	MW93-35	873.53	11.08	9.92	11.44	---	11.48	9.70	11.05	11.21	9.73
	MW93-36	873.32	6.91	6.94	6.82	---	6.46	4.82	6.00	7.40	5.23
	MW93-37	873.28	8.62	8.20	8.43	---	8.36	6.46	7.83	8.61	6.85

TABLE 3-6

Summary of Phase I and II RI and Supplemental Monitoring Analytical Methods Jefferson Proving Ground Madison, Indiana

Analytical	USAEC[a] Method		USEPA[b] Method		Method
Parameter	Soil	Water	Soil	Water	Type
Anions					
Alkalinity	**NA** [c]	**NA**	**NA**	**310.1**	
Bromine	N/A	TT09	N/A	N/A	Chromatography
Chloride	N/A	TT09	N/A	300.0	Chromatography
Fluoride	N/A	TT09	N/A	N/A	
Nitrate	N/A	LL8	N/A	300.0	Chromatography
Phosphate	N/A	TF29	N/A	N/A	
Sulfate	N/A	TT09	N/A	300.0	Chromatography
Sulfide	**N/A**	**N/A**	**N/A**	**376.1**	
Total Kjeldahl Nitrogen	**N/A**	**N/A**	**N/A**	**415.1**	
Total Organic Carbon	**N/A**	**N/A**	**N/A**	**351.3**	
Metals					
Arsenic	B9	AX8	7060	7060	GFAA[d]
Antimony	N/A	N/A	7041	7041	GFAA
Beryllium	N/A	N/A	7091	7091	GFAA
Mercury	Y9	CC8	7471	7470	CVAA[e]
Lead	JD21	SD18	7421	7421	GFAA
Selenium	JD20	SD25	7740	7740	GFAA
Thallium	N/A	N/A	7841	7841	GFAA
ICP[f] Metals	JS12	SS12	6010	6010	ICP
TCLP[g] Metals	N/A	N/A	6010	6010	ICP SIM[h]
Cyanide	KF15	TF34	9012	9012	SPEC[i]
BTEX	AA9	AV8	8020	8020	**GC**[j]
Explosives	LW23	UW25	8330	8330	HPLC[k]
Dioxin/Furans	N/A	N/A	8280	8280	GCMS

TABLE 3-6

Summary of Phase I and II RI and Supplemental Monitoring Analytical Methods Jefferson Proving Ground Madison, Indiana

Analytical	USAEC[a] Method		USEPA[b] Method		Method
Parameter	Soil	Water	Soil	Water	Type
Herbicides	LH18	UH10	8150	8150	GCEC[l]
Pesticides/PCBs	LH17	UH20	8080	8080	GCEC
VOC[m]	LM23	UM21	8240	8260	GCMS[q]
PAHs	NA	NA	8330	8330	HPLC
SVOCs(n)	LM25	UM25	8270	8270	GCMS
Gases	**N/A**	**N/A**	**N/A**	**RSK175**	**GC**
TPH[o]	N/A	N/A	418.1	418.1	IR SPEC[p]

Footnotes:

(a) U.S. Army Environmental Center
(b) U.S. Environmental Protection Agency
(c) Not applicable or available
(d) Graphite Furnace Atomic Absorption
(e) Cold Vapor Atomic Absorption
(f) Inductively Coupled Plasma
(g) Toxicity Characteristic Leaching Procedure
(h) Inductively Coupled Plasma/Selective Ion Monitoring
(i) Spectroscopy
(j) Gas Chromatography
(k) High Pressure Liquid Chromatography
(l) Gas Chromatography/Electron Capture
(m) Volatile organic compound
(n) Semi-volatile organic compound
(o) Total petroleum hydrocarbons
(p) Infrared Spectroscopy
(q) Gas Chromatography/Mass Spectroscopy

TABLE 3-7

Summary of Data Quality Objectives for Site-Specific Phase II RI Data
Jefferson Proving Ground
Madison, Indiana

Site No.	Site Name	Data Requirement	Data Usage
1	Building 185 Incinerator	USEPA Modified Level III quality laboratory data for dioxins in soils	Human health and ecological risk assessments
2	Building 177 Sewage Treatment Plant	Conduct USEPA Level IV data validation on existing results. Collect additional USEPA Modified Level III quality data for SVOC if required.	Human health and ecological risk assessments
3	Explosive Burning Area	USEPA Modified Level III quality laboratory data for metals and explosives in soils.	Nature and extent of contamination, contaminant mobility, and human health and ecological risk assessments.
4	Abandoned Landfill	USEPA Modified Level III quality laboratory data for metals, VOCs, SVOCs, and explosives.	Groundwater flow and contaminant distribution and human health and ecological risk assessments.
5	Former Wood Storage Pile	Conduct USEPA Level IV data validation on existing results. Collect additional USEPA Modified Level III quality data for dioxins/furans.	Confirm presence or absence of dioxins/furans in soils. Provide data for human health and ecological risk assessments.
6	Wood Burning Area	Same as Site 5	Same as Site 5
7	Red Lead Disposal Area	Install additional monitoring well to ensure system is capable of detecting downgradient contamination. Collect USEPA Modified Level III quality data for metals in groundwater.	Determine groundwater flow and contaminant distribution. Provide data for human health and ecological risk assessments.

TABLE 3-7

Summary of Data Quality Objectives for Site-Specific Phase II RI Data
Jefferson Proving Ground
Madison, Indiana

Site No.	Site Name	Data Requirement	Data Usage
9	Gate 19 Landfill	USEPA Modified Level III quality laboratory data for metals, VOCs, SVOCs, and explosives.	Determine groundwater flow and contaminant distribution. Provide data for human health risk assessment.
10	Burning Ground South of Gate 19 Landfill	USEPA Modified Level III quality laboratory data for SVOCs and explosives in soils.	Confirm presence or absence of SVOCs and explosives in soils. Provide data for human health and ecological risk assessments.
12A	Building 602 Solvent Pit	USEPA Modified Level III quality laboratory data for solvents and petroleum hydrocarbon analysis.	Determine groundwater flow and contaminant distribution. Provide data for human health risk assessment. Provide information for evaluation of cleanup technologies
12B	Building 617 Solvent Pit	Same as Site 12A	Same as Site 12A
12C	Building 279 Solvent Pit	Same as Site 12A	Same as Site 12A
13	Old Fire Training Pit	Install additional monitoring well and collect USEPA Modified Level III quality data for metals, VOCs, and SVOCs. Collect additional USEPA Level III quality data for SVOCS in soil samples.	Determine groundwater flow and contaminant distribution. Verify lack of contaminants exceeding risk-based criteria. Confirm presence of absence of SVOCs in soils. Provide data to conduct human health and ecological risk assessments.
14	Yellow Sulfur Disposal Area	USEPA Modified Level III quality data for metals in soils and groundwater.	Determine vertical and horizontal extent of metals in soils. Determine groundwater flow and contaminant distribution. Provide data to conduct human health and ecological risk assessments.

TABLE 3-7

Summary of Data Quality Objectives for Site-Specific Phase II RI Data
Jefferson Proving Ground
Madison, Indiana

Site No.	Site Name	Data Requirement	Data Usage
15	Burn Area South of New Incinerator	USEPA Modified Level III quality data for metals in soil.	Better define vertical and horizontal extent of metals in soils. Provide data to conduct human health and ecological risk assessments.
21A	Building 204 Temporary Storage Area	USEPA Modified Level III quality data for pesticides in soil.	Evaluate nature and extent of contamination. Provide data for the human health and ecological risk assessments.
25	Papermill Road Disposal Area	Conduct USEPA Level IV data validation on previous SVOC results. Collect USEPA Modified Level III quality data for metals and SVOCs in soils as required.	Confirm presence or absence of SVOCs in soils. Determine presence or absence of beryllium and thallium. Provide data for human health and ecological risk assessments.
26	DRMO Storage Area and Possible Disposal Sites south of DRMO	Conduct USEPA Level IV data validation on previous SVOC results. Collect additional USEPA Modified Level III quality data for SVOCs and metals.	Confirm presence or absence of SVOC contaminants. Better define nature and extent of metals contamination. Provide data for human health and ecological risk assessments.
27	Sewage Sludge Application Areas	USEPA Modified Level III quality data for metals in soils.	Characterization of vertical and horizontal extent of metals contamination. Provide data for human health and ecological risk assessments.
28	Gator Z Open Burn Area	USEPA Modified Level III quality data for metals in soils.	Define vertical and horizontal extent of metals contamination. Provide data for human health and ecological risk assessments. Provide distribution data for possible removal action.

TABLE 3-7

Summary of Data Quality Objectives for Site-Specific Phase II RI Data
Jefferson Proving Ground
Madison, Indiana

Site No.	Site Name	Data Requirement	Data Usage
33	Building 333 New Incinerator	USEPA Modified Level III quality data for dioxins/furans in soils.	Determine presence or absence of dioxins/furans exceeding risk-based concentrations. Provide data for human health and ecological risk assessments.
39	Gator Z Mine Test Area	USEPA Modified Level III quality data for explosives.	Confirm presence or absence of explosives in soils. Provide data for human health and ecological risk assessments if required.
51	Background Sampling Locations	USEPA Modified Level III quality data for metals in soil and groundwater. Also for dioxins/furans in soils.	Establish background data set for site-specific data screening. Provide background data to be used in COPC selection process for human health and ecological risk assessments.
All	Interim Measures Sites	USEPA Level III quality data for all contaminants of concern.	Confirm reduction in contaminant levels to or below risk management criteria.

FIGURES

ANALTICAL DATA FLOW FOR RI LEVEL SAMPLES

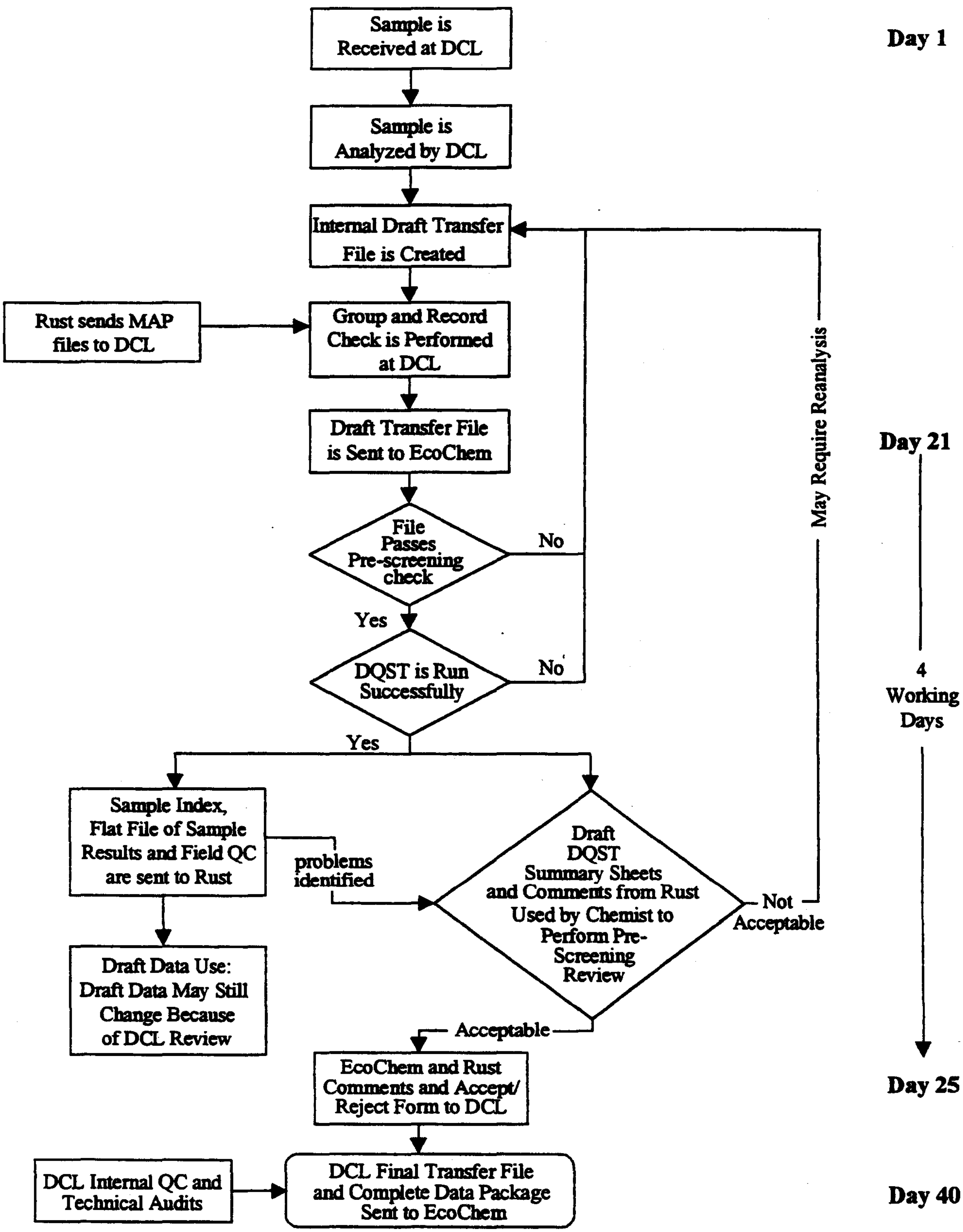

Figure 3-1. Flow Chart Phase I and Phase II RI Data at JPG

4.0 CONTAMINANT FATE AND TRANSPORT

Understanding the fate and transport of contaminants is integral to assessing the potential for exposure and requirements for remediation. This section provides a summary discussion of the types of contaminants detected at JPG sites and the factors influencing their transport or mobility and ultimate fate in the environment. Site-specific discussions of local conditions affecting contaminant fate and transport are presented in Sections 6.0 through 28.0.

Contamination at JPG has the potential to occurs in soils, groundwater, surface water, and sediments. The mobility and persistence of contaminants within each of these environmental media are affected by the physical and chemical characteristics of the media and of the contaminant. These complex interactions between the contaminants and the media are summarized in the following sections. Section 4.1 presents potential physical and chemical migration pathways operating at JPG sites south of the Firing Line, and Section 4.2 discusses the relative significance of migration pathways with respect to transport characteristics, and Section 4.3 discusses natural attenuation processes and their potential to mitigate contamination at JPG.

4.1 POTENTIAL MIGRATION PATHWAYS

Fate and transport of contaminants at JPG are controlled by release, migration, and degradation processes operating in each of the environmental media present: surface and subsurface soils, groundwater, surface water, sediments, air, and biota. Processes likely to control contaminant migration and transport at JPG are discussed below. ; tThe discussion is based on known site conditions using data from historical investigations as well as from the Phase I and Phase II RI. Because human activities can also influence the distribution of contaminants at the site, especially contaminants resident in surface soils, probable anthropogenic processes are also considered. Chemical contaminant migration is discussed in general terms in subsequent portions of the section and on a site-specific level in the risk assessment portions of Sections 6.0 through 28.0.

4.1.1 Transport Processes in JPG Media

The following presents the potential contaminant transport pathways and physical and chemical-specific migration processes expected to be operating at JPG south of the Firing Line. These processes are discussed for each environmental media.

4.1.1.1 Soil Processes. Contaminants have been introduced into the JPG environment by previous facility operations and waste disposal practices. Historically, releases to soils account for a large portion of known and potential contamination at JPG. At most sites investigated, soils were initially impacted affected by historical facility operations, including but not limited to open burn/open detonation of munitions, landfilling of wastes, and land treatment of sewage sludge. Other potential contamination of soils may have occurred from

leaking USTs, waste disposal in pits, waste spills or runoff from storage locations, and deposition of airborne incinerator wastes. These practices resulted in the direct release of contaminants at the ground surface and at depth.

Both organic and inorganic contaminant groups have been detected in soils at JPG sites located south of the Firing Line. The organic compounds detected include VOCs, SVOCs, pesticides, PCBs, dioxins, and explosives. Inorganic contaminants include metals and anions.

Contaminants released to vadose zone soils have the potential to migrate from the contaminant source areas to underlying groundwater. Contaminated soils are subject to a variety of potential desorption and leaching processes involving the infiltration of meteoric water from the ground surface through the soil matrix and fractures or macro-pores. Contaminants with high aqueous ~~solubilities~~solubility are most susceptible to leaching and desorption, while contaminants with an affinity for the solid phase (low solubility) are generally retarded in the vadose zone and exhibit low mobility. The vadose zone soils may act as an attenuating and retarding medium to the downward transport of contaminants because of their physical and chemical properties (i.e., high clay content and low permeability).

Where organic contaminants are present in surface soils, releases to the atmosphere by volatilization may occur. Volatile and semi-volatile contaminants in subsurface soils may migrate to the atmosphere via volatilization to soil gas, which then migrates through the vadose zone to the atmosphere. In general, volatilization leads to dispersion, migration, and dilution of contaminants in the vapor phase. Solid phase contaminants or contaminants adsorbed to the solid phase may be released to the air for transport by the suspension of contaminated particles by wind erosion or anthropogenic processes. Transport of contaminants as fugitive dust results in redeposition on surface soils in the downwind directions.

In addition to transport processes affecting contaminants in JPG soils, there are various decay and transformational processes that alter the concentration or persistence of contaminant species. Decay and transformation can be caused by abiotic chemical reactions, such as oxidation, hydrolysis, or photolysis. Degradation and transformation also can be biologically mediated by microbes and other organisms residing in surface soils and the vadose zone of the glacial till. These degradation and transformation processes act to diminish existing contaminant concentrations with time. Additional discussion of natural attenuation processes and biodegradation is contained in Section 4.3.

4.1.1.2 Groundwater Processes. ~~Since~~ Because contaminants may have been released at depths below the water table, groundwater at JPG is both a source of contamination and a contaminant transport medium. Several contaminants at JPG, specifically the chlorinated solvents, ~~are thought to~~may have originated as pure liquid phases that potentially migrated to groundwater after percolating ~~directly~~ through the vadose zone soils consisting of unsaturated glacial deposits. For contamination residing in surface and subsurface soils, migration to groundwater can occur by various desorption, dissolution, and leaching processes. Another potential mechanism of contaminant release to groundwater is the dissolution of immobile

residual free-phase organic contaminants residing in vadose zone soils or in direct contact with groundwater in saturated soils. Free-phase organic liquids have not been observed in groundwater samples, nor have the concentrations detected in vadose zone soils or groundwater been high enough to suggest the presence of free-phase product. ~~However, groundwater concentrations in the parts per million (ppm) range indicate that this process could have been active at the solvent disposal pits.~~ Although VOC concentrations in groundwater at a few locations have been observed in the mg/L range, the concentrations observed during the RI have been below the solubility limits of the various constituents.

Once having entered groundwater, contaminants can migrate further by advective flow, which is the transport of solutes via bulk flow of groundwater in response to hydraulic gradients. Contaminants in groundwater may also migrate by dispersion. Dispersion~~, which~~ is primarily caused ~~primarily~~ by mechanical mixing during fluid flow through the matrix, and generally results in the dilution of contaminants with increasing distance from the source. ~~Under matrix flow conditions, t~~The migration of contaminants is typically retarded to some degree with respect to groundwater flow rates by the interaction of contaminants with the solid ~~phases~~matrix~~ present~~. Retardation of contaminants is a function of the affinity of a contaminant for the solid phase, and is dependent on the properties of the contaminant and on the organic carbon or clay content of the aquifer materials.

Since the apparent hydraulic conductivity of the glacial till and bedrock materials is low and fractures in both units have been observed, fracture flow may ~~dominate~~ affect groundwater movement at JPG. Under fracture flow conditions, contaminant migration processes discussed above ~~are not as~~may be less significant. Movement of groundwater and solid and liquid phase contaminants will follow fractures ~~and fracture trends~~ both laterally and vertically in downgradient directions. Therefore, contaminant migration in groundwater can result in downgradient contamination in the glacial till and bedrock units, and in contamination of surface water via seeps observed along drainages at JPG.

Contaminants may migrate ~~in~~from groundwater ~~may also migrate further~~ by volatilization to soil gas ~~and become susceptible to~~or through evapotranspiration to the atmosphere. Volatilization of contaminants from groundwater is controlled by several factors, including the thickness of the overlying vadose zone soils, soil permeability, moisture content, vapor concentration gradients, vapor pressure, and the Henry's law constants of individual contaminants. In addition, water table fluctuations and the rate of recharge are significant factors. Evapotranspiration involves the direct evaporation of water or the uptake of groundwater by plants, which in turn releases it to the atmosphere. Evapotranspiration occurs at JPG, and seasonal variations may account for considerable water loss in certain locations, although contaminant transport through evapotranspiration is ~~typically~~ may be insignificant when compared to other operating pathways. As in the vadose zone soils, decay and transformation processes can alter or degrade contaminants in the saturated zone under matrix flow and fracture-dominated groundwater flow conditions. The type, rate, and completeness of these processes are controlled by the local physical and chemical conditions that are present.

4.1.1.3 Surface Water Processes. Transportation of contaminants by surface water can occur~~s~~ at JPG through ~~many~~ several different pathways. Historically, potential contaminants at the sewage treatment plant may have been directly released to Harberts Creek because of direct by-pass of the sewer system. Groundwater may discharge directly into creek drainages through seeps; however, no evidence of contaminant migration along this pathway exists. Contaminants may be released to the surface water by leaching from surface soil, by suspension of soil particles in flowing surface water due to episodic surface erosion during precipitation events or snowmelt, or settling of entrained particles from wind dispersion. ~~At JPG, s~~Surface water ~~potentially~~ containing dissolved or suspended contaminants could potentially ~~is likely either to~~ infiltrate through the vadose zone soils to the water table or flow into the drainages downgradient from source locations within JPG. Transport of contaminants could also occur~~s~~ when contaminants in the aqueous dissolved phase or in the solid phase adsorb to suspended material or bed load sediments. If ~~C~~concentrations of volatile contaminants ~~in~~entered surface waters, they ~~would likely~~may ~~are expected to~~ diminish rapidly through direct volatilization to the atmosphere.

4.1.1.4 Sediment Processes. Sediments at JPG ~~can~~ could potentially become contaminated through sedimentation processes described above involving surface water. ~~Potentially, c~~Contaminated sediments ~~are~~ could mobilize ~~since they will tend to~~and be transported downstream within creek channels or be deposited in the creek bed or bank materials and subsequently subjected to erosion processes. Contaminants that adhere to sediments are also subject to dissolution processes that may release aqueous phase contaminants into the creek waters. This results in a reduction of sediment concentrations.

4.1.1.5 Air Processes. Contaminants may enter the atmosphere ~~at JPG either~~ through direct volatilization from contaminant sources, surface soil, surface water, or groundwater seeps; by atmospheric exchange with soil gas; or by eolian resuspension of contaminants adsorbed to particulates. Historically, potentially contaminated particulates ~~were~~ could have been released to the air as incinerator discharges and ~~are suspected of being~~ redeposited in nearby downwind locations. ~~Any v~~~~V~~In this process, volatile contaminants have usually dissipated. Other contaminants ~~were suspected to~~could have been released through open burning and open detonation of potentially contaminated materials at JPG. Contaminants from these activities ~~are suspected to~~could have been transported downwind as particulates and redeposited on surface soils within a short distance of the source area.

Air is generally not considered a significant pathway for volatile gas-phase contaminants that attenuate and degrade rapidly in the atmosphere. However, volatile contaminants in soils could migrate into a confined space, such as basements or structures ~~at JPG~~ where volatile compounds would not disperse as rapidly in the open atmosphere.

4.1.1.6 Biotic Processes. Biota may be exposed to contaminants by root uptake of contaminants, ingestion of contaminated materials, inhalation, or contact with contaminated soils or water. Although low trophic-level species may serve as contaminant pathways to higher trophic-level species, biota as a whole are normally considered to be receptors. Biological media are not a significant contaminant transport pathway at JPG from a volumetric

standpoint. However, even minor concentrations of highly bioaccumulative contaminants in lower trophic (feeding) levels are important because of biomagnification of contaminants through successive predation in a food web. Potential contamination in biota and its behavior in the food web are discussed in greater detail in the Ecological Risk Assessment Methodology section of this report (Section 5.2).

4.1.1.7 Anthropogenic Processes. Human activities resulting in contaminant transport that would not otherwise occur are referred to as anthropogenic processes. Examples of anthropogenic transport of contaminants include the adherence of contaminated soil particles to vehicles or equipment, or modification of ground surface by excavations, grading, or construction activities.

The future contribution to contaminant transport by anthropogenic processes is less likely to occur because of mitigative measures implemented to minimize human influence. At JPG, access to and egress from potentially contaminated sites are restricted and controlled by fences, signs, and security procedures, decreasing the probability of incidental transport. If access is needed for maintenance, sampling, or monitoring, individuals adhere to strict personal and equipment decontamination procedures as well as health and safety protocols specifically designed to prevent the spread of contamination. Interim remedial measures ~~remediation of several contaminated sites has~~have been ~~conducted~~performed at several sites. During these remediation activities, engineering controls such as dust suppression are implemented to minimize potential contaminant transport.

4.2 CONTAMINANT BEHAVIOR

This section provides a general discussion of the behavior of compound groups detected at JPG sites south of the Firing Line.

4.2.1 Volatile Organic Compounds

VOCs were detected in soil and groundwater at JPG during the RI. No VOCs were detected ~~reported for~~ in surface water or sediments, although analyses for VOCs were only performed for surface water and sediment samples collected at the Burning Ground South of the Gate 19 Landfill (Site 9) and along reaches of Middle Fork Creek. Based on these results, only migration pathways related to soil and groundwater media are considered significant for VOCs at JPG sites south of the Firing Line.

At the former solvent disposal sites and the landfill, VOCs as chlorinated solvents were detected at low concentrations (less than 10 ppb) in shallow soils. These relatively low concentrations in disposal areas indicate that VOCs released to surface soils have volatilized, degraded, or have migrated ~~downward through the unsaturated zone~~. In the groundwater at these sites, ~~concentration of~~ chlorinated solvents are reported at concentrations up to 200 ppm.

Typically, chlorinated solvents released to soils may migrate in dissolved or free-phase liquid vertically through the vadose zone by gravity and capillary forces. The volume of solvents that are retained in vadose zone soils is dependent upon source mass, residual oil saturation properties of the soil/solvent mix,concentrations, the octanol-water partition coefficient ofretardation factor for the individual compounds, and the aqueous solubility. The high clay content of JPG soils and glacial till would suggest that retention of the chlorinated solvents in unsaturated soils occurs at some of these sites.

Relatively high concentrations of chlorinated solvents in groundwater beneath potential source areas indicate that the chlorinated solvents have moved migrated through the unsaturated soils. Free phase solvents have not been observed in groundwater samples. The dominant chlorinated solvents detected in the groundwater are 1,1,1-trichloroethane, 1,1-dichloroethane, and trichloroethene. Each of these solvents have a solubility well in excess of the concentrations detected in groundwater samples on site (1,1,1-trichloroethane solubility ranges from 4,400 to 5,500 ppm; 1,1-dichloroethane solubility is estimated to be 5,500 ppm; and trichloroethene solubility is estimated to be 1,100 ppm- Verschueren, 1983).

Although the concentrations of chlorinated solvents in groundwater were high, the concentrations of chlorinated solvents in groundwater were less than 1% of their respective solubility limit. Therefore, the possibility that a dense non-aqueous phase liquid (DNAPL) may be present as residual contamination in the saturated or unsaturated soils is remoteless likely than if greater than 1% of their solubility limit. Furthermore, free phase solvents have not been observed in soil or groundwater samples. The residual These pools of DNAPLs chlorinated solvents in pore water above the water table and adsorbed to soils above or below the water table may volatilize or serve as a continuous or declining source of dissolved chlorinated solvents to groundwater. advective and dispersive flow to form plumes and/or migrate via fractures.

Volatiles are also present at the old fire training area of JPG and are associated with petroleum hydrocarbons that remain due to incomplete combustion of fuels used in fire training exercises. The fuel-related contamination has migrated from the ground surface to the groundwater but has not migrated very far from the fire training pit. Total petroleum hydrocarbon analytical results indicate that a significant source of contamination still exists in near-surface soils (TPH up to 59,000 ug/g) at the fire training pit.

Volatilization to soil gas is another migration pathway for VOCs resident in soils and groundwater. Although volumetrically this pathway is likely to be inless significant, soil gas may penetrate foundations or basements and, if not ventilated, may result in exposures to VOCs.

The lackabsence of detected VOCs in the few surface water samples suggestsindicates that groundwater contaminated by chlorinated solvents or petroleum has not impacted downgradient surface water pathways. Currently, oOther migration pathways operating at the ground surface are considered to be insignificant for VOCs since possible sources exposed to the atmosphere have apparently been reduced through direct volatilization.

Over time, natural biological processes can reduce the concentrations of chlorinated solvents by altering the chemical structure of the compound in a process known as ~~converting them to harmless forms~~biodegradation. Naturally occurring microbial populations ~~transform~~ may degrade chlorinated solvents, generally through a process of reductive dechlorination, hydrolysis and/or oxidation. The intermediate degradation (daughter) products are lower chlorinated compounds that may in turn, degrade~~,~~ to non-chlorinated environmentally acceptable ~~(daughter)~~ products. Evidence that these biological processes are occurring includes ~~such things~~ the presence of daughter products in conjunction with the appropriate conditions for biological degradation. Evidence that these reactions are occurring at significant rates include observations that the plume is ~~as a~~ stable or shrinking ~~plume, a plume~~ or that a plume is expanding more slowly than expected given estimated contaminant migration rates. ~~groundwater movement adjusting for retardation, the inverse relationship between electron acceptors and contaminant concentrations, and the detection of daughter products.~~ The current Phase I and Phase II RI sampling results indicate that biodegradation of the chlorinated solvents at JPG is occurring. Section 4.3 further discusses biodegradation as well as other natural attenuation processes in detail and presents their potential at JPG.

4.2.2 Semivolatile Organic Compounds

SVOCs were detected in surface soils, subsurface soils, and groundwater at JPG. Although analyzed in numerous surface water and sediment samples from JPG, ~~no~~ SVOCs were not detected in these media. Soil samples were analyzed using various analytical methods to detect SVOCs. The analytical method used was selected based on specific site histories and suspected types of compounds released. The SVOCs detected in soils include PAHs, PCBs, TPH, organochlorine pesticides, and herbicides. Also detected in areas of previous burning activities were low levels of dioxins and furans.

These compounds are clearly less volatile and less mobile in the environment than VOCs. PAHs comprise the largest number of SVOCs detected in soils at JPG. These compounds are characterized by low ~~solubilities~~solubility, moderate to low ~~volatilities~~volatility, and moderate to high partition coefficients. PAHs are generally considered immobile in soil-water systems. The general absence of PAHs in deeper soil intervals or groundwater at JPG reflects the immobility of these compounds. The Abandoned Landfill (Site 4) and the temporary waste storage areas (Sites 20 and 21) present the only instances of SVOCs being detected at depth during the RI. Their presence in the groundwater at Site 4 ~~is likely~~may be a result of ~~direct~~ infiltration via fractures at this particular site. Because SVOCs typically exhibit low ~~solubilities~~solubility, low ~~volatilities~~volatility, and often complex molecular structure, they are generally considered to have low ~~mobilities~~mobility and are subject to a variety of degradation~~al~~ ~~and transformational~~ processes. Therefore, the most significant migration pathways for SVOCs are near surface pathways such as wind dispersion and overland flow of surface water.

4.2.3 Explosives

Explosives compounds, as a group, exhibit a wide variety of mobility in environmental media because of large differences in solubility, volatility, and molecular structure within this chemical group. However, as presented below, explosive compounds do not appear to be COCs at JPG based on the RI results.

Analyses for explosives were performed on samples collected from soil, groundwater, surface water, and sediments at JPG sites south of the Firing Line. Explosives were not detected in soils, groundwater, or sediments with the exception of low detections of 2,4-dinitrotoluene (2,4-DNT) at the burning area south of the Gate 19 Landfill (Site 9). This general absence of detections of explosives in media associated with sites such as the Burning Area for Explosive Residue indicates that explosives are not a significant group of contaminants at JPG. In surface water, 1,3,5-trinitrobenzene was detected in five of six samples at consistently low concentrations, which were similar to concentrations reported in laboratory method blanks for other lots analyzed during the same time period. The compound 1,3,5-trinitrobenzene was not dismissed and was carried through the risk assessment as a COPC. The results indicate that the hazards to human health from ingestion and dermal contact with 1,3,5-trinitrobenzene in the pond are insignificant. As a result, further sampling does not appear to be necessary (IN11). Because ~~no~~ other associated explosive compounds were not detected in surface water and only one explosive compound (2,4-DNT) was detected in other media at JPG during the RI, the results for surface water are considered probable artifacts of laboratory contamination.

4.2.4 Metals

Reported metals concentrations in soils, groundwater, surface water, and sediments at most sites at JPG are generally similar to background concentrations obtained for soil and groundwater, and therefore, indicate little evidence of contaminant release. At some sites, however, metals that were suspected contaminants were detected at concentrations that are ~~highly~~ elevated relative to background. For example, a surface-soil sample~~s~~ from the red lead area (Site 7) contained a lead concentration~~s~~ as high as 13,000 ~~µg/g~~mg/kg. Particular metals, such as arsenic in soil, may be present at ~~high~~ elevated concentrations relative to regulatory levels or exceed calculated background values at isolated sampling locations; however, background levels are likewise ~~high~~above regulatory levels.

The generally low levels of metals above background in groundwater indicate that various mechanisms in site soils are acting to restrict the mobility of these elements and, therefore, restrict the movement of these elements to the dissolved phase. These processes include adsorption to clays, interaction with iron oxyhydroxides and other reactive solid phases, ion exchange reactions, precipitation and co-precipitation reactions, and oxidation-reduction reactions. In the clay and iron oxyhydroxide-rich matrix of the glacial till, these processes are likely restricting the availability and mobility of these elements.

In general, the occurrence of many of the metals in soils at JPG appears to reflect natural variability of the glacial till deposits.~~soils derived from glacial till-type material sources.~~ The generally low levels of dissolved metals in groundwater above background at JPG suggest that little if any water soluble metals were released at the site. In addition, ~~that~~ natural reactions

diminish metal availability for transport in groundwater. Therefore, migration pathways for possible metal contaminants are primarily ~~near~~ surface pathways, such as wind dispersion, ~~and~~ surface water and sediment transport or anthropogenic dispersal ~~overland flow~~ of metals that are adhered to particulates. ~~Another metal contaminant pathway is anthropogenic dispersal from surface source areas.~~

4.2.5 Anions

Groundwater samples were analyzed during Phase I for a small suite of anions to evaluate chemical water quality. A dynamic equilibrium between numerous components of the geochemical environment of the groundwater controls the concentrations and mobility of these anions. Background concentrations of these anions were calculated to provide a relative or typical range of expected conditions for groundwater.

~~No anions,, e~~Except for sulfur anions at the yellow sulfur area ~~(~~Site 14), anions were not expected to be associated with possible contamination releases at JPG. Since sulfur and sulfur oxides can influence pH (acidify soils and water), sulfur and pH analyses were performed in association with metal analyses at Site 14. Sulfur and sulfur oxides are expected to be moderately mobile in the environment by dissolution into meteoric water and subsequent infiltration to soil~~s~~ or transport of the dissolved phase in overland flow, which can ultimately reach nearby drainages.

4.2.6 Dioxin/Furans

Samples were analyzed for ~~D~~dioxins and furans ~~were analyzed for~~ during Phase I and Phase II at locations where known or suspected burning of debris had taken place. ~~The d~~Dioxins and furans are ~~chlorinated pollutants~~ compounds that can form as by-products ~~during any of several~~ of combustion of certain materials, ~~-~~and during industrial activities. Much of the dioxin generated and transported in air in the United States is related to incineration of compounds like PCBs or pentachlorophenol. For that reason, the two small waste incinerators at JPG were studied for possible dioxin contamination. However, dioxins in soils over broad areas can be caused from air transport from larger off-site incinerators or other industrial sources resulting in widespread anthropogenic contamination. Several dioxin compounds were detected at each of the sites where samples were collected for dioxin/furan analysis. In addition, samples were ~~taken~~ collected at background locations for dioxin/furan analysis. The dioxin congener patterns for site-specific detections of dioxins/furans were compared against the background detections to determine if the dioxins for the sites ~~are~~ were related to anthropogenic background or site-related activities. In most cases, it appears that the site-specific congener patterns are similar to background.

4.3 NATURAL ATTENUATION

This section provides a review of naturally occurring physical and chemical processes that may reduce or eliminate site contaminant concentrations. Quantifying natural attenuation

processes involves understanding contaminant fate and transport mechanisms through the interpretation of geologic, hydrogeologic, and chemical data. Geologic and hydrogeologic data is applied to determine the most probable transport mechanisms for contaminants through the vadose zone and the saturated zone. Hydrogeologic and chemical data is applied to determine the distribution and magnitude of the contaminants and whether the nature of the contaminants is being altered through reactions with surrounding media. Through transport mechanisms and/or chemical reactions, contaminants will attenuate through time.

The following section provides a brief discussion of the physical and chemical attenuation mechanisms and their significance to interpreting the fate and transport of contaminants at the site. Geologic and hydrogeologic environments of the various sites at JPG are discussed on a site-specific basis in subsequent sections of this report. Sites 12A (Section 13), 12B (Section 14), and 12C (Section 15) were evaluated and scored as potential candidates for natural attenuation using the scoring method contained in the BIOCHLOR (USEPA, 2000) natural attenuation model. Scoring criteria and results are discussed in Sections 13, 14, and 15.

4.3.1 Summary of Physical/Chemical Attenuation Mechanisms

The fate and migration of organic and inorganic contaminants in the subsurface environment can be affected by a number of chemical and physical attenuation mechanisms, as discussed above. Combined, these chemical and physical aspects are known as natural attenuation. These mechanisms may cause a contaminant to remain in solution, precipitate out of solution, be adsorbed to a surface, be transformed or degraded into another compound, or diluted through mixing. If the mechanisms, especially biodegradation, are demonstrated through convincing evidence to play a significant role, then natural attenuation may be considered a viable remedial action option. The following discussion summarizes each of the potential fate and transport mechanisms involved and their relationship to the site.

4.3.1.1 Degradation. The degradation of most chlorinated solvents in groundwater occurs by oxidation-reduction reactions (Parsons, et. al., 1984) predominantly mediated by microorganisms in the environment. These degradation reactions can include reductive dehalogenation (electron acceptor reactions), electron donor reactions, and through co-metabolism[1]. Microbially initiated degradation reactions (i.e., biodegradation) may be an important fate mechanism for primary organic constituents that may break down into successive second order (daughter product) compounds under proper environmental conditions.

Biodegradation may result in partial or complete reduction of contaminant concentrations. Some chlorinated solvents may also degrade through abiotic (chemical) reactions that are mediated by metals (e.g., iron, and iron-complexes) or by water (e.g., hydrolysis reactions).

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1 Wiedemeier, T.H. , M.A. Swanson, and D.E. Moutoux, J.T. Wilson, D.H. Kampbell, J.E. Hansen, and P.Haas. Overview of the Technical Protocol for Natural Attenuation of Chlorinated Aliphatic Hydrocarbons in Ground Water Under Development for the U.S. Air Force Center for Environmental Excellence. In Proceedings of the Symposium on Natural Attenuation of Chlorinated Organics in Ground Water. May 1997.

These degradation pathways are not thought to be as significant in natural environments as biodegradation. However, the ability to recognize the mechanisms responsible for the eventual reduction of primary contaminants to daughter products may provide insight into the remedial actions necessary in the future for handling both the daughter products and the original contaminants.

4.3.1.2 Advection, Dispersion, Dilution. Advection is defined as the movement of molecules dissolved in water along the groundwater flow path at an average groundwater velocity. During advection, molecules will also spread along and away from the expected groundwater flow path. The process of mechanical dispersion results in a net dilution of the molecules in the groundwater. As discussed above, when compounds are introduced into groundwater, they will decrease in concentration as they are transported away from the source. However, dilution alone may not be entirely responsible for the distribution of contaminants.

4.3.1.3 Diffusion. Diffusion is another dispersive process that results from the movement of molecules along a concentration gradient. Molecular diffusion originates because of mixing caused by random molecular motions due to thermal kinetic energy of the solute. These random motions cause the molecules of the solute to move from areas of high concentration to low concentration. At JPG, diffusion does not appear to move contaminants significant horizontal distances because it is a relatively slow process. However, diffusion controls movement of contaminants into and out of fine grained soils. This process can limit the rate of cleanup due to the slow release of contaminants from fine grained soils (i.e., diffusion limited desorption).

4.3.1.4 Sorption/Desorption. Molecules can adsorb onto, and in some cases can be absorbed by, geologic materials. Over time, these molecules may desorb from the geologic materials in response to concentration gradients or other physical or chemical changes. Contaminants may be adsorbed or desorbed from soil and groundwater organic matter influencing the rate of migration. Strongly adsorbed contaminants are relatively immobile and tend not to leach or be transported. The amount of a compound that will be adsorbed is a function of its chemical properties, the geological matrix (e.g., soil type, clay content, percent organic matter), and the hydrogeochemical environment. Organic carbon may also be present in site soils at sufficient concentrations (2-10% for silt loam soils) to adsorb significant quantities of organic contaminants, thereby greatly retarding the movement of organic contaminants in groundwater.

4.3.1.5 Volatilization. Transfer of a molecule from an aqueous solution to the vapor phase (phase transfer) is termed volatilization. Chlorinated solvents are volatile compounds that partition between aqueous and gas phases, with the less-chlorinated compounds (e.g., vinyl chloride) having a tendency toward higher volatility. Volatilization may contribute to natural attenuation through the transfer of VOCs from groundwater to the vadose zone or directly to the atmosphere during discharge to the surface. Volatilization due to subsurface temperature increases, aeration, or mass transfer from a solid to liquid phase, liquid to gaseous phase, or solid to a gas phase may be significant under the site specific physical/geological/hydrological

conditions described in this report. Volatilization of VOCs from groundwater confined by low conductivity soils is generally greatly restricted.

4.3.1.6 Stabilization. Stabilization is a process whereby contaminant molecules become chemically bound by a stabilizing agent (e.g. clay, humic materials), thus reducing the mobility of the molecule in the groundwater.

4.3.1.7 Precipitation/Dissolution. The solubility of metal species under geochemical conditions present in the aquifer matrix controls precipitation or dissolution of metal contaminants in groundwater, and in turn affects the mobility of the metal. The geochemical factors that affect the solubility of metals in groundwater include pH, total dissolved solids, alkalinity/acidity, hardness, and the thermodynamic activity or solubility of the specific metals present.

4.3.2 Natural Attenuation in Soil

VOCs released into soil as a non-aqueous phase liquid (NAPL) will partition into four parts: a NAPL absorbed into the soil, a solute dissolved in the interstitial moisture (i.e., water contained in the vadose zone by tension and/or capillary forces), a gas phase, and adsorbed into the soil and organic matter. The equilibrium for these four components will depend on the chemical and physical properties of the specific VOCs. For example, a low water solubility will drive the equilibrium toward the adsorbed state, while a high vapor pressure and Henry's law constant will tend to drive a constituent towards the gaseous phase. The lower the organic carbon partition coefficient, the less strongly adsorbed to the organic matter, and the more mobile the compound.

The relative migration rate of a VOC through the unsaturated soil depends on the amount of the compound present (i.e., whether the amount present will saturate the water or vapor that is present), the particle size (and thus the pore space), the amount of organic carbon present in the soil, and the amount of interstitial moisture and the percent saturation of the soil, as well as seasonal variables such as temperature and barometric pressure. Finally, breakdown may result in some of the parent compound degrading into a daughter product, further complicating assessment of relative migration rates.

The interrelation of these factors makes it difficult to accurately predict the relative migration rates of VOCs in soil. For example, acetone has a high vapor pressure, is completely miscible in water (i.e., solubility = 1×10^6 mg/L), has a relatively low Henry's law constant, and a low organic carbon partition coefficient. Therefore, acetone would be poorly adsorbed to soil, is volatile, and should enter the vapor phase. However, in the presence of water, it tends to remain in the liquid state, as shown by its Henry's law constant. Thus, the equilibrium for acetone is dependent on how much water is present. For a compound such as tetrachloroethene that is not as soluble in water (150 mg/L), the volume of contaminant may be a major factor, as only a fraction of the contaminant may dissolve in the water, leaving the remainder to be adsorbed to soil or be present in a NAPL.

Because of the complicated nature of migration rate assessment in soil, the retardation factor used to assess the relative migration rate once a compound has partitioned to the interstitial moisture and then entered the groundwater, is often used for estimation purposes. Calculated retardation factors for the common chlorinated VOCs indicate that a compound such as tetrachloroethene (PCE) may migrate in saturated soils at a slower rate than its breakdown products (trichloroethene (TCE), the dichloroethenes (DCE), and vinyl chloride(VC)) because of PCE having a stronger tendency toward attenuation. Generally, the higher the retardation factor, the slower the migration rate.

4.3.3 Natural Attenuation in Groundwater

Groundwater provides a primary migration pathway for contaminant transport. Contaminants released to the surface may migrate downward carried by infiltrating water. The fate and migration of these contaminants in the groundwater is dependent on the interrelationship between site-specific geological and chemical conditions, and the physical properties of the contaminant itself. Physical and chemical mechanisms that primarily affect the fate of organic compounds at the site include sorption and biodegradation.

4..3.3.1 Sorption. From the variety of soil components that can influence rates of adsorption, the organic carbon content has been shown to be the primary factor governing the adsorption of many neutral organic contaminants (Dragun, 1988) such as those present at the JPG sites. Compounds that dissolve in water will tend to adsorb onto solid phases that the water comes into contact with. The adsorption capacity is frequently expressed by the soil/water partitioning or distribution coefficient, K_d. The distribution coefficient K_d can be estimated as the organic carbon/water distribution coefficient K_{oc}, multiplied by the total organic carbon (TOC) content expressed as a fraction. The K_{oc} describes the relative affinity of a compound for soil organic matter and water, and can be estimated from the octanol-water partition coefficient (K_{ow}).

The effect of the aquifer matrix on the transport rate of organic chemicals in the saturated zone can be estimated using the chemical's retardation factor (R_f). The retardation factor describes the effect of sorption in decreasing the rate of contaminant transport in the liquid phase relative to non-reactive species (i.e., where R_f=1) (Fetter,1993).

The retardation factor (R_f) is calculated from the K_d adjusted for matrix conditions of bulk density P_b and effective aquifer porosity (n).

$$R_f = 1 + (p_b/n) * K_d \qquad (1)$$

where:

p_b = aquifer bulk density (g/cm^3), assumed 1.6 g/cm^3
n = total porosity of the aquifer, assumed 0.35 (unitless)
K_d = distribution coefficient (mL/g), calculated as $K_{oc} * F_{oc}$

and

F_{oc} = organic carbon content of soils, assumed F_{oc} is 8.0% in the silty loam, 0.1% for the sand, representative of site conditions

Since the K_d is a function of the organic carbon content, the adsorption of the organic chemicals in the aquifer is strongly correlated to the organic carbon content of the aquifer matrix. TOC percentages generally range from less than 1% in a sandy soil, 2 to 15% in a silt loam, and up to 30 to 50% in an organic soil (Dragun, 1988). Note that the chemical specific factor K_{oc} provides the relative difference between R_f values for each compound, while the remaining factors are aquifer matrix dependent. Thus, estimating the aquifer matrix values does not change the relative difference between compounds.

4.3.3.2 Biodegradation. At sites contaminated by chlorinated solvents, microbially induced reductive dechlorination of chlorinated alkenes and alkanes has been documented to occur in groundwater systems (Bouwer and McCarty 1983; Parsons, 1987). Reductive dechlorination involves the loss of chlorine ions from the solute contaminant with replacement by hydrogen ions in a microbially mediated reaction (Vogel and McCarty, 1987). In this reaction, hydrogen acts as an electron donor and the chlorinated solvent (the solute contaminant) acts as an electron acceptor as the chlorinated solvent becomes reduced while the reaction proceeds. Hydrogen is typically made available to the process during fermentation reactions in the subsurface media.

Reductive dechlorination is typically viewed as a first-order decay process, meaning that the rate of the reaction follows the first order decay equation. Typically, the more highly chlorinated the compound, the more rapidly the first-order decay process occurs (Vogel and McCarty, 1987). Therefore, it is possible to produce daughter products in higher concentration than the parent product as the biotransformation reaction proceeds.

Both chlorinated ethanes and ethenes undergo this dechlorination process as the parent product loses chlorine atoms during the microbially mediated reduction. Figure 4-1 shows the reductive dechlorination process for tetrachloroethene (PCE), TCE, and 1,1,1-trichloroethane (TCA). For chlorinated ethenes, reductive dechlorination proceeds sequentially from PCE; to trichloroethene (TCE); to cis-1,2-dichloroethene (cis-1,2-DCE), trans-1,2-dichloroethene (trans-1,2-DCE), or 1,1-dichloroethene (1,1-DCE); to VC; to ethene. The major pathway for TCE dechlorination is to cis-1,2-DCE, with trace amounts of trans-1,2-DCE and 1,1-DCE produced. For chlorinated ethanes, reductive dechlorination progresses sequentially from TCA, to 1,1-dichloroethane (DCA), to chloroethane, to ethane.

Degradation may result in partial or complete reduction of contaminant concentrations. In general, a reducing (anaerobic) condition is needed for degradation of the parent compounds (e.g., the higher chlorinated compounds) through reductive dechlorination. The rate of degradation of these constituents depends in large part on the degree of anaerobic conditions present at the site. For example, if anaerobic conditions exist within certain zones of the plume and aerobic conditions exist in the rest, degradation of the parent compounds would occur primarily within those zones that are anaerobic. Reductive dechlorination would largely cease outside of those zones. However, degradation of some of the daughter products,

especially VC, can occur through electron donor reactions, where the VC is used as a substrate and is directly degraded by the bacteria in an aerobic environment. Numerous references are available describing the conditions necessary for the degradation of chlorinated VOCs (Bouwer and McCarty, 1983; Barrio-Lage, et. al. 1987; DeBruin, et. al., 1992).

In general, the rate of biodegradation of the PCE, TCE, and DCE is more favorable under anaerobic conditions, while vinyl chloride degrades more quickly under aerobic processes (Bouwer and McCarty, 1983; Parsons et al., 1984; Dragun, 1988). Anaerobic degradation is noted by the distribution of the increasing levels of various common intermediate transformation products (e.g., 1,1-DCE, cis-1,2-DCE, trans-1,2-DCE, VC) and the corresponding decreases in the concentrations of PCE or TCE as the contaminant migrates downgradient from the contaminant source.

For biologically mediated reductive chlorination to proceed, several factors must be evaluated, including:

- The oxidation/reduction potential of the environment,
- The ability of the chlorinated solvent to undergo reductive dechlorination,
- The type and quantity of nutrients and other appropriate substrate available to promote bacterial growth, and
- The ability and appropriateness of the available bacteria to promote the reaction.

Reductive dechlorination of parent and most daughter compounds can proceed when nitrogen and oxygen have been consumed such that chemically reducing conditions exist in the subsurface environment. Hydrogen must also be available in the environment to allow the process to proceed. Chemically reducing conditions are critically important to the process because both oxygen and nitrogen are better electron acceptors than chlorinated compounds when hydrogen acts as the electron donor.

The presence of chemically reducing conditions during biological activity at a site results in the reduction of other groundwater constituents. The iron oxyhydroxide reactions described above or the development of inorganic species pairs such as sulfide/sulfate or iron II/iron III can be examined and the species ratio plus the pH can be used to estimate the oxidizing/reducing conditions on a site-specific basis. Inorganic constituents such as these are also often used as indicator parameters of degradation because they serve as electron acceptors under reducing (anaerobic) conditions. Indicator parameters used to assess reducing conditions include measurement of oxidation/reduction potential (ORP), dissolved oxygen, nitrate, ammonia, dissolved iron, dissolved manganese, sulfate, methane, BOD, chloride, acetate, and alkalinity. Measurements at a site generally show a distinct difference in background versus plume levels of indicator parameters in response to biological activity creating an anaerobic environment.

Dissolved oxygen is the first primary electron acceptor. As oxygen is depleted, nitrate, ferric iron oxyhydroxide, sulfate, and carbon dioxide (in that order of preference) become the additional electron acceptors. Therefore, it is important to evaluate the distribution of these additional electron acceptors to develop a thorough understanding of the dynamics at a given site (USEPA, 1998). The most rapid biodegradation affecting the widest range of chlorinated aliphatic hydrocarbons occur under sulfate-reducing and methanogenic conditions (Bower, 1994). However, the reductive dechlorination reaction depends on a source of carbon to fuel the process. The reductive dechlorination process will cease if the supply of electron donors from the carbon source is interrupted or exhausted. Thus, the supply of a carbon substrate in a reducing environment is a key component needed to promote reductive dechlorination.

Although electron donor reactions are the most common processes by which reductive dechlorination occurs, cometabilism also serves to degrade chlorinated solvents. Cometabilism occurs best in aerobic conditions. Thus, chlorinated ethenes, with the exception of PCE, are susceptible to sequential dechlorination (Vogel, 1994). Reduction of vinyl chloride (VC) to ethene frequently occurs in cometabolic reactions. The process of cometabilism also increases as dechlorination decreases.

A comprehensive understanding of the physical environment is important when assessing the potential for natural attenuation at a site. Understanding the composition of the geologic media, knowing the groundwater elevation in the subsurface, determining the aquifer hydraulics, identifying transient conditions such as groundwater withdrawl that could affect groundwater flow or redox conditions, and sufficiently analyzing groundwater quality for natural attenuation parameters are all elements of the site conceptual model that should be applied to the natural attenuation analysis.

4.3.4 Natural Attenuation Summary

The presence of daughter products, such as 1,1-DCA and ethane or cis-1,2-DCE and VC at a given site, provide strong evidence that reductive transformations are taking place at that location (McCarty, 1994). As long as redox conditions are favorable and an organic carbon substrate remains available in the system, reductive dechlorination of chlorinated alkenes to vinyl chloride will likely continue to occur. The same is true for chlorinated alkanes. Over time vinyl chloride will breakdown to ethene, ethane, and then completely mineralize. This rate is usually much slower than the rate of degradation of TCA and DCA, or TCE and DCE, compounds under anaerobic conditions. However, under aerobic conditions, vinyl chloride can readily degrade.

The amount of energy required to break the final chlorine bond in vinyl chloride and then the double bond from ethene to ethane is significant. The energy is much more readily available under aerobic conditions, and thus the rate of degradation for these species under aerobic conditions is much greater. Therefore, the ideal degradation environment is a sequential anaerobic then aerobic environment, where the higher chlorinated VOCs are degraded in the anaerobic environment and VC is degraded in the aerobic environment.

TEM/LBL/KJQ
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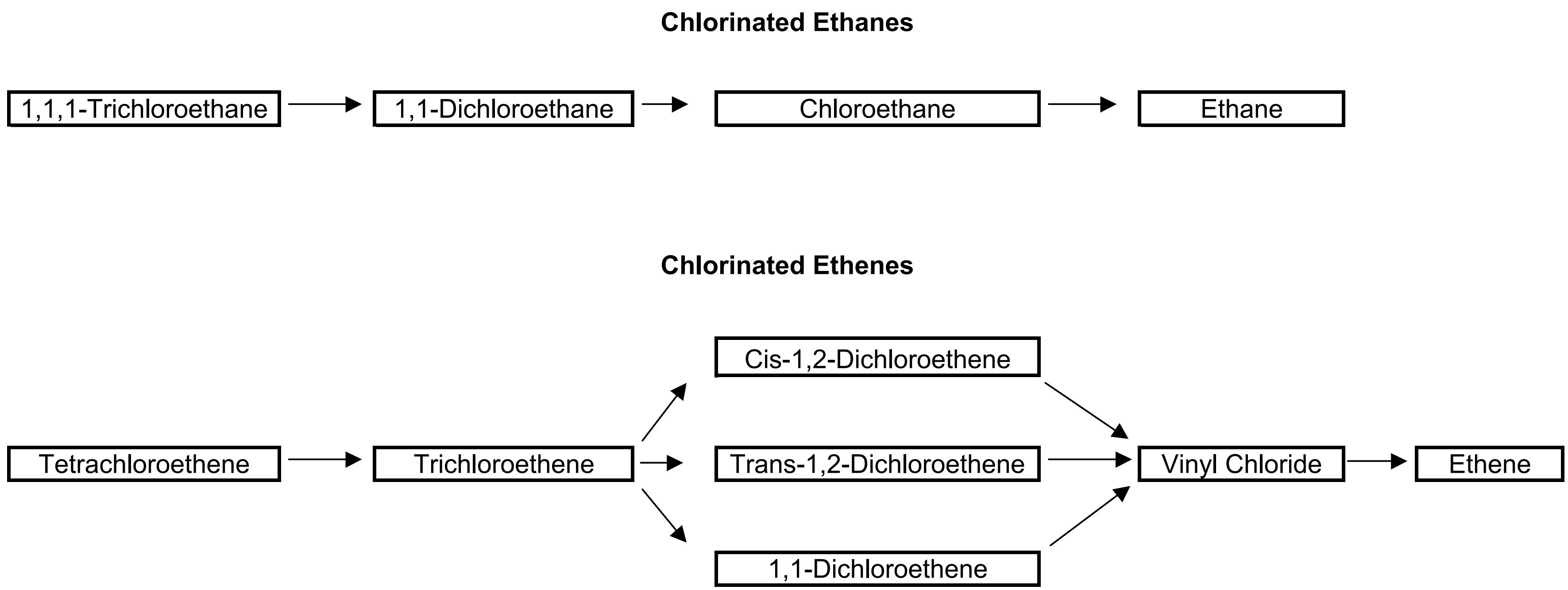
FIGURES



Note: Trichloroethene breakdown to cis-1,2-dichloroethene is the most preferred degradation pathway. Breakdown to 1,1-dichloroethene is least preferred

Figure 4-1 Reductive Dechlorination Pathways for Common Chlorinated Solvents

5.0 RISK ASSESSMENT METHODOLOGY

5.1 HUMAN HEALTH RISK ASSESSMENT METHODOLOGY

The purpose of the Human Health Risk Assessment (HHRA) is to evaluate the potential for present and future human health risks due to the identified chemical contaminants in environmental media South of the Firing Line at JPG. Based on the preliminary RI results and subsequent interim measures (IM) actions, 24 of 54 potentially contaminated sites were selected for evaluation in the HHRA (Table 5-1). The remaining 30 sites have been recommended with general regulatory concurrence for no further action and for removal from the RI/FS (Rust E&I 1996a).

This HHRA assesses the potential risks to the health of current area residents and to future individuals who might utilize the 24 sites for a variety of purposes under future land use scenarios being considered by the U.S. Army.—**. As shown in Table 5-1a, JPG land uses are predominately agricultural and industrial, but include some wildlife areas. After cleanup for "like use," future land uses will remain the same as current land uses (see Section 1). (EPA123)** The risk assessment estimates the potential for adverse impacts on human health that may result from contact with chemically contaminated media (i.e., air, soil, surface water, sediment, and groundwater) at each site. The RI analytical database is used for this assessment. The current-conditions scenario assessment will be utilized by project managers to determine if significant risks are currently present that require immediate remedial intervention. The future-conditions scenarios are assessed to determine what remedial responses would likely be necessary at a given site if that site were to be redeveloped into another land use at some time in the future. The risk assessment results will be used to determine appropriate risk-based environmental clean-up goals for site-related contaminants, consistent with the present and anticipated future (site) land uses, as necessary.

5.1.1 Summary of Approach

The approach used in conducting this HHRA is consistent with the methods suggested by the USEPA in *Risk Assessment Guidance for Superfund (RAGS), Volume I, Human Health Evaluation Manual (PART A)* (USEPA 1989b) and subsequent updates/guidance, including *Exposure Factors Handbook* (USEPA 1995a); memorandum entitled "Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors" (USEPA 1991a); *Guidance for Data Useability in Risk Assessment* (Part A; USEPA 1992c); and *Supplemental Guidance to RAGS:* "Calculating the Concentration Term" (USEPA 1992f).

The HHRA approach follows project-specific recommendations (i.e., those that are applicable to risk assessment), as specified in written review comments prepared by the State of Indiana, the USAEC, and USEPA Region 5 on the *Final Draft RI Report for Jefferson Proving Ground,*

South of the Firing Line (Rust E&I 1994). It should be noted that this human health risk assessment was not updated to conform to guidance that was issued after the completon of the RI Work Plan. Such changes are considered out of the scope of this assessment. In addition, the screening level step for data screened at the draft stage of the project were not rescreened with curren PRGs. However, the risk calculations have been updated using the most currently available toxicity values when this risk assessment was revised.

5.1.2 Overview of Risk Analysis Process

Risk assessment is the technical component of the risk analysis process used by risk managers to address chemical, radiological, and biological contamination in regard to their potential human health and environmental impacts. Risk assessment is a risk management tool and represents one of many inputs into risk management decisions. One primary use of a chemical-specific risk assessment, such as the one performed at JPG, is to focus remedial attention onto those chemicals and environmental media at a site that have the potential to be responsible for significant risks to the public and/or the environment. A risk assessment thus addresses the potential of the chemical contaminants associated with a project to generate risks in the future so that preventative management decisions can be made today.

It is important to put the risk assessment process into perspective. Risk assessments are not medically accurate; that is, they cannot accurately predict future health outcomes such as cancer incidence in exposed populations. There are some very basic reasons for this limitation. Not all data on the toxicity of chemical substances to humans are known today, nor can future human and animal exposure to site-specific chemicals be accurately quantified. The latter qualification is due to a lack of complete knowledge of the fate of chemicals in the environment, the uncertainty regarding release rates of chemical constituents from a site as a function of time, and the myriad individual behaviors that exist in any potentially exposed population which would lead to highly variable contaminant exposure.

The objective of this risk assessment, therefore, is *not* to calculate actual risks to people but rather to estimate *potential* risks to human health. Although scientists and behavioralists cannot predict exactly how sensitive a person's body might be to a specific chemical or how much exposure they will receive in the future, upper bounds of these characteristics have been established. Reasonable maximum exposure (RME) conditions are assumed in various land use scenarios and for receptors in risk assessments today. The RME represents the *highest* exposure that is reasonably expected to occur at the site. ~~Likewise, chemical toxicity toward humans is believed to be overstated in the criteria development procedures used by USEPA.~~ **(EPA121)** Thus, this overall approach to risk assessment ensures that if the calculated potential risks for any chemical contaminant fall into a regulatory-defined insignificant category, then any real risks presented by the chemicals at the site should be trivial. If a potential risk calculated at a particular site is significant (i.e., greater than USEPA's point of

departure level of 1E-06), then the associated contamination is highlighted and forwarded to the risk manager(s) for decisions regarding site remediation.

5.1.3 Organization of the Risk Assessment

This section provides a sequential discussion of the following four basic components of a risk assessment required to arrive at a consistent quantitative estimate of potential human health risk Nuclear Regulatory Commission (NRC 1983):

- Hazard identification
- Exposure assessment
- Toxicity assessment
- Risk characterization

Section 5.1.4 (Hazard Identification) provides a description of the methods used to evaluate the site analytical data, select the COPCs, and identify the appropriate receptor populations in each land use scenario. Section 5.1.5 (Exposure Assessment) discusses how the RMEs in these populations were derived. A discussion of the toxicological effects of the contaminants in over-exposed individuals is provided in Section 5.1.6 (Toxicity Assessment). The approach selected for assessing the magnitude of the potential health risks to the hypothetically exposed human populations is discussed in Section 5.1.7 (Risk Characterization). Section 5.1.8 discusses the uncertainty/sensitivity analysis.

5.1.4 Hazard Identification

The first step in the risk assessment process is hazard identification (NRC 1983). Hazard identification characterizes in a qualitative manner the potential hazard(s) posed by the site. Hazard identification focuses on the sources and chemicals likely to be responsible for the majority of the potential risk, the populations most likely to be exposed to these chemicals, and how, where, and over what time period this exposure would likely occur. In the hazard identification step, site environmental data are first summarized and then evaluated in order to select the site-specific COPCs. Once the COPCs are identified for the project, the environmental data along with other site data such as regional land uses, site hydrogeology, etc. are used to finalize a site conceptual model.

5.1.4.1 Data Assembly. This section summarizes the RI analytical database. Samples from various environmental media collected during RI field work (Phase I and Phase II) include surface soil samples, subsurface soil samples, surface water samples, sediment samples, and groundwater monitoring well samples.

For soil at the JPG sites, Phase I and Phase II RI data were compiled into a single database. However, a portion of the Phase II soil samples were collected to address concerns about Phase I data quality (i.e., high **certified reporting limits (**CRLs**)** for some **semivolatile organic compounds (**SVOCs**)**). **(EPA124)** -In these instances, the Phase I soil data for the problematic SVOC compounds were substituted with the Phase II data. This combination of data is thus intended to serve as the most up-to-date data set for soil in the risk assessment.

Background soil sampling was also conducted during the Phase I and the Phase II RI. Only background data from the Phase II RI were compiled and used in the risk assessment.

The Phase I background soil data samples were not used in the study due to concerns over whether these sampling locations were truly in unaffected areas at the facility.

Background surface water and sediment samples were collected only during Phase I of the RI. These data serve as the background data set for these media in the risk assessment.

For groundwater, four sampling rounds were conducted during Phase II at nine JPG sites (i.e., those sites with monitoring wells) and at pre-determined background areas. Since new wells were installed at most of these sites between the end of the Phase I and the start of the Phase II sampling events, the Phase II data are the most comprehensive and, therefore, were used quantitatively in the risk assessment. The glacial deposit/bedrock interface beneath JPG is the only hydrogeological zone that predictably yields sufficient groundwater for the installation of monitoring wells. Thus, the Phase II samples collected from wells screened across this zone serve as the data set for groundwater in the risk assessment.

Background groundwater sampling was also conducted during the Phase II RI. These background data were compiled separately and used in the risk assessment as data reflecting natural conditions in this medium at the facility.

Data assembly involves grouping the data by site and, within each site, by environmental medium (e.g., soil, groundwater) in order to describe conditions relevant to the risk assessment. This initial grouping of site data helps in determining if contamination in each site medium has been sufficiently characterized, in identifying any areas of relatively high concentration levels (“hot spots”), and in assessing the current extent of inter-media transfer of contaminants at the facility.

The RI analytical data targeted for use in the risk assessment were grouped and evaluated according to the following environmental media:

- Surface soil (surface samples collected from 0 to 0.5 feet bgs and samples collected from soil boring at depths less than 2.0 feet)

- Subsurface soil (samples collected from soil borings at 2.0 feet and deeper)
- Groundwater
- Surface water
- Sediment

~~5.1.4.2~~ 5.1.4.2 **Background Data.** Background samples were grouped and evaluated statistically according to environmental media. Background data are used to indicate those chemical concentrations that are either naturally occurring (natural background concentrations) or regional contamination having no association with the site under investigation (anthropogenic background concentrations). An example of anthropogenic background for this project is dioxin contamination in surface soil at areas of the facility that have not been impacted by site activities. Several studies have been conducted to date that detail the presence of these compounds in "non-contaminated" areas. (Bumb *et al*. 1980; Nestrick *et al*. 1986; Smith *et al*. 1983 (as cited in the *Final Draft RI Report*)). Background data are important for the risk assessment since this information is used to determine what is and what is not contamination at a site and whether or not past site activities are likely responsible for the contamination (USEPA 1989b). Anthropogenic background data, unlike natural background data, remain in the quantitative assessment.

5.1.4.2.1 Soil. The determination of background concentrations of inorganic analytes in soils at JPG was initially made during the Phase I RI on the basis of 15 sample locations (Figure 5-1). USEPA comments on the *Final Draft RI Report*, however, expressed concern that some of the background sample locations may have been too close to several of the JPG sites.

To ensure that the background surface soil samples represent areas not impacted by site activity, four new background locations were selected by the project team (including USEPA and IDEM staff) during an August 1995 JPG site visit (Figure 5-1). These locations were distributed to provide facility-wide data for statistical analysis and were selected so that each major soil type is represented (i.e., Cobbsfork, Avonburg, Rossmoyne). At each background sampling location, five 0-to-6-inch samples were collected on a 50-foot grid during the Phase II field work and analyzed for metals.

A total of 20 surface soil samples were collected from the background areas and submitted for laboratory chemical analyses during the Phase II RI. The background soil data were grouped in the risk assessment and evaluated statistically as discussed in Section 5.1.4.5. The background data are presented in summary tables, including frequency of detection, the mean concentration, range of detected concentrations, and the standard deviation for each analyte detected in background soil.

Background Dioxin Sampling. Several dioxin compounds were detected in relatively low concentrations (as compared to risk screening criteria) in soil samples collected at Sites 5 and 6, as reported in the *Final Draft RI Report*. The dioxin congener pattern and concentrations measured in these samples were noted to be similar to background dioxins in uncontaminated areas (Bumb *et al*. 1980; Nestrick *et al*. 1986; Smith *et al*. 1983 (as cited in the *Final Draft RI Report*)). Therefore, during the Phase II RI investigation, additional soil samples were collected at Sites 5 and 6; initial dioxin samples were also collected at the two incinerators (Sites 1 and 33). Additionally, in 1997 surface and subsurface soil samples from the New Burn Site adjacent to Sites 3 and 4 were analyzed for dioxins.

To determine if the dioxin concentrations in these site samples are a result of site activity or are anthropogenic background, five background dioxin soil samples were collected during the Phase II RI in each of the four Phase II grid sampling locations shown in Figure 5-1 (with the exception that two samples were collected at the Cobbsfork Soil Series background location). These samples were used to quantify anthropogenic background levels of dioxin compounds in areal soils (as discussed in Section 5.1.4.5). **All anthropogenic background data (i.e., dioxin data) were included in the risk assessment; however, in instances where dioxin exposure point concentrations were less than the risk-based screening criterion, dioxins were not carried forward in the assessment. (EPA117, EPA125)**

5.1.4.2.2 Groundwater. USEPA comments on the Final *Draft RI Report* also expressed concern about the location of upgradient wells used to determine background groundwater metal concentrations at several of the JPG sites. Some of these wells were located downgradient from other sites at JPG. Background Well Cluster C (three wells) and MW83-8 are, however, located upgradient from all JPG sites (Figure 5-1). During the August 1995 JPG site visit, it was decided that an additional background well would be installed near the east perimeter north of the main entrance to JPG (Figure 5-1). This new well plus these four existing upgradient wells comprise the background wells for this risk assessment. During the Phase II RI field work, these five background wells underwent four rounds of sampling, with each sample analyzed for total and dissolved metals.

Only total (not dissolved) metals data were used quantitatively in the risk assessment since the dissolved data were obtained using 0.45-micron filters, which exclude potentially mobile colloidal constituents (i.e., these constituents would not likely be trapped by the filter-pack surrounding a residential well screen). However, this approach is conservative since larger particulates could also be present in the unfiltered monitoring well samples.

Most of the project's site-specific monitoring wells are screened across the glacial/bedrock interface, which represents the most significant hydrogeologic unit at JPG. At any given location, this interface consists of one of five stratigraphically distinct limestone or dolomite lithologic units. Most of the background wells were constructed to intercept this

glacial/bedrock interface, and because they were located to be upgradient of JPG sites, these background wells are screened predominantly in the top of the Louisville Limestone. The exceptions are the two deeper wells in Well Cluster C. At this location, the glacial till-bedrock interface was encountered at approximately 14 feet bgs. Well MW93-7 was screened 75 to 95 feet bgs in the Laurel Dolomite, and Well MW93-8 was screened from 22 to 32 feet bgs in the Louisville Limestone. Well MW93-9 was screened 12 to 17 feet bgs in the glacial deposit/Louisville Limestone interface.

Background well MW83-4 was installed during a previous investigation in 1983 and is screened 8.5 to 13.5 feet bgs in the glacial deposit/Louisville Limestone interface and 23 to 28 feet bgs in the Louisville Limestone. Background well MW95-5 was screened 27 to 37 feet bgs in the glacial deposit/Louisville Limestone interface.

The Phase II RI data collected from the five upgradient wells were evaluated for usability as the natural groundwater background database for the risk assessment. The derivation of background groundwater concentrations for inorganic chemicals is discussed in Section 5.1.4.5. The summarized background data are presented in tabular form for each analyte, including frequency of detection, the mean concentration, the range of detected concentrations, and the standard deviation for each analyte.

5.1.4.2.3 Surface Water. In order to determine if activities at JPG have resulted in contamination to surface waters in the area of the facility, two rounds of surface water sampling were conducted, one in 1992 and one in 1993 (USAEHA 1993) at six entrance points of streams crossing the installation. These entrance point samples were analyzed for arsenic, mercury, and silver. The data from these surface water samples, albeit limited, serve as the background surface water database for the risk assessment (Table 5-6). Appendix Q contains the documentation of the background surface water sampling methodology and analytical results.

5.1.4.2.4 Sediment. As part of the above-mentioned effort to determine if JPG activities have impacted surface water bodies, three rounds of sediment sampling were conducted, two in 1992 and one in 1993 (SEC Donohue 1992; USAEHA 1993). The sediment sampling was conducted at nine stream entrance points to the facility. These sediment samples were analyzed for mercury, arsenic, and silver and were used in the statistical comparison of background data with site sediment sampling data. The data are grouped and summarized in tabular form in the risk assessment (Table 5-7). Appendix Q contains the documentation of the background sediment sampling methodology and analytical results.

5.1.4.3 Site Data.

5.1.4.3.1 Soil. The soil analytical data were grouped by site for the risk assessment. The site-specific data were then grouped by depth (i.e., surface (<2 feet bgs) and subsurface (≥ 2 feet

bgs)). In some instances, additional data subgroupings were used if, for example, any areas within a site were characterized by relatively high concentration levels ("hot spots").

The soil databases for each site (original Phase I RI data and Phase II data) were combined and evaluated statistically as discussed in Section 5.1.4.5. At certain sites (e.g., the Red Lead Disposal Area) where interim measures remediation has occurred, samples from the remediated areas were dropped from the data set. **Interim measure data were reviewed to determine if residual contamination exceeded residential PRGs.** Confirmatory interim measures data were not used in the risk assessment **if residual concentrations were less than corresponding PRGs.** ~~because the interim measures areas have regulatory approval for closure.~~ **However, at some sites, residual contamination exceeded PRGs, and additional investigation was conducted. For example, at Site 7, residual level for lead exceeded the 400 ppm cleanup level in a small area. Contaminants from this small area were removed and the excavated area was backfilled with clean soil. Further confirmatory samples were collected and a risk assessment was conducted on the contaminants located outside the excavated area. Site-specific interim measures conducted at each site and the data used for risk assessment are further discussed in the specific sections for such sites. It should be noted that groundwater pathway was evaluated for all sites. (EPA126)** The summarized site-specific data are presented in tabular form, including frequency of detection, the mean concentration, the range of detected concentrations, and the standard deviation for each analyte.

5.1.4.3.2 Groundwater. The groundwater data representing the glacial till/bedrock interface were grouped according to site and then by well location at each site (i.e., site upgradient versus down-gradient), and evaluated statistically as discussed in Section 5.1.4.5. The summarized data are presented in tabular form, including frequency of detection, the mean concentration, the standard deviation, and the range of detected concentrations for each analyte.

For risk assessment purposes, all of the groundwater data were used qualitatively in the discussion of historical water quality trends and in the nature and extent of detections. However, only the Phase II data were used quantitatively to estimate potential risks/hazards at the various sites.

Field duplicates and lab duplicates were handled in the following manner: (1) if both samples were detections, the values were averaged; (2) if only one of the samples was a detection, the detection was used; and (3) if both samples were nondetections, the lower detection limit was used.

Well-specific values for each chemical were derived by averaging the data from each of the four Phase II samples according to the following procedure: (1) if all samples were detections, all sample values were averaged; and (2) if there were nondetections, they were averaged in

with the detections only if ~~the full~~ ~~one half~~ **one-half the** detection limit was ~~less~~ **higher** than the highest detected value. **(EPA127)**

5.1.4.3.3 Surface Water. Surface water data were collected from Harberts Creek (downstream of the STP outfall) and the abandoned rock quarry pond (Sites 9 and 10). For the risk assessment, these surface water analytical data were grouped by site (i.e., according to the nearest adjacent site(s)) and evaluated statistically as discussed in Section 5.1.4.5. The summarized data are presented in tabular form, including frequency of detection, the mean concentration, the standard deviation, and the range of detected concentrations for each analyte.

5.1.4.3.4 Sediment. Sediment data were collected from Harberts Creek (downstream of the STP outfall), the abandoned rock quarry pond (Sites 9 and 10), and the drainage pathway (Site 14). For the risk assessment, these sediment analytical data were grouped by site (i.e., according to the nearest adjacent site(s)) and evaluated statistically as discussed in Section 5.1.4.5. The summarized data are presented in tabular form, including frequency of detection, the mean concentration, the standard deviation, and the range of detected concentrations for each analyte.

5.1.4.4 Data Evaluation. This step of the risk assessment process evaluates the RI analytical data for its usability. Usability of data for a risk assessment is determined by the data's level of certainty/uncertainty. Two basic questions are asked and answered in this analysis:

- Have the chemical constituents present in various environmental media at each site been adequately characterized and accurate levels established?
- Have all the likely exposure media at each site been sufficiently characterized?

The recommendations in the USEPA's manual entitled *Guidance for Data Usability in Risk Assessment* (USEPA 1992c) were followed in performing this evaluation. Six criteria, as described in this manual, were used to judge the adequacy of the RI data for this assessment:

- Quality of data reports
- Completeness of documentation
- Completeness and relevance of data sources
- Adequacy of analytical methods and quantitation limits
- Quality and completeness of data validation

- Comparison of data quality indicators

5.1.4.4.1 Quality of Data Reports. The *Final Draft RI Report* (Rust E&I 1994), *Phase II Field Sampling Plan* (Rust E&I 1996a), and *JPG Facility-Wide Quality Assurance Project Plan* (Rust E&I 1996b) provide detailed descriptions of the project site and provide the baseline data that were used to develop the risk assessment. The information provided in these reports includes a description of the site, its historical uses, detailed maps showing the regional setting, the overall layout of the site as well as the rationale for selection of sampling locations, and a description of the analytical methods and data quality assessment approach.

Analytical results were supplied electronically in the form of the **U.S. Army Environmental Center's (**USAEC's**) Installation Restoration Data Management Information System (**IRDMIS**)** **(EPA128)** database and included:

- Results for each analyte and each sample, with USEPA qualifiers for analytical limitations

- CRLs for USAEC methods and practical quantitation limits (PQLs) for SW846 methods

- Physical parameter data, when applicable, for sampled media

The quality of the data reports was determined to be acceptable for risk assessment purposes.

5.1.4.4.2 Completeness of Documentation. Data collection and analysis procedures must be accurately documented in order to substantiate the analyses of each sample, the proper correlation of sample results to geographic locations, the conclusions drawn from those analyses, and the reliability of the reported analytical data. Assessment of the site documentation, therefore, involves an examination of:

- Chain-of-custody records

- Records of sampling location and sampling dates

- Analytical records

Phase I documentation has been reviewed by EcoChem (data validation team). They identified several transcription errors in the analytical reports, which have subsequently been corrected. Other Phase I documentation was judged to be complete and usable (Appendix P).

A complete review of the Phase II sample documentation was conducted by EcoChem prior to this assessment. Their conclusions on the data set are provided in the risk assessment for each site and in Appendix P.

5.1.4.4.3 Completeness and Relevance of Data Sources. The Phase I and Phase II RI comprise the databases for quantitative use in this health risk assessment. Below are specific instances where either Phase I or Phase II data were not incorporated:

- Due to data quality issues with some SVOC compounds in the Phase I data, resampling was conducted for these analytes at specific sites at JPG. In these instances, the Phase II soil data for the problematic SVOC compounds were substituted for previous Phase I data.

- At some sites (e.g., the Red Lead Disposal Area) remediation activities have occurred and portions of these sites are considered closed. Data from the remediated areas were not considered in the site-specific risk assessments. **(See Section 5.1.4.3.1 for additional discussion interim measures data.) (EPA129)**

- Phase I groundwater data were not used in the risk assessment

EcoChem completed a review of the Phase I data for completeness and representativeness (Appendix P). Their evaluation determined that volatile organics, pesticides, explosives, semivolatile organics, and metals were all analyzed using a broad spectrum analysis, which included the USEPA's target analyte list and organic chemicals pertinent to military installations. Field screening procedures were used as a guide in selecting sampling locations.

5.1.4.4.4 Adequacy of Analytical Methods and Quantitation Limits. Appropriate analytical methods are those that have detection limits that meet risk assessment requirements for COPCs and have sufficient **quality control** (QC) measures to quantitate chemical identification and measurement. Appropriate analytical methods also minimize the probability of false negative results; that is, non-detection of an analyte when it truly is present at potentially significant concentrations.

All Phase I samples were analyzed using USAEC-certified methods or USEPA methods. Only USEPA methods were used to conduct the Phase II analyses. An analytical problem was identified during the initial Phase I **data quality assessment** (DQA) with the USAEC SVOC methods (LM25, soil; UM25, water). **(EPA130)** The potential existed for some analyte concentrations above the CRL to go undetected. To address this data gap, sites previously sampled for SVOCs were resampled in the Phase II investigation, and the samples were analyzed for SVOCs using USEPA SW846 methods.

All analytical data used quantitatively in the risk assessment have undergone a Modified USEPA Level III validation effort. An additional 20 percent have undergone an extensive USEPA Level IV/V validation. USEPA data qualifiers assigned during this process were incorporated into the electronic database and used to assess the level of certainty/uncertainty of the analytical results in the risk assessment on a site-by-site basis.

A comparison of Region 5 **desired quantitation limits (**DQLs**)** was also made in the risk assessment to all project **certified reporting limits (**CRLs**)** /**method detection limits (**MDLs**)** for those chemicals that were analyzed for but not detected in various environmental media. This comparison was made to determine if any chemical of potential concern may have been missed due to an elevated analytical reporting limit. **(EPA131)**

This approach is appropriate because the MDL by definition is three times the standard deviation of seven replicate spiked samples handled as environmental samples. CRLs represent Contract Required Quantitation Limits (CRQLs), and represent levels that a Contract Laboratory Program (CLP) laboratory has the ability to routinely and reliably detect and quantify in a variety of sample matrices. The sample quantitation limit (SQL) is the MDL, which has been corrected for sample dilution and other sample-specific adjustments (percent solids for soils, sample volume extracted for waters). Therefore, CRLs are analogous to SQLs. In this risk assessment, CRLs were used in the derivation of EPCs. (EPA119)

These DQLs ~~are~~ **were** derived exclusively from the Region 9 Preliminary Remediation Goals and are health-based (USEPA 1995b; 1996c). Since DQL values are provided for soil and groundwater, but not surface water and sediment, surface water CRLs/MDLs were compared to drinking water DQLs, and sediment CRLs/MDLs were compared to soil DQLs. A discussion is provided in each site-specific risk assessment for this evaluation.

To determine if an elevated non-detect value for a given chemical warranted discussion in the site-specific risk assessments, three main criteria were used. First, the elevated non-detect value had to substantially exceed the DQL**, at least twice the DQL**. **(EPA132)** Second, for locations/wells that had multiple sampling events, the elevated non-detect value(s) did not warrant discussion if at least half of the other events exhibited an acceptable CRL. Third, for sites with multiple sampled locations/wells, the elevated non-detect value(s) did not warrant discussion if at least half of the other sampled locations/wells exhibited an acceptable CRL. **The distinction between the second and third items is the former refers to intrawell well events and the latter refers to interwell events. (EPA132)** Other criteria were also used, such as the relative likelihood for any given chemical type to be found at the site or location/well.

5.1.4.4.5 Quality and Completeness of Data Validation. An initial DQA was performed by EcoChem on approximately 10 percent of the Phase I analytical data. The assessment

followed USAEC's PAM-11-41 (USATHAMA 1990) and USEPA's Functional Guidelines (USEPA 1988a; USEPA 1988b; USEPA 1991b) as described previously in Section 3.4.2. Results of this analysis were used to help determine data quality issues and data gaps, which were subsequently addressed in the Phase II RI.

In addition to this initial DQA, 100 percent of the analytical data (Phase I and Phase II) has undergone a Modified Level III validation effort by EcoChem using a DQST or equivalent manual screening method as previously described in Section 3.4.2.

This DQST identifies "critical lots" (i.e., lots with 5 percent or more of the QC points outside of the acceptance criteria). Since the presence of these outliers indicates that some external event (e.g., matrix interferences, poor analytical technique, etc.) has affected the data quality, these critical lots undergo an in-depth USEPA Level IV/V validation effort performed by EcoChem. EcoChem then assigns USEPA data qualifiers, which were incorporated into the electronic database for use in the risk assessment. A detailed description of the DQA and flowchart illustrating the DQST process is included in the JPG Facility-Wide QA Project Plan (Rust E&I 1996b).

Additional components of the data review for the risk assessment are described below.

5.1.4.4.6 Comparison of Data Quality Indicators. Data quality indicators were assessed to determine whether individual results for each sample, as well as entire data sets for each site at the facility, are of known and acceptable quality. This assessment required an evaluation of the data with regard to the following five criteria:

- Completeness—Are there sufficient data of known and acceptable quality for each medium, exposure pathway, and COPC to characterize risk? If not, what effect does this deficiency have on the risk assessment?

- Comparability—Were all data analyzed using comparable methods? Are samples reported in consistent units with consistent reporting limits?

- Representativeness—Are the data representative of the contamination in each medium (both in terms of concentration and locations)? Did the sampling or analysis procedures affect the representativeness (e.g., poor matrix recovery or inappropriate compositing)?

- Precision—Were sufficient data collected to estimate laboratory and field variability? What is the impact of the field variability on the original RI Work Plan sampling scheme's ability to detect "hot spots" and to establish background concentrations?

- Accuracy—Were sample spikes (matrix spikes), QC spikes, and surrogates analyzed to assess accuracy of nondetected and detected sample results?

This data evaluation step was performed on a site-specific basis, and a data evaluation summary is provided for each site-specific risk assessment.

5.1.4.5 Identification of Contaminants of Potential Concern. The objective of this step is to identify media-specific COPCs for each of the sites that could pose potentially significant risks to human health. The chemical data set for this risk assessment includes Phase I (1992 and 1993) and Phase II (1995, 1996, and 1997) sample data.

Quality control or data affected by quality control samples were removed as follows:

- Any filtered metal data were removed.

- Tentatively identified compounds (TICs) were removed, **but where levels above a health-based screening criterion** **(EPA133)** were detected in a sample, these results are discussed qualitatively.

- Field quality control samples such as equipment rinse blanks, trip blanks, and matrix spike samples were removed.

- Laboratory quality control samples such as method blanks, laboratory control spikes, and matrix spike samples were removed.

- Data qualified as rejected (data qualifier "R") were removed.

- Duplicate data from two different methods were handled in the following manner for a given sample: if there was a detection with one method, the detected value was used in the risk assessment; if both values were detects, the highest detected value was used; and if both values were nondetects, one-half of the lower nondetect value was used.

- Field duplicate **(i.e., a second sample collected in the same location as the original sample and analyzed in the laboratory using the same analytical methods)** **(EPA134)** results were averaged with the primary investigative results, and the average value was used in the risk assessment.

- All data collected using the same equipment type from the same medium were compared to field blank data based on the 5x/10x rule (USEPA 1989b; USEPA 1992c).

- All volatile compound samples collected on the same day were compared to trip blank data based on the 5x/10x rule (USEPA 1989b; USEPA 1992c).

- Samples were compared to method blank data based on the 5x/10x rule, as appropriate (USEPA 1989b; USEPA 1992c).

- Any chemical that was not detected in any environmental media at a site using acceptable detection limits was removed.

At this point, the chemical data were divided into the respective sites. Individual site data sets were reviewed for qualifiers and any impact to the site data set was documented. The qualityassessment for individual sites is discussed in their respective sections of this document.

The COPC selection process incorporated guidance from the following documents: *Risk Assessment Guidance for Superfund (RAGS), Vol. 1; Human Health Evaluation Manual (Part A*) (USEPA 1989b); *Calculating the Concentration Term* (USEPA 1992f); and "Region 9 Preliminary Remediation Goals" (PRGs; USEPA 1996c). To focus the risk assessment on those site-related chemicals that present the greatest potential risk, the chemicals in each medium were screened in a step-wise fashion to obtain a set of COPCs for each site. This screening process included the following steps, which are summarized in the flow chart in Figure 5-2.

5.1.4.5.1 Data Usability. The entire analytical database for each site was first reviewed for data usability. This step included the application of USEPA data qualifiers, comparison of site sample results to blank results, and an assessment of data completeness and representativeness for the site.

5.1.4.5.2 Background Screening - Inorganics. In this step, the concentrations of inorganic chemicals detected in site soil, sediment, surface water, and groundwater were compared to the concentrations of these analytes in the respective facility background samples. Surface soil and subsurface soil were screened separately for the background comparison.

Soil. The background data were first segregated by soil series (Cobbsfork, Avonburg, or Rossmoyne). The means of each inorganic data set were compared among the soil types with both parametric ANOVA (using raw and log-transformed data) and the nonparametric Kruskal-Wallis test (SYSTAT; v.6). The mean concentration of zinc, lead, nickel, manganese, and cobalt differed significantly among the three soil types for all tests. Therefore, the data for the different soil types were segregated for the purposes of the background comparison. Tables 5-2, 5-3, and 5-4 summarize the background data sets for the Cobbsfork, Avonburg, and Rossmoyne series, respectively.

If the percent of detections for a specific analyte in either the background or the site data set was greater than 50 percent, both data sets were tested for distribution normality using the Shapiro-Wilk test (Gilbert 1987). Levene's median test (Kuehl 1994) was also used to

determine if the variances of the site and background data sets for each analyte were equal. If both data sets were normally distributed, a one-tailed Student t-test with $\alpha = 0.05$ was performed. If the variances were unequal, a two-sample t-test for independent samples with unequal variances was used. If normality could not be demonstrated, the data were log-transformed and again tested for normality. If normality was demonstrated for both transformed data sets, the Student t-test was performed on the log-transformed data. The t-test was supplemented with a 95 percent confidence interval for the difference between the two means. The confidence interval is statistically equivalent to the t-test and shows the range within which the true mean difference may lie. If one of the following conditions existed, the nonparametric Kruskal-Wallis test (SYSTAT, v. 6) was performed: the distribution for both data sets was not the same; neither data set was normally or lognormally distributed; or the number of detections was less than 50 but greater than 10 percent.

A minimum of four data points in each data set (site and background) were required to perform the above-described tests.

If the percent of detections was less than 10 percent (but there was at least one detection) or the number of data points was less than 4 in the site data set, an upper limit of background concentration was calculated as the mean of the background data plus two times the standard deviation (see Tables 5-2, 5-3, and 5-4). For this calculation, the nondetections were entered as one-half their respective **CRLs**. **(EPA135)** The maximum site detect value was then compared to this calculated upper limit.

If there were no detections in the background data set for an inorganic chemical, the site concentration was considered to exceed background if there were any detections of the chemical in the site samples. When comparing site with background using the Student t-test or the Mann-Whitney test, the site concentrations were considered to exceed background if the p-value for the test was less than 0.05. For the extreme value comparison, site concentrations were considered to exceed background if the maximum site concentration exceeded the calculated upper limit for background.

For subsurface soil samples, the samples from 2 feet and below (down to a depth of 10 feet bgs) were averaged for comparison with the background surface soil data. This procedure was conducted since metal concentrations were not observed to vary consistently with depth in the Phase I background subsurface soil samples. This practice of comparing background surface to subsurface soil samples data is valid if the soil type is identical throughout the soil column.

Groundwater. Four rounds of samples were collected from five background wells. The following procedure was followed to determine background groundwater concentrations of inorganics.

Field duplicates and lab duplicates were handled in the following manner~~: if~~: **if** both samples were detections, the values were averaged; if only one of the samples was a detection, the detection was used; and if both samples were nondetections, the lower detection limit was used.

Well-specific values for each inorganic were derived by averaging the data from each of the four samples according to the following procedure: if all samples were detections, all sample values were averaged; if there were any nondetections, they were averaged in with the detections only if the full detection limit was less than the highest detected value.

It was noted that one background well had consistently much higher concentrations of inorganic constituents than the other four wells. The sample descriptions for the sample rounds were reviewed and showed that the samples collected from MW95-5 were described as turbid/brown and slightly cloudy for two of the rounds; for the other rounds the information was missing or not recorded. For the remaining four background wells, samples were described as clear. It was therefore decided that data from MW95-5 would not be used to establish background since the higher concentrations of inorganics appeared to be related to suspended solids in the samples as opposed to natural background variation. The background data set therefore consisted of well-specific values from the following four wells: MW93-7, MW93-8, MW93-9, and MW83-4.

In the background calculations (regardless of whether there was a threshold calculated or a statistical test performed), all four sample values were used if they were all detections. Nondetections were not used if the full detection limit exceeded the highest detected value. Nondetections used in the calculations were entered as one-half of the detection limit. Table 5-5 summarizes the background groundwater data.

Surface Water. Arsenic data from six grab samples collected in July 1992 comprise the background surface water database for this metal. Surface water samples from the six entrance points were analyzed for both mercury and silver in July 1992 and July 1993. At some entrance points, two samples were collected. When this occurred, the results of the two samples were averaged if both were detections. If one value was a detection, the detected value was used. If both samples were nondetections, the lower detection limit was used. This same procedure was followed when comparing results from 1992 and 1993 for the same sampling location, so that the final background surface water databases for mercury and silver each had six data points, one for each sampling point. Table 5-6 summarizes the surface water natural background threshold values for arsenic, mercury, and silver.

Comparison of the analytical data from site surface water samples was performed in the same manner as described above for soils. Any other metals other than arsenic, mercury, and silver, if detected in site surface water samples, were considered COPCs since no background data are available for comparison.

Sediment. The USEPA expressed concern over the reliability of the sediment analytical results from the January 1992 sampling event. Therefore, the results from this sampling event were not considered in the background evaluation. The July 1992 samples were analyzed for arsenic and these six data points comprise the background sediment database for this metal. Sediment samples from nine entrance points were analyzed for mercury in July 1992 and July 1993. At some entrance points, two samples were collected. When this occurred, the results of the two samples were averaged if both were detections. If one value was a detect, the detected value was used. If both samples were nondetections, the lower detection limit was used. This same procedure was followed when comparing results from 1992 and 1993 for the same sampling location, so that the final background sediment database for mercury had nine data points, one for each sampling point. Silver was not detected in background sediment samples. Table 5-7 summarizes the sediment natural background threshold values for arsenic and mercury.

Comparison of the analytical data from site sediment samples was performed in the same manner as described above for soils. Metals other than arsenic and mercury, if detected in site sediment samples, were considered COPCs since no background data are available for comparison, or in the case of silver, the analyte was not detected in background samples.

5.1.4.5.3 ~~5.1.4.5.3~~ **Background Screening - Organics (Dioxins/Furans)**. **The anthropogenic background sites were established in August 1995 with concurrance by USEPA, IDEM, AND COE. The group indentified four areas south of the firing line for the collection of surface soil samples in grids of five samples each based on a final sampling plan approved by USEPA and IDEM. The 1995 agreement also included collection of background groundwater samples from existing a background well cluster located near the eastern boundary of JPG, from the DU background well located near the southeast corner of JPG, and from a new well to be installed north of the main entrance to JPG. It is noted that the National Climatic Data Center indicates the prevailing winds are generally from the southwest during most of the year. (EPA30)**

The f~~F~~ive soil samples, which all parties agreed have not likely been impacted by site activity, were collected during the Phase II RI in areas south of the firing line at JPG for dioxin analysis. These samples were used to determine anthropogenic background levels of dioxin compounds in a manner identical to that described for inorganics in soil. In addition, the congener-specific pattern of dioxins and furans detected in site samples was compared to the pattern in the background samples. If the congener patterns are similar for site and background and of the same toxicity equivalency (TEQ) magnitude (using statistical tests), this is suggestive of anthropogenic background.

No data were eliminated from the risk assessment based on this analysis. However, at those sites where the dioxin concentrations were considered anthropogenic background, any risks associated with this contamination were identified as non-site related. **All anthropogenic background dioxin data were included in the risk assessment; however, if the dioxin exposure point concentration (EPC) was less than the risk-based screening criterion, dioxins were not further evaluated in the assessment.(EPA30)**

5.1.4.5.4 Nutrient Screening/Frequency of Detection. In this step, the concentrations of nutrients detected above background levels in site soil, sediment, surface water, and groundwater were compared to nutrient screening values, which were derived according to the procedures described below. For soil, two separate data sets were screened: (1) data for nutrient chemicals detected in surface soil above background and (2) analytical results representing surface soil data combined with subsurface data (down to 10 feet bgs) for all nutrients detected above background in either surface or subsurface soil. This approach for soil data was used in order to accommodate the exposure scenarios selected in the conceptual site models (presented in Section 5.1.4.6).

For the risk assessment, nutrient screening values were calculated for nutrients detected in the soil and groundwater database without USEPA toxicity values (i.e., calcium, magnesium, iron, potassium, and sodium). The nutrient screening values were calculated using CERCLA guidance for the derivation of preliminary soil or drinking water remediation goals for a residential scenario (USEPA 1991c). The U.S. recommended daily allowance (RDA) was substituted for the toxicity value in the equation, and the target hazard quotient was 1.0. The RDAs were taken from Region 8 guidance (USEPA 1994b). In those instances where the calculated nutrient screening value exceeded 1E+06 ppm (i.e., calcium, magnesium, and sodium), the value of 1E+06 was used as the screening value. The soil screening values were used to screen nutrients detected in sediment samples. The groundwater screening values were used to screen nutrients detected in surface water samples.

Since an RDA was not provided for sodium (Na^+), a review of the medical literature was conducted by Rust E&I to determine an acceptable level of human consumption for this nutrient. Hypertensive patients, without mitigating complications, should not consume more than 4 to 6 grams of salt (1,600 to 2,400 mg Na^+) per day (Rakel 1990; Wyngaarden *et al.* 1992). The value of 1,600 mg Na^+ of salt per day was therefore selected as a safe human consumption level. Assuming an adult body weight of 70 kilograms (kg), a safe dose for sodium is estimated at approximately 20 milligrams per kilogram per day (mg/kg-day).

Table 5-8 summarizes the calculated nutrient screening values used in the risk assessment. A nutrient was eliminated from the database if all investigative results at a site were lower than its nutrient screening value.

Chemicals that are infrequently detected may be sampling or analytical artifacts unrelated to site operations. Such chemicals may be eliminated from the quantitative risk assessment if there is no reason to believe that the chemical may be present (USEPA 1989b). For the risk assessment, a chemical was eliminated from the analytical database if it was detected in 5 percent or fewer of the samples, if the history of the site suggests that it would not be expected to be present, and if its concentration was less than a risk-based screening level, such as the SSLs (USEPA 1996b).

5.1.4.5.5 Screening with Region 9 Preliminary Remediation Goals. For each site-specific risk assessment, a table of summary statistics for each medium and data grouping is provided, describing the preliminary COPCs at each area of concern (i.e., those chemicals judged to be contaminants at each site). These tables include frequency of detection, range of detections, range of CRLs, arithmetic mean concentration, the 95 percent upper confidence limit (UCL) of the mean, and the selected exposure point concentration (EPC) for each preliminary COPC.

Preliminary COPCs for sediment, surface water, groundwater, and site soil data sets were then screened by comparing their exposure point concentrations to USEPA Region **9** preliminary remediation goals (PRGs) to obtain the final list of COPCs for each site (USEPA **1998**~~1996c~~).

Soil. Before the final screening step of each site's soil databases was conducted, an analysis was undertaken to determine if hot spots of contamination in soil exist, which would warrant a separate evaluation. The process involved reviewing contaminant distribution across the site, the distance separating the various sample locations, and the size of the site with respect to a hypothetical 0.5-acre residential lot. The rationale underlying the hot-spot analysis is described in detail for each site.

As mentioned in Section 5.1.4.3.1, two data sets for soil were evaluated separately: (1) data for organic chemicals and inorganic chemicals detected in surface soil above background or above nutrient levels and (2) surface soil data combined with subsurface soil data (down to 10 feet bgs) for all organic chemicals and inorganic chemicals detected above background or above nutrient levels. This approach for soil data was used to accommodate the exposure scenarios selected in the conceptual site models (presented in Section 5.1.4.6).

A soil EPC was calculated for each soil data grouping at each site. This EPC was the maximum detected value or the 95% UCL of the mean, whichever was lower, for each contaminant (USEPA 1989b). One-half of the CRL was used for nondetects in this analysis. **The CRL value, as used, included corrections for sample weight, dilution factors, and moisture, and is equivalent to the sample quantitation limit (SQL)** **(EPA136)**. Each chemical-specific EPC was then compared to the appropriate Region **9** residential soil PRG. These PRGs assume the following exposure pathways: ingestion, inhalation of particulates, inhalation of volatiles, and dermal absorption. One-tenth of the value was used for most noncarcinogens. The exceptions were lead and organic chemicals for which the PRG is based

on saturation limits or maximum limits; for these chemicals the full PRG was used. The 1 x 10^{-6} PRGs were used for carcinogens. If the EPC exceeded the PRG, the chemical was retained and carried through the risk assessment as a COPC for soil. At the request of USEPA Region 5, all chemicals at each site that were screened out in this analysis are presented in an appendix (Appendix X), along with an order-of-magnitude estimate of their collective potential health risks. The order-of-magnitude cancer risk and noncancer hazard estimates for these eliminated chemicals were calculated as follows, as described in the Region **9** guidance (USEPA 199**8**c) (the full PRG was used for noncarcinogens for this calculation). The order-of-magnitude noncancer hazard index estimates do not include chemicals with PRGs based on saturation limits or maximum limits.

$$\begin{matrix} Order\text{-}of\text{-}Magnitude \\ Cancer\ Risk \end{matrix} = [(\frac{EPC_x}{PRG_x}) + (\frac{EPC_y}{PRG_y}) + (\frac{EPC_z}{PRG_z})]\ x\ 10^{-6}$$ (Equation 5-1)

$$\begin{matrix} Order\text{-}of\text{-}Magnitude \\ Hazard\ Index \end{matrix} = [(\frac{EPC_x}{PRG_x}) + (\frac{EPC_y}{PRGSUB}\ y) + (\frac{EPC_z}{PRG_z})]$$ (Equation 5-2)

Air. For all chemicals in soil that were carried through the risk assessment (i.e., those that exceeded the soil PRG), air concentrations were modeled, if appropriate for the site, as described in Appendix R. The modeled air concentrations were compared to the Region 9 ambient air PRGs (USEPA 1996c). One-tenth of the value was used for noncarcinogens. If the modeled air concentration exceeded the PRG, the chemical was retained and carried through the risk assessment as a COPC in air. All chemicals at a site that did not exceed the PRG are presented in Appendix X. The order-of-magnitude cancer risk and noncancer hazard for these eliminated chemicals were calculated as described above for soil COPCs.

Groundwater. An on-site groundwater EPC was calculated for each preliminary COPC at each site, as described above for soil. Each chemical-specific EPC was compared to the appropriate Region 9 tap water PRG (USEPA 1996c). These PRGs assume the following exposure pathways: ingestion from drinking and inhalation of volatiles. **Dermal contact with groundwater may be a complete exposure pathway for some receptors, but dermally absorbed doses are not accounted for in developing PRGs. The uncertainties associated with development of PRGs are discussed in the Uncertainty Section (EPA137).** One-tenth of the value was used for noncarcinogens; the 1 x 10^{-6} PRGs were used for carcinogens. If the EPC exceeded the PRG, the chemical was retained and carried through the risk assessment as a COPC for on-site groundwater.

All preliminary COPCs for groundwater (i.e., all chemicals detected at concentrations above background) were modeled to off-facility receptors. The model's output concentrations were screened against the tap water PRGs to select COPCs in groundwater for off-facility receptors.

All groundwater chemicals that did not exceed the tap water PRG are presented in Appendix X. The order-of-magnitude cancer risk and noncancer hazard for these eliminated chemicals were calculated as described above for soil.

Surface Water. A surface water EPC was calculated for each preliminary COPC at each applicable site, as described above for soil. Each chemical-specific EPC was compared to the appropriate Region 9 tap water PRG (USEPA 1996c). One-tenth of the value was used for noncarcinogens; the 1 x 10^{-6} PRGs were used for carcinogens. If the EPC exceeded the PRG, the chemical was retained and carried through the risk assessment as a COPC for surface water. All chemicals that did not exceed the tap water EPC are presented in Appendix X. The order-of-magnitude cancer risk and noncancer hazard for these eliminated chemicals were calculated as described above for soil.

Sediment. A sediment EPC was calculated for each preliminary COPC at each applicable site, as described above for soil. If the EPC exceeded the corresponding PRG, the chemical was retained and carried through the risk assessment as a COPC for sediment. All chemicals that did not exceed the residential soil **PRG** are presented in Appendix X. The order-of-magnitude cancer risk and noncancer hazard for these eliminated chemicals were calculated as described above for soil. **(EPA138)**

Region 9 published an updated PRG table in April 1998, after the completion of this draft RI. The updated PRGs were reviewed to determine the impact on the risk assessment if the updated rather than the 1996 PRGs were used for screening purposes. The ambient air and tap water PRGs did not change between the 1996 and 1998 tables, except for chemicals with updated toxicity values. Modifications in input parameters for the dermal pathway resulted in lower soil PRGs in the 1998 version compared to the 1996 version. In general, 1998 residential soil PRGs for inorganic chemicals decreased only slightly, and the residential soil PRGs for organic chemicals decreased about 16 to 20 percent. It does not appear that using the 1998 PRGs in the COPC selection process would change the conclusions of the risk assessment, with the exceptions noted below.

In April 1998 the USEPA withdrew the oral slope factor for beryllium and its compounds. At all sites, beryllium in all media would have been screened out in the COPC selection process. The Region 9 1998 PRG table now includes screening values for iron; the soil screening value is lower than the nutrient screening value for iron developed by Rust E&I. The Region 9 iron PRG is based on a provisional oral reference dose (RfD) not available in IRIS or HEAST. However, it is very similar to the RDA for iron used by Rust E&I to develop a screening value.

Exceedance of the iron screening values implies only that the RDA for this nutrient would be exceeded, not necessarily that adverse effects would occur to human health.

5.1.4.6 Generalized Conceptual Site Models. Once the COPCs are selected, these data along with other project data such as regional land uses, site hydrogeology, etc., are used to finalize site conceptual models. A health risk assessment conceptual model for a site schematically describes the relationship between the source materials and the potentially impacted human receptor populations. It details the various known and/or potentially contaminated environmental media at a site and then describes the various exposure pathways by which human populations may come into contact with the site chemicals in these media. A conceptual model was developed for each land use scenario for which the site was evaluated in the risk assessment.

Based on the descriptions of site characteristics, including the history of operations at JPG and a review of the Phase I and Phase II data, two conceptual models were developed for this project as shown in Figures 5-3 and 5-4. For both models, no further remedial action (beyond the voluntary interim actions) was assumed to occur at each site so that the potential receptors were presumed to be exposed to the current levels of contaminants measured in soil, surface water, sediment, and groundwater. This approach enabled the study to determine if any additional future remedial action is needed at any site and, if so, what chemicals and media should be addressed.

As shown in Figures 5-3 and 5-4, the risk assessment conceptual models for the JPG sites south of the Firing Line are categorized as follows:

- Facility-wide scenarios—Describe the likely human receptor populations and their aggregate potential exposures to contaminants originating at multiple JPG sites under existing conditions (e.g., a closed, fenced former munitions/weapons testing facility) and under possible future land uses.

- Site-specific scenarios—Describe the likely human receptor populations and their potential routes of exposure to contaminants at individual JPG sites, under three alternative future land uses.

The U.S. Army selected three alternative future land use scenarios for evaluation of these sites in the risk assessment. These scenarios assume conversion of a select site into (1) leased agricultural acreage (open areas only), (2) industrial properties, or (3) residential lots (open areas or where current housing exists). Under the future conceptual models, each of the sites selected for inclusion in the risk assessment was evaluated as residential real estate and as either an industrial property or an agricultural field. The risk assessment, therefore, determines the potential of each site to impact human health under existing conditions and under two possible alternative future land uses.

5.1.4.6.1 Facility-Wide Conceptual Model. The installation consists of industrial buildings, former workshops, and former test facilities, as well as administrative buildings and former personnel housing in the area south of the Firing Line. A major portion of JPG is wooded and the remainder is open grassland. Some of the buildings at the facility (none of which are sites for this investigation) are currently being leased to tenant residents and tenant employees. The locations of these employees and the type of jobs they perform are listed in Section 1.2.2, Table 1-2. Access to the facility is still controlled at the main gate. However, the entire facility is not routinely patrolled as in the past.

JPG is surrounded by several small rural towns, including New Marian, Holton, Nebraska, Rexville, Grantsburg, Belleview, Middlefork, San Jacinto, and Wirt. The area immediately adjacent to the installation is used predominantly for small family farms. Approximately 100 farmhouses and other dwellings are located within 1 mile downgradient of JPG south of the Firing Line. The major local crops are tobacco, corn, and soybeans, and little change is expected in the foreseeable future.

Figure 5-3 describes the facility-wide conceptual model, which includes the current land use scenario as a closed, fenced, former munitions/weapons testing facility and possible future land use scenario(s). This conceptual model was developed to address the potential for facility-wide risks (i.e., multiple sites) to currently impact receptors located both on- and off-site.

Current Land Use Scenario. In the current scenario, the most likely receptor populations are those individuals who could have direct contact with site media because they currently reside or work at the facility (tenant residents and tenant employees), illegally trespass on the facility (trespassers), or live nearby and thus could be exposed indirectly to contaminants dispersed from numerous sites if/when these chemicals migrate off the property (off-facility residents). On-site trespassers were assumed to visit all of the sites of potential concern upon each entry into the facility. Since all existing facility-related activities at JPG ceased on September 20, 1995, there are currently no on-site facility workers or other Army-approved visitors at any of the sites selected for evaluation in this risk assessment. **Access is still controlled at the main gate. However, the entire facility is not routinely patrolled as in the past. (EPA141)** The current tenant employees and residents are located in buildings that are not listed in this investigation and do not trespass onto these areas of concern. Therefore, their exposure to site contaminants is likely limited to inhalation of volatile chemicals and dusts at their place of residence or work place, and VOCs and dusts that originate from the various sites under investigation. One site (Site 25 - the Paper Mill Road Disposal Area) is currently being farmed. However, the agricultural scenario for this site was evaluated as a future land use scenario. Only three receptor populations are therefore evaluated under the current land use scenario:

- Facility trespassers
- Off-facility (nearby) rural residents
- On-site tenant residents and employees

Trespassers. Trespassers represent the major receptor population who could be exposed directly to the existing contaminated media at JPG. The trespasser is assumed to be a local resident (e.g., adolescent) who enters the facility illegally since the installation property is fenced, locked, and posted. The trespasser has the potential to be exposed to contaminants at each of the sites of potential concern, located south of the Firing Line, primarily through incidental ingestion of and skin contact with surface soil, surface water, and sediment (Figure 5-3). Inhalation/ ingestion of airborne fugitive dusts and inhalation of gaseous emissions are viewed as complete but minor exposure pathways for these receptors. Because Harberts Creek (and the other ditches/ponds sampled during the RI) are small and too shallow for swimming, trespasser contact with surface water and sediment is restricted to intermittent wading only.

Inhalation and ingestion of fugitive dusts by the trespasser are viewed as minor exposure pathways because the potential for generation of fugitive dust at most sites is low due to the fact that vehicle traffic and other outdoor activities (such as weapons testing) with the potential for dust generation are minimal for a closed property. In addition, the generation of significant levels of respirable particulates (PM_{10} fraction) through wind erosion is unlikely to occur to any extent at most sites because they are currently well vegetated. Portions of several JPG sites are also currently covered by pavement, concrete, and buildings. However, for those sites that are poorly vegetated, non-vegetated, or lacking concrete/pavement, the generation of fugitive dust and the dispersion of particulate-bound contaminants could occur. Trespasser exposure of airborne dusts at these specific sites was therefore addressed quantitatively in this assessment.

The inhalation of VOC emissions from surface/subsurface soils **and groundwater (EPA142)** at sites with VOC contamination is also viewed as a potential minor exposure pathway for the trespasser due to the limited number and small size of potential source areas (and the fact that VOC emissions are likely to readily disperse in outdoor air to low ambient levels). **Furthermore, trespassers are exposed to site contaminants for a very short period during each trespassing event. Therefore, this pathway is not evaluated quantitatively and will be addressed in the Uncertainty Section. (EPA142).** This pathway is nevertheless included in the risk assessment conceptual model.

Trespassers are not anticipated to be exposed to contaminated subsurface soil or groundwater beneath JPG. No water supply wells currently exist at JPG, making groundwater an incomplete exposure pathway in the current scenario. Trespasser exposure to subsurface contamination is considered a highly unlikely exposure pathway, since these individuals are

not envisioned to dig at any location within the property in any repetitive manner that could expose them chronically to subsurface contaminants (i.e., contamination greater than 2 feet deep).

Adolescent trespasser exposures were therefore evaluated quantitatively in the risk assessment for the following six exposure routes:

- Incidental ingestion of surface soil (all sites)
- Dermal contact with surface soil (all sites)
- Incidental ingestion of surface water/sediment
- Dermal contact with surface water/sediment
- Inhalation of fugitive dusts from surface soils (select sites)
- Inhalation of VOC emissions from surface/subsurface soils (select sites)

Off-facility (Nearby) Rural Residents. Off-facility (nearby) rural residents (adults and toddlers) represent one other current receptor population with the potential for exposure to contaminants originating at numerous JPG sites (Figure 5-3). These individuals are assumed to reside adjacent to the installation property boundary but not have any direct contact with contaminants; that is, it is assumed that they do not trespass on the facility. Their only contact with JPG chemicals would therefore be indirect. Off-facility residents could potentially be exposed to contaminants through inhalation/ingestion of fugitive dust leaving the installation property, through inhalation of airborne VOCs leaving the installation property, and through contact (ingestion, skin contact, inhalation of VOCs) with contaminated groundwater in private water supply wells downgradient of JPG.

The current potential for the generation of fugitive dusts and gaseous emissions from surface soils at JPG sites is expected to be low, as indicated previously for the adolescent trespasser. Although the off-facility migration of dust and VOCs would decrease chemical concentrations still further due to the distance of residential areas from JPG sites, this pathway is complete and therefore is still selected for inclusion in the risk assessment conceptual model.

Exposure to contaminated groundwater off-facility is currently incomplete due to the large distance downgradient from potential contaminant sources to off-facility locations and also the potential for attenuation of chemical concentrations (i.e., the result of dilution, dispersion, and degradation). Furthermore, most of the potable water in the vicinity of JPG is obtained from the alluvial aquifer along the Ohio River Valley. There are very few wells in the vicinity of JPG that are used for domestic water supplies, thus reducing the potential for the

groundwater contamination pathway to currently be complete. A review of state well records during the preparation of the *Final Draft RI Report* (Rust E&I 1994) identified only one well within 1 mile downgradient from the area south of the Firing Line at JPG (located 100 feet west of the east boundary and 1,700 feet south of north boundary of section 36 of township T5N, R9E). There is the potential for this pathway to be complete for off-site residents under the future land use scenarios; therefore, exposure to contaminated off-site groundwater in the future was addressed quantitively, as described in Section ~~5.1.5~~ **5.1.5.3.4 and 29.0. (EPA143)**

Current off-site residents' exposures was therefore quantitatively addressed for the following indirect exposure routes:

- Inhalation of fugitive dust from surface soils
- Inhalation of VOC emissions from surface/subsurface soils

Current On-site Tenant Employees/Residents. On-facility adult tenant employees/residents represent one other current receptor population with the potential for exposure to contaminants originating at numerous JPG sites (Figure 5-3). These individuals reside/work in existing buildings at the facility, as listed in Table 5-7. Since these buildings are all located some distance from the various sites listed for this investigation and since they have been notified of the existing contamination at the facility, it is unlikely that these individuals would trespass on any of the areas of concern. Their only contact with site contaminants were assumed to be inhalation/ingestion of fugitive dusts and inhalation of airborne VOCs emanating from the various sites. They were assumed to be exposed via these pathways at locations near their residences/work places.

The current potential for the generation of fugitive dusts and gaseous emissions from surface soils at JPG sites is expected to be low, as indicated for the adolescent trespasser. Yet, this exposure pathway is complete for these receptors, and therefore, it was quantitatively evaluated in this risk assessment.

Exposure to contaminated groundwater on-site is incomplete for these populations since a sufficient water supply is available from Madison. It was also assumed that it would be unlikely for any of these individuals to directly contact contaminated surface water/sediments at the facility given their locations relative to the various JPG sites. **Furthermore, the risk ~~posed due~~ attributable to exposure to groundwater will be the similar to those estimated for hunters and trespassers. (EPA145)**

Therefore, exposure of on-site tenant employees/residents to site contaminants was quantitatively addressed for the following two indirect exposure routes:

- Inhalation of VOC emissions from surface/subsurface soils;

- Inhalation of fugitive dust from surface soils.

Future Land Use Scenario. As mentioned previously, the U.S. Army selected three alternative future land use scenarios for evaluation in this risk assessment: (1) leased agricultural acreage, (2) industrial properties, and (3) residential lots. Under the first and second scenarios,– the most likely "receptor" population to have direct contact with contaminants originating from multiple sites are those individuals who hunt wild game within the facility property boundary (and are assumed to visit all of the sites of potential concern). Hunters are unlikely to be present under the third scenario listed above (i.e., residential) since it would probably be unlawful to discharge a firearm on (or near) residences.

The hardwood forests, mature pine stands, open fields, streams, and many other features at JPG provide an almost ideal habitat for the wide variety of game animals that were harvested historically on the installation. Hunting was formerly allowed on some 30,000 acres of designated land for employees of JPG and their guests, and for a small number of state hunters drawn by lottery. Mammals and fowl harvested previously on JPG included whitetail deer, fox squirrel, eastern gray squirrel, eastern cottontail rabbit, and wild turkey. According to the former Natural Resource Manager at JPG, Mr. Ken Knouf, 550 to 750 whitetail deer were harvested annually. The wild turkey harvest averaged 50 birds per year (Rust E&I 1994). Hunting may be allowed at JPG again at some future time.

In addition, as mentioned above, the potential exists in the future for current contaminants in on-site groundwater to migrate off site. Under the future land use scenario two receptor populations were therefore evaluated as part of the facility-wide assessment:

- Hunters

- Off-facility (nearby) rural residents.

Hunters. Hunters (adults) may contact site chemicals by inhalation of gaseous emissions from sites with soil contaminated by VOCs, inhalation/ingestion of windblown fugitive dusts, and incidental ingestion of and dermal contact with surface soil, surface water, and sediment. Under the future scenario, it was assumed that industrial activities, construction or tilling/planting will disturb vegetation and uncover soils previously capped by pavement and concrete. Therefore, unlike the current land use scenario (i.e., the trespasser) where only non-vegetated sites are considered potential source areas, it was assumed that fugitive dusts will be emitted from all sites under future land use conditions.

The inhalation of VOCs volatilizing from contaminated groundwater to ambient air is viewed as a potential minor exposure pathway for the hunters. Due to the limited exposure time of hunters (9 days per year) and the fact that VOC emissions are likely to

readily disperse in outdoor air to low ambient levels, this pathway is not evaluated quantitatively. This pathway will be addressed in the Uncertainty Section. (EPA146).

This future receptor is unlikely to be exposed to contaminants in subsurface soil because there would be no need for hunters to excavate any area within this property. Likewise, it is assumed that they would not be exposed to contaminants in groundwater since each hunter would probably carry a canteen or water jug filled at an off-facility source; it is also unlikely that they would have access to any future on-facility water supply well(s).

Game hunted on the facility could be exposed to chemicals through ingestion of contaminated surface water, ingestion of vegetation grown in contaminated soil, direct incidental ingestion of contaminated soil or sediment while foraging or grooming, and through inhalation of dust/VOCs emanating from contaminated soil. The magnitude of chemical bioaccumulation would depend on the types and concentration of chemicals present in these media, the areal extent of contamination relative to the size of the habitat and range of the game species, and the foraging behaviors of the game species. Deer in particular have a large home range, much larger than any of these specific areas of potential concern. Also, the total area of all the areas of potential concern is a relatively small percentage of the total area at JPG south of the Firing Line. Therefore, it is unlikely that game could accumulate significant concentrations of contaminants from occasional exposure to environmental media at these select sites south of the Firing Line. Consequently, the hunter's potential exposure to contaminants, through the ingestion of wild game, is considered negligible and thus was not evaluated quantitatively in the risk assessment.

Hunters' exposures therefore were quantitatively evaluated for the following six exposure routes:

- Incidental ingestion of surface soil (all sites)
- Dermal contact with surface soil (all sites)
- Incidental ingestion of surface water/sediment
- Dermal contact with surface water/sediment
- Inhalation of fugitive dusts from surface soils (all sites)
- Inhalation of VOC emissions from surface/subsurface soils (select sites)

Off-facility (Nearby) Rural Residents. The potential exists for fugitive dusts and gaseous emissions from surface soils at JPG sites to migrate off site. Since the pathway is potentially

complete, inhalation of dusts and VOCs was addressed quantitatively in the risk assessment for these receptors.

Because there are no institutional or regulatory controls prohibiting the use or installation of water supply wells downgradient of JPG, any future nearby resident with a downgradient private well could potentially be exposed to site contaminants in groundwater. Therefore, this exposure pathway was assumed to be complete for the purposes of this investigation. Future off-facility residents' exposure to groundwater contaminants could occur by drinking groundwater obtained from a carbonate aquifer downgradient of JPG, and through dermal contact and inhalation (of any VOC contaminants) while showering/bathing. **and inhalation of VOCs in indoor air via a soil/groundwater vapor intrusion pathway. (EPA148)**

Section 5.1.5.1.2 and Appendix S discuss the saturated zone transport modeling that was conducted to address the potential for JPG to present risks through the off-facility migration of current groundwater contamination. During this analysis it was determined that groundwater discharge to Middle Fork Creek is a potentially important pathway for future receptors.**; therefore, exposure to contaminated off-site groundwater in the future was addressed quantitatively, as described in Section 5.1.5. (EPA144)** This pathway was also evaluated quantitatively in the risk assessment for off-site receptors. Receptor exposures to groundwater contaminants migrating to Middle Fork Creek could occur through incidental ingestion of and dermal contact with surface water while wading in the creek.

Off-site residents' exposure were therefore quantitatively addressed for the following indirect exposure routes:

- Inhalation of VOC emissions from surface/subsurface soils (all sites)
- Inhalation of fugitive dusts from surface soils (select sites)
- Ingestion of contaminated drinking water (groundwater)
- Dermal contact with contaminated water
- Inhalation of volatile chemicals in contaminated groundwater while showering/bathing
- Incidental ingestion of contaminated surface water (Middle Fork Creek)
- Dermal contact with contaminated surface water (Middle Fork Creek)

5.1.4.6.2 Site-Specific Conceptual Models. As mentioned previously, all facility-related activities ceased on September 20, 1995. As a result, there are currently no on-site facility workers, or other Army-approved visitors at any of the sites selected for evaluation in this risk

assessment except at Site 25 (the Paper Mill Road Disposal Area) where farming has occurred. There is a current tenant resident/employee population at the facility, but these individuals are not likely to come into direct contact with any of the listed sites in this investigation. Thus, the site-specific conceptual models developed for the risk assessment are applicable only to plausible and/or hypothetical future land use conditions.

The future land use scenarios described below are site-specific in the sense that separate risk calculations were conducted for each individual site that is under consideration for a particular land use (i.e., it was assumed that receptors do not visit multiple sites, so the risks calculated for each individual site were not summed or combined with the risk estimates associated with other sites).

Future Land Use Scenarios. Figure 5-4 describes the three possible future land use scenarios that were addressed in the risk assessment by conversion of the property into (1) leased agricultural acreage, (2) industrial properties, and (3) residential lots. The U.S. Army currently leases or is considering leasing several sites for agricultural or industrial use, depending on each site's potential suitability (i.e., numerous buildings were originally constructed for industrial purposes). Furthermore, these scenarios are consistent with historical local and regional land uses (i.e., the area immediately adjacent to the installation is currently used predominantly for small family farms). The U.S. Army also decided to include a hypothetical residential scenario in the risk assessment.

Each of the JPG sites selected for inclusion in the risk assessment was therefore evaluated individually as residential real estate (open areas or areas where current housing exists) and either as an industrial property or as an agricultural field (open areas only). Three receptor populations were therefore evaluated in this site-specific study under the future land use scenarios:

- Off-facility agricultural consumers (i.e., consumers of agricultural products grown on-site, adults and children)

- On-site workers (adults)

- On-site rural residents (adults and toddlers)

Off-Facility Agricultural Consumers. Under the agricultural land use scenario, some of the JPG sites are assumed to be leased to off-facility farmers for the purpose of cultivating cash crops such as corn and soybeans. In this scenario, the most likely receptor populations would be individuals residing in off-facility communities who consume beef and milk from off-facility cattle fed crops harvested at JPG. These individuals were assumed to reside in nearby communities but have no direct contact with contaminants; that is, it is assumed that they do not work, hunt, or trespass on the facility. Their only contact with JPG contaminants would

be indirectly through the ingestion of beef and milk products obtained from off-facility cattle raised on these foodstuffs.

Exposures to off-facility consumers were therefore evaluated quantitatively in this risk assessment for the following two exposure routes:

- Ingestion of off-facility ~~(but locally produced)~~ beef
- Ingestion of off-facility ~~(but locally produced)~~ milk **(EPA150)**

Per the U.S. Army, the sites that were evaluated as leased agricultural acreage are the following:

- Building 185 Incinerator (Site 1)
- Sewage Sludge Application Area (Site 27)
- Explosives Burning Area (Site 3) and Abandoned Landfill (Site 4)
- Paper Mill Road Disposal Area (Site 25) - currently farmed

On-Site Workers. Industrial land use is considered to be a plausible future option for most of the sites at JPG. On-site industrial workers (adult males and females) were assumed to be individuals who could be exposed directly to contaminated media at each applicable site at which they are employed. They would be expected to have direct contact with contaminants in surface soil, but not in subsurface soil. On-site industrial workers are also not likely to visit any drainage pathways or surface water bodies such as creeks or ponds.

On-site industrial workers were assumed to be exposed to fugitive dust from surface soils and VOC emissions from surface/subsurface soils. The air concentration at any one site was assumed to consist of dusts and VOCs emanating not only from that site, but from all of the other sites evaluated in the risk assessment.

On-site water supply wells do not currently exist within the installation property because the facility obtains its water from the City of Madison. For the purposes of this risk assessment, however, it was ~~conservatively~~ **(EPA121)** assumed that future on-site workers will be allowed to install a well on-site since there are no institutional controls or regulatory restrictions prohibiting groundwater usage in the area at the present time. However, this scenario is unlikely to ever occur because a sufficient water supply will continue to be available from Madison. **However, on-site workers (as well as construction workers) may be exposed to VOCs that are volatilized from groundwater via a vapor intrusion pathway (see Section 5.1.5.3.1). (EPA151, EPA152)** **Construction workers were not**

included as a receptor in this HHRA for reasons further discussed in the Uncertainty Section. (EPA149) . Exposures to on-site industrial workers were therefore evaluated quantitatively in this risk assessment for the following five exposure routes:

- Inhalation of vapor-phase chemicals (all sites)
- Inhalation of airborne fugitive particulates (all sites)
- Ingestion of on-site surface soil
- Dermal contact with on-site surface soil
- Ingestion by drinking water from water wells

The on-site well represents a hypothetical drinking water well; no drinking water wells currently exist at this site. (EPA153)

Per the U.S. Army, the sites that were evaluated as industrial properties were all of the JPG sites except for the five sites that were selected for possible agricultural use.

On-Site Rural Residents. Residential land use was selected as another potential future land use for those JPG sites south of the Firing Line that are currently open land or have existing housing. Under the future residential land use scenario (Figure 5-4), each site was assumed to be developed for residential use, with the supposition that a family would build a house directly on or within any one of the areas of potential concern.

~~**Direct contact exposures were calculated for both surface soil only as well as for a combination of surface/subsurface soil.**~~

On-site residents consist of adults and toddlers. Persons living on the site would be expected to have direct contact with all surface and subsurface soil contamination (down to 10 feet) while playing or gardening. Under this land use scenario, it was assumed that subsurface soil (at those sites with subsurface soil analytical data) may or may not be excavated to a depth of 10 feet during the construction of homes. In the excavation scenario, subsurface soil was assumed to be mixed and dispersed with surface soil across the ground surface at each home-site. **Therefore, direct contact exposures were calculated for: (1) surface soil only, and (2) a combination of surface/subsurface soil. (EPA154)**

These rural residents were also assumed to consume vegetables grown in contaminated soils within their yards (i.e., backyard gardens) at all sites and to consume beef and milk from locally raised cattle at select sites (i.e., animals that graze at the sites identically to what is assumed to occur for the off-facility consumer).

For those sites at JPG characterized by on-site (or nearby) shallow surface water bodies (i.e., Harberts Creek), residents were assumed to be exposed to site chemicals by direct contact with contaminated water and sediment during occasional recreational activities involving wading.

Future on-site residents were also ~~conservatively~~ **(EPA121)** assumed to be exposed indirectly to contaminants in surface and subsurface soil through inhalation of volatile emissions and inhalation/ingestion of air-borne particulates. However, the magnitude of the dust emissions from a residential site is expected to be much less than the air concentrations associated with the industrial scenario since, under residential land use, most sites were assumed to be covered by houses, concrete or paved driveways, and dense vegetation such as cultivated (grass) lawns. Air emissions were assumed to be significant only from the five sites that are large enough to be used for farming. For each potential residential site, air concentrations were estimated assuming the combined contribution from the five agricultural sites. **Flower gardens and small construction projects would generate some dust on occasion, but these activities typically involve small areas and short time periods. The flower and vegetable gardens are generally kept damp through watering, which minimizes dust emissions. The amount of dust generated annually is therefore expected to be relatively small compared to that generated from the larger agricultural areas. Therefore, dust emissions for this minor pathway was not included in the risk assessment.(IN12)**

On-site water supply wells do not currently exist at the property, but it was conservatively assumed in the risk assessment that future on-site rural residents will install private water supply wells at each site at which monitoring wells currently exist. **Where monitoring wells do not exist, the groundwater exposure pathways are not quantified**. **(EPA155)** However, this scenario is unlikely because a sufficient water supply will be available from Madison. Under this future land use scenario, on-site residents' exposure to groundwater contaminants could occur by drinking groundwater obtained from the carbonate aquifer (at its interface with glacial till) and through dermal contact and inhalation (of any VOC contaminants) while showering/ bathing. **In addition, exposure to VOCs in groundwater could occur via a vapor intrusion pathway as described in Section 5.1.5.3.1. (EPA156)** Exposures to on-site residents were therefore evaluated quantitatively for the following 12 exposure routes:

- Incidental ingestion of soil while gardening/playing outdoors (both surface soil only and surface/subsurface soil combined, if applicable)

- Dermal contact with soil while gardening/playing outdoors (both surface soil only and surface/subsurface soil combined, if applicable)

- Ingestion of fresh homegrown fruits and vegetables (grown in both surface soil only and surface/subsurface soil combined, if applicable)

- Ingestion of (locally raised) beef and milk (select sites only)
- Inhalation of vapor-phase chemicals
- Inhalation of airborne fugitive particulates
- Incidental ingestion of surface water/sediment (select sites only)
- Dermal contact with surface water/sediment (select sites only)
- Ingestion of contaminated drinking water (groundwater)
- Dermal contact with contaminated groundwater
- Inhalation of volatile chemicals in contaminated groundwater while showering/bathing

A summary of the exposure pathways for all of the scenarios evaluated in the risk assessment is shown in Table 5-9. These conceptual site models were based on an assessment of the Phase I and Phase II RI environmental data and the COPCs selected for each site.

A modification was made to the site-specific conceptual model for Sites 9 and 10. Although soil samples were collected at Sites 9 and 10 during the Phase I and Phase II RI field work from within the Gate 19 Landfill boundary, all of these analytical data were not addressed quantitatively in the risk assessment.

Future residents are not likely to build a home within the landfill's boundary due to the existence of the disposal areas, which would be unable to physically support the construction of a home. As stated by the USEPA in its recently established Presumptive Remedy for CERCLA Municipal Landfills (USEPA 1993d), the long-term management goals at landfills should be directed towards maintaining the integrity of the waste containment systems (i.e., not excavating into existing landfill caps). This landfill has been closed under an IDEM-approved closure plan that involves 10 years of groundwater monitoring. Therefore, residential use of the area located within the Gate 19 Landfill cap boundary would be incompatible with this long-term management goal. Areas outside this cap were considered as residential land in this risk assessment.

5.1.5 Exposure Assessment

The exposure assessment is the step in the risk assessment process in which the intensity, frequency, and duration of human exposure to the COPCs in the project are specified. Based on these parameters and the exposure point concentrations of the various COPCs, human exposure to site contaminants is then quantified. In the context of a human health risk assessment, exposure is defined as human contact, either direct or indirect, with a contaminant. An example of direct exposure is a child's dermal contact with contaminated soil while playing. An example of indirect exposure is consumption of the garden vegetables that have bioaccumulated (taken up) contaminants while growing in contaminated soil. An exposure assessment involves quantitation of human contact with COPCs from each complete exposure pathway for each selected receptor population.

~~An exposure pathway consists of four main elements: (1) a source and/or mechanism of chemical release to the environment; (2) a point of potential contact by a receptor with the contaminated medium (referred to as the exposure point); (3) a route of exposure (e.g., ingestion, inhalation, dermal contact) at the exposure point; and (4) a receptor population.~~ **An exposure pathway generally consists of four elements: (1) a source and mechanism of chemical release, (2) a retention or transport medium (or media in cases involving media transfer of chemicals), (3) a point of potential human contact with the contaminated medium (referred to as the exposure point), and (4) an exposure route (e.g., ingestion) at the contact point (EPA1989). (EPA157)** If any of these ~~factors~~ **elements** is absent, the pathway is incomplete and exposure ~~cannot~~ **is unlikely to** occur. Therefore, the objectives of the exposure assessment step in a risk assessment are to:

- Identify the general locations where each of the potentially exposed receptor populations would be expected to come into contact with site chemicals (e.g., the exposure points for each receptor in each land use scenario);

- Identify the potentially complete exposure pathways for these individuals at these exposure points; and

- Quantify each receptor's reasonable maximum exposure to the COPCs at these exposure points (i.e., to translate the contaminant concentrations in the various site media into exposure doses for each receptor).

The general approach forwarded by the USEPA for exposure assessments is to utilize conservative assumptions (i.e., assumptions that tend to overestimate chemical exposure for most if not all individuals) in the exposure dose equations. Thus, the final estimates of human contact with site contaminants (and their associated risk estimates), as modeled for the hypothetical receptors in the assessment, are likely to be greater in magnitude than for any

individual actually living/working near a project site today, or living/visiting/working at this site in the future.

The exposure assessment used in this risk assessment is consistent with this conservative approach in four ways. First, the receptor populations that have been chosen for quantitative analysis are those individuals who would have the most opportunity to be *maximally* exposed to site contaminants. Secondly, these receptors were assumed to be exposed preferentially to specific contaminated areas at this site. Thirdly, the human behavioral assumptions (e.g., frequency of contact) selected for these individuals were those that result in maximum or near-maximum contact with the COPCs. Lastly, site contaminant levels (either maximum values or 95 percent UCL of the mean values for the analytical data) were used to represent exposure levels at the site throughout each receptor's exposure period (assumed to be up to 30 years for local residents); no degradation, attenuation, or any other chemical disposition process was assumed to occur at the project sites.

5.1.5.1 Environmental Fate Analysis. Groundwater transport modeling of site contaminants to off-site receptor points and air dispersion modeling of site contaminants on- and off-site were conducted for the risk assessment since some of the receptor populations (e.g., off-facility residents) are located distant from the JPG sites.

5.1.5.1.1 Air Emission/Dispersion Modeling. The volatilization of VOCs from soil into ambient (outdoor) air and the dispersion of fugitive dusts (metals, SVOCs, and explosives) are potential complete exposure pathways for current off-facility residents, current on-facility tenant employees/residents and trespassers, and for future off-facility residents, on-site residents, hunters, and workers. Details of the air emissions/dispersion modeling are discussed in Appendix R.

5.1.5.1.2 Saturated Zone Transport Modeling. For human health risk assessment purposes, groundwater exposure was evaluated under the future land use scenarios. These evaluations were based on potential groundwater usage (such as drinking and/or showering) by nearby off-facility residents who could in the future live downgradient (west-southwest) of JPG and by future on-site receptors (residents and workers addressed under site-specific evaluations). To address the potential for JPG to present risks through the off-facility migration pathway (i.e., as a facility-wide assessment), a conservative screening-level analytical modeling approach was used to predict contaminant transport in groundwater and establish exposure point concentrations distant to the sites. Modeling was used to evaluate the groundwater fate of only those contaminants currently detected in site monitoring wells. Appendix S documents the saturated zone transport modeling methodology.

5.1.5.2 Exposure Point Concentrations. The human receptors selected for inclusion in this risk assessment were assumed to be exposed simultaneously to site contaminants from multiple media and through a number of exposure routes. The derivation of the exposure point

concentrations of the COPCs in these relevant environmental media at the JPG sites is summarized below. Statistical procedures used to derive the exposure point concentrations (USEPA 1992f; Gilbert 1987) were described previously (Section 5.1.4.1). In general, the 95 percent UCL of the arithmetic mean of sample concentrations within each data set or the highest detected concentration in the data set, whichever was lower, was designated as the media- and chemical-specific exposure point concentration (USEPA 1989b).

5.1.5.2.1 Outdoor Air. Air dispersion modeling results were used to obtain particulate-bound chemical concentrations, as well as volatile chemical concentrations, in ambient air at each receptor exposure point location, as described in Appendix R.

The maximum cumulative annual average off-facility ambient air concentrations of dust-bound contaminants and VOCs, representing all potential/applicable on-site source areas, was used as the exposure point concentrations with respect to the nearby current (off-facility) residential receptors. The receptor exposure point location was determined by the modeling outputs; that is, the locations of the maximum off-facility air dispersion isopleths for particulates and VOCs. These current residential receptors were assumed to live at the point(s) of maximum off-facility air concentrations where a residence is (or could be) located.

The maximum cumulative annual average on-facility ambient air concentrations of dust-bound contaminants and VOCs in the region of where current tenant resident/employees are located were used as the exposure point concentrations for these current receptors. The receptor exposure point location was determined by the modeling outputs, as grid points closest to the existing inhabited buildings.

The exposure point concentrations for the future on-site workers and future on-site residents were the maximum on-site annual average air concentrations (of dust-bound contaminants and VOCs), based on the combined contribution of all sites to each of the other sites. The receptor exposure point locations were determined by the modeling outputs (i.e., the locations of the maximum site-specific air dispersion isopleths for particulates and VOCs). These future on-site receptors were assumed to live or work at the points of maximum on-site air concentrations where a residence or industry could be located at each site.

Facility-wide Concentrations. The term "facility-wide" refers to the entire facility south of the Firing Line. For estimating facility-wide exposure of the current trespasser and the future hunter to contaminants in ambient air, the on-site annual average air concentrations (of dust-bound contaminants and VOCs) were averaged over the entire facility south of the Firing Line (see Appendix R).

5.1.5.2.2 Surface Soil. The surface soil data (0 to 2 feet bgs) for surface soil COPCs were grouped on a site-specific basis. Further sub-grouping of the data was based on the nature and extent of contamination (i.e., hot spots). The 95 percent UCL of the arithmetic mean of the

concentration for each analyte in each final data grouping or its highest detected concentration, whichever was lower, was used as the site-specific surface soil exposure concentration for the future on-site worker or as the input concentration for estimating soil uptake by agricultural crops. (The soil exposure point concentrations for the future on-site resident are discussed in Section 5.1.5.2.3.)

Facility-Wide Concentrations. Current trespassers and future hunters are assumed to have direct contact with soil at multiple sites. Facility-wide exposure point concentrations were derived by multiplying the individual site-specific surface soil concentrations of contaminants by a site-specific modifying factor, then summing the modified site-specific concentrations. The site-specific modifying factor was derived by dividing the area of the site by the area of the entire facility south of the Firing Line.

5.1.5.2.3 Subsurface Soil. The subsurface soil data used in this risk assessment were the RI investigation samples from both Phase I and II. For the future on-site residential scenario, two scenarios were assumed: (1) that only exposure to surface soil occurs and (2) that subsurface soil (excavated during home construction) becomes mixed with the pre-existing surface soil. In this latter case, the subsurface soil data collected above 10 feet in depth were combined with the surface soil data on a site-specific basis.

The original surface soil data set and the combined surface/subsurface data set were then grouped according to the site-specific area of potential concern. Further sub-grouping of the data was based on the nature and extent of contamination (i.e., hot spots). The 95 percent UCL of the arithmetic mean of the concentration for each analyte in the surface soil only data set and in this combined data grouping for each area or its highest detected concentration, whichever was lower, was used as the site-specific soil exposure concentrations to evaluate future on-site residential exposures.

5.1.5.2.4 Groundwater. For human health risk assessment purposes, exposure to contaminants present in groundwater was evaluated under two types of scenarios: (1) a facility-wide scenario with respect to future off-facility residents and (2) site-specific future land use scenarios (i.e., on-site workers and on-site residents).

For the site-specific future land use scenarios, the Phase II data collected from each site's monitoring wells (e.g., those screened in or just below the till/bedrock interface) were assembled on a site-specific basis, with the exception that any data from upgradient monitoring wells at the individual site (where present) were excluded. Groundwater exposure point concentrations of COPCs were then determined for each site-specific well grouping as described in Section 5.1.4.3.2.

Groundwater transport modeling was used to evaluate the off-facility migration pathway with respect to those contaminants currently detected in site monitoring wells. The modeled

concentration of COPCs, at the nearest downgradient property boundary (as described in Appendix S), were used as the groundwater exposure point concentrations in the quantitative risk characterization for nearby future off-facility residents.

5.1.5.2.5 Shower Air. To evaluate potential inhalation of VOCs while showering, shower air concentrations of chemicals in groundwater were calculated using the contaminant fate model described in Appendix T. For each VOC of potential concern in groundwater, the exposure point concentrations calculated for direct contact with groundwater (on-site and off-facility), as described above, were used as the input values to the shower air model.

5.1.5.2.6 Surface Water. The exposure point concentrations for on-site surface water were based on the creek- or pond-specific analytical sampling data. The 95 percent UCL of the arithmetic mean of the concentration for each analyte in the final data grouping or its highest detected concentration, whichever was lower, was used as the surface water exposure concentration.

For future off-site receptor exposure to groundwater contaminants which have migrated to Middle Fork Creek, surface water concentrations were calculated using the contaminant fate model described in Appendix T.

5.1.5.2.7 Sediment. The exposure point concentrations for sediment were based on the ditch-, creek-, or pond-specific analytical sampling data. The 95 percent UCL of the arithmetic mean of the concentration for each analyte in the final data grouping or its highest detected concentration, whichever was lower, was used as the sediment exposure concentration.

5.1.5.2.8 Agricultural Crops and Homegrown Produce. Chemical contamination of agricultural crops and fresh homegrown garden produce can arise from chemical uptake from contaminated soil. Vegetation accumulation of the COPCs detected in soil were calculated for the following garden foods (for the future on-site residents) and crops (for on-facility future residents and off-facility consumers of agricultural products (beef and milk)):

- Garden Foods
  - Potatoes
  - Tomatoes
  - Lettuce
  - Carrots
  - Beans/peas

- Crops
  - Corn and/or soybeans

Vegetation accumulation was estimated only for inorganic and semi-volatile COPCs. Volatile COPCs would not be expected to bioaccumulate in vegetation, since they would be more likely to leach through the soil or volatilize into the air.

Root Uptake by Root Vegetables. Root uptake of chemical contaminants in root vegetables was calculated as follows:

$$CVR = \frac{CS \bullet RCF \bullet VG}{K_d}$$ (Equation 5-3)

where

CVR = contaminant level in root vegetables via root uptake from soil (mg/kg - fresh wt)
RCF = ratio of concentration in roots to concentration in soil pore water (L/kg; chemical-specific)
VG = below ground vegetable correction factor (unitless) = 0.01
K_d = soil-water partition coefficient (L/kg; chemical-specific)
CS = contaminant level in soil (mg/kg)

For metals, RCF and K_d values were taken from USEPA (1995c) and NUREG (1992). The RCF for organic chemicals was calculated using the following equation (from USEPA 1995c):

$$\text{Log } RCF = (0.77)(\text{Log } K_{ow}) - 1.52$$ (Equation 5-4)

Log K_{ow} values were taken from Montgomery and Welkom (1990). For organic COPCs, K_d = $K_{oc} \cdot f_{oc}$ (f_{oc} = fraction of organic carbon in soil). A site-specific f_{oc} of 0.007 was used in the risk assessment; this value is the average f_{oc} for 54 surface soil samples collected at the facility in October 1997. K_{oc} values were taken from USEPA (1995c), Montgomery and Welkom (1990), and Layton *et al.* (1987). Root uptake factors for the various COPCs in this study are provided in Table 5-10a (inorganic chemicals) and Table 5-10b (organic chemicals).

Root Uptake by Above-Ground Vegetables/Crops. Root uptake of chemical contaminants in above-ground vegetation was calculated as follows:

$$CVR = RUF \times CS \times DWF$$ (Equation 5-5)

where

CVR = contaminant level in vegetation via root uptake (mg/kg - dry weight)
RUF = root uptake factor (kg/kg)
CS = contaminant level in soil (mg/kg)
DWF = dry-to-wet weight conversion factor (unitless) of 0.06 (tomatoes); 0.05 (lettuce); and 0.18 (beans) (Wenck 1983; Wiersma *et al*. 1986); contaminant levels in above-ground fruits and vegetables consumed by humans are expressed on a wet-weight basis; contaminant levels in crops consumed by livestock are expressed on a dry-weight basis.

Soybeans were not modeled because they comprise a smaller percentage of the livestock diet than other crops, and they are likely to undergo processing and be mixed with soybeans from other fields. Corn silage was therefore modeled as the most significant potential source of site-specific chemicals for livestock.

The root uptake factor (RUF) values for metals were taken from NUREG (1992). The RUF values for organic chemicals were calculated using the following equation (from Travis and Arms 1988):

$$\log RUF = 1.588 - (0.578 \times \log K_{ow}) \quad \text{(Equation 5-6)}$$

The contaminant levels in soil (CS) for homegrown vegetables, which represent chemical-specific inputs to Equation 5-6, were the soil exposure point concentrations calculated for the future residential scenario (based on surface soil analytical data and on the mixing of surface and subsurface soil, as described previously). CS for agricultural crops (i.e., corn silage) were the soil exposure point concentrations calculated for each individual applicable agricultural site (based on the site-specific surface soil analytical data only).

5.1.5.2.9 Bioaccumulation in Beef. Beef cattle living on or off the facility that consume contaminated crops grown on JPG sites may accumulate contaminants in their muscle tissue (including fat). It was assumed that the only source of site-related contaminants for the beef cattle was corn (silage) grown at the agricultural site. Since even the on-site beef cattle don't graze at the site (crops are limited to corn and/or soybeans), ingestion of contaminated soil by these animals was not considered to be a complete pathway. The equation that was used to estimate potential contaminant concentration in beef was:

$$CB = I_{CS} \times BTF_{beef} \quad \text{(Equation 5-7)}$$

where

CB = concentration of contaminant in beef (mg/g)
I_{CS} = daily contaminant intake by beef cattle from ingestion of corn silage (mg/d)
BTF_{beef} = biotransfer factor for beef (d/g)

Daily contaminant intake by beef cattle from ingestion of corn silage (I_{CS}) was calculated as follows:

$$I_{CS} = CV_{CS} \times CR_{CS} \quad \text{(Equation 5-8)}$$

where

I_{CS} = contaminant intake via corn silage (mg/d)
CV_{CS} = contaminant level in corn silage (mg/kg)
CR_{CS} = beef cattle consumption rate of corn silage = 8.71 kg/d dry weight (Neumann 1977)

The beef biotransfer factors for arsenic, cadmium, and chromium published by Stevens (1992) were utilized for these metals. Biotransfer factors (BTFs) for other metals were obtained from NUREG (1992) and Baes *et al.* (1984). The BTF_{beef} for 2,3,7,8-TCDD equivalents was taken from Stevens and Gerbec (1988). The BTF_{beef} for other organics was calculated using the following equation (from Travis and Arms 1988):

$$\log BTF_{beef} = -7.6 + \log K_{ow} \quad \text{(Equation 5-9)}$$

The BTF values calculated using this equation are in units of d/kg. The BTF_{beef} values used in the risk assessment are summarized in Table 5-10a (inorganic chemicals) and Table 5-10b (organic chemicals). The BTF_{beef} values in the tables were converted to units of d/g.

5.1.5.2.10 Bioaccumulation in Milk. Dairy cattle living off-facility who consume contaminated crops grown on JPG sites may accumulate contaminants in their milk. It was assumed that the only source of site-related contaminants for the dairy cattle was corn (silage) grown at the agricultural site. Since even the on-site dairy cattle do not graze at the site (crops are limited to corn and/or soybeans), soil ingestion by these animals was not considered to be a complete pathway. The equation that was used to estimate potential contaminant concentration in milk was:

$$CM = I_{CS} \text{ x } BTF_{milk} \quad \text{(Equation 5-10)}$$

where

CM = concentration of contaminant in milk (mg/L)
I_{CS} = daily contaminant intake by dairy cattle from ingestion of corn silage (mg/d)
BTF_{milk} = biotransfer factor for milk (d/L)

Daily contaminant intake by dairy cattle from ingestion of corn silage (I_{CS}) was calculated as follows:

$$I_{CS} = CV_{CS} \times CR_{CS}$$ (Equation 5-11)

where

I_{CS} = contaminant intake via corn silage (mg/d)
CV_{CS} = contaminant level in corn silage (mg/kg)
CR_{CS} = dairy cattle consumption rate of corn silage = 5.61 kg/d dry weight (Linn *et al.* 1981)

The milk biotransfer factors for arsenic, cadmium, and chromium published by Stevens (1991) were utilized for these metals. BTFs for other metals were obtained from NUREG (1992) and Baes *et al.* (1984). The BTF_{milk} for 2,3,7,8-TCDD equivalents was taken from Stevens and Gerbec (1988). The BTF_{milk} for other organics was calculated using the following equation (from Travis and Arms 1988):

$$\log BTF_{milk} = -8.1 + \log K_{ow}$$ (Equation 5-12)

The BTF values calculated using this equation are in units of d/L; these values are summarized in Table 5-10a (inorganic chemicals) and Table 5-10b (organic chemicals).

5.1.5.3 Exposure Dose Algorithms. In the exposure assessment step of a risk assessment, the contaminant concentrations of the COPCs at a site are translated into RME doses for the various human receptor(s). This translation of environmental contamination levels into human doses of the COPCs is made by using variations of the standard exposure assessment equation (USEPA 1989b):

$$I = \frac{C \ x \ CR \ x \ EF \ x \ ED}{BW \ x \ AT}$$ (Equation 5-13)

where

- I = intake, the amount of chemical at the exchange boundary (mg chemical/kg body weight-day)
- C = exposure point concentration; the concentration of a contaminant at the location on the site where receptor contact is made (e.g., mg/kg soil)
- CR = contact rate, the amount of contaminated medium contacted per unit time or event (e.g., kg/day)
- EF = exposure frequency (describes how often exposure occurs [days/year])
- ED = exposure duration (describes how long the exposure period is [years])
- BW = body weight (the average body weight of the receptor over the exposure period [kg])

AT = averaging time (time period over which exposure is averaged [days]).

Thus, each individual's chemical exposure dose is dependent upon:

- Concentration of the chemical in an environmental medium at the point of exposure
- Extent of contact that the individual has with that medium
- How often the individual comes into contact with that contaminated medium
- How long the exposure occurs
- Body weight of the receptor

The exposure point concentrations of COPCs at each site for each receptor population were derived as described (above) in Section 5.1.5.2. This section details the assumptions related to how each receptor's exposure was envisioned to occur. The assumptions are consistent with the HHRA Work Plan for this facility, which was submitted to and accepted by the USEPA Region 5 (Rust E&I 1997i). Specific details of the exposure equations that were used for this assessment, as well as the assumed value of each input parameter, are provided in the remainder of this section.

5.1.5.3.1 ***Inhalation of Contaminated Air.*** The potential exists for fugitive dust to be generated at various sites and for it to disperse in the ambient air. In addition, VOCs in contaminated soil may also be released into the ambient air. Dispersion of volatile chemicals and particulates could also occur beyond the boundaries of the facility where off-facility residents reside. Thus, inhalation of airborne contaminants (VOCs and particulates) is a potential route of exposure for any individual within the air dispersion impact zone of a site. This potential impact zone is defined on the basis of air dispersion modeling, as described in Appendix R. This pathway is applicable to the following receptors: current off-facility residents and facility-wide trespassers; current on-facility tenant residents/employees; and future on-site residents and workers, facility-wide hunters, and off-site residents (at locations of off-site groundwater and surface water modeling).

The equation used for calculating human exposure doses of COPCs due to inhalation of volatile and dust-bound contaminants is provided in Table 5-11, along with the values of the exposure variables proposed for each receptor. The values for the exposure variables are explained in further detail below.

Contaminant Concentrations in Ambient Air (CAA). These values were the projected annual average ambient air levels of each VOC and particulate-bound chemical of potential concern at the specific receptor locations. These values represent the direct output of the air dispersion

modeling, as described in Appendix R. **In addition, the Johnson and Ettinger model (EPA2000) was used to evaluate VOCs in indoor air attributable to impacted shallow groundwater; however, this is not a significant exposure pathway. (EPA159)**

The potential for VOCs at Sites 12A and 12B to migrate from soil or groundwater into indoor air was evaluated as part of this risk assessment. These are the only sites appropriate for this evaluation. More specifically, confirmation data for Site 12C did not exceed EPA Region 9 PRGs, and Site 3/4 will be carried forward to the FS.

Indoor air risk estimates were made using the Johnson and Ettinger model (1991, revised) for subsurface vapor intrusions into buildings, using U.S. Environmental Protection Agency (EPA) software (U.S. EPA, 2000a). Doses were estimated by modeling maximum detected concentrations of VOCs in groundwater and soil at this location. Cancer risk and hazard estimates were prepared for an industrial worker scenario, because this is the current and most likely future land use at this location. The details of this evaluation are provided in Appendix R. (EPA120d)

Inhalation Rate (IR_A). The average inhalation rate of a receptor is dependent upon his/her age (or size), sex, and activity level. The inhalation rate used for the current on-site trespasser was 2.24 m^3/hour. This value corresponds to the average respiration rate associated with moderate activity for age groups from 10 through 17 years old (USEPA 1995a). The value selected for the inhalation rate of current on-facility tenant residents/employees, current and future off-facility and future on-site resident adults, and future workers and hunters was 0.83 M^3/hour (standard default factor; USEPA 1991a). For the current and future off-facility toddlers and future on-site toddlers, a value of 0.67 M^3/hour was used (USEPA 1995a).

Exposure Time (ET). The exposure time is the period of each day that the person is assumed to be present in the impact zone of a site. For current on-facility and off-facility residents and future on-site
residents (adults and toddlers), and future off-facility residents at the modeled groundwater locations, it was ~~conservatively~~ **(EPA121)** assumed that exposure to potential site-related air contaminants occurs 24 hours per day.

For the current adolescent trespasser, the exposure time was assumed to be 4 hours per visit. The current on-facility employee and the future on-site worker were assumed to have an exposure period of 8 hours per day. The future facility-wide hunter was assumed to spend, on average, 6 hours per visit hunting various types of game. Future visitors to Middle Fork Creek were assumed to spend 1 hour per visit to the surface water body.

Exposure Frequency (EF). The exposure frequency is the number of days per year that an individual comes into contact with a contaminated environmental medium. The average monthly low temperature in southern Indiana is less than freezing (32 °F) for 3 months of the year (Table 2-1). Generation of fugitive dust and volatile emissions would be expected to be greatly reduced during these 3 winter months. The current trespasser, therefore, was assumed to be exposed to facility contaminants via inhalation of air 2 days per week, 4 weeks per month, during the 9 warmer months (72 days per year). Current and future residents (adults and children) were assumed to be exposed to contaminants in ambient air 252 days per year (7 days per week, 4 weeks per month, 9 months per year).

Current and future on-site workers were assumed to be exposed **250** ~~180~~ days per year ~~(5 days per week, 4 weeks per month, 9 months per year)~~. **(EPA161)** The future hunter was assumed to hunt on site 18 days per year (1 day each weekend during all hunting seasons; deer—October 15 through December 15; small game—November 1 through January 31; and turkey—April 15 through May 15). However, 9 of those days occur during the winter months (assuming the winter months are December through February). Therefore, the exposure frequency for this exposure route for the hunter was assumed to be just 9 days per year (18 days minus the 9 days with negligible exposure).

Future off-facility residents were assumed to visit Middle Fork Creek each week during the warm months, for a total of 36 visits (1 day/week, 4 weeks/month, 9 months/year).

Exposure Duration (ED). The exposure duration is the number of years that an individual comes into contact with the contaminated environmental medium. Current on-facility and off-facility residents and future on-site and off-facility residents were assumed to live in the area for 30 years (90th percentile for time spent at one residence; USEPA 1989b). Children were assumed to be exposed for 6 years (ages 1 through 6). Adolescent trespassers were assumed to be exposed for 12 years (ages 7 through 18). Current and future workers were assumed to work 25 years (USEPA 1991a). Hunters were assumed to be nearby residents; therefore, their exposure duration was also 30 years.

Body Weight (BW). The body weight term in the equation in Table 5-11 refers to the average weight of the receptor during the period of time that his/her exposure to site contaminants occurs. For purposes of this assessment, the values suggested by the USEPA (1991a) were used: 70 kg for adults and 15 kg for toddlers. The adolescent body weight was estimated at 35 kg, which represent the 50th percentile weight for 10-year-old boys (USEPA 1995a).

Averaging Time (AT). The averaging time is the time interval (in days) over which the health criterion is applicable. For cancer effects, this term is fixed at 25,550 days (70 years x 365 days/year) (USEPA 1989b). For noncancer effects, this term is the number of years a receptor is exposed (exposure duration) multiplied by 365 days/year (USEPA 1989b). For adult residents and hunters, this value is 10,950 days (30 years x 365 days). For toddlers, this value

is 2,190 days (6 years x 365 days/year). For current and future on-site workers, the value is 9,125 days (25 years x 365 days/year), and for facility trespassers this value is 4,380 days (12 years x 365 days/year).

5.1.5.3.2 Incidental Ingestion of Contaminated On-site Soil. Mouthing behavior (toddlers) and incidental ingestion of soil with recreational or work-related activities may expose human receptors to contaminated on-site soil via the oral route of exposure. The equation used to calculate the human exposure dose due to incidental ingestion of contaminated soil is presented in Table 5-12. The assumed values for the exposure parameters are also listed in this table. This pathway was assumed to be complete for all receptors except current on-facility residents/employees and current and future off-facility residents. Details of the derivation of these values are presented below.

Contaminant Concentration in Soil (CS_L). The exposure point concentrations of the COPCs in surface soil for this exposure pathway are described in Sections 5.1.5.2.2 and 5.1.5.2.3.

Ingestion Rate (IR_S). An adult worker at each site was assumed to consume 50 mg of soil per day. This is the value recommended for a receptor in a commercial/industrial setting (USEPA 1991a). Soil consumption rates of 100 mg/day and 200 mg/day were used for the other adult receptor groups (on-site residents and hunters) and for toddlers, respectively (USEPA 1989b). The adolescent trespasser was also assumed to consume 100 mg of soil per day, which represents a default soil ingestion rate for age groups greater than 6 years old (USEPA 1989b).

Exposure Frequency (EF). It was assumed that direct contact with soil would be negligible during the 3 winter months. Therefore, the exposure frequencies for the receptors were the same as for exposure to ambient air, with the exception of future on-site residents. Since the soil ingestion rates for these receptors are daily averages, which already take into account seasonal differences in exposures, the exposure frequency of these receptors was assumed to be 350 days per year, a value which allows for 2 weeks per year away from the area (e.g., vacation).

5.1.5.3.3 Dermal Contact With Contaminated Soil. The chemicals in contaminated soil also may be absorbed into a receptor's body through dermal contact. Exposure depends on a variety of factors, including exposure time, skin surface area, types of activities, and hygienic practices. Thus, the estimates for these factors are highly variable. The equation that was used to calculate chemical doses due to dermal contact with contaminated soil is presented in Table 5-13, along with the assumed values for the exposure parameters. This pathway is relevant for all receptors except current on-facility and off-facility residents and current on-facility employees. Details of the derivation of these values are presented below.

Exposure Frequency (EF). Exposure frequencies for all receptors were the same as for exposure to ambient air, since dermal exposure would only be expected to be significant

during the warmer 9 months of the year: future residents—252 days/year; site-wide trespassers—72 days/year; future on-site workers—~~180~~ **250 (EPA122)** days/year; and hunters—9 days/year.

Skin Surface Area Available for Contact (SA). The value used in the equation for the surface area of the adult workers' skin available for contact with soil was 2,490 cm^2/event, which corresponds to the maximum surface area of the hands and forearms measured in men (USEPA 1989f). This same value was used for future facility-wide hunters.

~~Adolescent trespassers were also assumed to be dermally exposed to soil only on the hands and forearms. No information could be located on the skin surface area of the forearm in adolescents. The hands and forearms comprise about 10 percent of the total body surface area of adults. With this same proportionality applied to adolescents, a skin surface area of the hands and forearms for adolescents of 1,333 cm^2 was derived (0.1 times a total body surface area for male adolescents of 13,330 cm^2; USEPA 1989f).~~ **Adolescent tresspassers are also assumed to be dermally exposed to soil on the hands, forearms, exposed skin of the feet and a percentage of the exposed skin of lower leg. The average total body surface area of male adolescents is 1.83 m^2. The percentage of hands, arms, legs, and feet of 10 to 17 year old male adolescents are 5.39%, 13%, 32%, and 7.33%, respectively. Assuming that the forearms surface area is one third (0.33) of the total arms surface area and the exposed skin surface area of lower legs is ten percent (0.1) of the total legs surface area, a skin surface area of 3700 cm^2 for adolescent trespassers was derived in accordance with parameter values presented in EPA (1997). (EPA162)**

The value used for future on-site adult residents was 5,800 cm^2 (USEPA 1992h). For future resident toddlers, a value of 3,580 cm^2 (total surface area of arms, hands, legs, and feet (USEPA 1985b)) was used.

Adherence Factor of Soil to Skin (AF). A soil adherence factor of 0.2 mg/cm^2 was used (USEPA 1992g).

Dermal Absorption Factor (ABS). The absorption factor accounts for the desorption of the chemical from the soil matrix and the absorption of the chemical across the skin. For this assessment, USEPA Region 5 default absorption factors of 0.01 were assumed for inorganic chemicals and 0.10 for VOCs and SVOCs. Where chemical-specific factors have been developed (e.g., PAHs, dioxins), they were utilized instead of the above default values. The value for DDT was used for DDE. The USEPA Region 5 recommended dermal absorption factors are as follows for the listed compounds:

- PAHs—0.15
- DDT—0.05

- TCDD—0.05 (OC < 10%; OC = organic carbon content of soil (the site-specific OC is 0.7%)

- Arsenic—0.03

5.1.5.3.4 Ingestion of Contaminated Groundwater. Contaminated drinking water may be a source of chemical exposure for current off-facility residents and future on-site residents and workers. The equation to calculate human exposure doses due to ingestion of contaminated drinking water is provided in Table 5-14, along with the assumed values for the exposure parameters. **Exposure to contaminated groundwater for the off-site residential scenario was assume~~m~~d to occur at the facility boundary. (EPA143)** Details of the derivation of these values are provided below.

Contaminant Level in Groundwater (CGW). The exposure point concentrations of COPCs in groundwater were described in Section 5.1.5.2.4.

Ingestion Rate (IR_W). Future on-site and off-facility residents were ~~conservatively~~ **(EPA121)**assumed to consume 2 liters (adults) and 1 liter (children) of contaminated water per day (USEPA 1989b). Future on-site workers were assumed to drink 1 liter of water per day while on the job.

Exposure Frequency (EF). Future residents were ~~conservatively~~ **(EPA121)** assumed to consume water 350 days per year (USEPA 1991a). Workers were ~~conservatively~~ assumed to work at a site and consume water for 250 days per year (default value for number of days per year spent at work recommended by USEPA 1991a).

5.1.5.3.5 Dermal Contact with Groundwater. Exposure via dermal contact with chemicals in groundwater may occur when receptors shower or bathe. The equation used to calculate daily chemical doses due to dermal contact with contaminated groundwater is provided in Table 5-15. The values assumed for the exposure parameters in this equation are explained in further detail below.

Skin Surface Area Available for Contact (SA). The area of skin in contact with contaminated water during showering/bathing was assumed to be the total body surface area of the individual. The following whole-body surface areas were assumed in the risk assessment: adults—18,150 cm^2 and children—7,200 cm^2 (USEPA 1995a).

Chemical-specific Normalized Dermal Permeability Constant (PC). The estimation of exposure doses resulting from skin contact with groundwater requires the use of chemical-specific skin permeability constants (PCs), which are given in units of cm/hr. These skin penetration rates are not only a function of chemical property data but also of biological

properties (e.g., skin thickness). Values for the permeability coefficients of the COPCs in this risk assessment were obtained from one of the two sources described below.

For metals, the USEPA (~~1989b~~ 1992) default value for water (~~8.4 E-04~~ 1.0E-03 cm/hr) was used. (EPA163) For organic chemicals, the following equation, which was derived from empirical studies by Brown and Rossi (1989), was used to derive PCs:

$$PC = 0.1\,[K_{ow}^{0.75}/(120 + K_{ow}^{0.75})] \qquad \text{(Equation 5-14)}$$

where

K_{ow} = octanol/water partition coefficient of the contaminant.

Since the doses calculated using these dermal PC values represent *absorbed* doses of each chemical through the skin, these PC factors need to be adjusted relative to the oral absorption of each chemical in order to normalize the dermal doses to the oral doses for risk characterization. This adjustment is specified in RAGS (USEPA 1989b) guidance and is made using the following equation:

$$\begin{array}{c}\text{Normalized Dermal}\\ \text{Permeability Constant}\end{array} = \frac{\text{Permeability Constant}}{\text{Oral Absorption Efficiency}} \qquad \text{(Equation 5-15)}$$

The derivation of the normalized permeability constants is documented in Table 5-16.

Exposure Time (ET). The length of exposure time for this pathway also depends upon the nature of the activity involved. Showering/bathing is typically modeled to occur for 0.20 hours per day (USEPA 1989b).

Exposure Frequency (EF). The frequency of dermal contact with water is also a function of the activity involved. For showering, adult exposure is typically modeled to occur every day, while bathing children is modeled anywhere from every other day to 1 to 2 times per week. For this assessment, an exposure frequency of 350 days per year was assumed for adults (USEPA 1991a) and a frequency of 180 days per year was assumed for children.

5.1.5.3.6 Inhalation of Volatile Organic Chemicals While Showering/Bathing. Inhalation of VOCs while showering/bathing is a potential route of exposure in any risk assessment that involves the presence of these contaminants in residential water systems. The equation that was used to calculate human exposure dose due to inhalation of VOCs while showering/ bathing is provided in Table 5-17, along with the recommended values for the exposure parameters. Details of the derivation of these values are provided below.

Contaminant Concentrations in Shower Air (CSA). Shower air concentrations of volatile organic chemicals were calculated from their groundwater exposure point concentrations using the method described in Appendix T.

5.1.5.3.7 Incidental Ingestion of Contaminated Surface Water. Water ingested while wading in contaminated surface waters may be a source of exposure for facility-wide adolescent trespassers in the current scenario, and for hunters and specific on-site residents in the future scenario. The equation to calculate human exposure doses due to incidental ingestion of contaminated surface water is provided in Table 5-18, along with the assumed values for the exposure parameters.

Contaminant Level in Surface Water (CSW). The levels of contaminants that were used to quantify risk from exposure to surface water were discussed in Section 5.1.5.2.6.

Contact Rate (CR). The quantity of water consumed per hour while swimming—0.05 liter—was assumed for trespassers, hunters, and future residents exposed to surface water contaminants while wading in Harberts Creek and other surface water on site (e.g., water-filled pits).

Exposure Time (ET). Current adolescent trespassers and future hunters were assumed to spend one-quarter hour at each applicable surface water body at the facility during each visit. Future residents were assumed to spend 1 hour per visit at the surface water body within the designated site. Future off-facility ~~residents~~ **recreational visitors** who visit Middle Fork Creek were assumed to spend 1 hour per visit to this surface water body**. (EPA160)**

Exposure Frequency (EF). Adolescent trespassers and future hunters were assumed to have contact with each surface water body every time they visit the site. Therefore, the exposure frequency for each surface water location was 72 days per year for trespassers and 9 days per year for hunters (assuming no contact with surface water during winter months). Future residents were assumed to visit 1 surface water body each week during the warm months, for a total of 36 visits (1 day/ week, 4 weeks/month, 9 months/year). There are three surface water/sediment locations at the facility (i.e., Harberts Creek, the pond in the abandoned quarry at the Gate 19 landfill, and the drainage ditches south of the Yellow Sulfur Disposal Area). It was assumed that future on-site residents at each of these sites would visit the nearby surface water body 36 times per year. Future off-facility residents were assumed to visit Middle Fork Creek each week during the warm months, for a total of 36 visits.

5.1.5.3.8 Dermal Contact with Contaminated Surface Water. Human receptors (current trespassers, future hunters, and on-site residents) may also absorb chemicals through the skin while wading in Harberts Creek or other surface water/sediment locations at the facility. The equation that was used to calculate human exposure doses due to dermal contact with

contaminated surface water is provided in Table 5-19, along with the assumed values for the exposure parameters.

Skin Surface Area Available for Contact (SA). It was assumed that the hands, forearms, legs below the knees, and feet are all available for contact with surface water for adolescent trespassers and adults. For adult males, the maximum skin surface area of these body parts is estimated to be 7,010 cm^2 (USEPA 1995a). This is the value that was used for the hunter and the future adult resident. These body parts comprise approximately 35 percent of the 95th percentile total adult body surface area of males (20,280 cm^2; USEPA 1995a). With this same proportionality applied to adolescents, a skin surface area available for contact with surface water for adolescents of 4,650 cm^2 was derived (0.35 times a total body surface area for male adolescents of 13,300 cm^2; USEPA 1995a). For toddlers, a skin surface area available for contact with surface water of 3,580 cm^2 was used to estimate their dermal exposure dose (the same as used for dermal exposure to soil).

5.1.5.3.9 Incidental Ingestion of Contaminated Sediment. Receptors may also be exposed to contaminated sediments while wading in Harberts Creek or either of the other two surface water/sediment locations at the facility. The equation to calculate human exposure doses due to incidental ingestion of contaminated sediments is provided in Table 5-20, along with the assumed values for the exposure parameters. This pathway is relevant for adolescent trespassers in the current land scenario and for hunters and on-site residents in the future land use scenario. Details of the derivation of these values are provided below.

Chemical Concentration in Sediment (CSD). The concentrations of the COPCs in sediment that were used in the risk assessment were discussed in Section 5.1.5.2.7.

Ingestion Rate (IR_d). There are no scientific data published in the literature regarding how much sediment individuals ingest while wading/playing in surface water bodies. For the purposes of the risk assessment, sediment ingestion rates were assumed to be one-half of the soil ingestion rates for the various receptor age groups. Therefore, adolescent trespassers, hunters, and future adult residents were assumed to ingest 50 mg of sediment per visit. (For the hunters and trespassers, 16.7 mg per visit was assumed to be ingested from each of three surface water/ sediment locations.) Children were assumed to ingest 100 mg of sediment per visit, all at one of the four locations.

5.1.5.3.10 Dermal Contact with Contaminated Sediment. Receptors wading in Harberts Creek and at other surface water/sediment locations on the facility may also come into dermal contact with sediment-bound contaminants. The equation to calculate human exposure doses due to dermal contact with contaminated sediments is provided in Table 5-21, along with the values assumed for the exposure parameters. ~~Skin surface area and sediment to skin adherence values are the same as those used for soil.~~**Skin surface area is the same as that used for soil. Soil adherence studies indicate that soil moisture content can affect dermal**

adherence; soil with greater moisture content generally adheres more to the skin. Therefore, the sediment-to-skin adherence factor could be higher than soil-to-skin adherence factor. Massachusetts Department of Environmental Protection (DEP, 2000) developed a default sediment adherence factor of 1 mg/cm^2 which was used in this risk assessment. (EPA165).

5.1.5.3.11 Ingestion of Contaminated Fruits and Vegetables. Consumption of contaminated home-grown fruits and vegetables may be a source of chemical exposure for future on-site residents. The equation used to calculate human exposure dose due to ingestion of contaminated fruits and vegetables is provided in Table 5-22, with the recommended values for the exposure parameters. Details of the derivation of these values are provided below.

Concentration in Fruits/Vegetables (CV_i). The calculation of the concentrations of the COPCs in homegrown fruits and vegetables used in this risk assessment are discussed in Section 5.1.5.2.8.

NOTE: SECTION 5.1.5.3.12 IS MISSING. THIS SECTION, INGESTION OF CONTAMINATED BEEF, WAS IN THE ORIGINAL REPORT…….. A RESPONSE TO EPA 166 IS NEEDED IN THIS SECTION.

5.1.5.3.13 Ingestion of Contaminated Milk. This pathway may also be a significant source of exposure to future on-site and off-facility residents who may consume milk from cows that have eaten corn grown on leased land on the facility. The equation to calculate human exposure doses due to ingestion of contaminated milk is provided in Table 5-24, with the recommended values for the exposure parameters. Details of the derivation of these values are provided below.

Contaminant Concentration in Milk (CM). The derivation of the concentrations of the COPCs in milk to be used in this risk assessment was described in Section 5.1.5.2.10.

Consumption Rate for Milk (CONM). The consumption rates for milk for adults and children are provided in Table 5-24. These are upper 95th percentile values as determined by Pao and others (1982).

Fraction of Milk that is Locally Produced (FR_m). A default value of 1.0 was used for the future residents in this assessment.

Exposure Frequency (EF). The milk consumption rates provided in Table 5-24 have been averaged over an entire year. Therefore, the exposure frequency for milk ingestion for local residents is 350 days per year, allowing for 2 weeks per year away from home (e.g., vacation).

5.1.6 Toxicity Assessment

The toxicity assessment is the step in the risk assessment process in which the relationship between the dose of a chemical received and the incidence of adverse health effects in an exposed population is characterized. This characterization utilizes current available scientific (toxicological) knowledge on each COPC, as well as governmental policies in order to (1) characterize the nature and strength of the evidence of causation of chemical-induced health effects and (2) quantitatively estimate the incidence of health effects in an exposed population as a function of chemical dose when sufficient evidence exists. Toxicity assessments are critical components in risk assessments because they allow the calculated exposure doses of the various receptor populations (from the exposure dose algorithms) to be translated into potential health risks.

5.1.6.1 Abbreviated Toxicity Profiles. An abbreviated toxicity profile was prepared for each COC. COCs represent those COPCs that are determined to contribute significantly to potential hazards/risks, based on the risk characterization (as explained in Section 5.1.7). The toxicity profiles characterize the known chronic toxic effects in humans for the inhalation, ingestion, and dermal routes of exposure. Each profile in particular discusses the studies that have been used in the development of the USEPA's health criteria for that chemical. These profiles help clarify the risks/hazards posed by the sites and thus are discussed in the conclusions sections of Risk Characterization.

5.1.6.2 Noncarcinogenic Contaminants of Potential Concern. Noncarcinogenic health effects may occur to an individual upon exposure to a dose of a chemical above its toxicological threshold. The reference dose (RfD) of a chemical is the toxicity value currently proposed by the USEPA to represent this threshold for regulatory purposes. RfDs are reported as chemical intake (mg/kg-day). Also used to quantify noncarcinogenic effects are reference concentrations (RfCs), which are reported as concentrations of chemicals in air (mg/m^3). These values (RfDs, RfCs) were used to evaluate the potential for noncarcinogenic health effects to occur in human receptor populations potentially exposed to site-related chemicals (USEPA 1989b).

RfDs and RfCs are defined by the USEPA as estimates of daily exposure levels for the entire human population, including sensitive subpopulations, that are likely to be without appreciable deleterious effects. A discussion of how the RfDs/RfCs were used to calculate health hazards to the receptors is presented in Section 5.1.7 of this document.

Most RfDs and RfCs are derived from the highest concentration of a chemical at which no adverse effects were demonstrated in animal experiments (the NOAEL, or no observed adverse effect level). To calculate an RfD or RfC, the experimentally derived NOAEL is divided by uncertainty factors (UFs) and modifying factors (MFs). If a NOAEL is not available for a

chemical, a lowest observed adverse effect level in an experiment (LOAEL) is used, and it is divided by an additional safety factor (USEPA 1989a).

Uncertainty factors generally consist of multiples of 10, with each factor representing a specific area of uncertainty inherent in the extrapolation from the available toxicological data.

The use of UFs helps to ensure that the potential for adverse noncarcinogenic effects is not underestimated, even for sensitive subpopulations, during the derivation of RfDs/RfCs. This is an important point to stress. The purpose of deriving an RfD or RfC is to obtain an exposure estimate at a safe level for ~~even~~ sensitive receptors within the population at large based on what is toxicologically known about that chemical, not to predict an actual toxicological threshold for each chemical ~~(since that currently is impossible to do).~~ **.(EPA168)** Thus, for the vast majority and perhaps all individuals in the population, this allowable exposure level is likely lower (and may be much lower) than what exposure concentration would actually be required to produce an adverse health effect.

Chronic RfDs/RfCs were used to evaluate exposures to both adults and children. Conversion of toxicity values from RfCs (concentration) to RfDs (dose) was employed for the toxicity assessments utilized in this risk assessment. The inhalation pathway was evaluated in terms of dose (i.e., RfDs) in order to provide consistency with the other exposure routes addressed and to allow for a project-specific exposure assessment (to accommodate receptor-specific adjustments in physiological and behavioral assumptions of the various human populations).

For assessing hazards from skin contact with groundwater and surface water, dermally absorbed doses were adjusted to the oral route by the use of normalized PCs, as discussed in Sections 5.1.5.3.5 and 5.1.5.3.8. Thus, oral RfDs (which are based on administered doses) were used directly in the risk assessment to evaluate dermal exposure to site media. ~~However, the dermal pathway was only evaluated if the health effect due to oral exposure is systemic (i.e., not related to a direct effect on one or more components of the gastrointestinal system including the liver).~~**The uncertainty associated with the use of oral toxicity values for the dermal pathway is discussed in the Uncertainty Section. (EPA169)**

The primary source of the RfDs and RfCs was IRIS (USEPA **2002**~~1998~~). If an RfD/RfC was unavailable in IRIS, HEAST (USEPA 1997b) was utilized. If a toxicity value was not available from IRIS or HEAST, provisional criteria were obtained from other sources **(see Table 5-25). (EPA170b).** , ~~such as the National Center for Environmental Assessment (NCEA) and the USEPA Region 3 Risk-Based Concentration Table (version October 1997). Values from this source were used instead of the USEPA Region 9 PRG tables since the Region 3 tables are more current with respect to toxicity values (the most recent version of the Region 9 tables was dated August 1996). For any remaining chemicals (i.e., for those lacking inhalation toxicity values), Rust E&I evaluated the development of inhalation criteria from~~

~~oral toxicity values. This route-to-route extrapolation was done only if the health effect due to oral exposure is systemic.~~

The chronic oral RfDs used in the risk assessment are summarized in Table 5-25. Table 5-26 summarizes the chronic inhalation RfDs.

5.1.6.3 Carcinogenic Contaminants of Potential Concern. To estimate the lifetime (assumed to be 70 years) probability of human receptors contracting cancer as a result of their exposure to known or suspected carcinogens of potential concern in the project database, exposure doses were multiplied by USEPA carcinogen slope factors. Oral slope factors (SFs) were used for ingestion exposure pathways. Inhalation SFs, either published by USEPA or derived from published inhalation unit risks (URs), were used for the inhalation exposure pathway.

SFs/URs are derived under the regulatory policy that assumes that a threshold for carcinogenicity does not exist. SFs represent the estimated risk of cancer per unit of exposure dose. URs represent the estimated risk of cancer per unit of exposure (air) concentration.

SFs/URs represent plausible upper-bound estimates of the probability of a carcinogenic response per unit of chemical exposure continuously over a lifetime. They are usually derived from the upper 95th percent confidence limit of an extrapolated slope of the dose-response curve for a chemical in an animal carcinogenicity study. The SF is expressed as the reciprocal of mg of chemical intake per kg of body weight per day ((mg/kg-day)-1)]. The UR is expressed as the reciprocal of chemical concentration in air ($(ug/M^3)^{-1}$).

The SFs/URs are used in risk assessments to estimate an upper-bound lifetime probability of an individual developing cancer as a result of exposure to a particular dose/concentration of a potential carcinogen. SFs/URs are accompanied by their weight-of-evidence classification to indicate the strength of evidence that the chemical may be a human carcinogen (USEPA 1989a).

Carcinogenic risk was quantified in only those exposure pathways involving the routes of exposure for which the chemical is known or suspected to be carcinogenic. In addition, conversion of toxicity values from URs (concentration) to SFs (dose) was employed for the toxicity assessments. The inhalation pathway was evaluated in terms of dose (i.e., SFs) in order to provide consistency with the other exposure routes addressed and to allow for a project-specific exposure assessment (to accommodate receptor-specific adjustments in physiological and behavioral assumptions of the various human populations).

For assessing hazards from skin contact with groundwater and surface water, dermally absorbed doses were adjusted to the oral route by the use of normalized PCs, as discussed in Sections 5.1.5.3.4 and 5.1.5.3.8. Thus, oral SFs (which are based on administered doses) were

used directly in the risk assessment to evaluate dermal exposure to site media. However, the dermal pathway was evaluated only if the health effect due to oral exposure is systemic (i.e., not related to a direct effect on one or more components of the gastrointestinal system including the liver).

As previously described, IRIS (USEPA 1998), HEAST (USEPA 1997b), NCEA, and the USEPA Region 3 Risk-Based Concentration Table (version October 1997b) were the sources for each SF/UR. For any remaining chemicals (i.e., for those lacking inhalation toxicity values), Rust E&I evaluated the development of inhalation criteria from oral toxicity values. This route-to-route extrapolation was done only if the health effect due to oral exposure is systemic (i.e., not related to a direct effect on one or more components of the gastrointestinal system including the liver).

Tables 5-27 and 5-28, respectively, present the oral and inhalation SFs used in the risk assessment. Section 5.1.7 provides details on how the USEPA SFs were used to assess carcinogenic risk.

5.1.6.3.1 Toxicity Equivalency Factors. For assessing risks associated with carcinogenic PAHs, USEPA has adopted a toxicity equivalency factor (TEF) methodology based on the relative potency of each individual PAH to that of benzo(a)pyrene (BaP). This toxicity equivalency factor approach was used to convert the slope factor for BaP into slope factors for the other PAHs. The following TEF values were used in these calculations (USEPA 1993f):

- Benzo(a)pyrene—1.0
- Benzo(a)anthracene—0.1
- Benzo(b)fluoranthene—0.1
- Benzo(k)fluoranthene—0.01
- Chrysene—0.001
- Dibenzo(a,h)anthracene—1.0
- Indeno(1,2,3-c,d)pyrene—0.1
- All others—0

The equation that was used to develop the slope factors for the PAHs other than benzo(a)pyrene is:

SF   *SF for specific PAH = (SF for BaP) x (TEF for*

The USEPA (1989g) has also provided guidance for assessing the risk of TCDDs/TCDFs (dioxins), based on the relative potency of each compound to 2,3,7,8-TCDD. These TEFs, which are listed below, were also used in this risk assessment to convert the concentrations of other dioxin/furan congeners into 2,3,7,8-TCDD equivalent concentrations:

- 2,3,7,8-TCDD—1.0
- 2,3,7,8-PeCDD—0.5
- 2,3,7,8-HxCDDs—0.1
- 2,3,7,8-HpCDD—0.01
- OCDD—0.001
- 2,3,7,8-TCDF—0.1
- 1,2,3,7,8-PeCDF—0.05
- 2,3,4,7,8-PeCDF—0.5
- 2,3,7,8-HxCDFs—0.1
- 2,3,7,8-HpCDFs—0.01
- OCDF—0.001
- All other congeners—0

The equation that was used to develop concentrations for TCDDs/TCDFs other than 2,3,7,8-TCDD is:

2,3,7,8 – TCDD Equivalent concentration of specific congener = Concentration of specific congener x TEF for specific congener (Equation 5-19)

5.1.7 Risk Characterization

Risk/hazard characterization is the last step in the risk assessment process. In this step, the potential incidence of human cancer risks and the potential noncarcinogenic health hazards were estimated for each JPG site and for the facility-wide scenarios. These health indices were calculated by integrating the exposure assessment and the toxicity assessment databases. To characterize potential noncarcinogenic hazards, comparisons were made between the receptor-specific exposure doses and the appropriate toxicity criteria (subchronic and chronic RfDs). To quantify potential carcinogenic risks, receptor-specific exposure doses were multiplied by the applicable toxicity criteria (i.e., SFs). Each of these numerical expressions of risk was then accompanied by explanatory text interpreting the results.

5.1.7.1 Potential Chronic Health Hazards. By convention, the average daily exposure doses to human receptors over the specific time-frame of exposure are used for calculation of noncarcinogenic health hazards (USEPA 1989b). The noncarcinogenic daily exposure doses calculated in the exposure assessment were used to calculate hazard quotients (HQs) for each of the COPCs for each receptor. The HQ was determined from the receptor-specific and pathway-specific exposure doses (calculated in the Exposure Assessment) using the following equation:

$$HQ = \frac{Calculated\ Exposure\ Dose\ (mg/kgday)}{RfD\ (mg/kgday)} \qquad \text{(Equation 5-20)}$$

The HQ approach assumes that there is a level of exposure to a chemical (e.g., RfD) at which it is unlikely for even sensitive individuals in a population to experience adverse health effects. Therefore, if the HQ for a given substance was less than or equal to 1.00, the calculated receptor-specific exposure dose was less than or equal to the chemical's regulatory threshold dose, indicating that the chemical concentration in that site medium will probably not produce a noncarcinogenic health hazard to the receptor population. A ratio greater than 1.00 indicated the *potential* for adverse health effects in the modeled population, but not necessarily that they would occur (due principally to the fact that the RfDs are calculated in such a highly conservative fashion).

When multiple noncarcinogenic chemical substances are evaluated in a medium and/or when a receptor's exposure is to multiple environmental media, a summation of all of the appropriate chemical-specific HQ for a receptor is made (USEPA 1986). The result of this summation process is a receptor-specific screening hazard index (HI). The same interpretation of this resulting HI, as described above for the HQ, is then used to characterize the overall potential for the site to induce noncarcinogenic toxic effects in the receptor population.

Those COPCs that exceed an HQ of 1.00 were identified as COCs. COCs represent the primary contributors to the potential noncancer hazard for the receptor-specific exposure pathway under evaluation.

5.1.7.2 Potential Excess Lifetime Cancer Risks. A 70-year lifetime is used by convention to calculate lifetime-equivalent exposure doses to human receptors for the carcinogenic risk calculations (USEPA 1989b). In this assessment, the receptor-specific exposure doses derived for each direct and indirect exposure pathway (e.g., exposure to chemicals in soil, sediment, surface water, groundwater, air, beef, milk, and/or vegetables) were translated into cancer risks. The cancer risks were determined from the pathway-specific exposure doses (calculated in the Exposure Dose Algorithms) and the oral SFs using the following equation:

$$\frac{\text{Excess Lifetime}}{\text{Cancer Risk}} = 1 - \exp(-D \times SF) \qquad \text{(Equation 5-21)}$$

where

D = Pathway-specific exposure dose (mg/kg-d)
SF = Chemical-specific slope factor [$(\text{mg/kg-d})^{-1}$].

Equation 5-21, which is referred to as the one-hit equation, is valid at both low (<1E-02) and high risk levels (USEPA 1989b). This equation is typically selected for sites where some of the calculated exposure doses (and associated risks) are anticipated to be high.

To assess the simultaneous exposure of a receptor population to multiple carcinogens from multiple exposure routes, all of the cancer risks calculated for a receptor population were summed (USEPA 1986). Each overall receptor cancer risk is then compared to USEPA's target risk range (1E-06 to 1E-04). To put the overall cancer risks calculated for each receptor population into perspective, the risk management criterion of 1.0E-04 was used. Any chemical individually associated with a risk level greater than 1.0E-05 was identified as a COC. COCs represent the primary contributors to the potential cancer risk for the receptor-specific exposure pathway under evaluation. If the total cancer risk for a receptor from all exposure pathways was less than 1.0E-04, then it was concluded that the site(s) does not pose a significant risk to that receptor.

5.1.8 Uncertainty/Sensitivity Analyses

The numerical risks/hazards that are calculated in a risk assessment represent conditional estimates of risk based on various assumptions concerning contaminant exposure and toxicity. These estimates of risk/hazard are derived using a series of conservative assumptions about the identity and quantity of contaminants in the environment, their fate in the environment, the pathways of receptor exposure, human behaviors that lead to contaminant exposures, and the dose-response relationships underlying the various health criteria. The purpose of the uncertainty analysis is therefore to specify the major assumptions and uncertainties inherent in the present risk assessment and to describe their influence on the outcome of the assessment.

As discussed earlier in Section 5.0, the principle use of a baseline risk assessment is not to predict actuarial risks to a population due to exposure to environmental contamination (because this is currently not possible) but to assist project managers in the prioritization of risk management actions involving site permitting/remediation, etc. Risk assessment is thus used in a relative sense to evaluate the potential of project COPCs to generate risks/hazards. The uncertainty analysis presents a perspective on the risk assessment results for the benefit of the project manager(s) who must interpret, prioritize, and subsequently take action based on the results.

Uncertainty can be defined as a lack of precise scientific data and/or factual information as to what the truth is, whether qualitative or quantitative (NRC 1994). Uncertainty in a baseline risk assessment can be classified into ~~three~~ four broad categories:

- Scenario Uncertainty

- **Sampling and Analysis Uncertainty**

- Parameter Uncertainty

- Model Uncertainty

Scenario uncertainty pertains to missing or incomplete information, including non-numeric assumptions, that would otherwise be useful in fully defining exposure and dose (USEPA 1992i); for example, knowing the exact nature of the localized direction and rate of flow of groundwater from a site. Incorrect non-numeric assumptions, as well as descriptive errors related to the study's conceptual site model all lead to scenario uncertainty. Some examples of these types of uncertainties in this risk assessment include:

- Selection of the possible future land uses of the facility

- Selection of relevant exposure pathways (e.g., beef cattle/dairy cows grazing at select sites)

- All current and future risks associated with the present level of contamination at these sites (i.e., assuming that no chemical loss would occur)

Selection of relevant exposure pathway introduces uncertainty to the estimated risk. For example, exposure to volatile emissions from soil and groundwater were not evaluated for hunters and trespassers. This may lead to an underestimation of risk. However, the impact on estimated risks are expected to be insignificant due to dispersal of volatiles in ambient air and the limited exposure potential for such receptors. (EPA142, 146) Also,

hunters may ingest contaminated game from the site. However, this pathway was not considered to be significant. (EPA147)

Construction workers were not selected for quantitative evaluation because risks to such workers are expected to be less than those to industrial workers. Construction workers are typically exposed to contaminants for less than one year. Illinois EPA (2001) suggests an exposure duration of 40 days for construction workers. Industrial workers were assumed to be exposed for 250 days per year for a period of 250 years. This difference in exposure frequency and duration is expected to offset any difference due to toxicity factors, available skin surface area, and exposure point concentrations for surface soil versus surface and subsurface soil combined. (EPA3d, 120a, 140, 151)

Beeff cattle are raised in on-site areas and they may forage for food. Incidental ingestion of soil may result during such activities. However, on-site cattle ingestion of soil via foraging activities was not evaluated because only silage is expected to grow in the future as is grown under the current conditions. It is unlikely that grassland will exist at the site in the future, and therefore, cattle grazing in the future is unlikely. Likewise, the consumption of milk from cows that are fed only silage harvested from contaminated areas is also unlikely. (EPA120c, 140, 158, 166, 167)

Sampling and analysis uncertainty pretains to the ability to collect and appropriately group samples, and how well the analytical result reflect true contaminant concentrations. For example, the sources of antimony at JPG are uncertain. It is known that antimony may be alloyed with lead to provide hardening of munitions casings, which produces shrapnel upon detonation. Antimony is also used in batteries, pigments, semicondutors, and in fire-retardants for canvas and children's clothing. Therefore, antimony may have been released to the environment through burning and detonation of munitions, or burning and/or disposal of paints and batteries. Apparently, no records exist that provide background information on potential sources of antimony or the quantities that may have been present during the facility's operation. —However, antimony may be naturally present in soils at low concentrations. (EPA99-105)

In addition, uncertainty may be introduced in assembling data to estimate exposure point concentrations (EPCs). For example, the JPG risk assessment methodology estimates groundwater EPCs by individual sites (as 95% UCLs). However, this methodology may imply a greater level of detail or knowledge about localized groundwater concentrations than is presently known or may be surmised. However, this approach provides excellent information regarding the locations of contaminant concentrations because smaller data sets are used to estimate EPCs for individual sites than EPCs based on groundwater concentrations for the entire site. (EPA118)

Moreover, uncertainty may be introduced in the risk assessment through the analytical quality assurance/quality control (QA/QC) process. For example, Phase I antimony results obtained by USATHAMA-certified methods were acceptable under USATHAMA QA/QC guidelines, but were later rejected due to low recoveries for matrix spike, matrix duplicate, and laboratory control samples in accordance with EPA CLP functional guidelines for data review. The rejected data were not used *quantitatively* in the risk assessments. The lack of results may underestimate risk to human health and ecological receptors. The absence of data will be addressed *qualitatively* in the uncertainty analysis for sites where antimony results were rejected. (EPA99-105)

Parameter uncertainty refers to uncertainty in the magnitude of the input variables used in risk assessments in the calculation of chemical fate and transport, exposure point concentrations, and chemical intake calculations (USEPA 1989b). Types of parameter uncertainty include measurement error, sampling error, variability, and the use of surrogate values (NRC 1994; USEPA 1992i). In this risk assessment, parameter uncertainty includes:

- Use of maximum measured contaminant concentrations in various media to represent exposure concentrations
- Variability in the behaviors of the members in each receptor population at various receptor locations
- Uncertainty associated with screening criteria (e.g., PRGs).

The USEPA Region 9 screening PRGs for groundwater do not account for dermally absorbed doses which may potentially underestimate risks at some sites especially for organic compounds. (EPA137)

Model uncertainty pertains to the consideration of how well an exposure model (or its mathematical expression) approximates the true relationships between actual, site-specific environmental conditions and estimates based on contaminant fate and transport models (USEPA 1989b). Model uncertainty is also inherent in USEPA toxicity assessments (e.g., dose-response models). With respect to this assessment, model uncertainty includes:

- Use of simplified fate and transport algorithms to predict chemical accumulation in fruits and vegetables, beef and milk, and off-facility groundwater and surface water
- Use of air dispersion models to predict ambient air concentrations of COPCs at each **receptor point**
- **Use of a vapor intrusion model to predict VOCs in indoor** air **(EPA148)**

- Use of USEPA-derived chronic toxicity criteria (carcinogenic slope factors, reference doses)

- **Use of oral toxicity factors (which are based on administered doses) to evaluate dermal exposure (EPA169)**

- Summation of chemical-specific risks/hazards for each receptor population

The major uncertainties pertaining to this risk assessment are reviewed qualitatively in the uncertainty/sensitivity section of each of the site-specific and facility-wide human health risk assessments.

5.2 DETAILED ECOLOGICAL RISK ASSESSMENT BACKGROUND AND PROGRAM STATUS

5.2.1 Introduction

As part of the Phase I RI, Rust E&I prepared a draft RI report that included a preliminary ecological risk assessment (PERA) that was submitted in July 1994 to the USAEC, USEPA, and IDEM. Following additional discussions and site visits, which took place from 1994 through January 1997, the PERA (Section 47 and Appendix U of the RI Report) was revised and resubmitted in March 1997 to the USEPA, USAEC, and USACE. The USAEC transferred responsibility for the management and operations of JPG to the USACE in June 1997.

Based on the results of the PERA and comments received from the various agencies, the need for a more comprehensive and detailed ecological risk assessment (DERA) was identified for several sites. A technical memorandum (TM) was submitted to the regulators in June 1997 which identified the sites to be included in the DERA, as well as proposed assessment and measurement endpoints. Following a meeting between the USEPA, USACE, and IDEM in August 1997, both the PERA and TM were revised, and field studies for 1997 were refined. The final TM was submitted to USEPA and IDEM on September 2, 1997, and the revised final PERA on December 15, 1997.

The revised DERA work plan was submitted to the agencies in January 1998 (Rust E&I 1998). The DERA work plan summarized the results of the PERA and presented the proposed scope of work for the DERA field investigations for the area south of the firing line. The work plan was written to reflect the consensus gained from meetings held October 24, 1995; December 17, 1996; April 17, 1997; August 14, 1997; and several telephone conference calls which occurred from November 21, 1995 through the spring of 1997. These conference calls and site visits included personnel from the USAEC, JPG, USEPA, USFWS, IDEM, USACE,

and Rust E&I. For the purposes of this ecological risk assessment, the individuals representing those agencies and their contractors comprised the DERA Scoping Group (DSG). The DERA work plan consisted of three main components: (1) site background and history, (2) the DERA approach, and (3) the Field Sampling and Analysis Plan (FSAP). Minutes for the meetings and conference calls were included as were addenda to both the JPG Site Health & Safety Plan (SHSP) and Quality Assurance Project Plan (QAPjP). The meeting minutes and conference call notes are provided in Appendix BB of this report.

The DERA followed the DERA work plan, and also incorporated comments received on the work plan. The DERA consists of the following components: (1) problem formulation, (2) analysis, and (3) risk characterization.

5.2.2 Program Status

A draft DERA work plan was submitted to the agencies in March 1996; however, this document was not approved since the USEPA had outstanding issues associated with the PERA. Following a meeting in Chicago in January 1997, the PERA was revised. In addition, a new screening to reduce the number of sites and COPCs was performed with Phase II background soil data; however, the revised PERA used only the Phase I site data for risk estimates as agreed upon by the USEPA. Based on comments received on the PERA (July 17, 1997), a revised final PERA was submitted to the regulatory agencies on December 15, 1997 (Rust E&I 1997g).

The 1998 DERA work plan changed substantially from the March 1996 submittal. Based on detailed discussions with key personnel representing the USAEC, USACE, JPG, USEPA, USFWS, IDEM, U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM), and Rust E&I, the January 1998 version of the work plan represents a major revision to the March 1996 version. The contents of the work plan represented the direction received from the regulatory agencies, USACHPPM, and the USACE. Collection of biotic material for chemical analysis was no longer planned; however, soil toxicity testing with plants and earthworms was performed. The main factors that played a part in this change in direction were as follows:

- Many of the sites have been heavily disturbed by plowing and other agricultural practices; potential addition of agricultural chemicals could result in confounding tissue analytical data.

- Many of the sites are currently undergoing interim measures (IM) remediation for human health risk concerns.

- Many of the sites are very small in size and/or have very limited contamination levels.

- All of the sites are being transitioned to private leaseholders for various agricultural and light industrial purposes under the BRAC program.

- The majority of the contaminants present are not expected to biomagnify in food chains; therefore, sampling biological tissues would fail to detect potential adverse effects; rather, the COPCs are expected to be more toxic due to contact with or ingestion of contaminated source media.

Areas identified in the TM (Rust E&I 1997f) as requiring additional study were based upon the conclusions reached in the PERA, and subsequent discussions with IDEM and the USEPA (August 1997). These areas included all sites previously identified as having the potential for causing harm to either the flora or fauna at the site, or sites where information was inadequate

to reach conclusions regarding potential ecological harm. As a result, a total of eight study areas were included for further evaluation. The DERA sites not screened out in either the PERA or TM are 2/27, 3/4, 7/21b, 9, 11, 14/15, 25, and 28/29/39 (see sections 7.7, 8.7, 10.7, 12.7, 31, 17.7/18.7, 20.7, 22.7, respectively, and refer to Table 5-29). Three terrestrial reference areas and one aquatic reference area within the site boundaries were also proposed (see Figures 32-1 through 32-3 in Section 32 and Figure 7.7-2 in Section 7.7, respectively).

Following submittal of the DERA work plan, comments were received from the USEPA. These comments have been incorporated into the DERA, rather than issuing a revised DERA work plan. This represented a significant cost savings, and allowed the Army draft DERA to be released in April 1998. A revised draft of DERA was also submitted in August 1998.

Due to the rapid transition under BRAC towards privatization, many areas south of the Firing Line, which had originally been planned for ecological studies, have since been plowed and planted in food crops. Logging of forests ~~will likely~~ **may** be implemented in the ~~near~~ future. These activities remain ongoing and ~~restrict~~ **restricted** the number and location of ecological studies proposed in the work plan. ~~For this reason, there are no~~ **A** habitat ~~maps~~ **map is also** included as part of the DERA **(Figure 5.3-13). This map reflects conditions observed at JPG in (EPA127)**. ~~However~~ **In spite of the transitory nature of JPG**, risk was modeled for all key terrestrial receptors at existing terrestrial locations, and for all key wetland receptors at Harberts Creek, as though the existing habitat would remain.

Areas identified as potentially being contaminated were visited by representatives from the USEPA, USAEC, USACE, and Rust E&I to evaluate if the proposed ecological sampling plan was satisfactory for each site. Following these site visits, it was agreed by those present that many of the proposed sites did not require additional sampling because (1) the small size of the site limited the number of potential receptors and their resultant exposure, (2) many of the sites were already planned for interim remedial action, or (3) the exposure pathways to wildlife were not complete. All sites listed in Table 5-29 were evaluated in the DERA; however, additional terrestrial field data were collected only at Sites 2/27, 3/4, 9, 11, 14/15, 25, and 39 (including 28/29) and three reference areas. Aquatic field data collection was limited to Harberts Creek adjacent to Sites 2/27 and an upstream reference area. **In 1993, the U.S. Fish and Wildlife Service sent a letter to a contractor for the U.S. Army regarding the presence of Federally-listed species or habitat within the contaminant area of JPG (see Appendix Z). (EPA184)**

5.2.3 Supporting Documentation

Guidance for the selection and definition of field methods and sampling procedures was obtained from a number of sources. The primary sources utilized to perform the DERA and the related field efforts were:

- *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final* (USEPA June 5, 1997).

- *Proposed Guidelines for Ecological Risk Assessment (Federal Register, FRL-5605-9, 9/9/96).*

- *Tri-Service Procedural Guidelines for Ecological Risk Assessments (USAEC 1996).*

- *Risk Assessment Guidance for Superfund, Volume II, Environmental Evaluation Manual* (USEPA 1989a).

- *Wildlife Exposure Factors Handbook :Volumes 1 and 2* (USEPA 1993a).

- *Risk Assessment Handbook (Volumes I and II)*, EM 200-1-4, EM 200-1-6, (U.S. Army Corps of Engineers, 1996).

- *Procedural Guidelines for Ecological Risk Assessments at U.S. Army Sites, Volume I.* (ERDEC, U.S. Army Chemical and Biological Defense Command, Aberdeen Proving Ground, MD, 1994).

- *Procedural Guidelines for Ecological Risk Assessments at U.S. Army Sites, Volume II - Research and Biomonitoring Methods for the Characterization of Ecological Effects*. (ERDEC, U.S. Army Chemical and Biological Defense Command, Aberdeen Proving Ground, MD, 1995).

5.2.4 Purpose

The primary purposes of this DERA are (1) to ensure regulatory compliance and (2) to identify and characterize adverse effects, if any, on the ecosystem at JPG South of the Firing Line due to site-related contamination. Each purpose is discussed in the following sections.

5.2.4.1 Regulatory Requirements. Activities at JPG are affected by regulations covered under several jurisdictions, including the CERCLA, RCRA, and BRAC.

Guidelines for the remediation of hazardous constituents released from federal facilities are provided in Section 120 of CERCLA. Essentially, all guidelines, rules, regulations, and criteria propagated under CERCLA apply to federal facilities. In that context, environmental studies and future remediation activities conducted at JPG are governed by CERCLA under the review and approval of the USEPA, Region 5, and the State of Indiana. The U.S. Army is responsible for the study and cleanup of waste sites at JPG. Environmental evaluation is specified in Sections 121(b)(1) and (d) of CERCLA, which require that remedial actions be protective of the environment and follow the guidance provided in the National Contingency

Plan (NCP) and other USEPA documents. Although JPG is not listed as a National Priority List (NPL) site under CERCLA, the USAEC, acting under the Installation Restoration Program (IRP), voluntarily placed the facility under CERCLA regulations.

A baseline ecological risk assessment evaluates potential threats to the environment in the absence of any remedial actions (i.e., the no-action alternative). The no-action alternative (NAA) assumes no corrective actions will take place and no restrictions will be placed on future uses of the area. Evaluation of this NAA is required under 40 CFR Part 300 Section 300.430(d) of the NCP.

JPG also requires a RCRA Interim Permit because pyrotechnics, explosives, and propellants were stored and thermally treated at the facility. A RCRA Subpart X Hazardous Waste Part B Permit application has been submitted, but is still under review by USEPA Region 5.

As stated previously, JPG was recommended for closure by the BRAC Commission. Closure activities are performed in a manner consistent with President Clinton's July 2, 1993, five-point program to expedite economic recovery at communities where military bases are slated to close. This five-point program establishes guidance and procedures for (1) establishing base realignment and closure teams, (2) accelerating the NEPA process, (3) increasing public involvement in the cleanup program, (4) guiding the Suitability to Lease decision process, and (5) implementing the CERFA for identification of uncontaminated real estate.

The CERCLA process specifies that site cleanups must attain standards from federal and state environmental programs that are ARARs under the circumstances. These standards, both federal and state ARARs, have been developed for JPG (see Table 1-3). Generally, these ARARs represent federal requirements except for those areas where state requirements are more stringent than the federal requirements. In addition to federal or state requirements, there are also USAEC and Department of Defense requirements that must be met regarding UXO.

The following federal ARARs are directly related to investigating the various ecological components at JPG: *Fish and Wildlife Coordination Act* (16 USC 661-666), *Endangered Species Act* (16 USC 1531, 50 CFR Parts 200 and 402), *Migratory Bird Treaty* (16 USC 703), *Protection of Bald and Golden Eagles* (16 USC 668-668d), *Protection of Migrating Game and Insectivorous Birds* (16 USC 701-718h), and *Endangered and Threatened Wildlife and Plants* (50 CFR 17.11 and 17.12), *Wetlands Protection Act* (Executive Order 11990 as amended by Executive Order 12608), and Clean Water Act (33USC 1251-1376). In addition, state regulations that apply are the *Indiana Nongame and Endangered Species Act of 1973* (IC 14-2-8.5), and *Indiana Fish and Wildlife Administrative Rules* (310 IAC 3.1-2.7).

5.2.4.2 Characterization of Ecological Effects. The DERA is based on the USEPA guidance provided in the *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final* (USEPA 1997a), and

the Proposed Guidelines for Ecological Risk Assessment (Federal Register, FRL-5605-9, 9/9/96), *Risk Assessment Guidance for Superfund, Volume II, Environmental Evaluation Manual* (USEPA 1989a), *Framework for Ecological Risk Assessment* (USEPA 1992), *Ecological Risk Assessments of Hazardous Waste Sites: A Field and Laboratory Reference Document* (USEPA 1989c), and the *Wildlife Exposure Factors Handbook* (USEPA 1993a).

Two approaches were used to identify and quantify ecological risk at JPG: measures of effects and measures of exposure. Measures of effects were suggested by the regulators (Rust E&I 1997) and included performance of laboratory phytotoxicity tests with JPG soils, *in situ* earthworm toxicity tests, and measurements of soil fauna community structure. These tests are cost effective and can assist in the identification of potential population impacts to organisms at the base of the JPG food web. Since most of the JPG contaminants do not tend to biomagnify in either the aquatic or terrestrial environments, and those compounds associated with biomagnification were detected infrequently or at low concentrations, tissue sampling was deemed unnecessary by the DSG. Instead, the focus of the DERA was directed at the base of the food web where the most obvious effects are expected to occur (Rust E&I 1997f). **However, the bioaccumulation potential was addressed in the DERA by modeling the dietary pathway. (EPA185)** In addition, measured soil, surface water, and sediment concentrations (measures of exposure) were used to estimate chemical intakes and quantify potential risks. Furthermore, since JPG is moving towards privatization, habitat loss and disturbance may prevent many terrestrial animals from utilizing the JPG sites as habitat; however, plants and soil fauna remain important under all circumstances in the absence of pavement.

5.2.5 Facility Habitats

A major portion of JPG is wooded and the remainder is open grassland. Five primary habitat types have been identified for the JPG (Karns 1993):

1. Disturbed Areas—Developed areas (buildings, mowed lawns, pavement, roads).

2. Wet Woodland—Wooded areas of varying successional stage and size with permanent water resources (e.g., ponds, streams).

3. Dry Woodland—Wooded areas of varying successional stage and size without permanent water resources (e.g., ponds, streams), but may be wet due to soil type and poor drainage at various times of the year.

4. Riparian Corridor—Stream habitat and adjacent borders.

5. Old Field/Open Grassland—Graminoid-dominated areas previously maintained by mowing, burning, or tilling. **(EPA186)**

Summary-level site habitat descriptions are provided for each site included in the DERA. The terrestrial reference areas and JPG Phase II background discussions are located in Section 32.0. Flora and fauna observed during 1- or 2-day site visits in the spring and summer of 1993 are also discussed. Figure 2-10 (Section 2.4) provides the JPG soils map for reference. Detailed descriptions of site vegetation, surface hydrology, soils mapping, and analytical results are located throughout this RI report.

5.3 DETAILED ECOLOGICAL RISK ASSESSMENT METHODOLOGY

[Note: All figures and tables for Section 5.3 are located sequentially at the end of this section.]

The evaluation of ecological risk at JPG is based on USEPA Superfund guidance for conducting ecological risk assessments as discussed in Section 5.2.3.

A screening-level risk assessment was represented by the PERA (Rust E&I 1997g), in which many of the sites were screened from further consideration due to the absence of potential ecological risk. The DERA represents a more in-depth evaluation of the data at the remaining sites, where further ecological investigations were conducted and quantitative risk assessment was performed for specific ecological receptors and complete exposure pathways. Part of the DERA includes further definition of exposure pathways to be assessed, and explicit descriptions of the assessment and measurement endpoints.

This section includes the description of the methodology for the field studies to support the DERA. The studies were designed to provide both measures of exposure and effects. Discussions with the USEPA and the IDEM indicated that earthworm and plant toxicity tests would provide valuable data to support the analysis of measures of effects, and assist in developing PRGs). The structure and composition of the soil fauna and plant communities are critical to other wildlife species that depend on them for food and/or habitat. The evaluation of data generated by the toxicity tests and aquatic and terrestrial community evaluations provide additional lines of evidence to support the risk characterization.

Table 5.3-1 presents the eight steps in the USEPA guidance (USEPA 1997a) as they relate to the investigation of ecological risk at JPG and their relationship to scientific management decision points (SMDPs). Each step results in a decision point that requires all stakeholders to reach a consensus on the effort before proceeding to the next step. This process serves to focus further efforts and results in a more timely conclusion to the risk assessment. The end result is the DERA, which evaluates the data and potential risk in a manner that is most useful to the risk managers. The DERA contains three main components as identified in the current ecological risk assessment guidances: (1) problem formulation, (2) analysis, and (3) risk

characterization. Each of these components is discussed in greater detail in the following sections.

The first and second steps in the risk assessment process (Table 5.3-1) and the corresponding SMDP (a) were represented by the revised final PERA, which was a screening-level risk assessment. At the DERA work plan scoping meeting (August 14, 1997, Appendix BB), the revised conceptual site model, food web, key ecological receptors, and DERA approach were presented to and agreed upon by the USEPA and IDEM (Rust E&I 1997h). The exposure pathways that would be addressed quantitatively in the DERA were also presented and accepted. Subsequent to that meeting, a final TM (Rust E&I 1997f) identified those sites that would be carried forward into the DERA, the revised assessment and measurement endpoints, key ecological receptors, and proposed field studies for 1997 based on the August 1997 meeting with the regulatory agencies. The final TM was incorporated into the DERA work plan; additional information was also included so that the DERA work plan addressed Steps 3, 4, and 5 of the risk assessment process (Table 5.3-1). Approval of the DERA work plan would complete SMDPs (b), (c), and (d). The DERA and resulting Record of Decision (ROD) to be completed fulfill the remaining steps (Steps 6, 7, and 8).

5.3.1 DERA Objectives

The primary goal of characterizing the current and future adverse effects on the ecosystems South of the Firing Line at JPG was accomplished through several specific objectives. The following objectives help to ensure that all major contaminant sources, exposure pathways, and receptors are adequately addressed so that the DERA conclusions are defensible:

- Select appropriate key ecological receptors (which may include Federally listed threatened or endangered, candidate, or State of Indiana sensitive species) and exposure pathways with the greatest exposure potential;

- Collect data to support the analysis of ecological effects and risk characterization;

- Collect adequate data from which statistically sound decisions can be made;

- Conduct earthworm and plant toxicity tests within selected source areas to allow evaluation of potential contaminant-related effects;

- Collect soil samples from source areas to identify soil fauna, to characterize soil fauna community composition and structure, and to allow evaluation of potential contaminant-related effects;

- Collect soil samples for chemical analysis to support interpretation of toxicity tests;

- Characterize risk through linkage of contaminant exposure to measured biological effects;
- Identify contamination levels representing unacceptable risk;
- Identify and characterize unacceptable ecological risks, if any, to assessment endpoints;
- Achieve optimum benefit with given resources and schedule.

Collection of field data was intended to support risk management decisions and to support development of site-specific PRGs for ecological remediation, if remediation is deemed necessary.

5.3.2 Problem Formulation

Screening-level problem formulation occurred in the PERA, where sites that had the potential for posing an unacceptable ecological risk were identified and recommended for further evaluation. The focus of the DERA is on those identified sites. Included is an in-depth evaluation of existing data in order to develop quantitative risk estimates.

Data sources available for use in the DERA are discussed in the problem formulation. The key receptors selected and ecosystems at risk are described, as are the assessment and measurement endpoints, exposure pathways, and JPG food webs. Literature-based toxicity reference values (TRVs) were obtained for each receptor and COPC as available. These activities culminated in the development of a conceptual site model.

The DERA problem formulation further develops the PERA screening-level problem formulation. As shown in Figure 5.3-1, the PERA activities were as follows:

- Initial evaluation of background soil data
- Initial COPC screening using both Phase I and Phase II site data
- Initial identification of potential exposure pathways
- Preliminary selection of endpoints
- Preliminary identification of potential ecological receptors
- Preliminary identification of JPG food webs and conceptual site model
- Qualitative flora and fauna surveys

A key component of the DERA problem formulation is the integration of available information. Information pertaining to the sources and nature of the stressors (i.e., contaminants), potential routes of exposure, and ecological receptors is integrated with data on the potential toxicological effects and existing site data in order to create a conceptual site model. Existing data sources included, but were not limited to, previous environmental investigations that provided both qualitative and quantitative data (Rust E&I 1994), IM confirmation sampling data (SAIC 1997, Sverdrup 1997a, 1997b; Toltest 1997a, 1997b, and 1997c), ecological risk assessments (ERAs) at other Army facilities (Rust E&I 1997d), and toxicological literature reviews.

The following specific activities were performed in the DERA problem formulation phase:

- Made minor editorial changes to the assessment endpoints identified in the revised TM
- (Rust E&I 1997f) for clarity
- Focused the problem formulation around the key ecological receptors for which quantitative risk assessment was performed as agreed upon by the USEPA, IDEM, USACE, and USACHPPM at an August 14, 1997 meeting (Rust E&I 1997h)
- Selected key receptors representative of Special Status species that could be exposed to site-related contamination (e.g., little brown myotis to represent the Indiana bat)
- Identified all complete exposure pathways to be quantitatively addressed in the DERA (Rust E&I 1997f);
- Refined the JPG food web model to apply to the DERA (Rust E&I 1997f)
- Refined the conceptual site model as it applied to the DERA (Rust E&I 1997f)

5.3.2.1 Selection of Contaminants of Potential Concern. The following is a discussion of the screening process used to identify COPCs in site soils (Figure 5.3-2). The screening process was used to determine whether concentrations of inorganics were elevated above the JPG Phase II background soil data hereafter referred to as “background”. Organic analytes were assumed to be due to anthropogenic activities and all were retained as COPCs if detected. The screening process focuses the DERA on those contaminants most likely to cause adverse effects. A conservative screening approach was taken; no assumptions regarding bioavailability, persistence, or mobility were made. Instead, all inorganic data were evaluated as per the flow diagram (Figure 5.3-3). Inorganic analytes that were not COPCs (including macronutrients) were removed from evaluation in the DERA.

5.3.2.1.1 Background Data Set. The background data for JPG (Rust E&I 1997i) were obtained from 20 surface soil samples taken from areas representing the three soil types at JPG: Avonburg, Cobbsfork, and Rossmoyne. The background samples were collected during the Phase II RI activities in the Fall of 1995. The background data were not segregated by soil type. This approach was agreed upon by the DSG and reported in the TM (Rust E&I 1997f).

Surface water data collected by the USACHPPM (formerly USAEHA) were evaluated for use as a background surface water data set (USAEHA 1993). No comparisons to background surface water or sediment were made. This is a conservative approach in the risk assessment process. The number of analytes represented by the proposed background data set was limited (arsenic, mercury, and silver) as is the number of JPG sites with surface water data.

The soil background data were reviewed, and silver, boron, mercury and tin had no detects. Inorganics with low detection frequency (≤ 15%) were identified (i.e., cadmium, molybdenum, and thallium). The macronutrients calcium, potassium, sodium, and magnesium were not considered in either the background or DERA site data sets since toxicity is not expected due to these analytes. Duplicate data were incorporated by averaging the original sample with its laboratory duplicate, and those results again averaged with the field duplicate, if available. Non-detect samples were incorporated by assigning one-half the detection limit for each non-detect.

The summary statistics (minimum, maximum, mean, standard deviation, detection frequency, and the UCL95 on the arithmetic mean) for the background data set are provided in Table 5.3-2. The analytes in the background data set were tested for normality or log normality with the Shapiro-Wilk (W) test. The results of the W test are summarized in Table 5.3-3.

5.3.2.1.2 Site Data Evaluation Process. The site data were collected in three phases and have been maintained and analyzed separately because of ongoing remediation activities at JPG and the need to evaluate both past and present ecological risks. Phase I data were collected in 1993 while Phase II data were collected from 1995 though June 1996. During the fall of 1997, Phase III samples representing the DERA sites and the New Burn Site adjacent to Sites 3/4 were collected. The DERA site data sets were restricted to soil samples taken from the surface to a depth of 2 feet. Figure 5.3-4 presents the data sets evaluated in this DERA, and Table 5.3-4 summarizes the types of analyses available for evaluation. The sample size for the sites varied from a single sample to as many as 30 samples.

Duplicate data were incorporated by averaging the original sample with its laboratory duplicate, and those results again averaged with the field duplicate, if available. Non-detect samples were incorporated into the data set by assigning one-half the detection limit for each non-detect. Analytes with a detection frequency of less than 5 percent were not evaluated in the DERA. Only mercury at Site 9 (Phase I) and antimony at Site 27 (Phase II) had a detection frequency of less than 5 percent. Sample records containing "greater than" values were

excluded as were records with "L or R" qualifiers. Due to the limited amount of organic data, no records were removed based on laboratory contamination unless so flagged with qualifiers by EcoChem, Inc. Summary statistics (minimum, maximum, mean, standard deviation, detection frequency, and UCL95 on the arithmetic mean) were calculated for each of the DERA sites and are reported in the individual sections pertaining to those sites.

As a matter of clarification, COPC screening on the 1997 site data (as well as all data for the DERA) was performed on the 0-to 2 foot depth profile; summary statistics calculated and EPCs estimated. The EPCs were used to estimate exposure intakes. (EPA188)

The process used to compare site data to background in order to identifiy analytes that were statistically elevated above background is shown in Figure 5.3.3.

The site data were examined for sample size and detection frequency (DF). If the sample size was less than 5 and there were no detects, the analyte was rejected as a COPC. If the sample size was less than 5, and there were one or more detects, the analyte was retained as a COPC but statistical analysis was not performed. If the sample size was 5 or greater, the data were evaluated for DF on an analyte-by-analyte basis:

- If the DF was ≥ 50%, then normality tests (Shapiro-Wilk W test) were performed.

- If the DF was < 50%, then the DF was examined to see if it was >10% *and* there were more than two detects. If the DF was >10% *and* there were more than two detects, then a Kruskal-Wallis (KW) test was performed. If the DF was ≤ 10%, then the DF was examined for the presence of any detects. If there were no detects, then the analyte was not considered a COPC for that site.

- If the DF was < 5%, the analyte was not retained as a COPC for that site.

- If the DF was ≥ 5 % but <10%, the analyte was retained as a COPC without statistical analysis.

- If the detection frequency range was at least 50%, the KW test was applied to determine if the JPG background mean differed significantly from the site mean.

Since silver, boron, mercury, and tin were not detected in the background data, these analytes were retained as COPCs where detected at any DERA site. Cadmium, molydenum, and thallium were also retained as COPCs where they occured at DERA sites because of low background detection frequency.

The W test was performed on the background data; if the data were not normal, they were log-transformed and tested for log-normality. Normality testing was then performed on site analyte data for which the corresponding background data exhibited normality. If the background data or site analyte data did not exhibit normality, the KW test was used for those analytes to determine if the means of the site and background data sets were significantly different. If both data sets were normal or lognormal, a Bartlett's test was performed to test for homogeneity of variance.

If both the background and the site data sets were homogeneous, a Student t-test was performed to determine if the background and site means were significantly different. If they were not homogeneous, then the KW test was applied to determine statistical difference in the means.

The KW test is a nonparametric test and makes no assumptions concerning the underlying nature of the sample data. If the null hypothesis (H_o) is not rejected (i.e., it is accepted), then the analyte data set was assumed to have the same mean as the background data set, and the analyte was not considered a COPC for the site. If the alternative hypothesis (H_a) is not rejected (i.e., it is accepted), then the analyte data set was assumed to *not* have the same mean as the background data set and the analyte was considered a COPC for that site. The null and alternative hypotheses for the KW test are provided below:

H_o: background mean = site mean (on an analyte-by-analyte basis)

H_a: background mean ≠ site mean (on an analyte-by-analyte basis)

The W test is considered effective for testing data sets with sample sizes less than 50 (Gilbert 1987). The W test is also applicable to lognormal distributions. For the W test, the null hypothesis, H_o, assumes the population follows a normal (or lognormal) distribution, and the alternative hypothesis, H_a , assumes that the population does not follow a normal (or lognormal) distribution. The null and alternative hypotheses for the W test are provided below:

H_o: The DERA site data set (on an analyte-by-analyte basis) is drawn from an underlying normal (or lognormal) population.

H_a: The DERA site data set (on an analyte-by-analyte basis) is not drawn from an underlying normal (or lognormal) population.

Although the Cochran C test was proposed in the DERA work plan, the Bartlett test was instead chosen since it was easily translated into a spreadsheet format. The Bartlett's test is an analysis of variance test that evaluates the hypothesis that the data sets come from populations with similar variances. The test assumes that each sample set was randomly and

independently drawn from a normal (or lognormal) population. The null hypothesis (H_o) assumes that the variances for the two data sets are equal. The alternative hypothesis (H_a) assumes that the variances are not equal. The null and alternative hypotheses for the Bartlett test are provided below:

H_o: background variance = Site variance (on an analyte-by-analyte basis)

$$\sigma^2_{background} = \sigma^2_{site}$$

H_a: background variance ≠ Site variance (on an analyte-by-analyte basis)

$$\sigma^2_{background} \neq \sigma^2_{site}$$

If the null hypothesis was not rejected (i.e., it was accepted), then the background and site data sets were assumed to have homogeneous variances. The homogeneous data sets were further evaluated using the Student-t test. If the alternative hypothesis, H_a, was not rejected (i.e., it was accepted), then the variance of the background data set was not homogeneous with respect to the site data set. The non-homogeneous site data sets were further evaluated using the nonparametric KW test to evaluate population means in a manner analogous to the parametric Student t-test.

The Student t-test assumes that the data sets are drawn from populations with an asymptotically normal (or lognormal) distribution, as determined by the W and Bartlett's tests, and the means of the data set are then compared. The null hypothesis, H_o, assumes that the means of the background and site data sets are the same. The alternative hypothesis, H_a, assumes that the means of the background and site data sets are not the same. The null and alternative hypotheses for the Student t-test are provided below:

H_o: background mean = site mean (on an analyte-by-analyte basis)

H_a: background mean ≠ site mean (on an analyte-by-analyte basis)

If the null hypothesis (H_o) was not rejected (i.e., it was accepted), then the analyte data set was assumed to have the same mean as the background data set, and the analyte was not considered a COPC for the site. If the alternative hypothesis (H_a) was not rejected (i.e., it was accepted), then the analyte data set was assumed not to have the same mean as the background data set, and the analyte was retained as COPC for that site.

A summary of the statistical evaluations and inclusion or exclusion of COPCs for the DERA sites are provided in tables found in Appendix BB.

As identified in the TM and DERA work plan, sites with more than one data set were identified, and the data sets were to be combined and summary statistics calculated. Upon further inspection of the data, however, the data were maintained as separate data sets in order

to facilitate the comparison of changes over time. Table 5.3-5 provides a preliminary COPC list by site and medium for the JPG data without comparison to background. Final COPCs are presented in the corresponding site sections (7.7, 8.7, 10.7, 12.7, 17.7, 18.7, 20.7, 22.7, and 31).

5.3.2.2 Selection of Key Ecological Receptors. Unlike the HHRA, which focuses on only one species, an ERA must address potential risks to numerous species and communities of species. However, an ERA cannot possibly address every species in a ecosystem on an individual basis unless the ecosystem is extraordinarily depauparate. Furthermore, there would be a great deal of redundancy in calculating risk estimates for every wildlife species listed in Table 5.3-6. Therefore, a subset of receptors was selected to represent the species that could occur and be exposed to COPCs at JPG. This simplifies the risk assessment process, since risks to key receptors are used to represent risk to other JPG species that share a similar position in the food web. For example, risks to the red

fox are intended to also represent risks to the coyote or gray fox. In a like manner, risks to the American kestrel were used to address potential risks to other raptors.

Key ecological receptors are those species or taxa of plants and animals that have been selected as critical components for the DERA. For the purposes of the DERA, the term "key receptor" indicates receptors for which quantitative risk assessment (i.e., calculations of risk estimates) was performed. The following criteria were considered in selecting key receptors:

- Special Status species (Federally listed threatened, endangered, candidate, or State of Indiana sensitive species) where protection at the individual level is required

- Game animals or wildlife that have social or economic value

- Species that are likely to have high COPC exposure due to life history

- Species that are present at JPG and are part of the food web

- Species that have significant biological or ecological relevance such as species that are a critical component of the JPG ecosystem, and their loss would alter structure or function of this ecosystem

- Species that are toxicologically sensitive to the COPCs

Master lists of wildlife (Table 5.3-6) and plant species (Table 5.3-7) were compiled from several sources, including the State of Indiana, the USFWS, and Hanover College. Included in these master lists were species that, while not physically observed, utilize habitats that exist at JPG and could possibly be present at this facility. Tables 5.3-6 and 5.3-7 provide the

common and scientific names, whether they were observed at JPG, whether appropriate habitat exists at JPG, and the status or classification of the species (i.e., Federally listed or State-of-Indiana listed). Extinct wildlife species are not included in Table 5.3-6.

Information on Special Status species as well as other species at JPG was obtained during conversations and through correspondence with the USFWS and the Indiana Division of Wildlife Resources. Based on observations or input from trained wildlife or ecological specialists from the Indiana Division of Natural Resources, the USFWS, and Rust E&I, species were identified and included for evaluation as key receptors. Input for the inclusion or exclusion of these species as key receptors was discussed at several of the meetings with the regulatory agencies (Appendix CC). Information such as food habits, home range, distribution at JPG, abundance, and activity patterns of the key receptors is discussed in the biological profiles included in Appendix BB. All potential exposure pathways were considered to ensure that species with a high likelihood of exposure would be included as key receptors.

The key receptors selected for the JPG DERA are presented in Table 5.3-8. As a component of SMDP (b), the key receptors identified in Table 5.3-8 were presented to and agreed upon by the USACE, USACHPPM, IDEM, and the USEPA at a meeting held on August 14, 1997 (Rust E&I 1997h).

5.3.2.3 Ecosystems Potentially at Risk. JPG has aquatic, wetland, and terrestrial ecosystems that may be at risk due to contamination by Army-related activities. Although other aquatic resources exist at JPG, they were not included for evaluation in the DERA. The only true aquatic ecosystem of concern in the DERA is Harberts Creek and its drainages. Riparian habitat exists along waterways and wetland areas at Site 14 (Yellow Sulfur Disposal Area) and Harberts Creek. Sites 9 and 29 include small ponds. Most of the terrestrial habitat at the DERA sites consists of old fields and woodlands. The five primary habitat types at JPG were presented in Section 5.2.5.1.

5.3.2.4 Food Web. The JPG food web diagram in Figure 5.3-5 depicts the major trophic level interactions between key receptors and outlines the nutrient flow and transfer of matter and energy through these levels. The diagram was developed from the master species lists (Tables 5.3-6 and 5.3-7) and from consideration of potential exposure pathways. For purposes of the DERA, the food web diagram portrays potential routes of COPCs from abiotic media to biotic species at various trophic levels. Figure 5.3-5 is a simplified version of the food web that was presented to and agreed upon by the USEPA and IDEM as appropriate for the DERA (Rust E&I 1997h) as a component of SMDP (b). In order to demonstrate the dietary pathway for the raccoon, aquatic vegetation was added to the food web. In addition, non-key receptors were removed for editorial purposes.

Dietary preferences were evaluated for each of the key species in Figure 5.3-5 and were used in the exposure analysis to model the dietary exposure pathway. Table 5.3-9 presents the

percentage of each major component of the diet for each key receptor. In order to facilitate modeling the dietary ingestion pathway, and because of a lack of species-specific uptake information, generalizations were made on dietary items. For example, there was no attempt at predicting exposure due to ingestion of different types of plants or invertebrates. Plants were considered as one group, as were terrestrial invertebrates. Thus, although a wild turkey eats seeds, nuts, and grains, these plant materials were modeled together as a single plant component.

The mourning dove is an herbivore and consumes mostly seeds (Palmer and Fowler 1975). The chimney swift feeds primarily on insects (Palmer and Fowler 1975). Wild turkeys are omnivores, although plant materials form a more important component of their diet than do animal materials (Eaton 1992).

The American kestrel is a small raptor that feeds on small mammals, invertebrates, and birds (Palmer and Fowler 1975). Percentage estimates of each item in their diet were made by reviewing a summary of stomach contents.

Great blue herons forage primarily on fish (Butler 1992; Quinney and Smith 1980); however, in some environments rodents make up 24 to 40 percent of the diet (Butler 1992). Fish, frogs, crayfish, and water snakes are consumed by the great blue heron, as are birds and mice. For the purposes of modeling the dietary pathway for the great blue heron, aquatic invertebrates and vertebrates were assumed to be major prey items (Table 5.3-9).

The white-footed mouse is an omnivore, consuming a diet approximately evenly divided between plant and animal matter (Palmer and Fowler 1975). Eastern cottontails are herbivores, while the little brown myotis consumes mostly soft insects, preferring flies and moths (Chapman and Feldhamer 1982).

Both the raccoon and the fox are omnivores. Raccoons consume fruits, nuts, invertebrates, and vertebrates, including rodents and birds. Crayfish are a preferred invertebrate, and even carrion is consumed. In general, however, plant matter (60 percent) is a more important dietary staple than is animal matter (40 percent). For the purposes of modeling the dietary pathway for the raccoon, the animal matter component for the raccoon was divided equally between aquatic invertebrates and aquatic vertebrates. It was assumed that all plant material would be aquatic vegetation. The fox depends more heavily on animals in winter, and invertebrates, fruit, and vegetation in summer. For the purposes of modeling the fox diet, 60 percent of the diet was attributed to animal matter, invertebrates were assumed to account for 30 percent, and 30 percent allocated evenly between rodents and lagomorphs (Chapman and Feldhamer 1982).

5.3.2.5 Exposure Assumptions. This section of the problem formulation discusses the exposure pathways, and determines which pathways are likely complete. In addition, the

parameters and exposure equations that were used for each receptor to quantitate exposure are presented in this section.

5.3.2.5.1 Exposure Pathways. Exposure pathways are the mechanism by which a contaminant in an environmental medium (i.e., the source) contacts an ecological receptor. A complete exposure pathway includes:

- Contaminant source
- Release mechanism that allows contaminants to become mobile or accessible
- Transport mechanism that moves contaminants away from the release
- Ecological receptor
- Route of exposure (e.g., dermal or direct contact, inhalation, or ingestion)

Only complete exposure pathways were quantitatively evaluated in the DERA. Because of the general absence of contaminants that biomagnify within food chains (e.g., organochlorine pesticides), tissue sampling was not recommended for the DERA (Rust E&I 1997h).

Risk estimates were calculated for the following complete exposure pathways as appropriate for each key receptor shown in the conceptual site model (Section 5.3.2.8):

- Surface water—direct ingestion
- Surface water—direct contact
- Soil—direct ingestion
- Soil—direct contact
- Sediment—direct ingestion
- Sediment—direct contact
- Dietary—ingestion of forage and/or prey as appropriate, by receptor

The major exposure pathways at JPG are direct contact with contaminated abiotic media (e.g., plants or invertebrates in contact with contaminated soil), ingestion of abiotic media (e.g., ingestion of soil, sediments, or surface water by birds or animals), and ingestion of potentially contaminated biological media (i.e., ingestion of plants or animals). Since the great majority

of the DERA COPCs are inorganics, the conceptual site model assumed that dermal exposure (i.e., uptake of chemicals across the skin) by birds or mammals would be minimal and would not contribute greatly to overall exposure.

5.3.2.5.2 Exposure Parameters. This section presents the species-specific parameters that are used to quantitate exposure. The data used to generate the exposure parameters are presented in Table 5.3-10 and supporting documentation included in Appendix DD.

In accordance with USEPA guidance, both the central tendency (CT) and RME intakes were estimated for the key receptors. To evaluate the CT exposure intakes, the mean of the available data for each parameter was used. The RME exposure intake, which is more conservative, used the 95th percentile of the available data.

Bioaccumulation Factors (BAFs)/Bioconcentration Factors (BCFs). The dietary pathway can contribute significantly to total exposure even when BAFs and BCFs are between 1 and 10. Therefore, literature-based BAFs and BCFs were used to conservatively estimate dietary exposure (Table 5.3-11). When BAFs could not be obtained from the literature, they were developed from plant, mammal, and invertebrate data collected at another Army site (Rust E&I 1997d). The tissue concentration for a terrestrial receptor was estimated as follows:

$$C_{soil} \; x \; BAF = C_{tissue} \qquad \text{(Equation 5.3-1)}$$

The BCF was multiplied by the concentration in water to obtain the tissue concentration for an aquatic receptor as follows:

$$C_{water} \; x \; BCF = C_{tissue} \qquad \text{(Equation 5.3-2)}$$

In order to be conservative, tissue concentrations in aquatic organisms were calculated using total (unfiltered) surface water and literature-based BCFs.

Home Range and Area Use Factor. Home range (HR) is the area that an animal is expected to occupy for feeding, breeding, and any other aspects of life history. The area of each site was divided by the HR for each receptor to obtain an area use factor (AUF). Appendix BB presents the key receptor biological profiles with home ranges, while Appendix DD presents the data used to obtain the CT and RME home range exposure parameters.

The HR values for the ecological receptors at JPG as listed in Appendix BB were obtained from the USEPA's *Wildlife Exposure Handbook* (USEPA 1993a). When the site area is smaller than the HR area, the AUF is less than 1. This reflects the fact that the animal feeds and moves over an area larger than the particular site by integrating exposure over the entire HR. Therefore, overall exposure at the site is reduced. When the site area exceeds the HR, a value of 1 was used in the intake equations (i.e., exposure does not increase above 100

percent). Table 5.3-12 presents a summary of RME and CT AUFs by site and receptor. The average HR was used to obtain a CT AUF, whereas the minimum HR was used to obtain the RME or conservative AUF. An AUF was applied to the ingestion of sediments for aquatic receptors; however, no AUF was applied to surface water intakes in order to be conservative, and because animals may share a common water source, leaving their feeding territories to access drinking water.

Water Ingestion Rate. The water ingestion rate (WIR) is the daily amount of water ingested, normalized for body weight (liter water/kilogram body weight/day (L water/kg bw/d)). The 95th percentile WIR was used to conservatively estimate RME intakes, whereas the average WIR was used to estimate the CT intakes. Risk estimates for surface water ingestion were obtained by using filtered surface water based on USEPA AWQC, which are for dissolved (filtered) analytes.

Soil/Sediment Ingestion Rate. Terrestrial animals were assumed to eat soil and aquatic receptors sediment. The soil and/or sediment ingestion rate (SIR) is the daily amount of soil or sediment ingested and normalized to body weight (kilogram soil/kilogram body weight/day (kg soil/kg bw/day)). The SIR was predicted from the DIR (Table 5.3-10) and the soil or sediment fraction in diet (SFD) as follows:

$$SIR = DIR \times SFD \qquad \text{(Equation 5.3-3)}$$

The 95th percentile SIR was used to ~~conservatively~~ **(EPA121)**estimate RME intakes (Table 5.3-13), whereas the average SIR was used to estimate the CT intakes (Table 5.3-14).

$$DIR_{adj} = (DIR - DIR \times SFD) \qquad \text{(Equation 5.3-4)}$$

Dietary Ingestion Rate. The dietary ingestion rate (DIR) is the total daily amount of food ingested, normalized to body weight (kilogram diet/kilogram body weight/day (kg diet/kg bw/d)). The 95th percentile DIR was used to ~~conservatively~~**(EPA121)** calculate RME intakes, whereas the average DIR was used to estimate the CT intakes. The adjusted DIR (DIR_{adj}) is the dietary ingestion rate minus the soil component.

Body Weight. Minimum and maximum body weights (BW) were used in allometric equations (USEPA 1993a) to obtain estimates of DIR and WIR when measured estimates of these parameters are lacking.

Table 5.3-13 summarizes the exposure parameters that were used for key terrestrial receptors for the RME scenario. Table 5.3-14 provides the CT exposure parameters for key terrestrial receptors.

5.3.2.5.3 Exposure Equations. Exposure equations similar to those presented for human health risk assessment (USEPA 1989b) were used to estimate exposure intakes. The EPCs for

each COPC were calculated and used to obtain daily exposure intakes. Intakes were calculated for each medium where analytical data were available. Daily exposure intakes were estimated by multiplying the daily media ingestion rate for a given receptor by the EPC in the same media. The general surface water intake equation is:

$$Intake_{(mg/kg\ bw/day)} = Water\ Ingestion\ Rate_{(L/kg\ bw\ /day)} * EPC_{(mg/L\ water)} \quad \text{(Equation 5.3-5)}$$

= Soil Injestion Rate * EPC * AUF

The general soil or sediment intake equation is:

(Equation 5.3-6)

where DIR and SIR are the dietary and soil ingestion rates, respectively.

In order to model intakes, terrestrial receptors were assumed to ingest soil, whereas aquatic wildlife receptors (i.e., great blue heron and raccoon) were assumed to ingest sediment.

The general dietary intake equation is:

(Equation 5.3-7)

$$Intake(mg/kg\ bw/d) = Dietary\ Ingestion\ Rate\ (kg/kg\ bw/d) * Fraction\ Soil\ Diet * EPC * AUF$$

$$Intake_{(mg/kgbw/d)} = (Dietary Ingestion Rate_{(kg/kgbw/d)} + Soil\ Ingestion Rate_{(kg/kgbw/d)}) * EPC Diet_{(mg/kg)} * AUF$$

$= DIR_{adj} * EPC * AUF$

Because each of the receptors has different feeding preferences (Table 5.3-9), Equation 5.3-7 varies for each receptor. This is because the EPC in each dietary component must be estimated for each receptor from the BAF or BCF and appropriate abiotic media. The receptor-specific equations are in Appendix DD.

5.3.2.6 Toxicity Evaluation. Toxicological data from the scientific literature were reviewed in order to define TRVs. The goal of the literature review was to obtain as many chemical and species-specific TRVs as possible for the risk characterization. The most pertinent studies reviewed for birds, mammals, plants, and soil fauna are summarized in Appendix DD. The TRVs for aquatic life (i.e., benthic invertebrates, aquatic plants, and fish) are the *Ambient Water Quality Criteria for the Protection of Freshwater Aquatic Life and their Uses* (AWQC) and the sediment quality criteria (SQC) (USEPA 1996b) or other appropriate sediment benchmark (Table 5.3-15). For water, the chronic value was used for the NOAEL TRV while the acute AWQC was used for the LOAEL TRV. The effects range low (ERL) was used to obtain a NOAEL TRV for sediments, whereas the no effects concentration (NEC) was used

to obtain the sediment LOAEL TRV. In order to select the most appropriate value to use as a final TRV, the following criteria were considered:

- Overall strength of the study
- Similarity of the test species to the key receptors
- Magnitude of the total applied uncertainty factors, which is related to the first two items

Table 5.3-16 provides the final TRVs for the JPG key receptors.

The following data sources were evaluated for toxicity information:

- Toxline (an on-line database specializing in toxicological data)
- USEPA documents
- Other sources including IRIS, HEAST, HSDB, and ATSDR

Appendix DD is critical to the technical review of this section. (EPA180a)

Selection of the TRVs focused on endpoints or health effects that are likely to adversely affect populations of ecological receptors at the site, as opposed to health effects such as cancer which occurs on an individual basis. Health effects that potentially impact populations include increased mortality, high rates of morbidity, and reproductive effects. For the purposes of the risk assessment, reproductive effects include developmental effects (i.e., fetotoxicity and embryotoxicity), as well as indices of reproductive success such as reduced litter size. Carcinogenicity and mutagenicity were not used as endpoints for the ecological risk assessment as these are effects that alter an individual's chance of survival. If cancer rates were very high, the endpoint for the population would be survival.

The literature was reviewed for chronic NOAELs. Chronic studies, wherein ecological receptors are exposed for entire lifetimes, were considered preferable to studies of shorter duration. Where possible, data from short-term studies (i.e., single dose or less than a week) and dose levels or dietary intakes that resulted in mortality were avoided. If NOAELs were unavailable, the LOAEL or another toxicity value was used. Where data were available, toxicity values for wildlife species likely to be found at JPG were used.

UFs associated with intertaxon extrapolation, threatened and endangered species (Special Status species), and study endpoint and study duration were incorporated in the final TRV. The UFs were multiplied as appropriate and used as a denominator to reduce the TRV to reflect a chronic NOAEL value. Table 5.3-17 provides the UF scheme that was used for the JPG

DERA. A TEF was also incorporated into the final TRV for dioxins and furans by dividing the TRV by the appropriate TEF (see Table 5.3-18).

5.3.2.7 Assessment and Measurement Endpoints. According to USEPA guidelines, "Assessment endpoints are explicit expressions of the actual environmental value that is to be protected" (USEPA 1997a; USEPA 1992d). They represent the link between the risk assessment process and risk management goals. Assessment endpoints include both a valued ecological entity and an attribute of that entity that is important to protect and that is potentially at risk (USEPA 1996a). For a risk assessment to have scientific validity, assessment endpoints must be ecologically relevant to the ecosystem they represent and be susceptible to the stressors of concern (USEPA 1996a). Assessment endpoints that cannot be linked with measurable attributes are not appropriate for risk assessment purposes.

The endpoints identified in the final TM (Rust E&I 1997f) were slightly revised for clarity (Table 5.3-19). USEPA has provided further clarification on "measurement endpoints", and has made the distinction between "measures of exposure" and "measures of effects" (USEPA 1996a). This distinction is useful in that measures of exposure (i.e., concentrations of COPCs in source media) can be related directly to HQs and HIs similar to human health risk assessment practices. A measure of effect is a study that quantitates the negative impacts to the ecological receptors and the assessment endpoints. Although more difficult to quantify, measures of effects may be obtained through biometric studies, toxicity testing, micronucleus analysis, histopathology, or long-term monitoring. These assessment and measurement endpoints (Table 5.3-19) represent components of SMDPs (b) and (c), and reflect the consensus of the risk managers and the risk assessment team (Rust E&I 1997h, Rust E&I 1997f).

Many of the assessment endpoints focus on receptors in close contact with soils, such as ground-feeding birds (i.e., mourning dove and wild turkey) and mammals (i.e., cottontails and mice). Effects to these assessment endpoints are thus expected to occur before risks to arboreal birds or mammals become apparent. The assessment endpoints include effects to the prey base for higher trophic level animals (for example, effects to populations of invertebrates or plants (Table 5.3-19). While the loss of an individual plant or invertebrate could be irrelevant to the JPG ecosystem, loss of whole populations or large shifts in community composition could produce changes in ecosystem structure or function. The assessment endpoints seek to address these potential effects.

5.3.2.8 Conceptual Site Model. The problem formulation phase culminated in the conceptual site model (USEPA 1997a; USEPA 1992d). As part of the initial problem formulation in the PERA, a preliminary conceptual site model was developed for the exposure pathways for JPG. That preliminary model was revised to provide greater detail on exposure sources and pathways. The conceptual site model shown in Figure 5.3-6**, which** was presented to and agreed upon by the USEPA and IDEM to be used in the DERA (Rust E&I 1997h) as a

component of SMDP (b), **has been revised to indicate the potential migration of groundwater contaminants to surface water. (EPA195)** The conceptual site model shows the complete exposure pathways to each receptor, including source, release mechanism, and route of exposure.

Contaminant concentrations in air are likely to be highly localized around burn and detonation areas; therefore, air is not likely to be an exposure medium. Thus, the air inhalation and dermal contact pathways were considered minor exposure pathways.

5.3.3 Analysis of Exposure and Ecological Effects

The objective of the analysis phase is to quantify contaminant exposure and potential ecological effects for each key receptor. The analysis phase consists of two principal components: (1) the characterization of exposure and (2) the characterization of effects. The principal products of this effort are site-by-site summary profiles that describe exposure and the stressor-response relationships.

The analysis phase included the following activities:

- Incorporating all DERA site data (i.e., Phase I, II, III, and IM confirmation sampling); surface soil data were limited to the 0-to-2-foot depth;
- Selecting appropriate reference areas where JPG Phase II background data were available;
- Conducting quantitative field studies to support measures-of-effects analysis by looking for significant differences in stream quality and riparian habitat due to the outfall of the Sewage Treatment Plant between upgradient and downgradient locations on Harberts Creek;
- Conducting quantitative field studies to support measures-of-effects analysis by looking for significant differences in soil fauna community structure between reference areas and study areas that can be attributed to site-related contamination;
- Conducting laboratory toxicity tests on plants and *in-situ* toxicity tests with earthworms using study area soils to evaluate measures of effects;
- Comparing toxicity test results to those from reference areas to test null hypotheses of no effect; and
- Collecting co-located soil samples for chemical analysis to support or refute toxicity test results; these analytical data were also used as measures of exposure.

As key components of the analysis phase, these activities are addressed in the following sections**, including the lines of evidence considered in the DERA**. **(EPA180b)** The results of the analysis phase are utilized in the risk characterization.

5.3.3.1 ~~**5.3.3.1**~~ **Study Design.** The overall objective in the design of the DERA field studies was to collect data of sufficient quantity and quality to support defensible decision-making. To achieve this objective, the DQO document *Guidance for Planning for Data Collection in Support of Environmental Decision Making Using the Data Quality Objectives Process* (QA/G-4, USEPA 1993b; USEPA 1994a) was used for determining the type, quantity, and quality of data to be obtained. The DQO guidance represents an integral component of the risk assessment process and was incorporated into the planning phases of this project (Figure 5.3-7).

Appropriate locations for reference areas were necessarily limited to areas south of the Firing Line and away from areas likely disturbed by facility activities or previous operations. The selection of the reference areas was made to coincide approximately with the approved Phase II background locations for comparative purposes. The Phase II background locations were selected with the concurrence of the regulatory agencies following a 1995 field visit to those locations. Since aspects of the field data (e.g., earthworm toxicity and soil fauna composition) were associated with soil chemistry, consistency pertaining to soil type was considered desirable. The Phase III DERA sampling and reference areas were selected with soil type in consideration (among other characteristics). (EPA189)

Additional data were required to support the analysis of exposure and ecological effects. The terrestrial field sampling study design used to collect the field data in the Fall of 1997 is presented in Figure 5.3-8. Five sampling locations at each of the study areas represented the best compromise between statistical power and confidence and budget.

To provide additional lines of evidence for the risk managers, plant and earthworm toxicity tests were recommended in the TM (Rust E&I 1997f). Soil fauna community structure is also a sensitive indicator of adverse effects due to soil contamination. Soil-type has a strong influence on soil chemistry and physical characteristics. Three reference areas were selected that correspond to the three predominant background soil types. This allowed summary statistics to be calculated individually on each of the three reference area data sets.

To determine adverse effects in the aquatic environment, the rapid bioassessment protocol (RBP) was recommended (Rust E&I 1997f). The aquatic field sampling design was presented in the TM (Rust E&I 1997f) and included the RBP (USEPA 1989d), benthic macroinvertebrate sampling, and fish counts. Data were collected at three sampling stations in Harberts Creek

above, adjacent to, and below the Sewage Treatment Plant, and three reference sampling stations upgradient of any impacts (Sections 5.3.3.3.3 and 7.7).

The extent of the aquatic sample collection was necessarily limited by the stream flow. For example, Harberts Creek may be relatively full with an average flow of less than 25 cubic feet per second or reduced to only standing pools of water depending on the season (Sections 5.3.3.3.3 and 7.7).

5.3.3.2 Exposure Analysis. This portion of the analysis phase evaluates the interaction of one or more stressors on one or more ecological receptors (or assessment endpoints). The results of the exposure analysis are then combined with the TRVs obtained from the toxicity evaluation to obtain estimates of risk (Section 5.3.4.1) in the form of HQs and HIs for each receptor and COPC.

The analytical data were evaluated in the exposure analysis phase and summarized in the site-by-site exposure and ecological effects profiles (i.e., stress-response profiles) for the DERA sites (Sections 7.7, 8.7, 10.7, 12.7, 17.7, 18.7, 20.7, 22.7, 31, and 32).

5.3.3.2.1 Data Incorporation. The analytical data sets for Phases I, II, III, and IM were examined to determine if data sets could be combined. Due to the differences in the analytical methodology between Phase I and Phase II and III, the decision was made to keep the data sets separate for the DERA. Soils were analyzed in Phase II and III using USEPA methods whereas the Phase I samples were analyzed under USATHAMA methods. The data incorporated into the DERA were as follows:

- RI Phase I soil, surface water, and sediment data.
- RI Phase II soil and surface water data.
- IM confirmation soil sampling data.
- Phase III DERA field (Fall 1997) data.
- Fall 1997 sampling data from the New Burn Site adjacent to Sites 3/4.

Figure 5.3-4 shows the data sets for each DERA site. Table 5.3-4 presents the analytical data types available for each DERA site. The analytical data are provided in Appendices N and O. The summary statistics and the EPCs used to obtain exposure intakes appear in tables for each DERA site (Sections 7.7, 8.7, 10.7, 12.7, 17.7, 18.7, 20.7, 22.7, 31, and 32).

Incorporate Phase I, II and Interim Measures Confirmation Sampling Data into the DERA. Several of the DERA sites were included in the IM remediation program (Sites 7/21b, 14/15, 28, and 29).

Soil and surface water sampling data from the Phase II RI field activities conducted in May 1995 were included in the risk assessment as follows:

- If a site was screened from further ecological consideration either in the PERA (Rust E&I 1997g) or TM (Rust E&I 1997f), then no further evaluation of that site occurred.

- If a site had IM confirmation sampling data, then those IM confirmation sampling data obtained from within the remediated areas were used for comparison to any historical data available for that site (e.g., Phase I or Phase II). All IM surface soil were evaluated regardless of depth.

- If a site had only Phase I data, a set of summary statistics for the COPCs was derived using only the Phase I data. Summary statistics were calculated for all media types available. Surface soil was evaluated only for the 0-to-2-foot depth as presented in the TM (Rust E&I 1997f).

- If a site had both Phase I and Phase II data, but no IM confirmation sampling data, a set of summary statistics for the COPCs were derived on each separate data set. Summary statistics were calculated for all media types available. Surface soil was evaluated only for the 0-to-2-foot depth.

EPCs in milligrams per kilogram (mg/kg), or as otherwise specified, were calculated from the summary statistics, and are presented in tables associated with each DERA site (Sections 7.7, 10.7, 12.7, 17.7, 18.7, 20.7, 22.7, 31, and 32). **The data used in calculating EPCs for ecological risk assessements are presented in Appendix AA. (EPA187)** EPCs were used in the calculation of exposure intakes. Non-detects were included at one-half the method detection limit or reporting limit to obtain summary statistics. EPCs were the lower of the UCL95 or maximum detected value.

Background data collected during Phase I were not used for comparison to site data since there had been concern that those earlier sampling locations were too close to known areas of contamination. The comparison of JPG sites to background for COPC screening occurs in the risk characterization and utilizes the background data obtained from Phase II sampling (Section 5.3.2.1.1).

Incorporate Fall 1997 Sampling Data into the DERA. ~~New analytical data for soils collected at the DERA study areas and reference **locations**~~ **Fall 1997 soil analytical data collected at the DERA study sites (3/4, 9,11,14/15, 25, 28/29/39) and Cobbsfork, Rossmoyne, and**

Avonburg reference areas (Figure 5.3-8**)** **were** co-located with biological field data (earthworm and plant toxicity test results, soil fauna identification) ~~were~~ **and** incorporated into the DERA. ~~COPC screening on site data was performed on the 0-to-2-foot-depth profile; summary statistics were calculated and EPCs estimated. The EPCs were used to estimate exposure intakes.~~ **(EPA188)**

5.3.3.2.2 Statistical Evaluation. The Phase III ecological soil analytical data were analyzed by one-way ANOVA by analyte and site location to determine if site COPC concentrations were significantly elevated above those at the reference areas. In addition, mean Phase III soil concentration data were compared to mean Phase II JPG background concentrations to identify whether inorganics were elevated in soil (Figures 5.3-9 through 5.3-12). The following conclusions were drawn from this statistical analysis:

- Aluminum concentrations across all of the ecological study areas (except Sites 3/4 and 9) and reference areas are very similar (Figure 5.3-9).

- Arsenic concentrations at the Rossmoyne reference area are just slightly below arsenic concentrations at Site 39. Arsenic levels at the other ecological areas are not remarkable (Figure 5.3-9).

- Barium at Sites 14/15, 3/4, and 9 was elevated with respect to the three reference areas and to Sites 11, 25, and 39 (Figure 5.3-9).

- Cadmium was highest for the Rossmoyne reference location. All other cadmium levels were substantially lower (Figure 5.3-9).

- Chromium was highest at Site 14/15. Chromium concentrations at the other ecological study areas and reference locations were not remarkably different (Figure 5.3-10).

- Cobalt at Sites 3/4 and 9 was almost 2 times higher than the highest value at Site 39 and considerably elevated above the reference areas (Figure 5.3-10).

- Copper at Site 3/4 was significantly elevated above all other ecological study locations and reference areas (Figure 5.3-10).

- Iron concentrations were highest at Site 39 but not significantly above iron at the Rossmoyne reference area. Iron concentrations across the site produced an apparent normal distribution of values (Figure 5.3-10).

- Lead concentrations at the reference areas were slightly below the concentrations at Sites 11, 25, and 39. Lead at Sites 14/15, 3/4, and 9 was elevated above the reference areas as well as background (Figure 5.3-11).

- Manganese concentrations at Sites 3/4 and 9 were considerably elevated above the other ecological study sites, reference areas, and background (Figure 5.3-11).

- Molybdenum concentrations varied little by site and were all at or below background (Figure 5.3-11).

- Nickel was elevated at all sites except Site 11 and Cobbsfork reference area with respect to background. Sites 3/4 and 9 had the highest nickel values (Figure 5.3-11).

- Antimony concentrations were all near or below background at all reference areas and ecological study locations (Figure 5.3-12).

- Selenium was only slightly above background at Site 39. Selenium at all other reference areas and ecological study locations was below background (Figure 5.3-12).

- Vanadium concentrations at Sites 3/4, 39, 9, Avonburg, and Rossmoyne all exceeded background and were below background at Sites 11, 14/15, and 25 (Figure 5.3-12).

- At Sites 3/4 and 9, zinc was elevated above background and the reference areas. Zinc concentrations at Cobbsfork and Site 11 were below background (Figure 5.3-12).

- Silver, mercury, tin, and boron were not detected in the JPG Phase II background; therefore, concentration graphs for these analytes were not included.

Graphical interpretation of risk results was used for evaluation of risks by receptor and location (see Sections 7.7, 8.7, 10.7, 12.7, 17.7, 18.7, 20.7, 22.7, 31, and 32).

5.3.3.2.3 Exposure Intakes. The lower of the values for maximum or the upper 95 percent confidence limits on the arithmetic mean (UCL95) was used to represent the EPC. Use of the UCL95 implies that 95 percent of the time, the mean concentration will fall below this value (ASTM 1994). If the UCL95 exceeds the maximum detected value at a site for a particular analyte, the maximum value is the more appropriate statistic from which to represent the EPC.

The EPCs in each media were calculated and used to obtain daily exposure intakes from the equations 5.3-5 through 5.3-7, and the receptor-specific equations in Appendix DD. Daily exposure intakes for each chemical were estimated by multiplying the daily media ingestion rate for a given receptor by the EPC in the same media.

In order to estimate dietary intakes for ecological receptors, literature uptake values were used to derive estimated COPC concentrations in food items because there were no site-specific biota tissue data. Therefore, soil, surface water, and sediment data were used in conjunction with BAFs or BCFs taken from the literature to derive these dietary concentrations.

Both the CT and RME intake scenarios were calculated for the key receptors. To evaluate the CT exposure scenario, average exposure parameters were used. The RME exposure scenario, which is more conservative, applied the 95th percentile exposure parameters. Appendix DD presents more specific information on how the dietary exposure pathway was addressed.

Exposure to volatile COPCs by inhalation was not evaluated since the vast majority of the COPCs are metals. Trichloroethylene was the only volatile COPC detected at Site 9 in the Phase I data. Fugitive dust is not considered a significant exposure medium due to the extensive vegetative cover and humidity at JPG.

During the exposure analysis process, it is necessary to consider exposure intensity, spatial occurrence, and duration. The primary product from this phase is the preparation of exposure and ecological effects profiles (i.e., stress-response profiles) for each receptor at each study location.

5.3.3.3 Ecological Effects Analysis. This step of the DERA focuses on the evaluation of ecological effects, such as mortality or changes in community structure, that can occur as a result of elevation of COPCs in the environment. Determining whether effects exist—and if they exist, whether they are due to Army-related activities—is the basis of the exposure and ecological effects profiles that result from this analysis.

5.3.3.3.1 Reference Area Selection. Data from reference areas are critical to the interpretation of risk, particularly when the COPCs are also naturally occurring, as is the case with inorganics. Reference area data were used to evaluate naturally occurring levels of inorganics in the environment, as well as to define natural variability in the ecological data (i.e., natural earthworm or plant mortality rates, natural soil fauna diversity). Reference area data serve to establish baseline conditions for biotic and abiotic parameters.

Reference area data were collected as part of the DERA work plan field activities; however, these data were not used as background data (i.e., for screening COPCs) but were carried through the risk characterization to demonstrate inherent risks. Because the reference area data were collected in an identical manner as the site data, including soil chemistry, pH, TOC, earthworm toxicity, plant toxicity, and soil fauna community structure, they allow the identification of natural variability both within and between JPG sites for each of these data types.

Terrestrial Ecosystem Reference Areas. Background locations established during the RI Phase II field work represented the three main soil types found at JPG (i.e., Avonburg, Cobbsfork, and Rossmoyne). As mentioned in Section 5.3.3 under Analysis Phase activities, three of these Phase II background locations were also selected as DERA reference areas. At each of these presumably unimpacted areas, soil samples for chemical analysis and biological data were collected during Phase III (Fall 1997) for comparison to the Phase II background results.

Aquatic Ecosystem Reference Area. **A presumably** ~~An~~ unimpacted section of Harberts Creek upstream of the Site 2/27 study area was chosen as the aquatic reference area~~.~~ **, the studies of which were intended to assess the impacts of the Sewage Treatment Plant near Harbert's Creek. (EPA190)** This **upstream** section of the stream was characterized and sampled in the same manner as the study area at the Sewage Treatment Plant to provide data for comparative analysis. The location of the reference site is provided in Section 7.7, Figure 7.7-2~~.~~ **The selection of the reference area was based on several factors**:

1. **It was necessary to select a reference area upgradient and presumable unimpacted by the Sewage Treatment Plant operations.**

2. **In order to conduct the rapid bioassessment protocol (RBP), sufficient stream flow was necessary. Other stream characteristics were also deemed important when considering a reference area such as depth, width, substrate, bank conditions, cover, presence of aquatic life, etc. It was deemed necessary to select a referece area ath had as much in common as practical with the study area. The choice of satisfactory areas was very limited espceially since the flow of Harbert's Creek is frequently reduced to all but occasional pools.**

3. **As offsite reference area was deemed inappropriate as contamination resulting from farming practices might well confound or obscure the results. JPG is surrounded by farming or highways on all sides. (EPA190)**

5.3.3.3.2 Terrestrial Field Studies to Support the DERA. Terrestrial field studies were conducted to provide data from which to analyze measures of effects (Table 5.3-19). Five sample locations each at Sites 3/4, 9, 11, 14/15, 25, and 39 were randomly selected by placing a grid over the site or groups of sites. These sample locations were in close proximity to previous soil sampling locations. Three reference locations corresponding to the three main soil types at JPG (i.e., Rossmoyne, Cobbsfork, and Avonburg) were also sampled at five grid locations. Each hole was hand excavated down to a maximum of 2 feet. The excavated soil was homogenized on clean polyethylene sheeting and used for the following:

- *In-situ* earthworm toxicity testing

- Plant toxicity testing
- Chemical analysis for metals, pH, and organic matter content
- Identification of soil fauna and relative abundance

All studies were co-located with one another within each study area and sampling location.

In-Situ Earthworm Toxicity Testing. Earthworm toxicity testing commenced on Tuesday, September 16, 1997 at Site 9 and ended on September 26, 1997 with Sites 3 and 4. Worms were purchased at Wholesale Bait Co., Hamilton, Ohio, enroute to JPG and kept cool in their original packing containers. Twenty earthworms (*Lumbricus* spp) were placed on top of soil excavated from 5 locations at each DERA site according to the DERA Work Plan (Rust E&I 1998). Disposable, powderless, nitrile gloves were used when preparing each bucket. The worms were counted twice and verified by another field team member. For each worm bucket, the excavated soil was placed in a new five-gallon plastic bucket with numerous holes drilled on the bottom. During excavation, the soil for each bucket was placed on a clean, plastic sheet and homogenized prior to placing into bucket. The soil in each bucket was first moistened with 24 ounces of deionized water added in increments while filling each bucket. Each worm was gently washed with deionized water prior to placing in the bucket. The bucket was returned to the excavated hole with the lid in place on top of wooden lath. Holes were also drilled in the lid as shown in DERA Work Plan (Rust E&I 1998). Each bucket was checked every other day (since weather was humid and mild) to see if adequate moisture was present. If necessary, 4 ounces of deionized water were sprinkled on top of the soil. The worms were harvested after 1 week. At the time of harvest, the contents of each bucket were spread out on a clean plastic sheet. As during bucket preparation, powderless, disposable, nitrile gloves were used for each bucket and disposed of between each bucket harvest. The worms were then counted as to whether alive or dead. In one case, there were more worms than were originally placed in the container due to reproduction (Location, #16, Rossmoyne). As before, the number of worms was counted twice and verified by another field team member. Other smaller, pink and reddish-colored worms were also observed but since these were not associated with the original worms, they were not included in the official counts. Photos were taken of each container with the lid removed during the week of toxicity testing although there was nothing significant observed.

In-situ earthworm toxicity tests were conducted at each of the five sampling locations within each study area. Mortality within a 7-day period was recorded and compared to mortality observed at the reference locations. The number of earthworms dead or missing divided by the total number placed in the container at the start of the test was used as the estimate of proportional mortality. According to Zar (1984), it is preferable to test proportions by contingency table analysis. Thus, a Chi-square (χ^2) test was used to determine if mortality differed significantly between the reference areas and the ecological study sites. However,

traditional multisample statistical procedures can be applied if the data are transformed with an arcsine transformation, and then the mean of each set of proportions is evaluated (Zar 1984). Therefore, mortality data were transformed and analyzed by ANOVA by location. Means that were significantly different were identified with a multiple range test. Scatter plots and linear regression were also used to look for trends in the mortality data relative to soil concentrations of each COPC in order to detect dose-response relationships. Only weak relationships were observed between earthworm mortality and any given individual COPC. -The strongest relationship was an r^2 of 23.8 percent for mortality compared to the log-transformed manganese concentration. Earthworm mortality did not significantly exceed the upper range of mortality observed at the reference sites. Earthworm mortality data are summarized in Table 5.3-19a. **(EPA191)** -These results strongly suggest that metals are not influencing earthworm mortality at JPG.

Plant Toxicity Testing. Soil for plant toxicity testing was collected at the same locations as the soil collected for the earthworm toxicity tests. Phytotoxicity tests can be used to verify the results of the risk assessment, as well as elucidate if physical disturbance or grazing rather than chemical contamination are responsible for observed changes in habitat structure.

Five soil samples were collected, as noted above, from within each of the on-site and reference area locations. By collecting five samples from each study area and three reference areas, estimates of within-location and between-location variability may be obtained. Approximately 2 kilograms of soil were sent to Ecological Planning and Toxicology, Inc. (EPT) for testing, where a plant toxicity test with perennial rye grass was conducted in the pure (0% dilution) soil samples.

The plant phytotoxicity data were evaluated to determine if metal concentrations in soil were sufficiently elevated such that plant community structure might be negatively altered. In addition, the plant phytotoxicity data from each of the study areas were statistically evaluated using ANOVA to determine if significant differences existed within or between locations. ANOVA was applied to the percent germination and the biomass data followed by a multiple range test to isolate the different effects.

Scatter plots and linear regression were also used to look for trends in the phytotoxicity data relative to soil concentrations of each COPC in order to detect dose-response relationships. Only weak relationships were observed between plant biomass and any given individual COPC. The strongest relationship for effects on biomass was an r^2 of 20.0 percent compared to the beryllium concentration in soil. The strongest relationship for effects on germination was an r^2 of 51.6 percent for barium in soil and an r^2 of 64.7 percent for TOC. These results strongly suggest that metals are not influencing plant biomass at JPG; however, barium and TOC may be adversely affecting % germination.

Soil Sample Collection for Chemical Analysis. Soil samples were collected at the same locations as the earthworm and plant phytotoxicity locations. Approximately 250 grams of the excavated soil were sent to DataChem Laboratories for analysis of metals and cyanide (as per the JPG Inorganic Target Analyte List (Table 5.3-20)), pH, and percent organic matter. QC samples associated with the data collection area are shown in Table 5.3-21. Both pH and organic matter are important parameters when interpreting earthworm and plant toxicity data. **For a given site, if analytes were detected above reference concentrations, the ranges of pH and TOC at that site were compared to reference area pH and TOC measurements. Refer to the specific site sections for these comparisons. (EPA192)**

Soil Fauna Identification. The same locations sampled for earthworm toxicity, plant toxicity, and soil chemistry were used to evaluate study area soils for soil fauna communities. Soil fauna samples were sent to Commonwealth Technology, Inc. (CTI) and identified to the lowest taxonomic level possible. Diversity was calculated with the Shannon-Wiener index (Brower and Zar 1977). ANOVA was used to sort out the differences in community response, soil chemistry, soil type, and location.

Species diversity calculated with the Shannon-Wiener index considers the number of species, the number of individuals, and the proportion of the total that occurs for each species. The index is appropriate when the data are a random sample from the community. The equation for the diversity index is:

$$H' = - H' = -\sum p_i \log p_i \qquad \text{(Equation 5.3-8)}$$

where

p_i = proportion of total individuals occurring in species *I*

Invertebrate density and diversity and number of species were compared by site location to see if there were any effects of site location on these metrics. Comparisons included one-way ANOVA and Kruskal-Wallis. No significant differences by location were observed. The invertebrate data were log-transformed and again evaluated for significant differences, and none were apparent. These results suggest that soil fauna community structure is not being adversely affected at JPG.

5.3.3.3.3 Aquatic Field Studies to Support the DERA. To assess the impacts of Sites 2/27 (Sewage Treatment Plant Outfall) on Harberts Creek, surveys of the fish and macroinvertebrate populations and adjacent habitats were conducted September 15-18, 1997. Both surveys were used to evaluate the overall conditions of Harberts Creek.

Benthic macroinvertebrates, in particular, are well-suited because they are found in most aquatic habitats, are large enough to collect easily, have a limited migration pattern, and have a sessile mode of life that is appropriate for assessing site-specific conditions. Fish are also an important component of the survey, and the fish community structure can be used to

evaluate water quality. In particular, fish are good indicators of long-term effects and broad habitat conditions because they are relatively long-lived, mobile, and a variety of trophic levels can be assessed.

The evaluation followed the RBP III (*Rapid Bioassessment Protocols for Use in Streams and Rivers: Benthic Macroinvertebrates and Fish* (EPA/440/4-89/001 May 1989d) for benthic macroinvertebrates, and the fish population survey was conducted using a modified RBP Level V. Completed field data forms (FDFs) are included as Appendix EE. A description of the procedure used for the aquatic field study sampling is also provided in Appendix EE. The results of the aquatic sampling activities at Harberts Creek are summarized in Section 7.7 for Sites 2/27.

Aquatic field studies at Harberts Creek were suggested in both the first draft of the DERA work plan (Rust E&I 1996d) and the final DERA work plan (Rust E&I 1998). These studies were proposed to address regulatory agency comments and to verify observations made by Dr. Daryl Karns from Hanover College in 1993 (Karns 1993) regarding Harberts Creek as being depauparate in certain species richness and abundance compared to other sites. The field studies were designed to measure differences in fish, benthic invertebrates, and habitat in relation to the Sewage Treatment Plant, which may impact Harberts Creek.

Aquatic Macroinvertebrate Sampling of Harberts Creek. An evaluation of Harberts Creek was necessary to provide an indication of the surface water and sediment quality, and to discern the value of the riparian habitat to many JPG receptors which utilize this water source. Comparison of the Harberts Creek data to a stream segment that is presumed to be unimpacted by site-related activities helps to link potential effects to measures of exposure and helps in the prediction of potential risks and effects to ecological receptors associated with this area.

Stream sampling was conducted in Harberts Creek at a presumably impacted area, and along another steam segment upgradient of the Sewage Treatment Plant, which was presumably unimpacted by site-related activities. The sampling effort consisted of three stream locations each in Harberts Creek adjacent to the Sewage Treatment Plant and a nearby upstream location. Benthic macroinvertebrate samples were collected using a kick net. Samples were stored in glass bottles, chilled, and sent to CTI laboratory for microscopic identification of macroinvertebrates. Microscopic evaluation included relative numbers and identification to the lowest possible taxonomic level. The reference area was compared to the study area to determine if there are differences in community structure.

CTI laboratory sorted and identified all aquatic macroinvertebrate samples. Taxonomic identifications were made to the lowest possible level. Taxa richness and total number of individuals were documented for the sample locations. To assess if conditions are similar between locations, the metrics specified in the USEPA guidance (USEPA 1989d) for RBP III were utilized. These metrics included species richness, modified Hisenhoff Biotic Index

(HBI), ratio of scraper and filtering collector functional feeding groups, ratio of EPT (Ephemeroptera, Plecoptera, Trichoptera) and Chironomidae abundances, percent contribution of dominant taxon, EPT index, community loss index, the ratio of shredder functional feeding group to all other functional groups, and total number of individuals collected.

As identified in the DERA Work Plan (Rust E&I 1998), diversity was to be calculated using the Shannon-Weiner index, and community similarity using the Jaccard Coefficient. These evaluations are not included in this report as they were deemed unnecessary following review of the overall risk assessment results.

Fish Surveys. The fish sampling methods were designed to give a realistic sample of fishes likely to occur in the stream and their relative abundance. Fish were sampled using a backpack electrofisher and block net (if there was no natural barrier between stream segments). To ensure standardization of fish community data, the entire stream segment was sampled to adequately sample species and their relative abundance.

Data were recorded on the Fish Collection FDF (Appendix EE). Information gathered included identification of individuals to species and number of each species. Fish were recorded and identified in the field and released. The Index of Biotic Integrity (IBI) (modified from Karr J.R. 1991; Miller and Levy 1993) was used to compare the fish community in Harberts Creek at Sites 2/27 to the upstream reference location. The IBI serves as an integrated analysis because individual metrics may differ in their relative sensitivities to various levels of biological condition. There are 12 components in the IBI metric: total number of fish species; darter species, sunfish species, sucker species, intolerant species, and tolerant species; proportion of individuals as omnivores; proportion of individuals as insectivores; proportion of individuals as top carnivores; number of individuals in sample; proportion of individuals as hybrids; and proportion of individuals with disease, tumors, fin damage, and skeletal anomalies.

Two stream sample locations, each consisting of three sampling segments, were used to assess the condition of Harberts Creek. Location No. 1 is the area adjacent to Sites 2/27 as shown in Figure 7.7-1 (Section 7.7). Location No. 2, located on an upstream portion of Harberts Creek as shown on Figure 7.7-2 (Section 7.7), served as a reference location. Within each location, the three sampling segments consisted of a stream reach of approximately 150 meters each.

Macroinvertebrates and fish were sampled within each of these segments. Where needed, block nets were used at the ends of the stream reach to increase fish sampling efficiency.

Rapid Bioassessment Protocol. The rapid bioassessment protocol (RBP) was conducted at the same location as the stream macroinvertebrate sampling and was similar to RPB III (USEPA 1989d). The RBP is an overall aquatic habitat assessment that evaluates habitat

quality by comparing measures of water quality/physical characteristics and biosurveys to the biotic potential of a site. In addition to the Harberts Creek stream segment adjacent to the Sewage Treatment Plant (Sites 2/27), the RBP was performed at the unimpacted upstream reference location. This aids in determining if population differences are related to contaminant concentrations or to differences in habitat quality. During the stream evaluation, stream width, depth, flow rate, temperature, dissolved oxygen, pH, conductivity, and turbidity were recorded at each sampling location. The RBP results in an index that can be compared from one location to another.

Aquatic Habitat Evaluation. Aquatic habitat evaluation included water quality analysis and general land use and physical stream characteristics documentation. Water quality parameters tested in the field included: pH, dissolved oxygen, specific conductance, temperature, and turbidity. General land use and stream characteristics documented included physical features such as stream flow, cover, habitat, and riparian vegetation.

The water quality data and the general land use and physical stream characteristics data were used to conduct a Habitat Quality Assessment (HQA) of Harberts Creek at Site 2 and at an upstream reference location. A comparison was then made between the two locations to determine potential site impacts. The HQA followed the RBP III and included a habitat assessment matrix that resulted in a habitat rating of excellent, good, fair, or poor.

5.3.3.4 Site-by-Site Exposure and Ecological Effects Profiles. The exposure analysis results in exposure intakes for each COPC. Exposure intakes (mg/kg bw/day) were estimated for each receptor as appropriate, and for each COPC for each reference area, study area, and DERA site. Exposure intakes were not calculated for certain receptors such as plants and invertebrates, for which exposure was quantified for direct contact pathways only. The exposure parameters and exposure equations were presented in Sections 5.3.2.5.2 and 5.3.2.5.3. Each exposure profile contains a brief discussion of the comparison of site data to background and to the reference areas.

The ecological analysis results in site-by-site exposure and ecological effects profiles (sometimes referred to as “stress-response profiles”) (Sections 7.7, 8.7, 10.7, 12.7, 17.7, 18.7, 20.7, 22.7, 31, and 32). These sections summarize the statistical analyses of the data and the risk assessment results.

The results of the measures of effects were used to evaluate possible ecological responses. The field data collected under the DERA were evaluated statistically to determine if significant differences between site and reference areas exist. The goal was to obtain evidence to link population effects to chemical exposure. The likelihood of deleterious impacts to site receptors was assessed.

The field data collected for the DERA, including toxicity test data, aquatic data, soil pH, and percent organic matter, were evaluated with respect to the sample analytical data as a means to correlate exposure with ecological effects. By selecting sampling or survey locations in areas of known contamination (as judged by results of the PERA), there is a high likelihood that adverse responses, if present, can be measured.

5.3.4 Risk Characterization

The three main components of the risk characterization phase of an ERA are (1) risk estimation, (2) risk description, and (3) an uncertainty analysis. The risk characterization weighs the results of the exposure analysis and ecological response analysis to obtain HQs. The HQs are summed as appropriate to obtain HIs.

HIs or HQs exceeding 1 for an ecological receptor may indicate the potential for risk. The HQs and HIs from the reference areas provide a measure of inherent risk. High levels of naturally occurring inorganics result in high indices of inherent risk. HIs for ~~JPG~~ DERA sites **representative of JPG exposure (EPA194)** were compared to HIs calculated from reference areas. The ratio of the HIs between JPG sites and reference areas is a measure of the relative risk. **These data were used as lines of evidence in the appropriate risk characterization sections. (EPA194)** This indicates the proportion of risk due to Army-related activities. The additional field data collected under the DERA work plan constitute additional lines of evidence with which to describe and estimate risk.

5.3.4.1 Risk Estimation. The risk estimation step integrates the results of the exposure and ecological analysis phases. Risk estimates may be obtained through several approaches, which include development of HQs, analysis of the biological survey data, and evaluation of the toxicity test results to obtain stress-response or dose-response profiles.

The exposure intakes for key wildlife receptors were divided by the literature-based TRVs to obtain an HQ:

$$HQ = \frac{Exposure\ Intake\ (mg/kg\ bw/day)}{TRV\ (mg/kg\ bw/day)} \qquad \text{(Equation 5.3-9)}$$

The EPCs for COPCs in soil at each JPG site were compared directly to the corresponding TRVs for plants and terrestrial invertebrates (i.e, direct contact pathways), rather than calculating daily intakes. Most of the toxicological information for these taxa are in units of mass chemical per mass soil or growth medium. In addition, information that could be used to calculate the dietary ingestion rates for invertebrates is largely lacking in the literature reviewed. The EPCs for sediment and surface water were compared to the AWQC and the SQC to obtain HQs for aquatic life. The AWQC and SQC are protective of most of the species expected in the aquatic ecosystem and are not species-specific TRVs. Therefore, one risk

estimate was made that applies to all key aquatic receptors (i.e., benthic invertebrates, pickerel frog, and creek chub). Subsequently, risk estimates for both the RME and CT exposure scenarios for these receptors would produce the same results.

The EPC for surface water was divided by the AWQC to obtain an HQ to address direct contact with surface water for aquatic life, including plants, invertebrates, and fish:

$$HQ = \frac{EPC_{surface\ water}\ (\mu g/L)}{AWQC\ (\mu g/L)} \qquad \text{(Equation 5.3-10)}$$

The EPC for sediment was divided by the SQC to obtain an HQ to address direct contact with sediment for aquatic life, including plants, invertebrates, and fish:

$$HQ = \frac{EPC_{sediment}\ (\mu g/g)}{SQC\ (\mu g/g)} \qquad \text{(Equation 5.3-11)}$$

The EPC for soil was divided by the TRV for plants or invertebrates to obtain an HQ for each COPC as follows:

$$HQ = \frac{EPC_{soil}\ (mg/kg)}{TRV\ (mg/kg)} \qquad \text{(Equation 5.3-12)}$$

HIs were calculated by summing all of the HQs as appropriate for each of the exposure pathways as shown in Equation 5.3-13:

(Equation 5.3-13)

$$HI_{total} = \Sigma\ (HQ_{soil\ ingestion} + HQ_{dietary\ ingestion} + HQ_{surface\ water\ ingestion} + HQ_{sediment\ ingestion} + \ldots\ldots HQ_n)$$

A total HI (HITOTAL) was calculated by summation of HQs across all chemicals to facilitate comparison of one site to another. However, since all of the toxicological effects are not additive, it is recommended that risk decisions be made on the HQ and HI and not the HI_{TOTAL}.

5.3.4.1.1 Lines of Evidence. Supporting information that serves to strengthen the conclusions about risk are referred to as lines of evidence (USEPA 1997a). In some cases, the lines of evidence based on site data may refute the risk conclusions from literature-based toxicity studies; however, these data are site-specific and therefore less uncertain, and are clearly identified. The lines of evidence available for the DERA include the following:

- Phytotoxicity test results

- Earthworm toxicity test results

- Assessment of potential impacts on soil fauna community structure

- Risk estimates comparing estimated exposure to literature-based toxicity values (HQs and HIs)

- Rapid Bioassessment Protocol results

- Benthic community biometrics and fish counts

5.3.4.2 Risk Description. The risk description serves to document the threshold of contaminant levels that may affect the assessment endpoints. The lower bound was based on the literature-derived NOAEL TRVs combined with RME intake estimates. These are typically the most conservative of all estimates. The upper bound was based on potential or observed impacts such as LOAEL-based toxicity values combined with an RME intake estimate. The CT exposure scenario can be used to profile the risk estimates.

5.3.4.3 Uncertainty Analysis. The UA is performed on the assumptions and data that comprise the DERA. The UA highlights areas of the DERA that are uncertain, and the potential impact that this has on the results. This process strengthens the DERA conclusions and aids in the formulation of recommendations for risk management decisions.

The current USEPA Superfund guidance (USEPA 1997a) addresses uncertainty in the risk characterization. It is acknowledged that the ERA process is an uncertain one, and the purpose of evaluating risk is not to eliminate risk but to identify uncertainty in the process to the extent possible (USEPA 1997a). The four major sources of uncertainty addressed in the DERA include:

- Uncertainty in the conceptual site model

- Natural variation in field data and soil chemistry

- Uncertainty in the exposure model and parameters

- Uncertainty in the sampling process and analytical methodology

Uncertainty in the DERA is addressed both qualitatively and quantitatively. There are two general approaches to tracking uncertainty quantitatively. The first is to develop point estimates for each exposure parameter and toxicity value, and to obtain a point estimate for

the HQ and HI. By using different sets of exposure parameters (i.e., average (CTE) or conservative (RME)) and toxicity values (i.e., NOAEL and LOAEL), the bounds of uncertainty of the risk estimates can be defined. The second approach is to perform a distributional analysis so that a distribution of the risks can be obtained.

5.3.4.3.1 Quantitative Uncertainty Analysis. A quantitative uncertainty analysis was performed using Crystal Ball© for the mourning dove, chimney swift, white-footed mouse, and eastern cottontail. These receptors were selected since they had the highest risk estimates for the Phase III data. The UA was performed by varying each of the exposure parameters DIR and SFD based on information presented in Appendix DD. Since DIR is expressed as a ratio to body weight, varying DIR also accounts for the uncertainty in body weight. In general, each exposure parameter was defined as a triangular distribution, with a minimum and maximum from the available data, and a most likely estimated midway between the two. The mouse SFD was reported as < 0.02. This was therefore used as the maximum with a value ½ the maximum as the most likely estimate, and a value ½ the most likely estimate as the minimum. The Monte Carlo assumptions are provided in Appendix DD. This gives a distribution ~~conservatively~~ **(EPA121)** skewed high. The SFD for birds (mourning dove, chimney swift) were very limited, and consisted of a single value (Appendix DD). The uncertainty in this estimate was assumed to be a factor of 2.

The parameters TRV and BAF were held at fixed values so the true uncertainty would actually be higher. However, since the NOAEL TRV was ~~conservatively~~ **(EPA121)**selected to represent toxicity, it was considered more appropriate to fix this value.

The mourning dove, chimney swift, and eastern cottontail each occupy one feeding guild (i.e., herbivore or insectivore). The mouse, however, is omnivorous. The fraction of plants relative to invertebrates was allowed to vary. Plant fraction in diet (PFD) and invertebrate fraction in diet (IFD) were assumed to be normally distributed with a mean of 0.5 and standard deviation of 10 percent of the mean (Appendix DD).

The Monte Carlo simulation was performed on the PRG equations for the above four receptors. A total of 1,000 trials ~~was~~were analyzed. In the simulation, each assumption was allowed to vary within the bounds of its distribution. A random number from within each distribution is inserted into the assumption cell, and the equation recalculated a new PRG given the values for the assumption. With each trial, new values are assigned to the assumptions. The resulting PRGs thus vary due to the uncertainty in the underlying parameters, resulting in a mean and standard deviation range of values that follow a frequency distribution.

Table 5.3-22 presents the summary statistics for each inorganic analyte for each receptor. The range mean is the measure of central tendency for the estimate of the PRG. Coefficients of variability and indication of variance relative to the magnitude of the mean are fairly tight and

range from 0.02 to 0.31. This indicates that these PRG estimates would be useful in estimating risk-based cleanup goals for ecological receptors. The range maxima need to be considered when determining if a site concentration truly exceeds a PRG since the range maximum is the highest value that would be expected given that the exposure parameters are naturally variable. For example, although a mean chimney swift PRG would be 166.97 mg/kg for nickel, the true NOAEL PRG could be as high as 278.84 mg/kg. Site values falling within the range should not be considered to be in exceedance of the PRG and would not trigger a remedial response.

5.3.4.3.2 Uncertainty in Sampling Process and Analytical Methodology. There is uncertainty in any sampling methodology. Laboratory QC samples associated with the analytical methods help to reduce uncertainty in the data. High MDLs associated with some analytical methods and matrix interferences may result in nondetects (i.e., false negatives). However, use of 1/2 the detection limit for nondetects in calculating the EPCs helps to minimize the likelihood of underestimating risk since the 1/2 the detection limit is also high. Furthermore, with the additional UFs incorporated in the final TRVs, the majority of the TRV-detection-limit comparisons were sufficiently low as to be protective of ecological receptors. This fact helps to minimize the likelihood of underestimating risks.

Because adverse effects on populations are difficult to measure directly with one season of ecological field sampling, the analytical data for soil, surface water, and sediment were used in conjunction with toxicity information from the literature to predict the presence of adverse effects. Therefore, the data quality objectives for the ecological risk assessment must address the following question:

- Were the analytical detection limits low enough to be ecotoxicologically relevant (i.e., to be protective of ecological receptors with respect to TRVs)?

The soil samples collected during Phase I were analyzed by the Army USATHAMA methods. Following discussions with the regulators over the concern that detection limits were not sufficiently low using Army methods, samples collected under Phase II and III were analyzed by USEPA methods with the same detection limits.

In order to determine whether the analytical detection limits were sufficiently low for risk assessment purposes, the CRL or MDL in the appropriate concentration units was multiplied by the appropriate dietary ingestion rate (i.e., soil) and compared to the corresponding TRV in terms of a "comparison value". The comparison value ("comp value") must be less than (or "pass") the TRV for the detection limit to be acceptable. For the purposes of this draft report, only the soil ingestion pathway was evaluated with respect to detection limits. The amount of surface water and sediment data is very limited for the JPG DERA.

Detection limits compared to TRVs are presented as tables in Appendix DD. These tables summarize the evaluation of detection limits relative to TRVs for soil ingestion. The detection

limits were sufficiently low if a "yes" appears in the "DL Pass" column for each table. Due to the very limited amount of organic data, and the fact that no organic analytes appear as risk drivers, detection limits for organics were not evaluated.

Where TRVs or analytical data were available, soil detection limits were met for all receptors with the following exceptions:

- Phase I
  - Arsenic—White-footed mouse, eastern cottontail
  - Molybdenum—White-footed mouse
  - Thallium—All terrestrial wildlife receptors
  - Tin—White-footed mouse, eastern cottontail, red fox, little brown myotis
  - Vanadium—Mourning dove, chimney swift, American kestrel, red fox, little brown myotis

- Phase II and Phase III
  - Tin—White-footed mouse, eastern cottontail, red fox, little brown myotis
  - Vanadium—Mourning dove, chimney swift, American kestrel, red fox, little brown myotis

The lack of antimony data associated with sites addressed under the DERA may underestimate ecological risks for sites that have not already been remediated through soil removal or capping; however, the underestimation is expected to be low. The nondetects in the Phase I antimony results were at 19.6 mg/kg. The ecological soil screening level (Eco-SSL) for antimony for mammalian herbivores propsed by the U.S. EPA (2000) is 120 mg/kg. For mammalian ground insectivores (e.g., shrews), the proposed Eco-SSL is 21 mg/kg, and for mammalian carnivores (e.g., weasel), the Eco-SSL is 1,100 mg/kg. The Eco-SSLs are above the non-detect level. EPA has not promulgated Eco-SSLs for soil invertebrates, plants, or avian species.(EPA99-105)

5.3.4.4 Estimating PRGs for JPG. The risk assessment uses exposure equations to produce quantitative estimates of risk. If the risk is fixed at some negligible level (e.g., an HQ of 1), and the equations are rearranged to solve for the EPC, a risk-based concentration (RBC) in soil is obtained for each COPC. The RBC represents the soil concentration of some COPC that corresponds to the desired risk level. Appendix DD presents both the equations for risk estimation and the equations used to generate an RBC for each receptor. The DERA RBCs can be used in conjunction with other RBCs, such as those from the human health risk assessment, in order to set PRGs for JPG.

DERA RBCs. Table 5.3-23 presents the DERA RBCs for soil for each terrestrial receptor. These were estimated using the conservative RME exposure parameters, the TRV NOAEL, and the receptor specific equations in Appendix DD. A minimum RBC was estimated from

the RBCs for each of the upper trophic level (UTL) receptors that would be protective of all of the assessment endpoints identified in Table 5.3-19. This minimum UTL RBC is reported in Table 1. A minimum RBC was developed from the RBCs for the lower trophic level (LTL) receptors (i.e., plants and soil fauna) that serve as prey, forage, or habitat for the UTL assessment endpoints (Table 5.3-24).

Because each of the exposure parameters has inherent variability, a quantitative uncertainty analysis (Section 5.3.4.3.1) was performed on the four UTL receptors for which risk was the highest in order to estimate an expected range around the terrestrial RBCs for these receptors (Table 5.3-22). The uncertainty analysis reports the range that the RBC can fall within, from the range minimum to the range maximum, just on the basis of variation in the underlying exposure parameters.

In addition, site-specific RBCs were developed from the biological data collected during Phase III. The biological data were evaluated statistically to determine if there were any adverse effects on any of the measured endpoints or biometrics that could be linked to soil metal concentrations. The measured endpoints or biometrics were plant germination, biomass, earthworm mortality, and soil fauna density, diversity, and species number. Each of these biometrics was compared by site location (One-Way ANOVA) to determine if site location significantly influenced the biometric. Each of the biometrics was also compared to the concentrations of each COPC in soil (One-Way ANOVA and visual comparison of means and 95% confidence intervals) to look for potential adverse effects that could be associated with soil COPC concentration. Table 5.3-25 presents the RBCs for the LTL receptors generated from the Phase III biological data.

The minimum site-specific RBC for LTL species was compared to the minimum LTL RBC based on toxicological literature to determine the most appropriate RBC to represent the LTL species. With the exception of barium and TOC relative to percent plant germination, no adverse effects were noted on any of the JPG biometrics at any of the measured soil concentrations of any COPCs. Thus, when the RBC based on site data exceeded the RBC based on the toxicological literature, the site-specific RBC was chosen as best representing toxicity to the LTL receptors. When the RBC based on the toxicological literature was higher than that based on the site data, it was selected as the basis of establishing the RBC on the assumption that maximum site concentrations never approached the toxicological threshold. In essence then, the maximum of the site-specific or literature-based RBC was chosen to represent the LTL RBC.

The LTL RBC was then compared to the UTL RBC, and the lowest value selected as best representing the ERA RBC. This RBC is conservative in that the most sensitive ecological receptor would be protected.

Human Health RBCs and 1998 PRGs. The human health risk assessment generated RBCs in a manner similar to that used for the ecological RBCs. The 1998 PRGs from USEPA Region 9 were also used as the basis of a comparison for human health values. These RBCs appear in Table 5.3-23. When the human health RBCs are lower than the ERA RBC, human health is the basis of any potential remediation. When the ERA RBC is lower, the ERA is driving the overall assessment of risk at any JPG site.

JPG Background. A recommended PRG –lower than background is not technically defensible, since this suggests that any remedial activities must clean up to below background concentrations. Therefore, Table 5.3-23 also presents the Phase II background values for each inorganic. Where the RBC recommended on the basis of protection of ecological or human health is below background, the background concentration is recommended as the basis of the PRG.

TABLES

TABLE 5-1

Sites Selected for the Risk Assessment
Jefferson Proving Ground
Madison, Indiana

Site No.	Site Name	Interim Remedial Action?	Proposed Interim Measures
1	Building 185 Incinerator	---	---
2	Sewage Treatment Plant and Water Quality Laboratory	---	---
3	Explosive Burning Area	---	Excavation and removal of surface soil; UXO[(a)] removal (if present).
4	Abandoned Landfill	Yes	Excavation/removal of soils and wastes within buried trench; UXO removal (if present).
5	Former Wood-Storage Pile	---	---
6	Wood-Burning Area	---	---
7	Red Lead Disposal Area	Yes	Excavation and removal of surface soil; removal of railroad track materials.
8	Building 295 Small Arms Firing Range	Yes	Removal of sand and soils from bullet traps inside range; cleaning of concrete and steel surfaces.
9	Burning Ground South of Gate 19 Landfill	---	---
10	Gate 19 Landfill	---	---
12A	Building 602 Solvent Pit	---	---
12B	Building 617 Solvent Pit	---	---
12C	Building 279 Solvent Pit	---	---
13	Old Fire Training Pit	---	---

TABLE 5-1

Sites Selected for the Risk Assessment
Jefferson Proving Ground
Madison, Indiana

Site No.	Site Name	Interim Remedial Action?	Proposed Interim Measures
14	Yellow Sulfur Disposal Area	Yes	Excavation/removal of surface and/or subsurface soils at discrete locations.
15	Burn Area South of New Incinerator	Yes	Excavation and removal of surface soil.
20B	Building 305 Temporary Waste Storage Area	---	---
21A	Building 204 Temporary Storage Area	---	---
21B	Building 211 Temporary Storage Area	---	---
25	Papermill Road Disposal Area	---	---
26	DRMO Storage Area and Possible Disposal Sites South of DRMO	Yes	Excavation and removal of surface soil.
27	Sewage Sludge Application Area	---	---
28	Gator Z Open Burn Area	Yes	Excavation and removal of surface soil; removal of debris and ash; UXO removal (if present).
29	Gator Z Mine Scrap Disposal Area	Yes	Temporary dewatering of former disposal pit; removal of exposed and/or buried scrap metal and debris from bottom of pit (if present).
30	Metal Pesticide Mixing Shed adjacent to Building 204	---	---
31	Building 227 Former Storage Pad	---	---
33	Building 333 New Incinerator	---	---
34	Building 136 Sandblasting Area	---	---
38	Northwest-Southeast Runway Flare Test Area	---	---

TABLE 5-1

Sites Selected for the Risk Assessment
Jefferson Proving Ground
Madison, Indiana

Site No.	Site Name	Interim Remedial Action?	Proposed Interim Measures
39	Gator Z Mine Test Area	---	---
42	Building 281 Indoor Range	Yes	Removal of sand and soils from bullet traps inside range; removal of soil from dirt floor at two firing lines; UXO removal (if present); cleaning of concrete and steel surfaces.

Footnotes:

(a) Unexploded ordnance.

TABLE 5-1a

Sites South of the Firing Line
Current/Likely Future Land Use
Jefferson Proving Ground
Madison, Indiana

Site No.	Site Name	Current/Likely Future Land Use
1	Building 185 Incinerator	Agriculture (current)or industrial in future
2	Building 177 Sewage Treatment Plant and Water Quality Laboratory	Industrial, mowed lawn
3	Explosive Burning Area	Agriculture (future) currently wooded
4	Abandoned Landfill	Agriculture (future) currently wooded
5	Wood Storage Pile	No further action (NFA), residential levels human health
6	Wood Burning Area	No further action, residential levels human health
7	Red Lead Disposal Area	Industrial
8	Small Arms Indoor Range	Industrial
9	Burning Ground South of Gate 19 Landfill	Wildlife refuge (north of firing line)
10	Gate 19 Landfill	Capped
11*	Burning Area for Explosive Residue	RCRA Part B
12A	Building 602 Solvent Pit	Industrial - currently occupied by workers
12B	Building 617 Solvent Pit	Industrial - currently occupied by workers
12C	Building 279 Solvent Pit	Industrial
13	Old Fire Training Pit	No further action, closed residential PRG
14	Yellow Sulfur Area	Agricultural
15	Burn Area South of New Incinerator	Industrial, agricultural
16*	Potential Ammo Dump Site	NFA
17*	Asbestos Containing Materials	NFA - No ecological
18*	Underground Storage Tanks	NFA - Taken out of RI

TABLE 5-1a

Sites South of the Firing Line
Current/Likely Future Land Use
Jefferson Proving Ground
Madison, Indiana

Site No.	Site Name	Current/Likely Future Land Use
19*	Off-Site Water Supply Wells	Transferred - Out of RI
20A*	Building 279 Temporary Waste Storage	Industrial
20B*	Building 305 Temporary Waste Storage	Industrial
21A	Building 204 Temporary Storage	Industrial
21B	Building 211 Temporary Storage	Industrial
22*	Building 216 Locomotive Maintenance Pit	Industrial
23*	Building 216 Potential Solvent Disposal Pit	Industrial
24*	Building 602 Soil Staging Area	Industrial
25	Paper Mill Road Disposal Area	Industrial
26	DRMO Storage Area	Agriculture
27	Sewage Sludge Application Area	Industrial
28	Gator Z Mine Open Burn Area	Ecological
29	Gator Z Mine Scrap Disposal	Ecological
30	Building 204 Pesticide Storage Area	Industrial
31	Building 227 Former Storage Pad	Industrial
32*	Building 105 Locomotive Maintenance Pit	Industrial
33	Building 333 New Incinerator	Industrial
34	Building 136 Sandblasting Area	Industrial
35*	Building 602 Former Leaking Underground Storage Tank	Industrial
36*	No. 2 Oil Spill at Building 103	Residential
37*	Gasoline Station, Building 118	Industrial
38	Northwest-Southeast Runway Test Area	Agricultural, residential, industrial

TABLE 5-1a

Sites South of the Firing Line
Current/Likely Future Land Use
Jefferson Proving Ground
Madison, Indiana

Site No.	Site Name	Current/Likely Future Land Use
39	Gator Z Mine Test Area	Ecological
40*	Discharge/Fill Pipe at Building 259	NFA
41*	Building 281 Fuel Oil from Former UST	NFA
42	Building 281 Indoor Range	NFA
43*	Possible USTs or Wells at Artillery and Infantry Roads	NFA
44*	Underground Concrete Vault near Airport Rail Tracks	NFA
45*	Possible UXO at the Airport	NFA
46*	Old Flare Test Sites (2) at South End Airport	NFA
47*	Wooded Area South of the Airport (possible test area)	NFA
48*	Ammunition Storage Igloos South of the Firing Line	NFA
49*	Explosive Ordnance South of the Firing Line	NFA
50*	Building 186 Wash Rack	NFA

General Note:

* = UST part of RI. Sites were recommended for NFA by the Phase I RI and therefore are not included in this Phase II RI.

TABLE 5-2

Summary of Soil Natural Background Threshold Values - Cobbsfork Series
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (mg/kg)[h]	Range of Nondetects[b] (mg/kg)	Average Concentration (mg/kg)	Standard Deviation (mg/kg)	Coefficient of Variation[c]	Site-specific Calculated Background Threshold[d] (mg/kg)
Aluminum	10/10	5,400 - 10,900	NA[e]	7,673	1,649	0.21	11,000
Antimony	9/10	0.31 - 0.42	1.0	0.38	0.06	0.15	0.49
Arsenic	10/10	3.27 - 9.46	NA	4.8	2.2	0.45	9.26
Barium	10/10	26.5 - 74.1	NA	49.8	17.3	0.35	84.5
Beryllium	10/10	0.12 - 0.45	NA	0.32	0.1	0.32	0.52
Boron	0/10	NA	10	NA	NA	NA	NA
Cadmium	0/10	NA	0.50	NA	NA	NA	NA
Calcium	10/10	130 - 681	NA	376	187	0.50	750
Chromium (total)	10/10	6.04 - 15.5	NA	9.7	2.7	0.27	15.1
Cobalt	10/10	0.8 - 3.6	NA	1.9	0.75	0.38	3.5
Copper	7/10	3.33 - 4.96	4.01 - 4.69	3.5	1.0	0.30	5.64
Iron	10/10	6,280 - 14,300	NA	8,798	3,010	0.34	14,800
Lead	10/10	12.3 - 14.6	NA	13.6	0.68	0.05	14.9
Magnesium	10/10	311 - 692	NA	469	116	0.25	700
Manganese	10/10	19.1 - 344	NA	115	94	0.82	302
Mercury	0/10	NA	0.10	NA	NA	NA	NA
Molybdenum	0/10	NA	10	NA	NA	NA	NA
Nickel	1/10	2.30	4.00 - 5.29	2.0[f]	0.1[f]	0.05[f]	2.23[f]

TABLE 5-2

Summary of Soil Natural Background Threshold Values - Cobbsfork Series
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (mg/kg)	Range of Nondetects[b] (mg/kg)	Average Concentration (mg/kg)	Standard Deviation (mg/kg)	Coefficient of Variation[c]	Site-specific Calculated Background Threshold[d] (mg/kg)
Potassium	10/10	170 - 766	NA	338	171	0.51	681
Selenium	5/10	0.35 - 0.66	0.50	0.40	0.17	0.44	0.74
Silver	0/10	NA	1.0	NA	NA	NA	NA
Sodium	10/10	25.4 - 56.9	NA	31.8	9.3	0.29	50.5
Thallium	1/10	0.43[g]	1.0	NA	NA	NA	0.43[g]
Tin	0/10	NA	10	NA	NA	NA	NA
Vanadium	10/10	15.6 - 27.6	NA	19.8	3.6	0.18	27.0
Zinc	10/10	10.3 - 18.5	NA	14.7	2.4	0.16	19.5

Footnotes:

(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Values presented are the detection limit(s) for that analyte. For analytes that were detected in all samples, the nondetects column does not apply.
(c) Standard deviation divided by the average concentration.
(d) Average concentration plus two times the standard deviation. Values presented rounded up to the number of decimal places in the values reported by the laboratory.
(e) Not applicable.
(f) One nondetection (i.e., ½ the detection limit) which exceeded the detected value was not used in the calculation of the background threshold.
(g) The single thallium detection was used as the background threshold value because all of the nondetections (½ of the detection limit) exceeded the single detection.
(h) Milligram per kilogram.

TABLE 5-3

Summary of Soil Natural Background Threshold Values - Avonburg Series
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (mg/kg) [f]	Range of Nondetects[b] (mg/kg)	Average Concentration (mg/kg)	Standard Deviation (mg/kg)	Coefficient of Variation[c]	Site-specific Calculated Background Threshold[d] (mg/kg)
Aluminum	5/5	5,610 - 14,900	NA[e]	8,626	3,982	0.46	16,600
Antimony	5/5	0.32 - 0.41	NA	0.37	0.03	0.09	0.44
Arsenic	5/5	3.90 - 5.84	NA	4.9	0.71	0.15	6.30
Barium	5/5	35.6 - 88.4	NA	50.5	22.3	0.44	95.0
Beryllium	5/5	0.26 - 0.45	NA	0.33	0.07	0.22	0.48
Boron	0/5	NA	10	NA	NA	NA	NA
Cadmium	0/5	NA	0.5	NA	NA	NA	NA
Calcium	5/5	145 - 511	NA	278	155	0.56	588
Chromium (total)	5/5	7.3 - 15.1	NA	11	3.5	0.32	18.0
Cobalt	5/5	2.4 - 4.8	NA	3.4	1.1	0.31	5.6
Copper	5/5	4.13 - 5.32	NA	4.7	0.49	0.10	5.71
Iron	5/5	8,350 - 11,300	NA	9,626	1,109	0.12	11,800
Lead	5/5	11.0 - 15.2	NA	12.7	1.7	0.14	16.2
Magnesium	5/5	395 - 890	NA	572	223	0.39	1,000
Manganese	5/5	245 - 668	NA	397	160	0.40	718

TABLE 5-3

Summary of Soil Natural Background Threshold Values - Avonburg Series
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[(a)]	Range of Detected Values (mg/kg)	Range of Nondetects[(b)] (mg/kg)	Average Concentration (mg/kg)	Standard Deviation (mg/kg)	Coefficient of Variation[(c)]	Site-specific Calculated Background Threshold[(d)] (mg/kg)
Mercury	0/5	NA	0.1	NA	NA	NA	NA
Molybdenum	0/5	NA	10	NA	NA	NA	NA
Nickel	3/5	3.40 - 5.77	4.00 - 5.42	3.5	1.4	0.41	6.31
Potassium	5/5	220 - 2,140	NA	704.2	827	1.17	2,360
Selenium	3/5	0.68 - 0.96	0.50	0.58	0.32	0.55	1.21
Silver	0/5	NA	1.0	NA	NA	NA	NA
Sodium	5/5	22 - 347	NA	93.2	142	1.5	377
Thallium	0/5	NA	1.0	NA	NA	NA	NA
Tin	0/5	NA	10	NA	NA	NA	NA
Vanadium	5/5	19.7 - 30.3	NA	23	4.3	0.19	31.7
Zinc	5/5	14.2 - 22.5	NA	17.3	3.3	0.19	23.9

Footnotes:

(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Values presented are the detection limit(s) for that analyte. For analytes that were detected in all samples, the nondetects column does not apply.
(c) Standard deviation divided by the average concentration.
(d) Average concentration plus two times the standard deviation. Values presented rounded up to the number of decimal places in the values reported by the laboratory.
(e) Not applicable.
(f) Milligram per kilogram.

TABLE 5-4

Summary of Soil Natural Background Threshold Values -Rossmoyne Series
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (mg/kg) [g]	Range of Nondetects[b] (mg/kg)	Average Concentration (mg/kg)	Standard Deviation (mg/kg)	Coefficient of Variation[c]	Site-specific Calculated Background Threshold[d] (mg/kg)
Aluminum	5/5	5,400 - 9,760	NA[e]	7,704	1,615	0.21	10,900
Antimony	4/5	0.32 - 0.64	1.0	0.52	0.12	0.23	0.76
Arsenic	5/5	4.00 - 6.82	NA	5.1	1.1	0.22	7.34
Barium	5/5	47.3 - 62.2	NA	53.4	6.2	0.12	66.0
Beryllium	5/5	0.29 - 0.38	NA	0.35	0.037	0.10	0.43
Boron	0/5	NA	10	NA	NA	NA	NA
Cadmium	3/5	0.18 - 0.53	0.50	0.34	0.16	0.47	0.67
Calcium	5/5	438 - 582	NA	505	66.8	0.13	639
Chromium (total)	5/5	10.5 - 14.2	NA	12.2	1.7	0.14	15.7
Cobalt	5/5	1.8 - 3.2	NA	2.7	0.55	0.21	3.8
Copper	3/5	4.83 - 6.50	5.12 - 5.18	4.3	1.7	0.4	7.70
Iron	5/5	8,760 - 12,400	NA	10,458	1,293	0.12	13,000
Lead	5/5	14.3 - 20.5	NA	16.5	2.5	0.15	21.5
Magnesium	5/5	568.5 - 716.3	NA	639	70	0.11	781.0

TABLE 5-4

Summary of Soil Natural Background Threshold Values -Rossmoyne Series
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[(a)]	Range of Detected Values (mg/kg)	Range of Nondetects[(b)] (mg/kg)	Average Concentration (mg/kg)	Standard Deviation (mg/kg)	Coefficient of Variation[(c)]	Site-specific Calculated Background Threshold[(d)] (mg/kg)
Manganese	5/5	72.9 - 234	NA	186	65	0.35	316
Mercury	0/5	NA	0.10	NA	NA	NA	NA
Molybdenum	2/5	1.3 - 2.2	10.0	1.8[(f)]	0.64[(f)]	0.36[(f)]	3.0[(f)]
Nickel	2/5	4.40 - 5.61	4.00 - 5.60	3.4	1.6	0.47	6.54
Potassium	5/5	360 - 568	NA	452	102	0.23	657
Selenium	4/5	0.46 - 0.73	0.50	0.51	0.17	0.34	0.85
Silver	0/5	NA	1.0	NA	NA	NA	NA
Sodium	5/5	31.8 - 41.1	NA	36	4.5	0.13	45.1
Thallium	1/5	0.43	1.0	NA	NA	NA	0.43[(f)]
Tin	0/5	NA	10	NA	NA	NA	NA
Vanadium	5/5	19.8 - 25.9	NA	22.6	2.3	0.10	27.2
Zinc	5/5	19.0 - 20.3	NA	19.4	0.53	0.03	20.5

Footnotes:

(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Values presented are the detection limit(s) for that analyte. For analytes that were detected in all samples, the nondetects column does not apply.
(c) Standard deviation divided by the average concentration.
(d) Average concentration plus two times the standard deviation. Values presented rounded up to the number of decimal places in the values reported by the laboratory.
(e) Not applicable.
(f) The single detect value is designated the background threshold value, since all nondetections (i.e., ½ the detection limit) exceed the detection.
(g) Milligram per kilogram.

TABLE 5-5

Summary of Groundwater Natural Background Threshold Values
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/L)[g]	Range of Nondetects[b] (µg/L)	Average Concentration (µg/L)	Standard Deviation (µg/L)	Coefficient of Variation[c]	Site-specific Calculated Background Threshold[d] (µg/L)
Aluminum, Total	4/4	19.4 - 443	NA[e]	166.7	193	1.16	553
Antimony, Total	0/4	NA	10.0	NA	NA	NA	NA
Arsenic, Total	1/4	2.57	5.0	2.5	0.04	0.02	2.60
Barium, Total	4/4	13.5 - 411	NA	127	191	1.5	509.3
Beryllium, Total	1/4	0.33	5.0	NA[e]	NA[e]	NA[e]	0.33[e]
Boron, Total	2/4	14.1 - 113.9	100	57.0	41.5	0.73	140
Cadmium, Total	1/4	2.70	5.0	2.55	0.10	0.04	2.75
Calcium, Total	4/4	76,825 - 91,437	NA	81,909	6,647	0.08	95,203
Chromium, Total	2/4	5.40 - 5.95	10.0	5.34	0.45	0.08	6.24
Cobalt, Total	0/4	NA	50.0	NA	NA	NA	NA
Copper, Total	0/4	NA	20.0	NA	NA	NA	NA
Iron, Total	4/4	52.8 - 915	NA	490	479	0.98	1,448
Lead, Total	1/4	1.66	3.0	1.54	0.08	0.05	1.71
Magnesium, Total	4/4	36,875 - 54,125	NA	46,894	8,426	0.18	63,746
Manganese, Total	4/4	25.7 - 208.3	NA	134.6	77.8	0.58	290
Mercury, Total	1/4	0.056	0.20	NA[f]	NA[f]	NA[f]	0.056[f]
Molybdenum, Total	2/4	6.38 - 8.10	100	7.24[f]	1.22[f]	0.17[f]	9.67[f]

TABLE 5-5

Summary of Groundwater Natural Background Threshold Values
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[(a)]	Range of Detected Values (µg/L)	Range of Nondetects[(b)] (µg/L)	Average Concentration (µg/L)	Standard Deviation (µg/L)	Coefficient of Variation[(c)]	Site-specific Calculated Background Threshold[(d)] (µg/L)
Nickel, Total	0/4	NA	40.0	NA	NA	NA	NA
Potassium, Total	4/4	157 - 2,703	NA	1,005	1,150	1.14	3,304
Selenium, Total	0/4	NA	5.0	NA	NA	NA	NA
Silver, Total	1/4	5.29	10.0	5.07	0.14	0.03	5.36
Sodium, Total	4/4	22,575 - 66,150	NA	45,838	20,575	0.45	86,987
Thallium, Total	0/4	NA	10.0	NA	NA	NA	NA
Tin, Total	4/4	43.9 - 51.3	NA	48.9	3.4	0.07	55.7
Vanadium, Total	1/4	2.89	50.0	NA[(f)]	NA[(f)]	NA[(f)]	2.89[(f)]
Zinc, Total	0/4	NA	20.0	NA	NA	NA	NA

Footnotes:

(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Values presented are the detection limit(s) for that analyte. For analytes that were detected in all samples, the nondetects column does not apply.
(c) Standard deviation divided by the average concentration.
(d) Average concentration plus two times the standard deviation. Values presented rounded up to the number of decimal places in the values reported by the laboratory.
(e) Not applicable.
(f) High detection limits (i.e., ½ of the detection limit) were not used in the calculation of the background threshold for this chemical.
(g) Microgram per liter.

TABLE 5-6

Summary of Surface Water Natural Background Threshold Values
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/L)[f]	Range of Nondetects[b] (µg/L)	Average Concentration (µg/L)	Standard Deviation (µg/L)	Coefficient of Variation[c]	Site-specific Calculated Background Threshold[d] (µg/L)
Arsenic, Total	1/6	3.0	1.0	0.92	1.0	1.1	3.0
Mercury, Total	6/6	0.22 - 0.27	NA[e]	0.236	0.018	0.08	0.27
Silver, Total	4/6	0.2 - 0.42	0.2	0.238	0.14	0.6	0.53

Footnotes:

(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Values presented are the detection limit(s) for that analyte. For analytes that were detected in all samples, the nondetects column does not apply.
(c) Standard deviation divided by the average concentration.
(d) Average concentration plus two times the standard deviation.
(e) Not applicable.
(f) Microgram per liter.

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TABLE 5-7

Summary of Sediment Natural Background Threshold Values
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/L)[f]	Range of Nondetects[b] (µg/L)	Average Concentration (µg/L)	Standard Deviation (µg/L)	Coefficient of Variation[c]	Site-specific Calculated Background Threshold[d] (µg/L)
Arsenic	6/6	1.8 - 11.0	NA[e]	6.13	3.8	0.62	13.7
Mercury	5/9	0.02 - 0.03	0.02 - 0.10	0.03	0.015	0.54	0.057

Footnotes:

(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Values presented are the detection limit(s) for that analyte. For analytes that were detected in all samples, the nondetects column does not apply.
(c) Standard deviation divided by the average concentration.
(d) Average concentration plus two times the standard deviation.
(e) Not applicable.
(f) Microgram per liter.

TABLE 5-8

Nutrient Screening Values
Jefferson Proving Ground
Madison, Indiana

		Nutrient Screening Value (ppm)	
Nutrient	**RDA[a] (mg/kg-d)[b]**	**Soil**	**Groundwater**
Calcium	14	1,000,000	510
Magnesium	5.7	1,000,000	200
Iron	0.26	70,000	9.4
Potassium	0.57	150,000	20
Sodium	20[c]	1,000,000	730

Footnotes:

(a) U.S. recommended daily allowance (USEPA 1994b).
(b) Milligrams per kilogram per day.
(c) See text.

TABLE 5-9

Summary of Receptors and Exposure Pathways Evaluated in the Human Health Risk Assessment
Jefferson Proving Ground
Madison, Indiana

		Exposure Pathway and Receptors						
Site	Potential Future Land Uses[a]	Inhalation of VOCs[b],[c],[d]	Inhalation of Fugitive Dust[c],[d]	Incidental Ingestion/ Dermal Contact with Soil[c]	Ingestion/Dermal Contact with Groundwater	Inhalation of Shower VOCs	Ingestion/Dermal Contact with Surface Water and Sediment[e]	Ingestion of Produce, Meat and Milk
Building 185 Incinerator (Site 1)	Leased for agricultural use; Residential lot; Hunting	Current: None Future: None (VOCs were not on the analytical parameter list)	Current: None (site is completely vegetated) Future: All receptors	Current: Sitewide trespasser Future: On-site resident; sitewide hunter	Current: None Future: None (no monitoring wells)	Current: None Future: None (no monitoring wells)	Current: None Future: On-site resident	Current: None Future: On-site resident; off-facility consumer of beef and milk
Sewage Treatment Plant (Site 2) and Sewage Sludge Application Area (Site 27)	Leased for agricultural use (Site 27 only); Residential lot; Hunting; Sewage Treatment Plant (Site 2 only`)	Current: None Future: None (VOCs were not on the analytical parameter list)	Current: None (site is completely vegetated) Future: All receptors	Current: Site-wide trespasser Future: On-site resident and on-site worker; site-wide hunter		Current: None Future: None (no monitoring wells)	Current: Site-wide trespasser Future: On-site resident; site-wide hunter (Harbert's Creek)	Current: None Future: On-site resident; off-facility consumer of beef, and milk
Explosives Burning Area (Site 3), Abandoned Landfill (Site 4), and adjacent New Burn Area	Leased for agricultural use; Residential lot; Hunting	Current: All receptors Future: All receptors	Current: None (site is completely vegetated) Future: All receptors	Current: Site-wide trespasser Future: On-site resident; site-wide hunter	Current: Off-facility resident Future: On-site resident and on-site worker	Current: Off-facility resident Future: On-site resident	Current: None Future: None	Current: None Future: On-site resident; off-facility consumer of beef, and milk
Wood Storage Pile (Site 5) and Wood Burning Area (Site 6)	Residential lot; Hunting; Industrial site	Current: All receptors Future: All receptors	Current: None (site is completely covered with vegetation or concrete) Future: All receptors	Current: Site-wide trespasser Future: On-site resident and on-site worker; site-wide hunter	Current: None Future: None (no monitoring wells)	Current: None Future: None (no monitoring wells)	Current: None Future: None	Current: None Future: On-site resident - produce only
Red Lead Disposal Area (Site 7) and Temporary Storage Building 211 (Site 21B)	Residential lot; Hunting; Industrial site	Current: None Future: None (VOCs were not on the analytical parameter list)	Current: All receptors Future: All receptors	Current: Site-wide trespasser Future: On-site resident and on-site worker; site-wide hunter	Current: Off-facility resident Future: On-site resident and on-site worker	Current: Off-facility resident Future: On-site resident	Current: None Future: None	Current: None Future: On-site residents - produce only
Burning Ground South of Gate 19 Landfill (Site 9) and Gate 19 Landfill (Site 10)	Residential lot; Hunting; Industrial site	Current: All receptors Future: All receptors	Current: None (site is completely vegetated) Future: All receptors	Current: Site-wide trespasser Future: On-site resident and on-site worker; site-wide hunter	Current: Off-facility resident Future: On-site resident and on-site worker	Current: Off-facility resident Future: On-site resident	Current: Site-wide trespasser Future: On-site resident; site-wide hunter (pond in abandoned rock quarry[B])	Current: None Future: On-site resident - produce only

TABLE 5-9

Exposure Pathways Evaluated in the Human Health Risk Assessment
Jefferson Proving Ground
Madison, Indiana

		Exposure Pathway and Receptors						
Site	**Potential Future Land Uses[a]**	**Inhalation of VOCs[b],[c],[d]**	**Inhalation of Fugitive Dust[c],[d]**	**Incidental Ingestion/ Dermal Contact with Soil[c]**	**Ingestion/Dermal Contact with Groundwater**	**Inhalation of Shower VOCs**	**Ingestion/Dermal Contact with Surface Water and Sediment[e]**	**Ingestion of Produce, Meat and Milk**
Building 602 Solvent Pit (Site 12A)	Residential lot; Industrial site; Hunting	Current: All receptors Future: All receptors	Current: None (surface area of pit too small to generate significant fugitive dust; rest of site completely covered with vegetation or pavement) Future: All receptors	Current: Site-wide trespasser Future: On-site resident and on-site worker; site-wide hunter	Current: Off-facility residents Future: On-site resident and on-site worker	Current: Off-facility residents Future: On-site resident	Current: None Future: None	Current: None Future: On-site resident - produce only
Building 617 Solvent Pit (Site 12B)	Residential lot; Industrial site; Hunting	Current: All receptors Future: All receptors	Current: None (surface area of pit too small to generate significant fugitive dust; rest of site completely covered with vegetation or pavement Future: All receptors	Current: Site-wide trespasser Future: On-site resident and on-site worker; site-wide hunter	Current: Off-facility resident Future: On-site resident and on-site worker	Current: Off-facility resident Future: On-site residents	Current: None Future: None	Current: None Future: On-site resident - produce only
Building 279 Solvent Pit (Site 12C)	Residential lot; Industrial site; Hunting	Current: All receptors Future: All receptors	Current: None (surface area of pit too small to generate significant fugitive dust; rest of site completely covered with vegetation or pavement Future: All receptors	Current: Site-wide trespasser Future: On-site resident and on-site worker; site-wide hunter	Current: Off-facility resident Future: On-site resident and on-site worker	Current: Off-facility resident Future: On-site resident	Current: None Future: None	Current: None Future: On-site resident - produce only

TABLE 5-9

Exposure Pathways Evaluated in the Human Health Risk Assessment
Jefferson Proving Ground
Madison, Indiana

Site	Potential Future Land Uses[a]	Exposure Pathway and Receptors: Inhalation of VOCs[b],[c],[d]	Inhalation of Fugitive Dust[c],[d]	Incidental Ingestion/ Dermal Contact with Soil[c]	Ingestion/Dermal Contact with Groundwater	Inhalation of Shower VOCs	Ingestion/Dermal Contact with Surface Water and Sediment[e]	Ingestion of Produce, Meat and Milk
Old Fire Training Pit (Site 13)	Residential lot; Industrial site; Hunting	Current: All receptors Future: All receptors	Current: None (site is completely covered with vegetation or concrete) Future: All receptors	Current: Site-wide trespasser Future: On-site resident and on-site worker; site-wide hunter	Current: Off-facility resident Future: On-site resident and on-site worker	Current: Off-facility resident Future: On-site resident	Current: None Future: None	Current: None Future: On-site resident - produce only
Yellow Sulfur Disposal Area (Site 14)	Residential lot; Industrial site; Hunting	Current: None (soil remediated) Future: None (soil remediated)	Current: None (soil remediated) Future: None (soil remediated)	Current: Site-wide trespasser Future: On-site resident and on-site worker; site-wide hunter	Current: Off-facility resident Future: On-site resident and on-site worker	Current: Off-facility resident Future: On-site resident	Current: Site-wide trespasser Future: On-site resident; site-wide hunter (drainage ditches south of site - sediment samples only)	Current: None Future: On-site resident - produce only
Building 204 Temporary Storage Area (Site 21A and 30)	Residential lot; Industrial site; Hunting	Current: None Future: None (VOCs were not included in the analytical parameter list)	Current: All receptors Future: All receptors	Current: Site-wide trespasser Future: On-site resident and on-site worker; site-wide hunter	Current: None Future: None (no monitoring wells)	Current: None Future: None (no monitoring wells)	Current: None Future: None	Current: None Future: On-site resident - produce only
Paper Mill Road Disposal Area (Site 25)	Leased for agricultural use; Residential lot; Hunting	Current: All receptors Future: All receptors	Current: All receptors Future: All receptors	Current: Site-wide trespasser Future: On-site resident and on-site worker; site-wide hunter	Current: None Future: None (no monitoring wells)	Current: None Future: None (no monitoring wells)	Current: None Future: None	Current: None Future: On-site resident; off-facility consumer of beef and milk
Building 227 Former Storage Pad (Site 31)	Residential lot; Industrial site; Hunting	Current: None Future: None (VOCs were not included in the analytical parameter list)	Current: None (site is completely covered with grass, asphalt, or concrete) Future: All receptors	Current: Site-wide trespasser Future: On-site resident and on-site worker; site-wide hunter	Current: None Future: None (no monitoring wells)	Current: None Future: None (no monitoring wells)	Current: None Future: None	Current: None Future: On-site resident - produce only
Building 333 New Incinerator (Site 33)	Residential lot; Industrial site; Hunting	Current: None Future: None (VOCs were not included in the analytical parameter list)	Current: None (site is completely covered with woods or grassy field) Future: All receptors	Current: Site-wide trespasser Future: On-site resident and on-site worker; site-wide hunter	Current: None Future: None (no monitoring wells)	Current: None Future: None (no monitoring wells)	Current: None Future: None	Current: None Future: On-site resident - produce only
Building 136 Sandblasting Area (Site 34)	Residential lot; Industrial site; Hunting	Current: None Future: None (VOCs were not included in the analytical parameter list)	Current: None (site is completely covered with grass or asphalt) Future: All receptors	Current: Site-wide trespasser Future: On-site resident and on-site worker; site-wide hunter	Current: None Future: None (no monitoring wells)	Current: None Future: None (no monitoring wells)	Current: None Future: None	Current: None Future: On-site resident - produce only

TABLE 5-9

Exposure Pathways Evaluated in the Human Health Risk Assessment
Jefferson Proving Ground
Madison, Indiana

		Exposure Pathway and Receptors						
Site	Potential Future Land Uses[(a)]	Inhalation of VOCs[(b),(c),(d)]	Inhalation of Fugitive Dust[(c),(d)]	Incidental Ingestion/ Dermal Contact with Soil[(c)]	Ingestion/Dermal Contact with Groundwater	Inhalation of Shower VOCs	Ingestion/Dermal Contact with Surface Water and Sediment[(e)]	Ingestion of Produce, Meat and Milk
Northwest-Southeast Runway Flare Test Site Area (Site 38)	Residential lot; Industrial site; Hunting	Current: None Future: None (VOCs were not included in the analytical parameter list)	Current: All receptors Future: All receptors	Current: Site-wide trespasser Future: On-site resident and on-site worker; site-wide hunter	Current: None Future: None (no monitoring wells)	Current: None Future: None (no monitoring wells)	Current: None Future: None	Current: None Future: On-site resident - produce only
Gator Z Mine Test Area (Site 39)	Residential lot; Industrial site; Hunting	Current: None Future: None (VOCs were not included in the analytical parameter list)	Current: None (revegetation and reforestation occurring since site no longer in use) Future: All receptors	Current: Site-wide trespasser Future: On-site resident and on-site worker; site-wide hunter	Current: None Future: None (no monitoring wells)	Current: None Future: None (no monitoring wells)	Current: None Future: None	Current: None Future: On-site resident - produce only

Footnotes:

(a) U.S. recommended daily allowance (USEPA 1994b).
(a) The current land use conceptual model includes on-site trespassers and off-facility nearby residents.
(b) VOCs were assumed to volatilize from both surface and subsurface soil.
(c) Future hunters were assumed to visit accessible sites each time they visit the facility to hunt; the soil and air exposure point concentrations were calculated on a site-wide, proportional basis (see Section 5.3.2 of work plan text).
(d) Inhalation of VOCs and fugitive dusts was evaluated for all current and future receptors, including all future on-site residents at each site. This table indicates whether or not there was the potential for a site to contribute to site-wide air contamination based on the analytical parameter list and site conditions (amount of vegetation, etc.).
(e) Current trespassers and future hunters and were assumed to visit each surface water body on each visit to the facility; future on-site residents were assumed to visit only one surface water body per visit at those sites where surface water bodies exist. For any sites without subsurface soil data, the surface soil. database only was used to evaluate residential contact with soil.

Table 5-10a

Chemical-Specific Values for Modeling Contaminants of Potential Concern (COPC) Uptake into Plants, Beef, and Milk – Inorganic Chemicals Jefferson Proving Ground Madison, Indiana

			RUF[(a)] (kg/kg)				
Chemical	Kd (L/kg)	RCF[(b)] (L/kg)	Tomatoes/ Beans	Lettuce	Corn/ Corn silage	BTF_{beef}[(c)] (d/g)	BTF_{milk} (d/L)
Aluminum	1,500	0.1	6.5E-04	4.0E-03	6.5E-04	1.5E-06	2.0E-04
Arsenic	29	0.008	6.0E-03	4.0E-02	6.0E-03	1.3E-06	3.0E-06
Barium	41	0.015	1.5E-02	1.5E-01	1.5E-02	1.5E-07	3.5E-04
Beryllium	790	0.0015	1.5E-03	1.0E-02	1.5E-03	1.0E-06	9.0E-07
Cadmium	75	0.032	1.5E-01	5.5E-01	1.5E-01	1.7E-07	1.3E-06
Chromium	19	0.0045	4.5E-03	7.5E-03	4.5E-03	1.9E-06	1.4E-06
Manganese	65	0.15	5.0E-02	5.6E-01	2.9E-01	4.0E-07	3.5E-04
Silver	8.3	0.1	8.0E-04	2.7E-04	1.0E-01	3.0E-06	2.0E-02
Thallium	71	0	4.0E-04	4.0E-03	4.0E-04	4.0E-05	2.0E-03
Vanadium	1000	0.003	3.0E-03	5.5E-03	3.0E-03	2.5E-06	2.0E-03
Zinc	62	0.1	9.0E-01	1.4E+00	1.3E+0	1.0E-04	1.0E-02

Footnotes:

(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(a) Root uptake factor.
(b) Ratio of concentration factor.
(c) Biotransfer factor.

Sources: NUREG 1992; Baes et al. 1984; USEPA 1995c; Stevens 1991, 1992.

TABLE 5-10b

Chemical-Specific Values for Modeling Contaminants of Potential Concern (COPC) Uptake into Plants, Beef, and Milk -Organic Chemicals Jefferson Proving Ground Madison, Indiana

Chemical	log K_{ow}	Koc (L/kg)	RCF[a] (L/kg)	RUF[b] (kg/kg)	BTF_{beef}[c] (d/g)	BTF_{milk}[d] (d/L)
2,3,7,8-TCDD equivalents	6.64	4.57E+06	3.92E+03	5.62E-03	7.10E-04[E]	2.60E-02[E]
Benzo(a)anthracene	5.82	3.58E+05	9.15E+02	1.68E-02	1.66E-05	5.25E-03
Benzo(a)pyrene	6.09	9.69E+05	1.48E+03	1.17E-02	3.09E-05	9.77E-03
Benzo(b)fluoranthene	6.57	1.23E+06	3.46E+03	6.17E-03	9.33E-05	2.95E-02
DDE	5.77	8.64E+04	8.37E+02	1.79E-02	1.48E-05	4.68E-03
Dibenz(a,h)anthracene	6.75	1.79E+06	4.76E+03	4.86E-03	1.41E-04	4.47E-02
Dieldrin	4.51	2.55E+04	8.97E+01	9.58E-02	8.13E-07	2.57E-04
Indeno(1,2,3-cd)pyrene	5.97	3.47E+06	1.19E+03	1.37E-02	2.34E-05	7.41E-03

Footnotes:

(a) Ratio of concentration factor = 10(0.77 x log Kow) - 1.52
(b) Root uptake factor = 10(1.588 - (0.578 x log Kow))
(c) Biotransfer factor for beef = (10 (-7.6 + log Kow))/1000
(d) Biotransfer factor for milk = 10(-8.1 + log Kow)

Note.—Sources for Koc and Kow were USEPA 1996b and Montgomery and Welkom 1990.

TABLE 5-11

Variable Values for Inhalation of Vapor Phase and Particulate-Bound Chemicals
Jefferson Proving Ground
Madison, Indiana

Equation:

$$\text{Inhalation Dose (mg/kg-day)} = \frac{CAA \times IR_A \times ET \times EF \times ED}{BW \times AT}$$

where:

CAA	=	Contaminant level in air (mg/m^3)
IR_A	=	Inhalation rate (m^3/hour)
ET	=	Exposure time (hours/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

Exposure variables:

	IR_A	ET	EF	ED	BW	AT	
	(m^3/hr)	(hr/d)	(d/yr)	(yr)	(kg)	(days)	
						Cancer	Noncancer
CURRENT SCENARIOS							
On-facility tenant employees	0.83	8	250	25	70	25,550	9,125
On-facility tenant residents							
Adults	0.83	24	252	30	70	25,550	10,950
Off-facility residents							
Adults	0.83	24	252	30	70	25,550	10,950
Children	0.67	24	252	6	15	25,550	2,190
Facility-wide trespassers	2.24	4	72	12	35	25,550	4,380
FUTURE SCENARIOS							
On-site workers	0.83	8	250	25	70	25,550	9,125
On-site residents							
Adults	0.83	24	252	30	70	25,550	10,950
Children	0.67	24	252	6	15	25,550	2,190
Facility-wide hunters	0.83	6	9	30	70	25,550	10,950
Off-facility residents (at modeled groundwater locations)							
Adults	0.83	24	252	30	70	25,550	10,950
Children	0.67	24	252	6	15	25,550	2,190
Off-facility recreational users (EPA 160) (at Middle Fork Creek)							
Adults	0.83	1	36	30	70	25,550	10,950
Children	0.67	1	36	6	15	25,550	2,190

TABLE 5-12

Variable Values for Ingestion of Chemicals in Soil
Jefferson Proving Ground
Madison, Indiana

Equation:

$$\text{Soil Ingestion Dose (mg/kg-day)} = \frac{CS_L \times IR_S \times CF \times EF \times ED}{BW \times AT}$$

where:

CS_L	=	Contaminant level in soil (mg/kg)
IR_S	=	Ingestion rate (mg soil/day)
CF	=	Conversion factor (10^{-6} kg/mg)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

Exposure variables:

	IR_S (mg/d)	EF (d/yr)	ED (yr)	BW (kg)	AT (days) Cancer	AT (days) Noncancer
CURRENT SCENARIOS						
Facility-wide trespassers	100	72	12	35	25,550	4,380
FUTURE SCENARIOS						
On-site workers	50	250	25	70	25,550	9,125
On-site residents						
Adults	100	350	30	70	25,550	10,950
Children	200	350	6	15	25,550	2,190
Facility-wide hunters	100	9	30	70	25,550	10,950

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TABLE 5-13

Variable Values for Dermal Contact with Chemicals in Soil
Jefferson Proving Ground
Madison, Indiana

Equation:

$$\text{Soil Dermal Contact Dose (mg/kg-day)} = \frac{CS_L \times CF \times SA \times AF \times EF \times ED \times ABS}{BW \times AT}$$

where:

CS_L	=	Contaminant level in soil (mg/kg)
CF	=	Conversion factor (10^{-6} kg/mg)
SA	=	Skin surface area unavailable for contact (cm^2/event)
AF	=	Soil-to-skin adherence factor = 0.2 mg/cm^2
EF	=	Exposure frequency (events/year)
ED	=	Exposure duration (years)
ABS	=	Dermal absorption factor (chemical-specific)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

Exposure variables:

	SA	EF	ED	BW	AT	
	(cm^2/event)	(events/yr)	(yr)	(kg)	(days)	
					Cancer	Noncancer
CURRENT SCENARIOS						
Facility-wide trespassers	3,700	72	12	35	25,550	4,380
FUTURE SCENARIOS						
On-site workers	2,490	250	25	70	25,550	9,125
On-site residents						
Adults	5,800	252	30	70	25,550	10,950
Children	3,580	252	6	15	25,550	2,190
Facility-wide hunters	2,490	9	30	70	25,550	10,950

TABLE 5-14

Variable Values for Ingestion of Chemicals in Groundwater
Jefferson Proving Ground
Madison, Indiana

Equation:

$$\text{Groundwater Ingestion Dose (mg/kg-day)} = \frac{CGW \times IR_W \times EF \times ED}{BW \times AT}$$

where:

CAW	=	Contaminant level in groundwater (mg/L)
IRW	=	Ingestion rate (L water/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

Exposure variables:

	IR_W (L/d)	EF (d/yr)	ED (yr)	BW (kg)	AT (days) Cancer	AT (days) Noncancer
FUTURE SCENARIOS						
Off-facility residents						
Adults	2	350	30	70	25,550	10,950
Children	1	350	6	15	25,550	2,190
On-site workers	1	250	25	70	25,550	9,125
On-site residents						
Adults	2	350	30	70	25,550	10,950
Children	1	350	6	15	25,550	2,190

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TABLE 5-15

Variable Values for Dermal Contact with Chemicals While Showering/Bathing
Jefferson Proving Ground
Madison, Indiana

Equation:

$$\text{Groundwater Dermal Contact Dose (mg/kg-day)} = \frac{CGW \times SA \times PC \times ET \times EF \times ED \times CF}{BW \times AT}$$

where:

- CGW = Contaminant level in groundwater (mg/L)
- SA = Skin surface area available for contact (cm^2)
- PC = Normalized chemical-specific dermal permeability constant (cm/hr)
- ET = Exposure time (hours/day)
- EF = Exposure frequency (days/year)
- ED = Exposure duration (years)
- CF = Conversion factor (0.001 L/cm^3)
- BW = Body weight (kg)
- AT = Averaging time (days)

Exposure variables:

	SA (cm^2)	ET (hr/d)	EF (d/yr)	ED (yr)	BW (kg)	AT (days) Cancer	AT (days) Noncancer
FUTURE SCENARIOS							
Off-facility residents							
Adults	18,150	0.2	350	30	70	25,550	10,950
Children	7,200	0.2	180	6	15	25,550	2,190
On-site residents							
Adults	18,150	0.2	350	30	70	25,550	10,950
Children	7,200	0.2	180	6	15	25,550	2,190

TABLE 5-16

Dermal Permeability Constants for Contaminants of Potential Concern (COPCs) in Groundwater and Surface Water
Jefferson Proving Ground
Madison, Indiana

Chemicals	logKow	Permeability Constant[a] (cm/hr) [b]
Aluminum	NA	1.00E-03
Antimony	NA	1.00E-03
Arsenic	NA	1.00E-03
Barium	NA	1.00E-03
Beryllium	NA	1.00E-03
Chromium	NA	1.00E-03
Iron	NA	1.00E-03
Manganese	NA	1.00E-03
Molybdenum	NA	1.00E-03
1,1-Dichloroethane	1.79	8.90E-03
1,1-Dichloroethylene	2.13	1.60E-02
1,1,1-Trichloroethane	2.34	1.70E-02
1,1,2-Trichloroethane	2.18	8.40E-03
1,2-Dichloroethane	1.49	5.30E-03
1,2-Dichloroethylene	2.09	1.00E-03
1,3,5-Trinitrobenzene	1.18	6.80E-04
4-Amino-2,6-dinitrotoluene	0.60	2.29E-03
4-Chlorocresol	3.00	4.10E-02
Acetone	-0.24	5.70E-04
Benzene	2.0	2.10E-02
Benzo(a)anthracene	5.81	8.10E-01
Carbon disulfide	1.84	2.40E-02
Chloroform	1.95	8.90E-03
Pentachlorophenol	3.32	6.50E-01
Toluene	2.57	4.50E-02
Trichloroethylene	2.42	1.60E-02
Vinyl chloride	0.6	7.30E-03

Footnotes:
(a) EPA 1992. Dermal Exposure Assessment: Principles and Applications. EPA/600/8-91/011B. Washington D.C.
(b) Centimeter per hour

TABLE 5-17

Variable Values for Inhalation of Vapor Phase Chemicals While Showering/Bathing
Jefferson Proving Ground
Madison, Indiana

Equation:

$$\text{Inhalation Dose (mg/kg-day)} = \frac{CSA \times IRSUBA \times ET \times EF \times ED}{BW \times AT}$$

where

- CSA = Contaminant level in shower air (mg/m^3)
- IR_A = Inhalation rate (m^3/hour)
- ET = Exposure time (hours/day)
- EF = Exposure frequency (days/year)
- ED = Exposure duration (years)
- BW = Body weight (kg)
- AT = Averaging time (days)

Exposure variables:

	IR_A	ET	EF	ED	BW	AT	
	(m^3/hr)	(hr/d)	(d/yr)	(yr)	(kg)	(days)	
						Cancer	Noncancer
FUTURE SCENARIOS							
Off-facility residents							
Adults	0.83	0.2	350	30	70	25,550	10,950
Children	0.67	0.2	180	6	15	25,550	2,190
On-site residents							
Adults	0.83	0.2	350	30	70	25,550	10,950
Children	0.67	0.2	180	6	15	25,550	2,190

TABLE 5-18

Variable Values for Incidental Ingestion of Chemicals in Surface Water
Jefferson Proving Ground
Madison, Indiana

Equation:

$$\text{Surface Water Ingestion Dose (mg/kg-day)} = \frac{CSW \times CR \times ET \times EF \times ED}{BW \times AT}$$

where:

CSW	=	Contaminant level in surface water (mg/L)
CR	=	Contact rate (L/water/hour)
ET	=	Exposure time (hours/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

Exposure variables:

	CR (L/hr)	ET (hr/d)	EF (d/yr)	ED (yr)	BW (kg)	AT (days) Cancer	AT (days) Noncancer
CURRENT SCENARIOS							
Facility-wide trespassers	0.05	0.25	72[(a)]	12	35	25,550	4,380
FUTURE SCENARIOS							
On-site residents							
Adults	0.05	1.0	36[(b)]	30	70	25,550	10,950
Toddlers	0.05	1.0	36[(b)]	6	15	25,550	2,190
Facility-wide hunters	0.05	0.25	9[(a)]	30	70	25,550	10,950
Off-facility residents (visitors to Middle Fork Creek)							
Adults	0.05	1.0	36	30	70	25,550	10,950
Toddlers	0.05	1.0	36	6	15	25,550	2,190

Footnotes:

(a) These receptors were assumed to be exposed at all surface water/sediment locations during each visit.
(b) Exposure to surface water was assumed to occur at only the surface water/sediment location at the site where the receptor resides.

TABLE 5-19

Variable Values for Dermal Contact with Surface Water
Jefferson Proving Ground
Madison, Indiana

Equation:

$$\text{Surface Water Dermal Contact Dose (mg/kg-day)} = \frac{CSW \times SA \times PC \times ET \times EF \times ED \times CF}{BW \times AT}$$

where

CSW = Contaminant level in surface water (mg/L)
SA = Skin surface area available for contact (cm^2)
PC = Normalized chemical-specific dermal permeability constant (cm/hr)
ET = Exposure time (hours/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
CF = Conversion factor (0.001 L/cm^3)
BW = Body weight (kg)
AT = Averaging time (days)

Exposure variables:

	SA	ET	EF	ED	BW	AT	
	(cm^2)	(hr/d)	(d/yr)	(yr)	(kg)	(days)	
						Cancer	Noncancer
CURRENT SCENARIOS							
Facility-wide trespasser	4,650	0.25	72[(a)]	12	35	25,550	4,380
FUTURE SCENARIOS							
On-Site Residents							
Adults	7,010	1.0	36[(b)]	30	70	25,550	10,950
Children	3,580	1.0	36[(b)]	6	15	25,550	2,190
Facility-wide hunters	7,010	0.25	9[A]	30	70	25,550	10,950
Off-Facility Recreational Users (EPA 160) (visitors to Middle Fork Creek)							
Adults	7,010	1.0	36	30	70	25,550	10,950
Children	3,580	1.0	36	6	15	25,550	2,190

Footnotes:

(a) These receptors were assumed to be exposed at all surface water/sediment locations during each visit.
(b) Exposure to sediment was assumed to occur only at the surface water/sediment location at the site where the receptor resides.

TABLE 5-20

Variable Values for Ingestion of Chemicals in Sediment
Jefferson Proving Ground
Madison, Indiana

Equation:

$$\text{Sediment Ingestion Dose (mg/kg-day)} = \frac{\text{CSD FUNCx } IR_d \text{ x CF x EF x ED}}{\text{BW x AT}}$$

where

CSD = Contaminant level in sediment (mg/kg)
IR_d = Ingestion rate (mg sediment/day)
CF = Conversion factor (10^{-6} kg/mg)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (days)

Exposure variables:

	IR_d[a]	EF	ED	BW	AT	
	(mg/d)	(d/yr)	(yr)	(kg)	(days)	
					Cancer	Noncancer
CURRENT SCENARIOS						
Facility-wide trespassers	16.7[b]	72[b]	12	35	25,550	4,380
FUTURE SCENARIOS						
On-site Residents						
Adults	50	36[c]	30	70	25,550	10,950
Children	100	36[c]	6	15	25,550	2,190
Facility-wide hunters	16.7[b]	9[b]	30	70	25,550	10,950

Footnote:

(a) The sediment ingestion rate was assumed to be half of that assumed for soil.
(b) These receptors were assumed to be exposed at all surface water/sediment locations during each visit.
(c) Exposure to sediment was assumed to occur only at the surface water/sediment location at the site where the receptor resides.

TABLE 5-21

Variable Values for Dermal Contact with Chemicals in Sediment
Jefferson Proving Ground
Madison, Indiana

Equation:

$$\text{Sediment Dermal Contact Dose (mg/kg-day)} = \frac{CSD \times CF \times SA \times AF \times EF \times ED \times ABS}{BW \times AT}$$

where

CSD = Contaminant level in sediment (mg/kg)
CF = Conversion factor (10^{-6} kg/mg)
SA = Skin surface area available for contact (cm^2/event)
AF = Sediment-to-skin adherence factor = 1 mg/cm^2
EF = Exposure frequency (events/year)
ED = Exposure duration (years)
ABS = Dermal absorption factor = chemical-specific
BW = Body weight (kg)
AT = Averaging time (days)

Exposure variables:

	SA	EF	ED	BW	AT	
	(cm^2/event)	(events/yr)	(yr)	(kg)	(days)	
					Cancer	Noncancer
CURRENT SCENARIOS						
Facility-wide trespassers	3,700	72[(a)]	12	35	25,550	4,380
FUTURE SCENARIOS						
On-site Residents						
Adults	7,010	36[(b)]	30	70	25,550	10,950
Children	3,580	36[(b)]	6	15	25,550	2,190
Facility-wide hunters	7,010	9[(b)]	30	70	25,550	10,950

Footnote:

(a) These receptors were assumed to be exposed to all surface water/sediment locations during each visit.
(b) Exposure to sediment was assumed to occur only at the surface water/sediment location at the site where the receptor resides.

TABLE 5-22

Variable Values for Ingestion of Chemicals in Garden Fruits/Vegetables
Jefferson Proving Ground
Madison, Indiana

Equation:

$$\text{Fruit/Vegetable Ingestion Dose (mg/kg-day)} = \frac{(CV_i \times CONV_i) \times CF \times FR_v \times EF \times ED}{BW \times AT}$$

where:

CV_i = Contaminant level in fruit/vegetable 'I' (mg/kg)
$CONV_i$ = Consumption rate for fruit/vegetable 'I' (g/day)

	Potatoes	Tomatoes	Carrots	Beans/Peas	Lettuce
Adult	209	133	130	181	66
Toddler	123	67	85	104	29

CF = Conversion factor (1o^{-3} kg/g)
FR_v = Fraction of fruit/vegetables that is homegrown = 0.4 (unitless)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (days)

Exposure variables:

	EF (d/yr)	ED (yr)	BW (kg)	AT (days) Cancer	AT (days) Noncancer
FUTURE SCENARIOS					
On-site residents					
Adults	350	30	70	25,550	10,950
Children	350	6	15	25,550	2,190

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TABLE 5-23

Variable Values for Ingestion of Chemicals in Beef
Jefferson Proving Ground
Madison, Indiana

Equation:

$$\text{Beef Ingestion Dose (mg/kg-day)} = \frac{CB \times CONB \times FR_b \times EF \times ED}{BW \times AT}$$

where:

- CB = Contaminant level in beef (mg/g)
- CONB = Consumption rate for beef (g/day)
- FR_b = Fraction of beef that is locally produced (unitless) = 1.0 (default value)
- EF = Exposure frequency (days/year)
- ED = Exposure duration (years)
- BW = Body weight (kg)
- AT = Averaging time (days)

Exposure variables:

	CONB (g/d)	EF (d/yr)	ED (yr)	BW (kg)	AT (days) Cancer	AT (days) Noncancer
FUTURE SCENARIOS						
Off-facility residents						
Adults	199	350	30	70	25,550	10,950
Children	88	350	6	15	25,550	2,190
On-site residents						
Adults	199	350	30	70	25,550	10,950
Children	88	350	6	15	25,550	2,190

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TABLE 5-24

Variable Values for Ingestion of Chemicals in Milk
Jefferson Proving Ground
Madison, Indiana

Equation:

$$\text{Milk Ingestion Dose (mg/kg-day)} = \frac{CM \times CONM \times FR_m \times EF \times ED}{BW \times AT}$$

where:

- CM = Contaminant level in milk (mg/L)
- CONM = Consumption rate for milk (L/day)
- FR_m = Fraction of milk that is locally produced (unitless) = 1.0 (default value)
- EF = Exposure frequency (days/year)
- ED = Exposure duration (years)
- BW = Body weight (kg)
- AT = Averaging time (days)

Exposure variables:

	CONM (L/d)	EF (d/yr)	ED (yr)	BW (kg)	AT (days) Cancer	AT (days) Noncancer
FUTURE SCENARIOS						
Off-facility residents						
Adults	0.66	350	30	70	25,550	10,950
Children	0.81	350	6	15	25,550	2,190
On-site residents						
Adults	0.66	350	30	70	25,550	10,950
Children	0.81	350	6	15	25,550	2,190

TABLE 5-25

Chronic Oral Toxicity Values – Noncarcinogenic Effects
Jefferson Proving Ground
Madison, Indiana

Chemical	Chronic RfD (mg/kg-d)	Confidence Level	Critical Effect	Uncertainty/ Modifying Factor	Source
			Inorganics		
Aluminum	NA[a]	NA	NA	NA	
Antimony	4.0E-04	Low	Longevity; effects on blood glucose and cholesterol	1,000/1	IRIS[b]
Arsenic	3.0E-04	Medium	Hyperpigmentation	3/1	IRIS
Barium	7.0E-02	Medium	Increase in blood pressure	3/1	IRIS
Beryllium	2.0E-03	Low	None	100/1	IRIS
Cadmium (food)	1.0E-03	High	Significant proteinuria	10/1	IRIS
Chromium (VI)	3.0E-03	Low	No effects reported	500/1	IRIS
Copper	NA	NR[c]	Gastrointestinal irritation	NR	HEAST[d]
Iron	NA	NA	NA	NA	
Lead	e	NA	NA	NA	
Manganese (food)	1.4E-01[f]	Medium	CNS effects	1/1	IRIS
Manganese (water)	4.6E-02[f]	Medium	CNS effects	1/3	IRIS
Molybdenum	5.0E-03	Medium	Increased uric acid levels	30/1	IRIS
Silver	5.0E-03	Low	Argyria	3/1	IRIS
Thallium	8.0E-05	Low	No adverse effects	3,000/1	IRIS
Vanadium	7.0E-03	NR	None reported	100/NR	HEAST
Zinc	3.0E-01[g]	Medium	Decrease in erythrocyte superoxide dismutase concentration	3/1	IRIS

TABLE 5-25

Chronic Oral Toxicity Values – Noncarcinogenic Effects
Jefferson Proving Ground
Madison, Indiana

Chemical	Chronic RfD (mg/kg-d)	Confidence Level	Critical Effect	Uncertainty/ Modifying Factor	Source
			Organics		
1,1-Dichloroethane	1.0E-01	NR	None observed	1,000/NR	HEAST
1,1-Dichloroethylene	9.0E-03	Medium	Hepatic lesions	1,000/1	IRIS
1,1,1-Trichloroethane	2.0E-01	NR	NR	NR	Region V[(h)]
1,1,2-Trichloroethane	4.0E-03	Medium	Clinical serum chemistry	1,000/1	IRIS
1,2-Dichloroethane	ND[(i)]	ND	ND	ND	
1,2-Dichloroethylene (mixed isomers)	9.0E-03	Medium	Liver lesions	1,000/1	HEAST
1,3,5-Trinitrobenzene	3.0E-02	Medium	Methemoglobinemia and spleen erythroid cell hyperplasia	100/1	IRIS
2,3,7,8-TCDD	NA	ND	ND	ND	
4-Amino-2,6-dinitrotoluene	NA	NR	NR	NR	
4-Chlorocresol	NA	ND	ND	ND	
Acetone	1.0E-01	Low	Increased liver and kidney weights; nephropathy	1,000/1	IRIS
Benzene	NA	NR	NR	NR	
Benzo(a)anthracene	NA	ND	ND	ND	
Benzo(a)pyrene	NA	ND	ND	ND	
Benzo(b)fluoranthene	NA	ND	ND	ND	
Carbon disulfide	1.0E-01	Medium	Fetal toxicity	100/1	IRIS
Chlorobenzene	2.0E-02	Medium	Histopathologic changes in liver	1,000/1	IRIS

TABLE 5-25

Chronic Oral Toxicity Values – Noncarcinogenic Effects
Jefferson Proving Ground
Madison, Indiana

Chemical	Chronic RfD (mg/kg-d)	Confidence Level	Critical Effect	Uncertainty/ Modifying Factor	Source
			Organics		
Chloroform	1.0E-02	Medium	Fatty cyst formation in liver	1,000/1	IRIS
DDE	NA	ND	ND	ND	
Dibenz(a,h)anthracene	NA	ND	ND	ND	
Dieldrin	5.0E-05	Medium	Liver lesions	100/1	IRIS
Indeno(1,2,3-cd)pyrene	NA	ND	ND	ND	
Pentachlorophenol	3.0E-02	Medium	Liver and kidney pathology	100/1	IRIS
Toluene	2.0E-01	Medium	Changes in liver and kidney weights	1,000/1	IRIS
Trichloroethylene	6.0E-03	Low	Liver toxicity	3,000/1	Region V
Vinyl chloride	3.0E-03	ND	ND	ND	IRIS

Footnotes:
(a) Not applicable.
(b) Integrated Risk Information System.

(c) Not reported.
(d) Health Affects Assessment Summary Tables.
(e) Toxicity of lead is determined by using models to estimate blood lead levels. Commonly used models include the Integrated Exposure Uptake and Biokinetic (IEUBK) and Adult Lead Exposure Model (U.S.EPA, 1994. Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children (February 1994) [NTIS #PB93-963510, OSWER #9285.7-15-1]; U.S. EPA, 1996. Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil, December 1996)
(f) IRIS no longer separates manganese values for chronic oral RfDs into water and diet RfDs. The chronic oral RfD for the total oral intake of manganese is 1.40E-01. However, when assessing exposure to manganese from drinking water or soil, IRIS recommends using a modifying factor of 3, thereby lowering the RfD to 4.67E-02, which has been rounded to 4.6E-02. Rounding to 4.7E-02 is more accurate, but makes the value less conservative.
(g) Adult value only. As suggested in IRIS, an RfD for children was calculated from the recommended total daily intake of zinc for preadolescent children (10 mg/day; NRC 1989). The value of 10 mg/day was divided by the child's body weight of 15 kg to derive a zinc RfD for children of 6.6E-01 mg/kg.
(h) Toxicity Guidance value provided by Mark Johnson, USEPA, Region 5. Personal Communication with Pinaki Banerjee, MWH, 2000
(i) No data.

TABLE 5-26

Chronic Inhalation Toxicity Values - Noncarcinogenic Effects
Jefferson Proving Ground
Madison, Indiana

Chemical	Chronic RfC (mg/M^3)[h]	Chronic RfD[a] (mg/kg-d)[i]	Confidence Level	Critical Effect	Uncertainty/ Modifying Factor	Source
			Inorganics			
Aluminum	NA[b]	NA	NA	NA		
Arsenic	NA	NA	Medium	Hyperpigmentation	3/1	IRIS[c]
Barium	5.0E-04	1.43E-04	NR[d]	Fetotoxicity	1,000/NR	HEAST[e]
Beryllium	2.00E-05	5.71E-06	Low	None	100/1	IRIS
Cadmium	NA	NA	NA	NA	NA	
Chromium (VI)	1.00E-04	2.86E-05	Low	No effects reported	500/1	IRIS
Copper	ND[f]	ND	ND	ND	ND	
Lead	ND	ND	ND	ND	ND	
Manganese	5.0E-05	1.43E-05	Medium	Impairment of neurobehavioral function	1,000/1	IRIS
Molybdenum	NA	NA	NA	NA	NA	
Silver	NA	NA	NA	NA	NA	
Thallium	NA	NA	NA	NA	NA	
Vanadium	NA	NA	NA	NA	NA	
Zinc	NA	NA	NA	NA	NA	
			Organics			
1,1-Dichloroethane	5.0E-01	1.43E-01	NR	Kidney damage	1,000/NR	HEAST
1,1-Dichloroethylene	ND	ND	ND	ND	ND	
1,1,1-Trichloroethane	2.20E+00	6.29E-01	NR	Reduced body weight gain	1,000/NR	Region V[g]

TABLE 5-26

Chronic Inhalation Toxicity Values - Noncarcinogenic Effects
Jefferson Proving Ground
Madison, Indiana

Chemical	Chronic RfC (mg/M^3)	Chronic RfD[(a)] (mg/kg-d)	Confidence Level	Critical Effect	Uncertainty/ Modifying Factor	Source
			Organics			
1,1,2-Trichloroethane	ND	ND	ND	ND	ND	
1,2-Dichloroethane	ND	ND	ND	ND	ND	
1,2-Dichloroethylene	ND	ND	ND	ND	ND	
2,3,7,8-TCDD	ND	ND	ND	ND	ND	
4-Amino-2,6-dinitrotoluene	NA	NA	NR	NR	NR	
Acetone	NA	NA	NA	NA	NA	
Benzene	NA	NA	NA	NA	NA	
Benzo(a)anthracene	ND	ND	ND	ND	ND	
Benzo(a)pyrene	ND	ND	ND	ND	ND	
Benzo(b)fluroanthene	ND	ND	ND	ND	ND	
Carbon disulfide	7.0E-01	2.0E-01	Medium	Peripheral nervous system dysfunction	30/1	IRIS
Chlorobenzene	2.0E-02	5.71E-03	NR	Liver and kidney effects	10,000/NR	HEAST
Chloroform	ND	ND	ND	ND	ND	
DDE	ND	ND	ND	ND	ND	
Dibenz(a,h)anthracene	ND	ND	ND	ND	ND	
Dieldrin	ND	ND	ND	ND	ND	
Indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	ND	
Pentachlorophenol	NA	NA	NA	NA	NA	
Tetrachloroethylene	6.00E-01	1.71E-01	Medium	Liver and kidney effects	300/1	Region V

TABLE 5-26

Chronic Inhalation Toxicity Values - Noncarcinogenic Effects
Jefferson Proving Ground
Madison, Indiana

Chemical	Chronic RfC (mg/M^3)	Chronic RfD[(a)] (mg/kg-d)	Confidence Level	Critical Effect	Uncertainty/ Modifying Factor	Source
			Organics			
Toluene	4.0E-01	1.14E-01	Medium	Neurological effects; degeneration of nasal epithelium	300/1	IRIS
Trichloroethylene	ND	ND	ND	ND	ND	
Vinyl chloride	1.00E-01	2.86E-02	ND	ND	ND	IRIS

Footnotes:

(a) Inhalation RfD was calculated from the reported RfC (reference concentration):

$$\text{Inhalation RfD} = \frac{20\ \text{m3/d} \times \text{RfC (mg/m3)}}{70\ \text{kg}}$$

(b) Not applicable.
(c) Integrated Risk Information System.
(d) Not reported.
(e) Health Effects Assessment Summary Tables.
(f) No data.
(g) Toxicity Guidance value obtained through personal communication with Mark Johnson, USEPA, Region 5 in 2000.
(h) Milligram per cubic meter.
(i) Milligram per kilogram per day.

TABLE 5-27

Oral Toxicity Values - Carcinogenic Effects
Jefferson Proving Ground
Madison, Indiana

Chemical	Oral Slope Factor $(mg/kg\text{-}d)^{-1}$	Weight of Evidence[(a)]	Cancer Type/Target Organ/Species	Source
		Inorganics		
Aluminum	ND[(b)]	ND	ND	
Antimony	ND	ND	ND	
Arsenic	1.5E+00	A	Carcinomas/skin/human	IRIS[(c)]
Barium	ND	ND	ND	
Beryllium	ND	B2	Tumors/multiple sites/rat	IRIS
Cadmium	ND	ND	ND	
Chromium (VI)	ND	ND	ND	
Copper	ND	ND	ND	
Iron	ND	ND	ND	
Lead	ND	ND	ND	
Manganese	ND	D	ND	IRIS
Molybdenum	ND	ND	ND	
Silver	ND	ND	ND	
Thallium	ND	ND	ND	
Vanadium	ND	ND	ND	
Zinc	ND	D	ND	IRIS
		Organics		
1,1-Dichloroethane	ND	ND	ND	
1,1-Dichloroethylene	6.0E-01	C	Pheochromocytomas/adrenal/rat	IRIS
1,1,1-Trichloroethane	ND	ND	ND	
1,1,2-Trichloroethane	5.7E-02	C	Carcinoma/liver/mouse	IRIS
1,2-Dichloroethane	9.1E-02	B2	Hemagiosarcomas/blood vessels/rat	IRIS
1,2-Dichloroethylene (mixed isomers)	ND	ND	ND	
1,3,5-Trinitrobenzene	ND	ND	ND	
2,3,7,8-TCDD	1.5E+05	B2	Tumors/respiratory system/rat	HEAST[(d)]
4-Amino-2,6-dinitrotoluene	ND	ND	ND	
4-Chlorocresol	ND	ND	ND	

TABLE 5-27

Oral Toxicity Values - Carcinogenic Effects
Jefferson Proving Ground
Madison, Indiana

Chemical	Oral Slope Factor $(mg/kg\text{-}d)^{-1}$	Weight of Evidence[(a)]	Cancer Type/Target Organ/Species	Source
Acetone	ND	ND	ND	
Benzene	5.5E-02	A	Leukemia/bone marrow/humans	IRIS
Benzo(a)anthracene	7.3E-01[(e)]	B2	NA[(f)]	(TEF x BaP)[(e)]
Benzo(a)pyrene	7.3E+00	B2	Carcinomas/stomach/mouse	IRIS
Benzo(b)fluoranthene	7.3E-01[(e)]	B2	NA[(g)]	(TEF x BaP)[(e)]
Carbon disulfide	ND	ND	ND	
Chlorobenzene	ND	ND	ND	
Chloroform	6.1E-03	B2	Tumors/kidney/rat	IRIS
DDE	3.4E-01	B2	Carcinomas/liver/mouse	IRIS
Dibenz(a,h)anthracene	7.3E+00[(e)]	B2	NA	(TEF x BaP)[(e)]
Dieldrin	1.6E+01	B2	Carcinomas/liver/mouse	IRIS
Indeno(1,2,3-cd)pyrene	7.3E-01[(e)]	B2	NA	(TEF x BaP)[(e)]
Pentachorophenol	1.2E-01	B2	Carcinomas/liver and blood vessels/mouse	IRIS
Toluene	ND	ND	ND	
Trichloroethylene	1.1E-02	C/B2	NR[(g)]	Region V[(h)]
Vinyl chloride	1.4E+00	A	Tumors/lung and liver/rat	IRIS

Footnotes:

(a) The Weight-of-Evidence Classifications are: A = Human carcinogen; B1 = Probable human carcinogen; limited human data are available; B2 = Probable human carcinogen, sufficient evidence in animals & inadequate data in humans; C = Possible human carcinogen; D = Not classifiable as to human carcinogenicity.
(b) No data.
(c) Integrated Risk Information System.
(d) Health Effects Assessment Summary Tables.
(e) For assessing risks associated with polynuclear aromatic hydrocarbons (PAHs), toxicity equivalency factors (TEFs) were used to convert the slope factor for benzo[a]pyrene (BaP) into slope factors for the other carcinogenic PAHs. The TEF values used are documented in the report text (Section 5.1.4.4.1).
(f) Not Applicable.
(g) Not reported.
(h) Toxicity Guidance value obtained through personal communication with Mark Johnson, USEPA, Region 5 in 2000.

TABLE 5-28

Inhalation Toxicity Values - Carcinogenic Effects
Jefferson Proving Ground
Madison, Indiana

Chemical	Inhalation Unit Risk (µg/M^3)$^{-1}$	Inhalation Slope Factor[(a)] (mg/kg-d)$^{-1}$	Weight of Evidence[(b)]	Cancer Type/Target Organ/Species	Source
			Inorganics		
Aluminum	ND[(c)]	ND	ND	ND	
Antimony	ND	ND	ND	ND	
Arsenic	ND	ND	A	Carcinoma/lung/human	IRIS[(d)]
Barium	ND	ND	ND	ND	
Beryllium	2.4E-03	8.4E+00	B2	Carcinoma/lung/human	IRIS
Cadmium	ND	ND	B1	Carcinomas/respiratory tract/human	IRIS
Chromium (VI)	1.2E-02	4.2E+01	A	Carcinoma/lung/human	IRIS
Copper	ND	ND	ND	ND	
Iron	ND	ND	ND	ND	
Lead	ND	ND	ND	ND	
Manganese	ND	ND	D	ND	IRIS
Molybdenum	ND	ND	ND	ND	
Silver	ND	ND	D	ND	IRIS
Thallium	ND	ND	D	ND	IRIS
Vanadium	ND	ND	ND	ND	
Zinc	ND	ND	D	ND	IRIS
			Organics		
1,1-Dichloroethane	ND	ND	ND	ND	
1,1-Dichloroethylene	5.0E-05	1.75E-01	C	Carcinomas/kidney/mouse	IRIS
1,1,1-Trichloroethane	ND	ND	ND	ND	
1,1,2-Trichloroethane	1.6E-05	5.6E-02	C	Carcinomas/liver/mouse	IRIS
1,2-Dichloroethane	ND	ND	B2	Hemangiosarcomas/circulatory system/rat	IRIS
1,2-Dichloroethylene (mixed isomers)	ND	ND	ND	ND	
2,3,7,8-TCDD	3.3E-08	1.5E+05	B2	Tumors/respiratory system/rat	HEAST[(e)]
4-Amino-2,6-dinitrotoluene	ND	ND	ND	ND	
4-Chlorocresol	ND	ND	ND	ND	
Acetone	ND	ND	ND	ND	

TABLE 5-28

Inhalation Toxicity Values - Carcinogenic Effects
Jefferson Proving Ground
Madison, Indiana

Chemical	Inhalation Unit Risk $(\mu g/M^3)^{-1}$	Inhalation Slope Factor[(a)] $(mg/kg\text{-}d)^{-1}$	Weight of Evidence[(b)]	Cancer Type/Target Organ/Species	Source
Benzene	8.3E-06	2.73E-02	A	Leukemia/bone marrow/human	IRIS
Benzo(a)anthracene	NR[(f)]	3.1E-01	A	NR	Region 3 RBC[(g)]
Benzo(a)pyrene	NR	3.1E+00	A	NR	Region 3 RBC
Benzo(b)fluoranthene	NR	3.1E-01	A	NR	Region 3 RBC
Carbon disulfide	ND	ND	ND	ND	
Chlorobenzene	ND	ND	ND	ND	
Chloroform	2.3E-05	8.05E-02	B2	Carcinomas/liver/mouse	IRIS
DDE	ND	ND	ND	ND	
Dibenz(a,h)anthracene	NR	3.1E+00	B2	NA[(h)]	Region 3 RBC
Indeno(1,2,3-cd)pyrene	NR	3.1E-01	B2	NR	Region 3 RBC
Pentachlorophenol	NA	NA	B2	Carcinomas/liver and blood vessels/mouse	IRIS
Toluene	ND	ND	ND	ND	
Trichloroethylene	1.7E-06	6.0E-03	C/B2	NR	Region V[(i)]
Vinyl chloride	8.4E-05	3.08E-01	A	Tumors/liver/rat	HEAST

Footnotes:

(a) The inhalation slope factor was converted directly from the published inhalation unit risk:

$$SF = \frac{70\ kg \times UNIT\ RISK\ (\mu g/m^3)^{-1}}{20\ m^3/d \times 1.0E\text{-}03\ mg/\mu g}$$

(b) The Weight-of-Evidence Classifications are: A = Human carcinogen; B1 = Probable human carcinogen, limited human data are available; B2 = Probable human carcinogen, sufficient evidence in animals & inadequate data in humans; C = Possible human carcinogen; and D = Not classifiable as to human carcinogenicity.

(c) No Data.

(d) Integrated Risk Information System.

(e) Health Effects Assessment Summary Table.

(f) None Reported.

(g) USEPA Region 3 Risk-based Concentration Table; October 1997.

(h) Not applicable.

(i) Toxicity Guidance value obtained through personal communication with by Mark Johnson, USEPA, Region 5 in 2000.

TABLE 5-29

Sites Included in the Detailed Ecological Risk Assessment (DERA)
Jefferson Proving Ground
Madison, Indiana

Site	Description	Site Area(s)	Field Studies/Data Incorporation
2/27	Sewage Treatment Plant (STP)/Sewage Sludge Application Areas, STP outfall to Harberts Creek	2: 520 ft^2 27: 8.3 ac. Approximately 1500 ft for Harberts Creek	Macroinvertebrate sampling/Rapid Bioassessment, fish counts - Fall 1997 Phase I data were used for both Sites 2 and 27. Phase II data were used for Site 27 but were not available for Site 2.
3 & 4	Explosive Burning Area and Abandoned Landfill	3: 2.8 ac. 4: 2.8 ac.	Phase I data were used for both Sites 3 and 4. Phase II data were used for Site 3 but were not available for Site 4. Phase III data were collected at Site 3 and used to represent Site 4 as well.
New Burn Site	New burn site adjacent to Sites 3/4	Inside Trench: Approximately 1120 ft^2 Outside Trench: Approximately 7590 ft^2	Data collected in September 1997 for the RI were used in the DERA
7 & 21B	Red Lead Disposal Area/ Temporary Storage Area at Building 211	7: 300 ft^2 21B: 0.08 ac.	Phase I data were available and used for Site 7 and Site 21B. Phase II data were available and used for Site 21B Interim Measures (IM) confirmation sampling data were available and used for Sites 7/21B.
9	Burning Ground South of Gate 19 Landfill	4.6 ac.	Phase I and Phase II data were available and used for Site 9. Phase III data were collected and used for Site 9.

TABLE 5-29

Sites Included in the Detailed Ecological Risk Assessment (DERA)
Jefferson Proving Ground
Madison, Indiana

Site	Description	Site Area(s)	Field Studies/Data Incorporation
11	Burning Area for Explosive Residue	1.6 ac.	Phase I data were available and used for Site 11. RCRA closure plan sampling data were not available at the time of this report (???) Phase III data were collected and used for Site 11.
14 & 15	Yellow Sulfur Disposal Area/Burn Area South of New Incinerator	14: 0.11 ac. 15: 0.1 ac.	Phase I data were available and used for Site 14. IM confirmation sampling data were available and used for Site 14. Phase III data were collected at Site 14 and used to represent Site 15 as well. Phase I data were available and used for Site 15. IM confirmation sampling data were available and used for Site 15.
25	Papermill Road Disposal Area	0.9 ac.	Phase I and Phase II data were available and used for Site 25. Phase III data were collected and used for Site 25. IM confirmation sampling data were available and used for Site 25.
28, 29, **39**	Gator Z Area	28: 0.2 ac. 29: 0.5 ac. 39: 16 ac.	Phase I data were available and used for Sites 28, 29, and 39. IM confirmation sampling data for Sites 28 & 29 were available and incorporated into the DERA. Phase III data were collected at Site 39 and used to represent Sites 28 and 29 as well.

TABLE 5-29

Sites Included in the Detailed Ecological Risk Assessment (DERA)
Jefferson Proving Ground
Madison, Indiana

Site	Description	Site Area(s)	Field Studies/Data Incorporation
Reference areas - Terrestrial	3 Locations for Phase II background soil collection	0.23 ac for each location	Phase II data were used to represent JPG background; DERA field data were used to represent reference areas.
Reference Area - Aquatic	Harberts Creek stream segment	Approximately 1500 ft for Harberts Creek	DERA field data were used.

General Note:
1. Bold numbers indicate sites selected for DERA field studies.

TABLE 5.3-1

Steps in the Ecological Risk Assessment Process and Corresponding Decision Points in the Superfund Process
Jefferson Proving Ground
Madison, Indiana

Step	Description/Document	Scientific/Management Decision Points (SMDPs)	Date
1.	Screening-level Problem Formulation and Ecological Effects Evaluation (Revised Final PERA)		
2.	Screening-level Preliminary Exposure Estimate and Risk Calculation (Revised Final PERA)	SMDP (a)	Rust E&I 1997g.
3.	Baseline Risk Assessment Problem Formulation (Final TM, DERA Work Plan)	SMDP (b)	Rust E&I 1997f; 1/23/98
4.	Study Design and Data Quality Objectives (Final TM, DERA Work Plan)	SMDP (c)	Rust E&I 1997f; 1/23/98
5.	Field Verification of Sampling Design (Fall 1997 DERA Field Effort)	SMDP (d)	DERA - August 1998
6.	Site Investigation and Analysis of Exposure and Effects (DERA)	[SMDP]	DERA - August 1998
7.	Risk Characterization (DERA)		DERA - August 1998
8.	Risk Management	SMDP (e)	

Corresponding Decision Points in the Superfund Process:

SMDP	
a)	Decision about whether a full ecological risk assessment is necessary.
b)	Agreement among the risk assessors, risk manager, and other involved parties on the conceptual model, including assessment endpoints, exposure pathways, and questions or risk hypotheses.
c)	Agreement among the risk assessors and risk manager on the measurement endpoints, study design, and data interpretation and analysis.
d)	Signing approval of the work plan and sampling and analysis plan for the ecological risk assessment.
[SMDP]	Only if change to the sampling and analysis plan is necessary.
e)	Signing the record of decision (ROD).

Source: Exhibit I-3. USEPA 1997.

TABLE 5.3-2

Summary Statistics for Soil Depth 0-2 ft - Phase II Background Soil
Jefferson Proving Ground
Madison, Indiana

Analyte Code	Analyte	Minimum	Maximum	Mean	Std. Dev. [(a)]	UCL95 [(b)]	N [(c)]	EPC [(d)]	DF [(e)]	Distribution
AG	Silver	0.05	0.05	0.05	NA [(f)]	NA	20	NA	0	NA
AL	Aluminum	5400	14900	8128	2262	9003	20	9003	100	LN [(g)]
AS	Arsenic	3.27	9.46	4.9	1.64	5.55	20	5.5	100	LN
B	Boron	5.00	5.00	5.00	NA	NA	20	NA	0	NA
BA	Barium	26.5	88.4	50.9	16.0	57.1	20	57.09	100	N [(h)]
BE	Beryllium	0.12	0.45	0.33	0.1	0.4	20	0.36	100	N
CD	Cadmium	0.22	0.53	0.27	0.1	0.3	20	0.29	15	NLN [(i)]
CO	Cobalt	0.80	4.80	2.51	1.0	2.9	20	2.89	100	N
CR	Chromium	6.04	15.5	10.7	2.8	11.7	20	11.73	100	N
CU	Copper	2.01	6.51	3.99	1.2	4.4	20	4.45	75	N
FE	Iron	6280	14300	9420	2324	10318	20	10318	100	N
HG	Mercury	0.05	0.05	0.05	NA	NA	20	NA	0	NA
MN	Manganese	19.1	668	203.1	156.6	264	20	263.6	100	LN
MO	Molybdenum	3.15	5	4.87	0.43	5	20	5	10	NLN
NI	Nickel	2	5.77	2.7	1.10	3	20	3.12	30	NLN
PB	Lead	11	20.5	14.09	2.07	15	20	14.89	100	LN
SB	Antimony	0.31	0.64	0.42	0.090	0.45	20	0.451	90	LN
SE	Selenium	0.25	0.96	0.45	0.21	0.53	20	0.527	60	NLN
SN	Tin	1.15	1.15	1.15	NA	NA	20	NA	0	NA
TL	Thallium	0.43	0.5	0.49	0.02	0.50	20	0.5	10	NLN
V	Vanadium	15.6	30.3	21.3	3.69	22.74	20	22.74	100	N
ZN	Zinc	10.3	22.5	16.53	3.01	17.69	20	17.69	100	N

General Note:

1. For analytes with no detects, values represent 1/2 of the detection limit.

Footnotes:

(a) Standard deviation.

(b) Upper 95 % confidence limit.

(c) Number of samples.

(d) Exposure point concentration.

(e) Detection frequency.

(f) Not applicable.

(g) Lognormal.

(h) Normal.

(I) Not lognormal.

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TABLE 5.3-3

Shapiro-Wilk's Normality Test Results - Phase II Background Soil
Jefferson Proving Ground
Madison, Indiana

Analyte Code	Analyte	W Test Result - Normal values	W Test Result - Lognormal values
AG	Silver	NA [(a)] -no detects	NA-no detects
AL	Aluminum	NN[(b)]	LN[(c)]
AS	Arsenic	NN	LN
B	Boron	NA-no detects	NA-no detects
BA	Barium	N[(d)]	
BE	Beryllium	N	
CD	Cadmium	NN	NLN[(e)]
CO	Cobalt	N	
CR	Chromium	N	
CU	Copper	N	
FE	Iron	N	
HG	Mercury	NA-no detects	NA-no detects
MN	Manganese	NN	LN
MO	Molybdenum	NN	NLN
NI	Nickel	NN	NLN
PB	Lead	NN	LN
SB	Antimony	NN	LN
SE	Selenium	NN	NLN
SN	Tin	NA-no detects	NA-no detects
TL	Thallium	NN	NLN
V	Vanadium	N	
ZN	Zinc	N	

Footnotes:

(a) Not applicable.
(b) Not normal.
(c) Lognormal.
(d) Normal.
(e) Not lognormal.

TABLE 5.3-4

Summary of Data Collected at Detailed Ecological Risk Assessment (DERA) Sites Under Each Sampling Program
Jefferson Proving Ground
Madison, Indiana

PHASE 1						PHASE II					
Chemical Class	**CSE[a]**	**CSO[b]**	**CSW[c]**	**SITE**	**Total N**	**Chemical Class**	**CSE**	**CSO**	**CSW**	**SITE**	**Total N**
Metals		x		2,3,4,7,9,11,14,15,21,25,27,28,39	44	Metals		x		3,25,27	66
			x	2,9,29; 2,14,29 (filtered)	8; 6						
	x			2,9,29	11						
Volatile Organic Compounds (VOCs)		x		4,9,11,14,25	17	VOCs					
	x			9	3						
			x	9	3						
Anions			x	2	2	Anions					
Cyanide	x			2	5	Cyanide					
		x		27	12						
Explosives			x	9,29	6	Explosives			x	9	1
	x			9,29	6			x		3,9,39	11
		x		3,4,9,11,15,25,28,39	27						
Herbicides		x		11	14	Herbicides					
Pesticides			x	9	3	Pesticides					
		x		21,27	7						
pH		x		14	10	pH					
Semi-volatile organic compounds (SVOCs)	x			9	3	SVOCs		x		2,9,25	14
			x	9	3						
		x		2,4,7,9,11	15						
Total petroleum hydrocarbons (TPHC)	x			2	5	TPHC					
		x		2,15,21,25	12						
Total sulfur		x		14	10	Total S					
Pesticides / Polychlorinated biphenyls (PCBs)						Pesticides/PCBs		x		21	15

FALL 97 - Phase III					
Chemical Class	**CSE**	**CSO**	**CSW**	**SITE**	**Total N**
Metals		x		3/4, 9,11,14/15,25,39; New Burn Site (NB	45; 40
Cyanide		x		3/4, 9,11,14/15,25,39	45
Explosives				NBS	40
pH				3/4, 9,11,14/15,25,39	45
SVOCs				NBS	40
Dioxins				NBS	40
Total Organic Carbon (TOC)		x		3/4, 9,11,14/15,25,39	45

Interim Measures Confirmation Sampling					
Chemical Class	**CSE**	**CSO**	**CSW**	**SITE**	**Total N**
Metals		x		7	9
		x		14	27
		x		25	24
		x		28	11
			x	29	1
	x			29	2
VOCs		x		25	24
Explosives	x			29	2
Oil & Grease			x	29	1
pH		x		14	27
SVOCs		x		25	24
TPHC			x	29	1
Total S		x		14	27

Footnotes:

(a) Sediment.
(b) Surface soil.
(c) Surface water.

TABLE 5.3-5

Summary of Preliminary Contaminants of Potential Concern (COPCs) for Detailed Ecological Risk Assessment (DERA) Site Data
Jefferson Proving Ground
Madison, Indiana

Analyte Code	Analyte	Phase	Sites	Medium
TRCLE	Trichloroethylene	P1	4	CSO [(a)]
MET	**Metals**	P1	2,9,29	CSE [(b)]
MET	**Metals**	P1	3,4,7,9,11,14,15,21,25,27,28,39	CSO
BA, MN	Barium, manganese	P1	2	CSW [(c)]
AL, BA, FE, HG, MN, ZN	Aluminum, barium, iron, mercury, manganese, zinc	P1	9	CSW
AL, BA, CD, FE, MN, ZN	Aluminum, barium, cadmium, iron, manganese, zinc	P1	29	CSW
ALDRN,BENSLF,DLDRN,ENDRN,PPDDD,PPDDE,PPDDT	Aldrin, endosulfan II, dieldrin, endrin, ppDDD [(d)], ppDDE [(e)], ppDDT [(f)]	P1	21	CSO
DLDRN,ENDRN,PPDDT	Dieldrin, endrin, ppDDT	P1	27	CSO
TS	Total sulfur	P1	14	CSO
CYN	Cyanide anion	P1	27	CSO
TPHC	Total petroleum hydrocarbons	P1	2, 15, 21, 25	CSO
ANIONS - CL, NIT, P4, SO4	Chloride, nitrate-nitrite, nonspecific, phosphorus, sulfate	P1	2	CSW
SVOCs/PEST	**Semivolatile Organic Compounds/Pesticides**			
PPDDD	2,2-Bis(p-chlorophenyl)-1,1-dichloroethane	P1	2	CSO
2MNAP	2-Methylnaphthalene	P1	9	CSO
ANAPNE	Acenaphthene	P1	9	CSO
ANAPYL	Acenaphthylene	P1	9	CSO
B2EHP	Bis(2-ethylhexyl) phthalate	P1	9	CSO
BAANTR	Benzo[a]anthracene	P1	9	CSO
BBFANT	Benzo[b]fluoranthene	P1	9	CSO
BGHIPY	Benzo[ghi]perylene	P1	9	CSO
BKFANT	Benzo[k]fluoranthene	P1	9	CSO
CHRY	Chrysene	P1	9	CSO
DMP	Dimethyl phthalate	P1	4	CSO
DNBP	Di-n-butyl phthalate	P1	9, 11	CSO
FANT	Fluoranthene	P1	9	CSO
FLRENE	Fluorene	P1	9	CSO
PHANTR	Phenanthrene	P1	9	CSO
PHENOL	Phenol	P1	9	CSO
PYR	Pyrene	P1	9	CSO
EXPL	**Explosives**			
135TNB	1,3,5-trinitrobenzene	P1	9, 29	CSW
MET	**Metals**	P2	3,25,27	CSO
SVOCs	**Semivolatile Organic Compounds**			
24DNT	2,4-dinitrotoluene	P2	9	CSO
4MP	p-cresol	P2	9	CSO
BAANTR	Benzo[a]anthracene	P2	9	CSO
BAPYR	Benzo[a]pyrene	P2	9	CSO
BBFANT	Benzo[b]fluoranthene	P2	9	CSO
BGHIPY	Benzo[ghi]perylene	P2	9	CSO
BKFANT	Benzo[k]fluoranthene	P2	9	CSO
CHRY	Chrysene	P2	9	CSO
FANT	Fluoranthene	P2	9	CSO
ICDPYR	Indeno[1,2,3-C,D]pyrene	P2	9	CSO
NNDPA	N-nitrosodiphenylamine	P2	9	CSO
PHANTR	Phenanthrene	P2	9	CSO
PYR	Pyrene	P2	9	CSO
ALDRN, CLDAN,DLDRN,ENDRN,HPCL,HPCLE,PPDDE,PPDDT	Aldrin, chlordane, dieldrin, endrin, heptachlor, heptachlor epoxide, ppDDE, ppDDT	P2	21	CSO

TABLE 5.3-5

Summary of Preliminary Contaminants of Potential Concern (COPCs) for Detailed Ecological Risk Assessment (DERA) Site Data
Jefferson Proving Ground
Madison, Indiana

Analyte Code	Analyte	Phase	Sites	Medium
SVOC	**Semivolatile Organic Compounds**			
ANTRC	Anthracene	P2	25	CSO
B2EHP	Bis(2-ethylhexyl) phthalate	P2	25	CSO
BAANTR	Benzo[a]anthracene	P2	25	CSO
BAPYR	Benzo[a]pyrene	P2	25	CSO
BBFANT	Benzo[b]fluoranthene	P2	25	CSO
BGHIPY	Benzo[ghi]perylene	P2	25	CSO
BKFANT	Benzo[k]fluoranthene	P2	25	CSO
CHRY	Chrysene	P2	25	CSO
FANT	Fluoranthene	P2	25	CSO
ICDPYR	Indeno[1,2,3-C,D]pyrene	P2	25	CSO
PHANTR	Phenanthrene	P2	25	CSO
PYR	Pyrene	P2	25	CSO
MET, CYN	**Metals+cyanide**	P3-Eco	3/4, 9, 11, 14, 25, 39	CSO
MET	**Metals**	P3-NBS	NBS	CSO
SVOCs/PEST	**Semivolatile Organic Compounds/Pesticides**	P3-NBS	NBS	CSO
2MNAP	2-Methylnaphthalene	P3-NBS	NBS	CSO
2MPYR	2-Methylpyrene	P3-NBS	NBS	CSO
2PNAP	2-Phenylnaphthalene	P3-NBS	NBS	CSO
ANAPNE	Acenaphthene	P3-NBS	NBS	CSO
ANAPYL	Acenaphthylene	P3-NBS	NBS	CSO
ANTRC	Anthracene	P3-NBS	NBS	CSO
BAANTR	Benzo[a]anthracene	P3-NBS	NBS	CSO
BAPYR	Benzo[a]pyrene	P3-NBS	NBS	CSO
BBFANT	Benzo[b]fluoranthene	P3-NBS	NBS	CSO
BENZOA	Benzoic acid	P3-NBS	NBS	CSO
BEPYR	Benzo[e]pyrine	P3-NBS	NBS	CSO
BGHIPY	Benzo[ghi]perylene	P3-NBS	NBS	CSO
BJFANT	Benzo[j]fluoranthene	P3-NBS	NBS	CSO
BKFANT	Benzo[k]fluoranthene	P3-NBS	NBS	CSO
BN21DT	Benzo[b]naphtho[2,1-D]thiophene	P3-NBS	NBS	CSO
C14A	Myristic acid	P3-NBS	NBS	CSO
C16A	Palmitic acid	P3-NBS	NBS	CSO
C19	Nonadecane	P3-NBS	NBS	CSO
CARBAZ	Carbazole	P3-NBS	NBS	CSO
CHRY	Chrysene	P3-NBS	NBS	CSO
DBAHA	Dibenz[ah]anthracene	P3-NBS	NBS	CSO
DBZFUR	Dibenzofuran	P3-NBS	NBS	CSO
DBZTHP	Dibenzothiophene	P3-NBS	NBS	CSO
EICOSL	1-eicosanol	P3-NBS	NBS	CSO
FANT	Fluoranthene	P3-NBS	NBS	CSO
FLRENE	Fluorene	P3-NBS	NBS	CSO
ICDPYR	Indeno[1,2,3-C,D]pyrene	P3-NBS	NBS	CSO
NAP	Naphthalene	P3-NBS	NBS	CSO
ODECA	Stearic acid	P3-NBS	NBS	CSO
PAH	Polynuclear aromatic hydrocarbons	P3-NBS	NBS	CSO
PHANTR	Phenanthrene	P3-NBS	NBS	CSO
PPDDE	2,2-bis(p-chlorophenyl)-1,1-dichloroethene	P3-NBS	NBS	CSO
PPDDT	2,2-bis(p-chlorophenyl)-1,1,1-trichloroethane	P3-NBS	NBS	CSO
PYR	Pyrene	P3-NBS	NBS	CSO

TABLE 5.3-5

Summary of Preliminary Contaminants of Potential Concern (COPCs) for Detailed Ecological Risk Assessment (DERA) Site Data
Jefferson Proving Ground
Madison, Indiana

Analyte Code	Analyte	Phase	Sites	Medium
DIOX	**Dioxins/furans**	P3-NBS	NBS	CSO
234HXF	2,3,4,6,7,8-hexachlorodibenzofuran	P3-NBS	NBS	CSO
234PCF	2,3,4,7,8-pentachlorodibenzofuran	P3-NBS	NBS	CSO
678HPD	1,2,3,4,6,7,8-heptachlorodibenzo-p-dioxin	P3-NBS	NBS	CSO
678HPF	1,2,3,4,6,7,8-heptachlorodibenzofuran	P3-NBS	NBS	CSO
789HPF	1,2,3,4,7,8,9-heptachlorodibenzofuran	P3-NBS	NBS	CSO
789HXD	1,2,3,7,8,9-hexachlorodibenzo-p-dioxin	P3-NBS	NBS	CSO
789HXF	1,2,3,7,8,9-hexachlorodibenzofuran	P3-NBS	NBS	CSO
78HXDD	1,2,3,4,7,8-hexachlorodibenzo-p-dioxin	P3-NBS	NBS	CSO
78PCDD	1,2,3,7,8-pentachlorodibenzo-p-dioxin	P3-NBS	NBS	CSO
78PCDF	1,2,3,7,8-pentachlorodibenzofuran	P3-NBS	NBS	CSO
OCDD	Octachlorodibenzodioxin - nonspecific	P3-NBS	NBS	CSO
OCDF	Octachlorodibenzofuran - nonspecific	P3-NBS	NBS	CSO
TCDD	2,3,7,8-tetrachlorodibenzodioxin	P3-NBS	NBS	CSO
TCDF	2,3,7,8-tetrachlorodibenzofuran	P3-NBS	NBS	CSO

Footnotes:

(a) Surface soil
(b) Sediment.
(c) Surface water.
(d) 2,2-Bis(p-chlorophenyl)-1,1-dichloroethane.
(e) 2,2-Bis(p-chlorophenyl)-1,1-dichloroethene.
(f) 2,2-Bis(p-chlorophenyl)-1,1,1-trichloroethane.

TABLE 5.3-6

Observed and Potential Wildlife
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
	Phylum: Arthropoda			
	Class: Crustacea			
Order: Decopoda	**Crayfishes and Shrimps**			
Family: Astacidae	**Crayfish**			
Cambarus diogenes	Crayfish	x[(a)]	y[(b)]	
Cambarus rusticus	Crayfish	x	y	
	Class: Insecta			
Order: Lepidoptera	**Butterflies**			
Family: Lycaenidae	**Blues, Coppers, and Hairstreaks**			
Lycaeides melissa samuelis	Karner blue butterfly		z[(c)]	IE[(d)],FE[(e)]
Family: Nymphalidae	**Brush-footed butterflies**			
Neonympha mitchellii mitchellii	Mitchell's satyr butterfly		z	FE,IE
Order: Odonata	**Dragon-flies**			
Family: Cordulidae	**Green-eyed skimmers**			
Somatochlora hineana	Hine's emerald dragonfly		z	IEx,[(f)] FE
	Phylum: Chordata			
	Class: Amphibia			
Order: Anura				
Family: Pelobatidae	**Spadefoot Toads**			
Scaphiopus holbrookii holbrookii	Eastern spadefoot	UNK	UNK	ISS
Family: Bufonidae	**True Toads**			
Bufo americanus	Eastern American toad	x	y	
Bufo woodhousei fowleri	Fowler's toad	x	y	
Family: Hylidae	**Tree Frogs**			
Acris crepitans blanchardi	Blanchard's cricket frog		y	
Hyla chrysocelis	Cope's gray tree frog	x	y	
Pseudacris c.crucifer	Spring peeper	x	y	
Pseudacris triseriata	Northern chorus frog	x	y	

TABLE 5.3-6

Observed and Potential Wildlife
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Family: Ranidae	**True Frogs**			
Rana catesbeiana	Bullfrog	x	y	
Rana clamitans melanota	Green frog	x	y	
Rana areolata circulosa	Northern crawfish frog	UNK	UNK	IE
Rana pipiens	Northern leopard frog	UNK	UNK	ISS
Rana palustris	Pickerel frog	x	y	
Rana blairi	Plains leopard frog	UNK	UNK	ISS
Rana sylvatica	Wood frog	x	y	
Rana utricularia	Southern leopard frog	x	y	
Order: Caudata	**Salamanders**			
Family: Cryptobranchidae	**Giant Salamander Family**			
Cryptobranchus alleganiensis alleganiensis	Hellbender	UNK	UNK	IE
Family: Ambystomidae	**Mole Salamander Family**			
Ambystoma barbouri	Barbour's salamander	x	y	
Ambystoma laterale	Blue-spotted salamander	UNK	UNK	ISS
Ambystoma maculatum	Spotted salamander	x	y	
Ambystoma jeffersonianum	Jefferson salamander	x	y	
Family: Plethodontidae	**Lungless Salamanders**			
Hemidactylium scutatum	Four-toed salamander	UNK	UNK	IE
Aneides aeneus	Green salamander	UNK	UNK	IE
Desmognathus f. fuscus	Northern dusky salamander	x	y	
Eurycea cirrigera	Southern two-lined salamander	x	y	
Eurycea longicauda	Longtail salamander	x	y	
Eurycea lucifuga	Cave salamander	x	y	
Plethodon cinereus	Redback salamander	x	y	
Pseudotriton ruber ruber	Northern red salamander	UNK	UNK	IE
Plethodon glutinosus	Northern slimy salamander	x	y	

TABLE 5.3-6

Observed and Potential Wildlife
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Plethodon richmondi	Ravine salamander	x	y	
Family: Proteidae	**Mudpuppies**			
Necturus maculosus	Mudpuppy	x	y	ISS[(g)]
Family: Salamandridae	**Newts**			
Notopthalmus v.viridescens	Red-spotted newt	x	y	
	Class: Pisces			
Order: Percopsiformes				
Family: Amblyopsidae	**Cavefishes**			
Typhlichthys subterraneus	Southern cavefish	UNK	UNK	IE
Amblyopsis spelaea	Northern cavefish	UNK	UNK	IE
Family: Amildae	**Bowfin**			
Amia calva	Bowfin	x	y	
Family: Acipenseridae	**Sturgeons**			
Acipenser fulvescens	Lake sturgeon	UNK	UNK	IE
Family: Atherinidae	**Silverside**			
Labidesthes sicculus	Brook silverside	x	y	
Family: Catostomidae	**Suckers**			
Catostomus commersoni	White sucker	x	y	
Cycleptus elongatus	Blue sucker	UNK	UNK	ISS
Hypentelium nigricans	Northern hogsucker	x	y	
Minytrema melanops	Spotted sucker	x	y	
Lagochila lacera	Harelip sucker	UNK	UNK	ISS
Moxostoma carinatum	River redhorse	UNK	UNK	ISS
Moxostoma valenciennesi	Greater redhorse	UNK	UNK	IE
Moxostoma duquesnei	Black redhorse	x	y	
Moxostoma erythrurum	Golden redhorse	x	y	
Family: Centrarchidae	**Sunfish**			

TABLE 5.3-6

Observed and Potential Wildlife
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Ambloplites ruperstris	Rock bass	x	y	
Lepomis cyanellus	Green sunfish	x	y	
Lepomis symmetricus	Bantam sunfish	UNK	UNK	ISS
Lepomis macrochirus	Bluegill	x	y	
Lepomis megalotis	Longear sunfish	x	y	
Micropterus dolomieu	Smallmouth bass	x	y	
Micropterus punctulatus	Spotted bass	x	y	
Micropterus salmoides	Largemouth bass	x	y	
Lepomis spp.	Hybrid sunfish	x	y	
Family: Clupeidae	**Herring**			
Alosa alabamae	Alabama shad	UNK	UNK	IEx
Dorosoma cepedianum	Gizzard shad	x	y	
Family: Cyprinidae	**Minnows**			
Campostoma anomalum	Central stoneroller	x	y	
Cyprinella spiloptera	Spotfin shiner	x	y	
Cyprinus carpio	Common carp	x	y	
Clinostomus elongatus	Redside dace	UNK	UNK	IE
Luxilis chrysocephalus	Striped shiner	x	y	
Lythrurus umbratilis	Redfin shiner	x	y	
Notropis amblops	Bigeye chub	x	y	
Notropis ariommus	Popeye shiner	UNK	UNK	ISS
Notropis atherinoides	Emerald shiner	x	y	
Notropis boops	Bigeye shiner	x	y	
Notropis buccatus	Silverjaw minnow	x	y	
Notropis photogenis	Silver shiner	x	y	
Notropis stramineus	Sand shiner	x	y	
Notropis volucellus	Mimic shiner	x	y	

TABLE 5.3-6

Observed and Potential Wildlife
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Phenacobius mirablis	Suckermouth minnow	x	y	
Pimephales notatus	Bluntnose minnow	x	y	
Semotilus atromaculatus	Creek chub	x	y	
Family: Esocidae	**Pike**			
Esox masquinongy masquinongy	Great Lakes muskellunge	UNK	UNK	IEx
Esox americanus vermiculatus	Grass pickerel	x	y	
Family: Fundulidae	**Top Minnows (Killifishes)**			
Fundulus catenatus	Northern studfish	UNK	UNK	ISS
Family: Ictaluridae	**Catfish**			
Ameiurus melas	Black bullhead	x	y	
Ameiurus natalis	Yellow bullhead	x	y	
Ictalurus punctatus	Channel catfish	x	y	
Noturus miurus	Brindled madtom	x	y	
Family: Salmonidae	**Trouts**			
Coregonus artedi	Cisco	UNK	UNK	ISS
Family: Lepisosteidae	**Gar Family**			
Lepisosteus osseus	Longnose gar	x	y	
Family: Percidae	**Perch**			
Etheostoma camurum	Bluebreast darter	UNK	UNK	IE
Percina evides	Gilt darter	UNK	UNK	IE
Etheostoma blennioides	Greenside darter	x	y	
Etheostoma histrio	Harlequin darter	UNK	UNK	IE
Etheostoma caeruleum	Rainbow darter	x	y	
Etheostoma flabellare	Fantail darter	x	y	
Etheostoma nigrum	Johnny darter	x	y	
Crystallaria asprella	Crystal darter	UNK	UNK	ISS
Ammocrypta pellucida	Eastern sand darter	UNK	UNK	ISS

TABLE 5.3-6

Observed and Potential Wildlife
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Etheostoma spectabile	Orangethroat darter	x	y	
Etheostoma squamiceps	Spottail darter	UNK	UNK	IE
Etheostoma maculatum	Spotted darter	UNK	UNK	IE
Etheostoma tippecanoe	Tippecanoe darter	UNK	UNK	IE
Etheostoma variatum	Variegate darter	UNK	UNK	IE
Etheostoma zonale	Banded darter	x	y	
Percina uranidea	Stargazing darter	UNK	UNK	ISS
Percina caprodes	Logperch	x	y	
Percina maculata	Blackside darter	x	y	
	Class: Reptila			
Order: Chelonia	**Turtles**			
Family: Chelydridae	**Snapping Turtles**			
Macroclemys temminckii	Alligator snapping turtle	UNK	UNK	IE
Chelydra s. serpentina	Common snapping turtle	x	y	
Family: Emydidae	**Pond, Marsh, and Box Turtle Family**			
Chrysemys picta bellii	Western painted turtle		y	
Chrysemys concinna hieroglyphica	Hieroglyphic river cooter	UNK	UNK	IE
Emydoidea blandingii	Blanding’s turtle	UNK	UNK	IE
Clemmys guttata	Spotted turtle	UNK	UNK	IE
Terrapene ornata	Ornate box turtle	UNK	UNK	IE
Terrapene c. carolina	Eastern box turtle	x	y	
Family: Kinosternidae	**Musk and Mud Turtle Family**			
Kinosteron subrubrum subrubrum	Eastern mud turtle	UNK	UNK	IE
Sternotherus odoratus	Stinkpot		y	
Family: Trionychidae	**Softshell Turtle Family**			
Trionyx s. spiniferus	Eastern spiny softshell	x	y	
Order: Squamata	**Lizards and Snakes**			

TABLE 5.3-6

Observed and Potential Wildlife
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Suborder: Sauria	**Lizards**			
Family: Scincidae	**Skinks**			
Eumeces fasciatus	Five-lined skink	x	y	
Eumeces laticeps	Broadhead skink		y	
Suborder: Serpentes	**Snakes**			
Family: Colubridae	**Colubrids**			
Clonophis kirtlandii	Kirtland’s snake	x	y	IE
Tantilla coronata	Southeastern crowned snake	UNK	UNK	IE
Cemophora coccinea copei	Northern scarlet snake	UNK	UNK	IE
Farancia abacura reinwardtii	Western mud snake	UNK	UNK	IEx
Coluber constrictor priapus	Southern black racer	x	y	
Diadophis punctatus edwardsii	Northern ringneck snake	x	y	
Elaphe o. obsoleta	Black rat snake	x	y	
Heterodon platirhinos	Eastern hognose snake	x	y	
Lampropeltis getula nigra	Black kingsnake		y	
Lampropeltis triangulum	Milk snake		y	
Nerodia erythrogaster neglecta	Northern copperbelly water snake	UNK	UNK	FT, IE
Nerodia sipedon pleuralis	Midland water snake	x	y	
Thamnophis butleri	Butler’s garter snake	UNK	UNK	IE
Thamnophis proximus	Western ribbon snake	UNK	UNK	ISS
Opheodrys vernalis	Smooth green snake	UNK	UNK	IE
Opheodrys aestivus	Rough green snake		y	ISS
Regina septemvittata	Queen snake	x	y	
Thamnophis sirtalis	Common garter snake	x	y	
Family: Viperidae	**Vipers**			
Sistrurus catenatus catenatus	Eastern massasauga rattlesnake	UNK	UNK	IE
Crotalus horridus	Timber rattlesnake	UNK	UNK	IE

TABLE 5.3-6

Observed and Potential Wildlife
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Agkistrodon piscivorus leucostoma	Western cottonmouth	UNK	UNK	IE
Agkistrodon contortrix mokasen	Northern copperhead	x	y	
	Class: Aves			
Order: Anseriformes	**Waterfowl**			
Family: Anatidae	**Geese, Swans, and Ducks**			
Anas platyrhynchos	Mallard	x	y	
Cygnus buccinator	Trumpeter swan	UNK	UNK	IE
Aix sponsa	Wood duck	x	y	
Branta canadensis	Canada goose	x	y	
Order: Apodiformes	**Swifts and Hummingbirds**			
Family: Apodidae	**Swifts**			
Chaetura pelagica	Chimney swift	x	y	
Family: Trochilidae	**Hummingbirds**			
Archilochus colubris	Ruby-throated hummingbird		y	
Order: Caprimulgiformes	**Goatsuckers**			
Family: Caprimulgidae	**Nightjars**			
Caprimulgus vociferus	Whip-poor-will		y	
Order: Charadriiformes	**Shorebirds**			
Family: Alcedinidae	**Kingfishers**			
Megaceryle alcyon	Belted kingfisher	x	y	
Family: Charadriidae	**Plovers**			
Charadrius melodus	Piping plover		z	FE, IE
Charadrius vociferous	Killdeer	x	y	
Family: Laridae	**Gulls and Terns**			
Sterna antillarum	Least tern		z	FE, IE
Sterna antillarum athalassos	Interior least tern	UNK	UNK	FE, IE
Chlidonias niger	Black tern	UNK	UNK	IE

TABLE 5.3-6

Observed and Potential Wildlife
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Family: Scolopacidae	**Sandpipers and Phalaropes**			
Gallinago gallinago	Common snipe	x	y	
Bartramia longicauda	Upland sandpiper	UNK	UNK	IE
Philihela minor	American woodcock	x	y	
Order: Ciconiformes	**Herons and Storks**			
Family: Ardeidae	**Herons, Egrets, and Bitterns**			
Ardea herodias	Great blue heron	x	y	ISS
Butorides striatus	Green heron	x	y	
Ardea alba	Great egret	UNK	UNK	ISS
Ixobrychus exilis	Least bittern	UNK	UNK	IE
Botaurus lentiginosus	American bittern	UNK	UNK	FE
Nyctanassa violacea	Yellow-crown night-heron	UNK	UNK	IE
Nycticorax nycticorax	Black-crowned night-heron	UNK	UNK	IE
Order: Columbiformes	**Pigeons**			
Family: Columbidae	**Pigeons and Doves**			
Columba livia	Rock dove	x	y	
Zenaida macroura	Mourning dove	x	y	
Order: Falconiformes	**Birds of Prey**			
Family: Accipitridae	**Hawks and Eagles**			
Accipiter cooperi	Cooper's hawk	x	y	
Accipiter striatus	Sharp-shinned hawk	x	y	ISS
Pandion haliaetus	Osprey	UNK	UNK	IE
Ictinia mississippiensis	Mississippi kite	UNK	UNK	ISS
Buteo jamaicensis	Red-tailed hawk	x	y	
Buteo lagopus	Rough-legged hawk	x	y	
Buteo lineatus	Red-shouldered hawk	x	y	ISS
Buteo platypterus	Broad-winged hawk	x	y	ISS
Circus cyaneus	Northern harrier	x	y	IE

TABLE 5.3-6

Observed and Potential Wildlife
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Haliaeetus leucocephalus	Bald eagle		z	FT[h], IE
Family: Cathartidae	**Vultures**			
Carthartes aura	Turkey vulture	x	y	
Coragyps atratus	Black vulture	x	y	
Family: Falconidae	**Falcons**			
Falco pergrinus	Pergrine falcon		z	FE, IE
Falco sparverius	American kestrel		y	
Order: Galliformes	**Gallineaceous Birds**			
Family: Meleagrididae	**Turkeys**			
Meleagris gallopavo	American turkey	x	y	
Family: Phasianidae	**Fowl-like birds**			
Colinus virginianus	Northern bobwhite	x	y	
Order: Passeriformes	**Perching Birds (Passerines)**			
Family: Alaudidae	**Larks**			
Eremophilia alpestris	Horned lark	x	y	
Family: Bombycillidae	**Waxwings**			
Bombycilla cedrorum	Cedar waxwing	x	y	
Family: Certhiidae	**Creepers**			
Certhia americana	Brown creeper	x	y	
Family: Corvidae	**Jays, magpies, and crows**			
Corvus brachyrhynchos	American crow	x	y	
Cyanocitta cristata	Blue jay		y	
Family: Cuculidae	**Cuckoos**			
Coccyzus americanus	Yellow-billed cuckoo		y	
Coccyzus erythropthalmus	Black-billed cuckoo		y	
Family: Fringillidae	**Grosbeaks and sparrows**			
Aimophila aestivalis	Bachman’s sparrow	x	y	IE

TABLE 5.3-6

Observed and Potential Wildlife
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Ammodramus savannarum	Grasshopper sparrow	x	y	
Cardinalis cardinalis	Northern cardinal	x	y	
Carduelis tristis	American goldfinch	x	y	
Carpodacus mexicanus	House finch	x	y	
Guiraca caerulea	Blue grosbeak		y	
Junco hyemalis	Dark-eyed junco	x	y	
Melospiza georgiana	Swamp sparrow	x	y	
Melospiza melodia	Song sparrow		y	
Passerculus sandwichensis	Savannah sparrow		y	
Passerella iliaca	Fox sparrow	x	y	
Passerherbulus caudacutus	Le Conte's sparrow	x	y	
Ammodramus henslowii	Henslow's sparrow	x	y	IE
Passerina cyanea	Indigo bunting	x	y	
Pheusticus ludovicianus	Rose-breasted grosbeak	x	y	
Pipilo erythrophthalmus	Rufous-sided towhee	x	y	
Spiza americana	Dickcissel	x	y	
Spizella arborea	American tree sparrow	x	y	
Spizella passerina	Chipping sparrow	x	y	
Spizella pusilla	Field sparrow	x	y	
Zonotrichia albicollis	White-throated sparrow	x	y	
Zonotrichia leucophrys	White-crowned sparrow	x	y	
Family: Hirundinidae	**Swallows**			
Hirundo rustica	Barn swallow		y	
Stelgidopteryx serripennis	Northern rough-winged swallow	x	y	
Tachycineta bicolor	Tree swallow	x	y	
Family: Icterodae	**Blackbirds and Orioles**			
Agelaius phoeniceus	Red-winged blackbird		y	

TABLE 5.3-6

Observed and Potential Wildlife
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Xanthocephalus xanthocephalus	Yellow-headed blackbird	UNK	UNK	IE
Euphagus carolinus	Rusty blackbird	x	y	
Icterus galbula	Northern oriole	x	y	
Icterus spurius	Orchard oriole	x	y	
Molothrus ater	Brown-headed cowbird		y	
Quiscalus quiscula	Common grackle	x	y	
Sturnella neglecta	Western meadowlark	UNK	UNK	ISS
Sturnella magna	Eastern meadowlark	x	y	
Family: Lanidae				
Lanius ludovicianus	Loggerhead shrike	UNK	UNK	IE
Family: Mimidae	**Mockingbirds and thrashers**			
Dumetella carolinensis	Gray catbird		y	
Toxostoma rufum	Brown thrasher	x	y	
Family: Paridae	**Chickadees and titmice**			
Parus bicolor	Tufted titmouse		y	
Parus carolinensis	Carolina chickadee	x	y	
Family: Parulidae	**Wood warblers**			
Dendroica castanea	Bay-breasted warbler	x	y	
Mniotilta varia	Black-and-white warbler	UNK	UNK	ISS
Wilsonia citrina	Hooded warbler	UNK	UNK	ISS
Dendroica cerulea	Cerulean warbler		y	ISS
Dendroica coronata	Yellow-rumped warbler	x	y	
Dendroica dominica	Yellow-throated warbler		y	
Dendroica fusca	Blackburnian warbler	x	y	
Dendroica kirtlandii	Kirtland's warbler		z	FE, IE
Dendroica palmarum	Palm warbler	x	y	
Dendroica petechia	Yellow warbler		y	

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Observed and Potential Wildlife
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Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Dendroica pinus	Pine warbler	x	y	
Dendroica striata	Blackpoll warbler	x	y	
Geothlypis trichas	Common yellowthroat	x	y	
Icteria virens	Yellow-breasted chat	x	y	
Oporornis formosus	Kentucky warbler	x	y	
Parula americana	Northern parula warbler	x	y	
Seiurus aurocapillus	Ovenbird		y	
Seiurus motacilla	Louisiana waterthrush		y	
Setophaga ruticilla	American redstart		y	
Vermivora peregrina	Tennessee warbler	x	y	
Vermivora ruficapilla	Nashville warbler	x	y	
Helmitheros vermivorus	Worm-eating warbler	UNK	UNK	ISS
Vermivora chrysoptera	Golden-winged warbler	UNK	UNK	IE
Wilsonia canadensis	Canada warbler	x	y	
Family: Passeridae	**Old World sparrows**			
Passer domesticus	House sparrow	x	y	
Family: Sitidae	**Nuthatches**			
Sitta carolinensis	White-breasted nuthatch		y	
Family: Sturnidae	**Starlings**			
Sturnus vulgaris	European starling	x	y	
Family: Sylviidae	**Old world warblers**			
Polioptila caerulea	Blue-gray gnatcatcher		y	
Regulus calendula	Ruby-crowned kinglet	x	y	
Family: Thraupidae	**Tanagers**			
Piranga olivacea	Scarlet tanager		y	
Piranga rubra	Summer tanager		y	
Family: Troglodytidae	**Wrens**			

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Observed and Potential Wildlife
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Thryothorus ludovicianus	Carolina wren	x	y	
Cistothorus palustris	Marsh wren	UNK	UNK	IE
Cistothorus platensis	Sedge wren	UNK	UNK	IE
Thryomanes bewickii	Bewick's wren	UNK	UNK	IE
Family: Turdidae	**Thrushes**			
Catharus fuscescens	Veery	x	y	
Catharus minimus	Gray-cheeked thrush	x	y	
Catharus ustulatus	Swainson's thrush	x	y	
Hylocichla mustelina	Wood thrush		y	
Sialia sialis	Eastern bluebird	x	y	
Turdus migratorius	American robin	x	y	
Family: Tyrannidae	**Tyrant flycatchers**			
Contopus virens	Eastern wood pewee		y	
Empidonax minimus	Least flycatcher		y	
Empidonax traillii	Willow flycatcher		y	
Empidonax virescens	Acadian flycatcher		y	
Myiarchus crinitus	Great crested flycatcher	x	y	
Sayornis phoebe	Eastern phoebe	x	y	
Tyrannus tyrannus	Eastern kingbird	x	y	
Tyrannus verticalis	Western kingbird	x	y	
Family: Vireonidae	**Vireos**			
Vireo flavifrons	Yellow-throated vireo		y	
Vireo gilvus	Warbling vireo		y	
Vireo griseus	White-eyed vireo		y	
Vireo olivaceus	Red-eyed vireo		y	
Order: Piciformes	**Woodpeckers**			
Family: Picadae	**Woodpeckers**			

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Observed and Potential Wildlife
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Centurus carolinus	Red-bellied woodpecker	x	y	
Colaptes auratus	Flicker		y	
Dryocopus pileatus	Pileated woodpecker		y	
Melanerpes erythrocephalus	Red-headed woodpecker		y	
Picoides pubescens	Downy woodpecker	x	y	
Picoides villosus	Hairy woodpecker		y	
Order: Strigiformes	**Owls**			
Family: Strigidae	**Owls**			
Asio flammeus	Short-eared owl	x	y	IE
Asio otus	Long-eared owl		y	
Bubo virginianus	Great horned owl		y	
Otus asio	Screech owl		y	
Strix varia	Barred owl		y	
Family: Tytonidae	**Barn owls**			
Tyto alba	Common barn owl		y	IE
Order: Gruiformes				
Family: Rallidae	**Rails**			
Laterallus jamaicensis	Black rail	UNK	UNK	IE
Rallus limicola	Virginia rail	UNK	UNK	IE
Rallus elegans	King rail	UNK	UNK	IE
Family: Gruidae	**Cranes**			
Grus canadensis	Sandhill crane	UNK	UNK	IE
	Class: Mammalia			
Order: Artiodactyla	**Even-toed Ungulates**			
Family: Cervidae	**Deer**			
Odocoileus virginianus	White-tailed deer	x	y	
Cervus elaphus	Elk (or Wapiti)	UNK	UNK	IEx

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Observed and Potential Wildlife
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Family Bovidae				
Bos (bison) americanus	American bison	UNK	UNK	IEx
Order: Carnivora	**Carnivores**			
Family: Canidae	**Wolves, foxes, coyote**			
Canis latrans	Coyote		y	
Canis lupus	Gray wolf	UNK	UNK	IEx
Canis rufus	Red wolf	UNK	UNK	IEx
Urocyon cinereoargenteus	Gray fox		y	
Vulpes fulva	Red fox		y	
Family: Felidae	**Cats**			
Lynx lynx	Lynx	UNK	UNK	IEx
Felix concolor	Mountain lion	UNK	UNK	IEx
Lynx rufus	Bobcat		y	IE
Family: Ursidae				
Ursus americanus	Black bear	UNK	UNK	IEx
Family: Mustelidae	**Weasels, skunks, badgers**			
Mephitis mephitis	Striped skunk		y	
Mustela frenata	Long tailed weasel		y	
Spilogale putorius	Eastern spotted skunk	UNK	UNK	IEx
Gulo gulo	Wolverine	UNK	UNK	IEx
Taxidea taxus	American badger	UNK	UNK	IE
Mustela nivalis	Least weasel		y	ISS
Martes pennanti	Fisher	UNK	UNK	IEx
Lutra canadensis	River otter	UNK	UNK	IE
Mustela vison	Mink		y	
Family: Procyonidae	**Raccoons**			
Procyon lotor	Raccoon		y	

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Observed and Potential Wildlife
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Order: Chiroptera	**Bats**			
Family: Vespertilionidae	**Plainnose bats**			
Eptesicus fuscus	Big brown bat		y	
Lasionycteris noctivagans	Silver-haired bat		y	
Lasiurus borealis	Red bat		y	
Plecotus rafinesquii	Rafinesque's big-eared bat	UNK	UNK	ISS
Myotis grisescens	Gray bat	UNK	UNK	FE, IE
Lasiurus cinerus	Hoary bat		y	
Myotis keenii	Keen's myotis		y	
Myotis lucifugus	Little brown myotis		y	
Myotis austroriparius	Southeastern bat	UNK	UNK	IE
Myotis sodalis	Indiana myotis		y	FE, IE
Nycticeius humeralis	Evening bat		y	IE
Pipistrellus subflavus	Eastern pipistrelle		y	
Order: Insectivora	**Insectivores**			
Family: Soricidae	**Shrews**			
Blarina brevicauda	Short-tailed shrew		y	
Cryptotis parva	Least shrew		y	
Microsorex hoyi	Pigmy shrew	UNK	UNK	ISS
Sorex fumeus	Smoky shrew	UNK	UNK	ISS
Sorex cinerus	Masked shrew		y	
Sorex longirostris	Southeastern shrew		y	
Family: Talipidae	**Moles**			
Condylura cristata	Star-nosed mole		y	ISS
Scalopus aquaticus	Eastern mole		y	
Order: Lagomorpha	**Lagomorphs**			
Family: Leporidae	**Rabbits and hares**			

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Observed and Potential Wildlife
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Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Sylvilagus aquaticus	Swamp rabbit	UNK	UNK	IE
Sylvilagus floridanus	Eastern cottontail		y	
Order: Marsupiala	**Marsupials**			
Family: Didelphidae	**New World Opossums**			
Didelphis virginiana	Virginia opposum		y	
Order: Rodentia	**Rodents**			
Family: Castoridae	**Beavers**			
Castor canadensis	Beaver		y	
Family: Dipodidae	**Pocket & jumping mice, pocket**			
Geomys bursarius	Plains pocket gopher	UNK	UNK	ISS
Zapus hudsonius	Meadow jumping mouse		y	
Family: Erethizontidae				
Erethizon dorsatum	Common porcupine	UNK	UNK	IEx
Family: Muridae	**Mice, rats, lemmings, voles**			
Microtus pennsylvanicus	Meadow vole		y	
Microtus pinetorum	Woodland vole		y	
Microtus ochrogaster	Prairie vole		y	
Reithrodontomys megalotis	Western harvest mouse	UNK	UNK	ISS
Mus musculus	House mouse		y	
Neotoma magister	Allegheny woodrat	UNK	UNK	IE
Neotoma floridana	Eastern wood rat		y	
Rattus rattus	Black rat	UNK	UNK	IEx
Ordata zibethicus	Muskrat		y	
Peromyscus leucopus	White-footed mouse		y	
Peromyscus maniculatus	Deer mouse		y	
Rattus norvegicus	Norway rat		y	
Synaptomys cooperi	Southern bog lemming		y	

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Observed and Potential Wildlife
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Family: Sciuridae	**Squirrels**			
Glaucomys volans	Southern flying squirrel		y	
Marmota monax	Woodchuck		y	
Spermophilus franklinii	Franklin's ground squirrel	UNK	UNK	IE
Sciurus carolinensis	Gray squirrel		y	
Sciurus niger	Fox squirrel		y	
Tamiasciurus hudsonicus	Red squirrel		y	
Tamias striatus	Eastern chipmunk		y	
	Phylum: Mollusca			
	Class: ~~Pelecypoda (Clams)~~ Bivalvia			
Order: ~~Eulamellibranchia~~Unionoida	**Freshwater Mussels ~~Clams~~**			
Family: Unionidae	**Clams**			
Cyprogenia stegaria	Eastern fanshell		z	FE, IE
Subfamily: Anodontinae				
Simpsonaias ambigua	Salamander mussel	UNK	UNK	ISS
Subfamily: Lampsilinae	**Clams**			
Hemistena lata	Cracking pearlymussel		z	FE, IEx
Plethobasus cooperianus	Orangefoot pimple back pearlymussel		z	FE, IE
Epioblasma personata	Round combshell	UNK	UNK	IEx
Epioblasma sampsonii	Wabash riffleshell	UNK	UNK	IEx
Epioblasma propinqua	Tennessee riffleshell	UNK	UNK	IEx
Epioblasma flexuosa	Leafshell	UNK	UNK	IEx
Ptychobranchus fasciolaris	Kidneyshell	UNK	UNK	ISS
Venustaconcha ellipsiformis	Ellipse	UNK	UNK	ISS
Plethobasus cyphyus	Sheepnose	UNK	UNK	IE
Fusconaia subrotunda	Long-solid	UNK	UNK	IE
Plethobasus cicatricosus	White wartyback (pearlymussel)	UNK	UNK	FE, IE

TABLE 5.3-6

Observed and Potential Wildlife
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Pleurobema clava	Clubshell		z	FE, IE
Pleurobema pyramidatum	Pyramid pigtoe	UNK	UNK	IE
Pleurobema cordatum	Ohio pigtoe	UNK	UNK	ISS
Pleurobema plenum	Rough pigtoe	UNK	UNK	FE, IE
Quadrula cylindrica cylindrica	Rabbitsfoot	UNK	UNK	IE
Quadrula fragosa	Winged mapleleaf mussel		z	FE, IEx
Subfamily: Lampsilinae	**Clams**			
Epioblasma obliquata perobliqua	White catspaw		z	FE, IE
Epioblasma torulosa rangiana	Northern riffleshell		z	FE, IE
Villosa fabalis	Rayed bean	UNK	UNK	ISS
Epioblasma triquetra	Snuffbox	UNK	UNK	IE
Epioblasma obliquata obliquata	Purple cat’s paw pearlymussel		z	FE, IEx
Epioblasma torulosa torulosa	Tubercled blossom		z	FE, IE
Leptodea leptodon	Scaleshell	UNK	UNK	IEx
Toxolasma lividus	Purple lilliput	UNK	UNK	ISS
Lampsilis orbiculata	Pink mucket (pearlymussel)		z	FE, IE
Obovaria subrotunda	Round hickorynut	UNK	UNK	ISS
Obovaria retusa	Ring pink mussel		z	FE, IEx
Potamilus capax	Fat pocketbook		z	FE, IE
Lampsilis fasciola	Wavy-rayed lampmussel	UNK	UNK	ISS
Villosa lienosa	Little spectaclecase	UNK	UNK	ISS
Family: Margaritiferidae				
Cumberlandia monodonta	Spectaclecase	UNK	UNK	IEx
	Class: Gastropoda (Freshwater Snails)			
Subclass: Prosobranchia				
Order: Mesogastropoda				
Family: Vivparidae				

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Observed and Potential Wildlife
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Campeloma decisum	Pointed campeloma	UNK	UNK	ISS
Order: Basomamatophora				
Family: Lymnaeidae				
Lymnaea stagnalis	Swamp lymnaea	UNK	UNK	ISS

General Note:

Protection status classification is based on the Indiana Department of Natural Resources, Division of Nature Preserves and Fish and Wildlife. *Indiana's rare plants and animals- A checklist of endangered and threatened species* (1999) and U.S. Fish & Wildlife Services *Endangered and Threatened Wildlife and Plants* (June 30, 1999).

Footnotes:

(a) Observed.
(b) Yes.
(c) Historic range which indicates the known general distribution of the species as reported in Endangered and Threatened Wildlife and Plants (50 CFR 17.11 &17.12) (October 31, 1996).
(d) Indiana Endangered.
(e) Federal Endangered.
(f) Indiana Extirpated.
(g) Indiana Species of Special Concern.
(h) Indiana Threatened.
(i) Federal Threatened.

TABLE 5.3-7

Plant Species
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
	Shrubs and Subshrubs			
Family: Aceraceae	**Maple**			
Acer platanoides	Norway maple	x[(a)]	y[(b)]	
Acer rubrum	Red maple	x	y	
Acer saccharum	Sugar maple	x	y	
Family: Anacardiaceae	**Cashew**			
Rhus copallinum	Sumac	x	y	
Rhus glabra	Smooth sumac	x	y	
Toxicodendron radicans	Poison ivy	x	y	
Family: Annonaceae	**Custard apple**			
Asimina triloba	Paw-paw apple	x	y	
Family: Aquifoliaceae	**Holly Family**			
Ilex verticillata	Winterberry	x	y	
Family: Betulaceae	**Birch Family**			
Carpinus carolinianus	Blue beech	x	y	
Ostrya virginiana	Hop hornbeam	x	y	
Family: Bignoniaceae	**Bignonia Family**			
Campsis radicans	Trumpet creeper	x	y	
Family: Caprifoliaceae	**Honeysuckle**			
Sambucus caerulea	Blue Elder/Elderberry	x	y	
Sambucus canandensis	American elder	x	y	
Vibernum acerifolium	Mapleleaf viburnum	x	y	
Vibernum dentatum	Southern arrowwood	x	y	
Viburnum prunifolium	Black haw	x	y	
Family: Cornaceae	**Dogwood**			
Cornus florida	Flowering dogwood	x	y	

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Plant Species
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Nyssa sylvatica	Black gum	x	y	
Family: Cypressaceae	**Cypress Family**			
Eleocharis tenuis	Spike-rush	x	y	
Juniperus virginiana	Juniper	x	y	
Family: Ebenaceae	**Ebony Family**			
Diospyrous virginiana	Persimmon	x	y	
Family: Fagaceae	**Beech Family**			
Fagus grandifolia	American beech	x	y	
Quercus alba	White oak	x	y	
Quercus michauxii	Swamp chestnut oak	x	y	
Quercus muhlenbergii	Chinquapin oak	x	y	
Quercus palustris	Pin oak	x	y	
Quercus rubra	Northern red oak	x	y	
Family: Hamamelicaceae	**Witch-Hazel Family**			
Liquidambar styraciflua	Sweetgum	x	y	
Family: Hippocastanaceae	**Buckeye**			
Aesculus glabra	Ohio buckeye	x	y	
Family: Juglandaceae	**Walnut Family**			
Carya glabra	Pignut hickory	x	y	
Carya laciniosa	Shellbark hickory	x	y	
Carya ovata	Shagbark hickory	x	y	
Carya tomentosa	Mockernut hickory	x	y	
Juglans nigra	Black walnut	x	y	
Family: Lauraceae	**Laurel Family**			
Lindera benzoin	Laurel	x	y	
Sassafras albidum	Sassafras	x	y	
Family: Leguminosae	**Legume Family**			
Albizia julibrissim	Silktree	x	y	

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Plant Species
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Cercis canadensis	Redbud	x	y	
Family: Lycopodiaceae	**Club Moss**			
Lycopodium clavatum	Running pine	x	y	
Lycopodium digitatum	Southern ground-cedar	x	y	
Lycopodium obscurum	Tree clubmoss	x	y	IT[(c)]
Family: Magnoliaceae	**Magnolia Family**			
Liriodendron tulipifera	Tulip tree	x	y	
Family: Oleacae	**Olive Family**			
Fraxinus americana	White ash	x	y	
Fraxinus pennsylvanica	Green ash	x	y	
Fraxinus quadrangulata	Blue ash	x	y	
Family: Platanaceae	**Sycamore Family**			
Platanus occidentalis	Sycamore	x	y	
Family: Rosaceae	**Rose**			
Agrimonia pubescens	Agrimony	x	y	
Crataegus crus-gali	Cock-spur thorn	x	y	
Fragaria virginiana	Wild strawberry	x	y	
Geum canadense	Avens	x	y	
Rosa sp	Rose	x	y	
Rubus hispicus	Swamp dewberry	x	y	
Spiraea tomentosa	Hardhack	x	y	
Potentilla recta	Cinquefoil	x	y	
Potentilla simplex	Cinquefoil	x	y	
Prunus serotina	Black cherry	x	y	
Family: Salicaceae	**Willow**			
Populus deltoides	Eastern cottonwood	x	y	
Populus grandidentata	Bigtooth aspen	x	y	
Salix exigua	Coyote willow/Sandbar willow	x	y	
Salix nigra	Black willow	x	y	

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Plant Species
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Family: Tiliaceae	**Basswood (Linden) Family**			
Tilia americana	American basswood	x	y	
Family: Ulmaceae	**Elm**			
Ulmus americana	American Elm	x	y	
Ulmus rubra	Slippery elm	x	y	
Family: Vitaceae	**Grapes**			
Parthenocissus quinquefolia	Virginia creeper	x	y	
Vitis sp.	Grape	x	y	
	Forbs			
Family: Alismataceae	**Water-Plantain**			
Alisma triviale	Water plantain	x	y	
Sagittaria australis	Longbeak arrowhead	x	y	IR[(d)]
Sagittaria latifolia	Arrowhead	x	y	
Family: Apocynaceae	**Dogbane Family**			
Apocynum cannabinum	Indian hemp	x	y	
Family: Araceae	**Cala**			
Arisaema tryphyllum	Small jack-in-the-pulpit	x	y	
Family: Araliaceae	**Ginseng**			
Aralia spinosa	Sarsaparilla	x	y	
Panax quinquefolium	American ginseng	x	y	
Panax trifolium	Dwarf ginseng	x	y	IR
Family: Aristolochiaceae	**Dutchman's Pipe**			
Aristolochia serpentaria	Virginia snakeroot	x	y	
Asarum canadense	Wild ginger	x	y	
Family: Asclepiacaceae	**Milkweed**			
Ampelamus albidus	Blue-vine	x	y	
Asclepias incarnata	Swamp milkweed	x	y	
Asclepias meadii	Mead's milkweed		z[(e)]	FT[(f)]
Asclepias syriaca	Common milkweed	x	y	

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Plant Species
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Asclepias tuberosa	Butterfly weed	x	y	
Asclepias viridis	Milkweed	x	y	
Family: Aspleniaceae	**Fern**			
Aspenium plaatyneuron	Spleenwort	x	y	
Family: Balsominaceae	**Touch-me-not Family**			
Impatiens capensis	Orange touch-me-not	x	y	
Family: Berberidaceae	**Barberry Family**			
Caulophyllum thalictroides	Blue cohosh	x	y	
Jeffersonia diphylla	Wood nettle	x	y	
Podophyllum peltatum	Mayapple	x	y	
Family: Blechnaceae	**Deer Fern**			
Woodwardia areolata	Netted chain-fern	x	y	IR
Family: Boraginaceae	**Borage**			
Myosotis scorpiodes	Forget-me-not	x	y	
Family: Brassicaceae	**Mustard**			
Lepidium campestre	Pepperweed	x	y	
Lepidium virginicum	Peppergrass	x	y	
Family: Campanulaceae	**Bluebell Family**			
Triodanis perfoliata	Venus looking glass	x	y	
Family: Caprifoliaceae	**Honeysuckles**			
Lonicera japonica	Honeysuckle	x	y	
Family: Caryophyllaceae	**Pink Family**			
Arenaria serphyllifolia	Thyme-leaved sandwort	x	y	
Cerastium sp.	Chickweed	x	y	
Dianthus armeria	Deptford pink	x	y	
Silene stellata	Starry catchfly	x	y	
Silene virginica	Firepink	x	y	
Stellaria graminea	Stitchwort	x	y	

TABLE 5.3-7

Plant Species
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Stellaria media	Chickweed	x	y	
Stellaria pubera	Great chickweed	x	y	
Family: Caesalpiniaceae	**Cassia**			
Cassia sp.	Cassia	x	y	
Family: Celastraceae	**Bittersweet**			
Eunonymus	Running eunonymus	x	y	
Family: Commelinaceae	**Dayflower**			
Tradescantia virginiana	Spiderwort	x	y	
Family: Compositae	**Daisy**			
Achillea millefolium	Yarrow	x	y	
Ambrosia trifida	Giant ragweed	x	y	
Aster cordifolius	Heart-leaved aster	x	y	
Aster macrophyllus	Large-leaved aster	x	y	
Aster shortii	Short’s aster	x	y	
Aster umbellatus	Flat-topped aster	x	y	
Bidens sp.	Beggar-ticks	x	y	
Chrysanthemun leucanthemun	Ox-eye daisy	x	y	
Cirsium pitcheri	Pitcher’s thistle		z	FT
Cirsium vulgare	Bull Thistle	x	y	
Crepis pulchera	Hawksbeard	x	y	
Erigeron annuus	Daisy fleabane	x	y	
Erigeron philadelphicus	Daisy fleabane	x	y	
Erigeron strigosa	Daisy fleabane	x	y	
Eupatorium fistulosum	Trumpetweed	x	y	
Eupatorium hyssopifolium	Hyssop-leaved boneset	x	y	
Eupatorium perfoliatum	Boneset	x	y	
Eupatorium rotundifolium	Round-leaved boneset	x	y	
Eupatorium rugosum	White snakeroot	x	y	
Eupatorium serotinum	Late-flowering boneset	x	y	

TABLE 5.3-7

Plant Species
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Hieraceum caespitosum	Yellow king-devil hawkweed	x	y	
Hieraceum gronvil	Hairy hawkweed	x	y	
Hieraceum scabrum	Rough hawkweed	x	y	
Helenium flexulosum	Sneezeweed	x	y	
Polymnia canadensis	Small-flower leafcup	x	y	
Prenanthes altissima	Tall white lettuce	x	y	
Rudbeckia hirta	Black-eyed susan	x	y	
Senecio aureus	Squaw-weed	x	y	
Solidago caesia	Blue-stemmed goldenrod	x	y	
Solidago flexicaulis	Zigzag goldenrod	x	y	
Solidago graminifolium	Flat-topped goldenrod	x	y	
Solidago rugosa	Rough-stemmed goldenrod	x	y	
Taraxacum officinale	Common dandelion	x	y	
Tragopogon dubius	Salsify	x	y	
Verbesina alternifolia	Yellow ironweed	x	y	
Family: Convolvulaceae	**Morningglory**			
Convolvulus arvensis	Field bindweed (Creeping	x	y	
Cuscuta sp.	Dodder	x	y	
Ipomoea lacunosa	Small morningglory	x	y	
Family: Crassulaceae	**Live-Forever Family**			
Sedum ternatum	Wild stonecrop	x	y	
Family: Cruciferae	**Mustard**			
Dentaria diphylla	Crinkleroot	x	y	
Dentaria heteropylla	Slender toothwort	x	y	
Dentaria laciniata	Cut-leaved toothwort	x	y	
Family: Dipsacaceae	**Teasel Family**			
Dipsacus sylvestris	Teasel	x	y	
Family: Fabaceae	**Bean**			
Amphicarpaea bracteata	Hog peanut	x	y	

TABLE 5.3-7

Plant Species
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Coronilla varia	Crown-vetch	x	y	
Desmodium glutinosum	Pointed-leaf tick trefoil	x	y	
Desmodium nudiflorum	Naked-flower tick trefoil	x	y	
Desmodium paniculatum	Panicled tick trefoil	x	y	
Lespedeza sp.	Bush clover	x	y	
Melilotus alba	White sweetclover	x	y	
Melilotus officinalis	Yellow sweetclover	x	y	
Robinia pseudoacacia	Locust	x	y	
Strophostyles leiosperma	Slick seed wild-bean	x	y	IT
Trifolium aureum	Yellow trefoil	x	y	
Trifolium campestre	Hop trefoil	x	y	
Trifolium dubium	Lesser yellow trefoil	x	y	
Trifolium hybridium	Alsike	x	y	
Trifolium medium	Zigzag clover	x	y	
Trifolium pratense	Red clover	x	y	
Trifolium repens	White clover	x	y	
Trifolium stoloniferum	Running buffalo clover		z	IE[(g)],FE[(h)]
Vicia cracca	Cow vetch	x	y	
Family: Gentianaceae	**Gentians**			
Bartonia paniculata	Twining bartonia	x	y	
Family: Geraniaceae	**Filaree**			
Geranium bicknelii	Bicknell northern crane's-bill	x	y	IE
Geranium carolinianum	Carolina geranium	x	y	
Family: Hypericaceae	**St.-John's-Wort Family**			
Hypericum perforatum	St. John's-wort	x	y	
Family: Iridaceae	**Iris**			
Sisyrinchium angustifolium	Blue-eyed grass	x	y	
Family: Labiatae	**Mints**			
Lamium amplexicale	Henbit	x	y	

TABLE 5.3-7

Plant Species
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Mentha spicata	Spearmint	x	y	
Monarda spp.	Beebalm	x	y	
Prunella vulgaris	Self-heal	x	y	
Pycnanthemum tenuifolium	Narrow-leaved mountain mint	x	y	
Salvia lyrata	Cancer-weed	x	y	
Scutellaria incana	Downy skullcap	x	y	
Scutellaria lateriflora	Mad-dog skullcap	x	y	
Family: Liliaceae	**Lily**			
Allium burdickii	Wild Onion	x	y	
Allium tricoccum	Wood leek	x	y	
Asparagus officinalis	Asparagus	x	y	
Dioscorea quaternata	Wild yam	x	y	
Erythronium americanum	Trout lily	x	y	
Lilium philadelphicum	Wood lily	x	y	
Polygonatum pubescens	Hairy Solomon's seal	x	y	
Smilacina racemosa	False Solomon's seal	x	y	
Smilax hispida	Hispid greenbrier	x	y	
Smilax rotundifolia	Roundleaf greenbrier	x	y	
Trillium flexipes	Drooping trillium	x	y	
Trillium sessile	Toadshade	x	y	
Uvularia grandiflora	Large-flowered bellwort	x	y	
Veratrum woodii	False hellebore	x	y	
Yucca sp.	Bear-grass	x	y	
Family: Linaceae	**Flax**			
Linum medium	Common yellow flax	x	y	
Linum striatum	Ridged yellow flax	x	y	IT
Linum virginiana	Wild yellow flax	x	y	
Family: Lobeliaceae	**Lobelia**			
Lobelia cardinalis	Cardinal flower	x	y	

TABLE 5.3-7

Plant Species
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Lobelia inflata	Indian tobacco	x	y	
Family: Melastomataceae	**Melastome Family**			
Rhexia mariana	Maryland meadow beauty	x	y	IE
Rhexia virginica	Meadow beauty	x	y	
Family: Menispermaceae	**Moonseed**			
Menispernum canadense	Moon seed	x	y	
Family: Onagraceae	**Evening Primrose**			
Circaea luteiana	Enchanter's nightshade	x	y	
Ludwigia alternifolia	Seedbox	x	y	
Ludwigia decurrens	Water primrose	x	y	IR
Oenothera perennis	Small sundrops	x	y	IT
Family: Onocleaceae	**Fern**			
Onoclea sensibilis	Sensitive fern	x	y	
Family: Ophioglossaceae	**Grape Fern**			
Botrychium dissectum var. obliquum	Lace-frond grape-fern	x	y	
Botrychium oneidense	Blunt-lobed grape-fern	x	y	
Family: Orchidaceae	**Orchids**			
Corallorhiza odontorhiza	Late coralroot	x	y	
Cypridedium calcelolus var. pubescens	Small yellow lady's slipper	x	y	
Goodyera pubescens	Downy rattlesnake-plantain	x	y	
Liparis lilifolia	Large twayblade	x	y	
Platanthera lacera	Green-fringed orchid	x	y	
Platanthera leucophaea	Eastern prairie fringed orchid		z	FT
Platanthera peramoena	Purple fringeless orchid	x	y	
Spiranthes cernua	Nodding ladies'-tresses	x	y	
Spiranthes ovalis	Lesser ladies'-tresses	x	y	
Spiranthes tuberosa	Little ladies'-tresses	x	y	
Family: Orobanchaceae	**Broom-Rape Family**			
Conopholis americana	Squawroot	x	y	

TABLE 5.3-7

Plant Species
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Family: Osmundaceae	**Osmunda Family**			
Osmunda regalis	Royal fern	x	y	
Osmunda cinnamomea	Cinnamon fern	x	y	
Family: Oxalidaceae	**Wood-sorrel**			
Oxalis stricta	Yellow wood-sorrel	x	y	
Family: Phrymaceae	**Phryma**			
Phryma lepostachya	Lopseed	x	y	
Family: Phytolaccaceae	**Pokeweed**			
Phytolacca americana	Pokeweed	x	y	
Family: Plantaginaceae	**Plantains**			
Plantago aristata	Plantain	x	y	
Plantago lanceolata	Plantain	x	y	
Plantago major	Plantain	x	y	
Family: Polemoniaceae	**Phlox**			
Phlox divaricata	Wild blue phlox	x	y	
Family: Polygalaceae	**Milkworts**			
Polygala sanguinea	Purple milkwort	x	y	
Polygala verticillata	Whorled milkwort	x	y	
Family: Polygonaceae	**Buckwheat**			
Polygonum persicaria	Lady's-thumb	x	y	
Polygonum sagitatum	Smartweed	x	y	
Polygonum virginiana	Virginia knotweed	x	y	
Rumex acetosela	Red sorrel	x	y	
Rumex crispus	Curly dock	x	y	
Family: Polypodiaceae	**Ferns**			
Adiantum	Maidenhair fern	x	y	
Athyrium felix-femina	Lady fern	x	y	
Athyrium pycnocarpon	Narrowleaf spleenwort	x	y	
Athyrium thelypterioides	Silvery spleenwort	x	y	

TABLE 5.3-7

Plant Species
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Cystoperis protusa	Fragile fern	x	y	
Dryopteris cristata	Crested fern	x	y	
Drytoperis carthusiana	Wood fern	x	y	
Polystichum acrostichoides	Christmas fern	x	y	
Thelypteris hexagonoptera	Broad beech fern	x	y	
Thelypteris noveboracensis	New York fern	x	y	
Family: Portulacaceae	**Purslane Family**			
Claytonia virginica	Spring beauty	x	y	
Portulaca oleracea	Purslane	x	y	
Family: Primulaceae	**Primrose**			
Lysimachia nummularia	Moneywort	x	y	
Lysimachia quadrifolia	Whorled loosestrife	x	y	
Samolus parviflorus	Water pimpernel	x	y	
Family: Pyrolaceae	**Shinleaf Family**			
Chimaphila maculata	Spotted wintergreen	x	y	
Family: Ranunculaceae	**Buttercup**			
Actea alba	White baneberry	x	y	
Anemone virginiana	Thimbleweed	x	y	
Aquilegia canadensis	Wild columbine	x	y	
Cimicifuga racemosa	Black bugbane	x	y	
Hydratis canadensis	Goldenseal	x	y	
Ranunculus hispidus	Hispid buttercup	x	y	
Family: Rubiaceae	**Bluet Family**			
Cephalanthus occidentalis	Button bush	x	y	
Galium circaezans	Wild licorice	x	y	
Galium concinnum	Shining bedstraw	x	y	
Galium obtusum	Bedstraw	x	y	
Galium tinctorium	Bedstraw	x	y	
Galium triflorum	Sweet-scented bedstraw	x	y	

TABLE 5.3-7

Plant Species
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Houstonia purpurea	Bluet	x	y	
Mitchella repens	Partridgeberry	x	y	
Family: Shizaeaceae	**Ferns**			
Lygodium palmatum	Climbing fern	x	y	IE
Family: Scrophulariaceae	**Figwort**			
Agalinis fasciculata	Clustered foxglove	x	y	
Chaenorrhinum minus	Dwarf snapdragon	x	y	
Collinsonia canadensis	Horse-balm	x	y	
Euphrasia officalis	Eyebright	x	y	
Penstemon digitalis	Penstemon	x	y	
Verbascum blatteria	Moth mullein	x	y	
Verbascum thapsus	Common mullein	x	y	
Family: Smilacaceae	**Carrion-flowers**			
Smilax sp.	Carrion-flower	x	y	
Family: Solanaceae	**Potato Family**			
Solanum carolinense	Horse nettle	x	y	
Family: Staphyleaceae	**Bladdernuts**			
Staphylea trifolia	American bladdernut	x	y	
Family: Typhaceae	**Cattail**			
Typha angustifolia	Narrowleaf Cattail	x	y	
Typha latifolia	Common Cattail	x	y	
Family: Umbelliferae	**Parsley Family**			
Chaerophyllum procumbens	Chervil	x	y	
Cryptotaenia canadensis	Honewort	x	y	
Daucus carota	Wild carrot	x	y	
Erigenia bulbosa	Harbinger-of-spring	x	y	
Osmorhiza claytonii	Sweet cicely	x	y	
Osmorhiza longistylus	Sweet cicely	x	y	

TABLE 5.3-7

Plant Species
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Pastinaca sativa	Parsnip	x	y	
Sanicula canadensis	Short-styled snakeroot	x	y	
Sanicula gregaria	Clustered snakeroot	x	y	
Sanicula trifoliata	Long-fruited snakeroot	x	y	
Family: Urticaceae	**Nettles**			
Boehmeria cylindrica	Chinese silk plant	x	y	
Pilea pumila	Clear weed	x	y	
Urtica dioica	Stinging nettle	x	y	
Family: Valerianaceae	**Valeriana Family**			
Valeriana pauciflora	Large-flower valarian	x	y	
Family: Violaceae	**Violet Family**			
Viola blanda	Smooth white violet	x	y	
Viola canadensis	Canada violet	x	y	
Viola pubescens	Downy yellow violet	x	y	
Viola rostrata	Long-spurred violet	x	y	
Viola sororia	Downy blue violet	x	y	
Viola striata	Pale violet	x	y	
	Graminoids			
Family: Cyperaceae	**Sedges**			
Carex abscondita	Thicket sedge	x	y	
Carex albursina	Sedge	x	y	
Carex artitecta	Sedge	x	y	
Carex bromoides	Sedge	x	y	
Carex communis	Sedge	x	y	
Carex debilis	Sedge	x	y	
Carex gracillima	Sedge	x	y	
Carex grayii	Sedge	x	y	
Carex intumescens	Sedge	x	y	
Carex laxiflora	Sedge	x	y	

TABLE 5.3-7

Plant Species
Jefferson Proving Ground
Madison, Indiana

Latin Name	Common Name	Observed	Appropriate Habitat	Special Status Species
Carex louisianica	Louisiana sedge	x	y	
Carex rosea	Sedge	x	y	
Carex swanii	Sedge	x	y	
Carex virescens	Sedge	x	y	
Carex woodii	Pretty sedge	x	y	
Scirpus atrovirens	Bulrush	x	y	
Scirpus cyperinus	Wool grass	x	y	
Family: Equisetaceae	**Horsetails**			
Equistum sp.	Scouring rushes	x	y	
Family: Juncaceae	**Rush**			
Juncus biflorus	Rush	x	y	
Juncus brachycarpus	Rush	x	y	
Juncus diffusissimus	Rush	x	y	
Juncus effusus	Soft rush	x	y	
Juncus marginatus	Rush	x	y	
Juncus tenuis	Path rush	x	y	
Family: Poaceae (Gramineae)	**Grass**			
Agrostis perennans	Upland bent grass	x	y	
Andropogon virginicus	Broom sedge	x	y	
Cinna arundinacea	Stout woodreed	x	y	
Diarrhena americana	Grass	x	y	
Festuca subverticillata	Nodding fescue	x	y	
Glyceria striata	Fowl mannagrass	x	y	
Hystrix patula	Bottle-brush	x	y	
Leersia virginica	Whitegrass	x	y	

TABLE 5.3-7

Plant Species
Jefferson Proving Ground
Madison, Indiana

General Note:

1. Protection status classification is based on the Indiana Department of Natural Resources, Division of Nature Preserves and Fish and Wildlife. *Indiana's rare plants and animals- A checklist of endangered and threatened species* (1993).

Footnotes:

(a) Observed.
(b) Yes.
(c) Indiana Threatened.
(d) Indiana Rare.
(e) Historic range which indicates the known general distribution of the species as reported in Endangered and Threatened Wildlife and Plants (50 CFR 17.11 &17.12) (October 31, 1996).
(f) Federal Threatened.
(g) Indiana Endangered.
(h) Federal Endangered.

TABLE 5.3-8

Key Receptors
Jefferson Proving Ground
Madison, Indiana

Common Name	Class	Scientific Name - Genus and Species	Feeding Guild	Examples of Other JPG Wildlife and Vegetation Represented by Key Receptor
Red fox	*Mammalia*	*Vulpes vulpes*	Carnivore/omnivore	Coyotes
Eastern cottontail	*Mammalia*	*Sylvilagus floridanus*	Herbivore	Deer
White-footed mouse	*Mammalia*	*Peromyscus leucopus*	Herbivore-insectivore	Shrews, voles
Little brown myotis	*Mammalia*	*Myotis lucifugus*	Insectivore	Mammalian insectivore
Raccoon	*Mammalia*	*Procyon lotor*	Omnivore	Omnivorous aquatic mammals
Mourning dove	*Aves*	*Zenaida macroura*	Granivore	Avian granivores
Chimney swift	*Aves*	*Chaetura pelagica*	Insectivore	Avian insectivores
Wild turkey	*Aves*	*Meleagris gallopavo*	Omnivore	Omnivorous upland game birds
American kestrel	*Aves*	*Falco sparverius*	Carnivore, insectivore	Raptors
Great blue heron*	*Aves*	*Ardea herodias*	Carnivore, insectivore	Omnivorous wading birds
Soil fauna (e.g., crayfish)	*Crustacea*	*Cambarus diogenes*	Omnivore, detritovore	Terrestrial invertebrates
Plants	----	-----	----	All vegetation
Creek chub	*Pisces*	*Semotilus atromaculatus atromaculatus*	Insectivore	All fish
Benthic invertebrates (e.g., crayfish)	*Crustacea*	*Cambarus rusticus*	Omnivore, detritovore	Aquatic and benthic invertebrates
Pickerel frog	*Amphibia*	*Rana palustris*	Insectivore	Amphibians

*State of Indiana Species of Special Concern (nests only)

TABLE 5.3-9

Dietary Items and Preferences for Key Receptors for Which the Dietary Pathway was Evaluated
Jefferson Proving Ground
Madison, Indiana

Receptor	Dietary Item	Percent	Source
Mourning Dove	Plants	100%	Palmer and Fowler 1975
Chimney Swift	Invertebrates (Insects)	100%	Palmer and Fowler 1975
Wild Turkey	Plants (seeds, nuts, grains) Invertebrates (insects, snails)	90% 10%	Eaton 1992; Palmer and Fowler 1975
American Kestrel	Small Mammals (mice) Birds (chimney swift) Invertebrates	30% 10% 60%	Palmer and Fowler 1975
Great Blue Heron	Aquatic Invertebrates (crayfish) Aquatic Vertebrates (frogs) Aquatic Vertebrates (fish)	20% 20% 60%	Butler 1992; Quinney and Smith 1980
White-footed Mouse	Plants Invertebrates	50% 50%	Palmer and Fowler 1975
Eastern Cottontail	Plants (herbs, grasses, woody plants)	100%	Chapman and Feldhamer 1982
Raccoon	Aquatic Plants Aquatic Invertebrates Aquatic Vertebrates (frogs)	60% 20% 20%	Chapman and Feldhamer 1982
Red Fox	Plants Invertebrates Small Mammals (mice) Medium Mammals (rabbit)	40% 30% 15% 15%	Chapman and Feldhamer 1982
Little Brown Myotis	Invertebrates (Insects)	100%	Chapman and Feldhamer 1982

TABLE 5.3-10

Summary of Exposure Parameters Key Receptors
Jefferson Proving Ground
Madison, Indiana

Receptor	Summary Statistics	Body Weight (kg) [a]	Dietary Ingestion Rate (kg/kg bw/d) [b]	Soil Fraction in Diet	Water Ingestion Rate (L/kg bw/d) [c]	Home Range (ha) [d]
Mourning Dove	95th percentile	0.123	*0.124*	0.104	*0.120*	*101.2*
	minimum	0.115	*0.121*	0.104	*0.118*	*99.7*
	maximum	0.123	*0.124*	0.104	*0.120*	*101.3*
	mean	0.119	*0.122*	0.104	*0.119*	*100.5*
Chimney Swift	95th percentile	0.029	*0.238*	0.104	*0.224*	*72.7*
	minimum	0.017	*0.198*	0.104	*0.188*	*64.2*
	maximum	0.030	*0.241*	0.104	*0.226*	*73.1*
	mean	0.023	*0.216*	0.104	*0.204*	*69.1*
Wild Turkey	95th percentile	7.241	*0.035*	0.104	*0.036*	*258.6*
	minimum	4.222	*0.029*	0.104	*0.030*	*228.4*
	maximum	7.400	*0.035*	0.104	*0.037*	*259.9*
	mean	5.811	*0.031*	0.104	*0.033*	*245.8*
American Kestrel	95th percentile	0.135	0.309	0.028	0.120	192.40
	minimum	0.103	0.290	0.028	0.110	13.10
	maximum	0.138	0.310	0.028	0.120	202.00
	mean	0.119	0.300	0.028	0.115	106.34
Great Blue Heron	95th percentile	2.529	0.180	0.025	*0.047*	8.01
	minimum	1.990	0.180	0.002	*0.043*	0.60
	maximum	2.576	0.180	0.030	*0.047*	8.40
	mean	2.268	0.180	0.011	*0.045*	4.50
White-footed Mouse	95th percentile	0.028	0.433	0.02	0.190	0.12
	minimum	0.015	0.180	0.02	0.190	0.01
	maximum	0.032	0.450	0.02	0.190	0.13
	mean	0.021	0.268	0.02	0.190	0.06
Eastern Cottontail	95th percentile	1.301	*0.085*	0.063	*0.098*	7.53
	minimum	1.132	*0.081*	0.063	*0.096*	1.50
	maximum	1.313	*0.085*	0.063	*0.098*	7.80
	mean	1.220	*0.083*	0.063	*0.097*	3.61
Raccoon	95th percentile	7.348	*0.054*	0.094	0.083	2122
	minimum	3.670	*0.048*	0.094	0.082	39
	maximum	7.600	*0.055*	0.094	0.083	2560
	mean	5.783	*0.050*	0.094	0.083	630
Red Fox	95th percentile	5.186	0.134	0.028	0.086	1878
	minimum	3.940	0.069	0.028	0.084	96
	maximum	5.250	0.14	0.028	0.086	1967
	mean	4.535	0.09	0.028	0.085	1038
Little Brown Myotis	95th percentile	0.005	*0.179*	0.02	*0.170*	*20.2*
	minimum	0.005	*0.173*	0.02	*0.167*	*18.8*
	maximum	0.006	*0.180*	0.02	*0.170*	*20.3*
	mean	0.005	*0.176*	0.02	*0.168*	*19.6*

General Note:

1. Italics indicate values obtained using allometric equations.
Source data are located in Appendix DD.

Footnotes:

(a) Kilogram.
(b) Kilogram per kilogram body weight per day.
(c) Liter per kilogram body weight per day.
(d) Hectare.

TABLE 5.3-11

Summary of Bioaccumulation and Bioconcentration Factors for Terrestrial and Aquatic Receptors
Jefferson Proving Ground
Madison, Indiana

	Bioaccumulation Factors (BAFs)				Bioconcentration Factors (BCFs)		
Analyte	**Plant**	**Invertebrate**	**Mammal**	**Bird**	**Aquatic Plant**	**Benthic Invertebrate**	**Fish or Frog**
1,3,5-Trinitrobenzene							
2,4-Dinitrotoluene							
2,3,4,6,7,8-Hexachlorodibenzofuran							*728000*
2,3,4,7,8-Pentachlorodibenzofuran							*728000*
2-Methylnaphthalene	**0.0130**		**0.0156**		79.4	206.1	107.8
2-Methylpyrene	**0.0130**		**0.0156**		79.4	206.1	107.8
2-Phenylnaphthalene	**0.0130**		**0.0156**		79.4	206.1	107.8
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin							*728000*
1,2,3,4,6,7,8-Heptachlorodibenzofuran							*728000*
1,2,3,4,7,8,9-Heptachlorodibenzofuran							*728000*
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin							*728000*
1,2,3,7,8,9-Hexachlorodibenzofuran							*728000*
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin							*728000*
1,2,3,7,8-Pentachlorodibenzo-p-dioxin							*728000*
1,2,3,7,8-Pentachlorodibenzofuran							*728000*
Acenaphthene	**0.0130**		**0.0156**		79.4	206.1	107.8
Acenaphthylene	**0.0130**		**0.0156**		79.4	206.1	107.8
Aldrin	0.03	4.29	0.02	0.477	1816.5	1342.5	1403.2
Aluminum	**0.004**	**0.011**	**0.001**				
Anthracene	**0.0130**		**0.0156**		79.4	206.1	107.8
Antimony	**0.263**	**0.191**	**0.093**				
Arsenic	**0.021**	**0.113**	**0.002**				
Benzo[a]anthracene	**0.0130**		**0.0156**		79.4	206.1	107.8
Barium	**0.147**	**0.036**	**0.016**				
Benzo[b]fluoranthene	**0.0130**		**0.0156**		79.4	206.1	107.8
Benzene							
Benzo(a)pyrene	**0.0130**		**0.0156**		79.4	206.1	107.8
Benzoic acid							
Benzo[e]pyrine	**0.0130**		**0.0156**		79.4	206.1	107.8
Beryllium	**0.004**	**0.011**	**0.001**				
Benzo[ghi]perylene	**0.0130**		**0.0156**		79.4	206.1	107.8
Biphenyl							
Bis(2-ethylhexyl) phthalate							
Benzo[j]fluoranthene	**0.0130**		**0.0156**		79.4	206.1	107.8
Benzo[k]fluoranthene	**0.0130**		**0.0156**		79.4	206.1	107.8
Benzo[b]naphtho[2,1-D]thiophene							
Boron	4						
Bromophenyl phenyl ether, 4-							
Butylbenzyl phthalate							
Cadmium	0.4	3.72	0.0024	0.002	322.5	110.8	8
Carbazole							
Chlordane	0.02	5	0.04	0.352	1	0.4	1.2
Chlorobenzene							
Chromium	0.012	0.026	0.005				
Chrysene	**0.0130**		**0.0156**		79.4	206.1	107.8
Cobalt	**0.018**	**0.035**	**0.001**				
Copper	**0.099**	0.88	0.15		995	612.2	87.3
Cyanide							
Dibenz[ah]anthracene	**0.0130**		**0.0156**		79.4	206.1	107.8
Di-n-butyl phthalate							
Diazinon							
Dibenzofuran							
Dibenzothiophene							
Dichlorobenzene, 1,2-							
Dichlorobenzene, 1,3-							
Dichlorobenzene, 1,4-							
Dichloroethane, 1,1-							
Dieldrin	0.03	4.29	0.02	0.477	1816.5	1342.5	1403.2
Diethyl phthalate							
Dimethyl phthalate							
1-Eicosanol							
Endosulfan I							
Endosulfan II							
Endosulfan, mixed isomers							
Endrin	0.03	4.29	0.02	0.477	1816.5	1342.5	1403.2
Ethylbenzene							
Fluoranthene	**0.0130**		**0.0156**		79.4	206.1	107.8
Fluorene	**0.0130**		**0.0156**		79.4	206.1	107.8
Heptachlor	0.086	1.67	0.11	2.25	18	41.5	595.7
Heptachlor epoxide	0.086	1.67	0.11	2.25	18	41.5	595.7
Hexachloroethane							
Indeno[1,2,3-C,D]pyrene	**0.0130**		**0.0156**		79.4	206.1	107.8
Iron	4.00E-03						

TABLE 5.3-11

Summary of Bioaccumulation and Bioconcentration Factors for Terrestrial and Aquatic Receptors
Jefferson Proving Ground
Madison, Indiana

	Bioaccumulation Factors (BAFs)				Bioconcentration Factors (BCFs)		
Analyte	**Plant**	**Invertebrate**	**Mammal**	**Bird**	**Aquatic Plant**	**Benthic Invertebrate**	**Fish or Frog**
Lead	0.13	0.07	0.0008	0.0003	53572.4	1380.3	69.8
Lindane/Hexachlorocyclohexane							
Malathion							
Manganese	**0.037**	**0.038**	**0.002**				
Mercury	0.002	1.44	1.24	1.214	486.8	95.8	163.6
Methoxychlor							
Molybdenum	0.25						
Myristic acid							
Naphthalene	**0.0130**		**0.0156**		79.4	206.1	107.8
Nickel	**0.044**	**0.05**	**0.003**				
N-Nitrosodiphenylamine							
Nonadecane							
Octachlorodibenzodioxin - nonspecific							*728000*
Octachlorodibenzofuran - nonspecific							*728000*
Stearic acid							
p-Cresol							
Polynuclear aromatic hydrocarbons	**0.0130**		**0.0156**		79.4	206.1	107.8
Palmitic acid							
Polychlorinated biphenyl	0.01	2.46	1.43	0.227	0.99	6.08	913.7
Pentachlorobenzene							
Pentachlorophenol							
Phenanthrene	**0.0130**		**0.0156**		79.4	206.1	107.8
Phenol							
ppDDD	0.01	1.98	0.45	0.905	559.4	3896.5	2358.1
2,2-Bis(p-chlorophenyl)-1,1-dichloroethene	0.01	1.98	0.45	0.905	559.4	3896.5	2358.1
2,2-Bis(p-chlorophenyl)-1,1,1-trichloroethane	0.01	1.98	0.45	0.905	559.4	3896.5	2358.1
Pyrene	**0.0130**		**0.0156**		79.4	206.1	107.8
Selenium	9.47	7.84	**0.209**	0.013	2224.9	44.7	
Silver	**0.048**	**0.12**	**0.083**				
Sulfur	1.5						
2,3,7,8-Tetrachlorodibenzodioxin							*728000*
2,3,7,8-Tetrachlorodibenzofuran							*728000*
Tellurium							
Tetrachloroethane 1,1,2,2-							
Tetrachloroethylene							
Tetrachloromethane							
Thallium	4.00E-03						
Tin	0.03		0.97				
Toluene							
Total Endosulfans							
Total petroleum hydrocarbons							
Toxaphene							
Tribromomethane							
Trichlorobenzene, 1,2,4-							
Trichloroethane, 1,1,1-							
Trichloroethylene							
Vanadium	**0.003**	**0.009**	**0.0005**				
Xylene, m							
Zinc	0.55	0.66	**0.065**	0.001	3385.2	1899	282

General Notes:
1. Value in gray is from Schroeder and Balassa, 1967.
2. Values in bold are from Tooele Army Depot, Rust E&I 1997.
3. Values in bold borders are from Bodek et al., 1988.
4. Values in italics are from USEPA 1993. TCDD value used for all dioxins and furans.
5. All other standard text values represent geometric means from lognormal distributions - See Appendix DD for source data .

TABLE 5.3-12

Area Use Factors (AUFs) For Key Receptors - Reasonable Maximum Exposure (RME) and Central Tendency (CT)
Jefferson Proving Ground
Madison, Indiana

RME AUF	Mourning Dove	Chimney Swift	Wild Turkey	American Kestrel	White-footed Mouse	Eastern Cottontail	Red Fox	Little Brown Myotis	Great Blue Heron	Raccoon	Benthic Invertebrate	Creek Chub	Pickerel Frog	Site Size (hecatares,ha)
11	0.006	0.010	0.0028	0.05	1.00	0.43	0.01	0.034	1.00	0.02	NA	NA	NA	0.648
14/15	0.001	0.001	0.0004	0.01	1.00	0.06	0.001	0.005	0.14	0.002	NA	NA	NA	0.085
25	0.004	0.006	0.0016	0.03	1.00	0.24	0.004	0.019	0.61	0.01	NA	NA	NA	0.364
3/4	0.023	0.035	0.0099	0.17	1.00	1.00	0.02	0.121	1.00	0.06	NA	NA	NA	2.266
39	0.065	0.101	0.0284	0.49	1.00	1.00	0.07	0.344	1.00	0.17	NA	NA	NA	6.475
9	0.019	0.029	0.0082	0.14	1.00	1.00	0.02	0.099	1.00	0.05	NA	NA	NA	1.862
NBS-in	0.0001	0.0002	0.00005	0.001	1.00	0.01	0.0001	0.001	0.02	0.0003	NA	NA	NA	0.010
7/21B	0.0004	0.001	0.0002	0.003	1.00	0.02	0.0004	0.002	0.06	0.001	NA	NA	NA	0.035
28	0.001	0.001	0.0004	0.01	1.00	0.05	0.001	0.004	0.13	0.002	NA	NA	NA	0.081
29	0.002	0.003	0.0009	0.02	1.00	0.13	0.002	0.011	0.34	0.01	NA	NA	NA	0.202
2/27	0.034	0.052	0.0147	0.26	1.00	1.00	0.04	0.179	1.00	0.09	NA	NA	NA	3.364
Avon	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	NA	NA	NA	1000
Cobbs	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	NA	NA	NA	1000
Ross	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	NA	NA	NA	1000
2	0.0000487	0.000	0.00002	0.0004	0.49	0.002	0.00	0.0003	0.01	0.0001	NA	NA	NA	0.005
3	0.011	0.018	0.0050	0.09	1.00	0.02	0.01	0.060	1.00	0.03	NA	NA	NA	1.133
4	0.011	0.018	0.0050	0.09	1.00	0.04	0.01	0.060	1.00	0.03	NA	NA	NA	1.133
7	0.00003	0.00004	0.00001	0.0002	0.28	0.01	0.00003	0.0001	0.005	0.0001	NA	NA	NA	0.003
14	0.0004	0.001	0.0002	0.003	1.00	0.0001	0.0005	0.002	0.07	0.001	NA	NA	NA	0.045
15	0.0004	0.001	0.0002	0.003	1.00	0.0002	0.0004	0.002	0.07	0.001	NA	NA	NA	0.040
21B	0.0003	0.001	0.0001	0.002	1.00	0.001	0.0003	0.002	0.05	0.001	NA	NA	NA	0.032
27	0.034	0.052	0.0147	0.26	1.00	1.00	0.03	0.179	1.00	0.09	NA	NA	NA	3.359
NBS-out	0.001	0.001	0.0003	0.01	1.00	0.02	0.001	0.004	0.12	0.002	NA	NA	NA	0.070

CT AUF	Mourning Dove	Chimney Swift	Wild Turkey	American Kestrel	White-footed Mouse	Eastern Cottontail	Red Fox	Little Brown Myotis	Great Blue Heron	Raccoon	Benthic Invertebrate	Creek Chub	Pickerel Frog	Site Size (ha)
11	0.006	0.009	0.0026	0.006	1.00	0.18	0.0006	0.033	0.14	0.001	NA	NA	NA	0.648
14/15	0.001	0.001	0.0003	0.001	1.00	0.02	0.0001	0.004	0.02	0.0001	NA	NA	NA	0.085
25	0.004	0.005	0.0015	0.003	1.00	0.10	0.0004	0.019	0.08	0.001	NA	NA	NA	0.364
3/4	0.023	0.033	0.0092	0.021	1.00	0.63	0.0022	0.116	0.50	0.004	NA	NA	NA	2.266
39	0.064	0.094	0.0263	0.061	1.00	1.00	0.0062	0.330	1.00	0.010	NA	NA	NA	6.475
9	0.019	0.027	0.0076	0.018	1.00	0.52	0.0018	0.095	0.41	0.003	NA	NA	NA	1.862
NBS-in	0.0001	0.0002	0.00004	0.0001	0.17	0.00	0.00001	0.001	0.00	0.00002	NA	NA	NA	0.010
7/21B	0.000	0.001	0.0001	0.000	0.59	0.01	0.0000	0.002	0.01	0.0001	NA	NA	NA	0.035
28	0.001	0.001	0.0003	0.001	1.00	0.02	0.0001	0.004	0.02	0.0001	NA	NA	NA	0.081
29	0.002	0.003	0.0008	0.002	1.00	0.06	0.000	0.010	0.04	0.000	NA	NA	NA	0.202
2/27	0.03	0.05	0.01	0.03	1.00	0.93	0.003	0.17	0.75	0.01	NA	NA	NA	3.364
Avon	1.00	1.00	1.00	1.00	1.00	1.00	0.963	1.00	1.00	1.00	NA	NA	NA	1000
Cobbs	1.00	1.00	1.00	1.00	1.00	1.00	0.963	1.00	1.00	1.00	NA	NA	NA	1000
Ross	1.00	1.00	1.00	1.00	1.00	1.00	0.963	1.00	1.00	1.00	NA	NA	NA	1000
2	0.00005	0.0001	0.00002	0.00005	0.08	0.001	0.000005	0.0002	0.00	0.00001	NA	NA	NA	0.005
3	0.01	0.02	0.0046	0.011	1.00	0.31	0.001	0.058	0.25	0.002	NA	NA	NA	1.133
4	0.01	0.02	0.0046	0.011	1.00	0.31	0.001	0.058	0.25	0.002	NA	NA	NA	1.133
7	0.00003	0.00004	0.00001	0.00003	0.05	0.00	0.000003	0.0001	0.001	0.000004	NA	NA	NA	0.003
14	0.0004	0.001	0.0002	0.0004	0.74	0.01	0.00004	0.002	0.01	0.0001	NA	NA	NA	0.045
15	0.0004	0.001	0.0002	0.0004	0.67	0.01	0.00004	0.002	0.01	0.0001	NA	NA	NA	0.040
21B	0.0003	0.0005	0.0001	0.0003	0.54	0.01	0.00003	0.002	0.01	0.0001	NA	NA	NA	0.032
27	0.03	0.05	0.0137	0.032	1.00	0.93	0.003	0.171	0.75	0.005	NA	NA	NA	3.359
NBS-out	0.001	0.001	0.0003	0.001	1.00	0.02	0.0001	0.004	0.02	0.0001	NA	NA	NA	0.070

TABLE 5.3-13

Summary of Exposure Parameters for Terrestrial Receptors - Reasonable Maximum Exposure (RME)
Jefferson Proving Ground
Madison, Indiana

RME Parameter		Units	Terrestrial Receptors								Aquatic Receptors				
			Mourning Dove	Chimney Swift	Wild Turkey	American Kestrel	White-footed Mouse	Eastern Cottontail	Red Fox	Little Brown Myotis	Great Blue Heron	Raccoon	Benthic Invertebrate	Creek Chub	Pickerel Frog
Dietary Ingestion Rate	(DIR)	kg/kg-day	0.124	0.238	0.035	0.309	0.433	0.085	0.134	0.179	0.18	0.054	ND	ND	ND
Water Ingestion Rate	(WIR)	kg/kg-day	0.120	0.224	0.036	0.120	0.19	0.098	0.086	0.170	0.047	0.083	ND	ND	NA
Adjusted Dietary Ingestion Rate	(DIRadj)	kg/kg-day	0.111	0.213	0.031	0.300	0.424	0.080	0.130	0.175	0.176	0.049	ND	ND	ND
Soil Fraction in Diet	(SFD)	unitless	0.104	0.104	0.104	0.028	0.02	0.063	0.028	0.02	0.025	0.094	ND	ND	ND
Invert Fraction in Diet	(IFD)	unitless	0	1	0.1	0.6	0.5	0	0.3	1	0.2	0.2	ND	ND	ND
Fish Fraction in Diet	(FFD)	unitless	0	0	0	0	0	0	0	0	0.6	0	ND	ND	ND
Amphibian Fraction	(AFD)	unitless	0	0	0	0	0	0	0	0	0.2	0.2	ND	ND	ND
Mammal Fraction in Diet	(MFD)	unitless	0	0	0	0.3	0	0	0.3	0	0	0	ND	ND	ND
Bird Fraction in Diet	(BFD)	unitless	0	0	0	0.1	0	0	0	0	0	0	ND	ND	ND
Plant Fraction in Diet	(PFD)	unitless	1	0	0.9	0	0.5	1	0.4	0	0	0.6	ND	ND	ND
Body Weight	(BW)	g	115	17	4,222	103	15.0	1,132	3,940	5.00	1,990	3,670	ND	ND	ND
Body Weight	(BW)	kg	0.115	0.017	4.22	0.103	0.015	1.132	3.94	0.005	1.99	3.67	ND	ND	ND
Home Range/Territory Size	(HR)	hectares	99.70	64.20	228.4	13.10	0.01	1.50	96	18.8	0.60	39.0	ND	ND	ND

General Notes:

1. Body weights and home range are minima; all other parameters are 95th percentile values.
2. Body weights are minima, which result in more conservative assumptions if allometric equations are used to obtain DIR.
3. NA—Not applicable.
4. ND—Not determined.

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TABLE 5.3-14

Summary of Exposure Parameters for Terrestrial Receptors - Central Tendency (CT)
Jefferson Proving Ground
Madison, Indiana

CT Parameter		Units	Terrestrial Receptors								Aquatic Receptors				
			Mourning Dove	Chimney Swift	Wild Turkey	American Kestrel	White-footed Mouse	Eastern Cottontail	Red Fox	Little Brown Myotis	Great Blue Heron	Raccoon	Benthic Invertebrate	Creek Chub	Pickerel Frog
Dietary Ingestion Rate	(DIR)	kg/kg-day	0.122	0.216	0.031	0.3	0.268	0.083	0.09	0.176	0.18	0.05	ND	ND	ND
Water Ingestion Rate	(WIR)	kg/kg-day	0.119	0.204	0.033	0.115	0.19	0.097	0.085	0.168	0.045	0.083	ND	ND	NA
Adjusted Dietary Ingestion Rate	(DIRadj)	kg/kg-day	0.109	0.194	0.028	0.292	0.263	0.078	0.087	0.172	0.176	0.045	ND	ND	ND
Soil Fraction in Diet	(SFD)	unitless	0.104	0.104	0.104	0.028	0.02	0.063	0.028	0.02	0.025	0.094	ND	ND	ND
Invert Fraction in Diet	(IFD)	unitless	0	1	0.1	0.6	0.5	0	0.3	1	0.2	0.2	ND	ND	ND
Fish Fraction in Diet	(FFD)	unitless	0	0	0	0	0	0	0	0	0.6	0	ND	ND	ND
Amphibian Fraction	(AFD)	unitless	0	0	0	0	0	0	0	0	0.2	0.2	ND	ND	ND
Mammal Fraction in Diet	(MFD)	unitless	0	0	0	0.3	0	0	0.3	0	0	0	ND	ND	ND
Bird Fraction in Diet	(BFD)	unitless	0	0	0	0.1	0	0	0	0	0	0	ND	ND	ND
Plant Fraction in Diet	(PFD)	unitless	1	0	0.9	0	0.5	1	0.4	0	0	0.6	ND	ND	ND
Body Weight	(BW)	g	119	23	5,811	119	21	1220	4,535	5	2,268	5,783	ND	ND	ND
Body Weight	(BW)	kg	0.119	0.023	5.811	0.119	0.021	1.22	4.535	0.005	2.268	5.783	ND	ND	ND
Home Range/Territory Size	(HR)	hectares	100.5	69.10	245.8	106.3	0.06	3.61	1,038	19.6	4.50	630.0	ND	ND	ND

General Notes:

1. All values are means.
2. NA=Not applicable.
3. ND= Not determined.
4. kg = kilogram
5. g = gram

TABLE 5.3-15

Summary of Aquatic Toxicological Information
Jefferson Proving Ground
Madison, Indiana

	Freshwater (µg/L) [(a)]			Sediments (mg/kg) [(b)]					
Analyte	**Chronic AWQC [(c)], FCV [(d)], or Tier II Value**		**Acute AWQC [(e)]**	**USEPA Freshwater SQC [(f)]**	**USEPA SQB [(g)] or NOAA ERL [(h)]**		**USEPA ARCS SEC [(i)]**	**Ontario Lower Effect Level**	**USEPA NEC [(j)]**
2,4-Dinitrotoluene	NA [(k)]		NA	NA	NA		NA	NA	NA
2,3,4,6,7,8-Hexachlorodibenzofuran	NA		NA	NA	NA		NA	NA	NA
2,3,4,7,8-Pentachlorodibenzofuran	NA		NA	NA	NA		NA	NA	NA
2-Methylnaphthalene	NA		NA	NA	NA		NA	NA	NA
2-Methylpyrene	NA		NA	NA	NA		NA	NA	NA
2-Phenylnaphthalene	NA		NA	NA	NA		NA	NA	NA
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	NA		NA	NA	NA		NA	NA	NA
1,2,3,4,6,7,8-Heptachlorodibenzofuran	NA		NA	NA	NA		NA	NA	NA
1,2,3,4,7,8,9-Heptachlorodibenzofuran	NA		NA	NA	NA		NA	NA	NA
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	NA		NA	NA	NA		NA	NA	NA
1,2,3,7,8,9-Hexachlorodibenzofuran	NA		NA	NA	NA		NA	NA	NA
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	NA		NA	NA	NA		NA	NA	NA
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	NA		NA	NA	NA		NA	NA	NA
1,2,3,7,8-Pentachlorodibenzofuran	NA		NA	NA	NA		NA	NA	NA
Acenaphthene	23	f [(l)]	1700	0.62	0.016	ERL	NA	NA	31.11
Acenaphthylene	NA		NA	NA	NA		NA	NA	NA
Aldrin	NA		NA	NA	NA		NA	NA	NA
Aluminum	NA		NA	NA	NA		NA	NA	73160
Anthracene	NA		NA	NA	NA		0.083	0.22	80
Antimony	NA		NA	NA	NA		NA	NA	NA
Arsenic	190		360	NA	8.2	ERL	13.26	6	92.9
Benzo[a]anthracene	NA		NA	NA	NA		NA	NA	NA
Barium	3.9	II	NA	NA	NA		NA	NA	NA
Benzo[b]fluoranthene	NA		NA	NA	NA		NA	NA	NA
Benzene	46	II	5300	NA	0.057		NA	NA	NA
Benzo(a)pyrene	0.014	II	NA	NA	0.43	ERL	0.21	0.37	80
Benzoic acid	NA		NA	NA	NA		NA	NA	NA
Benzo[e]pyrine	NA		NA	NA	NA		NA	NA	NA
Beryllium	5.1	II	130	NA	NA		NA	NA	NA
Benzo[ghi]perylene	NA		NA	NA	NA		NA	NA	NA
Biphenyl	14	II	NA	NA	1.1		NA	NA	NA
Bis(2-ethylhexyl) phthalate	32	II	NA	NA	NA		NA	NA	NA
Benzo[j]fluoranthene	NA		NA	NA	NA		NA	NA	NA
Benzo[k]fluoranthene	NA		NA	NA	NA		NA	NA	NA
Benzo[b]naphtho[2,1-D]thiophene	NA		NA	NA	NA		NA	NA	NA
Boron	NA		NA	NA	NA		NA	NA	NA
Bromophenyl phenyl ether, 4-	1.5	II	NA	NA	1.3		NA	NA	NA
Butylbenzyl phthalate	19	II	NA	NA	11		NA	NA	NA
Cadmium	1	h	3.9	NA	1.2	ERL	2.15	0.6	8
Carbazole	NA		NA	NA	NA		NA	NA	NA
Chlordane			2.4	NA	NA		NA	0.007	NA
Chlorobenzene	130	II	250.0	NA	0.82		NA	NA	NA
Chromium	180	h	1700	NA	240	ERL	25.60	26	95
Chrysene	NA		NA	NA	NA		0.29	0.34	80
Cobalt	3	II	NA	NA	NA		NA	NA	NA
Copper	11	h	18	NA	34	ERL	49.02	16	325
Cyanide	5.2		22	NA	NA		NA	NA	NA
Dibenz[ah]anthracene	NA		NA	NA	NA		NA	NA	NA
Diazinon	0.043	f	NA	NA	0.0019		NA	NA	NA
Dibenzofuran	20	II	NA	NA	2		NA	NA	NA
Dibenzothiophene	NA		NA	NA	NA		NA	NA	NA
Dichlorobenzene, 1,2-	14	II	1120	NA	0.34		NA	NA	NA
Dichlorobenzene, 1,3-	71	II	1120	NA	1.7		NA	NA	NA
Dichlorobenzene, 1,4-	15	II	1120	NA	0.35		NA	NA	NA
Dichloroethane, 1,1-	47	II	NA	NA	NA		NA	NA	NA
Dieldrin	0.062	f	2.5	0.052	NA		NA	0.002	NA
Diethyl phthalate	220	II	NA	NA	0.63		NA	NA	NA
Dimethyl phthalate	220	II	NA	NA	0.63		NA	NA	NA
Di-n-butyl phthalate	33	II	NA	NA	11		NA	NA	NA
1-Eicosanol	NA		NA	NA	NA		NA	NA	NA

TABLE 5.3-15

Summary of Aquatic Toxicological Information
Jefferson Proving Ground
Madison, Indiana

	Freshwater (µg/L) [a]			Sediments (mg/kg) [b]					
Analyte	Chronic AWQC [c], FCV [d], or Tier II Value		Acute AWQC [e]	USEPA Freshwater SQC [f]	USEPA SQB [g] or NOAA ERL [h]		USEPA ARCS SEC [i]	Ontario Lower Effect Level	USEPA NEC [j]
Endosulfan I	0.051	II	0.22	NA	0.0029		NA	NA	NA
Endosulfan II	0.051	II	0.22	NA	0.014		NA	NA	NA
Endosulfan, mixed isomers	0.051	II	0.22	NA	0.0		NA	NA	NA
Endrin	0.061	f	0.18	0.02	NA		NA	0.0	NA
Ethylbenzene	290	II	32000	NA	3.6		NA	NA	NA
Fluoranthene	6.2	f	3980	2.9	0.6	ERL	0.101	0.75	84.27
Fluorene	3.9	II	NA	NA	0.54		0.05	0.19	80
Heptachlor	0.0069	II	0.52	NA	NA		NA	0.005	NA
Heptachlor epoxide	0.0069	II	0.52	NA	NA		NA	0.005	NA
Hexachloroethane	12	II	980	NA	1		NA	NA	NA
Indeno[1,2,3-C,D]pyrene	NA		NA	NA	NA		NA	NA	NA
Iron	1000	i	NA	NA	NA		84400	20000	289900
Lead	2.5	h	83	NA	47	ERL	43.54	31	127
Lindane/Hexachlorocyclohexane	0.08	f	NA	NA	0.0037		NA	0.003	NA
Malathion	0.097	II	NA	NA	0.00067		NA	NA	NA
Manganese	80	II	NA	NA	NA		726.0	460.0	4460
Mercury	1.3	f	2.4	NA	0.15	ERL	NA	0.2	NA
Methoxychlor	0.019	II	NA	NA	0.019		NA	NA	NA
Molybdenum	240	II	NA	NA	NA		NA	NA	NA
Myristic acid	NA		NA	NA	NA		NA	NA	NA
Naphthalene	24	II	2300	NA	0.48		0.04	NA	80
Nickel	160	h	1400	NA	170	ERL	19.94	16	43
N-Nitrosodiphenylamine	NA		NA	NA	NA		NA	NA	NA
Nonadecane	NA		NA	NA	NA		NA	NA	NA
Octachlorodibenzodioxin - nonspecific	NA		NA	NA	NA		NA	NA	NA
Octachlorodibenzofuran - nonspecific	NA		NA	NA	NA		NA	NA	NA
Stearic acid	NA		NA	NA	NA		NA	NA	NA
Polynuclear aromatic hydrocarbon	NA		1700	NA	4	ERL	1.70	2	640
Palmitic acid	NA		NA	NA	NA		NA	NA	NA
Polychlorinated biphenyl	0.19	II	2	NA	0.023	ERL	0.05	0.07	10.78
p-Cresol	NA		NA	NA	NA		NA	NA	NA
Pentachlorobenzene	0.47	II	NA	NA	0.69		NA	NA	NA
Pentachlorophenol	13.00	pH	20.00	NA	NA		NA	NA	NA
Phenanthrene	6.30	f	NA	0.85	0.24	ERL	0.26	NA	222.2
Phenol	NA		NA	NA	NA		NA	NA	NA
2,2-Bis(p-chlorophenyl)-1,1-dichloroethane	NA		NA	NA	NA		NA	0.008	NA
2,2-Bis(p-chlorophenyl)-1,1-dichloroethene	NA		1050	NA	NA		NA	0.005	NA
2,2-Bis(p-chlorophenyl)-1,1,1-trichloroethane	0.0	II	1.1	NA	0.0016	ERL	NA	0.008	NA
Pyrene	NA		NA	NA	0.7		0.2	0.5	147.5
Selenium	5		20	NA	NA		NA	NA	NA
Silver	0.12	*	4.1	NA	NA		NA	NA	NA
Sulfur	NA		NA	NA	NA		NA	NA	NA
2,3,7,8-Tetrachlorodibenzodioxin	NA		NA	NA	NA		NA	NA	NA
2,3,7,8-Tetrachlorodibenzofuran	NA		NA	NA	NA		NA	NA	NA
Tellurium	NA		NA	NA	NA		NA	NA	NA
Tetrachloroethane 1,1,2,2-	420	II	NA	NA	0.94		NA	NA	NA
Tetrachloroethylene	120	II	5280	NA	0.53		NA	NA	NA
Tetrachloromethane	240	II	NA	NA	1.2		NA	NA	NA
Thallium	NA		1400	NA	NA		NA	NA	NA
Tin	NA		NA	NA	NA		NA	NA	NA
Toluene	130	II	17500	NA	NA		NA	NA	NA
Total Endosulfans	0.051	II	0.22	NA	0.0054		NA	NA	NA
Total petroleum hydrocarbons	NA		NA	NA	NA		NA	NA	NA
Toxaphene	0.011	II	0.73	NA	0.028		NA	NA	NA
Tribromomethane	320	II	NA	NA	0.65		NA	NA	NA
Trichlorobenzene, 1,2,4-	110	II	NA	NA	9.2		NA	NA	NA
Trichloroethane, 1,1,1-	62	II	NA	NA	0.17		NA	NA	NA
Trichloroethylene	350	II	45000	NA	1.6		NA	NA	NA
1,3,5-Trinitrobenzene	NA		NA	NA	NA		NA	NA	NA
Vanadium	19	II	NA	NA	NA		NA	NA	NA
Xylene, m	1.8	II	NA	NA	0.025		NA	NA	NA
Zinc	100	h	120	NA	150	ERL	124.64	120	1300

TABLE 5.3-15

Summary of Aquatic Toxicological Information
Jefferson Proving Ground
Madison, Indiana

Source: USEPA 1996 (ECO Update, Ecotox Thresholds, Intermittent Bulletin, Vol. 3, No. 2)
Metal criteria are for total dissolved concentrations.

Footnotes:

(a) Microgram per liter, equivalent to parts per billion.
(b) Milligram per kilogram, equivalent to parts per million.
(c) AWQC - Ambient Water Quality Criterion
(d) Final Chronic Value
(e) Ambient Water Quality Criterion.
(f) Sediment Quality Criterion.
(g) Sediment Quality Benchmarks by equilibrium partitioning assuming 1% organic carbon
(h) ERL - Effects Range--Low (Long et al., 1995)
(i) Severe effect concentration.
(j) No effect concentration.
(k) Not available.
(l) Final chronic value.

General Notes:

h = hardness dependent ambient water quality criterion (100 mg/L CaCO3 used in table)
I = instantaneous maximum
pH = pH dependent ambient water quality criterion (7.8 pH used in table)
II = Great Lakes Water Quality Initiative Tier II Methodology
* USEPA 1980. AWQC for Silver. Value currently withdrawn 11/24/97
Source: USEPA 1996c (ARCS)
USEPA ARCs NEC = Lowest NEC values for each analyte from USEPA 1996c. Dry-weight basis.
Based on 14 d Chironomid or 28 d Hyalella total extraction data; normalized to TOC for organics
NOTE: ACUTE ARE CURRENT AS OF 1992 from an USEPA online document.
Use chronic as NOAEL, acute as LOAEL. Use ERL as NOAEL, NEC as LOAEL.

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TABLE 5.3-16

Summary of Final Toxicity Reference Values (TRVs) for JPG Key Receptors
Jefferson Proving Ground
Madison, Indiana

Parameter	Mourning Dove-NOAEL[a]	Mourning Dove-LOAEL[b]	Chimney Swift-NOAEL	Chimney Swift-LOAEL	Wild Turkey-NOAEL	Wild Turkey-LOAEL	American Kestrel-NOAEL	American Kestrel - LOAEL	White-footed Mouse-NOAEL	White-Footed Mouse-LOAEL	Eastern Cottontail-NOAEL	Eastern Cottontail-LOAEL
2,4-Dinitrotoluene	NA[c]	NA	NA	NA	NA	NA	NA	NA	0.04	0.3	0.04	0.3
2,3,4,6,7,8-Hexachlorodibenzofuran	1.33E-05	4.00E-04	1.33E-05	4.00E-04	2.22E-05	6.67E-04	1.33E-05	4.00E-04	6.67E-07	6.67E-06	4.00E-07	4.00E-06
2,3,4,7,8-Pentachlorodibenzofuran	2.67E-06	8.00E-05	2.67E-06	8.00E-05	4.44E-06	1.33E-04	2.67E-06	8.00E-05	1.33E-07	1.33E-06	8.00E-08	8.00E-07
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	1.33E-04	4.00E-03	1.33E-04	4.00E-03	2.22E-04	6.67E-03	1.33E-04	4.00E-03	6.67E-06	6.67E-05	4.00E-06	4.00E-05
1,2,3,4,6,7,8-Heptachlorodibenzofuran	1.33E-04	4.00E-03	1.33E-04	4.00E-03	2.22E-04	6.67E-03	1.33E-04	4.00E-03	6.67E-06	6.67E-05	4.00E-06	4.00E-05
1,2,3,4,7,8,9-Heptachlorodibenzofuran	1.33E-04	4.00E-03	1.33E-04	4.00E-03	2.22E-04	6.67E-03	1.33E-04	4.00E-03	6.67E-06	6.67E-05	4.00E-06	4.00E-05
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	1.33E-05	4.00E-04	1.33E-05	4.00E-04	2.22E-05	6.67E-04	1.33E-05	4.00E-04	6.67E-07	6.67E-06	4.00E-07	4.00E-06
1,2,3,7,8,9-Hexachlorodibenzofuran	1.33E-05	4.00E-04	1.33E-05	4.00E-04	2.22E-05	6.67E-04	1.33E-05	4.00E-04	6.67E-07	6.67E-06	4.00E-07	4.00E-06
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	1.33E-05	4.00E-04	1.33E-05	4.00E-04	2.22E-05	6.67E-04	1.33E-05	4.00E-04	6.67E-07	6.67E-06	4.00E-07	4.00E-06
2-Methylnaphthalene	NA	NA	NA	NA	NA	NA	NA	NA	0.13	3.33	0.08	2.0
2-Methylpyrene	NA	NA	NA	NA	NA	NA	NA	NA	0.13	3.33	0.08	2.0
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	2.67E-06	8.00E-05	2.67E-06	8.00E-05	4.44E-06	1.33E-04	2.67E-06	8.00E-05	1.33E-07	1.33E-06	8.00E-08	8.00E-07
1,2,3,7,8-Pentachlorodibenzofuran	2.67E-05	8.00E-04	2.67E-05	8.00E-04	4.44E-05	1.33E-03	2.67E-05	8.00E-04	1.33E-06	1.33E-05	8.00E-07	8.00E-06
2-Phenylnaphthalene	NA	NA	NA	NA	NA	NA	NA	NA	0.13	3.33	0.08	2.0
Acenaphthene	NA	NA	NA	NA	NA	NA	NA	NA	0.13	3.33	0.08	2.0
Acenaphthylene	NA	NA	NA	NA	NA	NA	NA	NA	0.13	3.33	0.08	2.0
Aldrin	0.10	NA	0.10	NA	0.10	NA	0.10	NA	0.03	0.10	0.02	0.06
Aluminum	321.0	NA	192.6	NA	192.6	NA	192.6	NA	11.40	22.48	6.84	13.49
Anthracene	NA	NA	NA	NA	NA	NA	NA	NA	0.13	3.33	0.08	2.0
Antimony	NA	NA	NA	NA	NA	NA	NA	NA	0.20	0.60	0.12	0.36
Arsenic	2.80	8.40	2.80	8.40	2.80	8.40	2.80	8.40	0.01	0.13	0.01	0.08
Benzo[a]anthracene	NA	NA	NA	NA	NA	NA	NA	NA	0.13	3.33	0.08	2.0
Barium	3.88	38.80	3.88	38.80	6.47	64.67	3.88	38.80	2.37	NA	1.424	NA
Benzo[b]fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	0.13	3.33	0.08	2.0
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	0.13	3.33	0.08	2.0
Benzoic Acid	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	3.88	97.00	3.88	97.00	6.47	161.7	3.88	97.00	4.72	14.17	2.8	8.5
Benzo[e]pyrine	NA	NA	NA	NA	NA	NA	NA	NA	0.13	3.33	0.08	2.0
Benzo[ghi]perylene	NA	NA	NA	NA	NA	NA	NA	NA	0.13	3.33	0.08	2.0
Bis(2-ethylhexyl) phthalate	2.08	31.20	2.08	31.20	3.47	52.00	2.08	31.20	11.33	170	6.80	102
Benzo[j]fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	0.13	3.33	0.08	2.0
Benzo[k]fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	0.13	3.33	0.08	2.0
Benzo[b]naphtho[2,1-D]thiophene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Boron	11.2	44.8	11.2	44.8	11.20	44.8	11.2	44.8	1.42	2.83	0.85	1.7
Cadmium	0.03	0.40	0.03	0.40	0.03	0.40	0.03	0.40	0.17	NA	0.1	NA
Carbazole	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chlordane	0.03	0.43	0.03	0.43	0.028	0.43	0.03	0.43	NA	NA	NA	NA
Chromium	0.26	0.51	0.26	0.51	0.256	0.51	0.26	0.51	1.33	NA	1.33	NA
Chrysene	NA	NA	NA	NA	NA	NA	NA	NA	0.13	3.33	0.08	2.0
Cobalt	1.68	5.04	1.68	5.04	1.68	5.04	1.68	5.04	0.06	4.00	0.03	2.40
Copper	11.06	14.53	11.06	14.53	18.43	24.22	11.06	14.53	4.33	NA	2.6	NA
Cyanide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenz[ah]anthracene	NA	NA	NA	NA	NA	NA	NA	NA	0.13	3.33	0.08	2.0
Dibenzofuran	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzothiophene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dimethyl phthalate	2.08	31.20	2.08	31.20	3.47	52.00	2.08	31.20	11.33	170	6.80	102

TABLE 5.3-16

Summary of Final Toxicity Reference Values (TRVs) for JPG Key Receptors
Jefferson Proving Ground
Madison, Indiana

Parameter	Mourning Dove-NOAEL[a]	Mourning Dove-LOAEL[b]	Chimney Swift-NOAEL	Chimney Swift-LOAEL	Wild Turkey-NOAEL	Wild Turkey-LOAEL	American Kestrel-NOAEL	American Kestrel - LOAEL	White-footed Mouse-NOAEL	White-Footed Mouse-LOAEL	Eastern Cottontail-NOAEL	Eastern Cottontail-LOAEL
Di-n-butyl phthalate	2.08	31.20	2.08	31.20	3.47	52.00	2.08	31.20	11.33	170	6.80	102
Dieldrin	0.10	NA	0.10	NA	0.100	NA	0.10	NA	0.03	0.10	0.018	0.062
1-Eicosanol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endosulfan II	0.06	6.24	0.06	6.24	0.0624	6.24	0.06	6.24	NA	NA	NA	NA
Endrin	0.01	0.038	0.01	0.038	0.0064	0.038	0.01	0.04	0.01	0.01	0.01	0.01
Fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	0.13	3.33	0.08	2.0
Fluorene	NA	NA	NA	NA	NA	NA	NA	NA	0.13	3.33	0.08	2.0
Heptachlor	0.06	NA	0.06	NA	0.108	NA	0.06	NA	NA	NA	NA	NA
Heptachlor epoxide	0.06	NA	0.06	NA	0.108	NA	0.06	NA	NA	NA	NA	NA
Indeno[1,2,3-C,D]pyrene	NA	NA	NA	NA	NA	NA	NA	NA	0.13	3.33	0.08	2.0
Iron	78.00	156	78.00	156	78.00	156	78.00	156.00	33.33	66.67	20	40
Lead	2.90	8.7	2.90	8.7	2.90	8.7	14.50	43.50	1.33	56.67	0.80	34
Manganese	82.00	164	82.00	164	82.00	164	82.00	164.00	66.67	205.00	40	123
Mercury	0.50	2.5	0.50	2.5	0.83	2.5	0.50	2.50	0.26	1.30	0.156	0.78
Molybdenum	3.9	5.8	3.9	5.8	3.88	5.8	3.9	5.8	0.1	0.5	0.1	0.5
Myristic acid	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Naphthalene	NA	NA	NA	NA	NA	NA	NA	NA	0.13	3.33	0.08	2.0
Nickel	5.82	17.46	5.82	17.46	5.82	29.1	5.82	17.46	17.56	52.67	10.53	31.60
N-Nitrosodiphenylamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
p-Cresol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Palmitic acid	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Octachlorodibenzodioxin - nonspecific	1.33E-03	4.00E-02	1.33E-03	4.00E-02	2.22E-03	6.67E-02	1.33E-03	4.00E-02	6.67E-05	6.67E-04	4.00E-05	4.00E-04
Octachlorodibenzofuran - nonspecific	1.33E-03	4.00E-02	1.33E-03	4.00E-02	2.22E-03	6.67E-02	1.33E-03	4.00E-02	6.67E-05	6.67E-04	4.00E-05	4.00E-04
Stearic acid	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nonadecane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Polynuclear aromatic hydrocarbons	NA	NA	NA	NA	NA	NA	NA	NA	0.13	3.33	0.08	2
Polychlorinated biphenyl	0.04	0.36	0.04	0.36	0.06	0.6	0.04	0.36	0.57	1.70	0.113	0.34
Phenanthrene	NA	NA	NA	NA	NA	NA	NA	NA	0.13	3.33	0.08	2.0
Phenol	NA	NA	NA	NA	NA	NA	NA	NA	6.67	NA	4.00	NA
2,2-Bis(p-chlorophenyl)-1,1-dichloroethane	0.06	0.6	0.06	0.6	0.06	0.6	0.08	0.75	2.83	14.33	1.7	8.6
2,2-Bis(p-chlorophenyl)-1,1-dichloroethene	0.06	0.6	0.06	0.6	0.06	0.6	0.08	0.75	2.83	14.33	1.7	8.6
2,2-Bis(p-chlorophenyl)-1,1,1-trichloroethane	0.06	0.6	0.06	0.6	0.06	0.6	0.08	0.75	2.83	14.33	1.7	8.6
Pyrene	NA	NA	NA	NA	NA	NA	NA	NA	0.13	3.33	0.08	2.0
Selenium	0.13	0.264	0.13	0.264	0.22	0.44	0.13	0.26	0.01	0.19	0.0076	0.114
Silver	5.82	17.46	5.82	17.46	29.10	87.3	5.82	17.46	21.67	43.33	13	26
Sulfur	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tellurium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	0.05	4.74	0.05	4.74	0.08	7.9	0.05	4.74	0.03	1.00	0.02	0.6
Tin	NA	NA	NA	NA	NA	NA	NA	NA	0.01	0.12	0.003	0.07
2,3,7,8-Tetrachlorodibenzodioxin	1.33E-06	4.00E-05	1.33E-06	4.00E-05	2.22E-06	6.67E-05	1.33E-06	4.00E-05	6.67E-08	6.67E-07	4.00E-08	4.00E-07
2,3,7,8-Tetrachlorodibenzofuran	1.33E-05	4.00E-04	1.33E-05	4.00E-04	2.22E-05	6.67E-04	1.33E-05	4.00E-04	6.67E-07	6.67E-06	4.00E-07	4.00E-06
Total petroleum hydrocarbons	25.20	252	25.20	252	25.20	252	25.20	252	106.7	5333	64.0	3200
Trichloroethylene	NA	NA	NA	NA	NA	NA	NA	NA	11.1	33.3	6.7	20.0
1,3,5-Trinitrobenzene	NA	NA	NA	NA	NA	NA	NA	NA	8.7	30.0	5.2	18.0
Vanadium	0.01	0.097	0.01	0.097	0.0108	0.162	0.01	0.10	0.01	0.02	0.003	0.010
Zinc	5.40	37.8	5.40	37.8	5.40	37.8	5.40	37.80	18.89	113.33	11.33	68.00

Footnotes:

(a) No Observed Adverse Effect level

(b) Lowest Observed Adverse Effect level

TABLE 5.3-17

Uncertainty Factors (UFs) for the Detailed Ecological Risk Assessment (DERA)
Jefferson Proving Ground
Madison, Indiana

Uncertainty Category	Duration/Endpoint	Uncertainty Factor
Intertaxon Extrapolation	Same class, different order	5
	Same order, different family	4
	Same family, different genus	3
	Same genus, different species	2
	Same species	1
	Special Status Species (includes Federal Threatened and Endangered (T&E) and State of Indiana Sensitive species)	2
Study Duration	Acute (≤ 14 days)	10
	Subacute, subchronic (15-30 days)	5
	Duration > 30 days	1
Study Endpoint	LD50[a], LC50[b]	10
	TD_{LO}[c] for lethality	7
	TD_{LO} for nonlethal/sublethal effects	5
	NOAEL[d]/NOEL[e] lethal *or* LOAEL[f]/LOEL[g] for nonlethal	3
	NOAEL for nonlethal	1

General Note:

1. Special Status Species UF used *in addition to* other Intertaxon Extrapolation UFs where applicable.

Footnotes:

(a) Lethal dose to 50% of population.
(b) Lethal concentration to 50% of population.
(c) Toxic dose-low
(d) No observed adverse effects level.
(e) No observed effects level.
(f) Lowest observed adverse effects level.
(g) Lowest observed effects level.

TABLE 5.3-18

Summary of Toxicity Equivalency Factors (TEFs) Used for Obtaining Final Toxicity Reference Values (TRVs) Jefferson Proving Ground Madison, Indiana

Analyte Code	TEF	Analyte Description
234HXF	0.1	2,3,4,6,7,8-Hexachlorodibenzofuran
234PCF	0.5	2,3,4,7,8-Pentachlorodibenzofuran
678HPD	0.01	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin
678HPF	0.01	1,2,3,4,6,7,8-Heptachlorodibenzofuran
789HPF	0.01	1,2,3,4,7,8,9-Heptachlorodibenzofuran
789HXD	0.1	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin
789HXF	0.1	1,2,3,7,8,9-Hexachlorodibenzofuran
78HXDD	0.1	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin
78PCDD	0.5	1,2,3,7,8-Pentachlorodibenzo-p-dioxin
78PCDF	0.05	1,2,3,7,8-Pentachlorodibenzofuran
OCDD	0.001	Octachlorodibenzodioxin, non specific
OCDF	0.001	Octachlorodibenzofuran
TCDD	1	2,3,7,8-Tetrachlorodibenzo-p-dioxin
TCDF	0.1	2,3,7,8-Tetrachlorodibenzofuran

Source: Table 10. 8290-65 SW-846 September 1994 Rev. 0

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TABLE 5.3-19

Assessment and Measurement Endpoints
Jefferson Proving Ground
Madison, Indiana

Assessment Endpoint	Applicable Sites	Measurement Endpoint	
		Measures of Exposure	Measures of Effects
Survival, growth, and reproduction of fish (e.g., creek chub), amphibians (e.g., Pickerel frog), and aquatic invertebrates (e.g., crayfish)	Sites 2/27 - Sewage Treatment Plant outfall to Harberts Creek, Site 9, Site 29 - Note: HQs and HIs were calculated as measures of exposure; however, no field studies were conducted at Site 29.	• Calculation of HQs[a] and HIs[b] for fish in direct contact with surface water and sediment by using site-specific surface water and sediment data • Calculation of HQs and HIs for amphibians in direct contact with surface water and sediment using site-specific surface water and sediment data • Calculation of HQs and HIs for aquatic invertebrates in direct contact with surface water and sediment using site-specific surface water and sediment data	• Fish surveys • Sampling of macroinvertebrate populations for species and abundance in the stream segment, adjacent to Sewage Treatment Plant and in a nearby unimpacted stream segment as an indication of water quality • Rapid Bioassessment Protocol as an indication of riparian habitat quality
Plant community composition and habitat value to mammalian, avian and reptilian species	Sites 2/27, 3/4, 7&21b, 9, 11, 14/15, 25, 28/29/39 Note: Endpoints apply to Sites 7&21b and New Burn Site adjacent to Sites 3/4; however, no field studies were conducted at these locations.	• Calculation of HQs and HIs for terrestrial plant species in direct contact with soil using site-specific soil data	• Plant toxicity testing on site soils and reference location by soil type to indicate effects on forage base
Survival, growth, and reproduction of avian species- granivore, omnivore, insectivore, and wading birds (e.g., mourning dove, wild turkey, chimney swift, great blue heron)	Sites 2/27, 3/4, 7&21b, 9, 11, 14/15, 25, 28/29/39 Note: Endpoints apply to Sites 7&21b and New Burn Site adjacent to Sites 3/4; however, no field studies were conducted at these locations. HQs and HIs for great blue heron only apply at Sites 2, 9, and 29.	Calculation of HQs and HIs for avian species: • ingesting surface water using site-specific surface water data • ingesting food by using literature-derived BAFs[c] and site-specific soil data to predict dietary COPC[d] concentrations • ingesting soil using site-specific soil data • ingesting sediment using sediment data (great blue heron only) • ingesting food by using literature-derived BCFs[e] and site-specific surface water data to predict dietary COPC concentrations (great blue heron only)	• Plant toxicity testing on site soils and reference location by soil type to indicate effects on forage base • In-situ earthworm toxicity testing on site soils and reference location by soil type ton indicate effects on prey base • Quantitative soil fauna identification on site soils and reference location by soil type to indicate effects on prey base

TABLE 5.3-19

Assessment and Measurement Endpoints
Jefferson Proving Ground
Madison, Indiana

Assessment Endpoint	Applicable Sites	Measurement Endpoint	
		Measures of Exposure	**Measures of Effects**
Survival, growth and reproduction of small mammal populations - herbivore-insectivore (e.g., white-footed mouse)	Sites 2/27, 3/4, 7&21b, 9, 11,14/15, 25, 28/29/39 Note: Endpoints apply to Sites 7&21b and New Burn Site adjacent to Sites 3/4; however, no field studies were conducted at these locations.	Calculation of HQs and HIs for small mammal species: • ingesting surface water using site-specific surface water data • ingesting food by using literature-derived BAFs and site-specific soil data to predict dietary COPC concentrations • ingesting soil using site-specific soil data	• Plant toxicity testing on site soils and reference location by soil type to indicate effects on forage base • In-situ earthworm toxicity testing on site soils and reference location by soil type to indicate effects on prey base • Quantitative soil fauna identification on site soils and reference location by soil type to indicate effects on prey base
Survival, growth and reproduction of avian raptors (e.g., American kestrel)	Sites 2/27, 3/4, 7&21b, 9, 11, 14/15, 25, 28/29/ 39 Note: Endpoints apply to Sites 7&21b and New Burn Site adjacent to Sites 3/4; however, no field studies were conducted at these locations.	Calculation of HQs and HIs for raptors: • ingesting surface water using site-specific surface water data • ingesting food by using literature-derived BAFs and site-specific soil data to predict dietary COPC concentrations • ingesting soil using site-specific soil data	• Plant toxicity testing on site soils and reference location by soil type to indicate effects on forage base • In-situ earthworm toxicity testing on site soils and reference location by soil type to indicate effects on prey base • Quantitative soil fauna identification on site soils and reference location by soil type to indicate effects on prey base
Survival, growth and reproduction of terrestrial mammalian carnivore/omnivore (e.g., red fox)	Sites 2/27, 3/4, 7&21b, 9, 11,14/15, 25, 28/29/39 Note: Endpoints apply to Sites 7&21b and New Burn Site adjacent to Sites 3/4; however, no field studies were conducted at these locations.	Calculation of HQs and HIs for medium-size carnivores: • ingesting surface water using site-specific surface water data • ingesting food by using literature-derived BAFs and site-specific soil data to predict dietary COPC concentrations • ingesting soil using site-specific soil data	• Plant toxicity testing on site soils and reference location by soil type to indicate effects on forage base • In-situ earthworm toxicity testing on site soils and reference location by soil type to indicate effects on prey base • Quantitative soil fauna identification on site soils and reference location by soil type to indicate effects on prey base
Survival, growth and reproduction of aquatic mammalian omnivores (e.g., raccoon)	Sites 2, 9, 29	Calculation of HQs and HIs for medium-size omnivores: • ingesting surface water using site-specific surface water data • ingesting food by using literature-derived BCFs and site-specific surface water data to predict dietary COPC concentrations • ingesting sediment using site-specific sediment data	• Fish surveys • Sampling of macroinvertebrate populations for species and abundance in the stream segment, adjacent to Sewage Treatment Plant and in a nearby unimpacted stream segment as an indication of water quality • Rapid bioassessment protocol as an indication of riparian habitat quality

TABLE 5.3-19

Assessment and Measurement Endpoints
Jefferson Proving Ground
Madison, Indiana

Assessment Endpoint	Applicable Sites	Measurement Endpoint	
		Measures of Exposure	**Measures of Effects**
Survival, growth and reproduction of mammalian insectivore (e.g., little brown myotis)	Sites 2/27, 3/4, 9, 11,14/15, 25, 28/ 29/ 39 Note: Endpoints apply to Sites 7&21b and New Burn Site adjacent to Sites 3/4; however, no field studies were conducted at these locations.	Calculation of HQs and HIs for mammalian insectivores: • ingesting surface water using site-specific surface water data • ingesting food by using literature-derived BAFs and site-specific soil data to predict dietary COPC concentrations • ingesting soil using site-specific soil data	• Plant toxicity testing on site soils and reference location by soil type to indicate effects on forage base • In-situ earthworm toxicity testing on site soils and reference location by soil type to indicate effects on prey base • Quantitative soil fauna identification on site soils and reference location by soil type to indicate effects on prey base
Survival, growth and reproduction of mammalian herbivores (e.g., eastern cottontail rabbit)	Sites 2/27, 3/4, 7&21b, 9, 11, 14/15, 25, 28 29/39 Note: Endpoints apply to Sites 7&21b and New Burn Site adjacent to Sites 3/4; however, no field studies were conducted at these locations.	Calculation of HQs and HIs for medium-size herbivores: • ingesting surface water using site-specific surface water data • ingesting diet by using literature-derived BAFs and site-specific soil data to predict dietary COPC concentrations • ingesting soil using site-specific soil data	• Plant toxicity testing on site soils and reference location by soil type to indicate effects on forage base • In-situ earthworm toxicity testing on site soils and reference location by soil type to indicate effects on prey base • Quantitative soil fauna identification on site soils and reference location by soil type to indicate effects on prey base
Survival, growth and reproduction of terrestrial reptiles (e.g., eastern box turtle)	Sites 2/27, 3/4, 7&21b, 9, 11,14/15, 25, 28/29/39 Note: Endpoints apply to Sites 7&21b and New Burn Site adjacent to Sites 3/4; however, no field studies were conducted at these locations.	It is assumed that evaluation of HQs and HIs for avian species will be protective of reptiles.	It is assumed that measures of effects for other terrestrial wildlife receptors will be protective of reptiles.
Soil invertebrate community structure and composition representing functional value to ecosystem	Sites 2/27, 3/4, 7&21b, 9, 11, 14/15, 25, 28/29/39 Note: Endpoints apply to Sites 7&21b and New Burn Site adjacent to Sites 3/4; however, no field studies will be conducted at these locations.	Calculation of HQs and HIs for soil invertebrates: • based on direct soil contact	• Plant toxicity testing on site soils and reference location by soil type to indicate effects on forage base • In-situ earthworm toxicity testing on site soils and reference location by soil type to indicate effects on soil fauna • Quantitative soil fauna identification on site soils and reference location by soil type to indicate effects on soil fauna

Footnotes:

(a) Hazard quotients.
(b) Hazard indices.
(c) Bioaccumulation factors.
(d) Contaminant of potential concern.
(e) Bioconcentration factors.

TABLE 5.3-20

Detailed Ecological Risk Assessment-Specific Target Analyte List (TAL)
Jefferson Proving Ground
Madison, Indiana

Analyte	Symbol	Limit of Quantitation (LOQ) µg/g [(a)]	Limit of Quantitation (LOQ) µg/L [(b)]	Comment
Aluminum	Al	20	200	SW-846 Method 6010 (ICP) [(c)]
Antimony	Sb	0.5	5	GFAA[(d)]- SW-846 Method 7041
Arsenic	As	0.5	5.0	SW-846 Method 6010-T [(e)]
Barium	Ba	2	20	SW-846 Method 6010
Beryllium	Be	0.5	5	SW-846 Method 6010
Boron	B	10	100	SW-846 Method 6010
Cadmium	Cd	0.5	5.0	SW-846 Method 6010-T
Calcium	Ca	10	100	SW-846 Method 6010
Chromium	Cr	1	10	SW-846 Method 6010
Cobalt	Co	5	50	SW-846 Method 6010
Copper	Cu	2	20	SW-846 Method 6010
Iron	Fe	5	50	SW-846 Method 6010
Lead	Pb	0.3	3.0	SW-846 Method 6010-T
Magnesiu	Mg	10	100	SW-846 Method 6010
Manganese	Mn	1	10	SW-846 Method 6010
Mercury	Hg	0.1	0.2	CVAA[(f)]- SW-846 Method 7471/ Method 7470 (water)
Molybdenu	Mo	10	100	SW-846 Method 6010
Nickel	Ni	4	40	SW-846 Method 6010
Potassium	K	300	3000	SW-846 Method 6010
Selenium	Se	0.5	5.0	SW-846 Method 6010-T
Silver	Ag	1	10	SW-846 Method 6010
Sodium	Na	20	200	SW-846 Method 6010
Thallium	Tl	1.0	10	SW-846 Method 6010-T
Tin	Sn	10	100	SW-846 Method 6010
Vanadium	V	5	50	SW-846 Method 6010
Zinc	Zn	2	20	SW-846 Method 6010
Cyanide	CN	0.5	3	SW-846 Method 9012
Soil pH	pH	NA[(g)]	NA	SW-846 Method 9045
Total organic carbon	TOC	NA	NA	Modified Lloyd-Kahn

Footnotes:
- (a) Micrograms per gram, equivalent to parts per million.
- (b) Micrograms per liter, equivalent to parts per billion.
- (c) Inductively-coupled plasma.
- (d) Graphite furnace atomic absorption.
- (e) Trace.
- (f) Cold vapor atomic absorption.
- (g) Not analyzed.

TABLE 5.3-21

Quality Control Requirements for Soil Samples
Jefferson Proving Ground
Madison, Indiana

Quality Control Sample Type	Frequency	Analysis	Comments
Temperature Monitor	1 per cooler	Temperature check	Temperature at approximately 4°C
Equipment Rinse	1 per day or 1 per 20 samples per equipment type	TAL [(a)] metals, cyanide	Number is dependent on whichever is most frequent
Field Duplicate	a minimum of 1 in 20 or at least 1 per day	TAL metals, cyanide	Collected only in areas of expected contamination
Field Blank	a minimum of 1 in 20 or at least 1 per day	TAL metals, cyanide	Number is dependent on whichever is most frequent
Matrix Spike/Matrix Spike Duplicate	a minimum of 1 in 20 or at least 1 per lot	TAL metals, cyanide, TOC [(b)], pH	Recommended but not required; created by laboratory

Footnotes:

(a) Target Analyte List.
(b) Total Organic Carbon.

TABLE 5.3-22

Summary of Monte Carlo Simulation Results for Soil Preliminary Remediation Goals (PRGs)
Jefferson Proving Ground
Madison, Indiana

Receptor	Analyte Code (mg/kg) [(a)]	Analyte	Range Minimum (mg/kg)	Range Maximum (mg/kg)	Range Mean (mg/kg)	Standard Deviation (mg/kg)	Coefficient of Variation
Chimney Swift	AG	Silver	82.58	170.18	119.53	15.69	0.13
Chimney Swift	AL	Aluminum	3,854	14,324	7,152	1,863	0.26
Chimney Swift	AS	Arsenic	40.49	85.19	59.17	8.03	0.14
Chimney Swift	B	Boron	233.8	987.7	454.7	131.6	0.29
Chimney Swift	BA	Barium	70.96	213.1	121.1	25.77	0.21
Chimney Swift	BE	Beryllium	77.64	288.6	144.1	37.53	0.26
Chimney Swift	CD	Cadmium	0.03	0.04	0.04	0.002	0.05
Chimney Swift	CO	Cobalt	30.83	93.25	52.77	11.31	0.21
Chimney Swift	CR	Chromium	4.85	15.70	8.53	1.96	0.23
Chimney Swift	CU	Copper	51.23	62.54	56.82	2.20	0.04
Chimney Swift	FE	Iron	1,628	6,878	3,167	916.4	0.29
Chimney Swift	HG	Mercury	1.50	1.82	1.66	0.07	0.04
Chimney Swift	MN	Manganese	1,490	4,412	2,528	530.2	0.21
Chimney Swift	MO	Molybdenum	81.00	342.2	157.5	45.59	0.29
Chimney Swift	NI	Nickel	101.6	278.8	167.0	32.24	0.19
Chimney Swift	PB	Lead	47.49	117.5	74.66	12.73	0.17
Chimney Swift	SE	Selenium	0.08	0.10	0.09	0.004	0.05
Chimney Swift	TL	Thallium	1.00	4.23	1.95	0.56	0.29
Chimney Swift	V	Vanadium	0.13	0.49	0.24	0.06	0.27
Chimney Swift	ZN	Zinc	31.20	39.41	35.40	1.48	0.04
Eastern Cottontail	AG	Silver	952.9	1,971	1,351	213.5	0.16
Eastern Cottontail	AL	Aluminum	652.5	2,217	1,127	301.4	0.27
Eastern Cottontail	AS	Arsenic	0.51	1.35	0.80	0.17	0.21
Eastern Cottontail	B	Boron	2.59	2.87	2.71	0.05	0.02
Eastern Cottontail	BA	Barium	68.26	98.90	82.04	6.47	0.08
Eastern Cottontail	BE	Beryllium	270.3	918.3	467.0	124.8	0.27
Eastern Cottontail	CD	Cadmium	2.52	2.91	2.71	0.08	0.03
Eastern Cottontail	CO	Cobalt	2.98	8.14	4.75	1.04	0.22
Eastern Cottontail	CR	Chromium	120.6	357.6	198.2	47.01	0.24
Eastern Cottontail	CU	Copper	150.1	244.9	190.8	20.17	0.11
Eastern Cottontail	FE	Iron	1,908	6,482	3,296	881.1	0.27
Eastern Cottontail	HG	Mercury	15.09	53.34	26.44	7.30	0.28
Eastern Cottontail	MN	Manganese	3,112	6,984	4,574	805.1	0.18
Eastern Cottontail	MO	Molybdenum	3.51	4.44	3.95	0.19	0.05
Eastern Cottontail	NI	Nickel	788.7	1,677	1,132	185.8	0.16
Eastern Cottontail	PB	Lead	40.75	61.19	49.82	4.33	0.09
Eastern Cottontail	SB	Antimony	4.07	5.10	4.56	0.21	0.05
Eastern Cottontail	SE	Selenium	0.01	0.01	0.01	0.0002	0.02
Eastern Cottontail	SN	Tin	0.27	0.65	0.41	0.08	0.19
Eastern Cottontail	TL	Thallium	1.91	6.48	3.30	0.88	0.27
Eastern Cottontail	V	Vanadium	0.32	1.11	0.56	0.15	0.27
Eastern Cottontail	ZN	Zinc	222.59	245.74	234.06	4.15	0.02
Mourning Dove	AG	Silver	195.2	483.7	304.2	59.50	0.20
Mourning Dove	AL	Aluminum	12,580	46,477	22,840	6,441	0.28
Mourning Dove	AS	Arsenic	103.0	315.1	174.5	42.05	0.24
Mourning Dove	B	Boron	23.71	27.08	25.17	0.70	0.03
Mourning Dove	BA	Barium	98.23	164.7	128.7	14.39	0.11
Mourning Dove	BE	Beryllium	152.1	561.8	276.1	77.85	0.28
Mourning Dove	CD	Cadmium	0.42	0.51	0.46	0.02	0.04
Mourning Dove	CO	Cobalt	62.49	196.8	107.0	26.47	0.25
Mourning Dove	CR	Chromium	9.73	32.66	17.07	4.46	0.26
Mourning Dove	CU	Copper	317.7	615.3	445.1	63.53	0.14
Mourning Dove	FE	Iron	3,057	11,293	5,550	1,565	0.28
Mourning Dove	HG	Mercury	19.75	74.92	36.19	10.42	0.29

TABLE 5.3-22

Summary of Monte Carlo Simulation Results for Soil Preliminary Remediation Goals (PRGs)
Jefferson Proving Ground
Madison, Indiana

Receptor	Analyte Code (mg/kg) [(a)]	Analyte	Range Minimum (mg/kg)	Range Maximum (mg/kg)	Range Mean (mg/kg)	Standard Deviation (mg/kg)	Coefficient of Variation
Mourning Dove	MN	Manganese	2,853	7,628	4,585	971.8	0.21
Mourning Dove	MO	Molybdenum	78.27	109.5	93.73	6.77	0.07
Mourning Dove	NI	Nickel	197.8	503.2	311.6	62.71	0.20
Mourning Dove	PB	Lead	76.64	134.4	102.6	12.45	0.12
Mourning Dove	SE	Selenium	0.12	0.14	0.13	0.004	0.03
Mourning Dove	TL	Thallium	1.88	6.95	3.42	0.96	0.28
Mourning Dove	V	Vanadium	0.25	0.95	0.46	0.13	0.28
Mourning Dove	ZN	Zinc	68.41	77.27	73.11	1.84	0.03
White-footed Mouse	AG	Silver	433.8	1394	801.2	164.8	0.21
White-footed Mouse	AL	Aluminum	1,047	4,586	2,156	558.1	0.26
White-footed Mouse	AS	Arsenic	0.24	0.79	0.45	0.09	0.21
White-footed Mouse	B	Boron	1.34	4.80	2.50	0.54	0.22
White-footed Mouse	BA	Barium	45.66	140.7	81.32	16.76	0.21
White-footed Mouse	BE	Beryllium	433.7	1900	893.0	231.2	0.26
White-footed Mouse	CD	Cadmium	0.15	0.52	0.29	0.06	0.21
White-footed Mouse	CO	Cobalt	2.79	9.68	5.32	1.14	0.22
White-footed Mouse	CR	Chromium	79.80	288.1	155.0	34.63	0.22
White-footed Mouse	CU	Copper	16.43	55.45	30.66	6.50	0.21
White-footed Mouse	FE	Iron	3,876	23,036	9,087	2,853	0.31
White-footed Mouse	HG	Mercury	0.67	2.31	1.26	0.27	0.22
White-footed Mouse	MN	Manganese	2,603	8,563	4,802	1,001	0.21
White-footed Mouse	MO	Molybdenum	1.41	4.80	2.59	0.55	0.21
White-footed Mouse	NI	Nickel	577.4	1,867	1,059	218.4	0.21
White-footed Mouse	PB	Lead	24.08	72.23	42.17	8.58	0.20
White-footed Mouse	SB	Antimony	1.70	5.08	2.96	0.60	0.20
White-footed Mouse	SE	Selenium	0.003	0.01	0.01	0.001	0.20
White-footed Mouse	SN	Tin	0.40	1.42	0.75	0.17	0.23
White-footed Mouse	TL	Thallium	3.88	23.04	9.09	2.85	0.31
White-footed Mouse	V	Vanadium	0.55	2.53	1.15	0.31	0.27
White-footed Mouse	ZN	Zinc	61.27	187.4	108.2	22.01	0.20

Footnote:

(a) Milligrams per kilogram.

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TABLE 5.3-23

Reasonable Maximum Exposure (RME)
Soil Preliminary Remediation Goals (PRGs)
Jefferson Proving Ground
Madison, Indiana

Parameter	**DERA RBC (mg/kg)**	**HHRA RBC (mg/kg)**	**1998 PRG (mg/kg)**	**JPG Phase II BKG (EPC, µg/g)**	**Basis of Driving PRG**
1,3,5-Trinitrobenzene	**971.1**		1600		DERA EC
2,4-Dinitrotoluene	**4.62**		110.0		DERA WFM
2,3,4,6,7,8-Hexachlorodibenzofuran	**7.47E-05**				DERA EC
2,3,4,7,8-Pentachlorodibenzofuran	**1.49E-05**				DERA EC
2-Methylnaphthalene	**11.68**	240.0			DERA WFM
2-Methylpyrene	**11.68**				DERA WFM
2-Phenylnaphthalene	**11.68**				DERA WFM
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	**7.47E-04**				DERA EC
1,2,3,4,6,7,8-Heptachlorodibenzofuran	**7.47E-04**				DERA EC
1,2,3,4,7,8,9-Heptachlorodibenzofuran	**7.47E-04**				DERA EC
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	**7.47E-05**				DERA EC
1,2,3,7,8,9-Hexachlorodibenzofuran	**7.47E-05**				DERA EC
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	**7.47E-05**				DERA EC
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	**1.49E-05**				DERA EC
1,2,3,7,8-Pentachlorodibenzofuran	**1.49E-04**				DERA EC
Acenaphthene	**11.68**	110.0	2,600		DERA WFM
Acenaphthylene	**11.68**				DERA WFM
Aldrin	**0.02**	0.03			DERA LBM
Aluminum	**962.6**	7,667	75,000	9,003	JPG BKG
Anthracene	11.68	**5.70**	14,000		HHRA
Antimony	**1.91**	3.00	30.0		DERA WFM
Arsenic	**0.26**	0.38	21 nc .38 ca	5.50	JPG BKG
Benzo[a]anthracene	11.68	0.61	**0.6**		1998 PRG
Barium	**49.98**	527.0	5,200	57.10	JPG BKG
Benzo[b]fluoranthene	11.68	0.61	**0.6**		1998 PRG
Benzo(a)pyrene	11.68		**0.1**		1998 PRG
Benzoic Acid	NA	**100,000**	100,000 max		HHRA
Benzo[e]pyrene	**11.68**				DERA WFM
Beryllium	10.00	**0.14**	150.0	0.36	JPG BKG
Benzo[ghi]perylene	**11.68**	100.0			DERA WFM
Bis(2-ethylhexyl) phthalate	84.03	**31.70**	32.0		HHRA
Benzo[j]fluoranthene	**11.68**				DERA WFM
Benzo[k]fluoranthene	11.68	6.10	**0.6**		1998 PRG
Benzo[b]naphtho[2,1-D]thiophene	NA				NA
Boron	**1.65**	586.0	4,900		DERA WFM
Cadmium	**0.03**	3.80	37.0	0.29	JPG BKG
Carbazole	NA	**22.00**	**22.0**		HHRA
Chlordane	**0.03**	0.34	1.6		DERA CS
Chromium	**8.45**	30.10	30.0	11.73	JPG BKG
Chrysene	11.68	**7.20**	56.0		HHRA
Cobalt	**2.87**	457.0	3,300	2.89	JPG BKG
Copper	**16.46**	285.0	2,800	4.45	DERA LBM
Dibenz[ah]anthracene	11.68		**0.1**		1998 PRG
Di-n-butyl phthalate	**84.03**				DERA CS
Dibenzofuran	NA	**140.0**	210.0		HHRA
Dibenzothiophene	NA				NA
Dieldrin	**0.02**	0.03	0.0		DERA LBM
Dimethyl phthalate	**84.03**		100,000		DERA CS
1-Eicosanol	NA				NA
Endosulfan II	**2.52**				DERA CS
Endrin	**0.01**	1.96	16.0		DERA WFM
Fluoranthene	**11.68**	261.0	2,000		DERA WFM
Fluorene	**11.68**	90.00	1,800		DERA WFM
Heptachlor	0.15	**0.10**	**0.1**		1998 PRG
Heptachlor epoxide	0.15	**0.05**	**0.0**		1998 PRG
Indeno[1,2,3-C,D]pyrene	11.68	**0.61**	**0.6**		1998 PRG
Iron	3151.26	**70000.00**	**22000.0**	10318.00	JPG BKG
Lead	26.10	400.0	400.0	14.89	DERA WFM
Manganese	1610	318.0	3,100	236.6	HHRA
Mercury	**0.10**	2.30	22.0		DERA SF
Molybdenum	**1.62**	38.30	370.0	5.00	JPG BKG
Myristic acid	NA				NA
Naphthalene	**11.68**	240.0	55.0		DERA WFM
Nickel	25.00	153.0	150.0	3.12	DERA P
N-Nitrosodiphenylamine	NA	**90.70**			HHRA
Nonadecane	NA				NA
Octachlorodibenzodioxin - nonspecific	**0.01**				DERA EC
Octachlorodibenzofuran - nonspecific	**0.01**				DERA EC
Stearic acid	**NA**				NA
p-Cresol	**NA**				NA
Polynuclear aromatic hydrocarbons	**11.68**				DERA WFM
Palmitic acid	NA				NA
Polychlorinated bipheny	**0.06**		0.2		DERA AK
Phenanthrene	**11.68**	100.00			DERA WFM
Phenol	**747.0**		33,000		DERA EC
2,2-Bis(p-chlorophenyl)-1,1-dichloroethane	**0.13**	1.85	2.4		DERA CS
2,2-Bis(p-chlorophenyl)-1,1-dichloroethene	**0.13**	1.31	1.7		DERA CS
2,2-Bis(p-chlorophenyl)-1,1,1-trichloroethane	**0.13**	1.31	1.7		DERA CS
Pyrene	**11.68**	100.0	1,500		DERA WFM
Selenium	**0.003**	38.30	370.0	0.53	JPG BKG
Silver	**5.00**	38.30	370.0		DERA P
Sulfur	NA				NA
2,3,7,8-Tetrachlorodibenzodioxin	**7.47E-06**				DERA EC

TABLE 5.3-23

Reasonable Maximum Exposure (RME)
Soil Preliminary Remediation Goals (PRGs)
Jefferson Proving Ground
Madison, Indiana

Parameter	DERA RBC (mg/kg)	HHRA RBC (mg/kg)	1998 PRG (mg/kg)	JPG Phase II BKG (EPC, µg/g)	Basis of Driving PRG
2,3,7,8-Tetrachlorodibenzofuran	**7.47E-05**				DERA EC
Thallium	0.97	0.54	5.2	0.50	HHRA
Tin	**0.37**	4,600	45,000		DERA WFM
Total petroleum hydrocarbons	**1,018**				DERA CS
Trichloroethylene	1,245	3.16	**2.7**		1998 PRG
Vanadium	**0.24**	54.00	520.0	22.74	JPG BKG
Zinc	**32.63**	2,300	22,000	17.69	DERA CS

General Notes:
1. Values in bold: Minimum PRG
2. Values in bold borders: JPG Phase II BKG> Minimum PRG
3. All values are in milligrams per kilogram (mg/kg) or microgram per gram (ug/g) equivalent to parts per million (ppm).

Abbreviations:
BKG: JPG Phase II Background
RBC:Risk Based Concentration
DERA: Detailed Ecological Risk Assessment
HHRA: Human Health Risk Assessment
PRG:Preliminary Remedial Goal
AK: American Kestrel
CS: Chimney Swift
EC: Eastern Cottontail
LBM: Little Brown Myotis
P: Plants
SF: Soil Fauna
WFM: White-footed Mouse
EPC: Exposure Point Concentration

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TABLE 5.3-24

Reasonable Maximum Exposure (RME) Soil Preliminary Remediation Goals (PRGs)
With Upper Trophic Level (UTL) and Lower Trophic Level (LTL) Receptors PRGs
Jefferson Proving Ground
Madison, Indiana

Parameter	Minimum UTL (mg/kg)	Minimum LTL (mg/kg)	Minimum Site Specific LTL (mg/kg)	DERA RBC (mg/kg)	HHRA RBC (mg/kg)	1998 PRG (mg/kg)	JPG Phase II BKG (epc, µg/g)	Basis of Driving PRG
1,3,5-Trinitrobenzene	9.71E+02	NA	NA	**971.1**		1,600		DERA EC
2,4-Dinitrotoluene	4.62E+00	NA	NA	**4.62**		110.0		DERA WFM
2,3,4,6,7,8-Hexachlorodibenzofuran	7.47E-05	NA	NA	**7.47E-05**				DERA EC
2,3,4,7,8-Pentachlorodibenzofuran	1.49E-05	NA	NA	**1.49E-05**				DERA EC
2-Methylnaphthalene	1.17E+01	1.25E+01	NA	**11.68**	240.0			DERA WFM
2-Methylpyrene	1.17E+01	1.25E+01	NA	**11.68**				DERA WFM
2-Phenylnaphthalene	1.17E+01	1.25E+01	NA	**11.68**				DERA WFM
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	7.47E-04	NA	NA	**7.47E-04**				DERA EC
1,2,3,4,6,7,8-Heptachlorodibenzofuran	7.47E-04	NA	NA	**7.47E-04**				DERA EC
1,2,3,4,7,8,9-Heptachlorodibenzofuran	7.47E-04	NA	NA	**7.47E-04**				DERA EC
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	7.47E-05	NA	NA	**7.47E-05**				DERA EC
1,2,3,7,8,9-Hexachlorodibenzofuran	7.47E-05	NA	NA	**7.47E-05**				DERA EC
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	7.47E-05	NA	NA	**7.47E-05**				DERA EC
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	1.49E-05	NA	NA	**1.49E-05**				DERA EC
1,2,3,7,8-Pentachlorodibenzofuran	1.49E-04	NA	NA	**1.49E-04**				DERA EC
Acenaphthene	1.17E+01	1.25E+01	NA	**11.68**	110.0	2,600		DERA WFM
Acenaphthylene	1.17E+01	1.25E+01	NA	**11.68**				DERA WFM
Aldrin	2.29E-02	5.00E+01	NA	**0.02**	0.03			DERA LBM
Aluminum	9.63E+02	5.00E+01	1.90E+04	**962.6**	7,667	75,000	9003	JPG BKG
Anthracene	1.17E+01	1.25E+01	NA	11.68	**5.70**	14,000		HHRA
Antimony	1.91E+00	5.00E+00	6.32E-01	**1.91**	3.00	30.0		DERA WFM
Arsenic	2.56E-01	1.00E+01	2.01E+01	**0.26**	0.38	21 nc .38 ca	5.50	JPG BKG
Benzo[a]anthracene	1.17E+01	1.25E+01	NA	11.68	0.61	**0.6**		1998 PRG
Barium	5.00E+01	5.00E+02	1.81E+02	**49.98**	527.0	5,200	57.10	JPG BKG
Benzo[b]fluoranthene	1.17E+01	1.25E+01	NA	11.68	0.61	**0.6**		1998 PRG
Benzo(a)pyrene	1.17E+01	1.25E+01	NA	11.68		**0.1**		1998 PRG
Benzoic Acid	NA	NA	NA	NA	**100,000**	100,000 max		HHRA
Benzo[e]pyrene	1.17E+01	1.25E+01	NA	**11.68**				DERA WFM
Beryllium	1.43E+02	1.00E+01	1.64E+00	10.00	**0.14**	150.0	0.36	JPG BKG
Benzo[ghi]perylene	1.17E+01	1.25E+01	NA	**11.68**	100.0			DERA WFM
Bis(2-ethylhexyl) phthalate	8.40E+01	1.00E+03	NA	84.03	**31.70**	32.0		HHRA
Benzo[j]fluoranthene	1.17E+01	1.25E+01	NA	**11.68**				DERA WFM
Benzo[k]fluoranthene	1.17E+01	1.25E+01	NA	11.68	6.10	**0.6**		1998 PRG
Benzo[b]naphtho[2,1-D]thiophene	NA	NA	NA	NA				NA
Boron	1.65E+00	NA	2.80E+01	**1.65**	586.0	4,900		DERA WFM
Cadmium	3.26E-02	3.00E+00	2.90E+00	**0.03**	3.80	37.0	0.29	JPG BKG
Carbazole	NA	NA	NA	NA	**22.00**	**22.0**		HHRA
Chlordane	2.60E-02	NA	NA	**0.03**	0.34	1.6		DERA CS
Chromium	8.45E+00	4.00E-01	1.02E+02	**8.45**	30.10	30.0	11.73	JPG BKG
Chrysene	1.17E+01	1.25E+01	NA	11.68	**7.20**	56.0		HHRA
Cobalt	2.87E+00	2.00E+01	1.13E+01	**2.87**	457.0	3,300	2.89	JPG BKG
Copper	1.65E+01	8.38E+01	1.61E+02	**16.46**	285.0	2,800	4.45	DERA LBM
Dibenz[ah]anthracene	1.17E+01	1.25E+01	NA	11.68		**0.1**		1998 PRG
Di-n-butyl phthalate	8.40E+01	1.00E+03	NA	**84.03**				DERA CS
Dibenzofuran	NA	NA	NA	NA	**140.0**	210.0		HHRA
Dibenzothiophene	NA	NA	NA	NA				NA
Dieldrin	2.29E-02	5.00E+01	NA	**0.02**	0.03	0.0		DERA LBM
Dimethyl phthalate	8.40E+01	1.00E+03	NA	**84.03**		100,000		DERA CS
1-Eicosanol	NA	NA	NA	NA				NA
Endosulfan II	2.52E+00	NA	NA	**2.52**				DERA CS
Endrin	6.48E-03	NA	NA	**0.01**	1.96	16.0		DERA WFM
Fluoranthene	1.17E+01	1.25E+01	NA	**11.68**	261.0	2,000		DERA WFM
Fluorene	1.17E+01	1.25E+01	NA	**11.68**	90.00	1,800		DERA WFM
Heptachlor	1.48E-01	NA	NA	0.15	**0.10**	**0.1**		1998 PRG
Heptachlor epoxide	1.48E-01	NA	NA	0.15	**0.05**	**0.0**		1998 PRG
Indeno[1,2,3-C,D]pyrene	1.17E+01	1.25E+01	NA	11.68	**0.61**	**0.6**		1998 PRG
Iron	3.15E+03	1.00E+03	4.42E+04	3151.26	**70,000**	**22,000**	10318.00	JPG BKG
Lead	2.61E+01	1.79E+02	5.03E+01	26.10	**400.0**	**400.0**	14.89	DERA WFM
Manganese	2.50E+03	5.00E+02	1.61E+03	1610	318.0	3100	236.6	HHRA
Mercury	6.09E-01	1.00E-01	8.33E-02	**0.10**	2.30	22.0		DERA SF
Molybdenum	1.62E+00	NA	6.94E+00	**1.62**	38.30	370.0	5.00	JPG BKG
Myristic acid	NA	NA	NA	NA				NA
Naphthalene	1.17E+01	1.25E+01	NA	**11.68**	240.0	55.0		DERA WFM

TABLE 5.3-24

Reasonable Maximum Exposure (RME) Soil Preliminary Remediation Goals (PRGs) With Upper Trophic Level (UTL) and Lower Trophic Level (LTL) Receptors PRGs Jefferson Proving Ground Madison, Indiana

Parameter	Minimum UTL (mg/kg)	Minimum LTL (mg/kg)	Minimum Site Specific LTL (mg/kg)	DERA RBC (mg/kg)	HHRA RBC (mg/kg)	1998 PRG (mg/kg)	JPG Phase II BKG (epc, µg/g)	Basis of Driving PRG
Nickel	1.64E+02	2.50E+01	1.62E+01	25.00	153.0	150.0	3.12	DERA P
N-Nitrosodiphenylamine	NA	NA	NA	NA	**90.70**			HHRA
Nonadecane	NA	NA	NA	NA				NA
Octachlorodibenzodioxin - nonspecific	7.47E-03	NA	NA	**0.01**				DERA EC
Octachlorodibenzofuran - nonspecific	7.47E-03	NA	NA	0.01				DERA EC
Stearic acid	NA	NA	NA	NA				NA
p-Cresol	NA	NA	NA	NA				NA
Polynuclear aromatic hydrocarbons	1.17E+01	3.00E+01	NA	**11.68**				DERA WFM
Palmitic acid	NA	NA	NA	NA				NA
Polychlorinated biphenyl	5.70E-02	4.00E+01	NA	**0.06**		0.2		DERA AK
Phenanthrene	1.17E+01	1.25E+01	NA	**11.68**	100.0			DERA WFM
Phenol	7.47E+02	NA	NA	**747.0**		33,000		DERA EC
2,2-Bis(p-chlorophenyl)-1,1-dichloroethane	1.34E-01	NA	NA	**0.13**	1.85	2.4		DERA CS
2,2-Bis(p-chlorophenyl)-1,1-dichloroethene	1.34E-01	NA	NA	**0.13**	1.31	1.7		DERA CS
2,2-Bis(p-chlorophenyl)-1,1,1-trichloroethane	1.34E-01	NA	NA	**0.13**	1.31	1.7		DERA CS
Pyrene	1.17E+01	1.25E+01	NA	**11.68**	100.0	1,500		DERA WFM
Selenium	3.44E-03	1.00E+00	7.71E-01	**0.003**	38.30	370.0	0.53	JPG BKG
Silver	1.16E+02	2.00E+00	5.00E+00	**5.00**	38.30	370.0		DERA P
Sulfur	NA	NA	NA	NA				NA
2,3,7,8-Tetrachlorodibenzodioxin	7.47E-06	NA	NA	**7.47E-06**				DERA EC
2,3,7,8-Tetrachlorodibenzofuran	7.47E-05	NA	NA	**7.47E-05**				DERA EC
Thallium	1.94E+00	NA	9.65E-01	0.97	0.54	5.2	0.50	HHRA
Tin	3.73E-01	NA	5.00E+00	**0.37**	4,600	45,000		DERA WFM
Total petroleum hydrocarbons	1.02E+03	NA	NA	**1,018**				DERA CS
Trichloroethylene	1.24E+03	NA	NA	1245	3.16	**2.7**		1998 PRG
Vanadium	2.42E-01	2.00E+00	7.77E+01	**0.24**	54.00	520.0	22.74	JPG BKG
Zinc	3.26E+01	5.00E+01	7.81E+01	**32.63**	2,300	22,000	17.69	DERA CS

General Notes:

1. Values in bold: Minimum PRG
2. Values in bold borders: JPG Phase II BKG> Minimum PRG
3. All values are in milligrams per kilogram (mg/kg) or microgram per gram (ug/g) equivalent to parts per million (ppm).

Abbreviations:

BKG: JPG Phase II Background
RBC:Risk Based Concentration
DERA: Detailed Ecological Risk Assessment
HHRA: Human Health Risk Assessment
PRG:Preliminary Remedial Goal
AK: American Kestrel
CS: Chimney Swift
EC: Eastern Cottontail
LBM: Little Brown Myotis
P: Plants
SF: Soil Fauna
WFM: White-footed Mouse
EPC: Exposure Point Concentration

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TABLE 5.3-25

Detailed Ecological Risk Assessment Site Soil Preliminary Remediation Goals (PRGs) From Biological Data
Jefferson Proving Ground
Madison, Indiana

Parameter	Plant Germination	Plant Wet Weight	Earthworm Toxicity	Soil Fauna Community Structure
1,3,5-Trinitrobenzene				
2,4-Dinitrotoluene				
2,3,4,6,7,8-Hexachlorodibenzofuran				
2,3,4,7,8-Pentachlorodibenzofuran				
2-Methylnaphthalene				
2-Methylpyrene				
2-Phenylnaphthalene				
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin				
1,2,3,4,6,7,8-Heptachlorodibenzofuran				
1,2,3,4,7,8,9-Heptachlorodibenzofuran				
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin				
1,2,3,7,8,9-Hexachlorodibenzofuran				
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin				
1,2,3,7,8-Pentachlorodibenzo-p-dioxin				
1,2,3,7,8-Pentachlorodibenzofuran				
Acenaphthene				
Acenaphthylene				
Aldrin				
Aluminum	19,000	19,000	19,000	19,000
Anthracene				
Antimony	0.632	0.632	0.632	0.632
Arsenic	20.1	20.1	20.1	20.1
Benzo[a]anthracene				
Barium	181	320	320	320
Benzo[b]fluoranthene				
Benzo(a)pyrene				
Benzoic Acid				
Benzo[e]pyrene				
Beryllium	1.64	1.64	1.64	1.64
Benzo[ghi]perylene				
Bis(2-ethylhexyl) phthalate				
Benzo[j]fluoranthene				
Benzo[k]fluoranthene				
Benzo[b]naphtho[2,1-D]thiophene				
Boron	28	28	28	28
Cadmium	2.90	2.90	2.90	2.90
Carbazole				
Chlordane				
Chromium	101.5	101.5	101.5	101.5
Chrysene				
Cobalt	11.25	11.25	11.25	11.25
Copper	161	161	161	161
Dibenz[ah]anthracene				
Di-n-butyl phthalate				
Dibenzofuran				
Dibenzothiophene				
Dieldrin				
Dimethyl phthalate				
1-Eicosanol				
Endosulfan II				
Endrin				
Fluoranthene				
Fluorene				
Heptachlor				
Heptachlor epoxide				
Indeno[1,2,3-C,D]pyrene				
Iron	44,200	44,200	44,200	44,200
Lead	50.3	50.3	50.3	50.3
Manganese	1,610	1,610	1,610	1,610
Mercury	0.0833	0.0833	0.0833	0.0833
Molybdenum	6.94	6.94	6.94	6.94

TABLE 5.3-25

Detailed Ecological Risk Assessment Site Soil Preliminary Remediation Goals (PRGs) From Biological Data
Jefferson Proving Ground
Madison, Indiana

Parameter	Plant Germination	Plant Wet Weight	Earthworm Toxicity	Soil Fauna Community Structure
Myristic acid				
Naphthalene				
Nickel	16.2	16.2	16.2	16.2
N-Nitrosodiphenylamine				
Nonadecane				
Octachlorodibenzodioxin - nonspecific				
Octachlorodibenzofuran - nonspecific				
Stearic acid				
p-Cresol				
Polynuclear aromatic hydrocarbons				
Palmitic acid				
Polychlorinated biphenyl				
Phenanthrene				
Phenol				
2,2-Bis(p-chlorophenyl)-1,1-dichloroethane				
2,2-Bis(p-chlorophenyl)-1,1-dichloroethene				
2,2-Bis(p-chlorophenyl)-1,1,1-trichloroethane				
Pyrene				
Selenium	0.771	0.771	0.771	0.771
Silver	5	5	5	5
Sulfur				
2,3,7,8-Tetrachlorodibenzodioxin				
2,3,7,8-Tetrachlorodibenzofuran				
Thallium	0.965	0.965	0.965	0.965
Tin	5	5	5	5
Total petroleum hydrocarbons				
Trichloroethylene				
Vanadium	77.7	77.7	77.7	77.7
Zinc	78.1	78.1	78.1	78.1

General Note:
1. All values in milligrams per kilogram (mg/kg), equivalent to parts per million (ppm).

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FIGURES

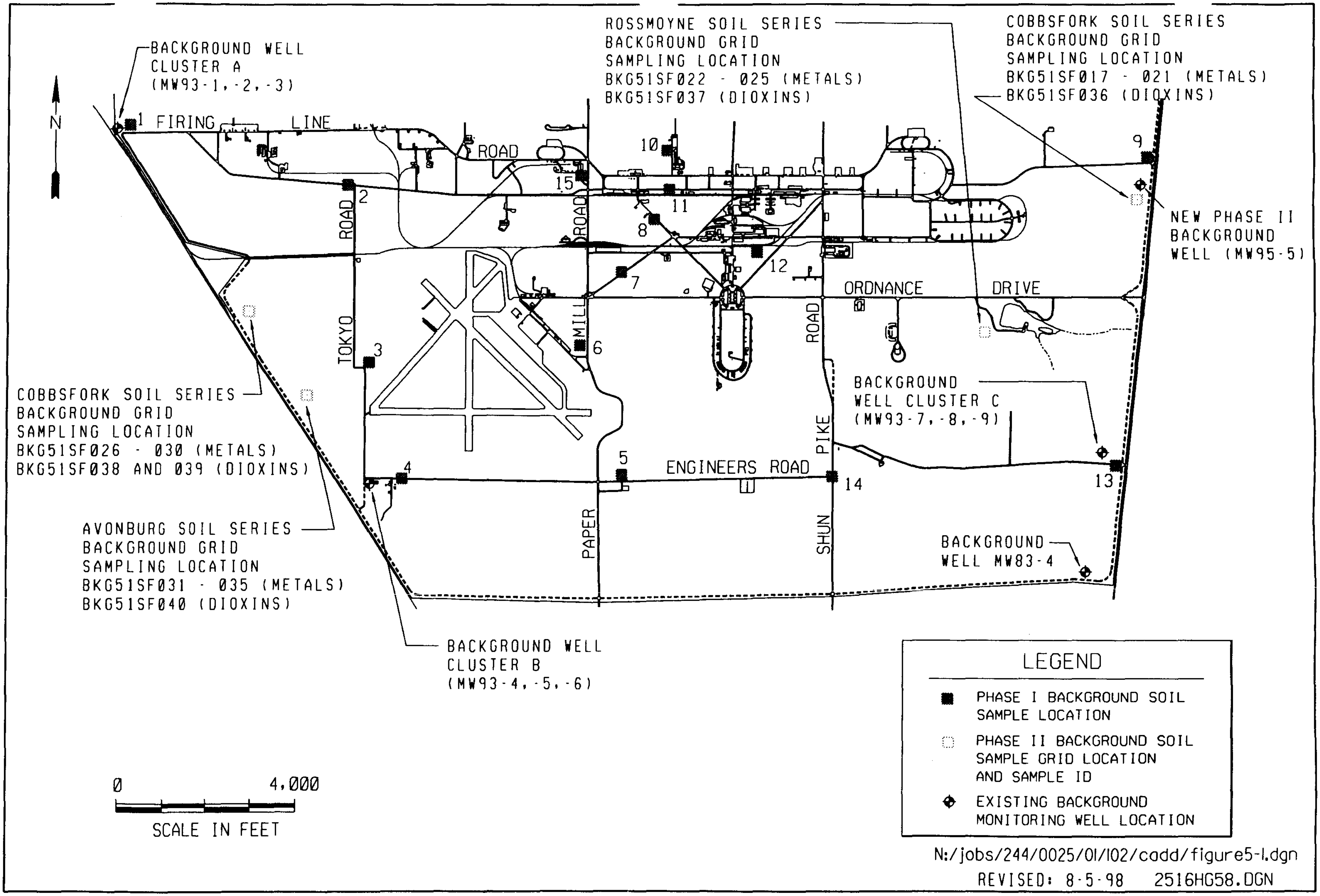


Figure 5-1. Phase I & II Background Sampling Site Locations

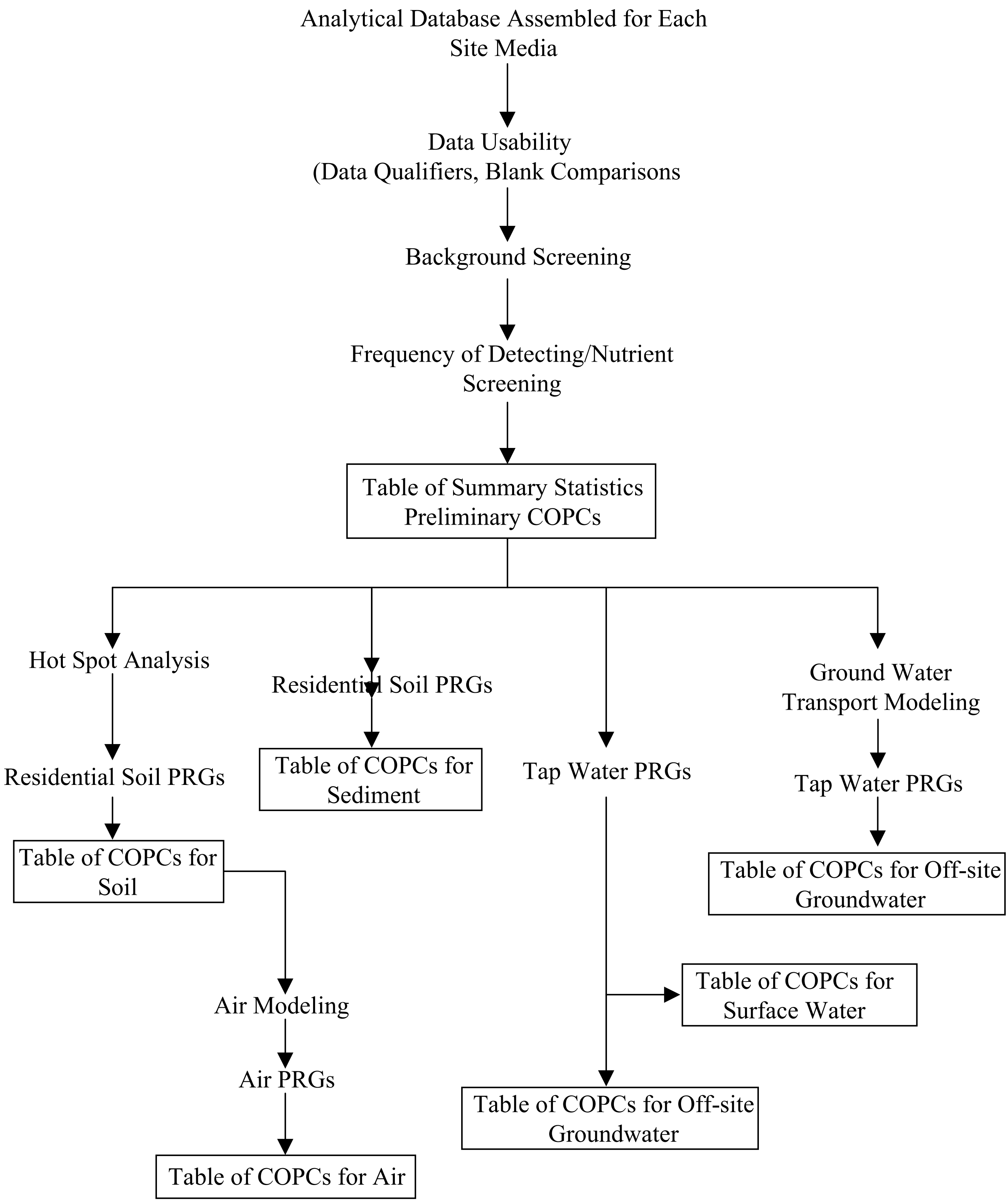


Figure 5-2. Flow Chart for Selection of Site-Specific COPCs

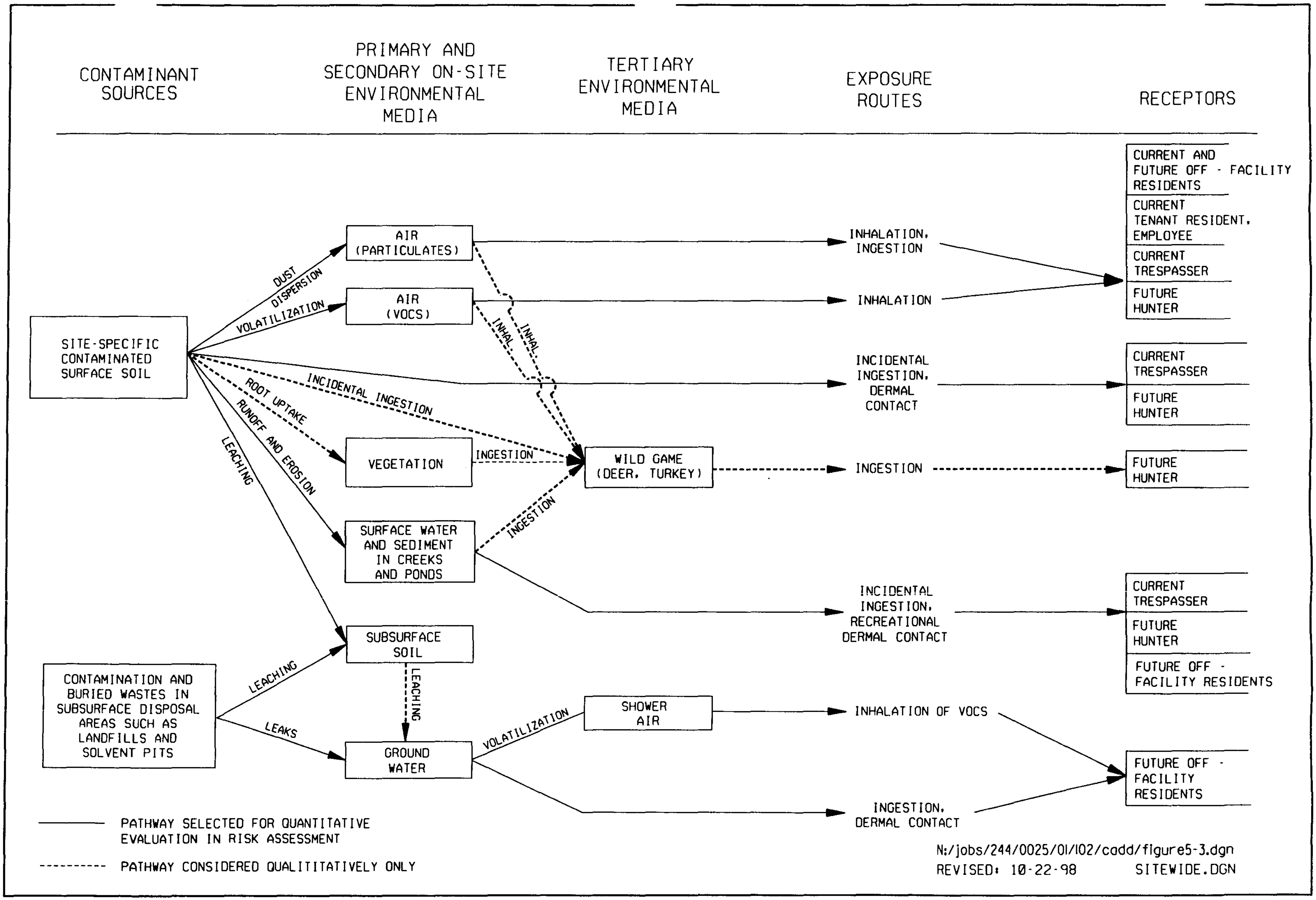


Figure 5-3. Facility-Wide Conceptual Model

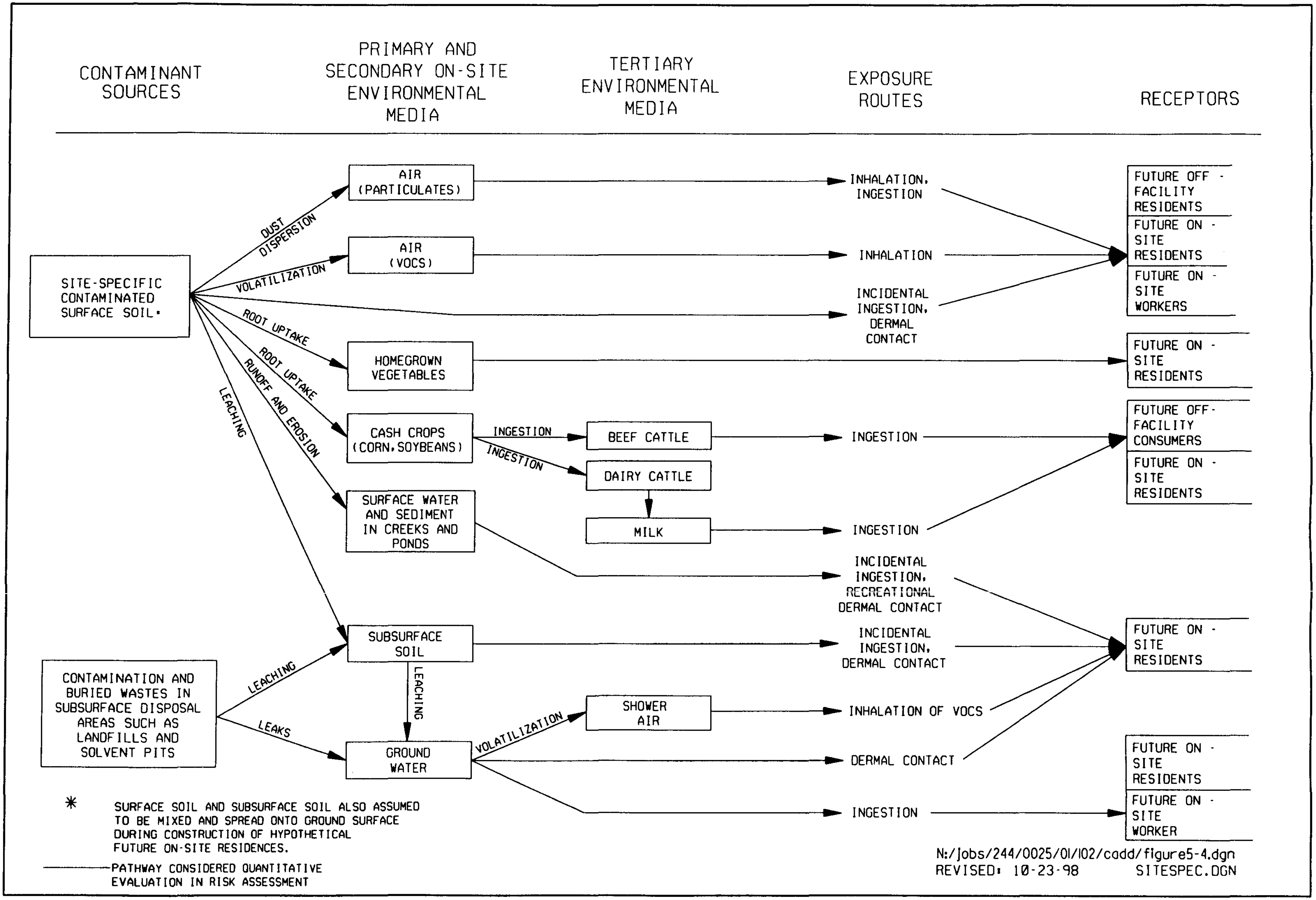


Figure 5-4. Site-Specific Conceptual Model

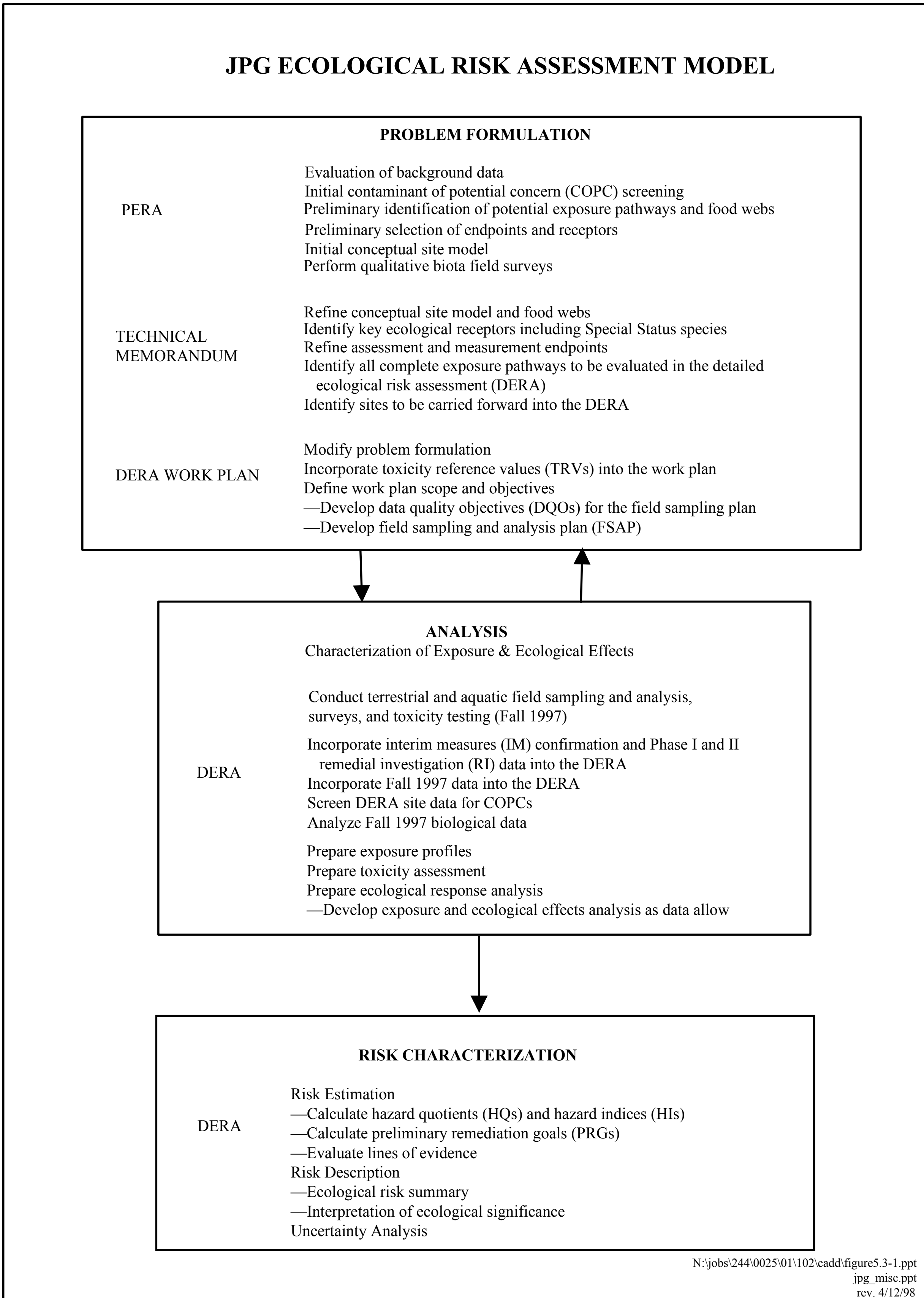
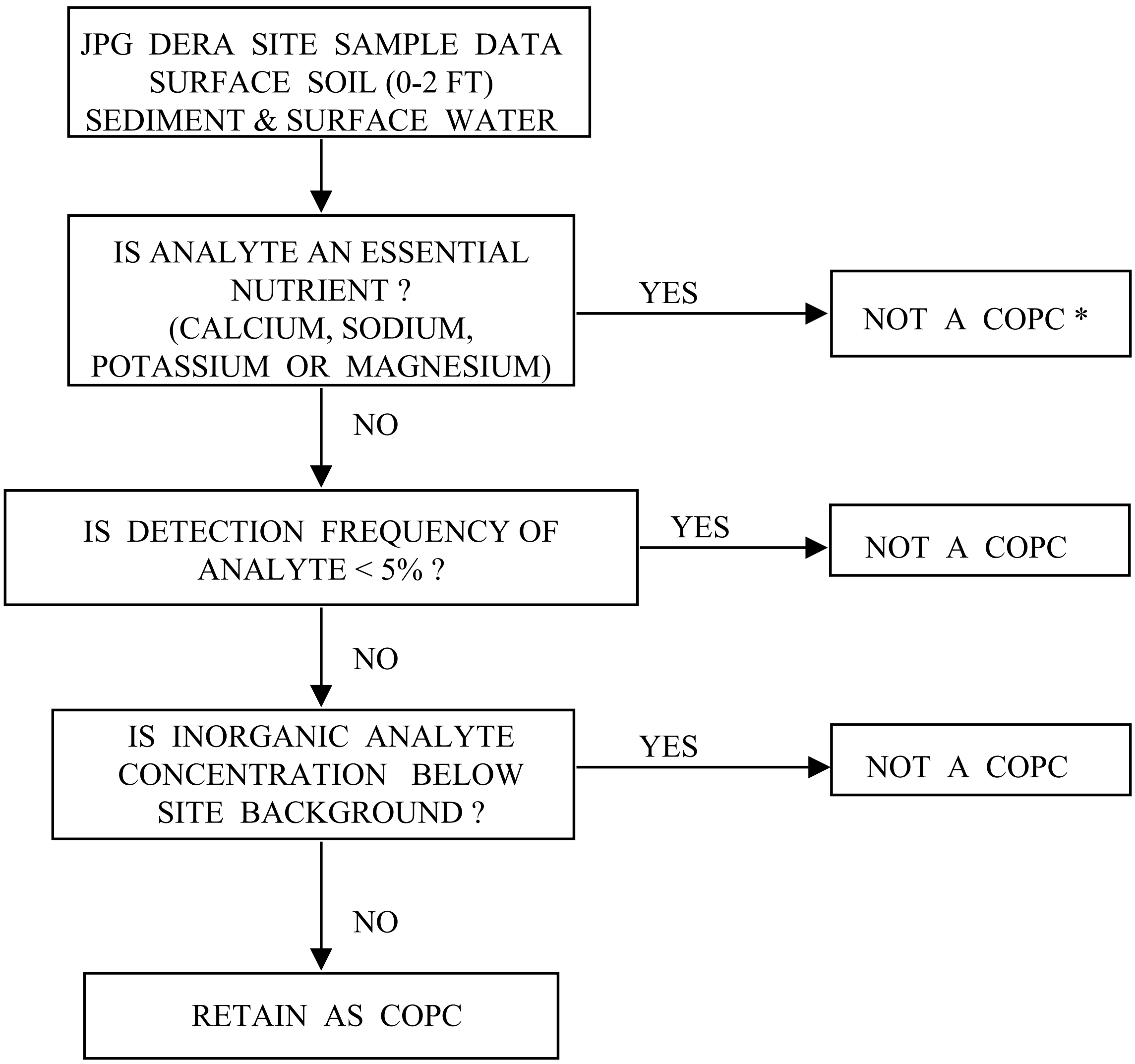


Figure 5.3-1. JPG Ecological Risk Assessment Model

JPG CONTAMINANT OF POTENTIAL CONCERN SCREENING APPROACH



*Contaminant of potential concern

Modified from USEPA Region 8 Superfund Technical Guidance No. RA-03 *Contaminants of Concern*, September 1994

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copc.ppt
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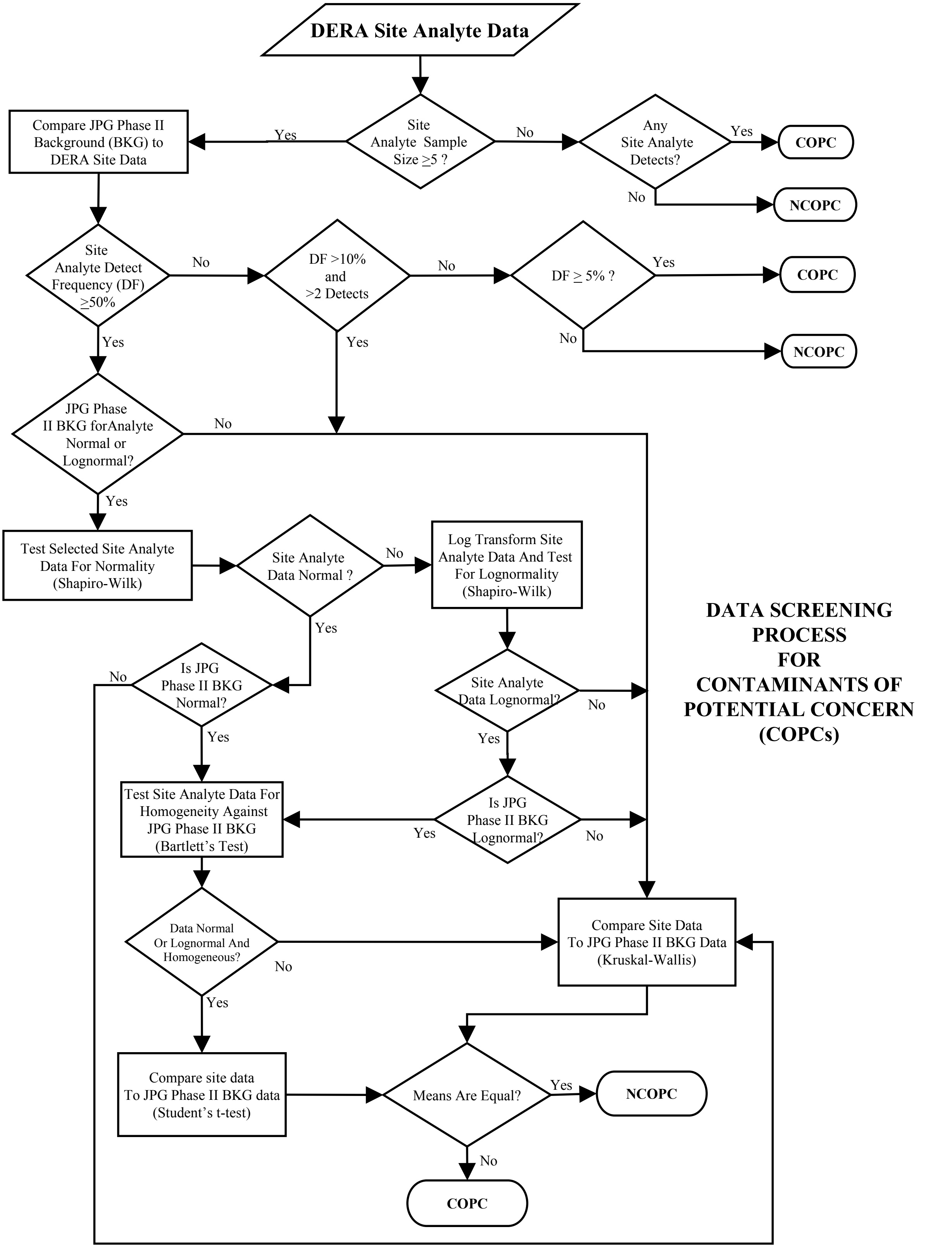
Figure 5.3-2. JPG Contaminant of Potential Concern Screening Approach



Modified from USEPA Region 8 Superfund Technical Guidance No. RA-03 *Contaminants of Concern*, September 1994

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FIG2211.PPT 7/14/98

Figure 5.3-3. Data Screening Process for Contaminants of Potential Concern (COPCs)

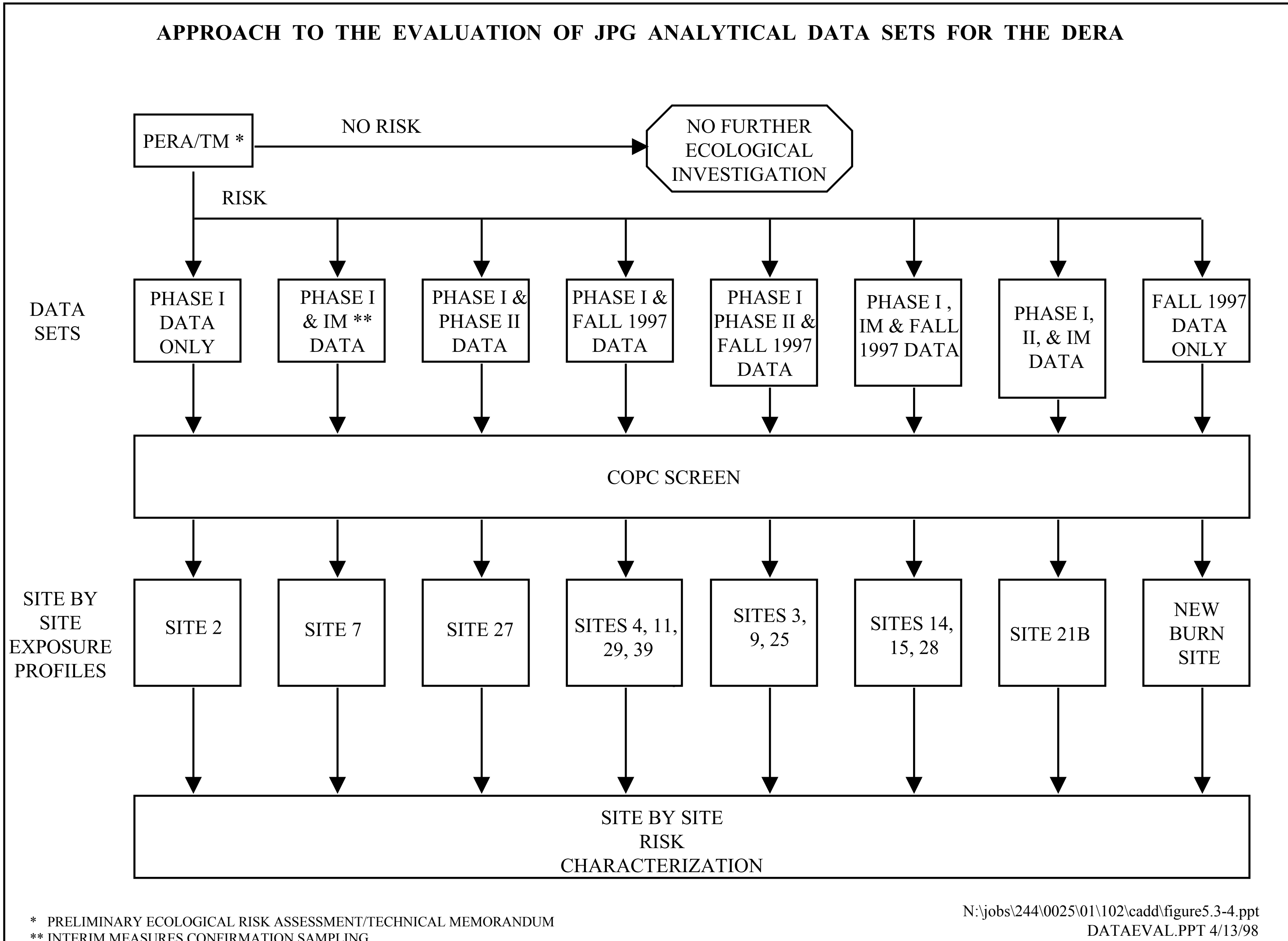

Figure 5.3-4. Approach to the Evaluation of JPG Analytical Data Sets for the DERA

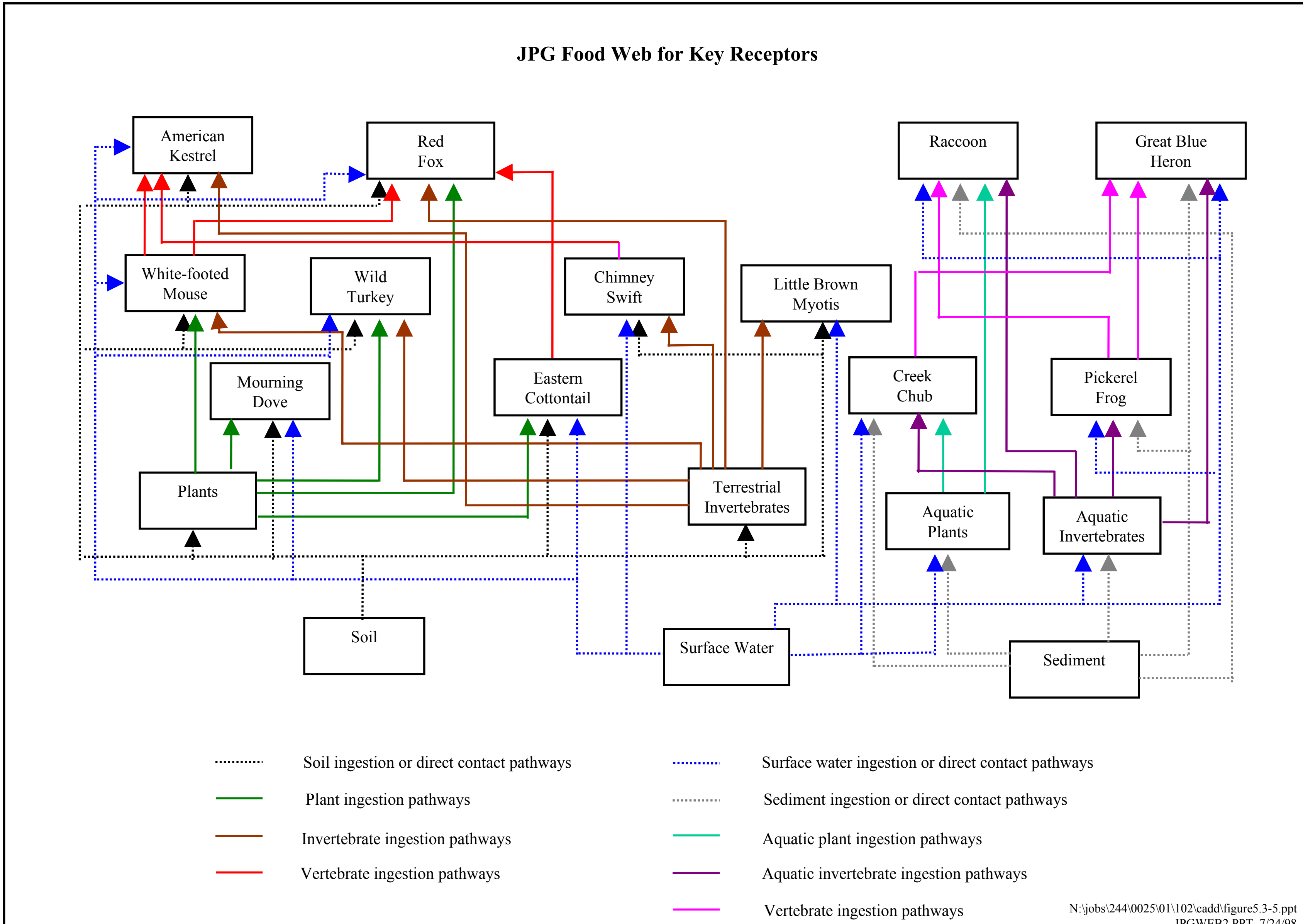

Figure 5.3-5. JPG Food Web for Key Receptors

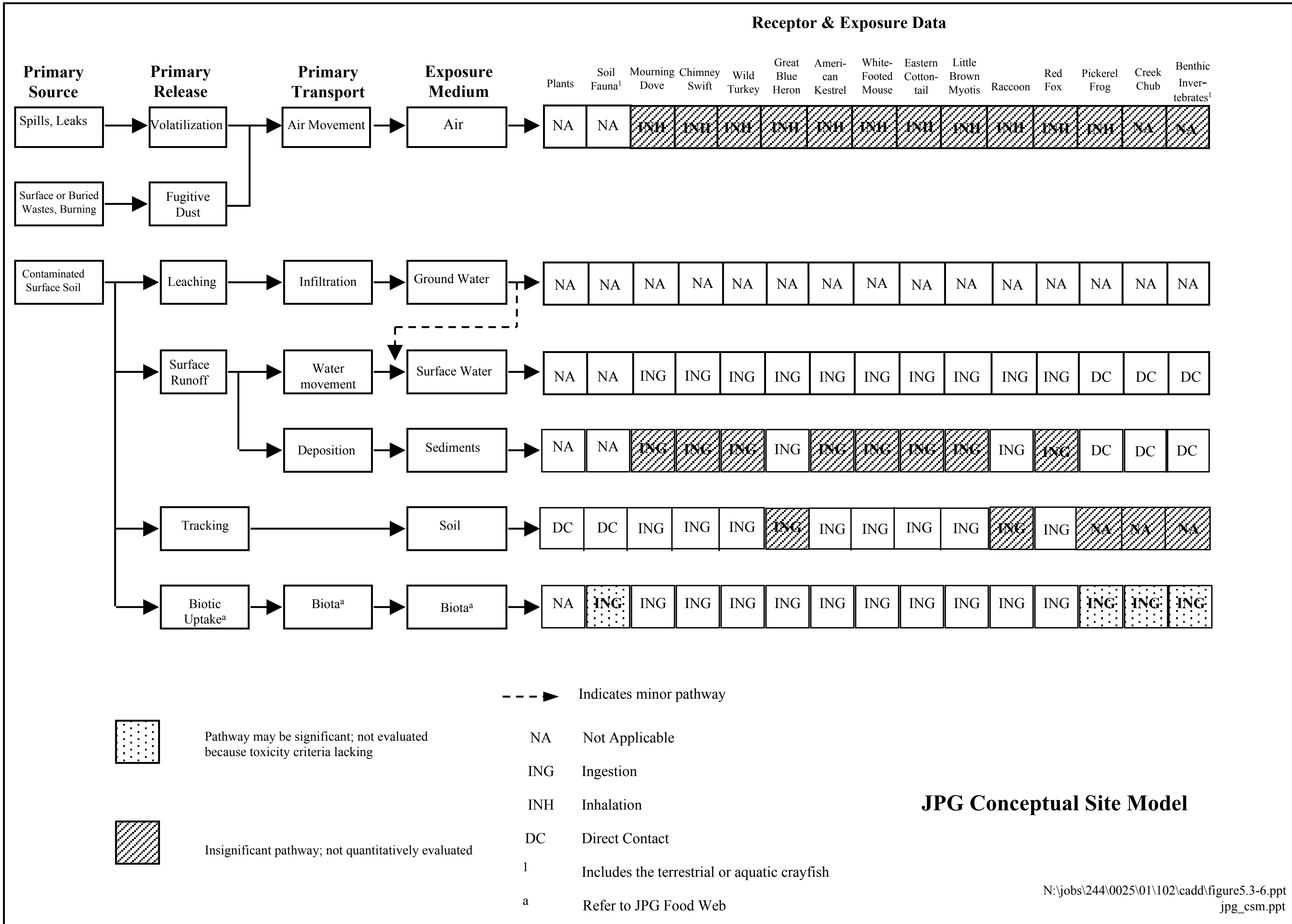

Figure 5.3-6. JPG Conceptual Site Model

Data Quality Objectives for the DERA

1. State the Problem

Army-related activities, resulting in exposure to contaminants of potential concern (COPCs) in soil, sediment and surface water, could adversely affect the survival, growth, and reproductive success of JPG wildlife.
Army-related activities, resulting in exposure to COPCs in soil, sediment and surface water, could adversely alter the soil fauna and plant community composition and thereby decrease habitat value and prey/forage base to JPG wildlife.

↓

2. Identify the Decision

Based upon risk results, decisions will be made as whether there is a potential for unacceptable risks to the ecosystem. The risk management decision will be made as to whether or not remediation is necessary.

↓

3. Identify Inputs to the Decision

Phytotoxicity data, soil fauna data, soil pH, percent organic matter in soil, abiotic analytical data (Phase I, II, Interim Measures (IM) confirmation sampling, Fall 1997), toxicity reference values (TRVs), ambient water quality criteria (AWQC), sediment quality criteria (SQC), water quality indicators (pH, turbidity, dissolved oxygen, conductivity, flow rate, and temperature), metrics and scores from Rapid Bioassessment Protocol (RBP), benthic macroinvertebrate sampling data, fish counts

↓

4. Define Study Boundaries

DERA terrestrial and aquatic study areas (SAs)
DERA sites and JPG boundaries South of the Firing Line
DERA reference terrestrial and aquatic SAs
Phase II background soil sampling locations
Phase I, Phase II and IM confirmation sampling locations

↓

5. Develop a Decision Rule

If hazard quotients / hazard indices (HQs/HIs) are greater than the HQs/HIs at appropriate reference area, *then* potential exists for unacceptable risk; consider other lines of evidence.

↓

6. Specify Limits on Decision Error

For sample size N=5: Confidence = 80%, Power=90%, Minimum Detectable Relative Difference (MDRD) = 20% or 2 standard deviations above reference area, Coefficient of Variation (CV)=20%.

↓ ↑

7. Optimize Design for Obtaining Data

Evaluate Fall 1997 data quality indicators (i.e, PARCC parameters).
Statistically evaluate Fall 1997 field data.
Evaluate other lines of evidence.

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Figure 5.3-7. Data Quality Objectives for the DERA

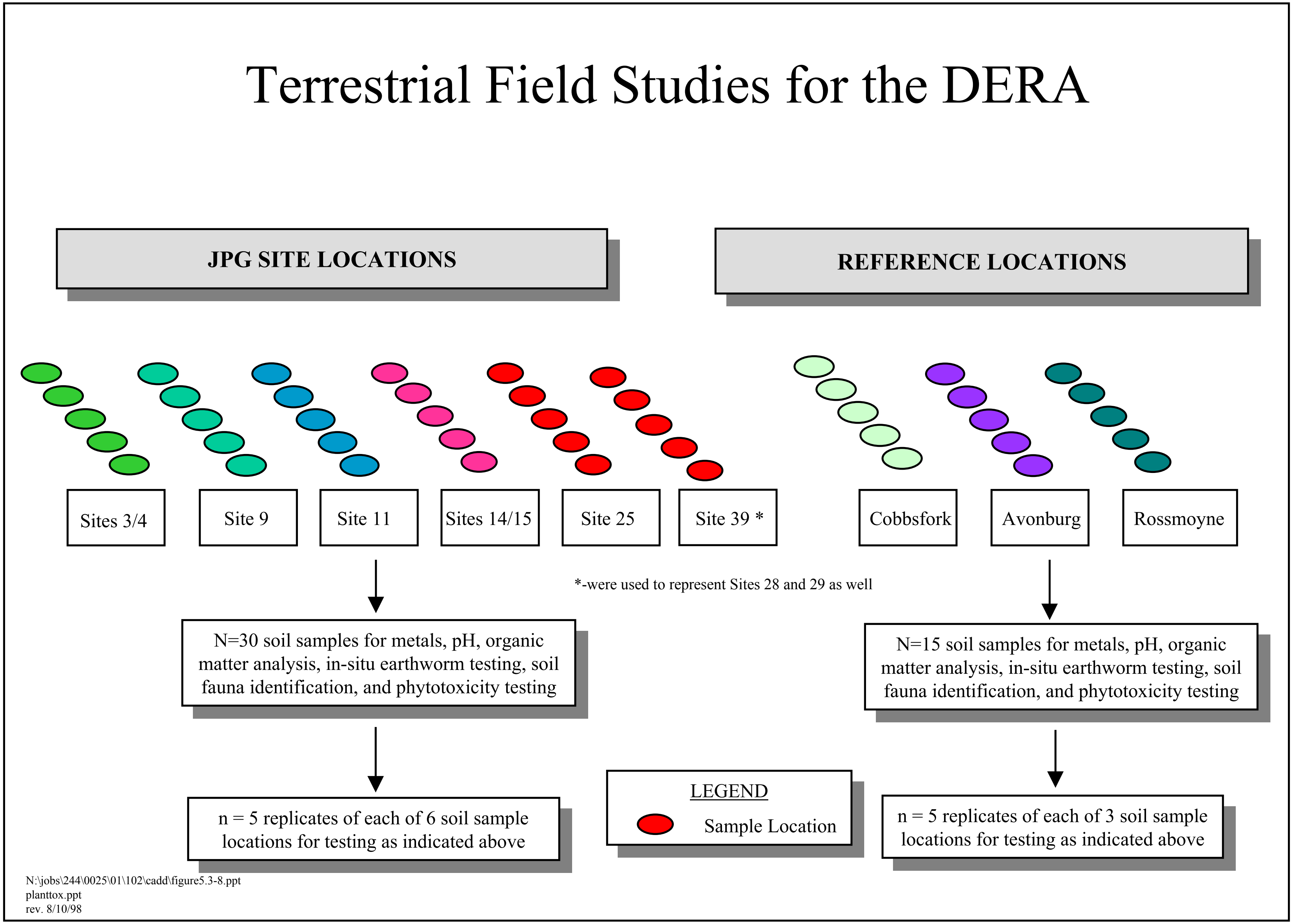


Figure 5.3-8. Terrestrial Field Studies for the DERA

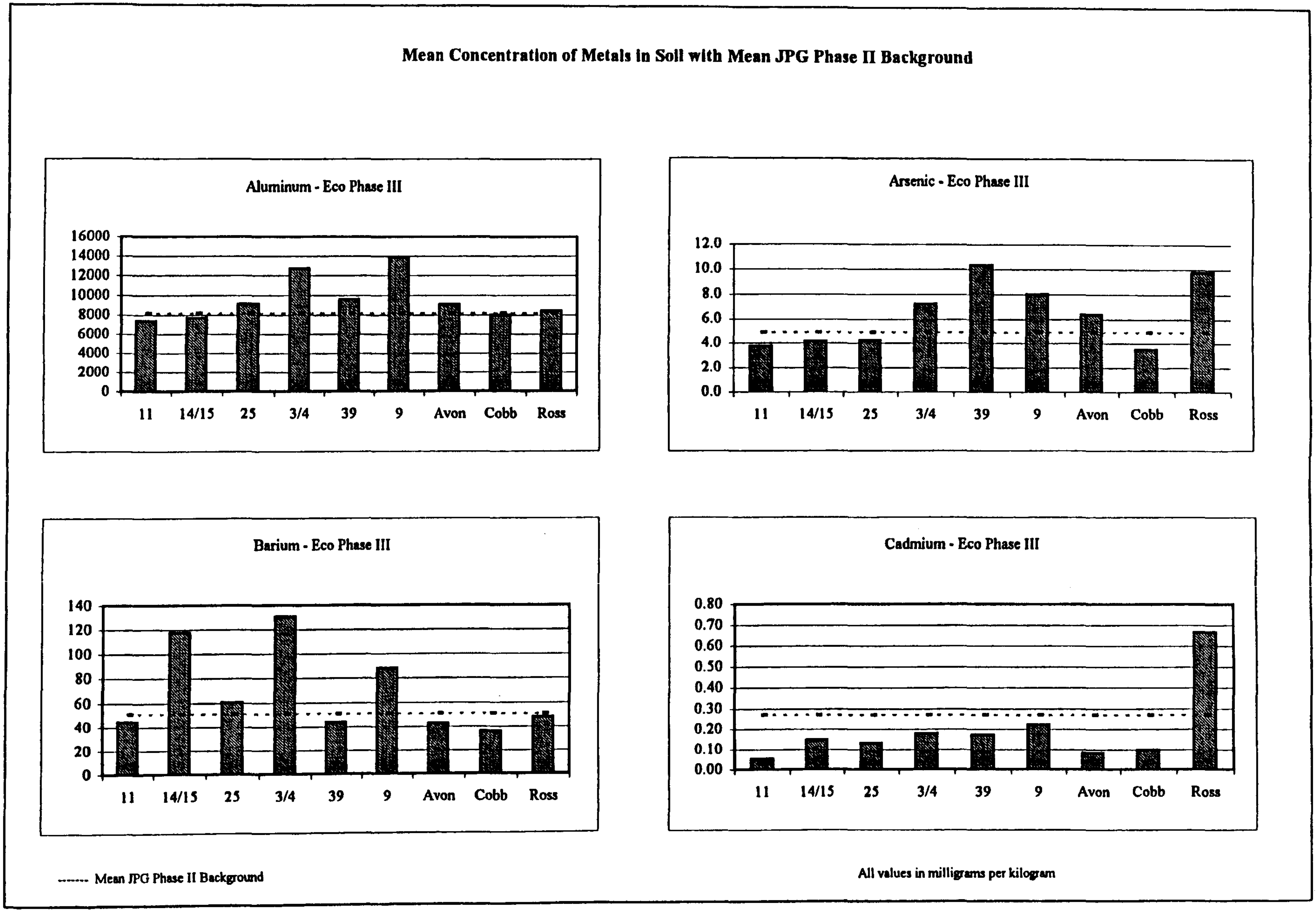


Figure 5.3-9. Mean Concentrations of Aluminum, Arsenic, Barium, and Cadmium in Soil with Mean JPG Phase II Background

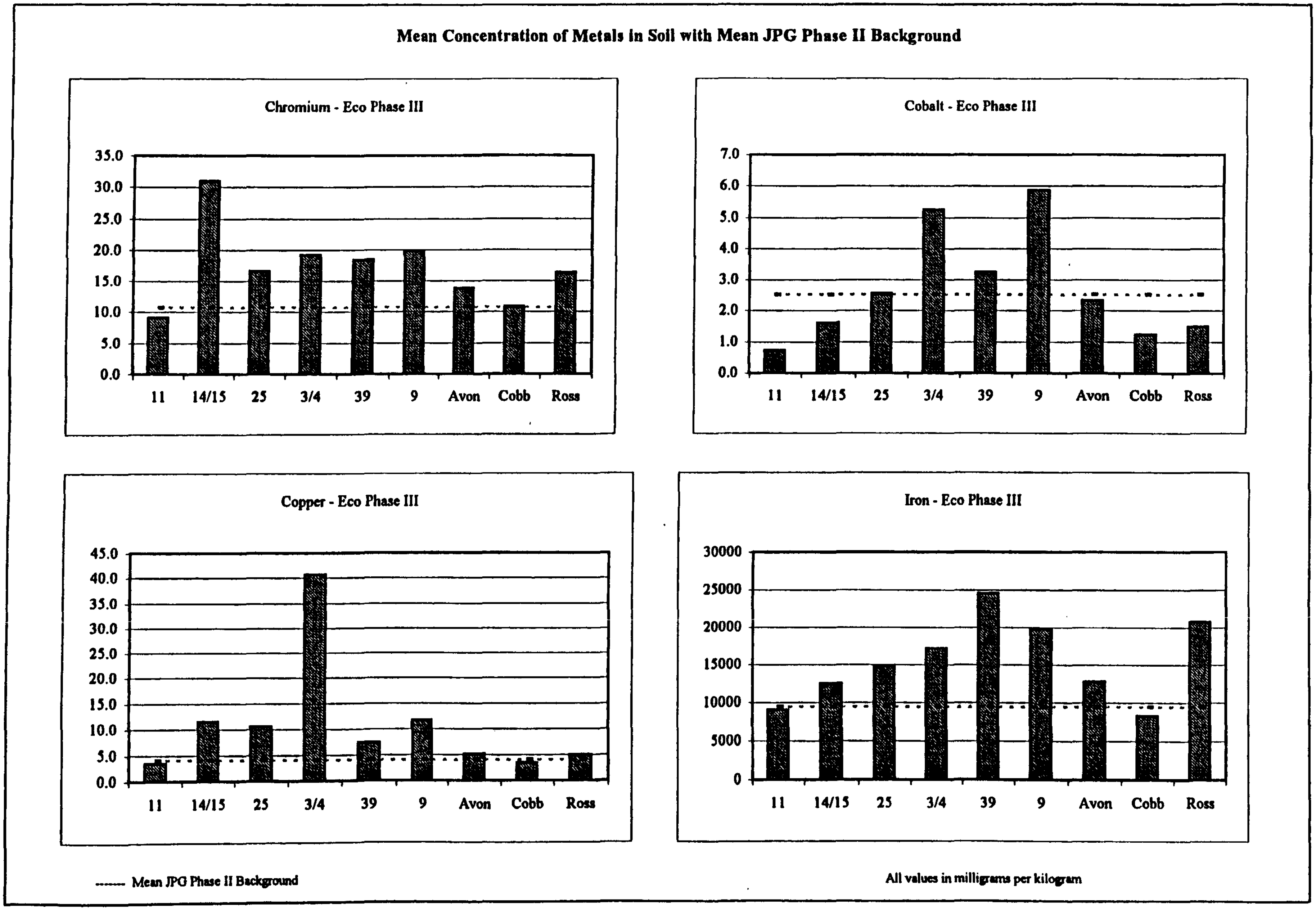


Figure 5.3-10. Mean Concentrations of Chromium, Cobalt, Copper, and Iron in Soil with Mean JPG Phase II Background

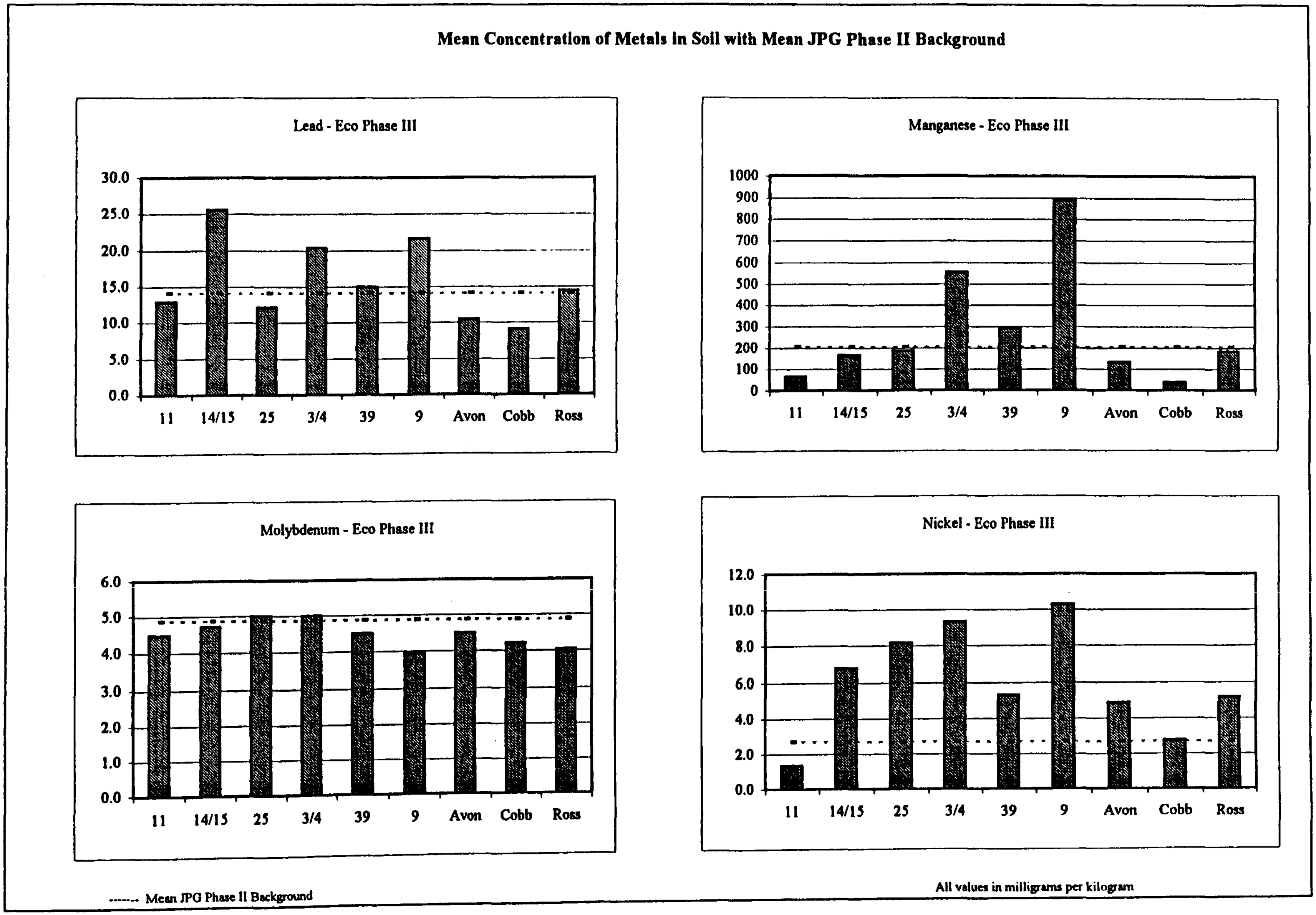


Figure 5.3-11. Mean Concentrations of Lead, Manganese, Molybdenum, and Nickel in Soil with Mean JPG Phase II Background

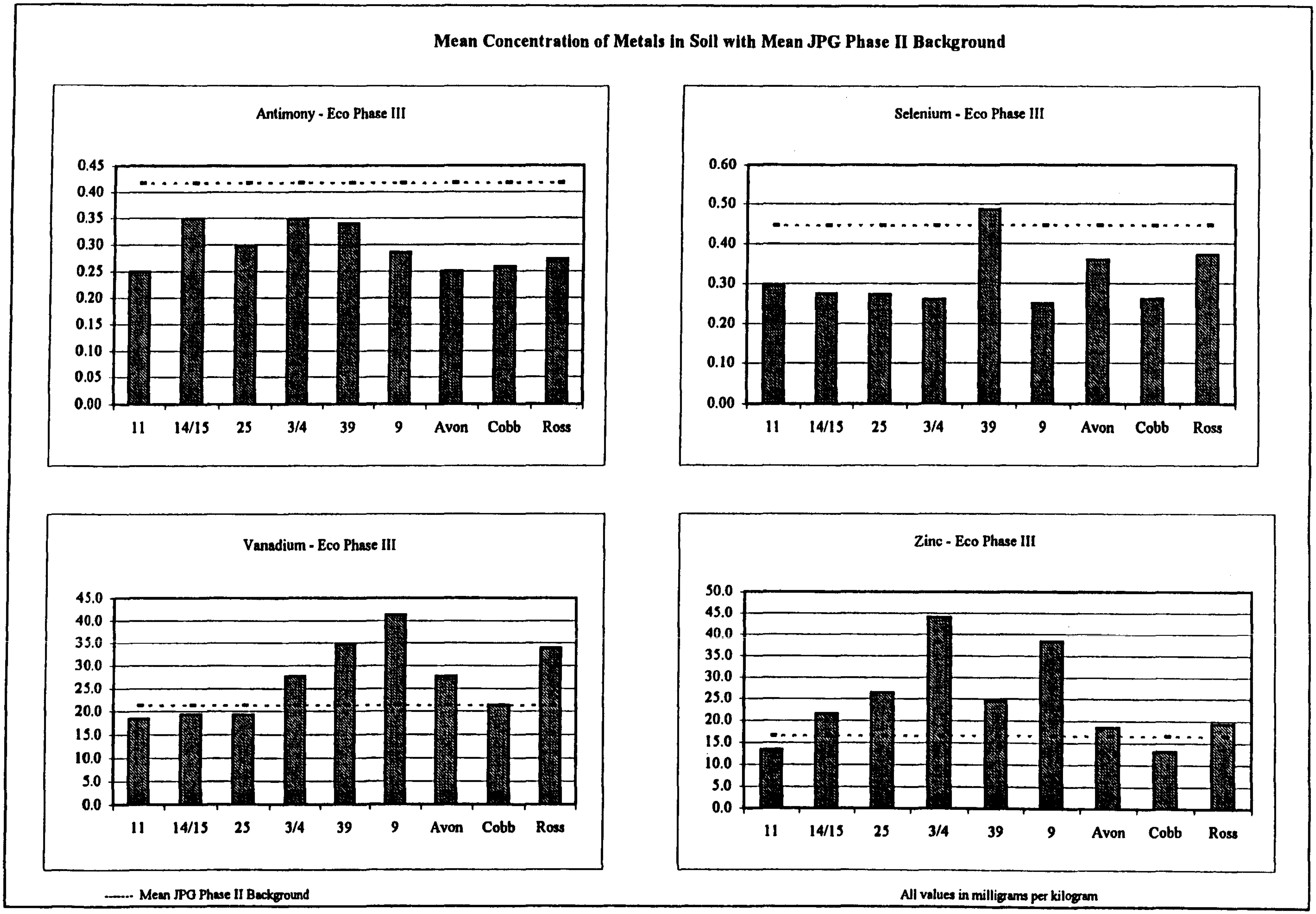


Figure 5.3-12. Mean Concentrations of Antimony, Selenium, Vanadium, and Zinc in Soil with Mean JPG Phase II Background

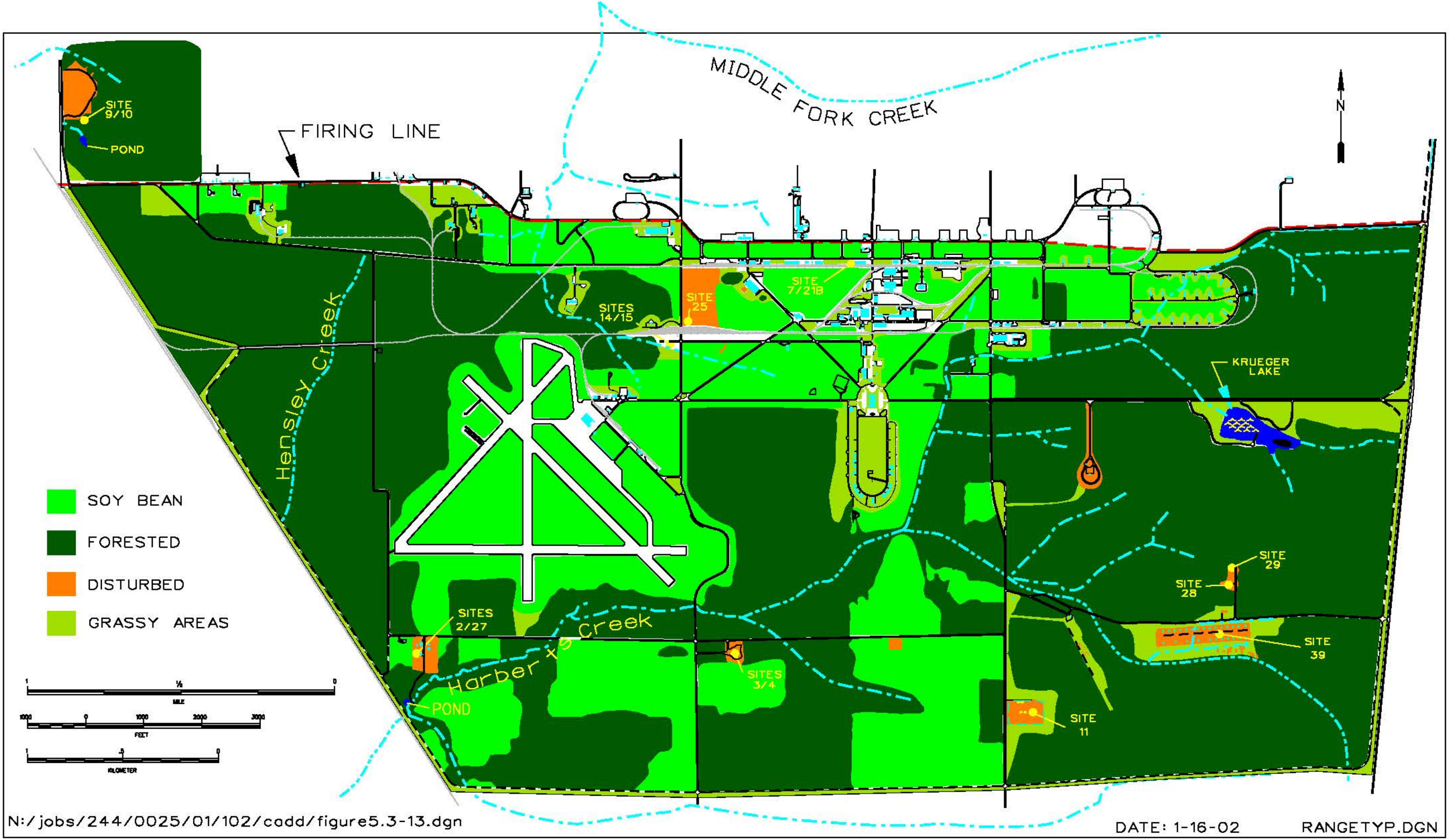


Figure 5.3-13. Habitat Types at JPG

6.0 BUILDING 185 INCINERATOR (SITE 1)

6.1 SITE CHARACTERISTICS

The Building 185 incinerator is located just west of the wastewater treatment plant in the extreme southwestern part of the installation near the intersection of Engineers Road and Tokyo Road (Figure 6-1). The incinerator consists of a Morse-Bouler, single-chamber, single-burner, single-stack incinerator without an afterburner unit. The incinerator was used from 1941 to 1978 and is currently inactive. This incinerator is located in an 800-square-foot building and was primarily used to burn debris, small ammunition, and paper products from the installation (Rust E&I 1994).

The primary concern at this site is potential contamination resulting from particulate matter that was released to the air during the past burning activity and settled on the surrounding surface soil. Based on the known waste steams at this facility, the primary COPCs from the incineration process are metals. However, it is not known whether some hazardous materials, specifically chlorinated solvents, were ever burned in the old incinerator (Rust E&I 1994). If dioxin-precursor chemicals such as chlorinated phenols, chlorinated benzenes and/or PCBs were present in the incinerator's waste feed, potential emissions may also have included dioxins. Thus, both metals and dioxins are considered the preliminary contaminants of potential concern at this site.

The topography around the Building 185 incinerator is characterized as flat to gently rolling. The surface generally slopes to the southeast towards Harberts Creek several hundred feet away (see Figure 2-1). The area immediately surrounding the inactive incinerator was covered by a thick growth of grass and other perennial plants during the Phase I RI and was included in the open area burning program in the spring of 1993. Since that time, the area surrounding the building has been plowed and planted into tobacco and soybean crops by the farmer leasing the area south of the firing line. The soils at this site belong to the Rossmoyne soil series. The soils are underlain by the Jeffersonville Limestone of Devonian age. The depth to bedrock is about 15 feet.

6.2 PREVIOUS INVESTIGATIONS

~~No e~~Environmental samples were not collected from Site 1 prior to the Phase I RI. This site was previously listed in the *Enhanced PA Report* (Ebasco 1990a) as SWMU 1. Ebasco further described the conditions at this site and proposed site-specific sampling activities in the *Master Environmental Plan* (Ebasco 1990b). Rust E&I was tasked with implementing the recommended sampling during the Phase I RI.

6.3 STUDY AREA INVESTIGATIONS

6.3.1 Phase I RI Field Activities

Based on a consideration of prevailing wind direction data, one near-surface soil sample (INC01SF002) was collected on the southeastern side of the building and the other (INC01SF001) on the north side of the building during Phase I of the RI. These surface samples were collected at 0 to 6 inches bgs to assess surface contamination. Both samples were analyzed for metals. The locations of the soil samples are shown in Figure 6-1.

6.3.2 Phase II RI Field Activities

After completion of the final *Draft RI Report*, the presence or absence of dioxin contamination in surface soils downwind of the building was identified as a data gap (i.e., additional information that must be obtained prior to conducting the risk assessment or making decisions on future remedial action). To address this data gap, two additional surface soil samples (INC01SF003 and INC01SF004) were collected from the previous Phase I locations (Figure 6-1) and analyzed for dioxins.

Soil borings and groundwater monitoring wells were not installed at this site because the concentrations of metals detected in Phase I surface soil samples were ~~all~~ below regulatory criteria and because dioxins do not appreciably leach through the soil column.

6.4 DATA EVALUATION

6.4.1 Data Validation Results

A Tier 1 review was conducted by EcoChem on the Phase I metals data for Site 1. ~~All~~ The metals data were found to be acceptable for use without qualification. During Phase II, a Tier 1 review was performed for the dioxin results. This review showed that ~~all~~ the initial results reported by the laboratory were incorrect because they were corrected twice for percent moisture values. However, the database was subsequently revised using the correct values and the Phase II data were then found to be acceptable. The validation results are presented in Appendix P.

6.4.1.1 Evaluation of Non-Detected Values. A comparison was made between the USEPA Region 5 DQLs and the project CRLs for chemicals that were analyzed for but not detected in environmental media at this site. ~~, and n~~No exceedances were identified.

6.4.2 Data Quality Summary

A review of QC sample results indicated that three dioxin compounds (2378 TCDF, 1234678 HpCDD, and OCDD) were detected in the method blank. The USEPA has determined that when blank contamination exists, the investigative results must exceed the blank result by a

factor of 5 (all compounds) or 10 (common laboratory contaminants) in order to be considered positive. The results for the three compounds with associated blank contamination were qualified since they were greater than the action level of 5 times the blank concentrations.

None of the data from the Phase I or Phase II RI were qualified or rejected, indicating that the analytical database for this site is 100 percent complete and usable for risk assessment purposes.

6.4.3 Background Screening

Of the four soil samples collected at this site, two were analyzed for metals and two for dioxins. ~~There was no o~~Obvious hot spot ~~of~~ contamination was not observed. Therefore, the four samples were grouped together for the purposes of background screening.

The anthropogenic background sites were established in August 1995 with concurrence by USEPA, IDEM, and COE. The group identified four areas south of the firing line for the collection of surface soil samples in grids of 5 samples each. The final field sampling plan was also approved by USEPA and IDEM. It is noted that the National Climatic Data Center indicates the prevailing winds are generally from the southwest during most of the year. (EPA30)

The background screening protocol is described in Section 5.1.4.5.2. The results of the background screening procedure for Site 1 are shown in Table 6-1. Since the site sample area had two samples that were analyzed for inorganics, the maximum detected concentration of each inorganic was compared to the calculated background threshold value for the appropriate soil series, in this case the Rossmoyne soil series. As shown in the table, the maximum concentration of every inorganic analyte detected in soil at this site exceeded the background threshold value. Therefore, all detected inorganics are considered potential contaminants at this site and are thus carried through to the COPC selection process.

Chlorinated dioxins and furans were also detected in surface soils at Site 1. Because these compounds are frequently encountered in the environment as anthropogenic background, site dioxins/furans were compared to background dioxins/furans to determine if the congeners detected in soil at this site are elevated and likely related to site activities or are consistent with anthropogenic background. This comparison was performed in two ways.

First, the profiles of the congeners within the individual samples collected at the site were compared to the profiles of the congeners in the five background samples (BKG51SF036, -37, -38, -38, and -40). In general, the lower chlorinated congeners degrade quickly in the environment, leaving behind the higher chlorinated congeners which can persist for hundreds of years (Bumb et al., 1980; Nestrick *et al.* 1986; Smith *et al.* 1983). For comparison purposes, bar graphs, which are presented in Figure 6-2, were constructed using *total* concentrations of ~~each of~~ the various congeners within a sample. The graphs are presented only to illustrate the overall pattern of the congener distribution within the samples, not to compare total dioxin/furan concentrations among the samples. The background samples show

the typical pattern in which the hepta- and octa-congeners predominate. In the site samples, the hepta- and octa-congeners predominate as well, which is suggestive of background anthropogenic contamination and not more recent site-related activities.

For the second type of comparison, the concentrations of ~~each of~~ the congeners were converted into 2,3,7,8-TCDD equivalent concentrations using USEPA-recommended TEFs, as described in Section ~~5.1.5.4.1~~5.1.6.3.1. The 2,3,7,8-TCDD-equivalent detected concentrations were then summed to derive a total 2,3,7,8-TCDD-equivalent concentration for each sample. Since there were only two site samples that were analyzed for dioxins/furans, the maximum site 2,3,7,8-TCDD-equivalent concentration was compared to the background 2,3,7,8-TCDD-equivalent threshold value, calculated as described in Section ~~5.1.6.3.1~~5.1.4.5.3. The maximum site concentration was less than the background threshold concentration. Therefore, the dioxin/furan concentrations are considered to be consistent with anthropogenic background.

6.4.4 Summary of Analytical Results

Table 6-2 presents the analytical results for the Phase I and Phase II surface soil samples collected at Site 1. A complete listing of~~on all~~ analytical results, including nondetected and below reporting limit analytes, is presented in Appendix N.

6.5 NATURE AND EXTENT OF CONTAMINATION

6.5.1 Soil

The surface soil-sample results indicate ~~that all of~~that the target metals exceed the threshold values established from the background soil data base (Table 6-2). However, only silver (two samples) appears to be present at ~~highly~~ elevated concentrations (14 ~~to~~ and 35 µg/g). Silver was not detected in the background data set. One possible source of the elevated silver concentrations might be the former burning of film and/or photographic chemicals at the incinerator. Another possible source is sewage sludge disposal (see the discussion in Section 7.1). Although silver concentrations at this site are elevated they are still much less than the USEPA Region 9 risk-based concentration criteria of 380 µg/g.

Other metals detected in surface soils at concentrations exceeding their background values in both samples include aluminum, barium, beryllium, boron, chromium, cobalt, manganese, mercury, nickel, vanadium, and zinc. Arsenic and lead were detected above background in only one sample. Aluminum, arsenic, beryllium, chromium, and manganese were the only metals that exceeded the USEPA Region 9 risk-based criteria. It should be noted that the background soils at JPG were also found to contain aluminum, arsenic, beryllium, chromium, and manganese at levels above the USEPA Region 9 criteria.

If the incinerator is to be dismantled and removed in the future, a potential exists for human (worker) exposure via inhalation of contaminated dusts (i.e., metals) that may remain in the

building and in the smokestack. Until that time, access to the incinerator should continue to be restricted (i.e., the building kept locked) to minimize potential risk to human health.

In summary, ~~all~~ metals except aluminum, arsenic, beryllium, chromium, and manganese at this site are at levels below the USEPA Region 9 risk-based criteria (Figure 6-3). Although silver concentrations are ~~highly~~ elevated relative to background, they are ~~significantly~~ less than the corresponding Region 9 criteria (380 µg/g). The maximum lead concentration measured at the site was 23.3 µg/g, which is much less than the USEPA lead cleanup level of 400 µg/g. Arsenic was detected in one sample at 7.8 µg/g. This value is only slightly greater than the background value of 7.3 µg/g for Rossmoyne soils and less than the maximum detection of arsenic in background soils. It is likely that the arsenic concentration at this site is a result of naturally occurring variations in soil types rather than a result of releases from the incinerator.

The results of the sampling for dioxins/furans during Phase II indicate that several dioxins/furans are present in the surface soils but at concentrations similar to those found in background samples at JPG. The OCDD concentrations, when converted to TCDD equivalent concentrations, were found to exceed the USEPA Region 9 criteria of 4.5 E-07. However, OCDD was also found to exceed this criteria in ~~all of~~ the background samples for JPG.

There is no clear evidence that the contamination detected in the Site 1 soil samples is directly related to previous releases from the incinerator. However, several metals and dioxins were carried forward into the risk assessments as potential COCs for the Site 1 risk assessment.

6.6 HUMAN HEALTH RISK ASSESSMENT

6.6.1 Selection of Contaminants of Potential Concern at Site 1

6.6.1.1 Surface Soil.

6.6.1.1.1 Frequency of Detection. Evaluation of frequency of detection was not undertaken at this site because of too few samples.

6.6.1.1.2 Nutrient Screening. The maximum value of ~~each of~~ the nutrients detected in soil at this site was less than the corresponding nutrient screening value: calcium (maximum 2,890 µg/g; screening value 1,000,000 µg/g), iron (maximum 32,300 µg/g; screening value 70,000 µg/g), magnesium (maximum 2,890 µg/g; screening value 1,000,000 µg/g), potassium (maximum 1,830 µg/g; screening value 150,000 µg/g), and sodium (maximum 146 µg/g; screening value 1,000,000 µg/g). Therefore, ~~all~~ nutrients were eliminated as COPCs in surface soil.

6.6.1.1.3 *Summary of Preliminary COPCs.* Table 6-3 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95% UCL of the mean, and the exposure point concentration for ~~each~~ preliminary COPCs in soil at Site 1.

Even though they were present in concentrations consistent with anthropogenic background, dioxins/furans were retained as preliminary COPCs.

6.6.1.1.4 Region 9 Preliminary Remediation Goal Screening. The calculated exposure point concentration for ~~each~~ preliminary soil COPCs ~~was~~**were** compared to the chemical-specific Region 9 residential soil PRG (Table 6-4) to screen the preliminary COPCs as to their potential health impacts. Per Region 9 guidance, one-tenth of the PRG was used for noncarcinogens, except for lead, for which the full PRG was used. As a result of the screening, only aluminum, arsenic, beryllium, chromium, manganese, and dioxins/furans were ***retained*** as COPCs in surface soil at Site 1.

6.6.1.2 Air.

6.6.1.2.1 Summary of Preliminary COPCs. Ambient air concentrations to which future receptors at this site might be exposed were estimated using air emission/dispersion modeling, as described in Appendix R. In the site-specific conceptual model, discussed below in Section 6.6.2.1. Site 1 is evaluated under two future site-specific scenarios: a future residential/ agricultural site and leased agricultural land.

For determining ambient air concentrations in the future residential scenario for the facility, ~~all~~ the sites were assumed to be residential except for the five sites designated agricultural. It was assumed that particulate emissions from the strictly residential sites would be negligible because the home sites would be covered with dense vegetation (lawns) and pavement. Therefore, under the residential scenario only the agricultural sites contribute to the air concentrations at ~~all of~~ the sites. The list of preliminary air COPCs is therefore the same for every site, although the concentrations vary. Table R-6 in Appendix R presents the estimated ambient air concentrations at Site 1 under the future residential land use scenario.

Under the leased agricultural land use scenario, the consumers of livestock products from animals fed crops grown at this site are assumed to live far enough distant from the site that their exposure to site-related air contaminants would be negligible. The air pathway was therefore not evaluated for these future off-site receptors.

6.6.1.2.2 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for ~~each~~ **the** preliminary air COPC**s** at Site 1 in the future residential scenario was compared to the chemical-specific Region 9 air PRG (Table 6-5). One-tenth of the PRG was used for noncarcinogens. The exception was lead, for which the full PRG was used. As a result of the screening, aluminum, arsenic, chromium, manganese, thallium, silver, vanadium, and zinc are retained as air COPCs for future residents at Site 1.

6.6.2 Exposure Assessment

6.6.2.1 Site Conceptual Model. As described in Section 5.1.4.6, several types of individuals could be affected by existing contamination at the facility. Those that would most likely be impacted simultaneously by multiple sites rather than by single units (i.e., current trespassers,

current off-site residents, and future hunters) are addressed on a facility-wide, cumulative basis in Sections 28 and 29 of this report.

Therefore, the site-specific conceptual model developed for Site 1 only addresses future land use development. Site 1 has two potential future land uses forwarded for evaluation:

- Agricultural
- Residential

Agricultural Use. Under this future land use scenario, Site 1 is assumed to be leased or sold to a farmer for the purpose of cultivating cash crops. The most likely receptor population would therefore consist of individuals residing in nearby communities who purchase and ingest these crops and/or who consume beef and milk products obtained from cattle who were fed crops harvested at JPG.

Residential Use. Under the future residential land use scenario, this site is assumed to be developed as homesteads, with the supposition that a family would build a house directly on/within this area of potential concern.

With respect to a risk assessment analysis, resident populations are assumed to consist of both adults and toddlers. ~~Each i~~**I**ndividual**s** would be expected to come in contact with site contaminants through the following pathways at Site 1:

- Inhalation of VOCs and fugitive particulates from soils
- Dermal contact with soil while gardening/playing outdoors
- Incidental ingestion of soil while gardening/playing outdoors
- Ingestion of fresh homegrown fruits and vegetables
- Ingestion of home-produced beef
- Ingestion of home-produced milk

6.6.2.2 Exposure Point Concentrations.

6.6.2.2.1 Air. The estimated ambient air concentrations of COPCs at this site for the future on-site resident are presented in Table 6-5.

6.6.2.2.2 Soil. The concentrations of COPCs in surface soil at this site are presented in Table 6-4. ~~No s~~**S**ubsurface samples were **not** collected at Site 1.

6.6.2.2.3 Fruits, Vegetables, and Crops. COPC concentrations in home-grown fruits and vegetables and crops (corn) grown for livestock consumption were estimated using the methods described in Section 5.1.5.2.8. Appendix U, Table U-1, documents the calculation of contaminant concentrations in fruits, vegetables, and crops at Site 1.

6.6.2.2.4 Beef and Milk. COPC concentrations in beef and milk were estimated using the methods described in Section 5.1.5.2.9 and 5.1.5.2.10, respectively. Table U-1, Appendix U, documents the calculation of contaminant concentrations in beef and milk at Site 1.

6.6.2.3 Human Exposure Doses

6.6.2.3.1 Inhalation of Contaminated Air. Inhalation of airborne contaminants (VOCs and particulates) is a potential route of exposure for future on-site residents (adults and children) at this site. The equation used for calculating human exposure doses of COPCs due to inhalation of volatile and dust-bound contaminants is provided in Section 5.1.5.3.1, Table 5-**11**~~12~~. Table V-1, Appendix V, documents the calculation of human exposure doses due to inhalation of contaminated air.

6.6.2.3.2 Incidental Ingestion of Contaminated On-site Soil. Mouthing behavior (toddlers) and incidental ingestion of soil with recreational or work-related activities may expose human receptors to contaminated soil at a site via the oral route of exposure. The equation used to calculate the human exposure dose due to incidental ingestion of contaminated soil is presented in Section 5.1.5.3.2, Table 5-**12**~~13~~. This pathway was assumed to be complete at Site 1 for future on-site residents (adults and children). Table V-1, Appendix V, documents the calculation of human exposure doses due to incidental ingestion of soil at Site 1.

6.6.2.3.3 Dermal Contact with Contaminated On-site Soil. The chemicals in contaminated soil also may be absorbed into a receptor's body through dermal contact. The equation used to calculate chemical doses due to dermal contact with contaminated soil is presented in Section 5.1.5.3.3, Table 5-**13**~~14~~. This pathway is relevant for future on-site residents (adults and children) at Site 1. Table V-1, Appendix V, documents the calculation of human exposure doses due to dermal contact with soil at Site 1.

6.6.2.3.4 Ingestion of Contaminated Fruits and Vegetables. Consumption of contaminated homegrown fruits and vegetables may be a source of chemical exposure for future on-site residents (adults and children). The equation used to calculate human exposure doses due to ingestion of contaminated fruits and vegetables is provided in Section 5.1.5.3.11, Table 5-**22**~~23~~. Table U-1, Appendix U, documents the calculation of human exposure doses due to ingestion of contaminated fruits and vegetables grown in surface soil at Site 1.

6.6.2.3.5 Ingestion of Contaminated Beef and Milk. Ingestion of contaminated beef and milk may be significant pathways of chemical exposure for future on-site residents and future off-site residents (adults and children) who consume these products from cattle fed corn (silage) harvested from fields at Site 1. The equation used to calculate human exposure doses

due to ingestion of contaminated beef is provided in Section 5.1.5.3.12, Table 5-**23**~~24~~. The equation used to calculated human exposure doses due to ingestion of contaminated milk is provided in Section 5.1.5.3.13, Table 5-**24**~~25~~. Table U-1, Appendix U, documents the calculation of the human exposure doses due to ingestion of contaminated beef and milk from cattle fed corn (silage) grown in fields at Site 1.

6.6.3 Risk Characterization

6.6.3.1 Chronic Health Hazards. The noncancer daily exposure doses calculated in the exposure assessment were used to calculate HQs for ~~each of~~ the COPCs possessing RfDs. Pathway-specific and overall HIs were then calculated for ~~each~~ **the** receptor**s**. The calculations of HQs and HIs are described in Section ~~5.1.5.1.1~~ **5.1.7**. If an overall HI is calculated to be greater than 1.0 for a particular receptor, then the exposure pathway(s) primarily responsible for the result is identified as a "critical pathway(s)." For each critical pathway, those chemical contaminants responsible for the majority of the HI are listed as COCs. Table W-1, Appendix W, documents the calculation of the pathway- and chemical-specific HQs for the human receptors at Site 1. The pathway-specific and overall HIs are summarized in Table 6-6.

6.6.3.1.1 Future On-Site Residents. The overall HIs for the future on-site adult and toddler residents at Site 1 are calculated to be **1.9** ~~2.6~~ and **7.4** ~~9.9~~, respectively. These HIs exceed the USEPA's risk management criterion of 1.0. The primary pathway of concern for both receptors is inhalation of fugitive dusts, and manganese is the primary COC. ~~Aluminum is also a noncarcinogenic COC for the future child resident for this pathway.~~

Because the calculated risks and hazards for the inhalation of the air pathway reflect combined modeled fugitive dust and/or VOC contributions from ~~all~~ **the** sites, the data were reviewed to determine the contribution of soil at Site 1 to the chemical-specific HQs calculated for the noncarcinogenic COCs for this pathway. ~~Aluminum and~~ M~~m~~anganese in Site 1 soils **is** ~~are~~ responsible for ~~89 and~~ **88**~~80~~ percent of the air pathway HQ~~s, respectively~~.

~~Aluminum and~~ M~~m~~anganese **is**~~are~~ present naturally in soils at the facility. The relative contributions of background soil concentrations of **this** ~~these~~ noncarcinogenic soil COC~~s~~ to the hazards at this site were estimated by comparing the average soil background concentrations of **this** ~~these~~ chemical~~s~~ (in Rossmoyne soils) to the average concentration in site soils. This analysis shows that background concentration~~s~~ of ~~aluminum and~~ manganese contribute<u>s</u> approximately ~~30 and~~ 25 percent to the total soil concentration~~s, respectively~~.

6.6.3.1.2 Future Off-Site Consumers of Beef and Milk. The overall HIs for the future off-site adult and toddler consumers of beef and milk produced at Site 1 are calculated to be 0.**0.06** ~~11~~ and **0.24** ~~0.46~~, respectively. Both of these HIs are less than USEPA's risk management criterion. Thus, ~~no~~ critical exposure pathways or chemicals of concern **were not** ~~are~~ identified for these receptors. The existing contamination at Site 1 would not present a chemical hazard

to future off-site consumers of beef and milk from cattle fed corn (silage) grown in fields at Site 1.

6.6.3.2 Excess Lifetime Cancer Risks. The cancer risks for each receptor were determined from the pathway-specific exposure doses and the route-specific SFs, as described in Section 5.1.7.2. To assess the simultaneous exposure of a receptor population to multiple carcinogens from multiple exposure routes,~~ all of~~ the cancer risks calculated for a receptor population were summed. ~~Each~~ **The** overall receptor cancer risks ~~was~~ **were** then compared to USEPA's target risk range (1.0E-06 to 1.0E-04). If the total cancer risk for a receptor from ~~all~~ **the** exposure pathways is less than 1.0E-04, then it is concluded that the site(s) does not pose a significant risk to that receptor. If the overall cancer risk exceeds the target risk range, ~~any~~ a chemical individually associated with a risk level greater than 1.0E-05 is identified as a COC. COCs represent the primary contributors to the potential cancer risk for the receptor-specific exposure pathway under evaluation. Table W-1, Appendix W, documents the calculation of the pathway- and chemical-specific cancer risks for the human receptors at Site 1. The pathway-specific and overall cancer risks are summarized in Table 6-6.

6.6.3.2.1 Future On-Site Residents. The overall cancer risk calculated for the future adults living at Site 1 is **1.1E-04** ~~1.2E-04~~. This cancer risk slightly exceeds USEPA's target risk range of 1.0E-06 to 1.0E-04. The primary exposure pathway of concern is ingestion of beef, and the chemical of concern for this pathway is 2,3,7,8-TCDD. Other carcinogenic COCs for this receptor are arsenic (from ingestion of home-grown vegetables) and chromium VI (from inhalation of fugitive dusts). It should be noted, however, that the 2,3,7,8-TCDD-equivalents detected in soils at this site were determined to be consistent with anthropogenic background (see Section 6.5.1). The total cancer risk to the future on-site adult resident at this site would fall within the USEPA's target risk range if the 2,3,7,8-TCDD detected in site soils is considered to be unrelated to site activities~~. In this case, there would be no carcinogenic COCs for the future adult on-site resident.~~

The overall cancer risk calculated for the future child resident at this site is **6.7E-05** ~~7.4E-05~~. This cancer risk is within the USEPA's target risk range of 1.0E-06 to 1.0E-04. Therefore, ~~no~~ critical exposure pathways or carcinogenic COCs ~~are~~ **were not** identified for this receptor population.

6.6.3.2.2 Future Off-Site Consumers of Beef and Milk. The overall cancer risks calculated for the future off-site adults and children consuming beef and milk from cattle fed corn (silage) grown at this site are 7.5E-05 and 3.5E-05, respectively. These cancer risks are within the USEPA's target risk range of 1.0E-06 to 1.0E-04. Therefore, ~~no~~ critical exposure pathways or carcinogenic COCs ~~are~~ **were not** identified for these receptor populations.

6.6.3.3 Uncertainty/Sensitivity Analysis. The numerical risks/hazards that are calculated in this risk assessment for Site 1 represent *conditional* estimates of risk based on various simplifying assumptions concerning contaminant exposure and toxicity. These estimates of risk/hazard are derived using a series of conservative procedures that address contaminant concentrations at the site, their fate in the environment, how someone currently or in the future

might be exposed to these contaminants, and the toxicity of ~~each~~ **individual** chemicals toward humans. The purpose of the uncertainty analysis is therefore to specify, when appropriate, the critical assumptions made for the site for the risk managers so that the site-specific results can be interpreted in a proper context.

To assist the risk managers in this project, a qualitative uncertainty analysis has been performed. The primary goals of a qualitative uncertainty analysis are (1) to itemize the major areas of uncertainty in the site-specific risk assessment and (2) to demonstrate that the assessment overall has been conservatively performed (i.e., that the potential risks/hazards at the site have not likely been underestimated, but may have been significantly overestimated).

The qualitative uncertainty analysis for this site is presented in Table 6-7. Based on this analysis, it can be concluded that this risk assessment is conservative. Some of the major uncertainties in this study that are most influential to the calculated risks/hazards include:

- Likely presence of anthropogenic background PCDD/PCDF at site
- **The conversion of TCDD conger concentrations to TCDD equivalents (EPA30)**
- **The selection of sites that represent anthropogenic background areas (EPA30)**
- Length of daily exposure time (24 hours/day) and exposure frequency (350 days/year) of receptors at site
- Assumption of 100 percent home-produced beef
- Assumed receptors' foodstuff ingestion rates (95th percentile of U.S. population)

6.7 ECOLOGICAL RISK ASSESSMENT

Utilizing a protocol approved by the regulators, the *Preliminary Ecological Risk Assessment* (Rust E&I 1997g) determined that silver was the sole contaminant of concern for ecological receptors. However, it was determined in the analysis leading to the September 1997 Technical Memorandum (Rust E&I 1997f) that, because the suspected area of contamination is very small (less than 0.01 acres), **because** only one COC has been identified, and **because** the natural area surrounding the site has been highly disturbed by agricultural activities, further ecological action is **not necessary.** ~~warranted.~~

6.8 CONCLUSIONS AND RECOMMENDATIONS

Phase I and Phase II RI sampling results indicate that metals in soils associated with the Building 185 Incinerator (Site 1) exceed background concentrations. As a result, metals were

carried forward into the human health risk assessment as COPCs. Dioxins/furans were also found to be present in surface soils but comparisons with background results indicate that the concentrations are consistent with background anthropogenic contamination rather than more recent site-related activities. However, dioxins/furans were also carried forward to the human health risk assessment as COPCs.

Results of the human health risk assessment indicate that under the future residential scenario, the adult and child residents would be at risk from exposure to metals and dioxins in fugitive dusts from contaminated soil. However, the dioxins in the soil may be background anthropogenic contamination and unrelated to previous Site 1 activities. In addition, it should be noted that background levels of several metals, including aluminum, arsenic, **chromium, beryllium,** and manganese (COPCs for this site), also exceed USEPA Region 9 PRGs.

Since the suspected area of contamination at Site 1 is small—only one contaminant (silver) ~~of concern~~ was identified for ecological concern ~~was identified (silver)~~—and the natural area surrounding the site has been highly disturbed by agricultural activities, it was determined that Site 1 does not pose a risk to ecological receptors and ~~no~~ additional investigation is **not necessary**. ~~warranted.~~ Due to the future residential risks estimated for Site 1 that exceed USEPA risk-based criteria, it is recommended that the site be carried forward to the FS.

TABLES

TABLE 6-1

Background Screening of Inorganic Chemicals Detected in Soil
Site 1 - Building 185 Incinerator
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Maximum Detected Value (µg/g)	Soil Series Background Screening Value[b] (µg/g)	Exceeds Soil Series Background?
Surface Soil				
Aluminum	2/2	28,400	10,900	**YES**
Arsenic	2/2	7.76	7.34	**YES**
Barium	2/2	120	66.0	**YES**
Beryllium	2/2	0.735	0.43	**YES**
Boron	2/2	14.5	ND[c]	**YES**
Chromium	2/2	30.8	15.7	**YES**
Cobalt	2/2	23.3	3.8	**YES**
Copper	2/2	25.9	7.70	**YES**
Lead	2/2	23.3	21.5	**YES**
Manganese	2/2	894	316	**YES**
Mercury	2/2	0.405	ND	**YES**
Nickel	2/2	16.3	6.54	**YES**
Silver	2/2	35.0	ND	**YES**
Vanadium	2/2	47.5	27.2	**YES**
Zinc	2/2	148	20.5	**YES**
Dioxins/Furans	2/2	1.13E-05	2.03E-05[d]	No

Footnotes:
(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) See Section 5.1.4.5.2 for an explanation of how the soil series-specific background screening values were calculated.
(c) Not detected.
(d) The dioxin background is unrelated to the soil series.

TABLE 6-2

Analytical Results for Surface Soil Samples
Site 1 - Building 185 Incinerator
Jefferson Proving Ground
Madison, Indiana

Analyte	INC01SF001 11/11/92 (ug/g)	INC01SF002 11/11/92 (ug/g)	INC01SF003 05/10/96 (ug/g)	INC01SF004 05/10/96 (ug/g)	Background (µg/g)[(a)]
Metals					
Aluminum	28,400	24,000	NA[(b)]	NA	10,900
Arsenic	7.76	6.86	NA	NA	7.34
Barium	120	96.9	NA	NA	66.0
Beryllium	0.735	0.648	NA	NA	0.43
Boron	11.1	14.5	NA	NA	ND[(c)]
Calcium	2890	2500	NA	NA	639
Chromium	30.8	28.6	NA	NA	15.7
Cobalt	8.66	23.3	NA	NA	3.8
Copper	25.9	24.6	NA	NA	7.70
Iron	32,300	25,700	NA	NA	13,000
Lead	23.3	6.70	NA	NA	21.5
Magnesium	2890	2230	NA	NA	781
Manganese	613	894	NA	NA	316
Mercury	0.298	0.405	NA	NA	ND
Nickel	16.3	11.9	NA	NA	6.54
Potassium	1830	1720	NA	NA	657
Silver	14.0	35.0	NA	NA	ND
Sodium	146	71.8	NA	NA	45.1
Vanadium	47.5	42.4	NA	NA	27.2
Zinc	145	148	NA	NA	20.5
Dioxins/Furans					
2,3,4,6,7,8-Hexachlorodibenzofuran	NA	NA	0.00000097	0.00000257	
2,3,4,7,8-Pentachloro-1,1-biphenyl	NA	NA	0.00000084	0.00000233	

TABLE 6-2

Analytical Results for Surface Soil Samples
Site 1 - Building 185 Incinerator
Jefferson Proving Ground
Madison, Indiana

Analyte	INC01SF001 11/11/92 (ug/g)	INC01SF002 11/11/92 (ug/g)	INC01SF003 05/10/96 (ug/g)	INC01SF004 05/10/96 (ug/g)	Background (µg/g)[(a)]
Dioxins/Furans					
1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	NA	NA	0.0000761	0.000117	
1,2,3,4,6,7,8-Heptachlorodibenzofuran	NA	NA	0.0000118	0.0000354	
1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin	NA	NA	0.00000295	0.00000551	
1,2,3,6,7,8-Hexachlorodibenzofuran	NA	NA	0.00000083	0.00000204	
1,2,3,4,7,8,9-Heptachlorodibenzofuran	NA	NA	0.00000052	0.00000133	
1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin	NA	NA	0.00000327	0.00000338	
1,2,3,4,7,8,-Hexachlorodibenzo-*p*-dioxin	NA	NA	0.00000123	LT [(d)] 0.00000194	
1,2,3,4,7,8-Hexaclorodibenzofuran	NA	NA	0.00000179	0.00000439	
1,2,3,7,8-Pentachlorodibenzo-*p*-dioxin	NA	NA	0.00000113	LT 0.00000197	
1,2,3,7,8-Pentachlorodibenzofuran	NA	NA	0.00000061	0.00000189	
Octachlorodibenzodioxin	NA	NA	0.00507	0.00614	
Octachlorodibenzofuran	NA	NA	LT 0.00000022	0.0000337	
2,3,7,8-Tetrachlorodibenzofuran	NA	NA	LT 0.00000194	0.00000562	

<u>Footnotes</u>:

(a) Micrograms per gram; all values are in µg/g.
(b) Not analyzed.
(c) Not detected.
(d) Less than the reporting limit.

TABLE 6-3

Soil Exposure Point Concentrations of Preliminary Contaminants of Potential Concern
Site 1 - Building 185 Incinerator
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/g)	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[b] (µg/g)
Surface Soil						
Aluminum	2/2	14,000 - 28,400	NA[c]	26,200	NC[d]	28,400
Arsenic	2/2	6.86 - 7.76	NA	7.31	NC	7.76
Barium	2/2	96.9 - 120	NA	108.5	NC	120
Beryllium	2/2	0.648 - 0.735	NA	0.692	NC	0.735
Boron	2/2	11.1 - 14.5	NA	12.8	NC	14.5
Chromium	2/2	28.6 - 30.8	NA	29.7	NC	30.8
Cobalt	2/2	8.66 - 23.3	NA	16.0	NC	23.3
Copper	2/2	24.6 - 25.9	NA	25.3	NC	25.9
Lead	2/2	6.7 - 23.3	NA	15.0	NC	23.3
Manganese	2/2	613 - 894	NA	754	NC	894
Mercury	2/2	0.298 - 0.405	NA	0.352	NC	0.405
Nickel	2/2	11.9 - 16.3	NA	14.1	NC	16.3
Silver	2/2	14.0 - 35.0	NA	24.5	NC	35.0
Vanadium	2/2	42.4 - 47.5	NA	45.0	NC	47.5
Zinc	2/2	145 - 148	NA	146.5	NC	148
Dioxins/Furans	2/2	8.1E-6 - 1.13E-5	NA	9.7E-6	NC	1.13E-5

Footnotes:

(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) The 95% UCL (upper confidence limit of the mean) or the maximum detected value, whichever is lower (USEPA 1989).
(c) Not applicable.
(d) Not calculated due to insufficient data.

TABLE 6-4

Selection of Contaminants of Potential Concern (COPC) in Soil Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 1 - Building 185 Incinerator
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG[a] Screening Data		
Chemical	**Residential PRG (µg/g)[b]**	**Exposure Point Conc. (µg/g)**	**Retained as Soil COPC?**
Surface Soil			
Aluminum	7,667	28,400	**YES**
Arsenic	0.38	7.76	**YES**
Barium	527	120	No
Beryllium	0.143	0.735	**YES**
Boron	586	14.5	No
Chromium	30.1[c]	30.8	**YES**
Cobalt	456	23.3	No
Copper	285	25.9	No
Lead	400[d]	23.3	No
Manganese	318	894	**YES**
Mercury	2.3[e]	0.405	No
Nickel	153	16.3	No
Silver	38.3	35.0	No
Vanadium	53.7	47.5	No
Zinc	2,300	148	No
Dioxins/Furans	3.77E-6	1.13E-5	**YES**

Footnotes:

(a) PRGs were taken directly from the United States Environmental Protection Agency (USEPA) Region 9 PRG Table (USEPA 1998) except as noted. Values for noncarcinogens are 1/10 of the Region 9 PRG.
(b) Micrograms per gram.
(c) Value for chromium VI.
(d) Value for lead is full PRG.
(e) Value for mercuric chloride.

TABLE 6-5

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 1 - Building 185 Incinerator
Jefferson Proving Ground
Madison, Indiana

Chemical	USEPA Region 9 PRG [(a)] Screen		
	Ambient Air PRG ($\mu g/m^3$)[(b)]	Exposure Point Conc. ($\mu g/m^3$)	Retained as Air COPC?
Residential Scenario			
Aluminum	NA[(c)]	3.20E+00	**YES**
Arsenic	4.5E-04	9.70E-04	**YES**
Barium	5.2E-02	1.30E-05	No
Beryllium	8.0E-04	8.87E-05	No
Cadmium	1.1E-03	2.54E-08	No
Chromium	2.3E-05	3.58E-03	**YES**
Lead	1.5E+00[(d)]	1.88E-06	No
Manganese	5.1E-03	1.13E-01	**YES**
Silver	NA	1.04E-03	**YES**
Thallium	NA	5.97E-05	**YES**
Vanadium	NA	9.42E-05	**YES**
Zinc	NA	1.30E-06	**YES**
Dioxins/Furans	4.5E-08	1.14E-09	No
Benzo(a)anthracene	9.2E-03	2.33E-09	No
Benzo(a)pyrene	9.2E-04	5.45E-09	No
Benzo(b)fluoranthene	9.2E-03	1.03E-08	No
DDE	2.0E-02	1.37E-09	No
Dibenz(a,h)anthracene	9.2E-04	2.74E-10	No
Dieldrin	4.2E-04	NA	No
Indeno(1,2,3-cd)pyrene	9.2E-03	1.40E-09	No
1,1-Dichloroethylene	3.8E-02	1.97E-09	No
Chlorobenzene	2.1E+00	3.84E-06	No

Footnotes:
(a) PRGs were taken directly from the United States Environmental Protection Agency (USEPA) Region 9 PRG Table (USEPA 1998). Values for noncarcinogens are 1/10 of the Region 9 PRG.
(b) Micrograms per cubic meter.
(c) Not applicable.
(d) Federal ambient air quality criterion for lead.

TABLE 6-6

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 1 - Building 185 Incinerator
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Chemicals of Concern	Pathway-specific Hazard Index	Noncarcinogenic Chemicals of Concern
	Future On-site Resident Adult			
Incidental ingestion of soil	7.83E-06		0.0587	
Dermal contact with soil	2.13E-06		0.0108	
Ingestion of home-grown fruits/vegetables	1.29E-05	Arsenic (80%)	0.2011	
Ingestion of beef	6.97E-05	2,3,7,8-TCDD (99%)	0.0245	
Ingestion of milk	5.39E-06		0.0329	
Inhalation of VOCs[a] and fugitive dusts	1.27E-05	Chromium VI (100%)	1.5771	Manganese (98%)
Total	1.11E-04		1.9051	
	Future On-site Resident Child			
Incidental ingestion of soil	1.46E-05	Arsenic (87%)	0.5483	
Dermal contact with soil	1.23E-06		0.0312	
Ingestion of home-grown fruits/vegetables	6.42E-06		0.4783	
Ingestion of beef	2.88E-05	2,3,7,8-TCDD (99%)	0.0505	
Ingestion of milk	6.17E-06		0.1884	
Inhalation of VOCs and fugitive dusts	9.54E-06		5.9411	Manganese (98%)
Total	6.68E-05		7.2378	

TABLE 6-6

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 1 - Building 185 Incinerator
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway		Pathway-specific Cancer Risk	Carcinogenic Chemicals of Concern	Pathway-specific Hazard Index	Noncarcinogenic Chemicals of Concern
		Future Off-site Adult Consumer of Beef and Milk			
Ingestion of beef		6.97E-05	2,3,7,8-TCDD (99%)	0.0245	
Ingestion of milk		5.39E-06		0.0329	
	Total	7.51E-05		0.0574	
		Future Off-site Child Consumer of Beef and Milk			
Ingestion of beef		2.88E-05	2,3,7,8-TCDD (99%)	0.0505	
Ingestion of milk		6.17E-06		0.1884	
	Total	3.50E-05		0.2389	

Note:
Numbers in parentheses are the percentages of risk/hazard the contaminant of potential concern (COPC) contributes to the total pathway risk/hazard.

Footnote:
(a) Volatile organic compounds.

TABLE 6-7

Qualitative Uncertainty Analysis
Site 1 - Building 185 Incinerator
Jefferson Proving Ground
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
A. Human Behavior				
Future receptors' exposure duration	30 years	Medium	Medium	National upper-bound time (90th percentile) at one residence
Future receptors' exposure frequency	350 days/year	Medium	Medium	High-end value
Future receptors' exposure time	24 hours/day	Low	High	Maximum possible value
Future receptors' food-chain ingestion rates	NA[a]	Low	High	Nearly impossible for an average weight receptor to ingest daily the 95th percentile U.S. population consumption amounts
Fraction of beef home produced	1.0	Low	High	Maximum possible value
Exclusion of certain exposure pathways in the quantitative analysis	NA	Low	Low	Pathways eliminated are those that have low possibility of contributing risk to these receptors
B. Chemical Fate/Transport in the Environment				
Calculation of exposure point concentration of COPC[b]	Maximum detected value	Low	High	Site average likely to be lower
Use of air dispersion modeling to predict air concentrations	NA	Low	High	Conservative assumptions and input parameters

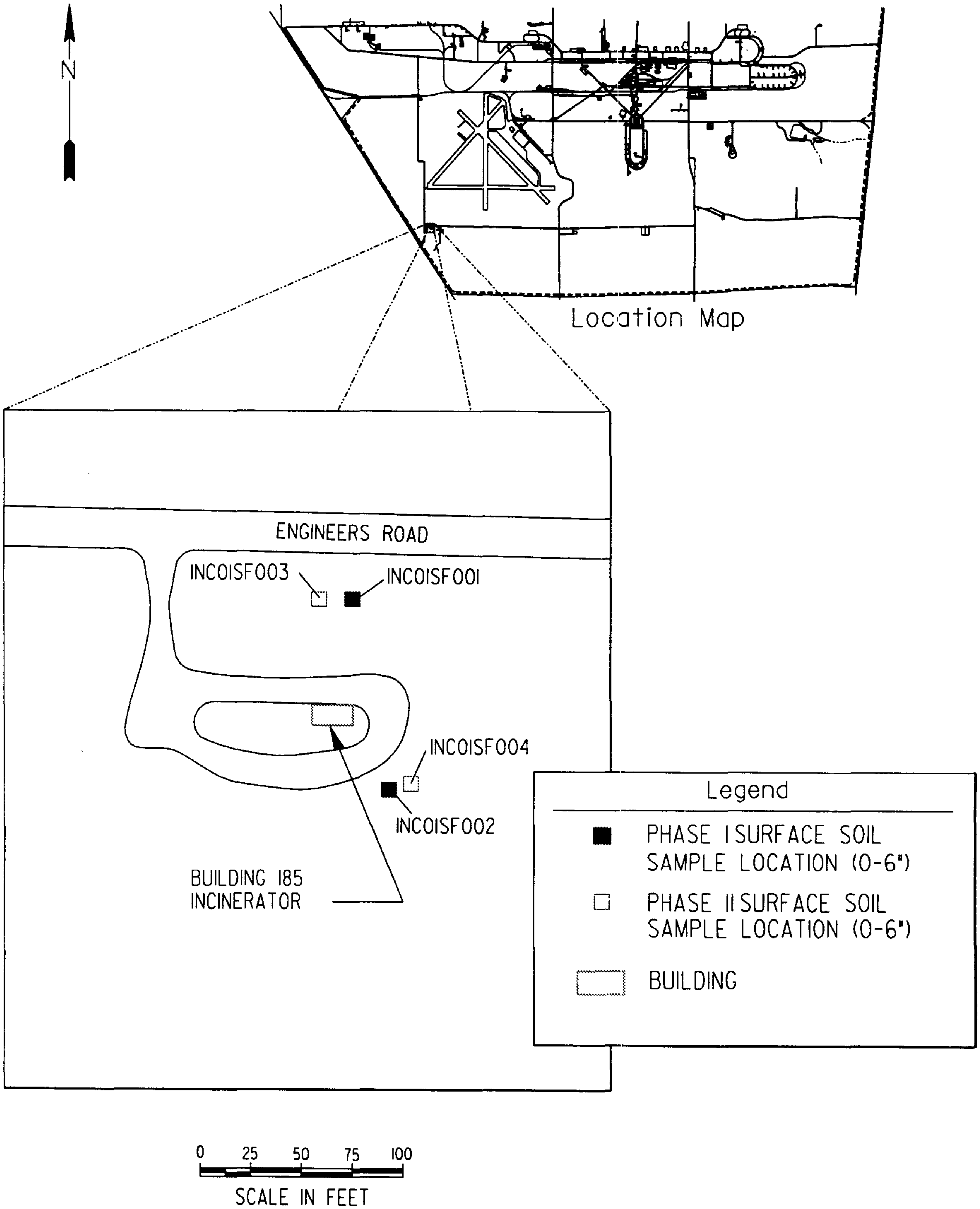
TABLE 6-7

Qualitative Uncertainty Analysis
Site 1 - Building 185 Incinerator
Jefferson Proving Ground
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Overestimation	Comments
C. Chemical Toxicity				
Assumption that USEPA[c] reference doses truly represent toxicological thresholds	Manganese inhalation RfD[d] (1.4E-05 mg/kg-d)	Low	Medium	IRIS[e] value; high degree of conservativeness utilized by USEPA in deriving RfDs from toxicological literature
	Al inhalation RfD (1.4E-03 mg/kg-d)	Low	High	Provisional criterion
Assumption that USEPA carcinogenic slope factors truly represent dose-response phenomena	NA	Low-moderate	Moderate-high	Use of linearized, multi-stage mathematical model to predict cancer incidence at low exposure levels is USEPA policy; not currently supported by scientific data
Assumption of risk/hazard additivity	NA	Moderate	Moderate	Summation of chemical-specific risks/hazards may over- or under-predict risks/hazards to receptors
Screening out of certain contaminants based on USEPA criteria	NA	Low	Low	Chemicals present in concentrations less than Region 9 criteria eliminated
D. Anthropogenic background PCDD/PCDF	NA	NA	NA	Concentrations and pattern of PCDD/PCDF at this site suggest that these contaminants are not site related, but more likely general background contamination to the facility.

Footnotes:
- (a) Not applicable.
- (b) Contaminant of potential concern.
- (c) United States Environmental Protection Agency.
- (d) Reference dose.
- (e) Integrated Risk Information System.

FIGURES



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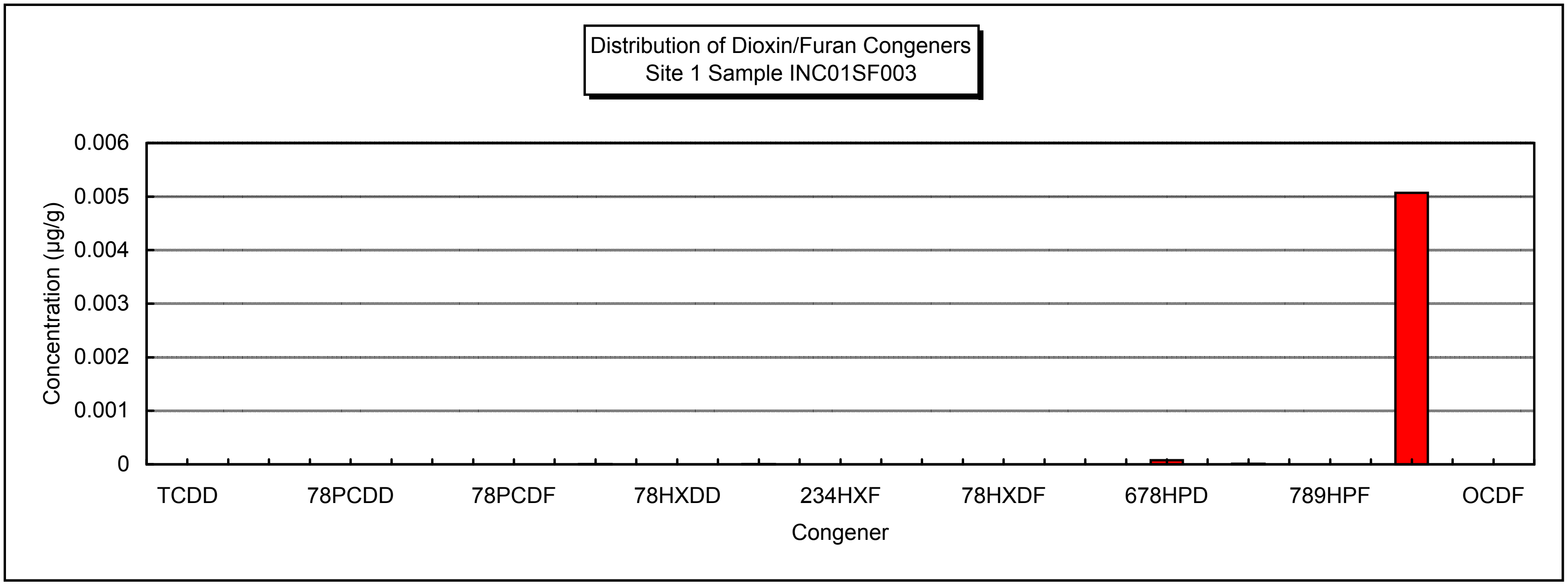
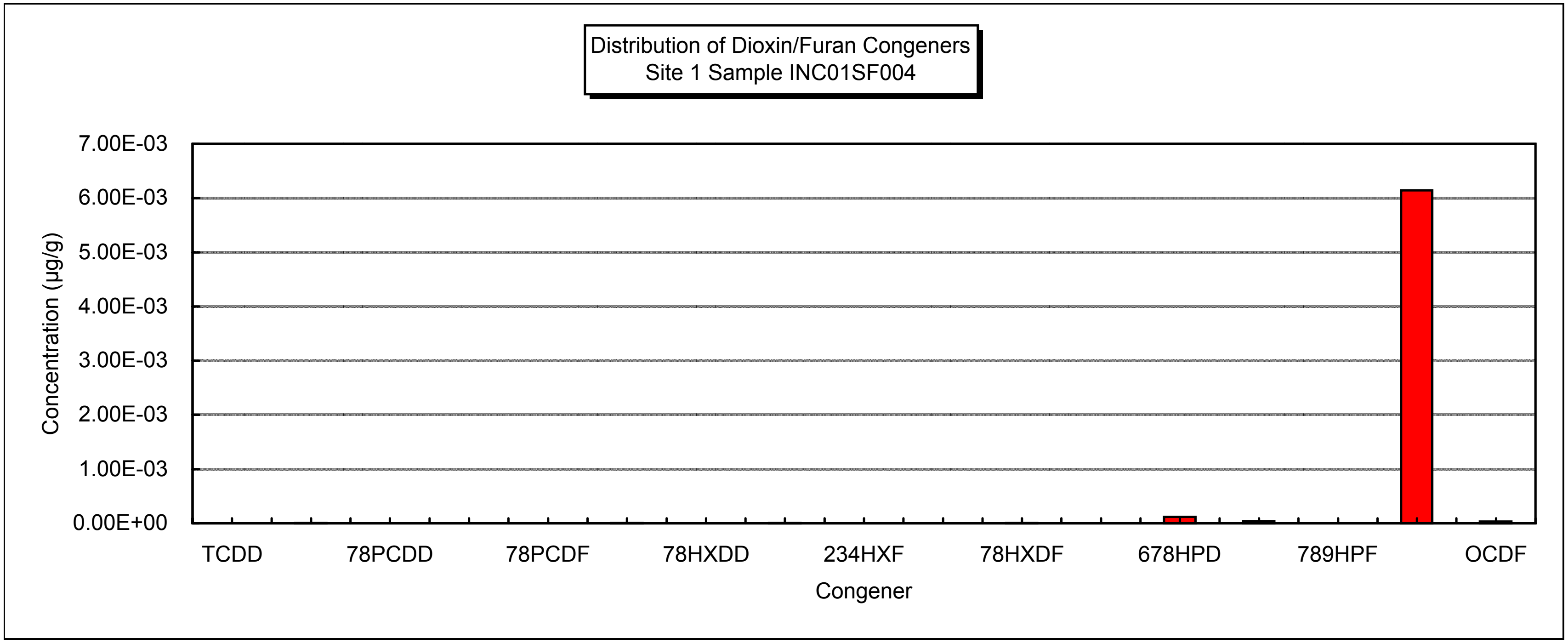
REVISED: 9-28-99 ILOCAT.DGN

Figure 6-1. Sampling Locations at the Building 185 Incinerator (Site 1)

Figure 6-2 Distribution of Dioxin/Furan Congeners at Building 185 Incinerator (Site 1)





N:/jobs/244/0025/01/wp/figure/Fig6-2.xls

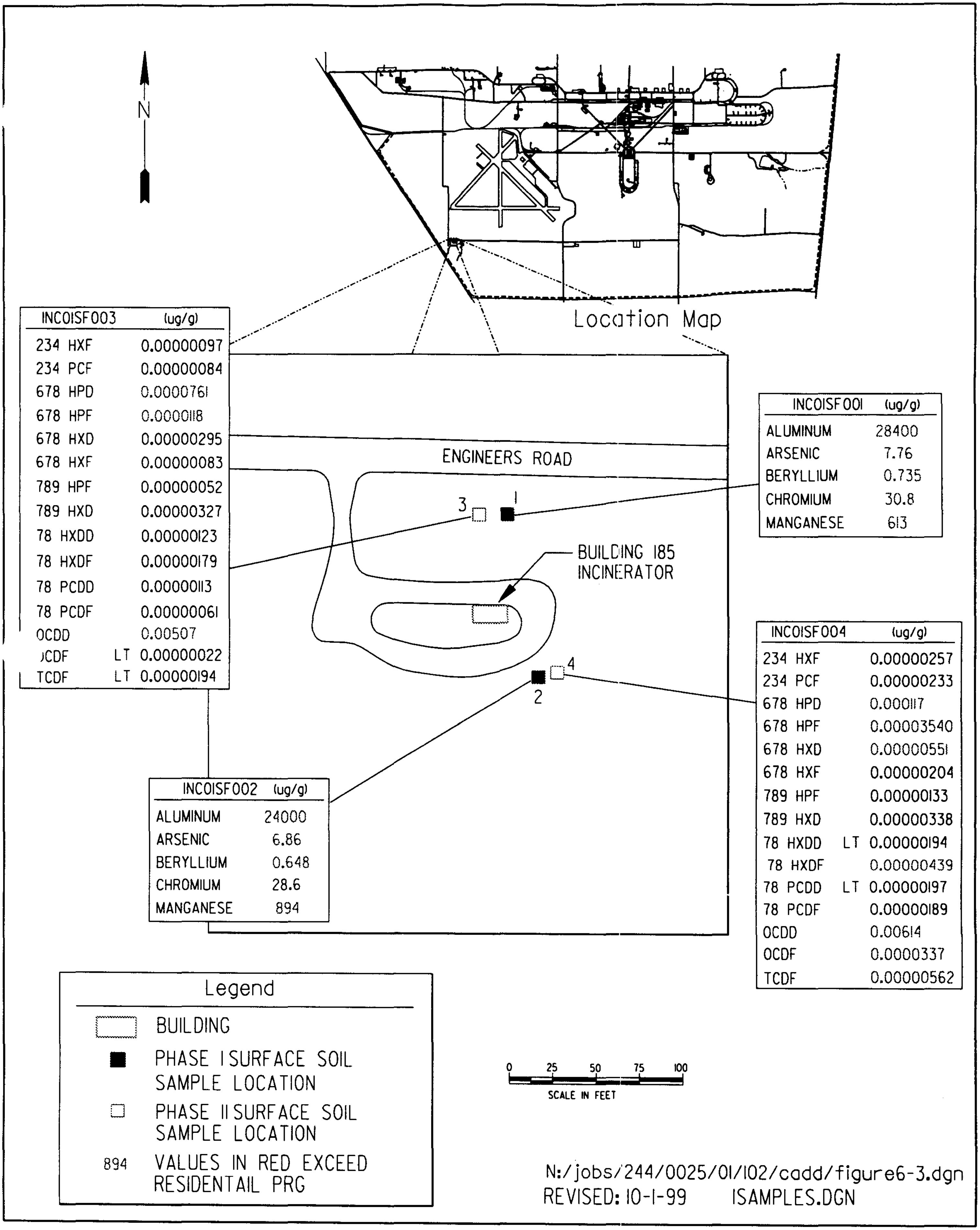


Figure 6-3. Summary of Contaminants Exceeding Background & Regulatory Risk-Based Concentrations, Building 185 Incinerator (Site 1)

7.0 SEWAGE TREATMENT PLANT (SITE 2) AND SEWAGE SLUDGE APPLICATION AREAS (SITE 27)

7.1 SITE CHARACTERISTICS

The Sewage Treatment Plant (STP) and the Sewage Sludge Application Areas (SSAs) are located adjacent to one another in the southwestern corner of JPG near the intersection of Engineers Road and Tokyo Road (Figure ~~7-1~~2-1). The flat to gently rolling land surface slopes to the southeast toward Harberts Creek a few hundred feet away (Figure ~~2-1~~7-1). The area immediately surrounding the STP is currently under cultivation, including tobacco and soybeans. There are no trees or shrubs within 200 feet of the STP. Four former SSAs, shown in Figure 7-~~2~~1, were identified by facilities personnel. Prior to being placed under cultivation, these areas were grass covered and were sometimes included in a spring open area burning program. The two larger SSAs are bounded on one side by dense woods. The soils in this area belong to the Rossmoyne soil series. The depth to bedrock is estimated to be less than 15 feet. The bedrock can be observed outcropping in the stream bottom of nearby Harberts Creek and based on fossil evidence, it appears to be the Jeffersonville Limestone of Devonian age.

The STP building covers an area of approximately 682 square feet with a capacity to process approximately 280,000 gallons of wastewater per day. The pumping station is located in the basement of Building 177. The treatment facility consists of a settling tank (Imhoff tank), sludge-drying beds, and a trickling filter system, wherein the processed water is recirculated several times prior to discharge to an NPDES-permitted outfall into Harberts Creek. The sanitary sewer lines leading to the plant have undergone significant repair and replacement, beginning in 1978 after an NPDES inspection of the STP in March 1975 revealed that wet weather inflow to the plant was up to four times greater than base flow. The problem was identified as storm water infiltration of precipitation into the vitreous clay pipes, and replacement of 28,000 feet of sewer pipe by the summer of 1989 had apparently mitigated the problem.

Currently, the majority of the wastewater is domestic sewage from privately leased buildings, which are predominantly used for residential, light industrial, and storage activities. Prior to facility closure in 1995, boiler blowdown water, rinses from Building 208 (photographic laboratory), and water from the Building 186 oil/water separator were also treated at the plant. The rinses from the photographic laboratory consisted of photographic wastes (approximately 170 gallons per day), which, before 1980, contained bleaches, silver, and cyanides. Some of the chemicals from the film processing unit were potentially toxic to the trickling filter organisms, as evidenced by infrequent partial kills to these organisms reported in the 1970s. Consequently, the photographic developing process was changed in 1980. The new process was designed to eliminate the use of bleaches and cyanides, and included a recovery unit where silver was reclaimed. The silver recovery unit, however, may not have completely removed ~~all of~~ the silver from the waste stream. ~~As a result, the sewage sludge was contaminated by silver as evidenced by RI sampling results.~~ No estimates were available on

the amount of industrial wastewater input from the Building 186 oil/water separator. Boiler blowdown water was also discharged to the sanitary sewer system. The boiler effluent was softened by the addition of sodium hydroxide (NaOH), tannin, and cyclohexylamine.

Historically, the sludge from the Imhoff tank was pumped to a drying bed constructed of concrete walls and sand floors. This sludge was routinely sampled prior to disposal, and laboratory results for EP toxicity silver were shown not to exceed 5.0 ppm (Mason and Hanger 1992). The area under these drying beds may contain contaminants that originated from the photographic laboratory prior to 1980. Historically, sludge from the ~~waste-water~~wastewater treatment plant was reportedly disposed ~~of~~ on a "clay bank" south of the Building 185 Incinerator (Site 1). Sludge was also reportedly spread on fields within the installation although facilities personnel were unable to pinpoint ~~any~~ sludge disposal areas other than those in the immediate vicinity of the sewage treatment plant. Sludge was reportedly stockpiled just east of the sludge-drying beds prior to disposal. These areas of sludge storage and disposal may have resulted in the contamination of soils with contaminants such as silver and cyanide. PCBs were also considered a potential contaminant at the sludge disposal areas because of their presence in sewage sludge at older treatment plants.

The STP site also includes the Water Quality Laboratory, which has been used for testing water quality at the STP since the 1960s. The laboratory, located on the first floor of Building 177 (Figure 7-1), generates small quantities of spent chemicals resulting from conducting laboratory analyses. Reportedly, chemicals from the laboratory were properly stored, handled, and disposed ~~of~~ according to standard operating procedures~~. However, past chemical disposal practices may have been uncontrolled~~. The ~~exact nature and quantity of chemicals released to the environment in the past are unknown, but the~~ amount of spent chemicals generated during laboratory analyses is thought to be small. A satellite accumulation area in the form of a small steel storage cabinet located outside on the western side of Building 177 was being used to store the laboratory wastes at the time of the RI. The materials stored inside of the cabinet were not identified. Visible staining was apparent on the concrete beneath the cabinet but did not appear to extend to nearby soil.

At the time of the Phase I RI, activities at the STP and the sewage sludge application areas were limited to one employee who worked at the water quality laboratory in Building 177 and maintenance personnel who gained intermittent access working on the STP. Hunters also accessed the area during the spring and fall. There is an archery range south of the STP between the sludge drying beds and Harberts Creek, but it did not appear to have been used frequently. Currently, the area is primarily accessed by farm workers during planting, cultivating, and harvesting of crops in the area surrounding the STP.

7.2 PREVIOUS INVESTIGATIONS

The STP is listed in the *Enhanced PA Report* (Ebasco 1990a) as SWMU 3. Routine monitoring data from previous sampling of the NPDES-permitted outfall and analyses of sewage sludge prior to off-site disposal indicate that the outfall and sludge have not contained significant concentrations of chemical contaminants. Also, no evidence exists that would indicate that the previous disposal practices at the Water Quality Laboratory resulted in significant risk to human health and the environment. Results of an USEPA *Environmental Audit* (USEPA 1990) indicated that no further investigations were required for the Water Quality Laboratory.

Routine laboratory analysis was required under the NPDES permit for the sewage-treatment facility. Effluent exceeded maximum limitations for total suspended solids several times in the past, and fecal-coliform limits were also exceeded. Analyses for EP toxicity heavy metals indicate that effluent metal concentrations have not exceeded water-quality standards. However, untreated water entering Harberts Creek during periods of bypass may have resulted in the release of contaminants to the surface-water pathway. The estimated amount and frequency of untreated wastewater discharge, if any, are unknown.

There were no identified previous data concerning possible wastes contained in the sludge-application areas; however, water and sediment samples ~~taken~~ collected from Harberts Creek in January of 1992 near the STP outfall revealed detectable concentrations of silver in the water and sediments. The silver was later confirmed in samples collected by the U.S. Army Environmental Hygiene Agency (USAEHA 1992, USAEHA 1993). The source of the silver was traced to the photographic processing laboratory by the USAEHA. This source was significantly reduced by changing the processing of discharge water from the photographic laboratory prior to entering the sewage treatment plant (USAEHA 1993). ~~All p~~Photographic processing had been discontinued prior to the closure of the facility in 1995.

Two additional incidents occurred at the Sewage Treatment Plant (Site 2) and the Sewage Sludge Application Area (Site 27). Mercury contamination was discovered and removed at Site 2 in 1996. Also, planting and harvesting tobacco occurred on Sites 2 and 27 in 1997. Subsequently, a Commissioner's Order was issued by IDEM in October to prevent moving the tobacco until adequate testing was performed to assess contaminant uptake by the plants. IDEM discovered that the plants had assimilated heavy metals, and the plants were disposed in an environmentally safe and lawful manner in April 1998. IDEM considered the Commissioner's Order to be satisfied (IN13).

7.3 STUDY AREA INVESTIGATIONS

7.3.1 Phase I RI Field Activities

7.3.1.1 Sewage Treatment Plant.

7.3.1.1.1 Surface Soils. Two soil samples (STP1 and STP2) were collected during Phase I of the RI from the surface next to the concrete where the satellite accumulation cabinet was located (Figure 7-2). These samples were analyzed for metals, SVOCs, and TPH.

7.3.1.1.2 Stream Surface Waters and Sediments. Three downstream (SD03 to SD05) and two upstream (SD01 and SD02) samples of sediment were collected from Harberts Creek during Phase I of the RI (Figure 7-1). The sample locations were spaced about 50 feet apart with the first upstream and downstream samples being located 50 feet from the sewage-treatment-plant outfall (see Figure 7-1). Upstream samples were collected to determine if the contaminants in the sediments (if any) were related to the wastewater discharge or to other upstream sources. Also, since discharged waste from the laboratory passes through the STP, sediment samples collected below the plant's outfall (downstream) also provided information on the Water Quality Laboratory discharge. Sediment samples were collected as grab samples from 0 to 6 inches in depth. ~~All s~~Sediment samples collected from Harberts Creek were analyzed for metals, cyanide, and TPH. Two surface-water samples were also collected, one upstream (SW01) and one downstream (SW02) of the STP outfall. These stream water samples were analyzed for anions and metals (total and filtered). At the time of sediment sampling, in November 1992, the reach of Harberts Creek where the samples were collected appeared to be relatively undisturbed; however, by the time the stream water samples were collected in June 1993, the stream channel had been straightened and the banks cleared of vegetation.

7.3.1.2 Sewage Sludge Application Area.

7.3.1.2.1 Surface Soils. Based on evaluation of reported historical information pertaining to sludge disposal locations, 4 specific areas where sludge storage or disposal may have occurred were identified and 12 surface-soil samples (SF001-SF003, SF004-SF008, SF009-SF010, SF011-SF012) were ~~taken~~ collected and analyzed for metals and cyanide as shown in Figure 7-2. In addition, four composite samples (one from each application area) were collected and analyzed for PCB/pesticides (surface-soil samples SF013 through SF016). Site personnel interviewed during the investigation were unable to provide information on the amount and frequency of sludge application or of untreated wastewater discharged. Maintenance records and NPDES permit files provided little pertinent information. No additional information about the frequency and amount of untreated releases, if any, was available.

7.3.2 Phase II RI Field Activities

7.3.2.1 Sewage Treatment Plant.

7.3.2.1.1 Surface Soils. Because some of the Phase I SVOC data from Site 2 were suspect (due to non-detected calibration standards during analyses), an additional surface soil sample (STP3) was collected during Phase II and analyzed for SVOCs to confirm the presence or absence of these compounds (see Figure ~~3-12~~7-2). ~~Since~~ Because there was no evidence of a significant contaminant release at Site 2 based on Phase I results, no soil borings or groundwater samples were determined to be required.

7.3.2.1.2 Stream Surface Waters and Sediments. No surface water or sediment samples were collected from Harberts Creek during Phase II of the RI.

7.3.2.2 Sewage Sludge Application Area.

7.3.2.2.1 Surface Soils. During Phase II, a 100-foot grid over a 600-by-600-foot area was established at Site 27 and 20 grid points (SF17 to SF36) were randomly selected for collection of surface soils for metals analysis to determine the horizontal extent of metals contamination (Figure 7-2).

7.3.2.2.2 Subsurface Soils. Also during Phase II of the RI, ~~soil borings~~ four soil borings (BH-A to BH-D) were drilled at ~~four previous~~Phase I surface sample locations (SF03, SF06, SF09, and SF12; respectively) ~~of~~where metals contamination was detected (see Figure 7-2).~~, and s~~ Soil samples were scheduled to be collected at depths of 2, 5, and 10 feet and analyzed for metals to determine the vertical extent of metals contamination. However, in two of the soil borings, bedrock was encountered prior to reaching the 10-foot depth and only the 2- and 5-foot samples were collected.

7.4 DATA EVALUATION

7.4.1 Data Validation Results

Surface soil samples from Site 2 were analyzed for metals, SVOCs, and TPH during Phase I, and a surface soil sample was only analyzed for SVOCs ~~only~~ during Phase II. In addition, sediment and surface water samples were analyzed for metals, TPH, and cyanide during Phase I only.

Surface~~ and subsurface~~ soil samples from Site 27 were analyzed for metals and cyanide during Phase I, and surface~~/~~ and subsurface soil samples were only analyzed for metals ~~only~~ during Phase II. In addition, surface soil composite samples were analyzed for pesticides/PCBs during Phase I only.

During Phase II, one surface sample (STP3) collected at Site 2 was analyzed for SVOCs to fill a potential data gap in the Phase I data.

7.4.1.1 Blank Assessment. The USEPA has determined that when blank contamination exists, the investigative results must exceed the blank result by a factor of 5 (all compounds) or 10 (common laboratory contaminants such as acetone) in order to be considered positive. Several SVOCs and metals were detected in blanks associated with Site 2 and Site 27 samples. Based on comparisons to blanks, select positive results were changed to nondetects ("U"). The associated sample quantitation limit became either the concentration detected in the sample, if the detected value was above the quantitation limit, or the quantitation limit, if detected results were less than the quantitation limit. Samples qualified nondetected were not listed in the validation report during Phase I; however, Phase I soil, sediment, and surface water only were listed in the database. Phase II samples were listed in the validation report and in the database.

During Phase I the following results were qualified nondetected:

- Surface Soil
  - Beryllium - STP02SF002
  - Boron - SSA27SF002 and -04
  - Cadmium - SSA27SF001, -02, -03, -04, -06, -07, -08, -09, -10, -11, and -12
  - Cyanide - SSA27SF001, -04, -05, -06, -07, -08, -09, -11, and -12
  - Mercury - SSA27SF001, -07, -08, -09, and -12
  - Sodium - SSA27SF002, -03, -06, and -07
  - TPH - STP02SF001
  - 2,2 bis(para-chlorophenyl)-1,1-dichloroethane - SSA27SF013, -15, -16, and -16dup
  - Dieldrin - SSA27SF016 and -16dup
  - Endrin - SSA27SF015, -16 and -16dup

- Sediment
  - Boron - STP02SD001, -02, -04, and -05
  - Potassium - SSA27SD001 and -02

During Phase II the following results were qualified nondetected:

- Phase II Surface Soil
  - Antimony - SSA27SF021, -24, -25, -29, and -30
  - Beryllium - SSA27SF017, -18, -19 , -23, -29, -30, -32, and -34
  - Boron - SSA27SF021, -25, -26 -27, -28, -31, and -35
  - Cadmium - SSA27SF017, -19, -22, -23, -24, -29, -30, -32, -33, and -34
  - Copper - SSA27SF026, -27, -28, and -35
  - Mercury - SSA27SF017, -23, -29, -30, -32, -33, -34, and -36
  - Molybdenum - SSA27SF017, -19, and -29
  - Nickel - SSA27SF032
  - Potassium - SSA27SF032

  - Selenium - SSA27SF017, -20, -22, -23, -29, -30, -33, and -36
  - Sodium - SSA27SF028 and -31
  - Tin - SSA27SF017, -18, -19, -23, -30, -32, -33, -34, and -36
  - Di-n-butylphthalate - STP02SF003

- Phase II Subsurface Soil
  - Beryllium - SSA27BHA01, -02, -03, -B01, -02, -C01, -02, -D01, -02, and -03
  - Cadmium - SSA27BHA03, -B01, -02, -C02, -D02, and -03
  - Chromium - SSA27BHA02, -03, -B01, -02, and -C02
  - Cobalt - SSA27BHA01, -02, -03, -B01 -02, -C01, -02, -D01, -02, and -03
  - Mercury - SSA27BHA01, -02, -03, -B01, -02, -C01, -02, -D01, -02, and -03
  - Nickel - SSA27BHA01, -02, -03, -B01, -02, -C01, -02, -D01, -02, and -03
  - Potassium - SSA27BHA01, -02, -03, -B01, -02, -C01, -02, -D01, -02, and -03
  - Selenium - SSA27BHA02
  - Tin - SSA27BHA01, -02, -03, -B01, -02, -C01, -02, -D01, and -02

7.4.1.2 Rejected Results. Results for soil antimony (Site 27) and several SVOCs, including all PCBs, were rejected during Phase I. The rejected antimony results were due to poor MS/MSD recoveries. Several parameters included in the SVOC list were rejected because of calibration problems. Due to these problems, all SVOC analyses were subjected to the Tier 2 validation. The Phase I SVOC results were not used for the risk assessment other than for qualitative information. In general, the following concerns were noted:

- All results for Phase I (**EPA31**) PCB compounds and toxaphene were rejected because they were not included in the calibration standard.

- Other low responses were noted for numerous SVOC compounds; however, qualifiers were not assigned unless other calibration information was also unacceptable.

- Pesticides in soil had an elevated CRL (above the Region 5 DQL) because of calibration problems.

For Phase II data, only one SVOC compound (kepone) was rejected due to low response in the calibration in the analytical batch. **(EPA31)** Non-target (unknown) SVOC compounds were rejected in the analysis due to blank contamination. The rejected data were not included in the database used for the risk assessment. The remaining results for metals, SVOCs, PCBs, and pesticides were determined to be acceptable for use in the risk assessment.

The following list identifies rejected Phase I/II sample results. Results are not listed below if a reanalysis provided acceptable data for the same sample. For example, the composite surface soil samples (SSA27SF013 to –016) from each of the sewage sludge application areas had sufficient sample to reanalyze and produce acceptable results for PCBs and pesticides. (EPA31)

- Phase I Surface Soil

- Antimony - SSA27SF001, -02, -03, -04, -05, -06, -07, -08, -09, -10, -11, and -12
- 2,4-Dinitrophenol - STP02SF001 and -02
- 4,6-Dinitro-2-cresol - STP02SF001 and -02
- 4-Chloroaniline - STP02SF001 and -02
- Atrazine - STP02SF001 and -02
- beta-Endosulfan - STP02SF001 and -02
- PCBs (1016, 1221, 1232, 1242, 1248, 1254, 1260, and 1262) - STP02SF001 and -02
- Toxaphene—STP02SF001 and -02

• Phase II Surface Soil
  - Kepone - STP02SF003

7.4.1.3 Evaluation of Non-Detected Values. A comparison was made between the USEPA Region 5 DQLs and the project CRLs for chemicals that were analyzed for but not detected in environmental media at this site. Exceedances for antimony and thallium were noted for surface water samples. No other exceedances were identified.

7.4.2 Data Quality Summary

Positive results were changed to nondetects ("U") for several metals analyzed during Phase I and Phase II. In particular, soil beryllium, cadmium, mercury, selenium, and tin results were affected by blank contamination. Most of the detections in the affected samples were below quantitation limits and/or the original detected values were below Region 9 PRGs. The exception is beryllium; most of the beryllium subsurface soil detections were changed to nondetections due to blank contamination, and ~~all of~~ these nondetections exceed the Region 9 soil PRG. Therefore, beryllium contamination is not well characterized in subsurface soil. In surface soil there are sufficient valid beryllium detections to characterize surface contamination with this metal. Many of the Phase I surface soil antimony results were rejected. Additionally, some of the Phase II antimony results were changed to nondetections because of blank contamination. However, the Phase II antimony nondetections were below the Region 9 PRG. Therefore, blank contamination and rejected data do not substantially affect the risk assessment conclusions.

In summary, the number of samples, the comprehensiveness ~~of the~~of the parameter list, and the quality of the data (with the exception of beryllium in subsurface soil) are adequate to characterize the nature and magnitude of soil contamination at the exposure area addressed in the risk assessment.

7.4.3 Background Screening

7.4.3.1 Surface Soil - Sites 2 and 27. Because these two sites are evaluated separately in selected future land use scenarios, the samples taken at the Sewage Treatment Plant were separated from the samples collected at the Sewage Sludge Application Areas for the background screening.

A review of the surface soil database for the Sewage Sludge Application Areas revealed what appeared to be an ~~distinct hot spot or~~ area of much higher metals contamination. ~~with metals.~~ As a result, Site 27 was divided into two areas of concern: the southwest corner (9 samples: SSA27SF001, -002, -003, -024, -025, -027, -028, -031, and -035) and the remainder of the site (the remaining 23 surface soil samples). The southwest corner consists of ~~all~~ the samples collected within the 200-foot corner grid, which appeared to have the highest concentrations of inorganic contaminants.

The background screening protocol is described in Section 5.1.4.5. There were sufficient samples at these sites to include the t-test and the Mann-Whitney statistical tests, as appropriate, as background screening methods. The results of the background screening for the three areas of concern at Sites 2 and 27 are presented in Table 7-1. Since not all surface samples were analyzed for metals, the number of samples within each area of concern in the background evaluation does not equal the total number of samples collected. Site inorganic data were compared to background inorganic data from the Rossmoyne soil series. Metals exceeding background in surface soil at Site 2 (Sewage Treatment Plant) include aluminum, arsenic, barium, beryllium, boron, chromium, cobalt, copper, lead, manganese, mercury, nickel, silver, vanadium, and zinc. The following metals exceeded background in the southwest corner of Site 27: aluminum, arsenic, barium, beryllium, boron, chromium, cobalt, copper, manganese, mercury, molybdenum, nickel, selenium, silver, thallium, tin, vanadium, and zinc. In the remainder of the site surface soil, all inorganics detected were above background.

7.4.3.2 Subsurface Soil - Sites 2 and 27. The subsurface analytical data were grouped to be consistent with the designated areas of concern for surface soil. No subsurface samples were collected at the Sewage Treatment Plant. Three subsurface samples comprise the database for the southwest corner: SSA27BHA01, -A02, and -A03. The following metals were above background in subsurface soil in the southwest corner (see Table 7-1): aluminum, arsenic, barium, chromium, copper, lead, manganese, silver, thallium, vanadium, and zinc. Samples SSA27BHB01 and -02; SSA27BHC01 and -02; and SSA27BHD01, -02, and -03 comprise the database for subsurface soil in the remainder of the site. Aluminum, arsenic, barium, boron, cobalt, copper, manganese, mercury, nickel, silver, thallium, tin, vanadium, and zinc were above background in these soil samples (see Table 7-1).

7.4.3.3 Sediment - Harberts Creek. The methodology used to establish sediment background is described in Section ~~5.1.4.5~~5.1.4.5.2. The only inorganic constituent detected in both background sediment and Harberts Creek sediment is arsenic. Harberts Creek arsenic data were compared to background arsenic using the t-test, which indicated that arsenic is

present in the creek at levels above background (Table 7-2). Arsenic and ~~all~~ other metals detected in Harberts Creek sediment (aluminum, barium, beryllium, boron, chromium, cobalt, copper, lead, magnesium, manganese, nickel, silver, vanadium, and zinc) are ~~therefore~~ retained as preliminary sediment COPCs for the risk assessment.

7.4.3.4 Surface Water - Harberts Creek. The methodology used to establish surface water background is described in Section ~~5.1.4.5~~5.1.4.5.2. The only inorganic constituent detected in both background surface water and Harberts Creek surface water is silver. Because there were only two surface water samples collected from Harberts Creek, the maximum detected value for silver was compared to the calculated surface water background screening value. As shown in Table 7-3, the maximum detected value for silver exceeds the background screening value. Therefore, silver and ~~all~~ other metals detected in Harberts Creek surface water (barium and manganese) are retained as preliminary surface water COPCs for the risk assessment.

7.4.4 Summary of Analytical Results

The summary of analytical results for metals in soil samples from Sites 2 and 27 are presented in Table 7-4. A ~~complete~~ comprehensive listing of ~~all~~ analyte results, including nondetected and below reporting limit analytes, is presented in Appendix N.

7.5 NATURE AND EXTENT OF CONTAMINATION

7.5.1 Surface Soils

Evaluation of the analytical results for samples collected from Phase I and Phase II field investigations reveals that silver concentrations in surface soils are elevated above background levels in 32 of 38 samples. The concentrations range from 0.015 to 210 µg/g, but none of the samples exceeded the USEPA Region 9 criteria ~~of 380 µg/g~~ for silver. The source of the elevated silver is thought to be discharges of photographic laboratory wastes to the sewage plant prior to 1980, which resulted in the contamination of the sewage sludge. The sludge was subsequently spread on the ground surface in several areas adjacent to the sewage treatment plant. Another potential source of silver contaminants is the burning of film and/or photographic chemicals in the nearby incinerator, since silver was also found in soils adjacent to the incinerator (Site 1).

There are a variety of other metals detected in the 38 surface soil and sediment samples collected in the SSAs and water quality laboratory satellite accumulation area that exceed their respective background concentrations (Table 7-4). These include aluminum (29 samples), antimony (1 sample), arsenic (14 samples), barium (30 samples), beryllium (26 samples), boron (23 samples), cadmium (6 samples), chromium (33 samples), cobalt (32 samples), copper (30 samples), lead (29 samples), manganese (30 samples), mercury (22 samples), molybdenum (3 samples), nickel (33 samples), selenium (4 samples), thallium (15 samples), tin (4 samples), vanadium (30 samples), and zinc (33 samples).

Elevated arsenic concentrations previously noted in stream sediments (Rust E&I 1992) were determined to be consistent with background conditions common for the area. The Phase I and Phase II RI soil samples had 14 of 38 samples with arsenic that exceeded background levels; concentrations ranged from 9.32 to 72.7 ug/g. ~~It should be noted, h~~ However, ~~that~~ all 38 surface soil samples contained arsenic above USEPA Region 9 criteria, indicating that naturally high background conditions for arsenic exist in surface soils throughout the JPG area. This is further supported by the background arsenic levels established for each of the three major soil types. The background values of 7.34, 9.26, and 6.3 µg/g for the Rossmoyne, Cobbsfork, and Avonburg soils, respectively, also exceed USEPA Region 9 criteria for carcinogenic risk.

Beryllium and manganese were also commonly detected above background concentrations and found to exceed USEPA Region 9 criteria. Beryllium exceeded background concentrations in 26 of 38 samples, ranging from 0.594 to 6.15 µg/g. It should be noted that the three background values for beryllium of 0.43, 0.52, and 0.48 for Rossmoyne, Cobbsfork, and Avonburg soils, respectively, also exceed the USEPA Region 9 value. ~~of 0.14 µg/g.~~ Manganese was reported in above-background concentrations in 31 of 38 samples, ranging from 401 to 13,000 µg/g. These samples also exceeded the USEPA Region 9 PRG ~~of 318 µg/g~~ for manganese.

Another metal found to exceed USEPA Region 9 criteria in addition to exceeding background concentrations is lead (1 sample at 600 µg/g). It should be noted that the maximum concentrations for antimony (3.19 µg/g), barium (1,650 µg/g), boron (408 µg/g), chromium (73 µg/g), and vanadium (128 µg/g) were found in the sample SSA27SF022. This sample also had the maximum concentrations for aluminum (43,800 µg/g), arsenic (72.7 µg/g), beryllium (6.15 µg/g), copper (74.2 µg/g), molybdenum (10.9 µg/g), and thallium (4.9 µ/g). ~~It appears that this location is a "hot spot" and should be considered for interim cleanup.~~ Sample SSA27SF024 also had similar elevated concentrations of the above-listed metals, ~~indicating a possible second "hot spot" area~~ located approximately 300 feet southwest of sample location SSA27SF022 (Figure 7-~~2~~3). (IN14)

Cyanide was detected in 3 of the 12 Phase I surface soil samples from the SSAs. Because it was not consistently detected, the extent of residual cyanide in these areas is not considered significant. The cyanide concentrations were all less than 4 µg/g, which is ~~significantly~~ less than the USEPA Region 9 criterion ~~of 130 µg/g~~ used for COPC selection.

During Phase I, four composite samples (one from each application area) were collected and analyzed for PCB/pesticides (surface-soil samples SSA27SF013 through -16). PCBs were not detected in the SSAs; however, the pesticides endrin, dieldrin, and PPDDT (found in sample SSA27SF014 only) were detected in samples SSA27SF013 and -14 at low levels well below the corresponding USEPA Region 9 criteria (Table 7-5). The only other contamination detected was associated with one of the soil samples collected near the satellite accumulation area behind the water quality laboratory at the Sewage Treatment Plant (Site 2). This sample contained 90 ppm of TPH and 0.28 ppm of DDD, a breakdown product of the pesticide DDT.

The TPH concentration did not exceed the state action level criterion of 100 ppm, and the DDD concentration did not exceed the EPA Region 9 PRG. An additional sample (STP3) was also collected during Phase II at this location for SVOC analysis. No SVOCs were detected in the Phase II sample. (EPA31 and 32)

Figure 7-3 shows sample locations with contaminants that exceed both background and regulatory risk-based concentrations in 1998.

7.5.2 Subsurface Soils

During the Phase II investigation, four soil borings (borings A, B, C, and D in Figure ~~7-3~~7-2) were drilled within four of the reported SSAs to help determine the vertical extent of metals contamination. These borings were located in the SSAs that were found to contain the highest levels of metals contamination during Phase I surface soil sampling. Borings were drilled to a maximum depth of 10 feet with samples for metals analysis collected at depths of approximately 2, 5, and 10 feet.

A review of the analytical results (see Table 7-~~1~~4) for the four soil borings indicates that there is not a distinct trend of decreasing or increasing contamination with depth. In general, however, many metals were shown to actually increase with depth, indicating potential vertical migration of metals from the surface, or possibly variations of metals concentrations with changes in lithology, or both. A review of the ~~lithologic logs from the~~ soil boring logs (Appendix E) shows that the increasing metals content likely corresponds to increasing clay content of the soils.

Boring A had higher clay content in the 2- and 10-foot samples than in the 5-foot sample. Boring B had fairly consistent lithology from the surface to bedrock. Boring C had higher clay content in the 5-foot sample than in the 2-foot sample. Bedrock was encountered in this boring, and samples were collected at 6.7 and 10 feet. Boring D had the highest clay content in the 10-foot sample. In most cases, the highest metals concentrations were found in the soils with the highest clay content.~~, indicating that adsorption processes are occurring in the subsurface soils.~~

Aluminum, arsenic, beryllium, chromium, manganese, silver, and thallium were detected at concentrations exceeding USEPA Region 9 criteria. However, it should be noted that arsenic and beryllium also exceed USEPA criteria in background samples and the concentrations in subsurface soils are consistent with background levels. Manganese was present at a concentration of 3,950 µg/g at a depth of 5 feet in Boring A. Results for soils above and below this interval were found to be well below this concentration.

7.5.3 Sediments

Many of the same metals detected in the surface-soil samples at concentrations greater than their background values were also detected in the stream sediments from Harberts Creek (Figure 7-4). These metals include arsenic, barium, beryllium, cobalt, chromium, copper, manganese, nickel, silver, vanadium, and zinc (Table 7-6). The silver concentrations reported for the three sediment samples (SD03 to SD05) ~~taken~~ collected downstream of the sewage treatment plant outfall into Harberts Creek were greater than the concentrations reported for the two upstream samples (SD01 and SD02) by a factor ranging from 3 to 43 times. This indicates that silver related to the film process wastewater from the former photographic laboratory was deposited in the stream sediments downstream of the outfall (Figure 7-1). None of the silver concentrations, however, exceeded USEPA Region 9 criteria.

Elevated arsenic concentrations were detected in sediment samples from Harberts Creek. Concentrations similar in magnitude were previously noted in stream sediments by SEC Donohue (1992) and were determined to be consistent with ~~high~~ elevated background levels identified for the entire JPG area. Arsenic in sediments from Harberts Creek exceeds the USEPA Region 9 criteria in ~~all~~ the five ~~of the~~ sediment samples. The samples also contained aluminum, beryllium, chromium, iron, manganese, and vanadium at concentrations above the corresponding USEPA Region 9 criteria. There were no detections of TPH and cyanide in the Harberts Creek sediment samples.

7.5.4 Stream Surface Waters

The two surface water samples (SW01 and SW02) ~~taken~~ collected during Phase I in June 1993 showed detectable silver in the unfiltered samples but at a concentration less than the ~~MCL~~PRG for silver in tap water (Table 7-6). The silver concentration of 0.87 µg/L reported for the sample collected downstream of the sewage treatment plant outfall was 2.3 times the concentration reported for the upstream sample (0.37 µg/L). No silver was detected in the filtered samples collected at the same time. Silver concentrations in stream water samples ~~taken~~ collected by USAEHA (1993) at the exit point of Harberts Creek from JPG ranged from 4.9 µg/L to 23.8 µg/L. The USAEHA report concluded that the source of the elevated silver concentrations was primarily the sewage treatment plant effluent discharge.

Although the outfall to Harberts Creek was monitored to satisfy NPDES permit requirements, bypass releases occurred in the past that may have resulted in the release of contaminants to surface water and sediments. It is suspected that the spent chemicals from the water quality laboratory were previously processed through the sewage treatment plant. This may also have resulted in contamination of surface-water and sediments in Harberts Creek if the removal of the contaminants through the primary and secondary treatment processes was incomplete. Also, in the past there were reports of untreated wastewater bypassing the treatment system and being discharged directly into Harberts Creek.

For these reasons, the Sewage Treatment Plant (Site 2) and the Sewage Sludge Application Areas (Site 27) were evaluated in the baseline risk assessment.

7.6 HUMAN HEALTH RISK ASSESSMENT

7.6.1 Selection of the Contaminants of Potential Concern at Sites 2 and 27

7.6.1.1 Surface Soil.

7.6.1.1.1 Data Grouping. As previously described, the samples collected at the Sewage Treatment Plant were segregated from the samples collected at the Sewage Sludge Applications Areas for the risk assessment. The Sewage Sludge Application Areas were further divided into samples collected within the southwest corner and samples collected in the remainder of the site (see Section 7.4.3.1 for specific sample identification).

7.6.1.1.2 Frequency of Detection. The remainder of the site was the only area of concern with enough samples to evaluate frequency of detection. No chemical was detected in fewer than 5 percent of the surface soil samples.

7.6.1.1.3 Nutrient Screening. The maximum value of each of the nutrients detected in surface soil within each area of concern at these sites was less than the corresponding nutrient screening value, with the exception of iron in soil in the remainder of the site:

- Sewage Treatment Plant (Site 2)
  - Calcium - maximum: 56,600 µg/g; screening value: 1,000,000 µg/g
  - Iron - maximum: 23,800 µg/g; screening value: 70,000 µg/g
  - Magnesium - maximum: 11,700 µg/g; screening value: 1,000,000 µg/g
  - Potassium - maximum: 1,290 µg/g; screening value: 150,000 µg/g
  - Sodium - maximum: 113 µg/g; screening value: 1,000,000 µg/g

- Southwest Corner of Site 27
  - Calcium - maximum: 96,800 µg/g; screening value: 1,000,000 µg/g)
  - Iron - maximum: 25,900 µg/g; screening value: 70,000 µg/g
  - Magnesium - maximum: 40,700 µg/g; screening value: 1,000,000 µg/g
  - Potassium - maximum: 1,930 µg/g; screening value: 150,000 µg/g
  - Sodium - maximum 972 µg/g; screening value: 1,000,000 µg/g

- Remainder of Site 27
  - Calcium - maximum: 40,500 µg/g; screening value: 1,000,000 µg/g
  - Iron - maximum: 85,000 µg/g; screening value: 70,000 µg/g
  - Magnesium - maximum: 9,220 µg/g; screening value: 1,000,000 µg/g
  - Potassium - maximum: 2,510 µg/g; screening value: 150,000 µg/g
  - Sodium - maximum: 1,720 µg/g; screening value: 1,000,000 µg/g

Iron in surface soil in the remainder of Site 27 is the only nutrient carried through to the next step of the COPC selection process.

7.6.1.1.4 Summary of Preliminary COPCs. Table 7-7 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95 percent UCL of the mean, and the exposure point concentrations for each preliminary COPC in surface soil at Sites 2 and 27. Soil preliminary COPCs are chemicals detected above background (or above the nutrient screening value) at a frequency of greater than 5 percent in soil samples.

7.6.1.1.5 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for each preliminary surface soil COPC was compared to the chemical-specific Region 9 residential soil PRG (Table 7-8). One-tenth of the PRG was used for noncarcinogens, with the exception of lead, for which the full PRG was used. Iron has no Region 9 PRG; for iron, the exposure point concentration was compared to the full nutrient screening value. As a result of this screening, the following chemicals were selected as COPCs in surface soil in the three areas of concern:

- Sewage Treatment Plant (Site 2)—aluminum, arsenic, beryllium, and manganese
- Southwest Corner of Site 27—aluminum, arsenic, chromium, manganese, silver, thallium, and vanadium
- Remainder of Site 27—aluminum, arsenic, beryllium, chromium, manganese, silver, and thallium

7.6.1.2 Surface/Subsurface Soil Combined.

7.6.1.2.1 Data Grouping. Data for surface/subsurface soil combined were grouped in a manner consistent with data groupings for surface soil, described above.

7.6.1.2.2 Frequency of Detection. The remainder of Site 27 was the only area of concern with enough samples to evaluate frequency of detection. No chemical was detected in fewer than 5 percent of the combined surface/subsurface soil samples.

7.6.1.2.3 Nutrient Screening. The maximum value of each of the nutrients detected in surface/subsurface soil combined within each area of concern at these sites was less than the corresponding nutrient screening value, with the exception of iron in the remainder of Site 27:

- Southwest Corner of Site 27
  - Calcium - maximum: 96,800 µg/g; screening value: 1,000,000 µg/g
  - Iron - maximum: 42,800 µg/g; screening value: 70,000 µg/g
  - Magnesium - maximum: 40,700 µg/g; screening value: 1,000,000 µg/g
  - Potassium - maximum: 1,930 µg/g; screening value: 150,000 µg/g)
  - Sodium - maximum: 972 µg/g; screening value: 1,000,000 µg/g
- Remainder of Site 27
  - Calcium - maximum: 13,800 µg/g; screening value: 1,000,000 µg/g

- Iron - maximum: 85,000 µg/g; screening value: 70,000 µg/g
- Magnesium - maximum: 4,830 µg/g; screening value: 1,000,000 µg/g
- Potassium - maximum: 2,120 µg/g; screening value: 150,000 µg/g
- Sodium - maximum: 96.5 µg/g; screening value: 1,000,000 µg/g

Iron in soil in the remainder of the site is the only nutrient carried through to the next step of the COPC selection process, which is a comparison of exposure point concentrations to screening values.

7.6.1.2.4 Summary of Preliminary COPCs. Table 7-7 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95 percent UCL of the mean, and the exposure point concentrations for each preliminary COPC in surface/subsurface soil at Sites 2 and 27. Soil preliminary COPCs are chemicals that have been detected above background (or above the nutrient screening value) at a frequency of greater than 5 percent in soil samples. Any metal determined to be above background in surface or subsurface soil or both was considered to be a preliminary COPC.

7.6.1.2.5 Region 9 Preliminary Remediation Goal Screening. The exposure point concentrations for each preliminary surface/subsurface soil COPC was compared to the chemical-specific Region 9 residential soil PRG (Table 7-8). One-tenth of the PRG was used for noncarcinogens, with the exception of lead, for which the full PRG was used. Iron has no Region 9 PRG. Iron was evaluated by comparing its exposure point concentration to the full iron nutrient screening value. As a result of this screening, the following chemicals were selected as COPCs in surface/subsurface soil combined in the various areas of concern:

- Southwest Corner of Site 27—aluminum, arsenic, beryllium, chromium, manganese, silver, and thallium

- Remainder of Site 27—aluminum, arsenic, beryllium, chromium, manganese, and thallium

7.6.1.3 Air.

7.6.1.3.1 Summary of Preliminary COPCs. Ambient air concentrations to which future receptors at these sites might be exposed were estimated using air emission/dispersion modeling, as described in Appendix R. In the site-specific conceptual model, discussed below in Section 7.6.2.1, Site 2 is evaluated under the following two future site-specific scenarios: as a residential site and as an industrial site. Site 27 is evaluated as a future residential/agricultural site and leased agricultural land.

In the future industrial land use scenario for the facility, all sites were assumed to be industrial, except for the five sites designated agricultural sites. Each site with particulate-bound COPCs in surface soil (metals, SVOCs, and dioxins/furans) and/or volatile COPCs in surface/subsurface soil combined was assumed to contribute to the air concentrations at all of the sites. In the future residential scenario for the facility, all sites were assumed to be

residential except for the five sites designated agricultural. It was assumed that particulate and VOC emissions from the strictly residential sites would be negligible because the home sites would be covered with dense vegetation (lawns) and pavement. Therefore, under the residential scenario only the five agricultural sites contribute to the air concentrations at all of the sites. The list of preliminary air COPCs is therefore the same for every site for a given scenario, but the concentrations of the COPCs vary. Tables R-4 and R-6 in Appendix R present the estimated ambient air concentrations at Sites 2 and 27 under the future industrial and residential scenarios, respectively.

7.6.1.3.2 Region 9 Preliminary Remediation Goal Screening. The exposure point concentrations for each preliminary air COPC at Site 2 (in the future residential scenario and the future industrial scenario) and Site 27 (in the future residential scenario) were compared to chemical-specific Region 9 air PRGs (Tables 7-9 and 7-10, respectively). One-tenth of the PRG was used for noncarcinogens. The exception was lead, for which the full PRG was used. As a result of the screening, aluminum, arsenic, chromium, manganese, silver, thallium, vanadium, and zinc are retained as COPCs in air for future on-site residents at Site 2. For future on-site workers at Site 2, the following chemicals were retained as COPCs in air: aluminum, arsenic, chromium, manganese, silver, thallium, vanadium, and zinc. At Site 27, these same metals were retained as COPCs in air for future on-site residents.

7.6.1.4 Sediment.

7.6.1.4.1 Frequency of Detection. Evaluating of frequency of detection was not undertaken for Harberts Creek sediment because of too few samples.

7.6.1.4.2 Nutrient Screening. The maximum value each of the nutrients detected in sediment from Harberts Creek was less than the corresponding nutrient screening value with the exception of iron:

- Calcium—maximum: 41,000 μg/g; screening value: 1,000,000 μg/g
- Iron—maximum: 79,000 μg/g; screening value: 70,000 μg/g
- Magnesium—maximum: 7,230 μg/g; screening value: 1,000,000 μg/g
- Potassium—maximum: 774 μg/g; screening value: 150,000 μg/g
- Sodium—maximum: 331 μg/g; screening value: 1,000,000 μg/g

Iron was also not analyzed for in background sediment, so no background comparison could be performed. Iron, therefore, is retained as a preliminary COPC in Harberts Creek sediment.

7.6.1.4.3 Summary of Preliminary COPCs. Table 7-11 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95 percent UCL

of the mean, and the exposure point concentrations for each preliminary COPC in Harberts Creek sediment. Sediment preliminary COPCs are chemicals that have been detected.

7.6.1.4.4 Region 9 Preliminary Remediation Goal Screening. The exposure point concentrations for each preliminary Harberts Creek sediment COPC was compared to the chemical-specific Region 9 residential soil PRG (Table 7-12). One-tenth of the PRG was used for noncarcinogens, with the exception of lead, for which the full PRG was used. Iron has no Region 9 PRG. Iron was evaluated by comparing its exposure point concentration to the full iron nutrient screening value. As a result of this screening, the following chemicals were selected as COPCs in Harberts Creek sediment: aluminum, arsenic, beryllium, chromium, iron, manganese, and vanadium (Figure 7-4).

7.6.1.5 Surface Water.

7.6.1.5.1 Frequency of Detection. Evaluation of frequency of detection was not undertaken for Harberts Creek surface water because of too few samples.

7.6.1.5.2 Nutrient Screening. The maximum value of each of the nutrients detected in surface water from Harberts Creek is less than the corresponding nutrient screening value:

- Calcium—maximum: 51.1 mg/L; screening value: 510 mg/L
- Iron—maximum: 0.238 mg/L; screening value: 9.4 mg/L
- Magnesium—maximum: 15.5 mg/L; screening value: 200 mg/L
- Potassium—maximum: 2.6 mg/L; screening value: 20 mg/L
- Sodium—maximum: 14.2 mg/L; screening value: 730 mg/L.

All nutrients, therefore, are eliminated as preliminary COPCs in Harberts Creek surface water.

7.6.1.5.3 Summary of Preliminary COPCs. Table 7-11 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95 percent UCL of the mean, and the exposure point concentrations for each preliminary COPC in Harberts Creek surface water. Surface water preliminary COPCs are chemicals that have been detected above background (or above the nutrient screening value) at a frequency of greater than 5 percent in surface water samples.

7.6.1.5.4 Region 9 Preliminary Remediation Goal Screening. The exposure point concentrations for each preliminary Harberts Creek surface water COPC was compared to the chemical-specific Region 9 tap water PRG (Table 7-13). One-tenth of the PRG was used for noncarcinogens. As a result of this screening, no chemicals are retained as COPCs for surface water.

7.6.2 Exposure Assessment

7.6.2.1 Site Conceptual Model. As described in detail in Section 5.1.4.6, the types of individuals who could be affected by the existing contamination at JPG under current scenarios are trespassers and off-site residents. For these individuals, potential exposure is addressed on a facility-wide basis rather than by specific sites (see Sections 28 and 29). Therefore, the site-specific conceptual model developed for Sites 2 and 27 only addresses future land use development. Sites 2 and 27 have four potential future land uses forwarded for evaluation:

- Agricultural (Site 27 only)
- Residential
- Hunting
- Sewage treatment plant (Site 2 only)

The hunting scenario, however, like the current land use scenario, is viewed as a facility-wide scenario and therefore evaluated separately in Section 33.

Agricultural Use. Under this future land use scenario, Site 27 is assumed to be leased to a nearby farmer for the purpose of cultivating cash crops. The most likely receptor population would therefore consist of individuals residing in nearby communities who purchase and ingest these crops and/or who consume beef and milk product obtained from cattle who were fed crops harvested at JPG.

Residential Use. Under the future residential land use scenario, both Site 2 and Site 27 are assumed to be developed as homesteads, with the supposition that a family would build a house directly on/within this area of potential concern.

With respect to a risk assessment analysis, resident populations are assumed to consist of both adults and toddlers. Each individual would be expected to come in contact with site contaminants through the following pathways at Sites 2 and 27:

- Inhalation of VOCs and fugitive particulates from soils
- Dermal contact with soil (surface or surface/subsurface combined) while gardening/playing outdoors
- Incidental ingestion of soil (surface or surface/subsurface combined) while gardening/playing outdoors
- Ingestion of fresh homegrown fruits and vegetables (grown in surface soil or surface/subsurface soil combined

- Ingestion of home-produced beef (Site 27 only)
- Ingestion of home-produced milk (Site 27 only)
- Incidental ingestion/dermal contact with surface water and sediment while wading in Harberts Creek

Industrial Use. Under this scenario, Site 2 is assumed to be a sewage treatment plant. On-site industrial workers at Site 2 (adult males and females) are assumed to be individuals who could be exposed directly to contaminated media through the following pathways:

- Inhalation of VOCs and fugitive particulates from soils
- Incidental ingestion/dermal contact with surface soil

On-site industrial workers are assumed not to visit any drainage pathways or surface water bodies such as creeks or ponds. Therefore, contact with surface water/sediment is not a concern for these receptors.

7.6.2.2 Exposure Point Concentrations.

7.6.2.2.1 Air. The estimated ambient air concentrations of COPCs at these sites for the future on-site residents and workers are presented in Tables ~~7-6 and 7-7~~ **7-9 and 7-10**.

7.6.2.2.2 Soil. The concentrations of COPCs in surface soil and surface/subsurface soil combined at these sites are presented in Table ~~7-5~~ **7-8**. At Site 27, two sub-areas of potential concern were identified: the southwest corner of the site and the remainder of the site. It was assumed a future resident could build a home in either of these sub-areas of potential concern, but that crops (corn) could be grown over the entire Site 27. Therefore, for the purpose of modeling uptake into corn, site-wide average concentrations of soil COPCs at Site 27 were calculated. A site-wide area-weighted concentration for each surface soil COPC was calculated by multiplying the concentration of the COPC in soil in the sub-area of potential concern by a modifying factor. The modifying factor was calculated as the area of the sub-area of potential concern divided by the area of the entire Site 27. The modified concentrations were then summed to derive a site-wide concentration for each surface soil COPC. These site-wide area-weighted concentrations are presented in Table 7-14.

7.6.2.2.3 Fruits, Vegetables, and Crops. COPC concentrations in home-grown fruits and vegetables, and crops (corn) grown for livestock consumption, were estimated using the methods described in Section 5.1.5.2.8. Appendix U, Table U-2, documents the calculation of contaminant concentrations in fruits and vegetables at Sites 2 and 27 and crops at Site 27.

7.6.2.2.4 Beef and Milk. COPC concentrations in beef and milk were estimated using the methods described in Section 5.1.5.2.9 and 5.1.5.2.10, respectively. Table U-2, Appendix U,

documents the calculation of contaminant concentrations in beef and milk from cattle fed corn (silage) grown in fields at Site 27.

7.6.2.2.5 Surface Water and Sediment. The concentrations of COPCs in sediment in Harberts Creek are presented in Table 7-12. No surface water COPCs were selected for this surface water body (see Table 7-13).

7.6.2.3 Human Exposure Doses.

7.6.2.3.1 Inhalation of Contaminated Air. Inhalation of airborne contaminants (VOCs and particulates) is a potential route of exposure for future on-site residents (adults and children) and workers at Site 2 and future on-site residents at Site 27. The equation used for calculating human exposure doses of contaminants of potential concern due to inhalation of volatile and dust-bound contaminants is provided in Section 5.1.5.3.1, Table 5-11~~2~~. Table V-2, Appendix V, documents the calculation of human exposure doses due to inhalation of contaminated air at these sites.

7.6.2.3.2 Incidental Ingestion of Contaminated On-site Soil. Mouthing behavior (toddlers) and incidental ingestion of soil with recreational or work-related activities may expose human receptors to contaminated soil at a site via the oral route of exposure. The equation used to calculate the human exposure dose due to incidental ingestion of contaminated soil is presented in Section 5.1.5.3.2, Table 5-12~~3~~. This pathway was assumed to be complete at Site 2 for future on-site residents (adults and children) and future workers, and complete at Site 27 for future on-site residents. Table V-2, Appendix V, documents the calculation of human exposure doses due to incidental ingestion of soil at Sites 2 and 27.

7.6.2.3.3 Dermal Contact with Contaminated On-site Soil. The chemicals in contaminated soil also may be absorbed into a receptor's body through dermal contact. The equation used to calculate chemical doses due to dermal contact with contaminated soil is presented in Section 5.1.5.3.3, Table 5- 13~~14~~. This pathway is relevant for future on-site residents (adults and children) and future workers at Site 2 and future on-site residents at Site 27. Table V-2, Appendix V, documents the calculation of human exposure doses due to dermal contact with soil at Sites 2 and 27.

7.6.2.3.4 Ingestion of Contaminated Fruits and Vegetables. Consumption of contaminated home-grown fruits and vegetables may be a source of chemical exposure for future on-site residents (adults and children) at Sites 2 and 27. The equation used to calculate human exposure doses due to ingestion of contaminated fruits and vegetables is provided in Section 5.1.5.3.11, Table 5-22~~23~~. Table U-2, Appendix U documents the calculation of human exposure doses due to ingestion of contaminated fruits and vegetables grown in soil at Sites 2 and 27.

7.6.2.3.5 Ingestion of Contaminated Beef and Milk. Ingestion of contaminated beef and milk may be significant pathways of chemical exposure for future on-site residents and future off-site residents (adults and children) who consume these products from cattle fed corn

(silage) harvested from fields at Site 27. The equation used to calculate human exposure doses due to ingestion of contaminated beef is provided in Section 5.1.5.3.12, Table 5-~~24~~23. The equation used to calculated human exposure doses due to ingestion of contaminated milk is provided in Section 5.1.5.3.13, Table 5-24~~25~~. Table U-2, Appendix U, documents the calculation of the human exposure doses due to ingestion of contaminated beef and milk from cattle fed corn (silage) grown in fields at Site 27.

7.6.2.3.6 Incidental Ingestion of Sediment in Harberts Creek. Receptors may be exposed to contaminated sediments while wading in Harberts Creek. The equation to calculate human exposure doses due to incidental ingestion of contaminated sediments is provided in Section 5.1.5.3.9, Table 5-20~~21~~. Table V-2, Appendix V, documents the calculation of human exposure doses due to incidental ingestion of contaminated sediment while wading in Harberts Creek. This pathway is complete for future on-site residents at Sites 2 and 27.

7.6.2.3.7 Dermal Contact with Sediment in Harberts Creek. Future on-site residents wading in Harberts Creek may also come into dermal contact with sediment-bound contaminants. The equation to calculate human exposure doses due to dermal contact with contaminated sediments is provided in Section 5.1.5.3.10, Table 5-21~~22~~. Table V-2, Appendix V, documents the calculation of human exposure doses due to dermal contact with contaminated sediment while wading in Harberts Creek.

7.6.3 Risk Characterization

7.6.3.1 Chronic Health Hazards. The noncancer daily exposure doses calculated in the exposure assessment were used to calculate HQs for each of the COPCs possessing RfDs. Pathway-specific and overall HIs were then calculated for each receptor. The calculations of HQs and HIs are described in Section 5.1.7.1. If an overall HI is calculated to be greater than 1.0 for a particular receptor, then the exposure pathway(s) primarily responsible for the result is identified as a "critical pathway(s)." For each critical pathway, those chemical contaminants responsible for the majority of the HI are listed as COCs. Table W-2, Appendix W, documents the calculation of the pathway- and chemical-specific HQs for the human receptors at Sites 2 and 27. The pathway-specific and overall HIs are summarized in Tables 7-15 (Site 2) and 7-16 (Site 27).

7.6.3.1.1 Future On-Site Residents—Site 2. The overall HIs for the future on-site adult and toddler residents at Site 2 are calculated to be **5.1** ~~6.1~~ and **19.3** ~~23~~, respectively. These HIs exceed the USEPA's risk management criterion of 1.0. The primary pathway of concern for both receptors is inhalation of fugitive dusts, and manganese is the primary COC. ~~Aluminum is also a noncarcinogenic COC for the future child resident for this pathway.~~

Because the calculated risks and hazards for the inhalation of air pathway reflect combined modeled fugitive dust and/or VOC contributions from all sites, the data were reviewed to determine the contribution of soil at Sites 2 and 27 to the chemical-specific HQs calculated for the noncarcinogenic COCs for this pathway at each of these sites. This analysis shows that

essentially all of the air pathway hazard for Site 2 and for Site 27 is due to fugitive dusts from Site 27.

Site 27 - Southwest Corner of Site. If future receptors build a home in the southwest corner of the site and are exposed to COPCs in surface soil only, the overall HIs for the future on-site adult and toddler residents are calculated to be **7.8** ~~9~~ and **33.1** ~~38~~, respectively. Both of these HIs exceed the USEPA's risk management criterion of 1.0. The primary critical exposure pathways for both receptors are ingestion of milk and inhalation of fugitive dusts. Silver is the noncarcinogenic COC for the milk ingestion pathway, and manganese is the primary COC for the inhalation pathway. ~~Aluminum is also a noncarcinogenic COC for the future child resident for the inhalation pathway.~~ The hazards for both of these exposure pathways are based on fate and transport modeling using site-wide average surface soil concentrations of contaminants (see Table 7-14). Silver and manganese contamination in surface soils at the remainder of the site is responsible for most of the chemical hazard from these pathways. Incidental ingestion of surface soil at the southwest corner of Site 27 and ingestion of homegrown fruits and vegetables grown in this soil are also critical exposure pathways for the future child resident. Arsenic and manganese are the noncarcinogenic COCs, with each having an HI slightly exceeding 1.0 for these pathways combined.

If subsurface soil is assumed to be mixed and dispersed with surface soil across the ground surface at the home-site in the southwest corner of the site, the overall HIs for the future on-site adult and toddler are calculated to be **7.8** ~~9.2~~ and **32.9** ~~38~~, respectively. This excavation scenario has the same critical pathways and noncarcinogenic COCs as the scenario in which these receptors are exposed to surface soil only.

Site 27 - Remainder of Site. If future receptors build a home on the remainder of Site 27 and are exposed to COPCs in surface soil only, the overall HIs for the future on-site adult and toddler residents are calculated to be **7.8** ~~9.1~~ and **34.1** ~~38~~, respectively. Both of these HIs exceed the USEPA's risk management criterion of 1.0. The primary critical exposure pathways for both receptors are ingestion of milk and inhalation of fugitive dusts. Silver is the noncarcinogenic COC for the milk ingestion pathway, and manganese is the primary COC for the inhalation pathway. ~~Aluminum is also a noncarcinogenic COC for the future child resident for the inhalation pathway.~~ The hazards calculated for both of these exposure pathways are based on fate and transport modeling using site-wide average surface soil concentrations of contaminants (see Table 7-14). Silver and manganese contamination in surface soils at the remainder of the site contributes most to the chemical hazard from these pathways. Incidental ingestion of surface soil from the remainder of Site 27 and ingestion of homegrown fruits and vegetables grown in this soil are also critical exposure pathways for the future child resident. Manganese is the noncarcinogenic COC, with a total HI for these pathways of 2.8~~1.6~~.

If subsurface soil is assumed to be mixed and dispersed with surface soil across the ground surface at the home-site on the remainder of the site, the overall HIs for the future on-site adult and toddler are calculated to be **7.8** ~~9~~ and **32.7** ~~37.5~~, respectively. This excavation scenario

has the same critical pathways and noncarcinogenic COCs as the scenario in which these receptors are exposed to surface soil only.

Within Site 27, fugitive dust emissions and the beef and milk pathways are based on site-wide average concentrations. A review of the data shows that ~~16 percent and~~ 10 percent of the ~~aluminum and~~ manganese HQ~~s, respectively, are~~**is** due to contamination in the Southwest Corner of the Site; ~~84 percent and~~ 90 percent of the ~~aluminum and~~ manganese HQ~~s, respectively, are~~ **is** attributable to contamination at the remainder of the site.

The noncarcinogenic COC~~s aluminum and~~ manganese is~~are~~ present naturally in Rossmoyne soils at the facility. Silver was not detected in background Rossmoyne soils. The relative contributions of background soil concentration~~s~~ of ~~aluminum and~~ manganese to the hazard~~s~~ at this site **was** ~~were~~ estimated by comparing the average soil background concentration~~s~~ of **manganese**~~these chemicals~~ to the average concentration in site soils. At the Southwest Corner of the site, background ~~aluminum contributes 31 percent and background~~ manganese **contributes** 26 percent to the total surface soil concentration~~s of these constituents~~. At the Remainder of the Site, background ~~aluminum contributes 36 percent and background~~ manganese **contributes** 15 percent to the total surface soil concentration~~s of these chemicals~~. For combined surface/subsurface soils, the percent contributions are similar.

Taking into consideration all pathways and the fact that some pathways are based on a site-wide average concentrations, background concentration~~s of aluminum and~~ manganese at Site 27 would contribute approximately ~~3 percent and~~ 10 percent~~, respectively,~~ to the total hazard~~s~~ estimated for each of the two areas of concern. The estimates of background contributions for **manganese** ~~these constituents~~ are the same for the scenarios in which surface and subsurface soil are combined.

7.6.3.1.2 Future On-Site Workers. The overall HI for the future on-site worker at Site 2 is calculated to be **1.7** ~~1.4~~. This value exceeds the USEPA's risk management criterion of 1.0. The critical exposure pathway is inhalation of fugitive dusts, and manganese is the COC for this pathway.

7.6.3.1.3 Future Off-Site Consumers of Beef and Milk. The overall HIs for the future off-site adult and toddler consumers of beef and milk produced at Site 27 are calculated to be **1.9** ~~2.0~~ and **10.1** ~~10.6~~, respectively. Both of these HIs exceed the USEPA's risk management criterion of 1.0. The critical exposure pathway for both receptors is ingestion of milk from cows fed corn (silage) grown at the site. The hazards associated with both of these exposure pathways are based on fate and transport modeling using site-wide average surface soil concentrations of contaminants (Table 7-14). Silver contamination in surface soils at the remainder of the site contributes most of the chemical hazard from this pathway.

7.6.3.2 Excess Lifetime Cancer Risks. The cancer risks for each receptor were determined from the pathway-specific exposure doses and the route-specific SFs, as described in Section 5.1.7.2. To assess the simultaneous exposure of a receptor population to multiple

carcinogens from multiple exposure routes, all of the cancer risks calculated for a receptor population were summed. Each overall receptor cancer risk was then compared to USEPA's target risk range (1.0E-06 to 1.0E-04). If the total cancer risk for a receptor from all exposure pathways is less than 1.0E-04, then it is concluded that the site(s) does not pose a significant risk to that receptor. If the overall cancer risk exceeds the target risk range, any chemical individually associated with a risk level greater than 1.0E-05 is identified as a COC. COCs represent the primary contributors to the potential cancer risk for the receptor-specific exposure pathway under evaluation. Table W-2, Appendix W, documents the calculation of the pathway- and chemical-specific cancer risks for the human receptors at Sites 2 and 27. The pathway-specific and overall cancer risks are summarized in Tables 7-15 (Site 2) and 7-16 (Site 27).

7.6.3.2.1 Future On-Site Residents—Site 2. The overall cancer risks for the future on-site adult and toddler residents at Site 2 are calculated to be **6.5E-05** ~~7.5E-05~~ and **5.7E-05** ~~6.8E-05~~, respectively. Both of these cancer risks are within the USEPA's target risk range of 1.0E-06 and 1.0E-04. Therefore, no critical pathways or carcinogenic COCs are identified for these receptors at this site.

Site 27 - Southwest Corner of Site. If future receptors build a home in the southwest corner of the site and are exposed to COPCs in surface soil only, the overall cancer risks for the future on-site adult and toddler residents are calculated to be **8.5E-05** ~~9.4E-05~~ and **7.5E-05** ~~8.3E-05~~, respectively. Both of these cancer risks are within the USEPA's target risk range of 1.0E-06 and 1.0E-04. Therefore, no critical pathways or carcinogenic COCs are identified for these receptors at this sub-area of potential concern at Site 27.

If subsurface soil is assumed to be mixed and dispersed with surface soil across the ground surface at the home-site in the southwest corner of the site, the overall cancer risks for the future on-site adult and toddler residents are calculated to be **6.9E-05** ~~8.9E-05~~ and **6.1E-05**~~8.1E-05~~, respectively. Both of these cancer risks are within the USEPA's target risk range of 1.0E-06 and 1.0E-04. Therefore, no critical pathways or carcinogenic COCs are identified for these receptors at this sub-area of potential concern at Site 27.

Site 27 - Remainder of Site. If future receptors build a home on the remainder of the site and are exposed to COPCs in surface soil only, the overall cancer risks for the future on-site adult and toddler residents are calculated to be **6.8E-05** ~~8.2E-05~~ and **5.9E-05** ~~7.4E-05~~, respectively. Both of these cancer risks are within the USEPA's target risk range of 1.0E-06 and 1.0E-04. Therefore, no critical pathways or carcinogenic COCs are identified for these receptors at this sub-area of potential concern at Site 27.

If subsurface soil is assumed to be mixed and dispersed with surface soil across the ground surface at the home-site on the remainder of the site, the overall cancer risks for the future on-site adult and toddler residents are calculated to be **6.5E-05** ~~7.8E-05~~ and **5.5E-05** ~~7.0E-05~~, respectively. Both of these cancer risks are within the USEPA's target risk range of 1.0E-06 and 1.0E-04. Therefore, no critical pathways or carcinogenic COCs are identified for these receptors at this sub-area of potential concern at Site 27.

7.6.3.2.2 Future On-Site Workers. The overall cancer risk for the future on-site worker at Site 2 is **1.2E-05** ~~1.1E-05~~. Since this cancer risk is within the USEPA's target risk range of 1.0E-06 to 1.0E-04, no critical exposure pathways or carcinogenic COCs are identified for this receptor at Site 2.

7.6.3.2.3 Future Off-Site Consumers of Beef and Milk. The overall cancer risks calculated for the future off-site adults and children consuming beef and milk from cattle fed corn (silage) grown at Site 27 are **1.7E-06** ~~1.8E-06~~ and **7.2E-07** ~~7.5E-07~~, respectively. These cancer risks are within or below the USEPA's target risk range of 1.0E-06 to 1.0E-04. Therefore, no critical exposure pathways or carcinogenic COCs are identified for these receptor populations.

7.6.3.3 Uncertainty/Sensitivity Analysis. The numerical risks/hazards that are calculated in this risk assessment for Sites 2 and 27 represent *conditional* estimates of risk based on various simplifying assumptions concerning contaminant exposure and toxicity. These estimates of risk/hazard are derived using a series of conservative procedures that address contaminant concentrations at the site, their fate in the environment, how someone currently or in the future might be exposed to these contaminants, and the toxicity of each chemical toward humans. The purpose of the uncertainty analysis is therefore to specify, when appropriate, the critical assumptions made for the site for the risk managers so that the site-specific results can be interpreted in a proper context.

To assist the risk managers in this project, a qualitative uncertainty analysis has been performed. The primary goals of a qualitative uncertainty analysis are (1) to itemize the major areas of uncertainty in the site-specific risk assessment and (2) to demonstrate that the assessment overall has been conservatively performed (i.e., that the potential risks/hazards at the site have not likely been underestimated, but may have been significantly overestimated).

The qualitative uncertainty analysis for this site is presented in Table 7-17. Based on this analysis, it can be concluded that this risk assessment is conservative. Some of the major uncertainties in this study that are most influential to the calculated risks/hazards include:

- Assumption of 100 percent home-produced milk,
- Assumed receptors' foodstuff ingestion rates (95th percentile of U.S. population),
- Receptors' exposure time (24 hours/day),
- Food chain concentrations were modeled, not measured.

7.7 ECOLOGICAL RISK ASSESSMENT

7.7.1 Ecological Site Description

The Sewage Treatment Plant (STP) (Site 2) and the Sewage Sludge Application Areas (Site 27) are located in the southwestern corner of JPG (see Figure ~~7-1~~2-1) and are now fenced. The flat to gently rolling land surface slopes to the southeast toward Harberts Creek a few hundred feet away. The area immediately surrounding the STP is grass covered and is regularly mowed. There are no trees or shrubs within 200 feet of the STP. The four former sewage sludge application areas (SSAs) (see Figure 7-1) were identified by facilities personnel. In 1993, these areas were not regularly mowed but were sometimes included in the spring open burning program. The vegetation was well established, indicating that the areas had not been used for disposal of sewage sludge in the recent past. Much of the area has recently been plowed and planted in corn, soybeans, and tobacco. The soils in this area belong to the Rossmoyne soil series. The depth to bedrock is estimated to be less than 15 feet.

Typical flatwoods are located to the north, east, and south along Harberts Creek near the sewage treatment plant outfall a few hundred feet away. Flatwoods are forested areas that occur on level or nearly level soils that are poorly drained, and have a shallow, perched water table. Harberts Creek occasionally floods in winter time. Typical tree species in this area include sycamore, slippery elm, and green ash. Other vegetation noted adjacent to Harberts Creek include jewelweed, forget-me-not, hedge bind-weed, giant ragweed, lady's thumb, yarrow, poison ivy, moneywort, grapevine, joe-pye-weed, spicebush, sandbar willow, common milkweed, and common plantain. All vegetation observed was in good condition**. Refer to Figure 5.3-13 for a map of habitat types at JPG. (EPA184)** Wildlife species that have been observed include white-tailed deer, bluebirds, turkey vultures, hawks, starlings, mourning doves, field sparrows, woodpeckers, and crows. Frogs and fish were also observed in the creek. Evidence of additional wildlife included crayfish burrows, killdeer nests, and reported sightings of wild turkey. **Refer to Table 7.7-a1 for a summary of Site 2/27 ecological habitat characteristics identified during site visits. (EPA184)** In 1993, JPG personnel were building an archery range (which may be used on an occasional basis by facility personnel) near the small pond located adjacent to Harberts Creek.

7.7.2 Sites 2/27 Investigations

The need for additional studies of the Harberts Creek was identified based on results of the PERA (Rust E&I 1997g). The DERA included an aquatic assessment of Site 2 (Sewage Treatment Plant) outfall to Harberts Creek. HQs and HIs were calculated for fish (creek chub), amphibians (Pickerel frog), and aquatic invertebrates (e.g., crayfish) that are in direct contact with the surface water and sediments of the creek and a rapid bioassessment of Harberts Creek. Population surveys were conducted for fish. In addition, a terrestrial ERA, which included calculations of HQs and HIs, was conducted on soils from Sites 2 and 27.

Additional terrestrial ecological field studies were not conducted at Sites 2 (Sewage Treatment Plant) or 27 (Sewage Sludge Application Areas) since these areas have been severely disturbed by recent agricultural activities (plowing and planting) conducted by the future owner of the facility (Rust E&I 1997f). To prevent future disturbance of Site 27, the sludge application areas have since been fenced off by the USACE. The tobacco crop planted in 1997 was not harvested. **(IN13)**

For convenience to the reader, summary statistics, EPCs, risk driver HQs, total RME and CT HIs, and aquatic ecosystem habitat results are provided in this section. All intakes and ~~other non risk-driving~~ HQs are located in Appendix AA. **The COPCs for each medium evaluated in the DERA are presented on the EPC tables in this section. Refer to Appendix AA for details pertaining to the specific data sets (e.g., sample numbers, depths, dates, etc.) used in the risk assessment for Sites 2 and 27. (EPA179)**

7.7.2.1 Phase I Activities. The Phase I data for Site 2 are summarized in Table 7.7-1. Table 7.7-2 provides the EPCs for Site 2. The Phase I data for Site 27 are summarized in Table 7.7-3; the EPCs for Site 27 are presented in Table 7.7-4. Sediment, surface water, and soil data were available for evaluation from Phase I. It should be noted the surface water and sediment data was only collected at Site 2.

7.7.2.2 Phase II Activities. One surface soil sample was collected at Site 2 during Phase II and analyzed for SVOCs. **There were no analytical detections in this sample. (EPA179)** The Phase II data for Site 27 are summarized in Table 7.7-5. Only soil data were available for Phase II. Table 7.7-6 provides the EPCs for Site 27.

7.7.2.3 Phase III Activities. In September 1997, aquatic sampling activities to support the ecological risk assessment were conducted. These activities were limited to evaluation of Harberts Creek adjacent to the outfall of the Sewage Treatment Plant (~~Site 2~~Figure 7.7-1) and an upstream reference area (Figure 7.7-2). The results of the aquatic field studies are summarized in Tables 7.7-7 through 7.7-11.

7.7.3 Exposure and Ecological Effects Profile

Fish, amphibians, reptiles, aquatic invertebrates, aquatic macrophytes, birds, and mammals may all be exposed to COPCs detected in Harberts Creek, either by direct contact with or ingestion of the surface water and/or sediments and soil. In addition, birds and mammals may be exposed to COPCs in soil at Site 27. To determine the estimated intake of the COPCs, various key receptor species were selected to evaluate the impacts to area wildlife. The key aquatic receptors evaluated for Site 2 (Phase I) included creek chub, Pickerel frog, crayfish, great blue heron, and raccoon; key terrestrial receptors evaluated at both Sites 2 and 27 included mourning dove, chimney swift, American kestrel, wild turkey, white-footed mouse, eastern cottontail, red fox, little brown myotis, plants and soil fauna.

The conceptual site model (CSM) for Site 2/27 provides an overview of the ecological receptors and exposure pathways evaluated in the ecological risk assessment. Refer to Figures 7.7-1a and 7.7-1b for schematics of the CSM for sites 2 and 27, respectively. Multiple lines of evidence were evaluated for the ecological assessment conducted at Site 2/27. For Site 2 both terrestrial and aquatic lines of evidence were evaluated. The lines of evidence were primarily hazard quotient (HQ) calculations for a number of different receptors, but for the aquatic ecosystem, a rapid bioassessment of Harberts Creek was

also conducted. toxicity testing was also conducted. Refer to Table 7.7-11a for a summary of the terrestrial and aquatic ecosystem lines of evidence. (EPA180a,b)

The exposure pathways and receptors evaluated at this site are as follows:

- Aquatic Ecosystem (Phase I data only)
  - Great blue heron - surface water and sediment ingestion**, and dietary ingestion of fish and crayfish**~~, and dietary ingestion of invertebrates (i.e., crayfish), fish and frogs~~ **(EPA196)**
  - Raccoon - surface water and sediment ingestion**, and dietary ingestion of fish and crayfish**~~, and dietary ingestion of invertebrates (i.e., crayfish), frogs, and aquatic plants~~ **(EPA196)**
  - Creek chub, pickerel frog, crayfish - direct contact with surface water and sediment
  - Aquatic invertebrates - direct contact with surface water and sediment

- Terrestrial Ecosystem (Phase I and II data)
  (all receptors except raccoon, great blue heron, creek chub, pickerel frog, crayfish)
  - All wildlife receptors - soil ingestion
  - All wildlife receptors - surface water ingestion
  - All wildlife receptors - dietary ingestion
  - Plants - direct contact with soil
  - Soil fauna - direct contact with soil

Note: TRVs for aquatic plants were unavailable from the literature; it was assumed that risks to other aquatic life would be representative of aquatic plants.

HQs associated with ~~The exposure pathways for~~ **dietary ingestion of invertebrates (e.g., crayfish) and frogs by a receptor (e.g., great blue heron) were** ~~not~~ **quantified for only four analytes (barium, iron, manganese, and silver) because these were the only metals detected in Site 2 surface water samples. HQs associated with direct contact with sediment were calculated for a limited number of metals due to a lack of toxicity values for benthic invertebrates, creek chub, and pickerel frogs**.~~the great blue heron and raccoon receptors due to a lack of BAFs or BCFs for the metals detected in surface water and sediment samples from Harbert's Creek.~~ **An HQ could not be calculated if partition coefficients (BAF or BCF) or exposure medium data (i.e., surface water, sediment or soil) were lacking. (EPA196)**

The Harbert's Creek environment was evaluated for areas of possible groundwater discharge to surface water. No apparent seeps, springs, or other potential discharge points were observed by field personnel. Therefore, the groundwater exposure pathway was considered to be incomplete. However, exposure to ingested surface water was quantified, so if any contaminants were contributed by groundwater discharges, they would be accounted for in the surface water exposure pathway. (EPA196)

7.7.3.1 Selection of COPCs. The surface water of Harberts Creek was sampled in 1993 (Rust E&I 1993; USACHPPM 1993) and silver was detected near the Sewage Treatment Plant outfall at concentrations from 0.371 to 0.869 µg/L, which exceeded the freshwater chronic AWQC for silver (0.12 µg/L). Since that time, the silver AWQC has been withdrawn by the USEPA for further review; therefore, it is possible that the very low value may no longer apply. Additionally, the sediments of Harberts Creek were sampled in this same location, and it was found that the levels of silver, arsenic, chromium, copper, iron, manganese, nickel, and zinc detected in the sediments exceeded published sediment screening values. Due to these exceedances, each of these analytes was evaluated as a COPC for area aquatic life.

There were no detects of cyanide or TPH~~C~~ in sediment at Site 2, nor were SVOCs detected in two surface soils at Site 2 in the Phase I data. Inorganic analytes from soil data collected during Phases I and II were compared to the JPG Phase II background data set (Section 5.3.2.1). Analytes that were not statistically elevated relative to background were removed from consideration as COPCs. No comparisons to background were made for sediment or surface water at the time of this report due to the limited amount of data available for these media. The COPCs for Sites 2/27 in the various media are presented in Tables 7.7-1 through 7.7-6.

Cadmium and selenium were not detected in soil for Phase I for Sites 2 or 27. No other analytes were removed as COPCs from the Phase I soil data. For Phase II Site 27, antimony was removed as a COPC since it had a detection frequency of less than 5 percent. Selenium was removed as a COPC in soil for Phase II Site 27 since it was not statistically different from background (refer to Appendix CC). (EPA197) SVOCs were not detected in the single surface soil collected during Phase II at Site 2.

7.7.3.2 Comparison of Site Data to Reference Area Concentrations. Risks based on the Phase I and Phase II soil concentration data were compared to Cobbsfork, Rossmayne, and Avonburg reference area sample data; these data were collected in 1997. The comparisons were performed in lieu of statistical comparisons of soil concentration data in investigative areas to reference area. (EPA198) ~~A comparison of site soil concentrations for Phase I and Phase II to reference area soil concentrations was not performed at the time of this report due to schedule constraints.~~

7.7.3.3 Rapid Bioassessment of Harberts Creek. A rapid bioassessment was conducted of Harberts Creek to evaluate whether actual negative impacts (due to elevated concentrations of the COPCs) could be detected when compared to an unimpacted reference area. The RBP followed USEPA guidelines described in USEPA 1989d. Actual methods utilized are described in Section**s 5.3.3.3.1,** 5.3.3.3.3 and Appendix EE of this document. **(EPA199)** Results of the assessment are discussed separately in the following subsections.

7.7.3.3.1 Benthic Macroinvertebrates. The benthic macroinvertebrate community was sampled at three locations (A to C) near the Sewage Treatment Plant outfall into Harberts Creek. Each location consisted of a stream reach of approximately 150 meters. The results

obtained from these three locations were then compared to sampling results obtained from three upstream reference locations (A to C), which also consisted of stream reaches of approximately 150 m each along Harberts Creek. The sampling locations are shown on Figures 7.7-1 and 7.7-2, respectively. Benthic macroinvertebrate sampling methods were described in Section 5.3.3.3.3 of this document.

Macroinvertebrate samples were sent to Commonwealth Technology, Inc. (CTI) of Lexington, Kentucky, for identification and classification according to taxa, pollution tolerance level, and functional feeding group. Results are presented in Appendix EE. Following this classification, CTI calculated eight community metrics to determine if significant differences between the Site 2 area samples and the reference area samples could be detected. The results of this metrics analysis are presented in Table 7.7-7 and in Appendix EE. Each metric analysis is discussed separately in the following paragraphs.

Taxa Richness. Taxa richness reflects the health of the community by measuring the total number of families present within the stream. Generally, as water quality, habitat diversity, and habitat suitability increases, the number of taxa increases. For Site 2, the taxa richness was 19, while for the reference area, the taxa was 23. The percent comparison for Site 2 (taxa richness at Site 2 divided by the taxa richness at the reference area) was 83 percent (19/23). The percent comparison score for the reference area is assumed to be 100 percent since it is representative of unimpacted conditions. According to USEPA protocols (USEPA 1989d), sites with a percent comparison above 80 percent receive a biological condition score of 6. Therefore, both sites (Site 2 and the reference area) received a biological assessment score of 6 for taxa richness.

$$HBI = \sum x_i \frac{t_i}{n}$$

Modified Hilsenhoff Biotic Index. This index was originally developed by Hilsenhoff in 1987 to summarize the overall pollution tolerance of the benthic arthropod community with a single value. Tolerance values range from 0 to 10, increasing as water quality decreases. The index was developed as a means of detecting organic pollution in communities inhabiting rock or gravel riffles and was modified to include non-arthropod species. The formula for calculating the Modified Hilsenhoff Biotic Index (HBI) is:

where

x_i = number of individuals within a species
t_i = tolerance value of a species
n = total number of organisms in the sample

For Site 2, the HBI was 6.68, while at the reference area it was 6.48. A percent comparison was made between the two locations, resulting in a percent comparison of 97 percent for Site

2 (6.48/6.68) (assume 100 percent for the reference area). According to USEPA guidelines (USEPA 1989d), percent comparison scores greater than 85 percent result in a biological condition score of 6. Therefore, both sites (Site 2 and the reference area) received a biological assessment score of 6.

Ratio of Scrapers and Filtering Collector Functional Feeding Groups. The Scraper and Filtering Collector Functional Group ratio reflects the riffle/run community foodbase and provides insight into the nature of potential disturbance factors. The proportion of the two feeding groups is important because predominance of a particular feeding type may indicate an unbalanced community responding to an overabundance of a particular food source. The predominant feeding strategy reflects the type of impact detected (USEPA 1989d). For Site 2, the ratio of scrapers to scrapers plus filterers was 0.95. For the reference area, the ratio was 0.80. A percent comparison was then made between the two locations, resulting in a percent comparison of >100 percent for Site 2 (0.95/0.80) (assume 100 percent for the reference area). According to USEPA protocols (USEPA 1989d), percent comparison scores greater than 50 percent result in a biological condition score of 6. Therefore, both sites (Site 2 and the reference area) received a biological assessment score of 6.

Ratio of EPT and Chironomidae Abundances. The Ephemeroptera, Plecoptera, and Trichoptera (EPT) and Chironomidae abundance ratio uses relative abundance of these indicator groups as a measure of community balance. Good biotic condition is reflected in communities having a fairly even distribution among all four major groups and with substantial representation in the sensitive EPT groups. Skewed populations having a disproportionate number of the generally tolerant Chironomidae relative to the more sensitive insect groups may indicate environmental stress. Chironomids tend to become increasingly dominant in terms of percent taxonomic composition and relative abundance along a gradient of increasing enrichment of heavy metals concentration (USEPA 1989d). For Site 2, the ratio of EPT to Chironomid Abundances was 2.33. For the reference area, the ratio was 0.93. A percent comparison was then made between the two locations, resulting in a percent comparison of >100 percent for Site 2 (2.33/0.93) (assume 100 percent for the reference area). According to USEPA protocols (USEPA 1989d), percent comparison scores greater than 75 percent result in a biological condition score of 6. Therefore, both sites (Site 2 and the reference area) received a biological assessment score of 6.

Percent Contribution of Dominant Taxon. The percent contribution of the numerically dominant taxon to the total number of organisms is an indication of community balance at the lowest positive taxonomic level. A community dominated by relatively few species would indicate environmental stress. For Site 2, the percent contribution of the dominant taxon was 0.25. For the reference area, the percent contribution was 0.21. According to USEPA protocols (USEPA 1989d), percent contribution scores between 20 and 30 percent result in a biological condition score of 4. Therefore, both sites (Site 2 and the reference area) received a biological assessment score of 4.

EPT Index. The EPT Index generally increases with increasing water quality. The EPT Index is the total number of distinct taxa within the orders Ephemeroptera, Plecoptera and

Trichoptera. This value summarizes taxa richness within the insect orders that are generally considered to be pollution sensitive. For both Site 2 and the reference area, the EPT Index was 4 resulting in a percent comparison of 100 percent. According to the USEPA protocols (USEPA 1989d), percent comparison scores greater than 90 percent result in a biological condition score of 6. Therefore, both sites (Site 2 and the reference area) received a biological assessment score of 6.

Community Loss Index. The Community Loss Index was used to compare benthic communities between Site 2 and the reference area location. The Community Loss Index measures the loss of benthic species between a reference station and the site of interest. The Community Loss Index was developed by Courtemanch and Davies in 1987 and is an index of dissimilarity with values increasing as the degree of dissimilarity from the reference station increases. Values range from 0 to infinity. The Community Loss Index is calculated as follows:

$$\text{Community Loss} = (a-b)/c$$

where

a = total number of species present in the sample from the reference area
b = number of species common to both the reference area sample and the site sample
c = total number of species present in the sample from the site

For Site 2, the Community Loss Index was 0.58. For the reference area, the Community Loss Index was 0. According to USEPA protocols (USEPA 1989d), Community Loss Indices below 0.5 result in a biological condition score of 6 and Indices between 0.5 and 1.5 receive a biological condition score of 4. Therefore, Site 2 received a score of 4 and the reference area received a score of 6 for Community Similarity.

Ratio of Shredder Functional Feeding Group and Total Number of Individuals Collected. Also based on the Functional Feeding Group concept, the abundance of the Shredder Functional Group relative to the abundance of all other Functional Groups allows evaluation of potential impairment as indicated by the CPOM-based shredder community. Shredders are sensitive to riparian zone impacts and are particularly good indicators of toxic effects when the toxicants involved are readily adsorbed to the CPOM and either affect the microbial communities colonizing the CPOM or the shredders directly (USEPA 1989d).

For Site 2, the ratio of shredders to the total number of individuals was 0, whereas for the reference area, the ratio was 0.02. According to USEPA protocols (USEPA 1989d), percent comparison scores below 0.20 result in a biological condition score of 0 (0/0.02). Therefore, Site 2 received a score of 0 and the reference area received a score of 6 (0.02/0.02) for this metric.

Overall Bioassessment Based on Macroinvertebrate Sampling. The total score for Site 2 was 38, compared to the reference area which had a total score of 46 for all metrics. The overall

percent comparison score is 83 percent for Site 2 as compared to the reference area. According to USEPA guidelines (USEPA 1989d), percent comparison scores >83 percent are nonimpaired (i.e., comparable to the best situation to be expected within an ecoregion with balanced trophic structure and optimum community structure) and sites with percent comparison scores between 54 and 79 percent are slightly impaired (i.e., community structure less than expected since the community richness is lower than expected due to loss of some intolerant forms). Therefore, the biological condition for Site 2 is rated as slightly impaired to nonimpaired as compared to the reference location.

7.7.3.4 Fish. The fish community was sampled at three locations near the Sewage Treatment Plant outfall into Harberts Creek. Each location consisted of a stream reach of approximately 150 meters. The results obtained from these three locations were then compared to sampling results obtained from three upstream, reference locations, which also consisted of stream reaches of approximately 150 m each along Harberts Creek. The sampling locations are shown in Figures 7.7-1 and 7.7-2. Fish sampling methods are described in Section 5.3.3.3.3 and Appendix EE of this document.

Fish were identified and examined in the field and released back into the stream reach following identification. A few select individuals were sent to CTI for taxonomic verification and identification. Fish were then categorized according to trophic level and pollution tolerance. Results are presented in Table 7.7-8. Following this classification, the Index of Biological Integrity (IBI) metrics were calculated to determine if significant differences between the Site 2 area samples and the reference area samples could be detected. The results of this analysis are presented in Table 7.7-9. Each metric analysis is discussed separately in the following paragraphs.

Total Number of Fish Species. The total number of fish species decreases with increased degradation; hybrids and introduced species are not included. For Site 2, the total number of fish species was 9, while for the reference area, it was 12. The percent comparison score for Site 2 was 75 percent (9/12). According to USEPA guidelines (USEPA 1989d), percent comparison scores over 67 percent receive a score of 5. Therefore, both Site 2 and the reference area receive a score of 5 for this metric.

Number of Darter Species. Darters are sensitive to degradation resulting from siltation and benthic oxygen depletion because they feed and reproduce in benthic habitats. Many smaller species live within the rubble interstices, are weak swimmers, and spend their entire lives in an area from 100 to 400 m^2. For Site 2, only one species of darter was identified, while in the reference area, three species were identified. The percent comparison score for Site 2 was 33 percent. According to USEPA guidelines (USEPA 1989d), percent comparison scores between 33 and 67 percent receive a score of 3, and if over 67 percent receive a score of 5. Therefore, Site 2 received a score of 3 and the reference area received a score of 5 for this metric.

Number of Sunfish Species. Sunfish are pool species and they decrease with increased degradation of pools and instream cover. Only one species of sunfish was recorded from both

Site 2 and the reference area; therefore, each received a score of 5 since the percent comparison score was 100 percent.

Number of Sucker Species. Suckers are common in medium and large streams and are sensitive to physical and chemical habitat degradation. No sucker species were recorded at either Site 2 or in the reference area; therefore, each received a score of 1 for this metric.

Number of Intolerant Species. This metric distinguishes high and moderate quality sites using species that are intolerant of various chemical and physical perturbations. Intolerant species are usually the first to disappear following a disturbance. No intolerant species were recorded at either Site 2 or in the reference area; therefore, each received a score of 1 for this metric.

Proportion of Individuals as Green Sunfish. This metric distinguishes low from moderate quality waters. Green sunfish show increased distribution of abundance despite historical degradation of surface waters, and they shift from incidental to dominant in disturbed sites. The proportion of green sunfish at Site 2 was 9.5 percent (40/422), whereas at the reference area, the proportion was 18 percent (82/452). According to USEPA guidelines (USEPA 1989d), proportions under 10 percent receive a score of 5 and if the score is between 10 and 25 percent, the score is 3. Therefore, for this metric, Site 2 received a score of 5 and the reference area received a score of 3.

Proportion of Individuals as Omnivores. The percent of omnivores in the community increases as the physical and chemical habitat decreases. At Site 2, the proportion of omnivores was 0.5 percent (2/422). For the reference area, the proportion of omnivores was 3.8 percent (17/452). According to USEPA guidelines (USEPA 1989d), sites that have a proportion of omnivores of less than 20 percent receive a score of 5; therefore, both Site 2 and the reference area received a score of 5 for this metric.

Proportion of Individuals as Insectivores. Insectivores are the dominant trophic guild of most North American surface waters. As the invertebrate food source decreases in abundance and diversity due to physicochemical habitat deterioration, there is a shift from insectivorous to omnivorous fish species. At Site 2, the proportion of insectivores was 84 percent (355/422), whereas at the reference area, the proportion of insectivores was 67 percent (302/452). According to USEPA guidelines (USEPA 1989d), sites that have a proportion of insectivores of more than 45 percent receive a score of 5; therefore, both Site 2 and the reference area received a score of 5 for this metric.

Proportion of Individuals as Carnivores. The top carnivore metric discriminates between systems with high and moderate integrity. Top carnivores are species that feed as adults predominantly on fish, other vertebrates, or crayfish. At Site 2, the proportion of carnivores was 2 percent (8/422), whereas at the reference area, the proportion of insectivores was 1 percent (5/452). According to USEPA guidelines (USEPA 1989d), sites that have a proportion of carnivores between 1 and 5 percent receive a score of 3; therefore, both Site 2 and the reference area received a score of 3 for this metric.

Total Number of Individuals. This metric evaluates population abundance and varies with region and stream size for small streams. Unusually low numbers generally indicate toxicity, making this metric most useful at the low end of the biological integrity scale. At Site 2, the total number of individuals captured was 422, while at the reference area, 452 individuals were captured. The percent comparison is 93 percent (422/452), which, according to the guidelines, indicates a score of 5 for each site.

Proportion of Individuals as Hybrids. This metric is an estimate of reproductive isolation or the suitability of the habitat for reproduction. Generally, as environmental degradation increases, the percent of hybrids and introduced species also increases. No hybrid individuals were recorded at either Site 2 or in the reference area; therefore, each received a score of 5 for this metric.

Proportion of Individuals with Disease/Anomalies. This metric depicts the health and condition of individual fish. These conditions occur infrequently or are absent from minimally impacted sites, but occur frequently below point sources and where toxic chemicals are concentrated. At Site 2, one individual with lesions was recorded (0.2 percent), whereas at the reference area, three individuals with lesions were noted (0.7 percent). According to USEPA guidelines (USEPA 1989d), proportions below 1 percent receive a score of 5; therefore, each site received a score of 5 for this metric.

Overall Bioassessment Based on Fish Sampling Data. Site 2 and the reference area both received a total score of 48 for the above metrics. This puts both sites into an Integrity Class of "Good". This indicates that there is some decreased species richness since some intolerant species are lacking. However, since the reference area is similar to Site 2, there is no apparent effect due to Army-related activities.

7.7.3.5 Habitat Assessment. The habitat assessment matrix is intended to support the biosurvey analysis (macroinvertebrate and fish sampling data). The various habitat parameters are weighted to emphasize the most biologically significant parameters, and all parameters are evaluated for each station. The ratings are then totaled and compared to a reference to provide a final habitat ranking. The scores increase as habitat quality increases. To ensure consistency in the evaluation procedure, descriptions of the physical parameters and relative criteria are included on the rating form. Completed rating forms are included as Appendix EE.

Reference conditions are used to normalize the assessment to the "best attainable" situation. This approach is critical to the assessment because the stream characteristics will vary dramatically across different regions (USEPA 1989d). Habitat parameters pertinent to the assessment of habitat quality are separated into three principal categories: primary, secondary, and tertiary parameters. Primary parameters are those that characterize the stream "microscale" habitat and have the greatest direct influence on the structure of the indigenous communities. The primary parameters, which include characterization of the bottom substrate and available cover, estimation of embeddedness, and estimation of the flow or velocity and depth regime, have the widest score range (0 to 20) to reflect their contribution to habitat

quality. The secondary parameters measure the "macroscale" habitat such as channel morphology characteristics. These parameters evaluate channel alteration, bottom scouring and deposition, and stream sinuosity. The secondary parameters have a score range of 0 to 15. Tertiary parameters evaluate riparian and bank structure and comprise three parameters: bank stability, bank vegetation, and streamside cover. These tertiary parameters include those that are most often ignored in biosurveys. The tertiary parameters have a score range of 0 to 10. The actual habitat assessment process involves rating the nine parameters as excellent, good, fair, or poor based on the criteria included on the Habitat Assessment Field Data Sheet (Appendix EE).

A total score is obtained for each biological station and compared to a site-specific control or regional reference station. The ratio between the score for the station of interest and the score for the reference area provides a percent comparability measure for each station. The station is then classified on the basis of its similarity to expected conditions (as represented by the reference area), and its apparent potential to support an acceptable level of biological health. Listed below is a general explanation for each of the nine habitat parameters evaluated as described in USEPA 1989d. Actual scores for Site 2 and the reference area are provided in Table 7.7-10.

Bottom Substrate. Bottom substrate refers to the availability of habitat for support of aquatic organisms. A variety of substrate materials and habitat types is desirable. The presence of rock and gravel in flowing streams is generally considered the most desirable habitat, although other kinds (e.g., logs, tree roots, submerged vegetation, undercut banks, etc.) will provide excellent habitat for a variety of organisms. Site 2 received an average score of 16.7 for this parameter (equal to a rating of "excellent"), whereas the reference area received a score of 15.0 ("good").

Embeddedness. Embeddedness is the degree to which boulders, rubble, or gravel are surrounded by fine sediment. Embeddedness is used as an indicator of the suitability of the stream substrate as habitat for benthic macroinvertebrates and for fish spawning and egg incubation. Site 2 received an average score of 15.3 for this parameter ("good"), whereas the reference area received a score of 12.3 ("good").

Stream Flow and/or Velocity. Stream flow relates to the ability of a stream to provide and maintain a stable aquatic environment. Stream flow (water quantity) is most critical to the support of aquatic communities when the representative low flow is less than 5 cfs. In larger streams and rivers (>5 cfs), velocity, in conjunction with depth, has a more direct influence than flow on the structure of benthic and fish communities. Site 2 received an average score of 7.7 for this parameter ("fair"), whereas the reference area received a score of 2.7 ("poor").

Channel Alteration. The character of sediment deposits from upstream is an indication of the severity of watershed and bank erosion and stability of the stream system. The growth or appearance of sediment bars tends to increase in depth and length with continued watershed disturbance. Channel alteration also results in deposition, which may occur on the inside of bends, below channel constrictions, and where stream gradient flattens out. Channelization

decreases stream sinuosity, thereby increasing stream velocity and the potential for scouring. Site 2 received an average score of 9.3 for this parameter ("good"), whereas the reference area received a score of 9.0 ("good").

Bottom Scouring and Deposition. These parameters relate to the destruction of instream habitat resulting from the problems described above. Characteristics to observe are scoured substrate and degree of siltation in pools and riffles. Scouring results from high velocity flows and the potential for scouring is increased by channelization. Deposition and scouring result from the transport of sediment or other particulates and may be an indication of large scale watershed erosion. Site 2 received an average score of 9.3 for this parameter ("good"), whereas the reference area received a score of 8.3 ("good").

Pool/Riffle or Run/Bend Ratio. These parameters assume that a stream with riffles or bends provides more diverse habitat than a straight (run) or uniform depth stream. Bends are included because low gradient streams may not have riffle areas, but excellent habitat can be provided by the cutting action of water at bends. Site 2 received an average score of 9.0 for this parameter ("good"), whereas the reference area received a score of 9.7 ("good").

Bank Stability. Bank stability is rated by observing existing or potential detachment of soil from the upper and lower stream bank and its potential movement into the stream. Steeper banks are generally more subject to erosion and failure, and may not support stable vegetation. Streams with poor banks will often have poor instream habitat. Site 2 received an average score of 6.3 for this parameter ("good"), whereas the reference area received a score of 6.7 ("good").

Bank Vegetative Stability. Bank soil is generally held in place by plant root systems. Erosional protection may also be provided by boulder, cobble, or gravel material. An estimate of the density of bank vegetation (or proportion of boulder, cobble, or gravel material) covering the bank provides an indication of bank stability and potential instream sedimentation. Site 2 received an average score of 10.0 for this parameter ("good"), whereas the reference area received a score of 8.0 ("good").

Streamside Cover. Streamside cover vegetation is evaluated in terms of provision of stream-shading and escape cover or refuge for fish. Generally, streamside cover consisting primarily of shrubs have a higher fish standing crop than similar-size streams having trees or grass streamside cover. Site 2 received an average score of 7.3 for this parameter ("good"), whereas the reference area received a score of 6.7 ("good").

Overall Habitat Assessment. As shown in Table 7.7-10, Site 2 received a total average score of 91 for habitat assessment for the three stream segments evaluated. The upstream reference area location received a total average score of 78.3 for the three stream segments evaluated. Both of these total scores indicate a rating of "good" for each stream location. The lowest scores were for flow (the areas were evaluated during a period of little rainfall and there was almost no recordable flow in most of the stream segments). Additionally, the reference area

received lower scores than Site 2 for embeddedness, which may be a result of Papermill Road crossing the sampling area (increased sedimentation as a result of run-off from the road).

7.7.3.6 Physical Characteristics of Harberts Creek and Water Quality Evaluation. Both physical characteristics and water quality parameters are pertinent to characterization of the stream habitat. An example of the data sheet used to characterize the physical characteristics and water quality of Harberts Creek is provided in Appendix EE. Physical characterization parameters include estimations of general land use and physical stream characteristics such as width, depth, flow, and substrate. The evaluation begins with the riparian zone (stream bank and drainage area) and proceeds instream to sediment/substrate descriptions. Such information provides insight as to what organisms may be present or are expected to be present, and to presence of stream impacts. The following parameters were evaluated: predominant surrounding land use, local watershed erosion, local watershed nonpoint-source pollution, estimated stream width, estimated stream depth, high water mark, velocity, presence of dams, channelization, canopy cover, sediment odors, sediment oils, sediment deposits, inorganic substrate components, and organic substrate components. Completed field data forms are provided in Appendix EE.

Water quality data collected for this assessment included temperature, dissolved oxygen, pH, conductivity, and turbidity. Observations were also made for the presence of water odors and surface oils. Results of the water quality measurements are presented in Table 7.7-11.

Overall, both Site 2 and the reference area were very similar when assessing physical characteristics and water quality. Dissolved oxygen was slightly lower and turbidity was slightly higher in the reference area than at Site 2 and may be the result of more sedimentation of the reference area near the Papermill Road crossing. The water temperature of Harberts Creek at Site 2 was slightly higher than at the reference area, but this can be attributed to the time of day the data were collected (early morning for the reference area, early afternoon for Site 2). All of these differences are slight and not considered significant.

7.7.4 Risk Characterization

HQs and HIs were used to evaluate the estimated risks of the COPCs for key receptor species ingesting soil, surface water, and sediments at Site 2/27. For select wildlife receptors ingestion of fish and crayfish were also assessed. (EPA196). Aquatic life was evaluated for direct contact with sediments and surface water. A~~dditionally, a~~n RBP was conducted at Harberts Creek as an additional line of evidence in order to evaluate whether actual negative impacts on the aquatic life in Harberts Creek (due to elevated concentrations of the COPCs) could be detected when compared to an unimpacted reference area. The results of these evaluations are presented in the following sections.

7.7.4.1 Risk Estimation. The HIs are summarized for each sampling event and receptor below. The HIs have been grouped by order of magnitude for discussion purposes. HIs based on RME and CT exposure parameters are presented. In addition, a conservative NOAEL-based TRV and a dose at which population-level effects may occur (LOAEL-based TRV) were

used to establish the lower and upper bounds on toxicity, respectively. These values define the risk boundaries. There are thus four sets of HI values for each location and sampling event (NOAEL-RME, NOAEL-CT, LOAEL-RME, and LOAEL-CT). The HQs are presented in Appendix AA. Figures 7.7-3 through 7.7-14 show the total NOAEL and LOAEL-based HI risks for both the RME and CT exposure scenarios by receptor. ~~The reference area RME-NOAEL HIs were presented graphically only on the RME-NOAEL site graphs due to the low risks generally observed.~~ The reference area HIs were overlayed on those figures where an HI was greater than 1 for one or more receptors.

Site 2

Phase I RME NOAEL HIs
(See Figure 7.7-3)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, American Kestrel, Wild Turkey, Great Blue Heron, Raccoon, Red Fox, Little Brown Myotis, Eastern Cottontail
HI Range 1.1-10: Benthic Invertebrates, Creek Chub, Pickerel Frog
HI Range 10.1-100: White-footed Mouse
HI Range 100.1-1000: Plants, Soil Fauna

Phase I RME LOAEL HIs
(See Figure 7.7-4)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, American Kestrel, Wild Turkey, Great Blue Heron, Raccoon, Red Fox, Little Brown Myotis, Eastern Cottontail
HI Range 1.1-10: Benthic Invertebrates, Creek Chub, Pickerel Frog, Soil Fauna
HI Range 10.1-100: White-footed Mouse, Plants
HI Range 100.1-1000: None

Phase I CT NOAEL HIs
(See Figure 7.7-5)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, American Kestrel, Wild Turkey, Great Blue Heron, Raccoon, Red Fox, Little Brown Myotis, Eastern Cottontail
HI Range 1.1-10: White-footed Mouse, Benthic Invertebrates, Creek Chub, Pickerel Frog
HI Range 10.1-100: None
HI Range 100.1-1000: None

Phase I CT LOAEL HIs
(See Figure 7.7-6)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, American Kestrel, Wild Turkey, Great Blue Heron, Raccoon, Eastern Cottontail, Red Fox, Little Brown Myotis
HI Range 1.1-10: White-footed Mouse, Benthic Invertebrates, Creek Chub, Pickerel Frog
HI Range 10.1-100: None
HI Range 100.1-1000: None

Site 27

Phase I RME NOAEL HIs
(See Figure 7.7-7)
Key Receptors with HI range 0-1: Wild Turkey
HI Range 1.1-10: Mourning Dove, Red Fox
HI Range 10.1-100: Chimney Swift, American Kestrel, Little Brown Myotis
HI Range 100.1-1000: White-footed Mouse, Eastern Cottontail, Plants, Soil Fauna

Phase I RME LOAEL HIs
(See Figure 7.7-8)
Key Receptors with HI range 0-1: Mourning Dove, Wild Turkey
HI Range 1.1-10: Chimney Swift, American Kestrel, Little Brown Myotis, Red Fox
HI Range 10.1-100: Eastern Cottontail, White-footed Mouse, Plants, Soil Fauna
HI Range 100.1-1000: None

Phase I CT NOAEL HIs
(See Figure 7.7-9)
Key Receptors with HI range 0-1: Wild Turkey, Red Fox
HI Range 1.1-10: Mourning Dove, American Kestrel
HI Range 10.1-100: Chimney Swift, Little Brown Myotis

HI Range 100.1-1000: White-footed Mouse, Eastern Cottontail

Phase I CT LOAEL HIs
(See Figure 7.7-10)
Key Receptors with HI range 0-1: Mourning Dove, American Kestrel, Wild Turkey, Red Fox
HI Range 1.1-10: Chimney Swift, Little Brown Myotis
HI Range 10.1-100: White-footed Mouse, Eastern Cottontail
HI Range 100.1-1000: None

Site 27

Phase II RME NOAEL HIs
(See Figure 7.7-11)
Key Receptors with HI range 0-1: Wild Turkey
HI Range 1.1-10: Mourning Dove, Red Fox
HI Range 10.1-100: Chimney Swift, American Kestrel, Little Brown Myotis
HI Range 100.1-1000: White-footed Mouse, Eastern Cottontail, Plants, Soil Fauna

Phase II RME LOAEL HIs
(See Figure 7.7-12)
Key Receptors with HI range 0-1: Mourning Dove, Wild Turkey
HI Range 1.1-10: Red Fox, Chimney Swift, American Kestrel, Little Brown Myotis, Soil Fauna
HI Range 10.1-100: White-footed Mouse, Eastern Cottontail, Plants
HI Range 100.1-1000: None

Phase II CT NOAEL HIs
(See Figure 7.7-13)
Key Receptors with HI range 0-1: Wild Turkey, Red Fox
HI Range 1.1-10: American Kestrel, Mourning Dove~~, Chimney Swift~~
HI Range 10.1-100: Little Brown Myotis, Chimney Swift
HI Range 100.1-1000: White-footed Mouse, Eastern Cottontail

Phase II CT LOAEL HIs
(See Figure 7.7-14)
Key Receptors with HI range 0-1: Mourning Dove, American Kestrel, Chimney Swift, Wild Turkey, Red Fox
HI Range 1.1-10: Little Brown Myotis
HI Range 10.1-100: White-footed Mouse, Eastern Cottontail
HI Range 100.1-1000: None

7.7.4.2 Risk Description. Phase I and Phase II soil data for Site 2/27 and Phase I surface water and sediment data for Harberts Creek were available at this location. Extensive biological effects data were collected for aquatic receptors during Phase III. Risk estimates were made for terrestrial and aquatic receptors.

Based on the RME-NOAEL scenario for Phase I data at Site 2 (Figure 7.7-3), risks are elevated above those at the reference areas for plants and soil fauna. The total HIs for aquatic life exceeded 1 but were less than 5. These risks are based on chronic exposure.

Based on the Phase I data for Site 27 (Figure 7.7-7), risks to plants and soil fauna exceeded those at the reference areas. There were no calculations of risk to aquatic receptors for Phase I Site 27 since there were no analytical data available.

Based on the Phase II data for Site 27 (Figure 7.7-11), risks to plants and soil fauna exceeded those at the reference areas. There were no calculations of risk to aquatic receptors for Phase I Site 27 since there were no analytical data available.

7.7.4.2.1 Risk Drivers/Summary of Lines of Evidence. Risk drivers associated with Sites 2 and 27 are summarized in Tables 7.7-12 through 7.7-17. A COPC was categorized as a risk driver if it produced an HQ greater than or equal to 1 for any exposure pathway.

In addition, to provide an overall summary of the multiple lines of evidence that were evaluated for the Site, a summary table was developed. The lines of evidence were primarily hazard quotient (HQ) calculations for a number of different receptors, but for the aquatic ecosystem, a rapid bioassessment of Harberts Creek was also conducted. Evaluated attributes included benthic macroinvertebrates, fish, habitat, and the creek's physical characteristics and water quality. Refer to Table 7.7-11a for a summary of the lines of evidence. A number of measurement endpoints were assessed for both aquatic and terrestrial ecosystems. An evaluation was made of which measurement endpoints were most sensitive in determining the potential for an ecological concern by terrestrial or aquatic ecosystem. (EPA180a,b)

Terrestrial Ecosystem

The most sensitive of the terrestrial measurement endpoints are plants, soil fauna, eastern cottontail, and white-footed mice. The highest reasonable maximum exposure (RME) no observed adverse effect level (NOAEL)-based hazard indices (HIs) for each of these receptors are as described below. For Site 2, the HIs are: 498 (plants), 108 (soil fauna), and 86 (white-footed mice). The primary contributor of risk to plants is aluminum (RME NOAEL HQ of 462) from direct contact with soil. The primary contributors of risk to soil fauna are chromium (RME NOAEL HQ of 69) and iron (RME NOAEL HQ of 24) from direct contact with soil. The primary contributors of risk to white-footed mice are vanadium through soil ingestion (RME NOAEL HQ of 28) and arsenic through dietary ingestion (RME NOAEL HQ of 19). All HQs were derived using Phase I data. For Site 27, the HIs are: 690 (plants), 267 (white-footed mice), 170 (eastern cottontail), and 168 (soil fauna). The primary contributor of risk to plants is aluminum (RME NOAEL HQ of 615) from direct contact with soil. The primary contributors of risk to soil fauna are chromium (RME NOAEL HQ of 108) and iron (RME NOAEL HQ of 43) from direct contact with soil. These HQs were derived using Phase I data. The primary contributors of risk to white-footed mice are vanadium through soil ingestion

(RME NOAEL HQ of 71) and arsenic through dietary ingestion (RME NOAEL HQ of 52). The primary contributors of risk to eastern cottontail are vanadium through soil ingestion (RME NOAEL HQ of 73) and boron through dietary ingestion (RME NOAEL HQ of 23). These HQs were derived using Phase II data. (EPA180a,b)

Although HIs for plants and soil fauna exceeded 1 for Site 2, they are similar to HIs calculated for reference areas. In addition, no adverse effects significantly above background were observed in the field earthworm and plant toxicity tests conducted at Site 2. (EPA180a,b) The HI calculated for white-footed mice is similar to HIs calculated for reference areas.

Although the HIs for soil fauna, white-footed mice, and eastern cottontail exceeded 1 for Site 27, they are similar to HIs calculated for reference areas. In addition, no adverse effects significantly above background were observed in the field earthworm toxicity tests conducted at Site 27. The HI for plants is above the HIs calculated for reference areas, but it is within an order of magnitude of the reference area HIs. (EPA180a,b)

Considering that the HIs for both Sites 2 and 27 are similar to reference sites, it appears that these investigative sites would unlikely have an affect on the terrestrial ecosystem.

Aquatic Ecosystem

The most sensitive of the aquatic measurement endpoints for Site 2 are benthic invertebrates, creek chub, and pickerel frog. The maximum RME NOAEL HI for these receptors is 5. The primary contributor of risk to aquatic life is arsenic (RME NOAEL HQ of 3) through direct contact with sediment. This HQ was derived using Phase I data. HQs for aquatic measurement endpoints were not calculated for Site 27. (EPA180a,b)

The following evaluations of aquatic habitat were performed for Site 2:

- **Bioassessment of Harbert's Creek based on benthic macroinvertebrate sampling: The overall percent comparison score is 83 percent for Site 2 as compared to the reference area. The biological condition for Site 2 is rated as slightly impaired to nonimpaired as compared to the reference location.**

- **Bioassessment of Harbert's Creek based on fish sampling: Site 2 and the reference area both received a total score of 48 for the above metrics. This puts both sites into an Integrity Class of "Good".**

- **Habitat assessment: Site 2 received a total average score of 91 for habitat assessment for the three stream segments evaluated. The upstream reference area location received a total average score of 78.3 for the three stream segments evaluated. Both of these total scores indicate a rating of "good" for each stream location.**

- **Physical characteristics and water quality of Harbert's Creek: Overall, Site 2 and the reference area were very similar when assessing physical characteristics and water quality.**

Based on both lines of evidence (i.e., HIs and Field Evaluation) Harbert's Creek does not appear to be substantially effected by Site 2 activities.

7.7.4.3 Uncertainty Analysis. The analytical soil data for Site 2 are only from Phase I, which makes risk estimates at Site 2 more uncertain. This is because the Phase I data are older than the Phase II and III data and were collected and analyzed by different methodologies. Analytical data at Site 27 were obtained from both Phase I and Phase II. The Phase III reference area data are not strictly comparable; however, no other basis of comparison was available. Since there are inherent levels of risk, it is important to compare site risks to reference areas as a reality check on the risk assessment.

Uncertainty in the exposure estimates is due primarily to:

- Variability in the exposure parameters, which produce a natural distribution of the variables in the intake equations for each of the receptors;
- Exposure parameters derived from literature and not measured on site;
- Uncertainty in the dietary ingestion pathway, which utilized BAFs to predict dietary concentrations;
- Variation in the concentrations of COPCs in the environment;
- Uncertainty as to whether the most conservative pathways have been addressed and evaluated.

The predicted effect of each of these sources of uncertainty on the risk assessment is as follows:

Variability in the exposure parameters—Because both the average and RME scenarios were quantitatively addressed, this source of uncertainty is expected to have no overall effect on the risk assessment results.

Exposure parameters are derived from the literature—Because so many ecological receptors were quantitatively considered in the ecological risk assessment, this source of uncertainty is expected to have no overall effect on the risk assessment.

Uncertainty in the dietary ingestion pathway—The use of literature-based BAFs or BCFs is expected to overestimate as opposed to underestimate concentrations in the dietary pathway. This is because under laboratory conditions, animals are chronically exposed on a daily basis and supposedly reach steady state. In the wild, as animals move in and out of contaminated

areas, metabolism and excretion are expected to reduce the body burden. Use of field-based BAFs from TEAD (Rust E&I 1997) is not expected to bias risk in any direction for these analytes, since these data were measured in conjunction with co-located soil samples.

Variation in the concentrations of COPCs in the environment—This uncertainty is not expected to bias the risk assessment towards underestimation of risk since maximum or UCL95 concentrations were used in all exposure scenarios to estimate the EPCs.

Uncertainty as to whether the most conservative pathways have been addressed—The receptors were considered carefully by the DSG, and typically have high exposure rates due to their life-histories (i.e., ground-feeding or burrowing). Therefore, this source of uncertainty is not expected to impact the risk assessment.

7.7.5 Ecological Risk Assessment Summary

The conceptual site model (CSM) for Site 2/27 provides an overview of the ecological receptors and exposure pathways evaluated in the ecological risk assessment. Refer to Figure 7.7-1a for a schematic of the CSM. Site 2/27 will likely be used for industrial purposes in the future. This future land use will alter the current CSM.

Multiple lines of evidence were evaluated for the ecological assessment conducted at Site 2/27. For Site 2 both terrestrial and aquatic lines of evidence were evaluated. For Site 27 only terrestrial line of evidence were evaluated. The lines of evidence were primarily hazard quotient (HQ) calculations for a number of different receptors, but for the aquatic ecosystem, a rapid bioassessment of Harberts Creek was also conducted. Refer to Table 7.7-11a for a summary of the terrestrial and aquatic ecosystem lines of evidence. (EPA180a,b) The following is a summary of the key results of the ecological assessment by ecosystem.

7.7.5.1 Aquatic Ecosystem. **Based on the HI estimates for aquatic life that exceed (1) there is the potential for risks to some aquatic species in Harbert's Creek. However, based on the other lines of evidence collected in the field, it appears that the site has not affected the aquatic ecosystem to any great degree. (EPA200)** Based on the collection of macroinvertebrate samples, fish community sampling, water quality measurements, and a habitat assessment of Site 2 as compared to an unimpacted, upstream reference area location, the aquatic life within Harberts Creek near Site 2 does not appear to be significantly different than that occurring at the upstream reference area. Site 2 had similar macroinvertebrate and fish communities as that of the reference area; the water quality measurements were similar; and the habitat rating for Site 2 was similar to or better than the habitat rating for the reference area. As a result of this assessment, the aquatic habitat at Site 2 does not appear to be negatively impacted by former site activities, and no further studies of the stream are recommended at this time.

7.7.5.2 Terrestrial Ecosystem. While risks to plants and soil fauna are ~~slightly~~ elevated with respect to the reference areas, consideration of all lines of evidence support that contamination

at Site 2/27 is not a likely threat to ecological health at this location. Other receptors assessed for these two sites had HI comparable to reference areas. In addition, plant life and soil fauna are known to co-exist with the contamination present at the site.

7.8 CONCLUSIONS AND RECOMMENDATIONS

The Sewage Treatment Plant (Site 2) and Sewage Sludge Application Areas (Site 27) included a broad area of contamination associated with the application of sewage sludge to the ground surface, a portion of Harberts Creek where discharges from the Sewage Treatment Plant resulted in sediment contamination, and a small area of contamination adjacent to the Water Quality Laboratory. Phase I and Phase II soil sample results indicate that the primary contaminants in soils are metals. Aluminum, arsenic, beryllium, chromium, manganese, silver, and thallium were found to exceed USEPA Region 9 PRGs and were retained as COPCs. Low concentrations of the pesticides dieldrin, endrin, and DDT were also detected in site soils but the levels were below USEPA Region 9 PRGs, and as a result, they were not carried forward into the human health risk assessment.

Harberts Creek sediments were also found to contain several metals at elevated concentrations. Aluminum, arsenic, beryllium, chromium, iron, manganese, and vanadium were selected as COPCs for the sediments. Surface water from Phase I was found to contain elevated barium, manganese, and silver. However, none of these contaminants were found to exceed USEPA Region 9 PRGs for tap water. As a result, no COPCs were identified for Harberts Creek surface water.

Results of the human health risk assessment indicate that chronic health hazards due primarily to inhalation of manganese in fugitive dust at Site 2 exceed USEPA risk-based criteria for the future on-site resident. For Site 27, the hazards to the on-site resident exceed USEPA criteria as a result of incidental ingestion of surface soil and ingestion of home-grown produce contaminated with arsenic and manganese in the southwest portion of the site. Hazards estimated for the remainder of Site 27 also exceed USEPA criteria due to ingestion of silver through the milk ingestion pathway and manganese through inhalation of fugitive dusts. Incidental ingestion of soil and ingestion of home-grown produce also contribute to these hazards. Hazards for the future on-site worker barely exceed USEPA criteria primarily due to inhalation of manganese in fugitive dust. Estimated carcinogenic risks for future residents and future on-site workers are ~~all~~ within the USEPA target range of 1E-04 to 1E-06.

Results of the ecological risk assessment indicate that Harberts Creek, downstream of Site 2, does not appear to have been negatively impacted by former site activities and that no further studies of the stream are ~~warranted~~ **necessary** under the RI/FS. For the terrestrial ecosystem associated with soils at Sites 2 and 27, risks to plants and soil fauna are slightly elevated when compared to the reference areas. Given that the current and future land uses for Sites 2/27 include planting and harvesting of agricultural crops, and possible logging, the projected ecological habitat at this location is limited. However, consideration of ~~all~~ **the** lines of

evidence support the conclusion that the contamination does not pose a threat to ecological health at this location.

Due to the chronic health hazards that exceed USEPA risk-based criteria, it is recommended that this site be carried forward to the FS. Sufficient data were collected during the Phase II RI to adequately characterize the contamination and to provide the information needed to evaluate remedial alternatives. Therefore, no further investigation under the RI is ~~warranted~~ **necessary**.

TABLES

TABLE 7-1

Background Screening of Inorganic Chemicals Detected in Soil
Site 2 - Sewage Treatment Plant and Site 27 – Sewage Sludge Application Areas
Jefferson Proving Ground
Madison, Indiana

Chemical	Location	Frequency of Detection[a]	Maximum Detected Value (µg/g)	Avg. Conc. (µg/g)	Median Conc. (µg/g)	Background Threshold[b] (µg/g)	Data Distribution	Test Performed	p value	Site > Bkgd?
Surface Soil										
Aluminum	Sewage Tx Plant	2/2	23,100	20,900	20,900		NA	Extreme value	NA	**YES**
	Southwest Corner	9/9	37,200	24,933	24,100		Normal	t test	<0.001	**YES**
	Remainder of Site	23/23	43,000	21,523	19,600		Lognormal	Mann-Whitney	<0.001	**YES**
	Background	**5/5**	**9,760**	**7,704**	**7,670**	**10,900**	**Normal**			
Antimony	Sewage Tx Plant	0/2	NA	NA	NA		NA	NA	NA	No
	Southwest Corner	0/9	NA	NA	NA		NA	NA	NA	No
	Remainder of Site	1/14	3.19	0.66	0.50		Neither	Extreme value	NA	**YES**
	Background	**4/5**	**0.64**	**0.52**	**0.54**	**0.76**	**Normal**			
Arsenic	Sewage Tx Plant	2/2	13.7	9.6	9.6		NA	Extreme value	NA	**YES**
	Southwest Corner	9/9	37.1	20.2	8.9		Lognormal	t test	0.009	**YES**
	Remainder of Site	23/23	72.7	10.6	8.9		Neither	Mann-Whitney	0.001	**YES**
	Background	**5/5**	**6.82**	**5.1**	**5.1**	**7.34**	**Lognormal**			
Barium	Sewage Tx Plant	2/2	110	106	106		NA	Extreme value	NA	**YES**
	Southwest Corner	9/9	755	164	96		Neither	Mann-Whitney	0.003	**YES**
	Remainder of Site	23/23	1,650	176	119		Neither	Mann-Whitney	<0.001	**YES**
	Background	**5/5**	**62.2**	**53.4**	**50.5**	**66.0**	**Lognormal**			
Beryllium	Sewage Tx Plant	½	0.754	0.49	0.49		NA	Extreme value	NA	**YES**
	Southwest Corner	9/9	3.19	0.96	0.72		Neither	Mann-Whitney	0.007	**YES**
	Remainder of Site	16/23	6.15	0.95	0.81		Neither	Mann-Whitney	0.002	**YES**
	Background	**5/5**	**0.38**	**0.35**	**0.36**	**0.43**	**Neither**			

TABLE 7-1

Background Screening of Inorganic Chemicals Detected in Soil
Site 2 - Sewage Treatment Plant and Site 27 – Sewage Sludge Application Areas
Jefferson Proving Ground
Madison, Indiana

Chemical	Location	Frequency of Detection[a]	Maximum Detected Value (µg/g)	Avg. Conc. (µg/g)	Median Conc. (µg/g)	Background Threshold[b] (µg/g)	Data Distribution	Test Performed	p value	Site > Bkgd?
Surface Soil - cont'd										
Boron	Sewage Tx Plant	2/2	9.19	9.85	9.85		NA	NA	NA	**YES**
	Southwest Corner	3/9	16.7	27.4	8.8		Neither	NA	NA	**YES**
	Remainder of Site	18/23	408	14.0	7.5		Neither	NA	NA	**YES**
	Background	**0/5**	**NA**	**NA**	**NA**	**NA**	**NA**			
Cadmium	Sewage Tx Plant	0/2	NA	NA	NA		NA	NA	NA	No
	Southwest Corner	0/6	NA	NA	NA		NA	NA	NA	No
	Remainder of Site	5/23	2.33	0.49	0.38		Neither	Mann-Whitney	0.04	**YES**
	Background	**3/5**	**0.53**	**0.34**	**0.25**	**0.67**	**Lognormal**			
Chromium (total)	Sewage Tx Plant	2/2	27.6	24.1	24.1		NA	Extreme value	NA	**YES**
	Southwest Corner	9/9	72.2	38.9	35.9		Lognormal	t test	<0.001	**YES**
	Remainder of Site	23/23	73.0	28.2	26.0		Lognormal	t test	<0.001	**YES**
	Background	**5/5**	**14.2**	**12.2**	**11.2**	**15.7**	**Lognormal**			
Cobalt	Sewage Tx Plant	2/2	9.4	8.7	8.7		NA	Extreme value	NA	**YES**
	Southwest Corner	9/9	16.5	12.2	12.1		Normal	t test	<0.001	**YES**
	Remainder of Site	22/23	56.7	11.4	9.8		Neither	Mann-Whitney	<0.001	**YES**
	Background	**5/5**	**3.2**	**2.7**	**2.8**	**3.8**	**Normal**			
Copper	Sewage Tx Plant	2/2	15.4	14.1	14.1		NA	Extreme value	NA	**YES**
	Southwest Corner	6/9	42.3	19.1	18.3		Lognormal	Mann-Whitney	0.001	**YES**
	Remainder of Site	22/23	74.2	16.8	14.8		Neither	Mann-Whitney	<0.001	**YES**
	Background	**3/5**	**6.5**	**4.3**	**4.8**	**7.7**	**Normal**			
Lead	Sewage Tx Plant	2/2	190	106	106		NA	Extreme value	NA	**YES**
	Southwest Corner	9/9	600	87.3	26.6		Neither	Mann-Whitney	0.08	No
	Remainder of Site	23/23	45.7	22.2	20.4		Neither	Mann-Whitney	0.046	**YES**
	Background	**5/5**	**20.5**	**16.5**	**15.9**	**21.5**	**Lognormal**			

TABLE 7-1

Background Screening of Inorganic Chemicals Detected in Soil
Site 2 - Sewage Treatment Plant and Site 27 – Sewage Sludge Application Areas
Jefferson Proving Ground
Madison, Indiana

Chemical	Location	Frequency of Detection[a]	Maximum Detected Value (µg/g)	Avg. Conc. (µg/g)	Median Conc. (µg/g)	Background Threshold[b] (µg/g)	Data Distribution	Test Performed	p value	Site > Bkgd?
Surface Soil - cont'd										
Manganese	Sewage Tx Plant	2/2	832	557	557		NA	Extreme value	NA	**YES**
	Southwest Corner	9/9	1,400	709	578		Lognormal	Mann-Whitney	0.003	**YES**
	Remainder of Site	23/23	13,000	1,218	767		Neither	Mann-Whitney	<0.001	**YES**
	Background	**5/5**	**234**	**186**	**199**	**316**	**Neither**			
Mercury	Sewage Tx Plant	2/2	0.21	0.14	0.14		NA	NA	NA	**YES**
	Southwest Corner	8/9	1.10	0.33	0.096		Lognormal	NA	NA	**YES**
	Remainder of Site	12/23	1.45	0.15	0.07		Neither	NA	NA	**YES**
	Background	**0/5**	**NA**	**NA**	**NA**	**NA**	**NA**			
Molybdenum	Sewage Tx Plant	0/2	NA	NA	NA		NA	NA	NA	No
	Southwest Corner	1/9	7.44	6.0	5.0		Neither	Extreme value	NA	**YES**
	Remainder of Site	2/23	10.9	6.1	6.3		Neither	Extreme value	NA	**YES**
	Background	**2/2**[c]	**2.2**	**1.8**	**1.8**	**3.0**	NA			
Nickel	Sewage Tx Plant	2/2	12.7	12.0	12.0		NA	Extreme value	NA	**YES**
	Southwest Corner	9/9	22.5	15.5	14.8		Normal	Mann-Whitney	0.001	**YES**
	Remainder of Site	23/23	41.0	15.2	13.5		Neither	Mann-Whitney	<0.001	**YES**
	Background	**2/5**	**5.6**	**3.4**	**2.8**	**6.54**	**Lognormal**			
Selenium	Sewage Tx Plant	0/2	NA	NA	NA		NA	NA	NA	No
	Southwest Corner	2/9	6.69	0.99	0.25		Neither	Mann-Whitney	0.06	No
	Remainder of Site	3/23	0.94	0.51	0.25		Neither	Mann-Whitney	0.02	**YES**
	Background	**4/5**	**0.73**	**0.51**	**0.54**	**0.85**	**Normal**			
Silver	Sewage Tx Plant	2/2	5.3	3.1	3.1		NA	NA	NA	**YES**
	Southwest Corner	8/9	61.0	13.1	0.53		Neither	NA	NA	**YES**
	Remainder of Site	22/23	210	10.8	1.63		Lognormal	NA	NA	**YES**
	Background	**0/5**	**NA**	**NA**	**NA**	**NA**	**NA**			

TABLE 7-1

Background Screening of Inorganic Chemicals Detected in Soil
Site 2 - Sewage Treatment Plant and Site 27 – Sewage Sludge Application Areas
Jefferson Proving Ground
Madison, Indiana

Chemical	Location	Frequency of Detection[a]	Maximum Detected Value (µg/g)	Avg. Conc. (µg/g)	Median Conc. (µg/g)	Background Threshold[b] (µg/g)	Data Distribution	Test Performed	p value	Site > Bkgd?
Surface Soil - cont'd										
Thallium	Sewage Tx Plant	0/2	NA	NA	NA		NA	NA	NA	No
	Southwest Corner	6/9	2.73	6.8	1.7		Neither	Extreme value	NA	**YES**
	Remainder of Site	9/23	4.9	8.6	1.4		Neither	Extreme value	NA	**YES**
	Background	**1/1[d]**	**0.43**	NA	NA	**0.43**	NA			
Tin	Sewage Tx Plant	0/2	NA	NA	NA		NA	NA	NA	No
	Southwest Corner	2/9	13.5	7.48	5.0		Neither	NA	NA	**YES**
	Remainder of Site	2/23	10.4	5.3	5.0		Neither	NA	NA	**YES**
	Background	**0/5**	**NA**	**NA**	**NA**	**NA**	**NA**			
Vanadium	Sewage Tx Plant	2/2	37.3	35.7	35.7		NA	Extreme value	NA	**YES**
	Southwest Corner	9/9	65.2	45.3	48.5		Normal	Mann-Whitney	0.002	**YES**
	Remainder of Site	23/23	128	39.7	34.1		Neither	Mann-Whitney	<0.001	**YES**
	Background	**5/5**	**25.9**	**22.6**	**23.0**	**27.2**	**Lognormal**			
Zinc	Sewage Tx Plant	2/2	172	160	160		NA	Extreme value	NA	**YES**
	Southwest Corner	9/9	101	65.0	64.0		Lognormal	t test	<0.001	**YES**
	Remainder of Site	2323	160	68.4	55.9		Neither	Mann-Whitney	<0.001	**YES**
	Background	**5/5**	**20.3**	**19.4**	**19.2**	**20.5**	**Lognormal**			
Subsurface Soil										
Aluminum	Southwest Corner	3/3	20,700	19,533	19,700		NA	Extreme value	NA	**YES**
	Remainder of Site	7/7	23,700	17,235	16,900		Normal	t test	0.001	**YES**
	Background	**5/5**	**9,760**	**7,704**	**7,670**	**10,900**	**Normal**			
Antimony	Southwest Corner	0/3	NA	NA	NA		NA	NA	NA	No
	Remainder of Site	1/7	0.594	0.513	0.50		Neither	Extreme value	NA	No
	Background	**4/5**	**0.64**	**0.52**	**0.54**	**0.76**	**Normal**			

TABLE 7-1

Background Screening of Inorganic Chemicals Detected in Soil
Site 2 - Sewage Treatment Plant and Site 27 – Sewage Sludge Application Areas
Jefferson Proving Ground
Madison, Indiana

Chemical	Location	Frequency of Detection[a]	Maximum Detected Value (µg/g)	Avg. Conc. (µg/g)	Median Conc. (µg/g)	Background Threshold[b] (µg/g)	Data Distribution	Test Performed	p value	Site > Bkgd?
Subsurface Soil - cont'd										
Arsenic	Southwest Corner	3/3	13.7	11.0	9.99		NA	Extreme value	NA	**YES**
	Remainder of Site	7/7	15.6	8.5	7.1		Lognormal	t test	0.031	**YES**
	Background	**5/5**	**6.82**	**5.1**	**5.1**	**7.34**	**Lognormal**			
Barium	Southwest Corner	3/3	132	104	119		NA	Extreme value	NA	**YES**
	Remainder of Site	7/7	266	121	99.8		Lognormal	t test	0.01	**YES**
	Background	**5/5**	**62.2**	**53.4**	**50.5**	**66.0**	**Lognormal**			
Beryllium	Southwest Corner	0/3	NA	NA	NA		NA	NA	NA	No
	Remainder of Site	2/7	1.82	0.66	0.38		Lognormal	Mann-Whitney	0.25	No
	Background	**5/5**	**0.38**	**0.35**	**0.36**	**0.43**	**Neither**			
Boron	Southwest Corner	0/3	NA	NA	NA		NA	NA	NA	No
	Remainder of Site	1/7	4.27[e]	NA	NA		NA	NA	NA	**YES**
	Background	**0/5**	**NA**	**NA**	**NA**	**NA**	**NA**			
Cadmium	Southwest Corner	0/3	NA	NA	NA		NA	NA	NA	No
	Remainder of Site	2/7	1.04	0.49	0.49		Lognormal	Mann-Whitney	0.19	No
	Background	**3/5**	**0.53**	**0.34**	**0.25**	**0.67**	**Lognormal**			
Chromium (total)	Southwest Corner	1/3	52.6	23.1	8.7		NA	Extreme value	NA	**YES**
	Remainder of Site	5/7	30.8	19.6	21.3		Normal	Mann-Whitney	0.11	No
	Background	**5/5**	**14.2**	**12.2**	**11.2**	**15.7**	**Lognormal**			
Cobalt	Southwest Corner	0/3	NA	NA	NA		NA	NA	NA	No
	Remainder of Site	2/7	12.1	6.2	5.7		Lognormal	Mann-Whitney	0.009	**YES**
	Background	**5/5**	**3.2**	**2.7**	**2.8**	**3.8**	**Normal**			
Copper	Southwest Corner	3/3	25.7	17.4	17.3		NA	Extreme value	NA	**YES**
	Remainder of Site	7/7	16.5	10.9	11.1		Normal	t test	0.002	**YES**
	Background	**3/5**	**6.5**	**4.3**	**4.8**	**7.7**	**Normal**			

TABLE 7-1

Background Screening of Inorganic Chemicals Detected in Soil
Site 2 - Sewage Treatment Plant and Site 27 – Sewage Sludge Application Areas
Jefferson Proving Ground
Madison, Indiana

Chemical	Location	Frequency of Detection[a]	Maximum Detected Value (µg/g)	Avg. Conc. (µg/g)	Median Conc. (µg/g)	Background Threshold[b] (µg/g)	Data Distribution	Test Performed	p value	Site > Bkgd?
Subsurface Soil - cont'd										
Lead	Southwest Corner	3/3	48.0	25.5	14.6		NA	Extreme value	NA	**YES**
	Remainder of Site	7/7	29.1	19.8	18.8		Lognormal	t test	0.11[f]	No
	Background	**5/5**	**20.5**	**16.5**	**15.9**	**21.5**	**Lognormal**			
Manganese	Southwest Corner	3/3	3,950	1,670	913		NA	Extreme value	NA	**YES**
	Remainder of Site	7/7	2,925	1,170	1,020		Lognormal	Mann-Whitney	0.002	**YES**
	Background	**5/5**	**234**	**186**	**199**	**316**	**Neither**			
Mercury	Southwest Corner	0/3	NA	NA	NA		NA	NA	NA	No
	Remainder of Site	2/7	0.127	0.068	0.062		Neither	NA	NA	**YES**
	Background	**0/5**	**NA**	**NA**	**NA**	**NA**	**NA**			
Molybdenum	Southwest Corner	0/3	NA	NA	NA		NA	NA	NA	No
	Remainder of Site	2/7	1.39[e]	NA	NA		NA	Extreme value	NA	No
	Background	**2/2[c]**	**2.2**	**1.8**	**1.8**	**3.0**	**NA**			
Nickel	Southwest Corner	0/3	NA	NA	NA		NA	NA	NA	No
	Remainder of Site	2/7	35.8	10.9	7.1		Lognormal	Mann-Whitney	0.006	**YES**
	Background	**2/5**	**5.6**	**3.4**	**2.8**	**6.54**	**Lognormal**			
Selenium	Southwest Corner	0/3	NA	NA	NA		NA	NA	NA	No
	Remainder of Site	3/7	0.96	0.47	0.25		Neither	Mann-Whitney	0.34	No
	Background	**4/5**	**0.73**	**0.51**	**0.54**	**0.85**	**Normal**			
Silver	Southwest Corner	3/3	1.64	1.08	1.08		NA	NA	NA	**YES**
	Remainder of Site	5/7	0.94	0.55	0.50		Lognormal	NA	NA	**YES**
	Background	**0/5**	**NA**	**NA**	**NA**	**NA**	**NA**			
Thallium	Southwest Corner	3/3	1.46	1.20	1.23		NA	Extreme value	NA	**YES**
	Remainder of Site	7/7	1.59	1.15	1.11		Lognormal	Extreme value	NA	**YES**
	Background	**1/1[d]**	**0.43**	**NA**	**NA**	**0.43**	**NA**			

TABLE 7-1

Background Screening of Inorganic Chemicals Detected in Soil
Site 2 - Sewage Treatment Plant and Site 27 – Sewage Sludge Application Areas
Jefferson Proving Ground
Madison, Indiana

Chemical	Location	Frequency of Detection[a]	Maximum Detected Value (µg/g)	Avg. Conc. (µg/g)	Median Conc. (µg/g)	Background Threshold[b] (µg/g)	Data Distribution	Test Performed	p value	Site > Bkgd?
Subsurface Soil - cont'd										
Tin	Southwest Corner	0/3	NA	NA	NA		NA	NA	NA	No
	Remainder of Site	2/7	8.5	6.0	6.2		Neither	NA	NA	**YES**
	Background	**0/5**	**NA**	**NA**	**NA**	**NA**	**NA**			
Vanadium	Southwest Corner	3/3	39.3	35.4	34.8		NA	Extreme value	NA	**YES**
	Remainder of Site	7/7	37.8	28.2	27.4		Lognormal	t test	0.017	**YES**
	Background	**5/5**	**25.9**	**22.6**	**23.0**	**27.2**	**Lognormal**			
Zinc	Southwest Corner	3/3	57.0	42.5	38.8		NA	Extreme value	NA	**YES**
	Remainder of Site	7/7	243	78.3	48.6		Neither	Mann-Whitney	0.002	**YES**
	Background	**5/5**	**20.3**	**19.4**	**19.2**	**20.5**	**Lognormal**			

Note:

NA = Not applicable.

Footnotes:

(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Average concentration plus two times the standard deviation. Values presented rounded up to the number of decimals in the values reported by the laboratory.
(c) Because the molybdenum nondetect values (½ of detection limit) were higher than the maximum detected value, only the two detected values were used to calculate the background threshold value.
(d) Because the thallium nondetect values (½ of detection limit) were higher than the maximum detected value, only the one detect value was used to determine the background threshold value.
(e) For the purposes of background comparisons, nondetect values (½ of the detection limit) were not used if they were higher than the maximum detected value.
(f) The 95% confidence interval for the difference between the two log transformed means is: -0.114 - 0.446.

TABLE 7-2

Background Screening of Inorganic Chemicals Detected in Sediment
Harberts Creek
Jefferson Proving Ground
Madison, Indiana

Chemical	Location	Frequency of Detection[a]	Maximum Detected Value (µg/g)[b]	Avg. Conc. (µg/g)	Median Conc. (µg/g)	Background(Bkgd.) Threshold (µg/g)	Data Distribution	Test Performed	p value	Site > Bkgd?
Arsenic	Site	5/5	26.1	13.7	12.6		Lognormal	t test	0.03	**YES**
	Background	**6/6**	**11.0**	**6.1**	**5.7**	**13.7**	**Lognormal**			

Foonotes:
(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Micrograms per gram.

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TABLE 7-3

Background Screening of Inorganic Chemicals Detected in Surface Water
Harberts Creek
Jefferson Proving Ground
Madison, Indiana

Chemical	**Frequency of Detection**[(a)]	**Maximum Detected Value (µg/L)**[(b)]	**Surface Water Background Screening Value**[(c)] **(µg/L)**	**Exceeds Surface Water Background?**
Silver	2/2	0.869	0.53	**YES**

Footnotes:

(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Micrograms per liter.
(c) See Section 5.1.4.5.2 for an explanation of how the surface water background screening values were calculated.

TABLE 7-4

Analytical Results for Metals in Surface Soil Samples
Site 2 - Sewage Treatment Plant and Site 27 - Sewage Sludge Application Areas
Jefferson Proving Ground
Madison, Indiana

Analyte	STP02SF001 11/11/92 (ug/g)	STP02SF002 11/11/92 (ug/g)	SSA27SF001 11/10/92 (ug/g)	SSA27SF002 11/11/92 (ug/g)	SSA27SF003 11/11/92 (ug/g)	SSA27SF004 11/11/92 (ug/g)	SSA27SF005 11/11/92 (ug/g)	SSA27SF006 11/11/92 (ug/g)	Background (µg/g)[a]
Aluminum	18,700	23,100	37,200	31,400	30,200	27,700	31,900	20,200	10,900
Antimony	LT[b] 19.6	LT 19.6	LT/R 19.6	LT/R 19.6	LT/R 19.6	LT/R 19.6	LT/R 19.6	LT/R 19.6	0.67
Arsenic	13.7	5.46	6.48	7.08	15.0	8.94	6.97	9.21	7.34
Barium	101	110	118	73.8	113	126	500	174	66.0
Beryllium	0.754	LT 0.427	0.674	0.835	0.723	0.779	1.60	1.11	0.43
Boron	9.19	10.5	10.3	LT 6.64	9.71	LT 6.64	10.4	11.0	0
Cadmium	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	2.33	LT 1.2	0.67
Calcium	19,000	56,600	1,030	1,350	1,340	2,510	2,350	2,360	639
Chromium	20.6	27.6	35.9	72.2	38.7	27.5	40.5	29.3	15.7
Cobalt	7.95	9.41	9.07	15.4	16.5	11.4	56.7	12.3	3.80
Copper	12.7	15.4	16.1	18.3	24.1	15.2	29.5	10.7	7.70
Iron	23,800	22,500	31,600	42,800	34,900	28,700	85,000	26,400	13,000
Lead	22.3	190	10.4	16.3	600	45.0	14.3	15.7	21.5
Magnesium	5,830	11,700	2,110	1,690	1,580	2,600	1,710	1,640	781
Manganese	832	281	401	578	1,400	647	13,000	1,600	316
Mercury	0.211	0.074	LT 0.05	0.096	0.067	0.071	0.103	0.136	0
Molybdenum	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	3.0
Nickel	12.7	11.3	17.6	20.1	14.2	17.3	41.0	13.5	6.54
Potassium	1,230	1,290	1,730	1,280	1,280	1,950	1,220	1,240	657
Selenium	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	0.85
Silver	5.30	0.80	0.53	5.50	0.40	0.58	1.90	8.00	0
Sodium	82.8	113	70.5	LT 38.7	LT 38.7	58.9	70.5	LT 38.7	45.1
Thallium	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	0.43
Tin	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	0
Vanadium	34.1	37.3	51.9	62.6	44.8	40.7	77.5	41.9	27.2
Zinc	148	172	64.0	67.6	98.8	66.1	101	55.5	20.5
Cyanide	NA	NA	LT 0.25	0.572	0.643	LT 0.25	LT 0.25	LT 0.25	NA

TABLE 7-4

Analytical Results for Metals in Surface Soil Samples
Site 2 - Sewage Treatment Plant and Site 27 - Sewage Sludge Application Areas
Jefferson Proving Ground
Madison, Indiana

Analyte	SSA27SF007 11/11/92 (ug/g)	SSA27SF008 11/11/92 (ug/g)	SSA27SF009 11/11/92 (ug/g)	SSA27SF010 11/11/9 (ug/g)	SSA27SF011 11/11/92 (ug/g)	SSA27SF012 11/11/92 (ug/g)	SSA27SF017 05/09/96 (ug/g)	SSA27SF018 05/09/96 (ug/g)	SSA27SF19 05/09/96 (ug/g)	Background (µg/g)
Aluminum	17,900	20,400	33,100	23,100	28,000	30,700	14,000	18,700	22,700	10,900
Antimony	LT/R 19.6	LT/R 19.6	LT/R 19.6	LT/R 19.6	LT/R 19.6	LT/R 19.6	LT 1.0	LT 1.0	LT 1.0	0.67
Arsenic	5.68	4.10	8.33	6.56	8.82	9.73	9.09	11.3	9.6	7.34
Barium	139	198	113	118	132	118	101	88.1	95.1	66.0
Beryllium	1.00	1.31	0.717	0.594	0.880	0.805	LT 0.767	LT 0.660	LT 0.699	0.43
Boron	9.94	12.5	13.8	12.0	15.5	16.7	4.38	5.54	6.30	0
Cadmium	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 0.641	0.326	LT 0.600	0.67
Calcium	1,770	1,670	2,430	13,800	2,410	2,740	1,270	1,720	2,000	639
Chromium	19.8	21.7	30.8	48.3	36.2	31.0	31.8	22.6	24.0	15.7
Cobalt	9.24	9.84	11.1	9.61	11.1	10.0	8.72	6.28	8.82	3.80
Copper	9.76	8.61	17.6	33.5	18.8	15.8	13.3	22.7	15.6	7.70
Iron	19,500	20,100	32,200	24,000	28,200	28,000	20,300	25,600	22,100	13,000
Lead	14.1	13.1	13.7	19.6	17.8	18.8	23.8	24.7	20.4	21.5
Magnesium	1,470	1,530	2,500	4,830	2,500	2,390	1,370	2,600	1,690	781
Manganese	1,290	1,800	561	602	725	670	767	220	444	316
Mercury	LT 0.05	LT 0.05	LT 0.05	0.257	0.067	LT 0.05	0.141	0.282	0.247	0
Molybdenum	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	12.8	LT 10.0	LT 12.0	3.0
Nickel	12.8	15.1	16.9	11.9	15.6	15.6	10.9	12.6	15.1	6.54
Potassium	1,020	1,380	1,960	1,400	2,120	2,080	526	1,100	1,300	657
Selenium	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.945	LT 0.50	LT 0.50	0.85
Silver	0.0979	0.125	0.105	210	8.60	0.316	7.62	17.5	6.73	0
Sodium	LT 38.7	70.1	77.9	82.2	81.9	96.5	LT 20.0	32.5	47.2	45.1
Thallium	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 1.00	0.603	1.21	27.2
Tin	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 12.8	LT 13.2	LT 12.0	0
Vanadium	31.0	30.5	48.1	35.2	45.7	46.9	29.9	30.3	34.1	27.2
Zinc	50.4	55.9	64.0	160	89.7	64.5	66.8	104	54.4	20.5
Cyanide	LT 0.25	LT 0.25	LT 0.25	3.89	LT 0.25	LT 0.25	NA	NA	NA	NA

TABLE 7-4

Analytical Results for Metals in Surface Soil Samples
Site 2 - Sewage Treatment Plant and Site 27 - Sewage Sludge Application Areas
Jefferson Proving Ground
Madison, Indiana

Analyte	SSA27SF20 05/09/96 (ug/g)	SSA27SF21 05/10/96 (ug/g)	SSA27SF22 05/09/96 (ug/g)	SSA27SF23 05/09/96 (ug/g)	SSA27SF24 05/10/96 (ug/g)	SSA27SF25 05/10/96 (ug/g)	SSA27SF26 05/10/96 (ug/g)	SSA27SF27 05/10/96 (ug/g)	Background (µg/g)
Aluminum	9,910	18,100	43,800	24,800	24,100	31,900	17,200	14,500	10,900
Antimony	LT 1.00	LT 1.28	3.19	LT 1.00	LT 1.85	LT 1.29	LT 1.00	LT 1.00	0.67
Arsenic	12.2	16.1	72.7	10.5	37.1	11.4	8.03	9.6	7.34
Barium	103	120	1650	99.5	755	96.7	74.9	95.1	66.0
Beryllium	1.06	0.852	6.15	LT 0.705	3.19	0.807	0.640	0.323	0.43
Boron	LT 10.0	LT 13.8	408	7.83	184	LT 22.5	LT 14.9	LT 6.30	0
Cadmium	0.423	LT 0.50	LT 1.11	LT 0.617	LT 0.933	LT 0.50	LT 0.50	0.60	0.67
Calcium	903	1,230	40,500	2,310	96,800	866	1,330	2,000	639
Chromium	19.2	22.4	73.0	26.0	38.5	33.8	28.8	24.0	15.7
Cobalt	9.49	11.5	20.0	9.42	12.2	10.4	11.9	8.82	3.80
Copper	7.19	27.6	74.2	15.2	42.3	20.7	LT 18.8	LT 15.6	7.70
Iron	18,700	20,700	29,600	22,300	18,900	25,900	22,000	22,100	13,000
Lead	24.1	23.7	45.7	24.3	26.6	23.4	19.6	20.4	21.5
Magnesium	860	1,900	9,220	1,980	40,700	1,760	1,450	1,690	781
Manganese	1,370	851	301	563	389	408	574	444	316
Mercury	0.128	0.062	0.738	LT 0.123	1.10	0.0825	1.45	0.247	0
Molybdenum	1.55	LT 10.0	10.9	LT 10.0	7.44	LT 10.0	LT 10.0	LT 10.0	3.0
Nickel	9.60	16.3	35.8	15.3	22.5	19.9	11.2	15.1	6.54
Potassium	441	1,090	2,510	1,600	1,550	1,930	920	1,300	657
Selenium	LT 0.674	0.839	18.4	LT 0.617	6.69	LT 0.50	LT 0.50	LT 0.50	0.85
Silver	0.486	0.635	11.5	1.63	47.4	1.92	29.9	6.73	0
Sodium	LT 20.0	35.3	1,720	57.4	972	63.3	26.4	47.2	45.1
Thallium	LT 1.00	0.983	4.90	1.07	2.73	1.16	1.60	1.21	0.43
Tin	LT 10.0	LT 10.0	LT 10.0	LT 12.3	13.5	LT 10.0	LT 10.0	LT 10.0	0
Vanadium	31.7	33.9	128	39.1	65.2	50.5	32.2	34.1	27.2
Zinc	34.6	53.6	121	54.1	101	69.8	55.7	54.4	20.5

TABLE 7-4

Analytical Results for Metals in Surface Soil Samples
Site 2 - Sewage Treatment Plant and Site 27 - Sewage Sludge Application Areas
Jefferson Proving Ground
Madison, Indiana

Analyte	SSA27SF28 05/10/96 (ug/g)	SSA27SF29 05/09/96 (ug/g)	SSA27SF30 05/09/96 (ug/g)	SSA27SF31 05/10/96 (ug/g)	SSA27SF32 05/09/96 (ug/g)	SSA27SF33 05/09/96 (ug/g)	SSA27SF34 05/09/96 (ug/g)	SSA27SF35 05/10/96 (ug/g)	SSA27SF36 05/09/96 (ug/g)	Background (µg/g)
Aluminum	17,100	15,000	12,400	15,400	15,600	19,600	13,900	22,600	14,900	10,900
Antimony	LT 1.00	LT 1.26	LT 1.29	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	0.67
Arsenic	8.81	8.34	5.79	8.89	7.92	11.5	6.31	11.8	9.94	7.34
Barium	72.6	119	142	96.0	165	164	114	92.5	112	66.0
Beryllium	0.669	LT 0.930	LT 0.983	0.668	LT 1.07	1.21	LT 0.782	0.783	0.907	0.43
Boron	LT 12.8	6.52	LT 10.0	LT 12.8	5.63	6.81	4.54	LT 17.6	LT 10.0	0
Cadmium	LT 0.50	LT 0.632	LT 0.644	LT 0.50	LT 0.633	LT 0.633	LT 0.638	LT 0.50	0.255	0.67
Calcium	2,090	2,570	1,420	1,840	1,560	2,400	1,660	1,750	2,000	639
Chromium	32.8	21.1	14.9	17.3	19.7	27.4	16.3	64.0	20.8	15.7
Cobalt	10.8	9.23	6.94	14.5	9.9	10.5	5.50	14.9	10.5	3.80
Copper	LT16.0	7.75	7.05	28.3	9.47	10.0	8.19	LT 14.9	14.8	7.70
Iron	21,500	14,200	11,800	19,300	14,700	19,600	13,400	25,800	20,400	13,000
Lead	41.0	22.4	19.6	27.9	20.8	24.8	19.3	28.7	27.8	21.5
Magnesium	1,210	1,660	1,030	1,520	1,480	1,720	1,080	1,620	1,570	781
Manganese	742	1,220	1,270	949	1,410	1,460	713	1,300	1,100	316
Mercury	1.06	LT 0.126	LT0.129	0.082	LT 0.127	LT 0.131	LT 0.128	0.110	LT 0.127	0
Molybdenum	LT 10.0	12.6	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0	3.0
Nickel	10.5	11.9	12.0	12.7	LT 13.4	16.6	11.4	14.8	12.0	6.54
Potassium	777	1,150	624	911	LT 1,220	1,460	733	1,290	630	657
Selenium	LT 0.50	LT 0.632	LT 0.644	0.589	LT 0.50	LT 1.36	LT 0.50	LT 0.50	0.806	0.85
Silver	61.0	1.80	0.441	0.438	LT 1.00	0.355	0.296	0.346	8.09	0
Sodium	LT 24.6	42.5	24.5	LT 25.5	30.8	59.7	33.5	44.5	24.8	45.1
Thallium	1.34	0.869	LT 1.0	1.33	LT 1.00	1.41	0.676	1.74	LT 1.00	0.43
Tin	LT 10.0	LT 10.0	LT 12.9	LT 10.0	LT 12.7	LT 14.4	LT 13.0	2.70	LT 12.5	0
Vanadium	32.1	29.3	22.0	27.8	26.8	38.5	24.9	48.5	29.9	27.2
Zinc	54.5	50.4	44.4	49.2	48.1	62.0	52.6	51.3	74.7	20.5

TABLE 7-4

Analytical Results for Metals in Surface Soil Samples
Site 2 - Sewage Treatment Plant and Site 27 - Sewage Sludge Application Areas
Jefferson Proving Ground
Madison, Indiana

Boring ID	SSA27BHA	SSA27BHA	SSA27BHA	SSA27BHB	SSA27BHB	SSA27BHC	SSA27BHC	SSA27BHD	SSA27BHD	SSA27BHD	
Sample No.	01	02	03	01	02	01	02	01	02	03	
Depth (feet)	2	5	10	2	5	2	5	2	5	10	
Sample Date											
Analyte	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	Background (µg/g)
Aluminum	18,200	20,700	19,700	10,400	10,600	16,900	14,000	22,700	23,700	23,200	10,900
Antimony	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	0.67
Arsenic	9.99	13.7	9.39	6.25	5.98	9.32	6.81	9.68	5.19	14.2	7.34
Barium	61.4	119	132	93.5	43.6	87.9	104	93.8	153	269	66.0
Beryllium	LT 0.588	LT 0.833	LT 0.928	LT 0.745	LT 0.600	LT 0.618	LT 0.749	LT 0.693	LT 1.42	LT 1.91	0.43
Boron	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0	4.27	LT 10.0	LT 10.0	0
Cadmium	LT 10.0	LT 1.00	LT 0.618	LT 0.605	LT 0.600	LT 1.00	LT 0.621	LT 1.00	LT 0.617	LT 1.08	0.67
Calcium	362	402	1,310	1,100	974	1,610	4,710	1,420	3,020	5,910	639
Chromium	52.6	LT 16.0	LT 17.3	LT 14.4	LT 13.3	21.3	LT 18.5	26.9	21.8	30.1	15.7
Cobalt	5.88	LT 39.9	LT 6.39	LT 8.11	LT 6.00	LT 11.6	LT 6.26	LT 11.4	LT 8.64	LT 9.55	3.80
Copper	9.19	25.7	17.3	6.15	6.88	14.0	8.34	12.5	11.1	16.5	7.70
Iron	25,400	29,500	25,600	13,700	17,000	21,800	16,400	21,800	16,900	32,300	13,000
Lead	13.9	48.0	14.6	16.9	13.8	18.8	15.0	20.8	22.6	30.0	21.5
Magnesium	838	957	1,210	857	900	1,660	1,200	1,590	1,440	1,780	781
Manganese	149	3,950	913	1020	318	468	862	1,020	1,550	2,860	316
Mercury	0.118	LT 0.123	LT 0.124	LT 0.121	LT 0.120	LT 0.124	LT 1.39	LT 0.121	LT 0.123	LT 0.130	0
Molybdenum	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0	1.39	LT 10.0	LT 10.0	0.797	3.0
Nickel	LT 9.00	LT 10.1	LT 13.3	LT 8.57	LT 8.06	LT 11.6	LT 12.0	LT 14.2	LT 16.0	LT 32.3	6.54
Potassium	LT 659	LT 719	LT 828	LT 399	LT 521	LT 769	LT 677	LT 1,140	LT 708	LT 878	657
Selenium	LT 0.50	LT 1.11	LT 2.50	1.00	LT 0.50	LT 0.50	LT 0.50	0.697	LT 0.50	0.566	0.85
Silver	1.08	0.523	1.64	1.01	0.714	LT 1.00	0.445	0.313	LT 1.00	0.657	0
Sodium	LT 20.0	21.2	28.7	20.3	20.8	22.6	29.8	41.1	44.8	66.2	45.1
Thallium	1.46	0.911	1.23	LT 1.0	1.11	1.53	0.742	1.59	0.847	0.932	0.43
Tin	LT 11.8	LT 12.3	LT 12.4	LT 12.1	LT 12.0	LT 12.4	LT 12.4	LT 12.1	LT 12.3	LT 10.0	0
Vanadium	39.3	34.8	32.0	22.5	22.8	27.4	27.8	37.8	26.5	41.6	27.2
Zinc	31.8	38.8	57.0	34.0	38.8	43.9	48.6	48.8	88.8	279	20.5

Note:
All surface soil samples are at zero depth.
R= Data qualified as unusable.

Footnotes:
(a) Micrograms per gram; all values are in µg/g.
(b) Less than the method reporting limit.

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TABLE 7-5

Summary of Organic Contaminants Detected in Composite Surface Soil Samples
Site 27 - Sewage Application Area
Jefferson Proving Ground
Madison, Indiana

Sample ID	Contaminant	Concentration (µg/g)[(a)]
SSA27SF013	Dieldrin	0.00822
	Endrin	0.01750
SSA27SF014	Dieldrin	0.00762
	Endrin	0.01280
	ppDDT	0.01390

Footnotes:

(a) Micrograms per gram.

N:\Jobs\244\0025\01\wp\tbl\Table 7-5.doc

TABLE 7-6

Analytical Results for Metals and Anions in Sediment and Surface Water Samples
Site 2 - SewageTreatment Plant and Site 27 - Sewage Sludge Application Areas
Jefferson Proving Ground
Madison, Indiana

	Sediment					Surface Water			
Sample ID / Analyte	STP02SD001 (µg/g)[(a)] Upstream	STP02SD002 (µg/g) Upstream	STP02SD003 (µg/g) Downstream	STP02SD004 (µg/g) Downstream	STP02SD005 (µg/g) Downstream	STP02SW001 (µg/L)[(b)] Downstream	STP02SW001 Filtered (µgL)	STP02SW002 (µg/L) Upstream	STP02SW002 Filtered (µg/L)
Aluminum	3,080	2,690	19,300	5,980	22,100	LT[(c)] 112	LT 112	LT 112	LT 112
Antimony	LT 19.6	LT 19.6	LT 19.6	LT 19.6	LT 19.6	LT 60.0	LT 60.0	LT 60.0	LT 60.0
Arsenic	15.5	12.6	8.12	26.1	6.16	LT 2.35	LT 2.35	LT 2.35	LT 2.35
Barium	86.9	375	145	74.4	84.4	66.6	66.9	66.8	66.1
Beryllium	0.758	0.773	1.11	2.35	0.624	LT 1.12	LT 1.12	LT 1.12	LT 1.12
Boron	LT 6.64	LT 6.64	11.1	LT 6.64	LT 6.64	LT 230	LT 230	LT 230	LT 230
Cadmium	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 6.78	LT 6.78	LT 6.78	LT 6.78
Calcium	2,290	41,000	5,530	2,200	8,780	51,100	50,600	51,100	49,600
Chromium	17.4	17.7	43.5	44.7	19.1	LT 16.8	LT 16.8	LT 16.8	LT 16.8
Cobalt	6.95	9.63	8.22	14.5	9.38	LT 25.0	LT 25.0	LT 25.0	LT 25.0
Copper	6.59	4.73	21.7	13.1	13.6	LT 18.8	LT 18.8	LT 18.8	LT 18.8
Iron	32,300	33,300	30,400	79,000	28,800	238	LT 77.5	214	LT 77.5
Lead	16.0	12.5	10.8	9.52	12.1	LT 4.47	LT 4.47	LT 4.47	LT 4.47
Magnesium	733	7,230	2,390	594	3,830	15,500	15,300	15,500	15,100
Manganese	691	2,200	670	1,400	1,020	57.4	51.3	52.4	51.9
Mercury	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.10	LT 0.10	LT 0.10	LT 0.10
Molybdenum	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 52.7	LT 52.7	LT 52.7	LT 52.7
Nickel	9.78	11.3	28.8	25.8	11.6	LT 32.1	LT 32.1	LT 32.1	LT 32.1
Potassium	LT 131	LT 131	765	246	774	2,600	2,420	2,490	2,600
Selenium	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 2.53	LT 2.53	LT 2.53	LT 2.53
Silver	0.330	0.390	2.20	17.0	0.95	0.869	LT 0.333	0.371	LT 0.333
Sodium	55.7	251	331	92.4	102	14,200	14,400	13,000	14,500
Tellurium	LT 14.9	LT 14.9	LT 14.9	LT 14.9	LT 14.9	LT 118	LT 118	LT 118	LT 118
Thallium	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 125	LT 125	LT 125	LT 125
Tin	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 59.9	LT 59.9	LT 59.9	LT 59.9
Vanadium	53.3	53.7	35.1	138	38.5	LT 27.6	LT 27.6	LT 27.6	LT 27.6
Zinc	54.0	78.3	185	104	55.0	LT 18.0	LT 18.0	LT 18.0	LT 18.0
Cyanide	LT 0.25	LT 0.25	LT 0.25	LT 0.25	LT 0.25	NA[(d)]	NA	NA	NA
Chloride	NA	NA	NA	NA	NA	11,000	NA	10,000	NA
Fluoride	NA	NA	NA	NA	NA	172	NA	191	NA
Nitrite/Nitrate	NA	NA	NA	NA	NA	770	NA	590	NA
Phosphorus	NA	NA	NA	NA	NA	77.3	NA	44.6	NA
Sulfate	NA	NA	NA	NA	NA	32,000	NA	32,000	NA

Footnotes:

(a) Micrograms per grams.
(b) Micrograms per liter.
(c) Less than the method reporting limit.
(d) Not analyzed.

TABLE 7-7

Soil Exposure Point Concentrations of Contaminants of Potential Concern
Site 2 – Sewage Treatment Plant and Site 27 - Sewage Sludge Application Area
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[(a)]	Range of Detected Values (µg/g)[(b)]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[(c)] (µg/g)
Surface Soil - Sewage Treatment Plant						
Aluminum	2/2	18,700 - 23,100	NA[(d)]	20,900	NC[(e)]	23,100
Arsenic	2/2	5.46 - 13.7	NA	9.58	NC	13.7
Barium	2/2	101 - 110	NA	105.5	NC	110
Beryllium	½	0.754	0.427	0.48	NC	0.754
Boron	2/2	9.19 - 10.5	NA	9.85	NC	10.5
Chromium	2/2	20.6 - 27.6	NA	24.1	NC	27.6
Cobalt	2/2	7.95 - 9.41	NA	8.68	NC	9.41
Copper	2/2	12.7 - 15.4	NA	14.0	NC	15.4
Lead	2/2	22.3 - 190	NA	106	NC	190
Manganese	2/2	281 - 832	NA	556	NC	832
Mercury	2/2	0.075 - 0.211	NA	0.143	NC	0.211
Nickel	2/2	11.3 - 12.7	NA	12.0	NC	12.7

TABLE 7-7

Soil Exposure Point Concentrations of Contaminants of Potential Concern
Site 2 – Sewage Treatment Plant and Site 27 - Sewage Sludge Application Area
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/g)[b]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[c] (µg/g)
Surface Soil - Sewage Treatment Plant						
Silver	2/2	0.80 - 5.3	NA	3.1	NC	5.3
Vanadium	2/2	34.1 - 37.3	NA	35.7	NC	37.3
Zinc	2/2	148 - 172	NA	160	NC	172
Surface Soil - Southwest Corner of Site 27						
Aluminum	9/9	14,500 - 37,200	NA	24,933	30,007	30,007
Arsenic	9/9	5.36 - 37.1	NA	12.4	20.2	20.2
Barium	9/9	56.7 - 755	NA	164	313	313
Beryllium	9/9	0.32 - 3.19	NA	0.96	1.58	1.58
Boron	3/9	9.70 - 184	6.64 - 22.5	27.4	88.3	88.3
Chromium	9/9	17.3 - 72.2	NA	38.9	58.5	58.5
Cobalt	9/9	6.06 - 16.5	NA	12.2	14.3	14.3
Copper	6/9	16.1 - 42.3	13.2 - 16.0	19.1	36.1	36.1
Manganese	9/9	218 - 1,400	NA	709	1,298	1,298
Mercury	8/9	0.067 - 1.10	0.05	0.33	2.18	1.10
Molybdenum	1/9	7.44	10.0 - 14.3	5.99	6.72	6.72

TABLE 7-7

Soil Exposure Point Concentrations of Contaminants of Potential Concern
Site 2 – Sewage Treatment Plant and Site 27 - Sewage Sludge Application Area
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/g)[b]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[c] (µg/g)
Surface Soil - Southwest Corner of Site 27						
Nickel	9/9	7.51 - 22.5	NA	15.5	18.6	18.6
Silver	8/9	0.346 - 61.0	1.0	13.1	1,331	61.0
Thallium	6/9	1.16 - 2.73	34.3	6.8	39.0	2.73
Tin	2/9	2.70 - 13.5	7.43 - 10.0	5.26	7.48	7.48
Vanadium	9/9	24.2 - 65.2	NA	45.3	54.3	54.3
Zinc	9/9	29.3 - 101	NA	65.0	87.5	87.5
Cyanide	2/3	0.572 - 0.643	0.25	0.45	NC	0.643
Surface Soil - Remainder of Site 27						
Aluminum	23/23	9,955 - 43,800	NA	21,523	24,857	24,857
Antimony	1/14	3.19	1.0 - 1.28	0.66	0.89	0.89
Arsenic	23/23	4.1 - 72.7	NA	10.6	13.5	13.5
Barium	23/23	74.9 - 1,650	NA	176	240	240
Beryllium	16/23	0.59 - 6.15	0.66 - 1.07	0.95	1.29	1.29
Boron	18/23	4.38 - 408	6.64 - 14.9	14.0	23.9	23.9
Cadmium	5/23	0.26 - 2.33	0.50 - 1.2	0.49	0.61	0.61
Chromium	23/23	14.75 - 73.0	NA	28.2	32.7	32.7

TABLE 7-7

Soil Exposure Point Concentrations of Contaminants of Potential Concern
Site 2 – Sewage Treatment Plant and Site 27 - Sewage Sludge Application Area
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/g)[b]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[c] (µg/g)
Surface Soil - Remainder of Site 27						
Cobalt	22/23	5.5 - 56.7	9.9	11.4	14.0	14.0
Copper	22/23	7.19 - 74.2	18.8	16.8	21.8	21.8
Iron	23/23	11,150 - 85,000	NA	24,374	28,613	28,613
Lead	23/23	13.1 - 45.7	NA	22.2	25.4	25.4
Manganese	23/23	220 - 13,000	NA	1,218	1,826	1,826
Mercury	12/23	0.06 - 1.45	0.05 - 0.14	0.15	0.27	0.27
Molybdenum	2/23	1.55 - 10.9	10.0 - 14.3	6.1	6.7	6.7
Nickel	22/23	9.16 - 41	13.4	15.2	17.9	17.9
Selenium	3/23	0.76 - 0.94	0.449 - 18.4	0.52	0.81	0.81
Silver	22/23	0.098 - 210	1.0	10.8	83.6	83.6
Thallium	9/23	0.603 - 4.9	1.0 - 34.3	8.64	29.8	4.9
Tin	2/23	6.48 - 10.38	7.43 - 14.4	5.3	5.94	5.94
Vanadium	23/23	21.6 - 128	NA	39.7	46.5	46.5
Zinc	23/23	35.8 - 160	NA	68.4	79.0	79.0
Cyanide	1/9	3.89	0.25	0.54	1.56	1.56
DDT	1/4	0.014	0.004	0.005	0.383	0.014

TABLE 7-7

Soil Exposure Point Concentrations of Contaminants of Potential Concern
Site 2 – Sewage Treatment Plant and Site 27 - Sewage Sludge Application Area
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/g)[b]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[c] (µg/g)
Surface Soil - Remainder of Site 27						
Dieldrin	2/4	0.008	0.002	0.004	0.009	0.008
Endrin	2/4	0.013 - 0.018	0.007	0.009	0.018	0.018
Surface/Subsurface Soil Combined - Southwest Corner of Site 27						
Aluminum	12/12	14,500 - 37,200	NA	23,583	28,610	28,610
Arsenic	12/12	5.36 - 37.1	NA	12.1	16.4	16.4
Barium	12/12	56.7 - 755	NA	149	220	220
Beryllium	9/12	0.32 - 3.19	0.588 - 0.928	0.821	1.24	1.24
Boron	3/12	9.7 - 184	6.64 - 22.5	21.8	38.2	38.2
Chromium	10/12	17.3 - 72.2	16.0 - 17.3	35.0	45.6	45.6
Cobalt	9/12	6.1 - 16.5	5.88 - 39.9	11.3	14.1	14.1
Copper	9/12	9.2 - 42.3	13.2 - 16.0	18.7	28.8	28.8
Lead	12/12	10.4 - 600	NA	71.9	137	137
Manganese	12/12	149 - 3,950	NA	950	2,000	2,000
Mercury	8/12	0.07 - 1.1	0.05 - 0.12	0.26	0.80	0.80
Molybdenum	1/12	7.44	10.0 - 14.3	5.7	6.3	6.3

TABLE 7-7

Soil Exposure Point Concentrations of Contaminants of Potential Concern
Site 2 – Sewage Treatment Plant and Site 27 - Sewage Sludge Application Area
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/g)[b]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[c] (µg/g)
Surface/Subsurface Soil Combined - Southwest Corner of Site 27						
Nickel	9/12	7.5 - 22.5	9.0 - 13.3	13.0	16.2	16.2
Silver	11/12	0.35 - 61.0	1.0	10.0	114	61.0
Thallium	9/12	0.91 - 2.73	34.3	5.4	16.3	2.73
Tin	2/12	2.7 - 13.5	7.43 - 12.4	5.5	6.9	6.9
Vanadium	12/12	24.2 - 65.2	NA	42.8	52.2	52.2
Zinc	12/12	29.3 - 101	NA	99.4	76.0	76.0
Surface/Subsurface Soil Combined - Remainder of Site 27						
Aluminum	30/30	9,955 - 43,800	NA	20,541	23,219	23,219
Antimony	2/21	0.59 - 3.19	1.0 - 1.28	0.61	0.73	0.73
Arsenic	30/30	4.1 - 72.7	NA	10.0	12.1	12.1
Barium	30/30	43.6 - 1,650	NA	163	210	210
Beryllium	18/30	0.59 - 6.15	0.60 - 1.42	0.88	1.15	1.15
Boron	19/30	4.27 - 408	6.64 - 14.9	11.4	16.8	16.8
Cadmium	7/30	0.26 - 2.33	0.50 - 1.2	0.49	0.59	0.59
Chromium	28/30	14.8 - 73.0	13.3 - 18.5	26.5	31.2	31.2

TABLE 7-7

Soil Exposure Point Concentrations of Contaminants of Potential Concern
Site 2 – Sewage Treatment Plant and Site 27 - Sewage Sludge Application Area
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[(a)]	Range of Detected Values (µg/g)[(b)]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[(c)] (µg/g)
Surface/Subsurface Soil Combined - Remainder of Site 27						
Cobalt	24/30	5.5 - 56.7	6.0 - 11.6	10.3	12.7	12.7
Copper	29/30	6.66 - 74.2	18.8	15.4	18.9	18.9
Lead	30/30	13.1 - 45.7	NA	21.7	24.0	24.0
Manganese	30/30	220 - 13,000	NA	1,208	1,680	1,680
Mercury	14/30	0.45 - 1.45	0.05 - 0.14	0.13	0.19	0.19
Molybdenum	4/30	1.34 - 10.9	4.99 - 14.3	5.52	6.15	6.15
Nickel	24/30	9.16 - 41.0	8.06 - 16.0	14.2	17.4	17.4
Selenium	6/30	0.62 - 0.96	0.449 - 18.4	0.50	0.71	0.71
Silver	27/30	0.098 - 210	1.0	6.29	25.4	25.4
Thallium	16/30	0.603 - 4.9	1.0 - 34.3	5.9	14.3	4.9
Tin	4/30	2.94 - 10.38	7.43 - 14.4	5.5	6.1	6.1
Vanadium	30/30	21.58 - 128	NA	36.8	42.0	42.0
Zinc	30/30	35.8 - 243.3	NA	69.5	81.8	81.8

Footnotes:
(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Micrograms per gram.
(c) The 95% UCL (upper confidence limit of the mean) or the maximum detected value, whichever is lower (USEPA 1989).
(d) Not applicable.
(e) Not calculated due to insufficient data.

TABLE 7-8

Selection of Contaminants of Potential Concern (COPC) in Soil Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 2 – Sewage Treatment Plant and Site 27 - Sewage Sludge Application Areas
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Residential PRG (µg/g)[(a)]**	**Exposure Point Conc. (µg/g)**	**Retained as Soil COPC?**
Surface Soil - Sewage Treatment Plant			
Aluminum	7,667	23,100	**YES**
Arsenic	0.38	13.7	**YES**
Barium	527	110	No
Beryllium	0.14	0.754	**YES**
Boron	586	10.5	No
Chromium	30.0	27.6	No
Cobalt	457	9.41	No
Copper	285	15.4	No
Lead	400[(b)]	190	No
Manganese	318	832	**YES**
Mercury	2.30	0.211	No
Nickel	153	12.7	No
Silver	38.3	5.3	No
Vanadium	54.0	37.3	No
Zinc	2,300	172	No
Surface Soil - Southwest Corner of Site 27			
Aluminum	7,667	30,007	**YES**
Arsenic	0.38	20.2	**YES**
Barium	527	313	No
Boron	586	88.3	No
Chromium	30.0	58.5	**YES**
Cobalt	457	14.3	No

TABLE 7-8

Selection of Contaminants of Potential Concern (COPC) in Soil Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 2 – Sewage Treatment Plant and Site 27 - Sewage Sludge Application Areas
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Residential PRG (µg/g)[(a)]**	**Exposure Point Conc. (µg/g)**	**Retained as Soil COPC?**
Copper	285	36.1	No
Manganese	318	1,298	**YES**
Mercury	2.30	1.10	No
Molybdenum	38.3	6.72	No
Nickel	153	18.6	No
Silver	38.3	61.0	**YES**
Thallium	0.54	2.73	**YES**
Tin	4,600	7.48	No
Vanadium	54.0	54.3	**YES**
Zinc	2,300	87.5	No
Cyanide	130	0.643	No
Surface Soil - Remainder of Site 27			
Aluminum	7,667	24,857	**YES**
Antimony	3.0	0.89	No
Arsenic	0.38	13.5	**YES**
Barium	527	240	No
Beryllium	0.14	1.29	**YES**
Boron	586	23.9	No
Cadmium	3.8	0.61	No
Chromium	30.0	32.7	**YES**
Cobalt	457	14.0	No
Copper	285	21.8	No

TABLE 7-8

Selection of Contaminants of Potential Concern (COPC) in Soil Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 2 – Sewage Treatment Plant and Site 27 - Sewage Sludge Application Areas
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	Residential PRG (µg/g)[(a)]	Exposure Point Conc. (µg/g)	Retained as Soil COPC?
Iron	70,000[(c)]	28,613	No
Lead	400[(b)]	25.4	No
Manganese	318	1,826	**YES**
Mercury	2.30	0.27	No
Molybdenum	38.3	6.7	No
Nickel	153	17.9	No
Selenium	38.3	0.81	No
Silver	38.3	83.6	**YES**
Thallium	0.54	4.9	**YES**
Tin	4,600	5.94	No
Vanadium	54.0	46.5	No
Zinc	2,300	79.0	No
Cyanide	130	3.89	No
DDT	1.3	0.014	No
Dieldrin	0.028	0.008	No
Endrin	1.96	0.018	No
Surface/Subsurface Soil Combined - Southwest Corner of Site 27			
Aluminum	7,667	28,610	**YES**
Arsenic	0.38	16.4	**YES**
Barium	527	220	No
Beryllium	0.143	1.24	**YES**
Boron	586	38.2	No

TABLE 7-8

Selection of Contaminants of Potential Concern (COPC) in Soil Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 2 – Sewage Treatment Plant and Site 27 - Sewage Sludge Application Areas
Jefferson Proving Ground
Madison, Indiana

Chemical	USEPA Region 9 PRG Screen		
	Residential PRG (µg/g)[(a)]	Exposure Point Conc. (µg/g)	Retained as Soil COPC?
Chromium	30.0	45.6	**YES**
Cobalt	457	14.1	No
Copper	285	26.8	No
Lead	400[(b)]	137	No
Manganese	318	2,000	**YES**
Mercury	2.30	0.80	No
Molybdenum	38.3	6.3	No
Nickel	153	16.2	No
Silver	38.3	61.0	**YES**
Thallium	0.54	2.73	**YES**
Tin	4,600	6.9	No
Vanadium	54.0	52.2	No
Zinc	2,300	76.0	No
Surface/Subsurface Soil Combined - Remainder of Site 27			
Aluminum	7,667	23,219	**YES**
Antimony	3.0	0.73	No
Arsenic	0.38	12.1	**YES**
Barium	527	210	No
Beryllium	0.143	1.15	**YES**
Boron	586	16.8	No
Cadmium	3.8	0.59	No
Chromium	30.0	31.2	**YES**

TABLE 7-8

Selection of Contaminants of Potential Concern (COPC) in Soil Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 2 – Sewage Treatment Plant and Site 27 - Sewage Sludge Application Areas
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Residential PRG (µg/g)[a]**	**Exposure Point Conc. (µg/g)**	**Retained as Soil COPC?**
Cobalt	457	12.7	No
Copper	285	18.9	No
Lead	400[b]	24.0	No
Manganese	318	1,680	**YES**
Mercury	2.30	0.19	No
Molybdenum	38.3	6.15	No
Nickel	153	17.4	No
Selenium	38.3	0.71	No
Silver	38.3	25.4	No
Thallium	0.54	4.9	**YES**
Tin	4,600	6.1	No
Vanadium	54.0	42.0	No
Zinc	2,300	81.8	No

Note:

PRGs were taken directly from the Region 9 PRG Table (USEPA 1998) except as noted in the footnotes. Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:

(a) Micrograms per gram.
(b) Full PRG used for lead.
(c) Nutrient screening value for iron (see Section 7.6.1.2.3).

TABLE 7-9

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 2 - Sewage Treatment Plant
Jefferson Proving Ground
Madison, Indiana

Chemical	USEPA Region 9 PRG Screen		
	Ambient Air PRG (µg/m^3)[a]	**Exposure Point Conc. (µg/m^3)**	**Retained as Air COPC?**
Residential Scenario			
Aluminum	NA[b]	5.00E+00	**YES**
Arsenic	4.5E-04	2.81E-03	**YES**
Barium	5.2E-02	1.48E-05	No
Beryllium	8.0E-04	2.19E-04	No
Cadmium	1.1E-03	2.88E-08	No
Chromium	2.3E-05	7.08E-03	**YES**
Lead	1.5E+00[c]	2.13E-06	No
Manganese	5.1E-03	3.43E-01	**YES**
Silver	NA	1.57E-02	**YES**
Thallium	NA	8.98E-04	**YES**
Vanadium	NA	1.42E-03	**YES**
Zinc	NA	1.47E-06	**YES**
Dioxins/Furans	4.5E-08	4.36E-12	No
Benzo(a)anthracene	9.2E-03	2.65E-09	No
Benzo(a)pyrene	9.2E-04	6.10E-09	No
Benzo(b)fluoranthene	9.2E-03	1.15E-08	No
DDE	2.0E-02	1.56E-09	No
Dibenz(a,h)anthracene	9.2E-04	3.11E-10	No
Dieldrin	4.2E-04	NA	No
Indeno(1,2,3-cd)pyrene	9.2E-03	1.60E-09	No
1,1-Dichloroethylene	3.8E-02	1.42E-09	No
Chlorobenzene	2.1E+00	3.57E-06	No
Industrial Scenario			
Aluminum	NA	5.43E+00	**YES**
Arsenic	4.5E-04	3.07E-03	**YES**

TABLE 7-9

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 2 - Sewage Treatment Plant
Jefferson Proving Ground
Madison, Indiana

Chemical	USEPA Region 9 PRG Screen		
	Ambient Air PRG (µg/m^3)[(a)]	**Exposure Point Conc. (µg/m^3)**	**Retained as Air COPC?**
Industrial Scenario			
Barium	5.2E-02	1.52E-05	No
Beryllium	8.0E-04	2.33E-04	No
Cadmium	1.1E-03	1.29E-07	No
Chromium	2.3E-05	7.09E-03	**YES**
Lead	1.5E+00[(c)]	2.13E-06	No
Manganese	5.1E-03	3.58E-01	**YES**
Silver	NA	1.57E-02	**YES**
Thallium	NA	8.98E-04	**YES**
Vanadium	NA	1.43E-03	**YES**
Zinc	NA	1.11E-04	**YES**
Dioxins/Furans	4.5E-08	7.33E-12	No
Benzo(a)anthracene	9.2E-03	2.65E-09	No
Benzo(a)pyrene	9.2E-04	6.15E-09	No
Benzo(b)fluoranthene	9.2E-03	1.15E-08	No
DDE	2.0E-02	1.56E-09	No
Dibenz(a,h)anthracene	9.2E-04	3.11E-10	No
Dieldrin	4.2E-04	1.81E-09	No
Indeno(1,2,3-cd)pyrene	9.2E-03	1.56E-09	No
1,1-Dichloroethylene	3.8E-02	1.42E-09	No
Chlorobenzene	2.1E+00	3.57E-06	No

Note:

PRGs were taken directly from the Region 9 PRG Table (USEPA 1998). Values for noncarcinogens are 1/10 of the Region 9 PRG.

EPCs are calculated and presented in Tables R-4 and R-6 in Appendix R.

Footnotes:

(a) Micrograms per cubic meter.
(b) Not applicable.
(c) Federal ambient air quality criterion for lead.

TABLE 7-10

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 27 -Sewage Sludge Application Area
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Ambient Air PRG (μg/m³)[(a)]**	**Exposure Point Conc. (μg/m³)**	**Retained as Air COPC?**
Residential Scenario			
Aluminum	NA	5.55E+00	**YES**
Arsenic	4.5E-04	3.12E-03	**YES**
Barium	5.2E-02	1.55E-05	No
Beryllium	8.0E-04	2.43E-04	No
Cadmium	1.1E-03	3.03E-08	No
Chromium	2.3E-05	7.86E-03	**YES**
Lead	1.5E+00[(c)]	2.24E-06	No
Manganese	5.1E-03	3.81E-01	**YES**
Silver	NA	1.75E-02	**YES**
Thallium	NA	9.98E-04	**YES**
Vanadium	NA	1.58E-03	**YES**
Zinc	NA	1.55E-06	**YES**
Dioxins/Furans	4.5E-08	1.92E-12	No
Benzo(a)anthracene	9.2E-03	2.78E-09	No
Benzo(a)pyrene	9.2E-04	6.27E-09	No
Benzo(b)fluoranthene	9.2E-03	1.17E-08	No
DDE	2.0E-02	1.64E-09	No
Dibenz(a,h)anthracene	9.2E-04	3.27E-10	No
Dieldrin	4.2E-04	NA	No
Indeno(1,2,3-cd)pyrene	9.2E-03	1.60E-09	No
1,1-Dichloroethylene	3.8E-02	1.49E-09	No
Chlorobenzene	2.1E+00	4.08E-06	No

Note:
PRGs were taken directly from the Region 9 PRG Table (USEPA 1998). Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:
(a) Micrograms per cubic meter.
(b) Not applicable.
(c) Federal ambient air quality criterion for lead.

TABLE 7-11

Sediment/Surface Water Exposure Point Concentrations of Preliminary Contaminants of Potential Concern (COPC)
Harberts Creek
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/g)[b]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[c] (µg/g)
Sediment						
Aluminum	5/5	2,690 - 22,100	NA[d]	10,601	137,553	22,100
Arsenic	5/5	6.16 - 26.1	NA	13.7	35.7	26.1
Barium	5/5	74.4 - 375	NA	147	528	375
Beryllium	5/5	0.624 - 2.35	NA	1.1	2.7	2.34
Boron	1/5	11.1	6.64	4.75	11.9	11.1
Chromium	5/5	17.4 - 44.7	NA	28.4	60	44.7
Cobalt	5/5	6.95 - 14.5	NA	9.74	13.6	13.6
Copper	5/5	4.73 - 21.7	NA	12.0	38.3	21.7
Iron	5/5	28,800 - 79,000	NA	40,291	76,087	76,087
Lead	5/5	9.52 - 16.0	NA	12.2	15.1	15.1
Manganese	5/5	670 - 2,200	NA	1,194	2,557	2,200
Nickel	5/5	9.78 - 28.8	NA	17.4	41.3	28.8
Silver	5/5	0.33 - 17.0	NA	3.3	3,075	17.0
Vanadium	5/5	35.1 - 138	NA	62.4	157	138

TABLE 7-11

Sediment/Surface Water Exposure Point Concentrations of Preliminary Contaminants of Potential Concern (COPC)
Harberts Creek
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/g)[b]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[c] (µg/g)
Sediment						
Zinc	5/5	54.0 - 185	NA	94.3	225	185
Surface Water						
Barium, Total	2/2	66.6 - 66.8	NA	66.7	NC[f]	66.8
Manganese, Total	2/2	52.4 - 57.4	NA	54.9	NC	57.4
Silver, Total	2/2	0.371 - 0.869	NA	0.62	NC	0.869

Footnotes:
(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Micrograms per gram.
(c) The 95% UCL (upper confidence limit of the mean) or the maximum detected value, whichever is lower (USEPA 1989a).
(d) Not applicable.
(e) Micrograms per liter.
(f) Not calculated due to insufficient samples.

TABLE 7-12

Selection of Contaminants of Potential Concern (COPCs) in Sediment Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Harberts Creek
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Residential PRG (µg/g)[(a)]**	**Exposure Point Conc. (µg/g)**	**Retained as Sediment COPC?**
Sediment			
Aluminum	7,667	22,100	**YES**
Arsenic	0.38	26.1	**YES**
Barium	527	375	No
Beryllium	0.14	2.34	**YES**
Boron	586	11.1	No
Chromium	30.0	44.7	**YES**
Cobalt	457	13.6	No
Copper	285	21.7	No
Iron	70,000[(b)]	76,087	**YES**
Lead	400[(c)]	15.1	No
Manganese	318	2,200	**YES**
Nickel	153	28.8	No
Silver	38.3	17.0	No
Vanadium	54.0	138	**YES**
Zinc	2,300	185	No

Note:

PRGs were taken directly from the Region 9 PRG table (USEPA 1998) except as noted in the footnotes. Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:

(a) Micrograms per gram.
(b) Nutrient screening value for iron (see Section 7.6.1.4.2)
(c) Full PRG used for lead.

TABLE 7-13

Selection of Contaminants of Potential Concern (COPC) in Surface Water Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Harberts Creek
Jefferson Proving Ground
Madison, Indiana

Chemical	USEPA Region 9 PRG Screen		
	Tap Water PRG (µg/L)[a]	Exposure Point Conc. (µg/L)	Retained as Surface Water COPC?
Surface Water			
Barium, Total	255.5	66.8	No
Manganese, Total	170.3	57.4	No
Silver, Total	18.3	0.869	No

Note:
PRGs were taken directly from the Region 9 PRG Table (USEPA 1998). Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:
(a) Micrograms per liter.

TABLE 7-14

Site-Wide Area-Weighted Concentrations of Contaminants of Potential Concern (COPC) in Soil
Site 27 - Sewage Sludge Application Area
Jefferson Proving Ground
Madison, Indiana

Chemical of Potential Concern	Soil Concentration[a] (µg/g)[b]		Area-Weighted Concentration in Sub-Area of Concern[c] (µg/g)		Site-Wide Area-Weighted Concentration (µg/g)
	Southwest Corner	Remainder of Site	Southwest Corner (MF[d] = 0.134)	Remainder of Site (MF = 0.866)	
Aluminum	30,007	24,857	4,021	21,526	25,547
Arsenic	20.2	13.5	2.7	11.7	14.4
Beryllium	NA[e]	1.29	NA	1.12	1.12
Chromium	58.5	32.7	7.8	28.3	36.2
Manganese	1,298	1,826	174	1,581	1,755
Silver	61	83.6	8.2	72.4	80.6
Thallium	2.73	4.9	0.4	4.2	4.6
Vanadium	54.3	NA	7.3	NA	7.3

Footnotes:
(a) The maximum concentration or the 95% UCL on the mean, whichever is lower.
(b) Micrograms per gram.
(c) The soil concentration times the modifying factor (MF).
(d) Modifying factor.
(e) Not applicable; chemical not a COPC in sub-area of concern.

TABLE 7-15

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 2 - Sewage Treatment Plant
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Chemicals of Concern	Pathway-specific Hazard Index	Noncarcinogenic Chemicals of Concern
Future On-site Resident Adult				
Incidental ingestion of soil	1.21E-05		0.0712	
Dermal contact with soil	3.02E-06		0.0164	
Ingestion of home-grown fruits/vegetables	1.82E-05		0.2208	
Incidental ingestion of sediment in Harberts Creek	1.18E-06		0.0098	
Dermal contact with sediment in Harberts Creek	4.97E-06		0.0309	
Inhalation of VOCs[(a)] and fugitive dusts	2.5E-05		4.7612	Manganese (99%)
Total	6.45E-05		5.1103	

TABLE 7-15

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 2 - Sewage Treatment Plant
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Chemicals of Concern	Pathway-specific Hazard Index	Noncarcinogenic Chemicals of Concern
		Future On-site Resident Child		
Incidental ingestion of soil	2.25E-05		0.6647	
Dermal contact with soil	1.74E-06		0.0472	
Ingestion of homegrown fruits/vegetables	8.78E-06		0.5251	
Incidental ingestion of sediment	2.21E-06		0.0911	
Dermal contact with sediment	2.37E-06		0.0736	
Inhalation of VOCs and fugitive dusts	1.89E-05		17.9358	manganese (99%)
Total	5.65E-05		19.3375	
		Future On-site Worker		
Incidental ingestion of soil	3.59E-06		0.0254	
Dermal contact with soil	1.07E-06		0.0070	
Inhalation of VOCs and fugitive dusts	6.91E-06		1.6426	Manganese (99%)
Total	1.16E-05		1.675	

Footnote:
(a) Volatile organic compounds.

RAB/PB
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TABLE 7-16

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 27 - Sewage Sludge Application Areas
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Chemicals of Concern	Pathway-specific Hazard Index	Noncarcinogenic Chemicals of Concern
Future On-site Resident Adult (Southwest Corner of Site - surface soil only)				
Incidental ingestion of soil	1.78E-05		0.2057	
Dermal contact with soil	4.46E-06		0.0326	
Ingestion of homegrown fruits/vegetables	2.68E-05		0.3748	
Ingestion of beef	1.71E-06		0.1827	
Ingestion of milk	8.45E-09		1.7025	Silver (96%)
Incidental ingestion of sediment in Harberts Creek	1.18E-06		0.0098	
Dermal contact with sediment in Harberts Creek	4.97E-06		0.0309	
Inhalation of VOCs[(a)] and fugitive dusts	2.78E-05		5.2886	Manganese (99%)
Total	8.47E-05		7.8276	
Future On-site Resident Child (Southwest Corner of Site - surface soil only)				
Incidental ingestion of soil	3.32E-05		1.9202	
Dermal contact with soil	2.57E-06		0.0939	
Ingestion of homegrown fruits/vegetables	1.30E-05		0.8974	
Ingestion of beef	7.08E-07		0.3771	
Ingestion of milk	9.68E-09		9.7505	Silver (96%)
Incidental ingestion of sediment in Harberts Creek	2.21E-06		0.0911	

TABLE 7-16

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 27 - Sewage Sludge Application Areas
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Chemicals of Concern	Pathway-specific Hazard Index	Noncarcinogenic Chemicals of Concern
Dermal contact with sediment in Harberts Creek	2.37E-06		0.0736	
Inhalation of VOCs and fugitive dusts	2.09E-05		19.9227	Manganese (99%)
Total	7.50E-05		33.1265	
Future On-site Resident Adult (Southwest Corner of Site - surface/subsurface soil combined)				
Incidental ingestion of soil	1.44E-05		0.1796	
Dermal contact with soil	3.62E-06		0.0275	
Ingestion of homegrown fruits/vegetables	2.17E-05		0.4448	
Ingestion of beef	1.71E-06		0.1827	
Ingestion of milk	8.45E-09		1.7025	Silver (96%)
Incidental ingestion of sediment in Harberts Creek	1.18E-06		0.0098	
Dermal contact with sediment in Harberts Creek	4.97E-06		0.0309	
Inhalation of VOCs and fugitive dusts	2.78E-05		5.2886	Manganese (99%)
Total	7.54E-05		7.8664	
Future On-site Resident Child (Southwest Corner of Site - surface/subsurface soil combined)				
Incidental ingestion of soil	2.7E-05		1.6761	
Dermal contact with soil	2.08E-06		0.0792	
Ingestion of homegrown fruits/vegetables	1.05E-05		1.0579	Manganese (81%)

TABLE 7-16

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 27 - Sewage Sludge Application Areas
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Chemicals of Concern	Pathway-specific Hazard Index	Noncarcinogenic Chemicals of Concern
Ingestion of beef	7.08E-07		0.3771	
Ingestion of milk	9.68E-09		9.7505	Silver (96%)
Incidental ingestion of sediment in Harberts Creek	2.21E-06		0.0911	
Dermal contact with sediment in Harberts Creek	2.37E-06		0.0736	
Inhalation of VOCs and fugitive dusts	2.09E-05		19.9227	Manganese (99%)
Total	6.58E-05		33.0282	
Future On-site Resident Adult (Remainder of Site - surface soil only)				
Incidental ingestion of soil	1.19E-05		0.2021	
Dermal contact with soil	2.98E-06		0.0272	
Ingestion of homegrown fruits/vegetables	1.79E-05		0.3998	
Ingestion of beef	1.71E-06		0.1827	
Ingestion of milk	8.45E-09		1.7025	Silver (96%)
Incidental ingestion of sediment in Harberts Creek	1.18E-06		0.0098	
Dermal contact with sediment in Harberts Creek	4.97E-06		0.0309	
Inhalation of VOCs and fugitive dusts	2.78E-05		5.2886	Manganese (99%)
Total	6.84E-05		7.8436	

TABLE 7-16

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 27 - Sewage Sludge Application Areas
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Chemicals of Concern	Pathway-specific Hazard Index	Noncarcinogenic Chemicals of Concern
Future On-site Resident Child (Remainder of Site - surface soil only)				
Incidental ingestion of soil	2.22E-05		1.8866	
Dermal contact with soil	1.72E-06		0.0783	
Ingestion of homegrown fruits/vegetables	8.66E-06		1.9505	Manganese (81%)
Ingestion of beef	7.08E-07		0.3771	
Ingestion of milk	9.68E-09		9.7505	Silver (96%)
Incidental ingestion of sediment in Harberts Creek	2.21E-06		0.0911	
Dermal contact with sediment in Harberts Creek	2.37E-06		0.0736	
Inhalation of VOCs and fugitive dusts	2.09E-05		19.9227	Manganese (99%)
Total	5.88E-05		34.1304	
Future On-site Resident Adult (Remainder of Site - surface/subsurface soil combined)				
Incidental ingestion of soil	1.07E-05		0.1721	
Dermal contact with soil	2.67E-06		0.0236	
Ingestion of homegrown fruits/vegetables	1.6E-05		0.3614	
Ingestion of beef	1.71E-06		0.1827	
Ingestion of milk	8.45E-09		1.7025	Silver (96%)
Incidental ingestion of sediment in Harberts Creek	1.18E-06		0.0098	

TABLE 7-16

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 27 - Sewage Sludge Application Areas
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Chemicals of Concern	Pathway-specific Hazard Index	Noncarcinogenic Chemicals of Concern
Dermal contact with sediment in Harberts Creek	4.97E-06		0.0309	
Inhalation of VOCs and fugitive dusts	2.78E-05		5.2886	Manganese (99%)
Total	6.50E-05		7.7716	
Future On-site Resident Child (Remainder of Site - surface/subsurface soil combined)				
Incidental ingestion of soil	1.99E-05		1.6059	
Dermal contact with soil	1.54E-06		0.0680	
Ingestion of homegrown fruits/vegetables	7.76E-06		0.8570	Manganese (83%)
Ingestion of beef	7.08E-07		0.3771	
Ingestion of milk	9.68E-09		9.7505	Silver (96%)
Incidental ingestion of sediment in Harberts Creek	2.21E-06		0.0911	
Dermal contact with sediment in Harberts Creek	2.37E-06		0.0736	
Inhalation of VOCs and fugitive dusts	2.09E-05		19.9227	Manganese (99%)
Total	5.54E-05		32.7459	
Future Off-site Adult Consumer of Beef and Milk				
Ingestion of beef	1.71E-06		0.1827	
Ingestion of milk	8.45E-09		1.7025	Silver (96%)
Total	1.72E-06		1.8852	

TABLE 7-16

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 27 - Sewage Sludge Application Areas
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway		Pathway-specific Cancer Risk	Carcinogenic Chemicals of Concern	Pathway-specific Hazard Index	Noncarcinogenic Chemicals of Concern
		Future Off-site Child Consumer of Beef and Milk			
Ingestion of beef		7.08E-07		0.3771	
Ingestion of milk		9.68E-09		9.7505	Silver (96%)
	Total	7.18E-07		10.1276	

NoteS:
Numbers in parentheses are the percent of the total pathway risk/HI attributable to the contaminant (or chemical) of concern.
Calculations for Cancer Risk and Hazard Index are presented in Appendix W.

Footnotes:
(a) Volatile organic compounds.

TABLE 7-17

Qualitative Uncertainty Analysis
Site 2 - Sewage Treatment Plant and Site 27 - Sewage Sludge Application Areas
Jefferson Proving Ground
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
A. Human Behavior				
Future receptors' exposure duration	30 years	Medium	Medium	National upper-bound time (90th percentile) at one residence
Future receptors' exposure frequency	350 days/year	Medium	Medium	High-end value
Future receptors' exposure time	24 hours/day	Low	High	Maximum possible value
Future receptors' foodchain ingestion rates	NA[a]	Low	High	Nearly impossible for an average weight receptor to ingest daily the 95th percentile U.S. population consumption amounts
Fraction of milk home produced	1.0	Low	High	Maximum possible value
Exclusion of certain exposure pathways in the quantitative analysis	NA	Low	Low	Pathways eliminated are those that have low possibility of contributing risk to these receptors
B. Chemical Fate/Transport in the Environment				
Calculation of exposure point concentration of COC[b]/foodchain modeling	NA	Low	High	Conservative assumptions and input parameters

TABLE 7-17

Qualitative Uncertainty Analysis
Site 2 - Sewage Treatment Plant and Site 27 - Sewage Sludge Application Areas
Jefferson Proving Ground
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
Use of air dispersion modeling to predict air concentrations	NA	Low	High	Conservative assumptions and input parameters
C. Chemical Toxicity				
Assumption that USEPA[c] reference doses truly represent toxicological thresholds	Mn inhalation RfD[d] (1.4E-05 mg/kg-d)	Low	Medium	IRIS[e] value; high degree of conservativeness utilized by USEPA in deriving RfDs from toxicological literature
	Al inhalation RfD (1.4E-03 mg/kg-d)	Low	High	Provisional criterion
Assumption that USEPA carcinogenic slope factors truly represent dose-response phenomena	NA	Low-moderate	Moderate-high	Use of linearized, multi-stage mathematical model to predict cancer incidence at low exposure levels is USEPA policy; not currently supported by scientific data
Assumption of risk/hazard additivity	NA	Moderate	Moderate	Summation of chemical-specific risks/hazards may over- or under-predict risks/hazards to receptors
Screening out of certain contaminants based on USEPA criteria	NA	Low	Low	Chemicals present in concentrations less than USEPA criteria eliminated

Footnotes:

(a) Not applicable.
(b) Contaminant of concern.
(c) U.S. Environmental Protection Agency
(d) Reference dose.
(e) Integrated Risk Information System.

TABLE 7.7-a1

Site 2 and 27 Habitat Summary

Site 2 - Sewage Treatment Plant
Date: 4/4-6/93; 4/26/93; 5/28/93
Acreage: 10
Soils mapping unit: NA
Vegetation mapping unit: Infrequently maintained grassland; at sewage outfall - near mature riparian forest

General site conditions: Maintained grass field
Slope: Gentle, 0-5 degrees
Aspect: South
Drainages: Harbert's Creek flowing northeast to southwest; drains predominantly to south and southeast
Surface water/wetlands: Creek
Evidence of flood/fire: Burned recently within 12 feet of roads, not near buildings; creek floods in winter
Description of surrounding area: Low lying woods to south (creek drainage); woods to north, east; to west is grass field - goldenrods, brush piles

Soils
Surface layer texture: Typical
Surface color: Typical

Vegetation
Ground cover description: Grass field
Species: Broomsedge, bluegrass, purple dead nettle, Queen Anne's lace, prickly lettuce, plantains, thistle, dandelion, wild onion, clover, chickweed, wild strawberry; raspberry and blackberry patches near creek; near outfall and Harbert's Creek - typical riparian forst
Canopy cover: None anong lane; typical flatwoods
Species: Approx. 30% bare ground; sycamore, slippery elm, green ash, spicebush
Successional status: Maintained grassfield and intermediate flatwoods
Vegetation condition: Good

Wildlife
Habitat type: Grass field/flatwoods
Species observations: Deer, crows, hawk, bluebirds, starlings, turkey vultures, mourning doves, field sparrows; woodpecker - adjacent woods; wood duck possibly nesting on pond area; frogs, fish in creek
Sign Observations: Deer (tracks, observations), crawdads (burrows), woodpecker (tree hole - pileated), turkey (reported by site employees), killdeer (burned out nests)

Remarks: Area is burned on a regular basis to maintain grass field; excavated area to southwest - unknown purpose; first burned in 1984; depending on water outfall quality, and soil/sediment quality, site may have several contamination sources and pathways

Site 2 and 27 Habitat Summary

Site 27 - Sewage Sludge Application Area
Date: 4/22/93; 5/27/93
Acreage: 3
Soils mapping unit: NA
Vegetation mapping unit: Infrequently maintained grassland

General site conditions: Open field
Slope: Mostly level; 0-5% slope
Aspect: South
Drainages: Harbert's Creek to south/southeast
Surface water/wetlands: None
Evidence of flood/fire: Fire recently
Description of surrounding area: Open grassland area surrounded on south, west, and eastern sides; woods along Harbert's Creek to south

Soils
Surface layer texture: Typical
Surface color: Typical

Vegetation
Ground cover description: Infrequently maintained grassland
Species: Typical species composition; however, area where sewage sludge was applied, vegetation is in less good condition than neighboring areas; more bare ground, somewhat more weedy; vegetation very good (1 " tall), grasses and forbs, few sedges; no evidence of bare ground (5/27/93)
Canopy cover: None
Species: Broomsedge and unidentified goldenrod
Successional status: Maintained grass
Vegetation condition: Fair

Wildlife
Habitat type: Open grassland
Species observations: None
Sign Observations: Deer track, crayfish burrows; many birds calling; deer; many butterflies

Remarks: Treatment areas exhibit somewhat more disturbed vegetation than adjacent areas; may be due to cropping (corn) or to application operations; pathways which could exist will be dependent upon contamination levels; no evidence of disturbed vegetation except wehre mowed for archery range; no indication of cropping; employees are developing an archery range in the south area (5/27/93)

TABLE 7.7-1

Summary Statistics for COPCs at JPG Site 2 - Phase
Analytes in Soil, Surface Water, and Sediments
Jefferson Proving Ground
Madison, Indiana

Site	Medium	Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Std. Deviation	UCL 95 [(a)]	EPC µg/g [(b)]	Exceed Background (Bkg)?	Retain as COPC[(c)]?	Comment
02	CSO[(d)]	Silver	2	2	100	0.80	5.30	3.05	3.18	17.26	5.30	Yes (Y)	Y	Not detected in Bkg.
02	CSO	Aluminum	2	2	100	18700	23100	20900	3111	34792	23100	NA[(e)]	Y	Insufficient sample size (N) and detection frequency (DF) for statistical comparisons
02	CSO	Arsenic	2	2	100	5.46	13.70	9.58	5.83	35.60	13.70	NA	Y	Insufficient N and DF for statistical comparisons
02	CSO	Boron	2	2	100	9.19	10.50	9.85	0.93	13.98	10.50	Y	Y	Not detected in Bkg.
02	CSO	Barium	2	2	100	101.0	110.0	105.5	6.36	133.9	110.0	NA	Y	Insufficient N and DF for statistical comparisons
02	CSO	Beryllium	1	2	50	0.21	0.75	0.48	0.38	2.19	0.75	NA	Y	Insufficient N and DF for statistical comparisons
02	CSO	Cadmium	0	2	0	NC[(f)]	NC	NC	NC	NC	NC	NA	N (No)	Not a COPC
02	CSO	Cobalt	2	2	100	7.95	9.41	8.68	1.03	13.29	9.41	NA	Y	Insufficient N and DF for statistical comparisons
02	CSO	Chromium	2	2	100	20.60	27.60	24.10	4.95	46.20	27.60	NA	Y	Insufficient N and DF for statistical comparisons
02	CSO	Copper	2	2	100	12.70	15.40	14.05	1.91	22.57	15.40	NA	Y	Insufficient N and DF for statistical comparisons
02	CSO	Iron	2	2	100	22500	23800	23150	919.2	27254	23800	NA	Y	Insufficient N and DF for statistical comparisons
02	CSO	Mercury	2	2	100	0.07	0.21	0.14	0.10	0.57	0.21	NA	Y	Insufficient N and DF for statistical comparisons
02	CSO	Manganese	2	2	100	281.0	832.0	556.5	389.6	2296	832.0	NA	Y	Insufficient N and DF for statistical comparisons
02	CSO	Molybdenum	0	2	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
02	CSO	Nickel	2	2	100	11.3	12.7	12.0	0.99	16.4	12.7	NA	Y	Insufficient N and DF for statistical comparisons
02	CSO	Lead	2	2	100	22.30	190.0	106.2	118.6	635.6	190.0	NA	Y	Insufficient N and DF for statistical comparisons
02	CSO	Antimony	0	2	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
02	CSO	Selenium	0	2	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
02	CSO	Tin	0	2	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
02	CSO	Tellurium	0	2	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
02	CSO	Thallium	0	2	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
02	CSO	Vanadium	2	2	100	34.10	37.3	35.7	2.3	46	37.3	NA	Y	Insufficient N and DF for statistical comparisons
02	CSO	Zinc	2	2	100	148.00	172.00	160.00	16.97	235.77	172.00	NA	Y	Insufficient N and DF for statistical comparisons
02	CSO	TPHC[(g)]	1	2	50	5.00	90.0	47.5	60.1	315.8	90.0	NA	Y	Insufficient N and DF for statistical comparisons
02	CSO	ppDDD[(h)]	1	2	50	0.28	0.31	0.30	0.02	0.40	0.31	NA	Y	Insufficient N and DF for statistical comparisons
Unfiltered	**surface water**										**µg/L[(i)]**			
02	CSW [(j)]	Silver	2	2	100	0.37	0.87	0.62	0.35	2.19	0.87	NA	Y	No comparisons to background surface water concentrations were made.
02	CSW	Barium	2	2	100	66.60	66.80	66.70	0.14	67.33	66.80	NA	Y	No comparisons to background surface water concentrations were made.
02	CSW	Iron	2	2	100	214.0	238.0	226.0	16.97	301.8	238.0	NA	Y	No comparisons to background surface water concentrations were made.
02	CSW	Manganese	2	2	100	52.40	57.40	54.90	3.54	70.69	57.40	NA	Y	No comparisons to background surface water concentrations were made.
02	CSW	Chloride	2	2	100	10000	11000	10500	707.1	13657	11000	NA	Y	No comparisons to background surface water concentrations were made.
02	CSW	Fluoride	2	2	100	172.0	191.0	181.5	13.44	241.5	191.0	NA	Y	No comparisons to background surface water concentrations were made.
02	CSW	NO_3[(k)]	2	2	100	590.0	770.0	680.0	127.3	1248	770.0	NA	Y	No comparisons to background surface water concentrations were made.
02	CSW	Phosphorus	2	2	100	44.60	77.30	60.95	23.12	164.18	77.30	NA	Y	No comparisons to background surface water concentrations were made.
02	CSW	Sulfate	2	2	100	32000	32000	32000	0.00	32000	32000	NA	Y	No comparisons to background surface water concentrations were made.
Filtered	**surface water**										**µg/L**			
02	CSW	Barium	2	2	100	66.10	66.90	66.50	0.57	69.03	66.90	NA	Y	No comparisons to background surface water concentrations were made.
02	CSW	Manganese	2	2	100	51.30	51.90	51.60	0.42	53.49	51.90	NA	Y	No comparisons to background surface water concentrations were made.

TABLE 7.7-1

Summary Statistics for COPCs at JPG Site 2 - Phase
Analytes in Soil, Surface Water, and Sediments
Jefferson Proving Ground
Madison, Indiana

Site	Medium	Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Std. Deviation	UCL 95 [(a)]	EPC µg/g [(b)]	Exceed Background (Bkg)?	Retain as COPC[(c)]?	Comment
Sediment											µg/g			
02	CSE[(l)]	Silver	5	5	100	0.33	17.00	4.17	7.21	11.05	11.05	NA	Y	No comparisons to background sediment concentrations were made.
02	CSE	Aluminum	5	5	100	2690	22100	10630	9333	19528	19528	NA	Y	No comparisons to background sediment concentrations were made.
02	CSE	Arsenic	5	5	100	6.16	26.10	13.70	7.85	21.18	21.18	NA	Y	No comparisons to background sediment concentrations were made.
02	CSE	Boron	1	5	20	3.32	11.10	4.88	3.48	8.19	8.19	NA	Y	No comparisons to background sediment concentrations were made.
02	CSE	Barium	5	5	100	74.40	375.00	153.14	127.08	274.31	274.31	NA	Y	No comparisons to background sediment concentrations were made.
02	CSE	Beryllium	5	5	100	0.62	2.35	1.12	0.71	1.80	1.80	NA	Y	No comparisons to background sediment concentrations were made.
02	CSE	Cobalt	5	5	100	6.95	14.50	9.74	2.87	12.47	12.47	NA	Y	No comparisons to background sediment concentrations were made.
02	CSE	Chromium	5	5	100	17.40	44.70	28.48	14.28	42.10	42.10	NA	Y	No comparisons to background sediment concentrations were made.
02	CSE	Copper	5	5	100	4.73	21.70	11.94	6.71	18.34	18.34	NA	Y	No comparisons to background sediment concentrations were made.
02	CSE	Iron	5	5	100	28800	79000	40760	21447	61209	61209	NA	Y	No comparisons to background sediment concentrations were made.
02	CSE	Manganese	5	5	100	670.0	2200	1196	634.9	1802	1802	NA	Y	No comparisons to background sediment concentrations were made.
02	CSE	Nickel	5	5	100	9.78	28.80	17.46	9.07	26.11	26.11	NA	Y	No comparisons to background sediment concentrations were made.
02	CSE	Lead	5	5	100	9.52	16.00	12.18	2.43	14.50	14.50	NA	Y	No comparisons to background sediment concentrations were made.
02	CSE	Vanadium	5	5	100	35.10	138.0	63.92	42.23	104.2	104.2	NA	Y	No comparisons to background sediment concentrations were made.
02	CSE	Zinc	5	5	100	54.00	185.0	95.26	54.18	146.9	146.9	NA	Y	No comparisons to background sediment concentrations were made.

General Notes:

1. Calcium, magnesium, sodium and potassium were not included in risk assessment as they are macronutrients. All other analytes in surface water or sediment have been included if they were detected in one or more samples.

Footnotes:

(a) Upper 95% confidence limit.
(b) Exposure point concentration, micrograms per gram, equivalent to parts per million.
(c) Contaminant of potential concern.
(d) CSO- surface soil.
(e) Not applicable.
(f) Not calculated. Not a COPC.
(g) Total petroleum hydrocarbons.
(h) 2,2-Bis(p-chlorophenyl)-1,1-dichloroethane.
(i) Micrograms per liter, equivalent to parts per billion.
(j) CSW - surface water.
(k) Nitrate, nitrite, nonspecific.
(l) CSE - sediment.

TABLE 7.7-2

Summary of Contaminants of Potential Concern (COPC) Exposure Point Concentrations by Medium for Site 2 - Phase I
Jefferson Proving Ground
Madison, Indiana

	Measured Concentrations in Abiotic Media				Estimated Concentrations in Biotic Media								
Analyte Name	Filtered Surface Water (µg/L) [(a)]	Sediment (mg/kg) [(b)]	Unfiltered Surface Water (mg/L) [(c)]	Soil (mg/kg)	Plant (mg/kg)	Invertebrate (mg/kg)	Mouse (mg/kg)	Swift (mg/kg)	Aquatic Plants (mg/kg)	Benthic Invertebrate (mg/kg)	Fish (mg/kg)	Frogs (mg/kg)
Aluminum		19528		23100	9.24E+01	2.54E+02	6.35E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic		21.18		13.70	2.88E-01	1.55E+00	2.38E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Barium	66.90	274.3	0.07	110.0	1.62E+01	3.96E+00	1.96E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beryllium		1.80		0.75	3.02E-03	8.29E-03	2.07E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Boron		8.19		10.50	4.20E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium		42.10		27.60	3.31E-01	7.18E-01	5.38E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt		12.47		9.41	1.69E-01	3.29E-01	4.38E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper		18.34		15.40	1.52E+00	1.36E+01	1.18E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Iron		61209	0.24	23800	9.52E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead		14.50		190.0	2.47E+01	1.33E+01	1.82E-02	9.92E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Manganese	51.90	1802	0.06	832.0	3.08E+01	3.16E+01	9.57E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury				0.21	4.22E-04	3.04E-01	1.94E-01	3.96E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel		26.11		12.70	5.59E-01	6.35E-01	2.55E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,2-Bis(p-chlorophenyl)-1,1-dichloroethane				0.31	3.13E-03	6.19E-01	1.43E-01	5.89E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Silver		11.05	0.001	5.30	2.54E-01	6.36E-01	4.57E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total petroleum hydrocarbons				90.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Vanadium		104.2		37.30	1.12E-01	3.36E-01	4.66E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc		146.9		172.0	9.46E+01	1.14E+02	6.99E+00	1.31E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Footnotes:

(a) Micrograms per liter, equivalent to parts per billion.
(b) Milligrams per kilogram, equivalent to parts per million.
(c) Milligrams per liter, equivalent to parts per million.

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TABLE 7.7-3

Summary Statistics for COPCs at JPG Site 27 - Phase I
Analytes in Surface Soil
Jefferson Proving Ground
Madison, Indiana

Site	Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Std. Deviation	UCL 95 [(a)]	EPC µg/g [(b)]	Exceed Background (Bkg)?	Retain as COPC[(c)]?	Comment
27	Silver	12	12	100	0.10	210.00	19.68	60.02	50.80	50.80	Yes (Y)	Y	Not detected in Bkg.
27	Aluminum	12	12	100	17900	37200	27650	5976	30748	30748	Y	Y	
27	Arsenic	12	12	100	4.10	15.00	8.08	2.73	9.49	9.49	Y	Y	
27	Boron	10	12	83	3.32	16.70	10.71	4.09	12.83	12.83	Y	Y	Not detected in Bkg.
27	Barium	12	12	100	73.80	500.0	160.2	111.5	218.0	218.0	Y	Y	
27	Beryllium	12	12	100	0.59	1.60	0.92	0.29	1.07	1.07	Y	Y	
27	Cadmium	1	12	8	0.60	2.33	0.74	0.50	1.00	1.00	Y	Y	
27	Cobalt	12	12	100	9.07	56.70	15.19	13.28	22.07	22.07	Y	Y	
27	Chromium	12	12	100	19.80	72.20	35.99	13.90	43.20	43.20	Y	Y	
27	Copper	12	12	100	8.61	33.50	18.16	7.60	22.11	22.11	Y	Y	
27	Iron	12	12	100	19500	85000	33450	17434	42489	42489	Y	Y	
27	Mercury	7	12	58	0.03	0.26	0.08	0.07	0.11	0.11	Y	Y	Not detected in Bkg.
27	Manganese	12	12	100	401.0	13000	1940	3514	3761	3761	Y	Y	
27	Molybdenum	0	12	0	NC[(d)]	NC	NC	NC	NC	NC	NA[(e)]	No (N)	Not a COPC
27	Nickel	12	12	100	11.90	41.00	17.63	7.70	21.63	21.63	Y	Y	
27	Lead	12	12	100	10.40	600.00	66.57	168.22	153.78	153.78	Y	Y	
27	Selenium	0	12	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
27	Tin	0	12	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
27	Tellurium	0	12	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
27	Thallium	0	12	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
27	Vanadium	12	12	100	30.50	77.50	46.40	13.26	53.28	53.28	Y	Y	
27	Zinc	12	12	100	50.40	160.0	78.13	30.8	94.1	94.1	Y	Y	
27	Cyanide	3	10	30	0.13	3.9	0.52	1.1	1.1	1.1	NA	Y	Not detected in Bkg.
27	Dieldrin	2	4	50	0.00	0.01	0.00	0.00	0.01	0.01	NA	Y	Not detected in Bkg.
27	Endrin	2	4	50	0.00	0.02	0.01	0.01	0.02	0.02	NA	Y	Not detected in Bkg.
27	2,2-Bis(p-chlorophenyl)-1,1,1-trichloroethane	1	4	25	0.00	0.01	0.00	0.01	0.01	0.01	NA	Y	Not detected in Bkg.

Notes:

Note-.Calcium, magnesium, sodium and potassium were not included in risk assessment as they are macronutrients.
All other analytes in soil have been included if they were detected in one or more samples.

Footnotes:

(a) Upper 95% confidence limit.
(b) Exposure point concentration, micrograms per gram, equivalent to parts per million.
(c) Contaminant of potential concern.
(d) Not calculated. Not a COPC.
(e) Not applicable or not evaluated.

TABLE 7.7-4

Summary of Samples Used in the JPG DERA for Site 27 - Phase I

Surface Soil Samples (Inorganics) Included in the DERA for Site 27 - Phase I

Sample I.D.	Date Sampled	Depth (feet)	Sample Type	Comment
SSA27SF001	11/10/1992	0.0	GRAB	Antimony result rejected.
SSA27SF002	11/11/1992	0.0	GRAB	Antimony result rejected.
SSA27SF003	11/11/1992	0.0	GRAB	Antimony result rejected.
SSA27SF004	11/11/1992	0.0	GRAB	Antimony result rejected.
SSA27SF005	11/11/1992	0.0	GRAB	Antimony result rejected.
SSA27SF006	11/11/1992	0.0	GRAB	Antimony result rejected.
SSA27SF007	11/11/1992	0.0	GRAB	Antimony result rejected.
SSA27SF008	11/11/1992	0.0	GRAB	Antimony result rejected.
SSA27SF009	11/11/1992	0.0	GRAB	Antimony result rejected.
SSA27SF010	11/11/1992	0.0	GRAB	Antimony result rejected.
SSA27SF011	11/11/1992	0.0	GRAB	Antimony result rejected.
SSA27SF012	11/11/1992	0.0	GRAB	Antimony result rejected.

Surface Soil Samples (Organics) Included in the DERA for Site 27 - Phase I

Sample I.D.	Date Sampled	Depth (feet)	Sample Type	Comment
SSA27SF013	6/21/1993	0.0	GRAB	
SSA27SF014	6/21/1993	0.0	GRAB	
SSA27SF015	6/21/1993	0.0	GRAB	
SSA27SF016	6/21/1993	0.0	GRAB	

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TABLE 7.7-5

Summary Statistics for Analytes in Surface Soil at JPG
Site 27 - Phase II
Jefferson Proving Ground
Madison, Indiana

Site	Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Std. Deviation	UCL 95 [(a)]	EPC µg/g [(b)]	Exceed Background (Bkg)?	Retain as COPC(c)?	Comment
27	Silver	21	24	88	0.30	61.0	8.41	15.86	14.00	14.00	Y	Y	Not detected in Bkg.
27	Aluminum	24	24	100	9955	43800	18946	7280	21510	21510	Y	Y	
27	Arsenic	24	24	100	5.36	72.7	13.19	14.03	18.13	18.13	Y	Y	
27	Boron	12	24	50	4.27	408.0	30.43	88.23	61.50	61.50	Y	Y	Not detected in Bkg.
27	Barium	24	24	100	56.70	1650	194.1	338.5	313.3	313.3	Y	Y	
27	Beryllium	14	24	58	0.29	6.15	0.93	1.26	1.37	1.37	Y	Y	
27	Cadmium	5	24	21	0.25	5.00	0.53	0.96	0.87	0.87	Y	Y	
27	Cobalt	20	24	83	2.94	20.0	9.33	3.81	10.67	10.67	Y	Y	
27	Chromium	24	24	100	13.80	73.0	28.69	15.00	33.97	33.97	Y	Y	
27	Copper	20	24	83	6.60	74.2	16.53	14.98	21.81	21.81	Y	Y	
27	Iron	24	24	100	11450	29600	20227	4643	21862	21862	Y	Y	
27	Mercury	14	24	58	0.05	1.45	0.27	0.40	0.41	0.41	Y	Y	Not detected in Bkg.
27	Manganese	24	24	100	149.0	1460	791.4	421.7	940	940	Y	Y	
27	Molybdenum	4	24	17	3.17	10.90	5.35	1.46	5.87	5.87	Y	Y	
27	Nickel	20	24	83	4.50	35.80	12.81	6.58	15.13	15.13	Y	Y	
27	Lead	24	24	100	11.40	45.70	23.87	7.33	26.46	26.46	Y	Y	
27	Antimony	1	24	4	0.50	3.19	0.65	0.55	0.84	0.84	Y	Y	Too low in detection frequency for statistical comparisons
27	Tin	5	24	21	2.70	13.50	6.13	1.92	6.81	6.81	Y	Y	Not detected in Bkg.
27	Thallium	19	24	79	0.50	4.9	1.26	0.95	1.60	1.60	Y	Y	
27	Vanadium	24	24	100	21.58	128.0	37.91	21.53	45.49	45.49	Y	Y	
27	Zinc	24	24	100	29.30	121.0	58.06	22.63	66.02	66.02	Y	Y	

Note:

Calcium, magnesium, sodium and potassium were not included in risk assessment as they are macronutrients.

Footnotes:

(a) Upper 95% confidence limit.

(b) Exposure point concentration, micrograms per gram, equivalent to parts per million.

(c) Contaminants of Potential Concern

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TABLE 7.7-6

Summary of Contaminants of Potential Concern (COPC) Exposure Point Concentrations by Medium
Site 27 - Phase II
Jefferson Proving Ground
Madison, Indiana

	Measured Concentrations in Abiotic Medi				Estimated Concentrations in Biotic Medi							
Analyte Name	**Filtered Surface Water (µg/L) [(a)]**	**Sediment (mg/kg) [(b)]**	**Unfiltered Surface Water (mg/L) [(c)]**	**Soil (mg/kg)**	**Plant (mg/kg)**	**Invertebrate (mg/kg)**	**Mouse (mg/kg)**	**Swift (mg/kg)**	**Aquatic Plants (mg/kg)**	**Benthic Invertebrate (mg/kg)**	**Fish (mg/kg)**	**Frogs (mg/kg)**
Aluminum				21510	8.60E+01	2.37E+02	5.92E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Antimony				0.84	2.22E-01	1.61E-01	1.94E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic				18.13	3.81E-01	2.05E+00	3.16E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Barium				313.3	4.61E+01	1.13E+01	5.59E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beryllium				1.37	5.49E-03	1.51E-02	3.78E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Boron				61.50	2.46E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium				0.87	3.47E-01	3.22E+00	4.33E-03	6.63E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium				33.97	4.08E-01	8.83E-01	6.62E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt				10.67	1.92E-01	3.73E-01	4.96E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper				21.81	2.16E+00	1.92E+01	1.67E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Iron				21862	8.74E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead				26.46	3.44E+00	1.85E+00	2.54E-03	1.38E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Manganese				939.9	3.48E+01	3.57E+01	1.08E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury				0.41	8.13E-04	5.85E-01	3.74E-01	7.62E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Molybdenum				5.87	1.47E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel				15.13	6.66E-01	7.57E-01	3.04E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Silver				14.00	6.72E-01	1.68E+00	1.21E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium				1.60	6.38E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tin				6.81	2.04E-01	0.00E+00	2.31E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Vanadium				45.49	1.36E-01	4.09E-01	5.68E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc				66.02	3.63E+01	4.36E+01	2.68E+00	5.04E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Footnotes:

(a) Micrograms per liter, equivalent to parts per billion.
(b) Milligrams per kilogram, equivalent to parts per million.
(c) Milligrams per liter, equivalent to parts per million.

n:\244\0024\01\wp\tbl\96_Table 7.7-5 and 7.7-6_Phase 2 RI.xls (sampdata)

TABLE 7.7-7

Macroinvertebrate Community Matrix Summary Sheet
Harberts Creek
Jefferson Proving Ground
Madison, Indiana

Parameter	Sample Result		% Comparison		IBI[c] Score	
	01[a]	02[b]	01	02	01	02
Taxa Richness	19	23	83%	100%	6	6
Modified Hilsenhoff Biotic Index	6.68	6.48	97%	100%	6	6
Scrapers / (Scrapers + Filterers)	0.95	0.8	>100%	100%	6	6
EPT / Chironomid Abundances	2.33	0.93	>100%	100%	6	6
% Contribution of Dominant Taxon	0.25	0.21	25%	21%	4	4
EPT Index (EPT Richness)	4	4	100%	100%	6	6
Community Loss Index	0.58	0	0.58	0	4	6
Ratio Shredders / Total	0	0.02	0	100%	0	6
			Total Score		38	46
			% Comparison Score		83%	100%

Footnotes:

(a) 01 is Harbert's Creek where Site 2 (Sewage Treatment Plant Outfall) is located (Figure 7.7-1).

(b) 02 is upstream along Harbert's Creek (reference area) near the crossing of Papermill Road (Figure 7.7-2).

(c) IBI = Index of Biological Activity

TABLE 7.7-8

Fish Summary Data
Harberts Creek
Jefferson Proving Grounc
Madison, Indiana

Fish Species	Trophic Level	Tolerance	Total Number Captured By Sample Location[(a)] 01-A	01-B	01-C	Total 01	02-A	02-B	02-C	Total 02
Creek Chub	Generalist	Tolerant	11	38	8	57	34	33	61	128
Striped Shiner	Insectivore	Intermediate	41	93	32	166	8	20	27	55
Grass Pickerel	Piscivore	Intermediate	3	2	3	8	5	0	0	5
Green Sunfish	Invertivore	Tolerant	7	14	19	40	21	25	36	82
Suckermouth Minnow	Insectivore	Intermediate	24	29	55	108	11	7	30	48
Bluntnose Minnow	Omnivore	Tolerant	1	0	1	2	4	2	11	17
Rainbow Darter	Insectivore	Intermediate	4	19	5	28	10	12	7	29
Yellow Bullhead	Insectivore	Tolerant	0	1	3	4	0	2	0	2
Silverjaw Minnow	Insectivore	Intermediate	0	0	9	9	6	6	39	51
Spotfin Shiner	Insectivore	Intermediate	0	0	0	0	1	0	0	1
Greenside Darter	Insectivore	Intermediate	0	0	0	0	1	0	0	1
Fantail Darter	Insectivore	Intermediate	0	0	0	0	0	0	33	33
Total			91	196	135	422	101	107	244	452

Footnote:
(a) 01 is Harbert's Creek where Site 2 (Sewage Treatment Plant Outfall) is located (Figure 7.7-1). 02 is upstream along Harbert's Creek (reference area) near 'the crossing of Papermill Road (Figure 7.7-2).

n:\244\0024\01\wp\tbl\96_Table 7.7-7 thru 7.7-11_Phase 2 RI.xls (Fish)

TABLE 7.7-9

Fish Index of Biological Integrity (IBI) Metrics Summary Sheet
Harberts Creek
Jefferson Proving Ground
Madison, Indiana

Parameter	Station		% Comparison		IBI[c] Score	
	01[a]	02	01	02	01	02
Total Number of Fish Species	9	12	75%	100%	5	5
Number of Darter Species	1	3	33%	100%	3	5
Number of Sunfish Species	1	1	100%	100%	5	5
Number of Sucker Species	0	0	NA[b]	NA	1	1
Number of Intolerant Species	0	0	NA	NA	1	1
Proportion of Individuals as Green Sunfish	9.5%	18%	NA	NA	5	3
Proportion of Individuals as Omnivores	0.5%	3.8%	NA	NA	5	5
Proportion of Individuals as Insectivores	84%	67%	NA	NA	5	5
Proportion of Individuals as Carnivores	2%	1%	NA	NA	3	3
Total Number of Individuals	422	452	93%	100%	5	5
Proportion of Individuals as Hybrids	0	0	NA	NA	5	5
Proportion of Individuals with Disease/Anomalies	0.2%	0.7%	NA	NA	5	5
Total Score					48	48

Footnotes:

(a) 01 is Harbert's Creek where Site 2 (Sewage Treatment Plant Outfall) is located (Figure 7.7-1). 02 is upstream long Harbert's Creek (reference area) near 'the crossing of Papermill Road (Figure 7.7-2).

(b) NA = Not Applicable

(c) Index Of Biological Intensity

n:\244\0024\01\wp\tbl\96_Table 7.7-7 thru 7.7-11_Phase 2 RI.xls (IBI Metrics)

TABLE 7.7-10

Riparian and Aquatic Habitat Assessment Summary Sheet
Harberts Creek
Jefferson Proving Ground
Madison, Indiana

Habitat Parameter[b]	Score By Location[a]							
	01-A	01-B	01-C	Average 01	02-A	02-B	02-C	Average 02
Bottom substrate/available cover	18	16	16	16.7	11	16	18	15.0
Embeddedness	16	14	16	15.3	10	14	13	12.3
Flow	11	1	11	7.7	2	3	3	2.7
Channel alteration	11	7	10	9.3	7	9	11	9.0
Bottom scouring and deposition	11	7	10	9.3	7	8	10	8.3
Pool/riffle, run/bend ratio	10	8	9	9.0	8	11	10	9.7
Bank stability	8	5	6	6.3	6	7	7	6.7
Bank vegetation stability	10	10	10	10.0	7	9	8	8.0
Streamside cover	8	7	7	7.3	6	7	7	6.7
Total Score[c]	103	75	95	91.0	64	84	87	78.3

Footnotes:

(a) 01 is Harbert's Creek where Site 2 (Sewage Treatment Plant Outfall) is located (Figure 7.7-1). 02 is upstream along Harbert's Creek (reference area) near the crossing of Papermill Road (Figure 7.7-2).

(b) Habitat parameters and scoring are explained in Section 7.7.3.9 of the text.

(c) Ratings of a habitat are based on total scores as follows:

Excellent = 106 - 135
Good = 71 - 105
Fair = 36 - 70
Poor = 0 - 35

n:\244\0024\01\wp\tbl\96_Table 7.7-7 thru 7.7-11_Phase 2 RI.xls (Hab Scores)

TABLE 7.7-11

Water Quality Data Summary
Harberts Creek
Jefferson Proving Ground
Madison, Indiana

	Location[a]							
Parameter[b]	01-A	01-B	01-C	Average 01	02-A	02-B	02-C	Average 02
pH	8.07	8.04	7.84	7.97	7.86	7.89	7.65	7.81
	8.02	7.75	8.07			7.88	7.76	
Dissolved Oxygen (mg/L)	5.1	6.8	2.8	4.65	1.7	3.2	0.85	2.75
	4.1	3.35	5.75			4.5	3.5	
Conductivity (mS/cm)	0.535	0.495	0.301	0.456	0.289	0.368	0.333	0.367
	0.559	0.538	0.307			0.52	0.327	
Temperature (degrees C)	16.7	18.3	17.8	17.6	16.5	16.2	17.1	16.3
	17.9	17.3	17.5			15.3	16.2	
Turbidity (NTUs)	2	2	2	3.3	9	19	33	32.0
	2	3	9			15	84	

Notes:
1. mg/L = milligram per liter
2. mS/cm = micormhos per centimeter
3. NTUs = nephelometric units
4. degrees C = degress centigrade

Footnotes:

(a) 01 is Harbert's Creek where Site 2 (Sewage Treatment Plant Outfall) is located (Figure 7.7-1).

(b) 02 is upstream along Harbert's Creek (reference area) near the crossing of Papermill Road (Figure 7.7-2).

TABLE 7.7-11a

Lines of Evidence in the Ecological Risk Assessment Based on Reasonable Maximum Exposure (RME)
Jefferson Proving Ground
Madison, Indiana

Section of Report	Site	End Use	Inorganic COPCs Exceeding Reference Area Concentrations	Terrestrial Endpoints													Aquatic Endpoints						
				Toxicity Tests			RME NOAEL[a] HI / RME LOAEL[b] HI[c]										Field Surveys		RME NOAEL HI / RME LOAEL HI				
			Soil	EW Tox	Plant Tox	Soil Fauna	mourning dove	chimney swift	wild turkey	american kestrel	white-footed mouse	eastern cottontail	red fox	little brown myotis	plants	soil fauna	diversity	community structure	great blue heron	raccoon	benthic invertebrate	creek chub	pickerel frog
7	2						Phase I	Phase I	Phase I	Phase I	Phase I	Phase I	Phase I	Phase I	Phase I	Phase I			Phase I	Phase I	Phase I	Phase I	Phase I
		Industrial	NA	NA	NA	NA	0.01 / 0.00	0.02 / 0.00	0.00 / 0.00	0.02 / 0.00	87.5 / 23.61	0.38 / 0.12	0.01 / 0.00	0.05 / 0.01	498 / 33.58	108 / 8.53	See notes	See notes	0.63 / 0.06	0.03 / 0.01	4.76 / 2.44	4.76 / 2.44	4.76 / 2.44
7	27						Phase I	Phase I	Phase I	Phase I	Phase II	Phase II	Phase II	Phase II	Phase I	Phase I			NA	NA	NA	NA	NA
		Industrial	NA	NA	NA	NA	4.32 / 0.46	14.97 / 1.51	0.36 / 0.05	21.30 / 2.18	267 / 71.14	170 / 52.25	4.99 / 1.39	33.10 / 7.29	690 / 44.04	168 / 11.22	NA	NA	NA	NA	NA	NA	NA
8	3						Phase III	Phase III	Phase I/III	Phase III	Phase III	Phase III	Phase III	Phase III	Phase I	Phase II			NA	NA	NA	NA	NA
		Agricultural	Al, Ba, Co, Mn, Ni, Zn	N	Y	N	0.28 / 0.10	1.11 / 0.34	0.03 / 0.01	1.01 / 0.36	159.46 / 22.45	67.23 / 14.28	1.66 / 0.31	14.15 / 1.82	375 / 26.47	105 / 4.36	NA	NA	NA	NA	NA	NA	NA
8	4						Phase I	Phase I	Phase I	Phase I	Phase I	Phase I	Phase I	Phase I	Phase I	Phase I			NA	NA	NA	NA	NA
		Agricultural	Al, Ba, Co, Mn, Ni, Zn	N	Y	N	2.00 / 0.25	11.45 / 1.13	0.20 / 0.02	8.46 / 0.87	621 / 64.93	230 / 34.51	3.48 / 0.50	26.07 / 2.86	574 / 38.84	192 / 11.07	NA	NA	NA	NA	NA	NA	NA
8	New Burn (W of 3/4)						Phase III	Phase III	Phase III	Phase III	Phase III	Phase III	Phase III	Phase III	Phase III	Phase III			NA	NA	NA	NA	NA
	Outside Trench	Agricultural	NA	NA	NA	NA	0.05 / 0.01	0.18 / 0.02	0.00 / 0.00	0.25 / 0.02	136 / 34.52	4.09 / 1.26	0.05 / 0.02	0.42 / 0.10	309 / 20.95	84.7 / 5.48	NA	NA	NA	NA	NA	NA	NA
8	New Burn (W of 3/4)						Phase III	Phase III	Phase III	Phase III	Phase III	Phase III	Phase III	Phase III	Phase III	Phase III			NA	NA	NA	NA	NA
	Inside Trench	Agricultural	NA	NA	NA	NA	0.00 / 0.00	0.02 / 0.00	0.00 / 0.00	0.01 / 0.00	580 / 167.24	1.75 / 0.49	0.03 / 0.01	0.19 / 0.05	228 / 6.23	99.6 / 2.27	NA	NA	NA	NA	NA	NA	NA
10	7						IM Confirm	IM Confirm	Phase I/IM	IM Confirm	IM Confirm	IM Confirm	IM Confirm	IM Confirm	Phase I	Phase I			NA	NA	NA	NA	NA
		Industrial	NA	NA	NA	NA	0.02 / 0.00	0.14 / 0.01	0.00 / 0.00	0.10 / 0.01	104.1 / 16.84	1.25 / 0.31	0.02 / 0.00	0.15 / 0.02	383.51 / 37.29	86.10 / 5.88	NA	NA	NA	NA	NA	NA	NA
10	21B						Phase I	Phase I	Phase I	Phase I	Phase I	Phase I	Phase I	Phase I	Phase I	Phase I			NA	NA	NA	NA	NA
		Industrial	NA	NA	NA	NA	0.13 / 0.01	2.51 / 0.17	0.02 / 0.00	0.80 / 0.06	1091 / 68.27	3.26 / 0.55	0.13 / 0.01	2.22 / 0.12	376 / 23.75	128 / 13.73	NA	NA	NA	NA	NA	NA	NA
12	9						Phase III	Phase III	Phase III	Phase III	Phase I	Phase III	Phase I	Phase I	Phase III	Phase III			Phase I	Phase I	Phase I	Phase I	Phase I
		Wildlife Refuge	Al, Be, Co, Mn, Zn	N	N	N	2.63 / 0.23	8.48 / 0.74	0.21 / 0.02	13.16 / 1.15	221 / 45.66	135.98 / 47.71	2.17 / 0.53	14.67 / 3.14	393.19 / 24.75	108.23 / 6.38	NA	NA	37.14 / 3.44	5.28 / 1.77	8.45 / 5.48	8.45 / 5.48	8.45 / 5.48
17	14						Phase I	Phase I	Phase I/III/IM	IM Confirm	Phase I	Phase I	Phase I	Phase I	Phase I	Phase I			Phase I	Phase I	Phase I	Phase I	Phase I
		Agricultural	Ba	N	N	N	0.04 / 0.01	0.10 / 0.03	0.0 / 0.0	0.07 / 0.03	354.17 / 11.17	5.06 / 0.17	0.07 / 0.01	0.47 / 0.01	2423.59 / 1130.40	1325.46 / 20.21	NA	NA	2.04 / 0.25	0.10 / 0.03	23.36 / 77.86	23.36 / 77.86	23.36 / 77.86
18	15						Phase I	Phase I	Phase I	Phase I	Phase I	Phase I	Phase I	Phase I	Phase I	Phase I			NA	NA	NA	NA	NA
		Industrial, Agricultural	Ba	NA	NA	NA	0.39 / 0.11	1.89 / 0.78	0.04 / 0.01	0.94 / 0.34	5974 / 243.68	44.8 / 3.21	1.18 / 0.44	11.97 / 0.35	2127 / 232.09	1313 / 212.86	NA	NA	NA	NA	NA	NA	NA
20	25						Phase I	Phase I	Phase I	Phase I	Phase I	Phase I	Phase I	Phase III	Phase I	Phase I			NA	NA	NA	NA	NA
		Industrial	no exceedances	N	N	N	0.16 / 0.05	0.44 / 0.15	0.02 / 0.01	0.70 / 0.23	117 / 44.99	21.30 / 8.36	0.24 / 0.09	1.21 / 0.08	25.40 / 1.92	362 / 0.20	NA	NA	NA	NA	NA	NA	NA
22	28						Phase I	Phase I	Phase I	Phase I	Phase I	Phase I	Phase I	Phase I	Phase I	Phase I			NA	NA	NA	NA	NA
		Ecological	no exceedances	NA	NA	NA	1.08 / 0.23	5.21 / 1.19	0.12 / 0.03	3.72 / 0.88	6421 / 497.87	208 / 18.50	3.29 / 0.56	18 / 1.11	2318.35 / 221.92	9569.72 / 124.59	NA	NA	NA	NA	NA	NA	NA
22	29						Phase I	Phase I	Phase I	Phase I	Phase I	Phase I	Phase I	Phase I	Phase I	Phase I			Phase I	Phase I	Phase I	Phase I	Phase I
		Ecological	no exceedances	NA	NA	NA	0.09 / 0.01	0.16 / 0.02	0.03 / 0.00	0.09 / 0.01	0.10 / 0.04	0.09 / 0.03	0.08 / 0.03	0.15 / 0.06	0.00 / 0.00	0.00 / 0.00	NA	NA	7.75 / 0.68	0.32 / 0.12	15.36 / 2.82	15.36 / 2.82	15.36 / 2.82
22	39						Phase III	Phase III	Phase III	Phase III	Phase III	Phase III	Phase III	Phase III	Phase III	Phase I			NA	NA	NA	NA	NA
		Ecological	no exceedances	N	N	N	6.82 / 0.68	22.04 / 2.15	0.54 / 0.06	34.19 / 3.38	174 / 42.49	111 / 33.40	6.43 / 1.76	50.6 / 11.24	31.48 / 1.08	140 / 0.31	NA	NA	NA	NA	NA	NA	NA
31	11						Phase III	Phase III	Phase III	Phase III	Phase III	Phase III	Phase III	Phase III	Phase III	Phase III			NA	NA	NA	NA	NA
		RCRA Part B	no exceedances	N	N	N	0.29 / 0.03	0.93 / 0.08	0.02 / 0.00	1.40 / 0.10	149.61 / 21.44	31.00 / 6.12	0.46 / 0.08	3.37 / 0.52	10.68 / 0.00	1.04 / 0.00	NA	NA	NA	NA	NA	NA	NA
	Reference Sites																						
32	Avonburg			0-5%	97-99% Germ		Phase III	Phase III	Phase III	Phase III	Phase III	Phase III	Phase III	Phase III	Phase III	Phase III	NA	NA	NA	NA	NA	NA	NA
		NA	NA	Mort	0.108-0.226g Wet Wt	NA	79.03 / 8.89	160.15 / 16.99	14.11 / 1.73	67.22 / 8.61	280.81 / 44.50	137.65 / 30.45	131.64 / 25.02	198.64 / 32.56	234.23 / 15.13	63.87 / 3.82	NA	NA	NA	NA	NA	NA	NA
32	Cobbsfork			0-10%	92-100% Germ		Phase III	Phase III	Phase III	Phase III	Phase III	Phase III	Phase III	Phase III	Phase III	Phase III	NA	NA	NA	NA	NA	NA	NA
		NA	NA	Mort	0.78-0.154g Wet Wt	NA	52.94 / 5.57	105.81 / 10.61	9.40 / 1.08	43.04 / 5.16	176.46 / 29.62	96.45 / 21.06	88.43 / 17.06	119.67 / 21.44	195.06 / 12.67	44.31 / 3.24	NA	NA	NA	NA	NA	NA	NA
32	Rossmoyne			0-15%	97-100% Germ		Phase III	Phase III	Phase III	Phase III	Phase III	Phase III	Phase III	Phase III	Phase III	Phase III	NA	NA	NA	NA	NA	NA	NA
		NA	NA	Mort	0.198-0.294g Wet Wt	NA	101.01 / 11.28	250.45 / 24.81	19.24 / 2.36	125.52 / 12.94	323.60 / 51.86	165.72 / 36.72	157.44 / 29.83	238.35 / 38.35	210.06 / 13.32	85.06 / 3.37	NA	NA	NA	NA	NA	NA	NA

General Notes:
1. Lines of evidence for both terrestrial and aquatic receptors are summarized for each site. For each site, the overall RME NOAEL-based HI and its corresponding RME LOAEL-based HI are listed for each evaluated receptor. The phase of data that these HI's are associated with are noted too.
2. Shaded NOAEL and/or LOAEL HI values greater than 1 attain or exceed the highest reference area HI values.

Site Specific Notes:

Site 2

The following summarize the results of field evaluations performed for Site 2:

-Bioassessment of Harbert's Creek based on benthic macroinvertebrate sampling: The overall percent comparison score is 83 percent for Site 2 as compared to the reference area. The biological condition for Site 2 is rated as slightly impaired to nonimpaired as compared to the reference location.

-Bioassessment of Harbert's Creek based on fish sampling: Site 2 and the reference area both received a total score of 48 for the above metrics. This puts both sites into an Integrity Class of "Good".

-Habitat assessment: Site 2 received a total average score of 91 for habitat assessment for the three stream segments evaluated. The upstream reference area location received a total average score of 78.3 for the three stream segments evaluated. Both of these total scores indicate a rating of "good" for each stream location.

-Physical characteristics and water quality of Harbert's Creek: Overall, Site 2 and the reference area were very similar when assessing physical characteristics and water quality.

Site 14

For Site 14, note that the total RME LOAEL-based HIs exceed the total RME NOAEL-based HIs for aquatic life (i.e. benthic invertebrates, creek chub, and pickerel frog). There are two reasons for this. (1) LOAEL values are available for aluminum, iron, and manganese, but NOAEL values are not available for these metals. (2) The nickel sediment benchmark chosen as a NOAEL is actually higher in magnitude than the sediment benchmark chosen as a LOAEL.

Footnotes:
(a) No Observed Adverse Effect Level
(b) Lowest Observed Adverse Effect Level
(c) Hazard index

Legend
Y = Adverse effects above reference were observed in the toxicity test.
N = No adverse effects above reference were observed in the toxicity test.
NA = Test or comparison was not performed.
Mort = Earthworm mortality observed in toxicity tests.
Germ = Plant germination observed in phytotoxicity tests.
Wet Wt = Plant wet weight observed in phytotoxicity tests.

TABLE 7.7-12

Summary of Detailed Ecological Risk Assessment Reasonable Maximum Exposure (RME) Risk Drivers
Site 2 - Phase 1
Jefferson Proving Ground
Madison, Indiana

2	NOAEL[(a)] -Based HQs[(b)] Due to Soil Ingestion or Direct Contact - RME			NOAEL-Based HQs Due to Sediment Ingestion or Direct Contact - RME			NOAEL-Based HQs Due to Dietary Ingestion - RME	Total NOAEL-Based HQs Summed Across Pathways - RME					
Parameter	**White-footed Mouse**	**Plants**	**Soil Fauna**	**Benthic Invertebrate**	**Creek Chub**	**Pickerel Frog**	**White-footed Mouse**	**White-footed Mouse**	**Benthic Invertebrate**	**Creek Chub**	**Pickerel Frog**	**Plants**	**Soil Fauna**
Aluminum	8.52	462.00	9.24				3.13	11.65				462.00	9.24
Arsenic	5.76	1.37		2.58	2.58	2.58	18.92	24.68	2.58	2.58	2.58	1.37	
Barium								1.07					
Boron							3.05	3.09					
Chromium		5.52	69.00									5.52	69.00
Cobalt								1.59					
Iron	3.00		23.80					3.30					23.80
Lead		1.06					2.94	3.54				1.06	
Manganese		1.66										1.66	
Mercury			2.11										2.11
Silver		2.65										2.65	
Vanadium	28.24	18.65	1.87				8.30	36.54				18.65	1.87
Zinc		3.44	1.72				1.14	1.17				3.44	1.72
HI [(c)]_NOAEL	**45.52**	**496.36**	**107.74**	**2.58**	**2.58**	**2.58**	**37.48**	**86.63**	**2.58**	**2.58**	**2.58**	**496.36**	**107.74**

2	LOAEL[(d)]-Based HQs Due to Soil Ingestion - RME			LOAEL-Based HQs Due to Dietary Ingestion - RME	Total LOAEL-Based HQs Summed Across Pathways - RME		
Parameter	**White-footed Mouse**	**Plants**	**Soil Fauna**	**White-footed Mouse**	**White-footed Mouse**	**Plants**	**Soil Fauna**
Aluminum	4.32	31.64	8.25	1.59	5.91	31.64	8.25
Arsenic				1.49	1.95		
Boron				1.53	1.54		
Iron	1.50				1.65		
Vanadium	9.41			2.77	12.18		
HI_LOAEL	**15.23**	**31.64**	**8.25**	**7.38**	**23.23**	**31.64**	**8.25**

Footnotes:

(a) No Obsereved Adverse Effect Level

(b) Hazard Quotient

(c) Hazard Index

(d) Lowest Observed Adverse Effect Level

TABLE 7.7-13

Summary of Detailed Ecological Risk Assessment Central Tendency (CT) Risk Drivers
Site 2 - Phase 1
Jefferson Proving Ground
Madison ,Indiana

2	NOAEL[(a)]-Based HQs[(b)] Due to Soil Ingestion - CT	NOAEL-Based HQs Due to Sediment Ingestion or Direct Contact - CT			NOAEL-Based H(	Total NOAEL-Based HQs Summed Across Pathways - CT		
Parameter	**White-footed Mouse**	**Benthic Invertebrate**	**Creek Chub**	**Pickerel Frog**	**White-footed Mouse**	**White-footed Mouse**	**Benthic Invertebrate**	**Creek Chub**
Aluminum						1.20		
Arsenic		2.58	2.58	2.58	1.95	2.55	2.58	2.58
Vanadium	2.91					3.77		
HI [(c)]_NOAEL	**2.91**	**2.58**	**2.58**	**2.58**	**1.95**	**7.52**	**2.58**	**2.58**

2	Total LOAEL[(d)]-Based HQs Summed Across Pathways - CT
Parameter	**White-footed Mouse**
Vanadium	1.26
HI_LOAEL	**1.26**

Footnotes:
(a) No Obsereved Adverse Effect Level
(b) Hazard Quotient
(c) Hazard Index
(d) Lowest Observed Adverse Effect Level

TABLE 7.7-14

Summary of Detailed Ecological Risk Assessment Reasonable Maximum Exposure (RME) Risk Drivers
Site 27 - Phase 1
Jefferson Proving Ground
Madison, Indiana

27	NOAEL[(a)]-Based HQs[(b)] Due to Soil Ingestion or Direct Contact - RME								NOAEL-Based HQs Due to Dietary Ingestion - RME			
Parameter	Mourning Dove	American Kestrel	White-footed Mouse	Eastern Cottontail	Red Fox	Little Brown Myotis	Plants	Soil Fauna	Chimney Swift	White-footed Mouse	Eastern Cottontail	Little Brown Myotis
Aluminum			23.36	24.07		2.88	614.96	12.30		8.58	1.43	1.55
Arsenic			8.22	8.47		1.01				26.98	2.65	5.60
Barium										3.57	1.79	
Boron										7.69	4.81	
Cadmium									1.56	5.24		1.17
Chromium							8.64	108.00				
Cobalt			3.34	3.45			1.10			4.34		
Copper										1.06		
Endrin										2.67		
Iron		1.21	11.04	11.38		1.36		42.49		1.08		
Lead				1.03						4.89	1.99	
Manganese							7.52					
Mercury								1.10				
Silver							25.40					
Vanadium	3.58	18.28	83.05	85.59	2.10	10.22	26.64	2.66		24.42	3.82	4.51
Zinc							1.88			1.28		
HI[(c)]_NOAEL	**3.58**	**19.49**	**129.01**	**133.99**	**2.10**	**15.47**	**686.15**	**166.55**	**1.56**	**91.81**	**16.49**	**12.83**

TABLE 7.7-14

Summary of Detailed Ecological Risk Assessment Reasonable Maximum Exposure (RME) Risk Drivers
Site 27 - Phase 1
Jefferson Proving Ground
Madison, Indiana

27	Total NOAEL-Based HQs Summed Across Pathways - RME								
Parameter	Mourning Dove	Chimney Swift	American Kestrel	White-footed Mouse	Eastern Cottontail	Red Fox	Little Brown Myotis	Plants	Soil Fauna
Aluminum				31.94	25.50		4.43	614.96	12.30
Arsenic				35.20	11.12		6.61		
Barium				4.36	2.61				
Boron				7.76	4.89				
Cadmium		1.61		5.30			1.17		
Chromium								8.64	108.00
Cobalt				7.69	4.37		1.13	1.10	
Copper				1.10					
Endrin				2.70					
Iron			1.21	12.12	12.05		1.36		42.49
Lead				5.89	3.02				
Manganese				1.39				7.52	
Mercury									1.10
Silver								25.40	
Vanadium	3.67	11.50	18.48	107.47	89.41	2.38	14.73	26.64	2.66
Zinc				1.32				1.88	
HI_NOAEL	**3.67**	**13.10**	**19.68**	**224.25**	**152.98**	**2.38**	**29.43**	**686.15**	**166.55**

27	LOAEL[d]-Based HQs Due to Soil Ingestion - RME						LOAEL-Based HQs Due to Dietary Ingestion - RME			Total LOAEL-Based HQs Summed Across Pathways - RME					
Parameter	American Kestrel	White-footed Mouse	Eastern Cottontail	Little Brown Myotis	Plants	Soil Fauna	White-footed Mouse	Eastern Cottontail	Little Brown Myotis	American Kestrel	White-footed Mouse	Eastern Cottontail	Little Brown Myotis	Plants	Soil Fauna
Aluminum		11.84	12.21	1.46	42.12	10.98	4.35				16.20	12.93	2.24	42.12	10.98
Arsenic							2.13				2.78				
Boron							3.84	2.40			3.88	2.44			
Endrin							1.60				1.62				
Iron		5.52	5.69								6.06	6.03			
Vanadium	1.22	27.68	28.53	3.41			8.14	1.27	1.50	1.23	35.82	29.80	4.91		
HI_LOAEL	**1.22**	**45.05**	**46.43**	**4.87**	**42.12**	**10.98**	**20.07**	**3.68**	**1.50**	**1.23**	**66.36**	**51.21**	**7.15**	**42.12**	**10.98**

Footnotes:

(a) No Obsereved Adverse Effect Level

(b) Hazard Quotient

(c) Hazard Index

(d) Lowest Observed Adverse Effect Level

TABLE 7.7-15

Summary of DERA CT Risk Drivers
Site 27 - Phase 1
Jefferson Proving Ground
Madison, Indiana

27	NOAEL-Based HQs Due to Soil Ingestion - CT						NOAEL-Based HQs Due to Dietary Ingestion - CT			
Parameter	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**Chimney Swift**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**
Aluminum				14.46	21.87	2.71		5.31	1.30	1.46
Arsenic				5.09	7.70			16.70	2.40	5.28
Barium								2.21	1.63	
Boron								4.76	4.37	
Cadmium							1.31	3.25		1.10
Cobalt				2.07	3.13			2.69		
Endrin								1.65		
Iron				6.83	10.34	1.28				
Lead								3.03	1.81	
Vanadium	3.49	9.00	2.19	51.40	77.77	9.64		15.11	3.47	4.25
HI_NOAEL	**3.49**	**9.00**	**2.19**	**79.85**	**120.81**	**13.64**	**1.31**	**54.71**	**14.98**	**12.10**

27	Total NOAEL-Based HQs Summed Across Pathways - CT					
Parameter	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**
Aluminum				19.77	23.17	4.17
Arsenic				21.79	10.10	6.24
Barium				2.70	2.37	
Boron				4.81	4.44	
Cadmium		1.35		3.28		1.11
Cobalt				4.76	3.97	1.06
Endrin				1.67		
Iron				7.50	10.95	1.28
Lead				3.65	2.75	
Vanadium	3.58	9.69	2.60	66.52	81.24	13.89
HI_NOAEL	**3.58**	**11.05**	**2.60**	**136.44**	**139.00**	**27.76**

27	LOAEL-Based HQs Due to Soil Ingestion - CT			LOAEL-Based HQs Due to Dietary Ingestion - CT			Total LOAEL-Based HQs Summed Across Pathways - CT		
Parameter	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**
Aluminum	7.33	11.09	1.38	2.69			10.02	11.75	2.12
Arsenic				1.32			1.72		
Boron				2.38	2.18		2.40	2.22	
Endrin							1.00		
Iron	3.42	5.17					3.75	5.48	
Vanadium	17.13	25.92	3.21	5.04	1.16	1.42	22.17	27.08	4.63
HI_LOAEL	**27.88**	**42.18**	**4.59**	**11.43**	**3.34**	**1.42**	**41.07**	**46.53**	**6.75**

Notes:
1. NOAEL = No Observed Adverse Effect Level
2. HQ = hazard quotient
3. HI = Hazard Index
4. LOAEL = Lowest Observed Adverse Effect Level
5. CT = Central Tendecy
6. DERA = Draft Ecological Risk Assessment

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TABLE 7.7-16

Summary of DERA RME Risk Drivers
Site 27 - Phase II
Jefferson Proving Ground
Madison, Indiana

27	NOAEL-Based HQs Due to Soil Ingestion or Direct Contact - RME									NOAEL-Based HQs Due to Dietary Ingestion - RME			
Parameter	Mourning Dove	Chimney Swift	American Kestrel	White-footed Mouse	Eastern Cottontail	Red Fox	Little Brown Myotis	Plants	Soil Fauna	Chimney Swift	White-footed Mouse	Eastern Cottontail	Little Brown Myotis
Aluminum				15.96	16.45		1.96	420.24	8.40		5.87		1.06
Arsenic				14.26	14.70		1.76	1.65			46.82	4.59	9.72
Barium				1.02	1.05						4.57	2.30	
Boron											30.14	18.85	
Cadmium										1.21	4.08		
Chromium								6.12	76.51				
Cobalt				1.56	1.60						2.02		
Copper													
Iron				5.81	5.99				22.38				
Lead													
Manganese								2.52					
Mercury								1.14	3.41				
Molybdenum											2.96	1.11	
Silver								5.72					
Tin				10.25	10.56		1.26				7.53	4.71	
Vanadium	2.86	8.51	14.58	66.25	68.27	1.67	8.16	21.25	2.12		19.48	3.05	3.60
Zinc								1.56			1.06		
HI_NOAEL	**2.86**	**8.51**	**14.58**	**115.1**	**118.6**	**1.67**	**13.14**	**460.2**	**112.8**	**1.21**	**124.5**	**34.61**	**14.38**

27	Total NOAEL-Based HQs Summed Across Pathways - RME								
Parameter	Mourning Dove	Chimney Swift	American Kestrel	White-footed Mouse	Eastern Cottontail	Red Fox	Little Brown Myotis	Plants	Soil Fauna
Aluminum				21.83	17.43		3.02	420.24	8.40
Arsenic				61.08	19.29		11.48	1.65	
Barium				5.59	3.35				
Boron				30.44	19.17				
Cadmium		1.25		4.12					
Chromium								6.12	76.51
Cobalt				3.58	2.03				
Copper				1.02					
Iron				6.38	6.35				22.38
Lead				1.02					
Manganese								2.52	
Mercury								1.14	3.41
Molybdenum				3.44	1.41				
Silver								5.72	
Tin				17.78	15.27		1.26		
Vanadium	2.93	9.17	14.74	85.72	71.32	1.90	11.75	21.25	2.12
Zinc				1.10				1.56	
HI_NOAEL	**2.93**	**10.42**	**14.74**	**243.1**	**155.6**	**1.90**	**27.51**	**460.2**	**112.8**

27	LOAEL-Based HQs Due to Soil Ingestion - RME					LOAEL-Based HQs Due to Dietary Ingestion RME			Total LOAEL-Based HQs Summed Across Pathways - RME				
Parameter	White-footed Mouse	Eastern Cottontail	Little Brown Myotis	Plants	Soil Fauna	White-footed Mouse	Eastern Cottontail	Little Brown Myotis	White-footed Mouse	Eastern Cottontail	Little Brown Myotis	Plants	Soil Fauna
Aluminum	8.09	8.34		28.78	7.50	2.97			11.07	8.84	1.53	28.78	7.50
Arsenic	1.13	1.16				3.70			4.82	1.52			
Boron						15.07	9.43		15.22	9.59			
Iron	2.91	3.00							3.19	3.17			
Vanadium	22.08	22.76	2.72			6.49	1.02	1.20	28.57	23.77	3.92		
HI_LOAEL	**34.21**	**35.26**	**2.72**	**28.78**	**7.50**	**28.23**	**10.44**	**1.20**	**62.88**	**46.89**	**5.45**	**28.78**	**7.50**

Notes:
1. NOAEL = No Observed Adverse Effect Level
2. LOAEL = Lowest Observed Adverse Effect Level
3. HQ = Hazard Quotient
4. RME = Reasonable Maximum Exposure
5. DERA = Draft Ecological Risk Assessment

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TABLE 7.7-17

Summary of DERA CT Risk Drivers
Site 27 - Phase II
Jefferson Proving Ground
Madison, Indiana

27	NOAEL-Based HQs Due to Soil Ingestion - CT						NOAEL-Based HQs Due to Dietary Ingestion - CT				Total NOAEL-Based HQs Summed Across Pathways - CT					
Parameter	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**Chimney Swift**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**
Aluminum				9.88	14.95	1.85		3.63						13.51	15.84	2.85
Arsenic				8.83	13.35	1.66		28.98	4.17	9.17				37.80	17.52	10.82
Barium								2.83	2.09					3.46	3.04	
Boron								18.65	17.13					18.84	17.42	
Cadmium							1.02	2.52				1.05		2.55		
Cobalt					1.46			1.25						2.21	1.85	
Iron				3.60	5.44									3.95	5.77	
Molybdenum								1.83	1.01					2.13	1.28	
Tin				6.34	9.60	1.19		4.66	4.28					11.01	13.88	1.19
Vanadium	2.79	7.18	1.74	41.00	62.03	7.69		12.05	2.77	3.39	2.86	7.73	2.07	53.06	64.80	11.08
HI_NOAEL	**2.79**	**7.18**	**1.74**	**69.65**	**106.8**	**12.39**	**1.02**	**76.41**	**31.45**	**12.56**	**2.86**	**8.79**	**2.07**	**148.5**	**141.4**	**25.95**

27	LOAEL-Based HQs Due to Soil Ingestion - CT			LOAEL-Based HQs Due to Dietary Ingestion - CT			Total LOAEL-Based HQs Summed Across Pathways - CT		
Parameter	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**
Aluminum	5.01	7.58		1.84			6.85	8.03	1.45
Arsenic		1.05		2.29			2.98	1.38	
Boron				9.33	8.57		9.42	8.71	
Iron	1.80	2.72					1.98	2.88	
Vanadium	13.67	20.68	2.56	4.02		1.13	17.69	21.60	3.69
HI_LOAEL	**20.48**	**32.03**	**2.56**	**17.47**	**8.57**	**1.13**	**38.92**	**42.61**	**5.14**

Notes:

1. NOAEL = No Observed Adverse Effect Level
2. LOAEL = Lowest Observed Adverse Effect Level
3. HQ = Hazard Quotient
4. DERA = Draft Ecological Risk Assessment
5. CT = Central Tendency

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FIGURES

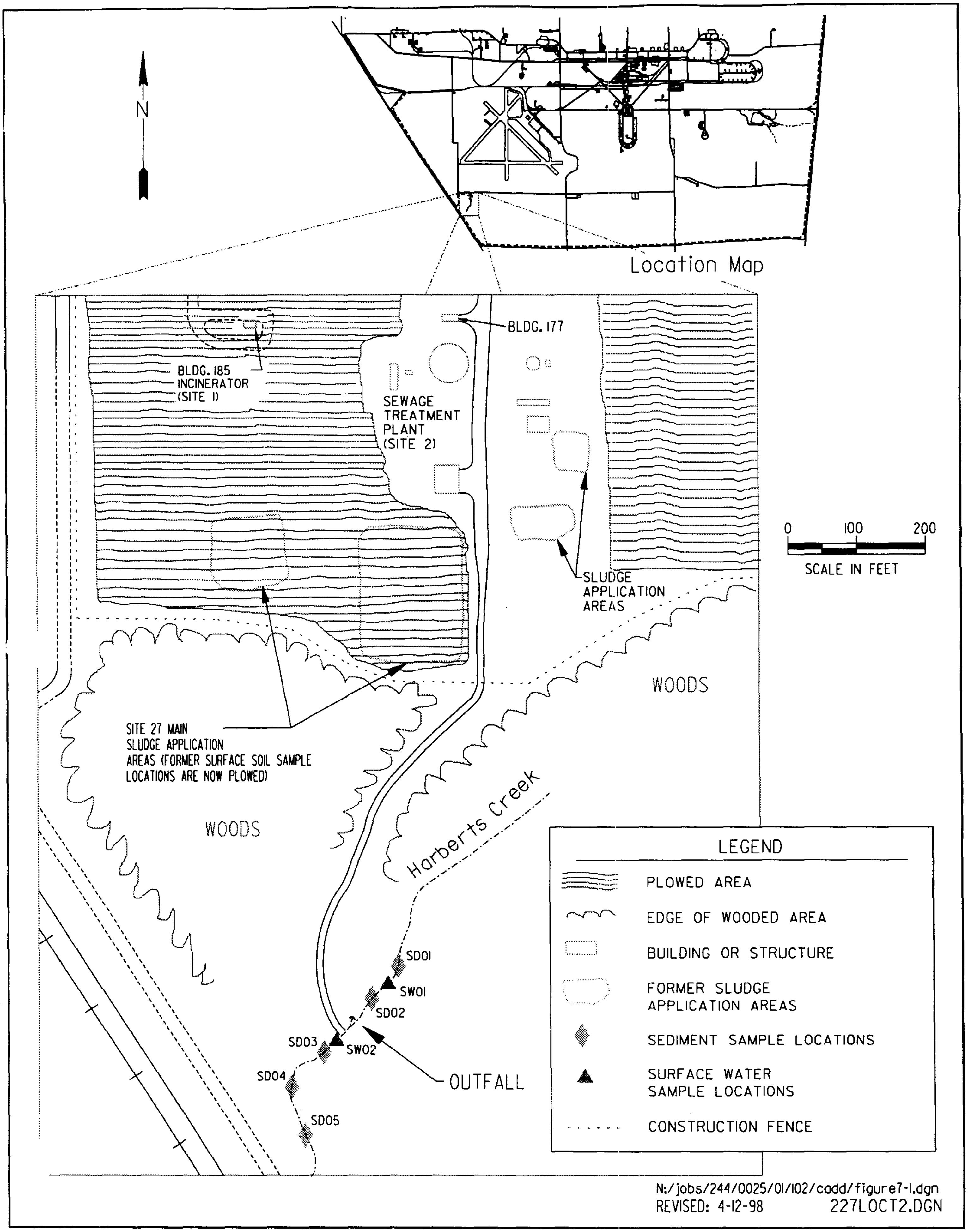


Figure 7-1. Phase I Sampling Locations at the Sewage Treatment Plant (Site 2), Sludge Application Areas (Site 27) & Harbert's Creek

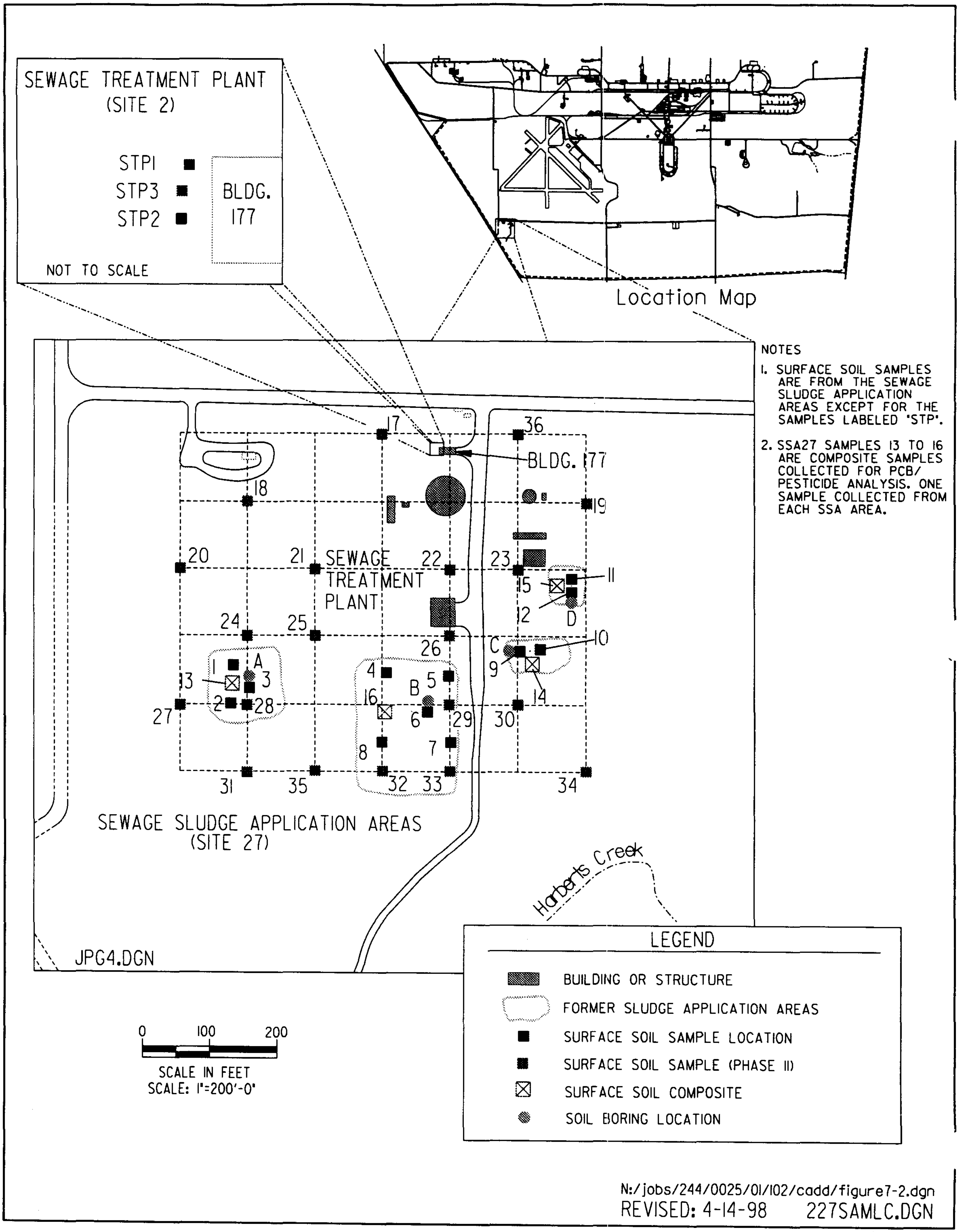


Figure 7-2. Phase I and Phase II Sample Locations at the Sewage Treatment Plant (Site 2) and Sewage Sludge Application Areas (Site 27)

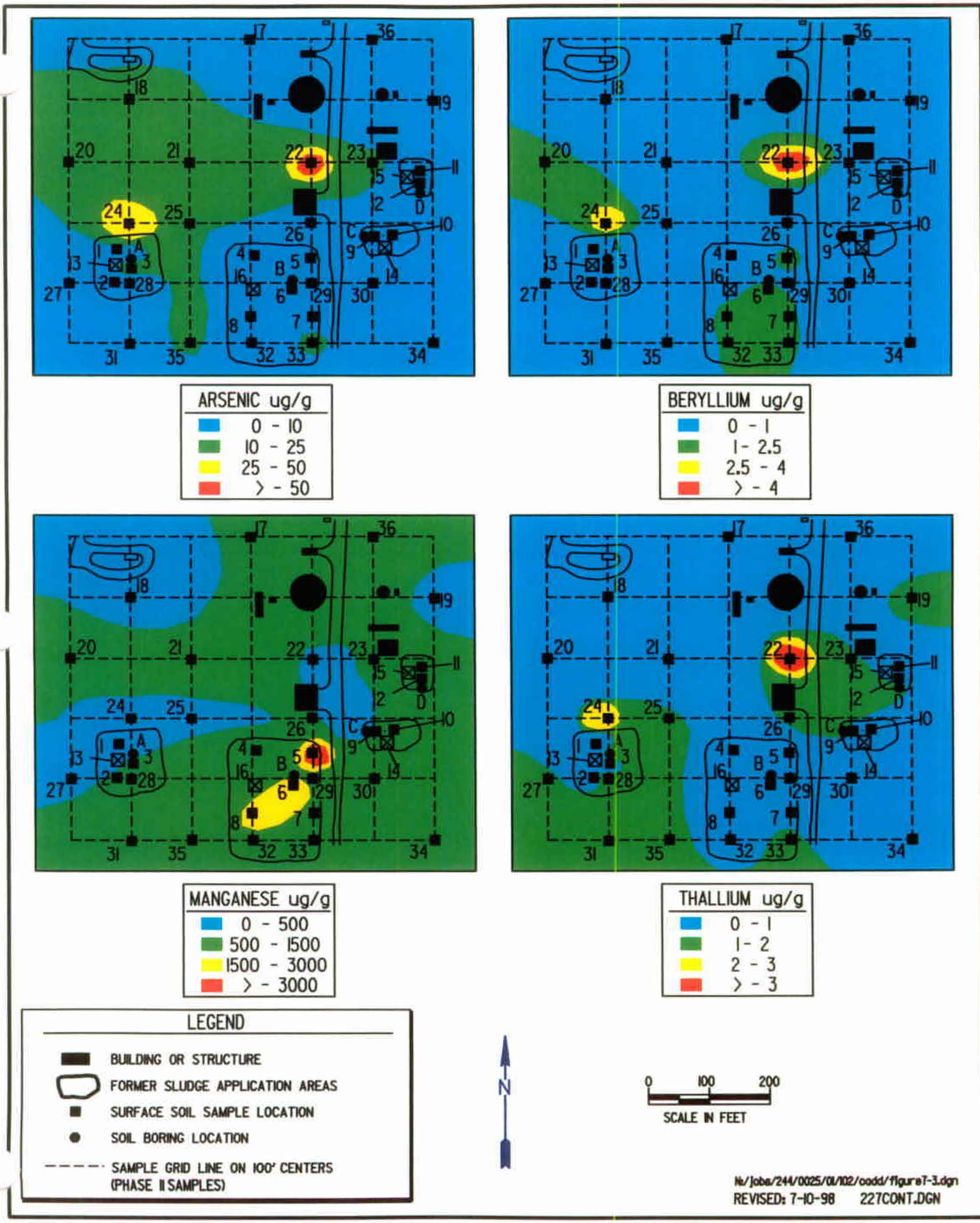


Figure 7-3. Contaminant Distribution Maps for Surface Soils at Sites 2/27

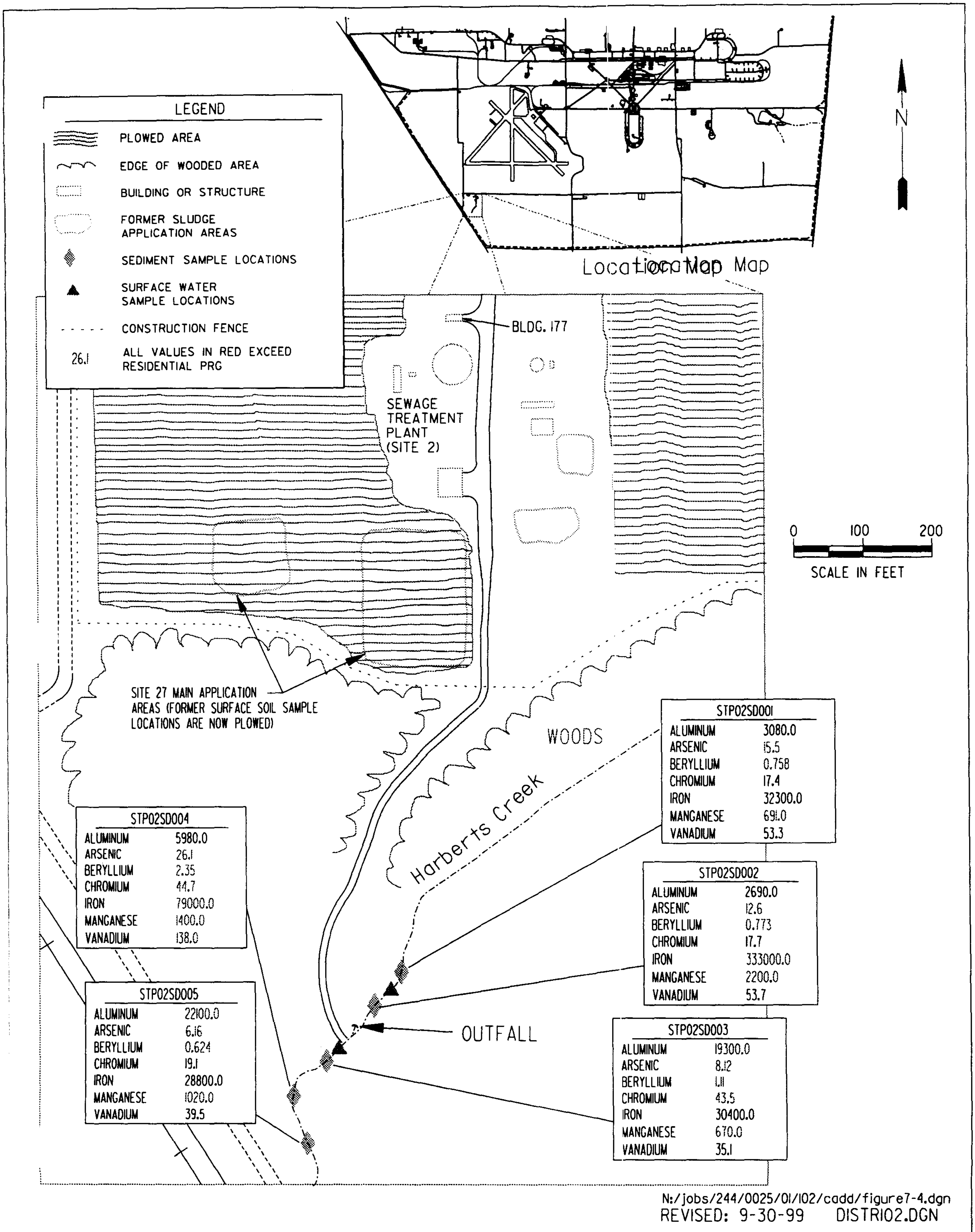


Figure 7-4. Summary of Metals Exceeding USEPA Region 9 Residential PRGs in Sediment at Sites 2/27

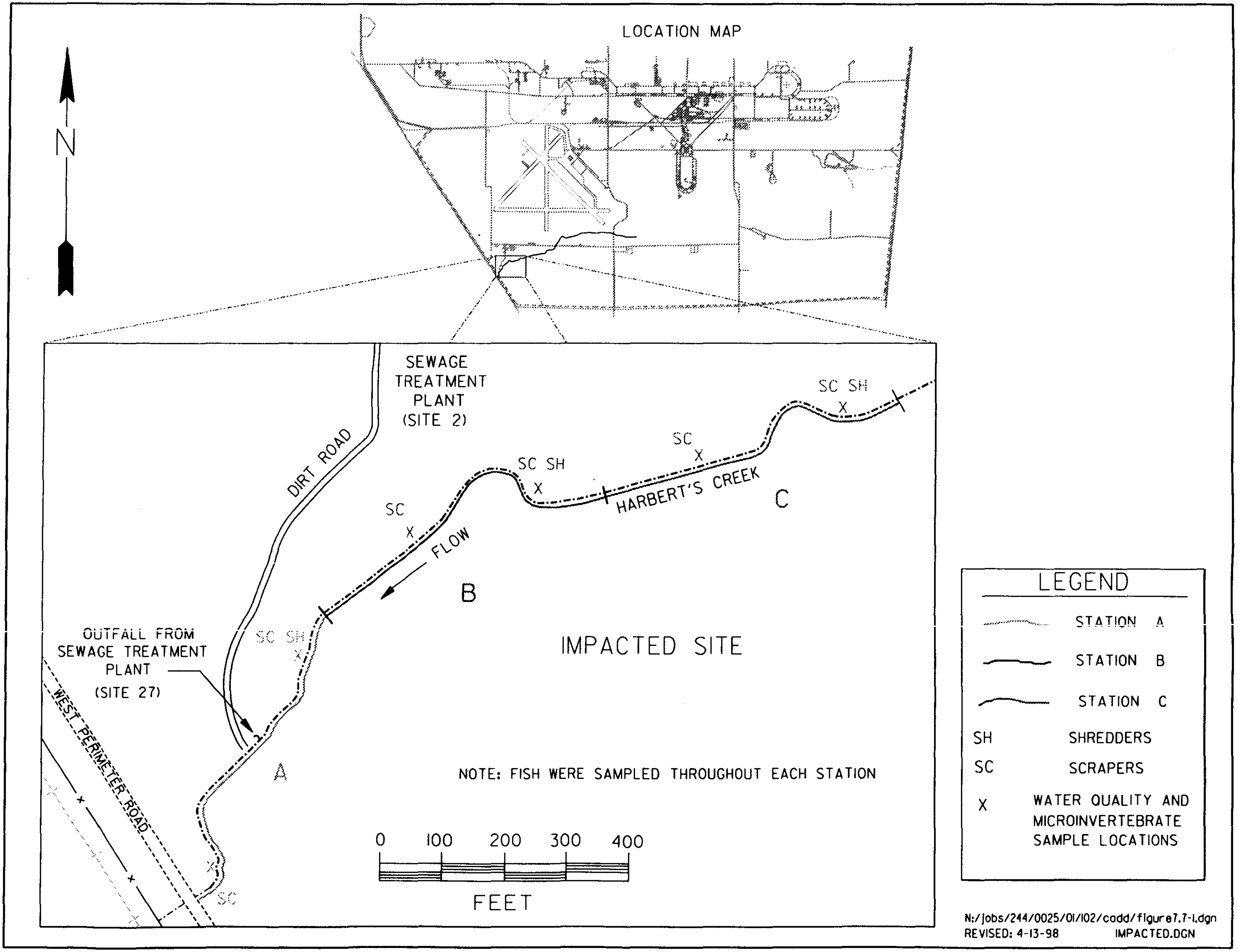
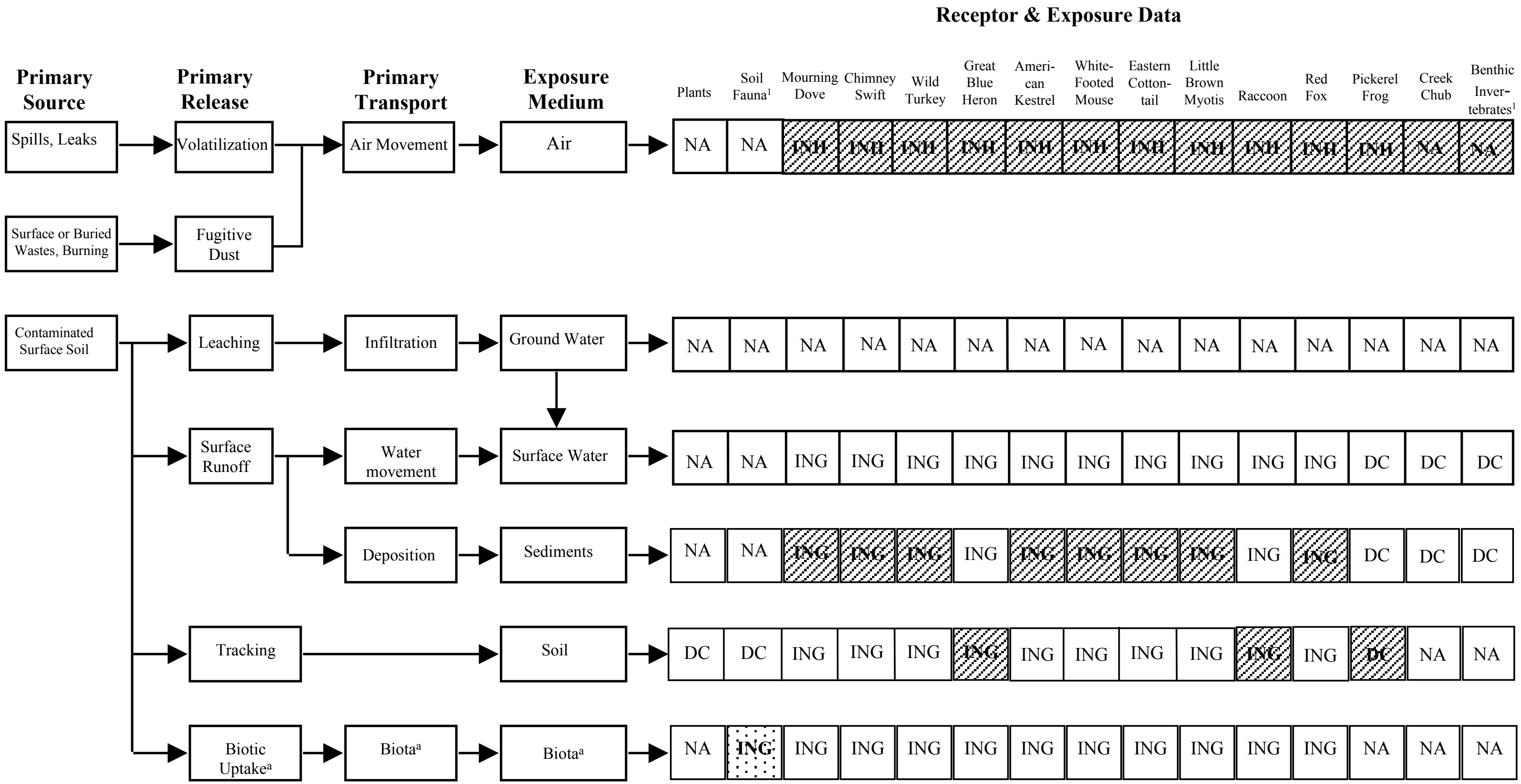


Figure 7.7-1. Aquatic Sampling Locations for Harbert's Creek Adjacent to Sites 2/27



Pathway may be significant; not evaluated because toxicity criteria lacking

Insignificant pathway; not quantitatively evaluated

NA Not Applicable

ING Ingestion

INH Inhalation

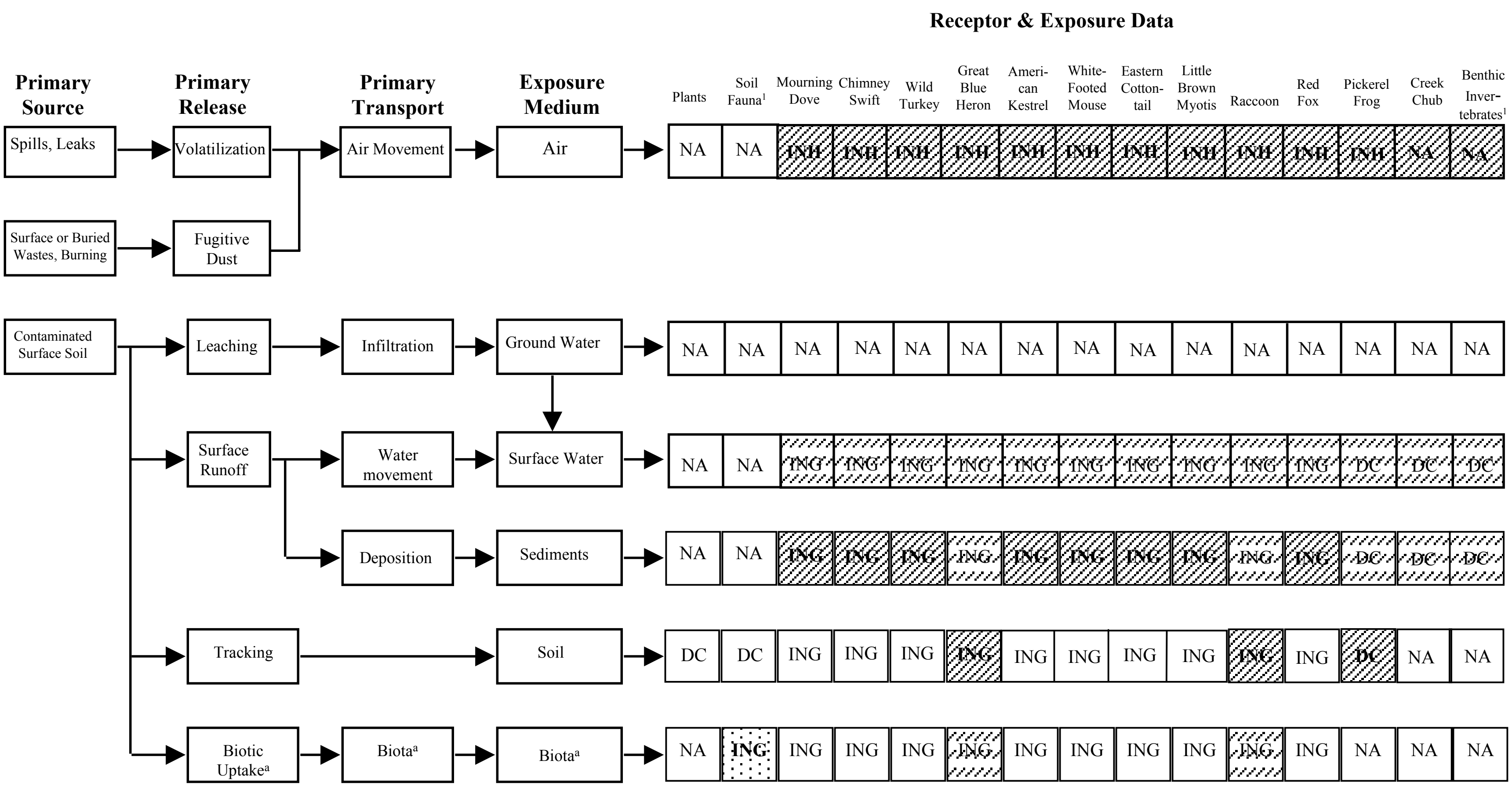
DC Direct Contact

1 Includes the terrestrial or aquatic crayfish

a Refer to JPG Food Web (Figure 5.3-5)

Figure 7.7-1a
JPG Conceptual Site Model
Site 2

N:Jobs\244\0025\01\102\cadd\figure7.7-1a.ppt



Pathway may be significant; not evaluated because toxicity criteria lacking

Pathway may be significant; not evaluated because analyte concentrations in medium (sediment or surface water) lacking

Insignificant pathway; not quantitatively evaluated

NA Not Applicable

ING Ingestion

INH Inhalation

DC Direct Contact

1 Includes the terrestrial or aquatic crayfish

a Refer to JPG Food Web (Figure 5.3-5)

Figure 7.7-1b
JPG Conceptual Site Model
Site 27

N:Jobs\244\0025\01\102\cadd\figure7.7-1b.ppt

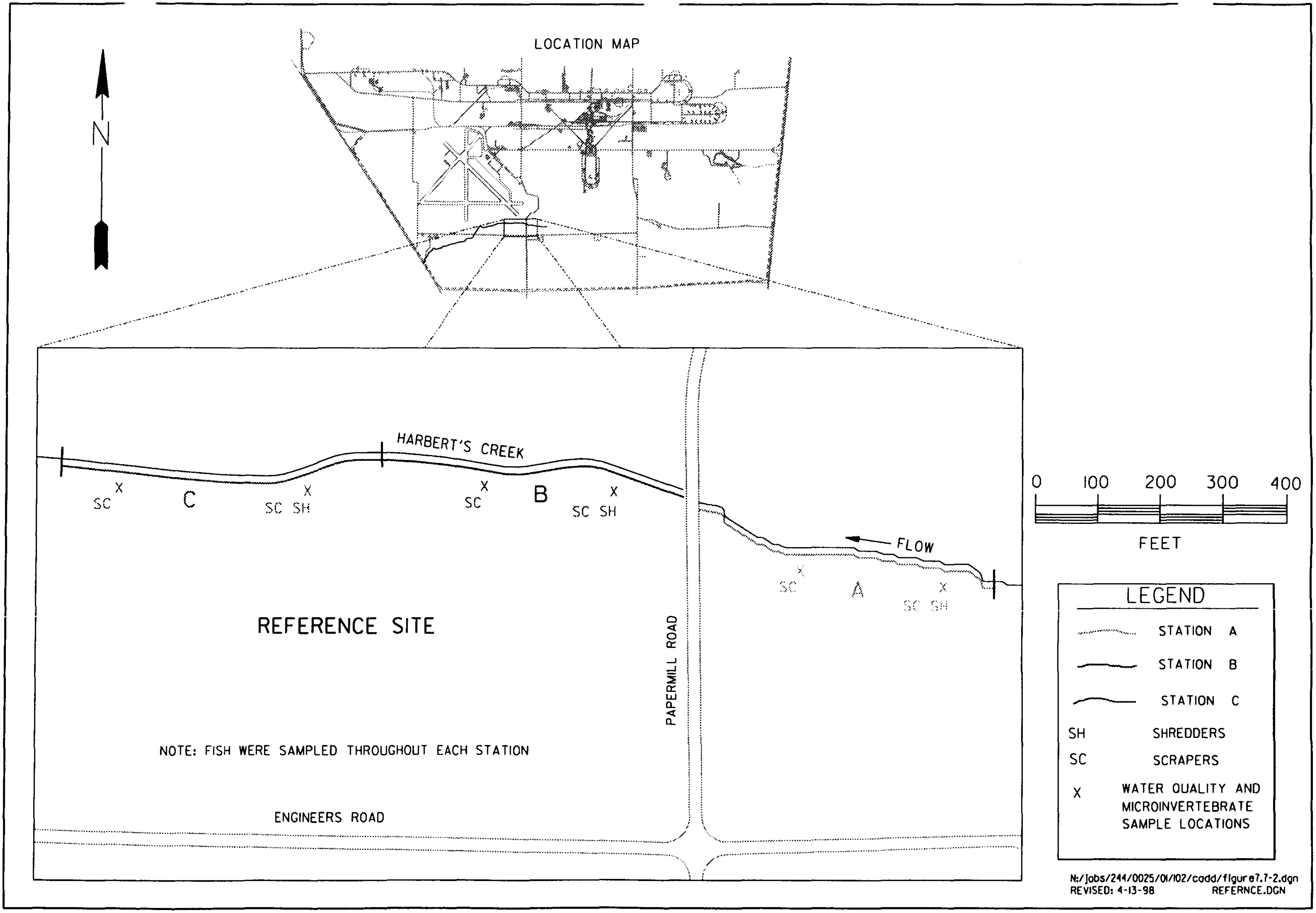


Figure 7.7-2. Aquatic Sampling Locations for Reference Stream Sediment

Figure 7.7-3 Total HIs - RME Risks Summed for All Pathways Based on NOAELs at Site 2 - Sewage Treatment Plant - Phase I

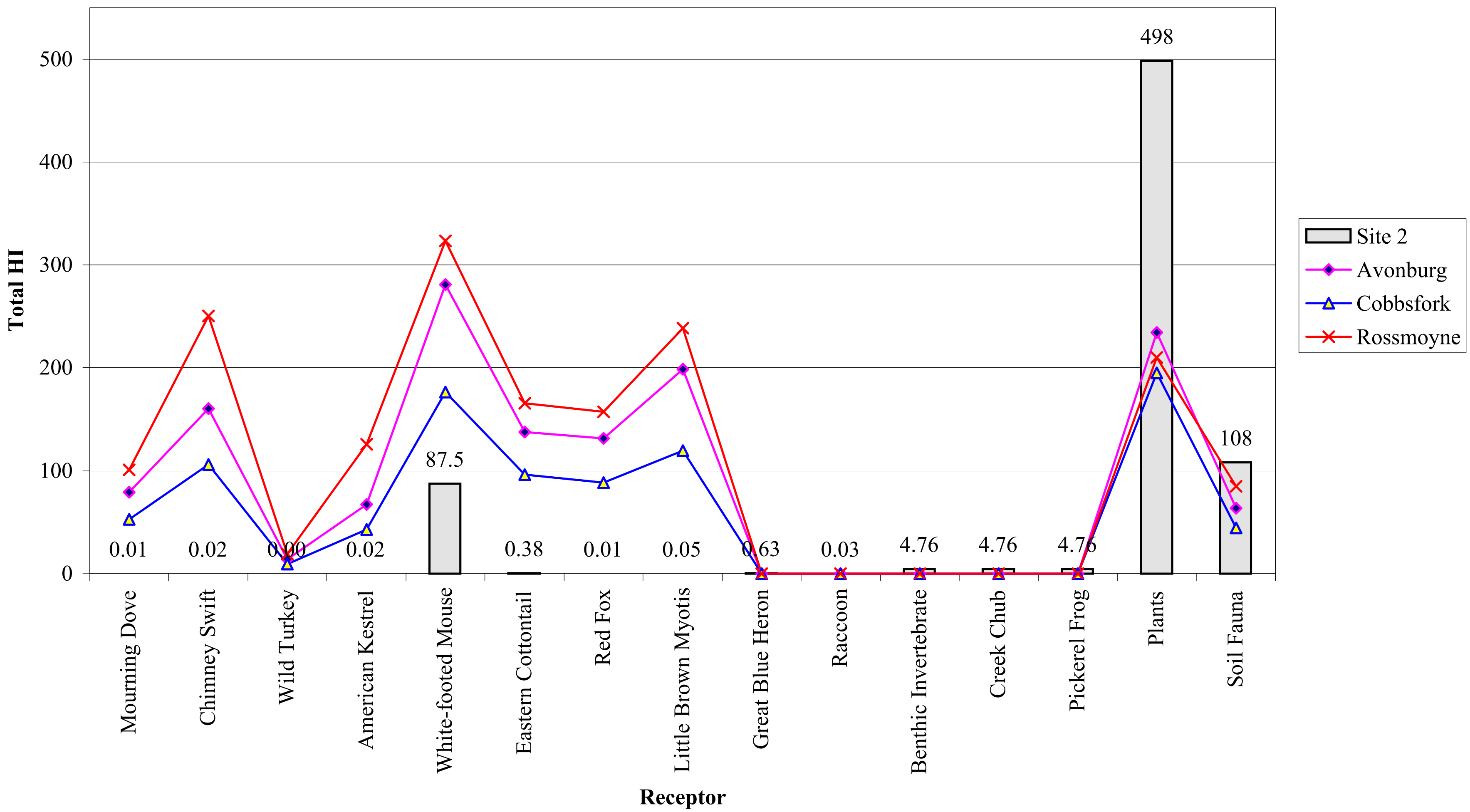
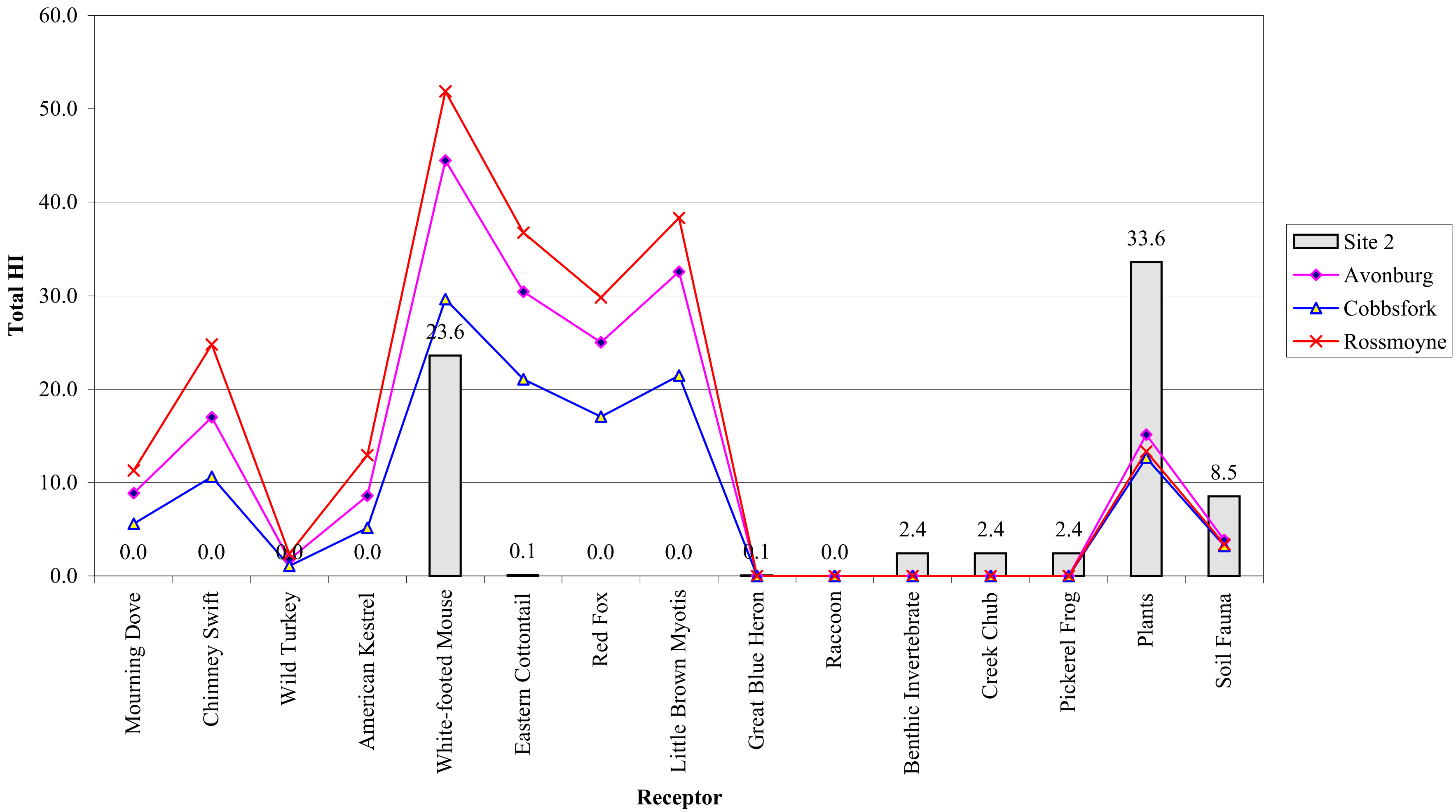
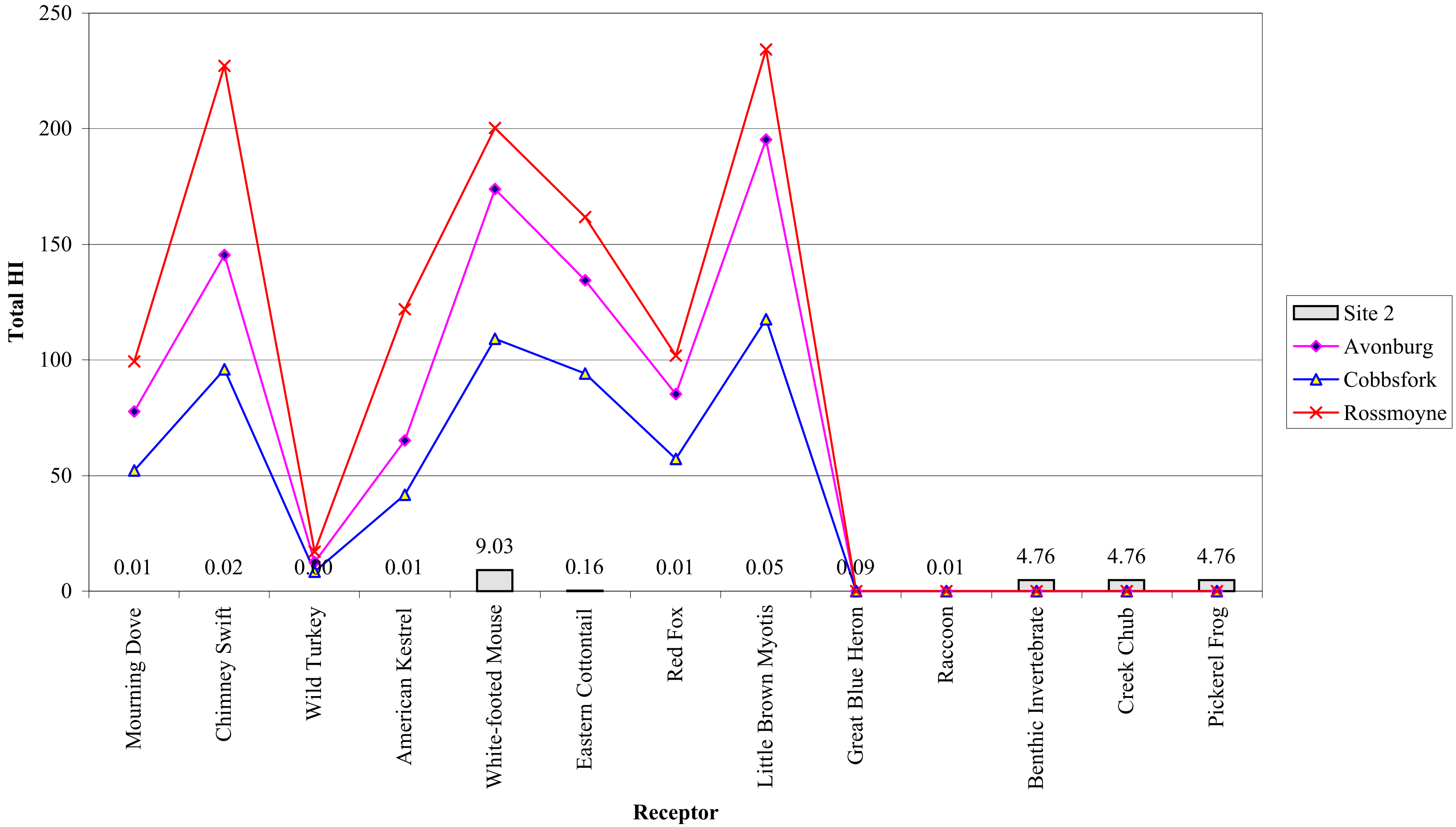


Figure 7.7-4 Total HIs - RME Risks Summed for All Pathways Based on LOAELs at Site 2 - Sewage Treatment Plant - Phase I



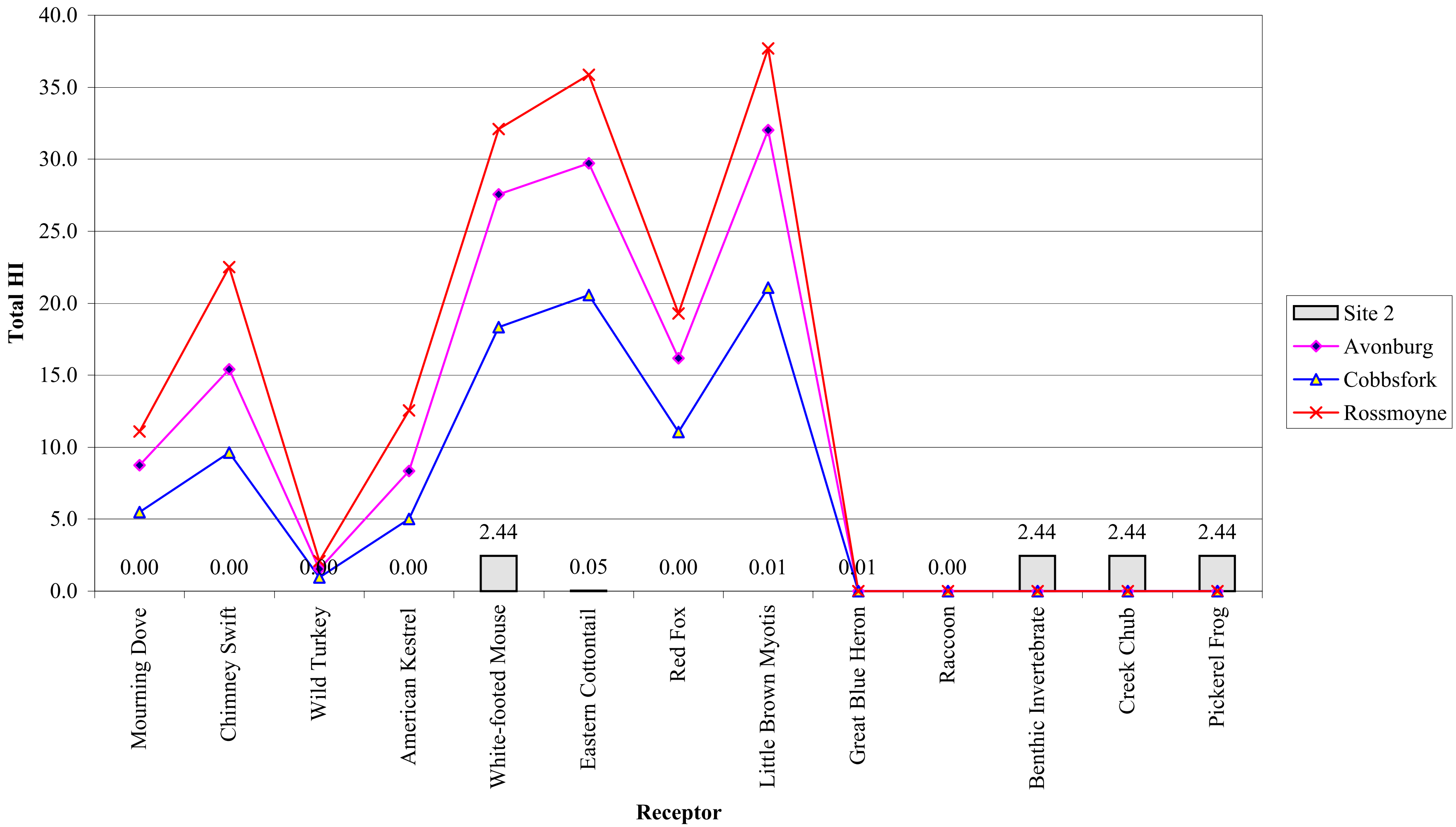
N:\jobs\244\0025\01\ET ECO FILES\Jpg\Phase1\Risk2\P1era_2MWH.xls Figure 7.7-4

Figure 7.7-5 Total HIs - CT Risks Summed for All Pathways Based on NOAELs at Site 2 - Sewage Treatment Plant-Phase I



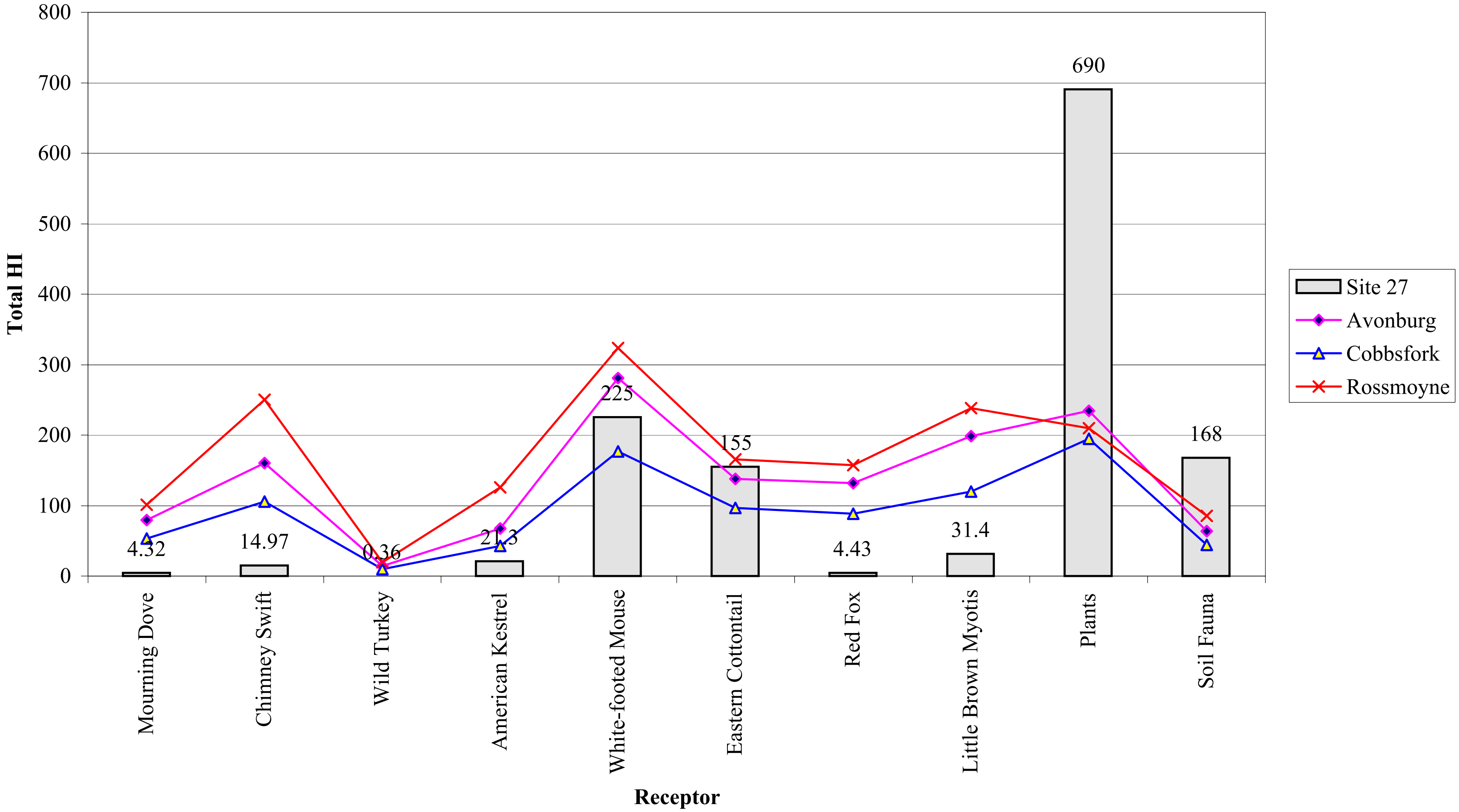
N:\jobs\244\0025\01\ET ECO FILES\Jpg\Phase1\Risk2\P1era_2MWH.xls Figure 7.7-5

Figure 7.7-6 Total HIs - CT Risks Summed for All Pathways Based on LOAELs at Site 2 - Sewage Treatment Plant-Phase I



N:\jobs\244\0025\01\ET ECO FILES\Jpg\Phase1\Risk2\P1era_2MWH.xls Figure 7.7-6

Figure 7.7-7 Total HIs - RME Risks Summed for All Pathways Based on NOAELs at Site 27 - Sewage Sludge Application Areas - Phase I



N:\jobs\244\0025\01\ET ECO FILES\Jpg\Phase1\Risk2\P1era_27MWH.xls Figure 7.7-7

Figure 7.7-8 Total HIs - RME Risks Summed for All Pathways Based on LOAELs at Site 27 - Sewage Sludge Application Areas - Phase I

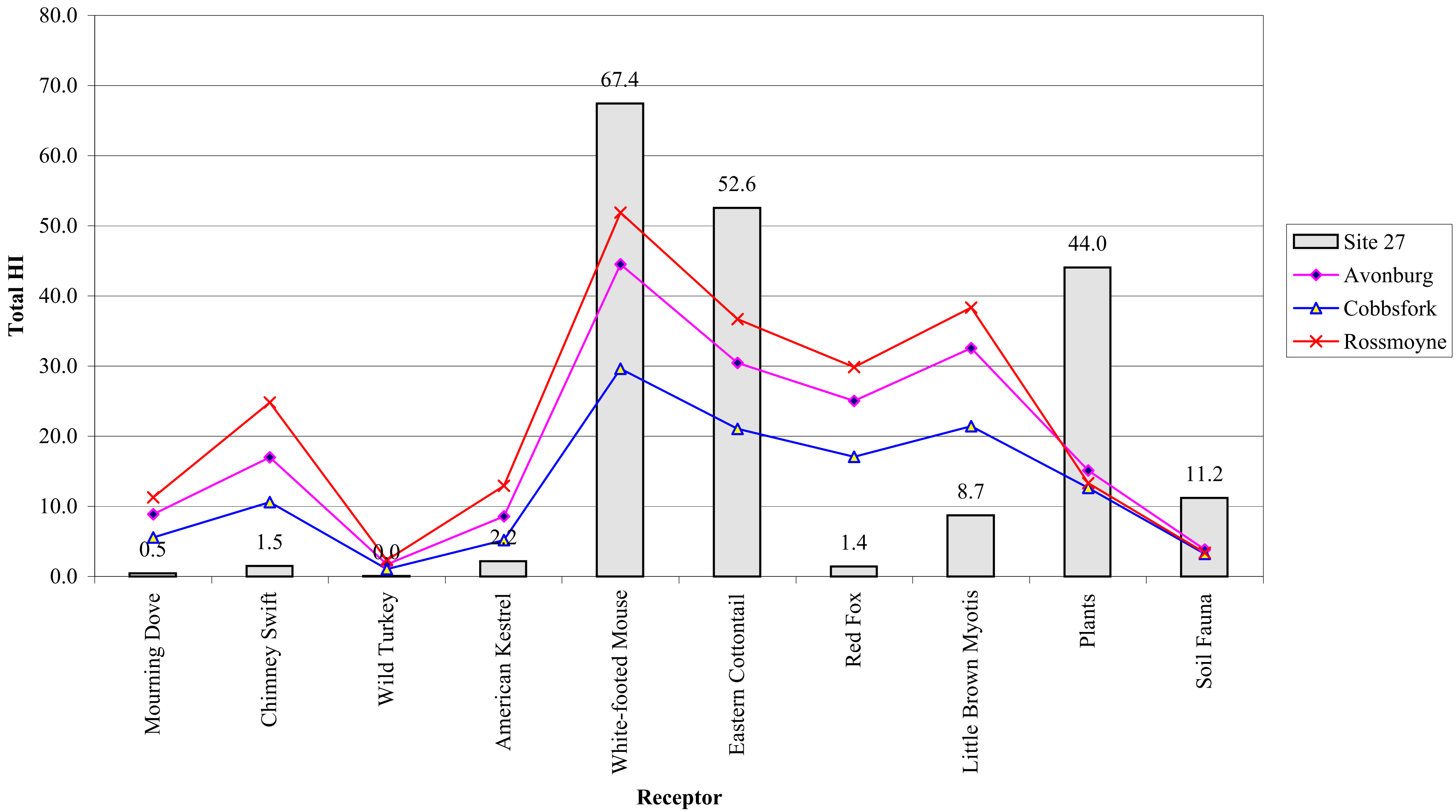


Figure 7.7-9 Total HIs - CT Risks Summed for All Pathways Based on NOAELs at Site 27 - Sewage Sludge Application Areas - Phase I

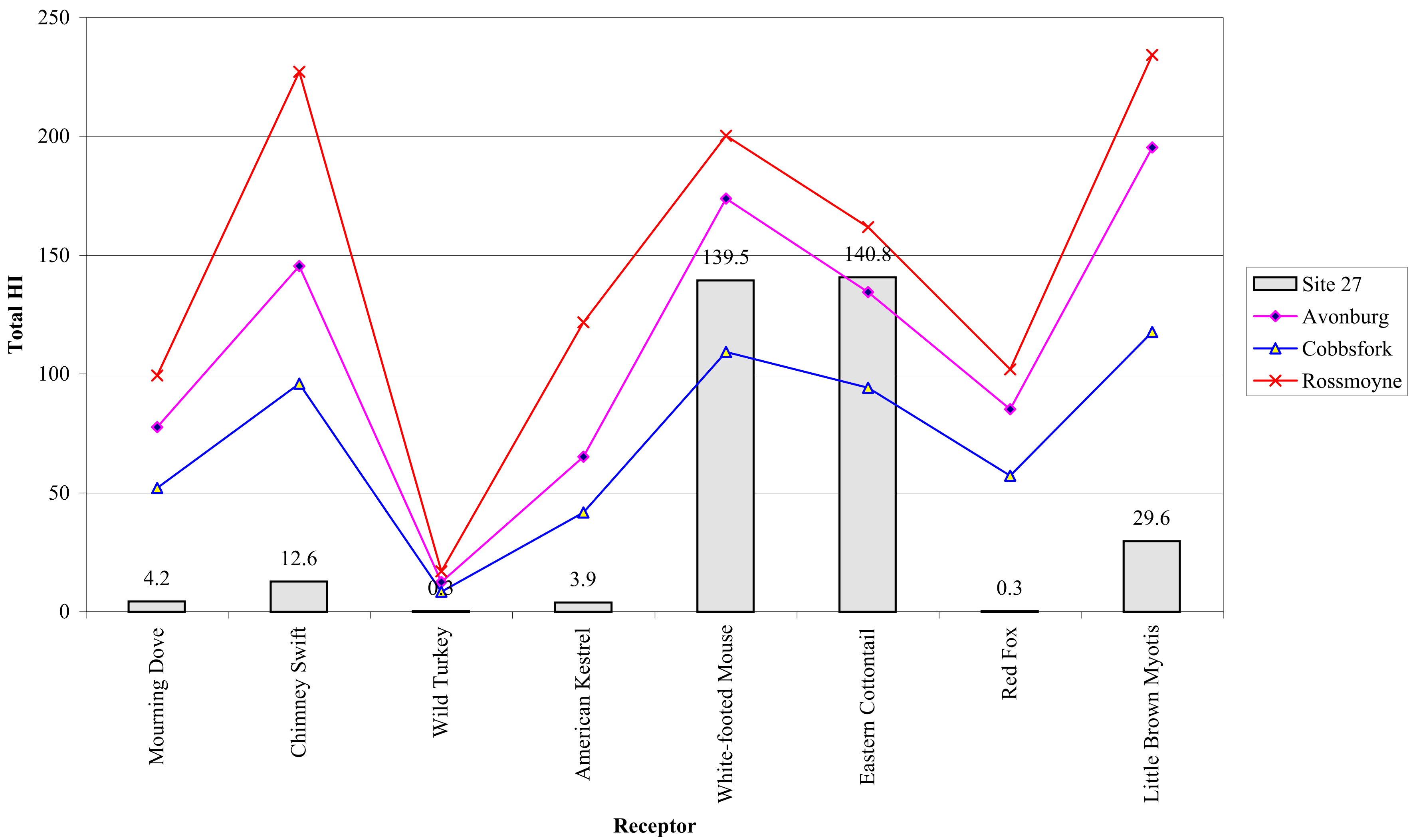
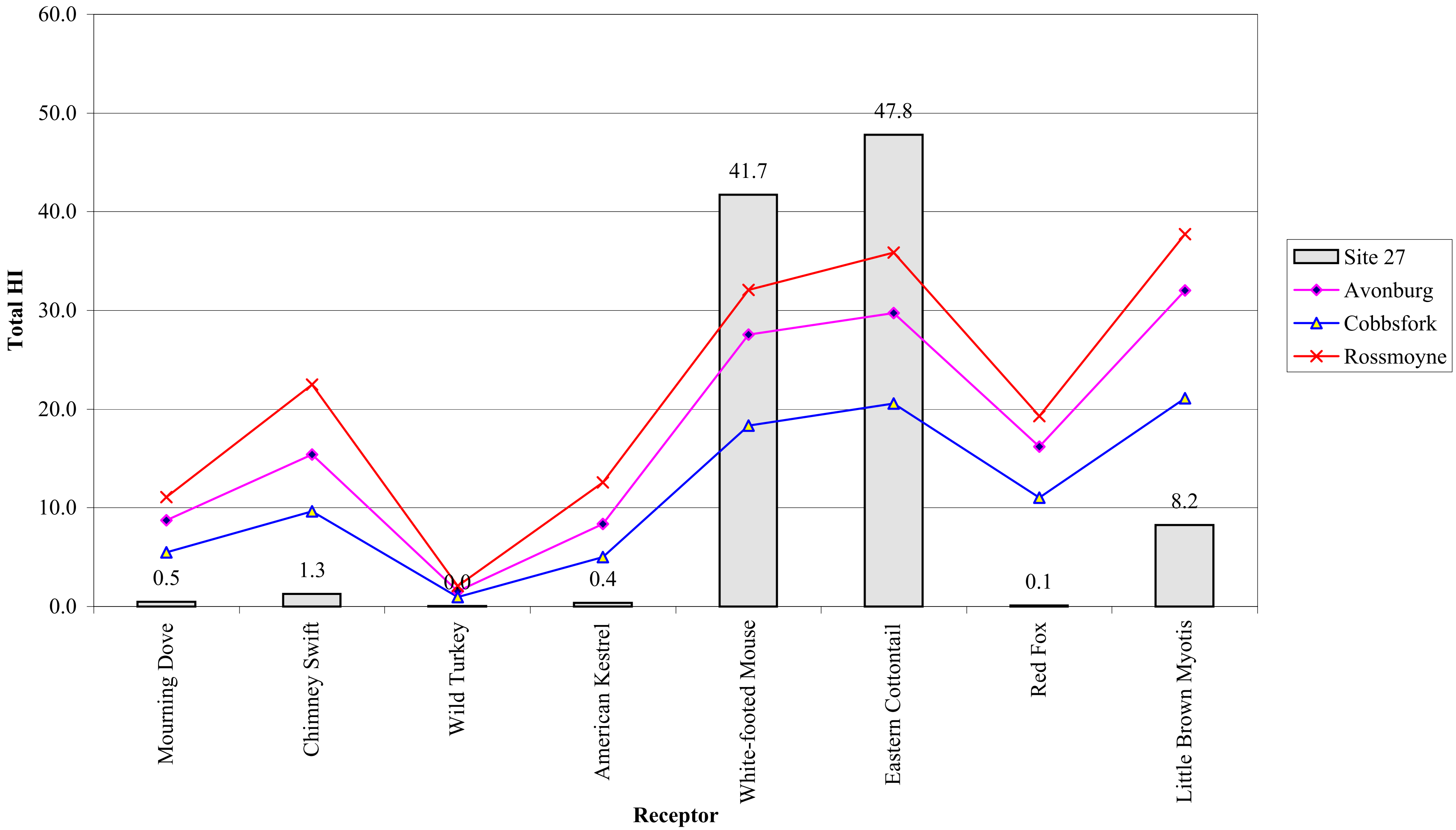
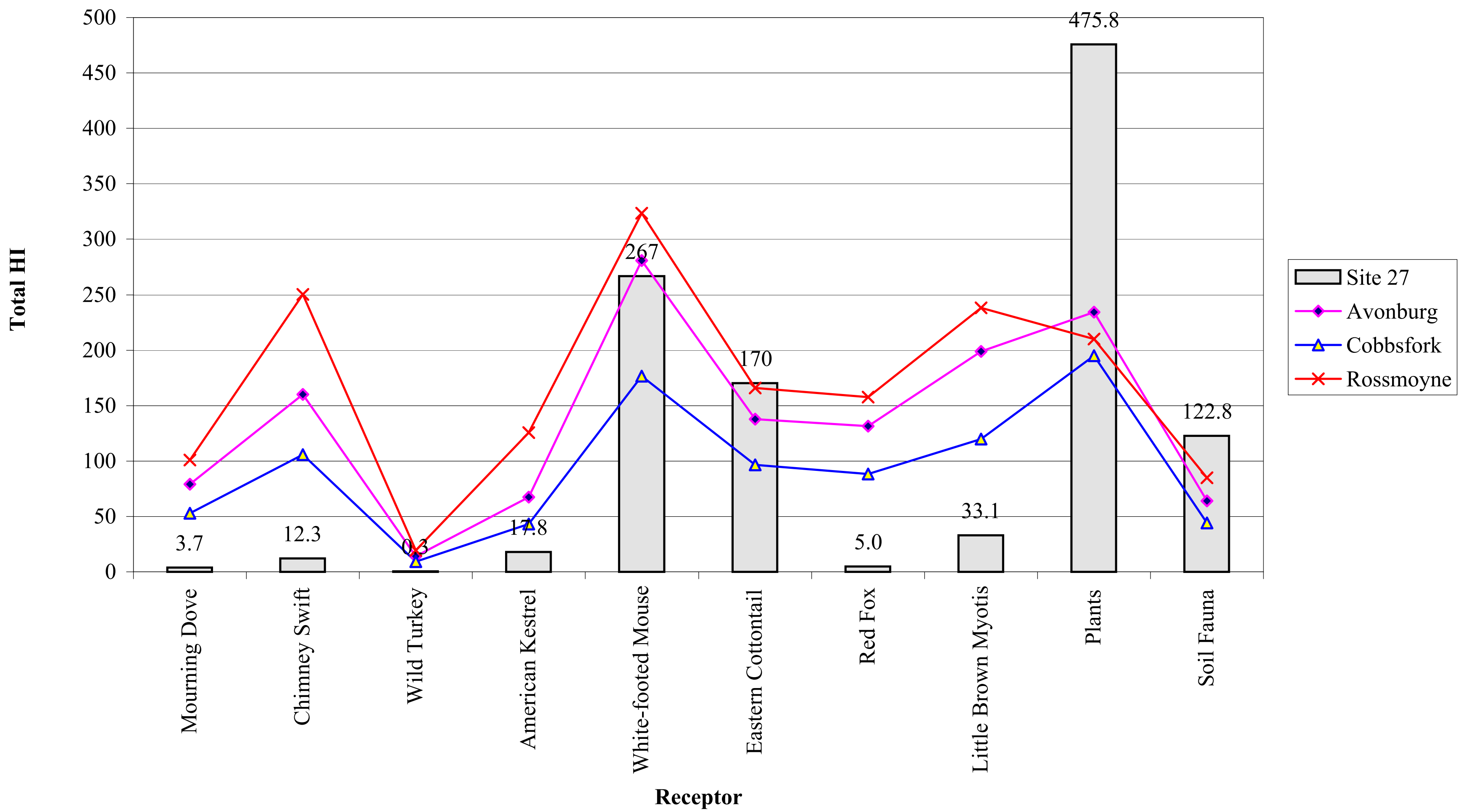


Figure 7.7-10 Total HIs - CT Risks Summed for All Pathways Based on LOAELs at Site 27 - Sewage Sludge Application Areas - Phase I



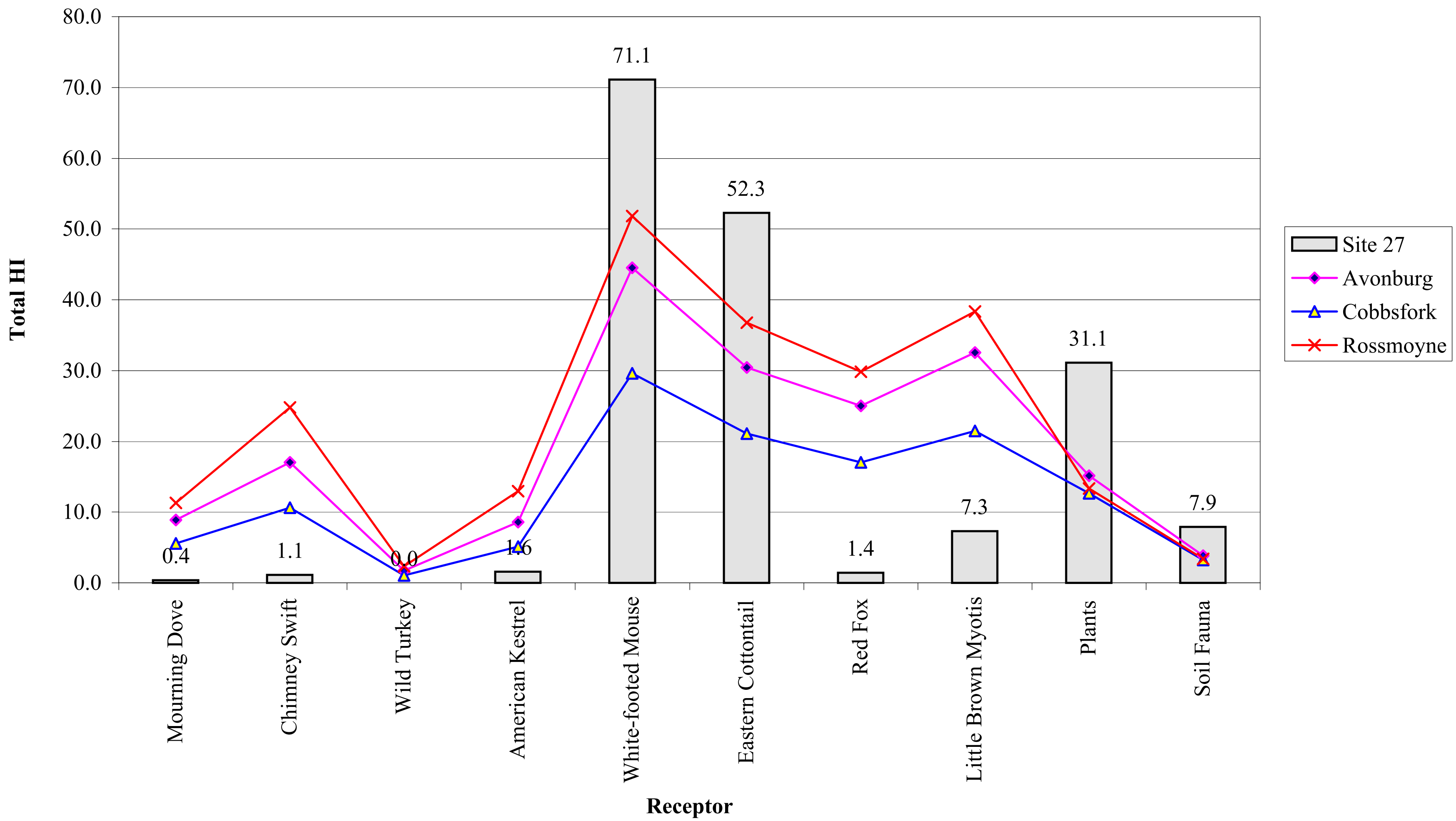
N:\jobs\244\0025\01\ET ECO FILES\Jpg\Phase1\Risk2\P1era_27MWH.xls Figure 7.7-10

Figure 7.7-11 Total HIs - RME Risks Summed for All Pathways Based on NOAELs at Site 27 - Sewage Sludge Application Areas - Phase II

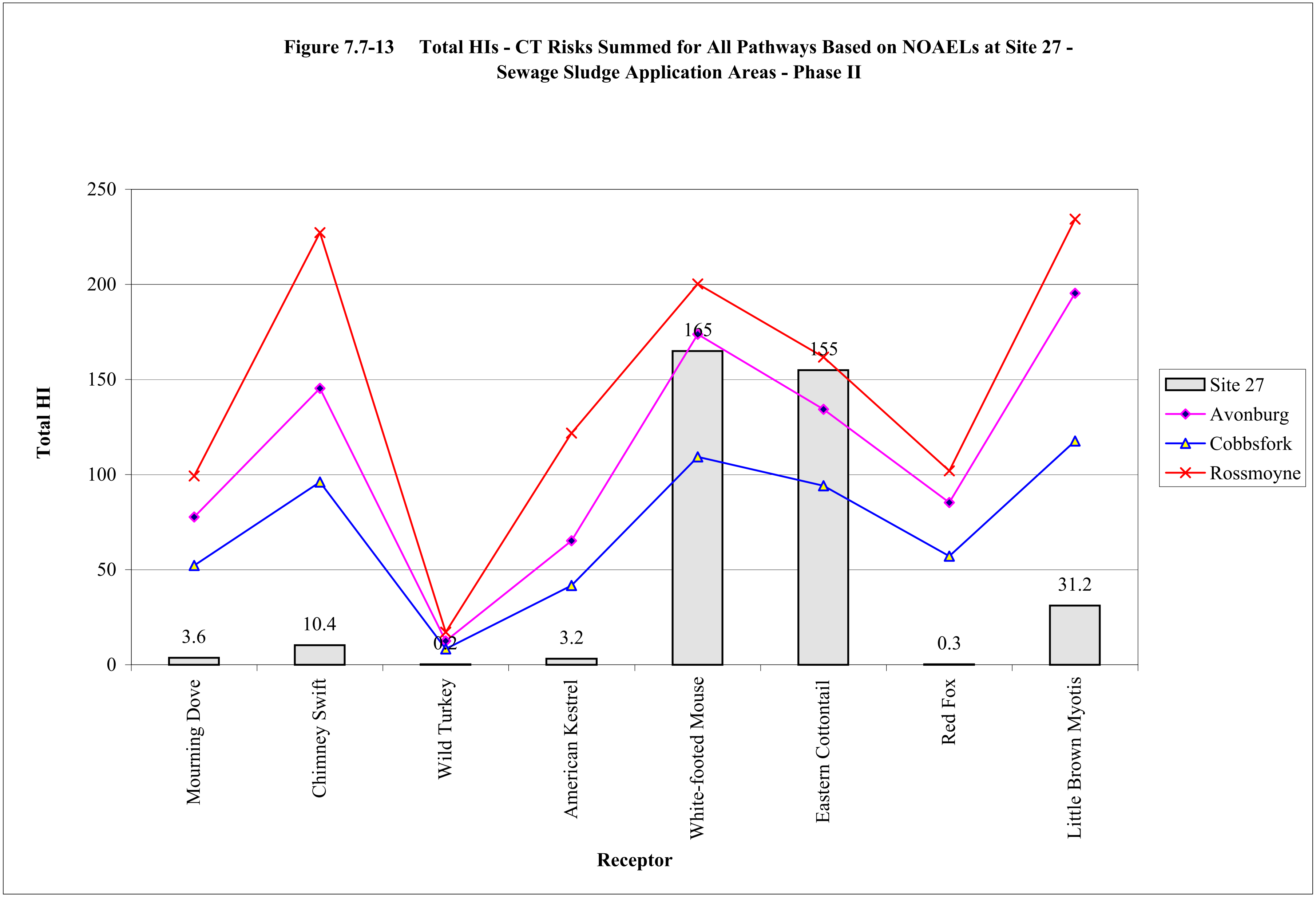


N:\jobs\244\0025\01\ET ECO FILES\Jpg\Phase2\Risk2\P2era_27MWH.xls Figure 7.7-11

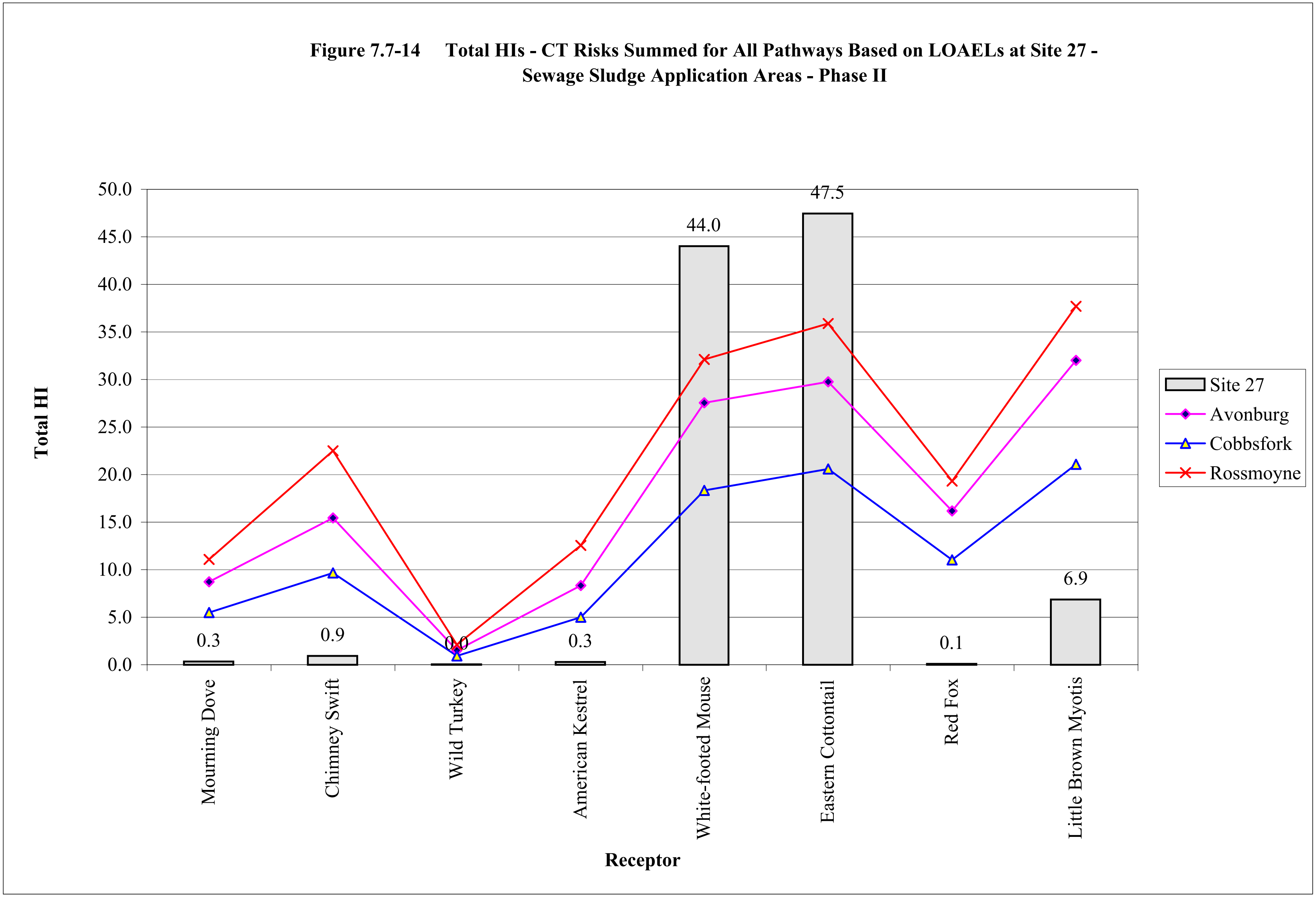
Figure 7.7-12 Total HIs - RME Risks Summed for All Pathways Based on LOAELs at Site 27 - Sewage Sludge Application Areas - Phase II



N:\jobs\244\0025\01\ET ECO FILES\Jpg\Phase2\Risk2\P2era_27MWH.xls Figure 7.7-12



N:\jobs\244\0025\01\ET ECO FILES\Jpg\Phase2\Risk2\P2era_27MWH.xls Figure 7.7-13



N:\jobs\244\0025\01\ET ECO FILES\Jpg\Phase2\Risk2\P2era_27MWH.xls Figure 7.7-14

8.0 EXPLOSIVE BURN AREA (SITE 3) AND ABANDONED LANDFILL (SITE 4)

8.1 SITE CHARACTERISTICS

The Explosive Burn Area~~,~~ (Site 3) is a large open field south of Engineers Road and east of Papermill Road in the south-central part of the installation (Figure ~~8-1~~2-1). This area also contains the Abandoned Landfill (Site 4), which reportedly covered about 1 acre on the east side of a 3-acre open area. The burn area reportedly consisted of the remaining 2-acre open area and was used in the mid-1970s for open burning of explosives and other burnable materials. Site features for the Explosives Burn Area and Abandoned Landfill are shown on Figure 8-1. ~~In actuality, it appears that t~~The open burning area was adjacent to the landfill trench, as evidenced by the burned film canisters around the landfill area. A third area, identified in 1995 immediately west of Sites 3 and 4, also appears to have been a burning area within a narrow and shallow trench.

Materials reportedly burned at the Explosive Burn Area included fuses, waste propellant, boxes, lumber, and paint residues. Waste materials resulting from incomplete combustion of explosives could include TNT, DNT, and heavy metals. It was reported by a former JPG employee that red lead (so called because lead oxide has a characteristic red color) may have been disposed of at the site. The Abandoned Landfill was reportedly used from 1941 to 1970 as primarily a dumping ground for film refuse from the photographic laboratory. In addition, it was reported that spent solvents were disposed ~~of~~ in this area. No formal records were maintained of the materials disposed ~~of~~ in the landfill. The Abandoned Landfill was described as being comprised of filled-in trenches. Acetate-based waste from photographic film was disposed ~~of~~ in this area and likely contained silver and cyanides. Pesticide containers, ash from the incineration of small arms ammunition, and paint wastes were likely disposed ~~of~~ in this landfill since it was the only landfill identified to be in operation between 1941 and the early 1960s. A sign that read "Closed - Deliver Combustible Waste to Building 333 Post Incinerator" was present during the Phase I RI, suggesting that combustible materials were probably burned at one time at the landfill. Because of the unknown nature of the materials disposed ~~of~~ in the landfill, potential contaminants could include metals, explosives, VOCs, and SVOCs. No records of the third area, herein referred to as the New Burn Site, exist. The ~~trench~~ Burn Area was identified during a UXO survey ~~that utilized a magnetometer. In addition, the soils within the trench area appear darker than the surrounding soils, allowing the trench boundary to be visually defined.~~by HFA in 1995. The New Burn Area appears to be a trench where soils darker soils have been observed west of the Explosives Burn Area and Abandoned Landfill.

The specific locations of the landfill trenches and the burning areas were not readily discernable during the initial site visit by Rust E&I in 1992. There was no evidence of recent activity at the area, and it was overgrown with grass at the time of the RI. Relatively young woods surround the open area on the east, north, and west sides. The south side connects with a larger open area ~~which,~~that based on interpretation of historic aerial photos, was used

historically as an agricultural field. Currently, the area south of the site has been put back into agricultural production with the planting of soybeans. Mowing of Sites 3 and 4 is not regularly conducted; however, the area was cleared in November of 1992 to facilitate access for geophysical surveys performed as part of the Phase I RI. The sites were also included in the installation's open burning program in the spring of 1993. Partial clearing of the area immediately to the west of the landfill in September 1997 was conducted as part of a sampling effort at the New Burn Site identified in 1995. By the start of the Phase II RI, the remainder of the area had once again become overgrown with grass and weeds.

Current activities are limited at the site to occasional access by investigation personnel, maintenance personnel, and hunters. No disposal activities are permitted in the area, and there are no other regularly scheduled installation activities in the vicinity with the exception of the active farming conducted in the large soybean field to the south. An orange fence has been placed around the contaminated sites, and signs have been posted to restrict access to Sites 3/4.

The land surface slopes to the northeast toward a branch of Harberts Creek located about 300 feet north of Engineers Road (Figure 2-1). The creek drains to the west. According to information gained from drilling shallow soil borings and monitoring wells at the site, the bedrock surface also slopes to the northeast toward Harberts Creek. The soils in the area belong to the Rossmoyne soil series. The glacial till across the site is about 9 6 to 14 feet thick and is underlain by the Geneva Dolomite of Devonian age. The geological cross section constructed from monitoring well data shows the soil types, the bedrock formations, screened intervals, and water levels (Figure 8-2).

Four groundwater-monitoring wells (MW93-20, MW93-21, MW93-22, and MW93-23) were installed in this area during Phase I, with total depths ranging from 39 to 51 feet bgs. The usual procedure of installing the screen across the bedrock-glacial till interface was not followed at the abandoned landfill because the uppermost bedrock formations yielded very little water. Instead, the wells were screened approximately 30 to 40 feet bgs in the Laurel Dolomite (Figure 8-2), which was the first bedrock formation encountered that yielded significant water. During Phase II, an additional monitoring well (MW95-06) was installed in the same formations to provide a well located directly downgradient of the **Abandoned** Landfill trench **and the Explosives Burn Area. (EPA 33) In June 2001, four additional monitoring wells were installed at downgradient locations in the bedrock and bedrock/till interface. One well MW01-03 was nested with existing well MW93-23 to provide information on the vertical gradient. (EPA 76b) A summary of monitoring well information is shown in Table 8-1a.**

During Phase II, slug tests were completed on each of the wells to determine the hydraulic conductivity of this water-bearing zone. The results revealed that the bedrock at this site has a hydraulic conductivity range from 2.02×10^{-5} (MW93-20) to 4.78×10^{-5} (MW93-21) cm/sec.

Based on nine rounds of water-level data collected from the wells (Table 10-1b), groundwater at this site is under confined conditions, with the at depths to the potentiometric surface ranging from 3 to 19 feet bgs (MW93-23 and MW93-20, respectively). Groundwater

elevations were measured during June, August, and September 1993, November 1995, and February, April, June, September, and November 1996. The Phase II data (1995 and 1996) are presented in Figures 8-3 and 8-4. Based on these water level measurements, bedrock groundwater at this site flows toward the west-southwest, with an average hydraulic gradient of 0.0034 foot/foot.

The additional monitoring wells installed in 2001 added two points (MW01-01 and MW01-02) to interpret the bedrock groundwater flow direction at the sites. Water level measurements are presented on Table 8-1b, and potentiometric surface maps for June and November 2001 are presented on Figures 8-4a and 8-4b, respectively. Groundwater flow based on the six bedrock monitoring wells continues to be towards the southwest. Another additional monitoring well (MW01-03) forms a nest with MW93-23. The new well nest indicates that the vertical gradients calculated for the area north of the Abandoned Landfill trench are relatively small and variable, ranging from 0.089 ft/ft (upward) to 0.019 ft/ft (downward) (Table 8-1c). (EPA33, 76a)

Figure 8-2 shows the top of the bedrock sloping toward the northeast, in the same direction as the surface topography (Figure 2-1). The northeast slope of the topography and the top of bedrock probably represents the downgradient direction for of groundwater flow in glacial till. Several piezometers were installed in the glacial till at probehole locations during the field-screening survey, and it was determined that the potentiometric surface of the glacial till groundwater follows mimics the surface terrain at the site. Thus, for the groundwater in the glacial till, upgradient corresponds with uphill and downgradient corresponds with downhill. Based on this interpretation of shallow groundwater flow in the glacial till, two of the four additional monitoring wells (MW01-03 and MW01-04) were installed at the bedrock/till interface. The two wells were located to the north of the Abandoned Landfill and Explosives Burning Area in the interpreted downgradient direction to evaluate whether a contaminant migration pathway existed at the bedrock/till interface. (EPA33, 76a)

A northeast-trending drainage swale is located at the northeastern edge of the landfill (Figure 8-2). This swale aligns with a fracture trend mapped by Greeman (1981) (see Figure 2-8) and may be a surface expression of a bedrock fracture.

8.2 PREVIOUS INVESTIGATIONS

Both the Explosive Burn Area and the Abandoned Landfill were included in previous investigations by Ebasco Environmental. In March 1990, visual site inspections, file searches, and JPG personnel interviews for both of these sites were included in the *Enhanced PA Report* (Ebasco 1990a), which lists the sites as SWMUs 4 and 5. The existing conditions and proposed sampling activities for these sites were then summarized in the *Master Environmental Plan* (Ebasco 1990b). Little information existed prior to the RI concerning the nature of the contaminants thought to be present in the former Explosives Burning Area. Similarly, no data had been collected from the Abandoned Landfill to establish the nature and

extent of potential contamination. The New Burn Site was discovered after Phase I RI activities were completed. Therefore, no previous information was available.

8.3 STUDY AREA INVESTIGATIONS

8.3.1 Phase I RI Field Activities

The 1-acre Abandoned lLandfill area was covered, vegetated, and barely discernable at the time of the Phase I field activities of the RI. Magnetometry and electromagnetic conductivity (EM-31) were used to delineate the location of a buried trench within the landfill. The surveys were performed using the USRAD system, which provided full coverage of the surveyed area.

Figures 8-5 show the approximate area of coverage and indicates the location of the geophysical anomaly results. The trench area and burn area are both discernable on the basis of the geophysical results in Appendix C. **(EPA 25)**

8.3.1.1 Surface Soils. Since the exact location of the burn area was not apparent, a review of the existing aerial photos was performed. No suspected burn area was identified other than the area around the former landfill trench, so a grid-sampling approach was proposed for this area to include the collection of 16 surface samples (Figure 8-5). During Phase I of the RI, surface samples were collected on a 100-by-100-foot grid system (with lines 25 feet apart), covering 1 acre of site. Sixteen grid locations were sampled using a hand-coring device from the surface to a depth of 6 inches.

One corner of the grid system was surveyed and tied to the state planar coordinate system. Sample location coordinates were determined by the use of a tape and line-of-sight with the surveyed point. Surface soil samples were collected from the suspected burn area and analyzed for explosives and metals to determine if the reported burning activities had resulted in soil contamination. Soils were scanned for VOCs with a PID at the time of collection. No VOCs were detected; thus, no samples were submitted for VOC analyses.

8.3.1.2 Subsurface Soils. Once the buried trench was identified by the geophysical survey, four soil borings (A to D) were drilled around the perimeter of the former trench to collect and analyze subsurface soils. Because of the possibility of UXO at this site, EODT personnel were present during all drilling operations. Drilling into the trench was avoided because of the potential for UXO. No evidence of UXO was discovered during the borehole drilling. **(EPA 11)** Soil borings were drilled to bedrock on each side of the former trench with samples collected at 5-foot intervals (Figure 8-18-5). PID readings taken during drilling indicated that solvent VOC contamination is was present in the two northern most boreholes (boreholes A and B in Figures 8-78-5). Since many different types of contaminants could have been present, surface- and subsurface-soil samples were analyzed for explosives, metals, VOCs, and SVOCs.

8.3.1.3 Geoprobe Field-Screening Survey. On the basis of the field observations made during drilling, a Geoprobe field-screening program was performed. The purpose of the survey was to delineate subsurface contamination in soil and groundwater in order to better position ~~optimal~~ monitoring well locations. A total of 22 probeholes (PH01 to PH23; no PH22) were conducted to collect 22 soil samples and 17 groundwater samples ~~were collected from 22 probeholes~~ (Figure ~~8-7~~8-5). (EPA 37, EPA 34)

8.3.1.4 Monitoring Wells. Based on the results of the field-screening survey, four groundwater-monitoring wells (MW93-20, MW93-21, MW93-22, MW93-23) were installed around the site (Figure 8-1). Because of the possibility of UXO at this site, EODT personnel were present during ~~all~~ drilling operations. No evidence of UXO was discovered during the monitoring well drilling. **(EPA 11)** Although most of the monitoring wells installed by Rust E&I at JPG in 1993 were screened at the glacial cover/bedrock boundary, there was little to no groundwater in the glacial till~~at this contact at the Abandoned Landfill~~ at these sites. Therefore, the wells were deepened to the first water-producing zone, the Laurel Dolomite. One well (MW93-22) was located at the north end of the former landfill trench and another (MW93-20) south of the former landfill trench. The other two wells (MW93-23 and MW93-21) were located north of the landfill, with one of the wells (MW93-21) located far enough west of the site to provide a good triangulation point for potentiometric surface mapping. These well locations were selected based on observations during the field screening survey that indicated groundwater flow to the northeast. Because the monitoring wells were then installed into a deeper hydrostratigraphic unit (i.e., bedrock), the groundwater flow direction was subsequently found to be to the west in the bedrock (Laurel Dolomite). As a result, an additional well was installed during the Phase II to address the bedrock flow direction. **(EPA 76a)** Groundwater samples collected from these monitoring wells were analyzed for explosives, metals, VOCs, and SVOCs.

8.3.2 Phase II RI Field Activities

8.3.2.1 Surface Soils. To further define the horizontal extent of soil contamination, a 300-by-400-foot area (which encompassed the entire area of Sites 3 and 4) was gridded during Phase II (Figure ~~8-9~~8-6). Using a 100-foot grid interval, 20 additional surface samples (samples 17 to 36, plus 3 duplicates) were ~~randomly selected,~~ collected~~,~~ and analyzed for total metals. Four of these samples (and one duplicate) were also analyzed for an expanded explosives analyte list. Although no explosives were detected in the Phase I samples, there was concern that explosives breakdown products not analyzed for during Phase I might be present.

Based on a UXO survey performed by HFA in 1995 that identified ~~a potential~~ the New Burn Area immediately to the west of Sites 3/4, Rust E&I and EODT collected additional surface soil samples in September 1997. As shown in Figure ~~8-10~~8-7, a total of 10 surface soil samples (SF1 to SF10) were collected on grids established in 2 debris areas delineated using a magnetometer. These samples were analyzed for metals, explosives, and dioxins/furans, which were potential contaminants from suspected burning activities.

8.3.2.2 Subsurface Soils. No subsurface soil samples were collected from Sites 3 and 4 during the 1995 Phase II field sampling effort. Three soil borings~~, however,~~(BH-A to BH-C) were hand augured to a depth of 5 feet in September 1997 at the New Burning Area ~~identified by HFA in 1995~~ (Figure ~~8-10~~8-7). The three borings were located within the suspected burn and debris burial locations in order to help define the vertical extent of contamination. Samples were collected at the surface, 1 foot, 3 feet, and 5 feet. The 12 boring samples were analyzed for metals, explosives, SVOCs, and dioxins/furans. The SVOC analyses were conducted for the borings on the basis of visual observations of a tarry substance at the surface within the suspected burn area.

8.3.2.3 Groundwater. During Phase II, an additional groundwater monitoring well (MW95-06) was installed ~~directly~~ downgradient of both the Abandoned Landfill trench and the Explosive Burn Area (Figure ~~8-9~~8-1). The new well and the four existing wells were sampled four times during Phase II for metals, VOCs, SVOCs, and explosives analysis.

In May 2001, four additional monitoring wells (MW01-01, MW01-02, MW01-03, and MW01-04) were installed at Sites 3 and 4 (see Figure 8-1). Monitoring wells MW01-01 and MW01-02 were installed in the bedrock (Laurel Dolomite) downgradient of the New Burn Area, Explosives Burn Area, and Abandoned Landfill trench. Because of the different groundwater flow direction at the glacial/bedrock interface, monitoring wells MW01-03 and MW01-04 were also installed downgradient of the Explosives Burn Area and Abandoned Landfill trench. Samples were collected in June 2001 from the nine monitoring wells, including the four new and five existing monitoring wells. The samples were analyzed for VOCs, SVOCs, explosives, and metals. [new work] (EPA 33)

8.4 DATA EVALUATION

8.4.1 Data Validation Results

Surface soil samples from Site 3 were analyzed for explosives and metals during Phases I and II only. Surface and subsurface soil samples from Site 4 were analyzed for explosives, VOCs, SVOCs, and metals during Phase I only; no subsurface soil samples were collected during Phase II. Groundwater samples that represent both sites were analyzed for explosives, VOCs, SVOCs, and metals during Phase I (one round) and Phase II (four rounds).

Supplemental groundwater samples from Sites 3/4 were analyzed for explosives, VOCs, SVOCs, and TAL metals during supplemental groundwater monitoring in June 2001.

8.4.1.1 Blanks Assessment. The USEPA has determined that when blank contamination exists, the investigative results must exceed the blank result by a factor of 5 (all compounds) or 10 (common laboratory contaminants such as acetone) in order to be considered positive. Several VOCs, SVOCs, and metals were detected in blanks associated with Site 3 and Site 4 samples. Based on comparisons to blanks, positive results in select samples were changed to nondetects ("U"). The associated sample quantitation limit became either the concentration

detected in the sample, if the detected value was above the quantitation limit, or the quantitation limit, if detected results were less than the quantitation limit. Samples qualified nondetected were not listed in the validation report during Phase I; however, Phase I soil results (not groundwater) were listed in the database. Phase II samples were listed in the validation report and in the database.

During Phase I the following results were qualified nondetected:

- Surface Soil
  - Arsenic—EBA03SF004, -06, and -11
  - Beryllium—EBA03SF003, -04, -05, -06, -09, -10, -11, -12, and -13; ALF04BHA01, -A01D, -B01, and -D01
  - Boron—EBA03SF001, -02, -04, -05, -06, -07, -08, -09, -11, and -15; ALF04BHA01, -A01D, -B01, -C01, and -D01
  - Cadmium—ALF04BHD01
  - Cobalt—ALF04BHD01
  - Copper—EBA03SF006; ALF04BHD01
  - Mercury—EBA03SF001, -02, -03, -04, -06, -07, -08, -09, -10, -11,-12, -13, -14, -15, and -16; ALF04BHD01
  - Nickel—ALF04BHD01
  - Sodium—EBA03SF002, -07, -08, -09, -15, and -16; ALF04BHA01 and -A01D
  - Tin—ALF04BHA01, -A01D, and -D01
  - Vanadium—EBA03SF006; ALF04BHD01
  - Dimethyl phthalate—ALF04BHD01

- Subsurface Soil
  - Beryllium—ALF04BHD02
  - Boron—ALF04BHC02, -C03, and -C03D
  - Mercury—ALF04BHA02, -C02, -C03, -C03D, -D02, and -D02D
  - Silver—ALF04BHA02
  - Sodium—ALF04BHD02
  - Benzyl alcohol—ALF04BHD02
  - Di-n-butyl phthalate—ALF04BHD03
  - Trichloroethylene—ALF04BHA02, -C02, -C03, -C03D, -D02, and -D02D

During Phase II the following results were qualified nondetected:

- Groundwater
  - Aluminum—ALF04GWB04
  - Antimony—ALF04GWC02
  - Beryllium—ALF04GWA04, -A04D, -B04, -B04D, -D04, -D04D, -E03, and -E04
  - Cadmium—ALF04GWA02, -A02D, -A03, -B03, -B03D, -B04, -B04D, -B05, -C02, -C02D, -C03, -D02, -D02D, -D03, -D03D, -E02, -E02D, -F03, and -F03D
  - Chromium—ALF04GWB05, -C05, -D05, -D05D, -E04, and -F05
  - Copper—ALF04GWC02

- Iron—ALF04GWE01
- Mercury—ALF04GWA02, -A03, -A03D, -B02, -C02, -C02D, -C03, -D02, -D02D, -E01, -E01D, -F02, and -F02D
- Molybdenum—ALF04GWB04, -B04D, -B05, -C05, -D04, -D05, -E02, -E02D, -F03, -F05, and -F05D
- Nickel—ALF04GWB04, -B04D, -B05, and -D04
- Potassium—ALF04GWA03, -A03D, and -B05
- Tin—ALF04GWA04, -A04D, -C04, -C04D, -D03, -D03D, -D04, and -F03
- Vanadium—ALF04GWA02, -A03, -A05, -B04, -D02, -D04, -E04, and -F05
- Di-n-butyl phthalate—ALF04GWA04, -A05, -B04, -B05, -C04, -C05, -D04, -D05, -E03, -E04, and -F05
- Methylene chloride—ALF04GWB04, -C04, -D04, and -E03

- Soil
  - Beryllium—EBA03SF023
  - Cadmium—EBA03SF018, -019, -023, -024, and -027
  - Copper—EBA03SF018, -024, -028, -029, -033, and -034
  - Mercury—EBA03SF019, -21, -023, -024, -026, -030, -031, and -033
  - Molybdenum—EBA03SF017, -018, -019, -022, -027, -028, -032, and -033
  - Silver—EBA03SF024
  - Thallium—EBA03SF020 and -032

During supplemental gGroundwater mMonitoring the following results were qualified not detected based on blank contamination.

- Nickel - S 3/4 MW93-21, S 3/4 MW93-22, S ¾ ¾ MW95-06, S ¾3/4 MW01-04, and S 3/4MW01-02

8.4.1.2 Rejected Results. Results for soil antimony, arsenic, selenium, and several SVOCs, including all PCBs, were rejected during Phase I. The rejected metals results were due to poor MS/MSD recoveries. Several parameters included in the SVOC list were rejected because of calibration problems. Due to these problems, all SVOC analyses were subjected to the Tier 2 validation. The Phase I SVOC results were not used for the risk assessment other than for qualitative information. In general the following concerns were noted:

- All results for PCB compounds and toxaphene were rejected because they were not included in the calibration standard.

- 4-Nitrophenol was rejected in several samples because of poor response during calibration.

- Other low responses were noted for numerous SVOC compounds; however, qualifiers were not assigned unless other calibration information was also unacceptable.

- Pesticides and methyl-n-butyl ketone in soil had an elevated CRL (above the Region 5 DQL) because of calibration problems.

For Phase II groundwater data, results for two VOCs (vinyl acetate and methyl ethyl ketone (MEK)) and one SVOC (kepone) were rejected due to low response in the calibration in one or more analytical batches. Other results for MEK (also known as 2-butanone) were estimated due to calibration outliers. –Non-target (unknown) VOC and SVOC compounds were rejected in several analyses due to blank contamination. Analytes associated with rejected data were not included in the database used for the risk assessment.

The following list identifies rejected sample results. Results are not listed below if a reanalysis provided acceptable data for the same sample.

- Phase I Groundwater
  - MEK—ALF04GWA01
  - 2-Chloroethylvinyl ether—ALF04GWA01
  - 4-Nitrophenol—ALF04GWB01, -C01, and -D01
  - Methoxychlor—ALF04GWB01, -C01, and -D01
  - Toxaphene—ALF04GWB01, -C01, and -D01
  - PCBs (1016, 1221, 1232, 1242, 1248, 1254, 1260, and 1262)—ALF04GWB01, -C01, and - D01

- Phase II Groundwater
  - MEK—ALF04GWA04, -A05, -B04, -B05, -F05, -C04, -C05, -D04, -D05, -E03, and -E04
  - Vinyl acetate—ALF04GWA02, -B02, -C02, -C05 -D02, and -E01, and -F02
  - Kepone—ALF04GWA02, -A03, -A04, -A05, -B02, -B03, -B04, -B05, -C02, -C03, -C04, -D02, -D03, -D04, -D05, -E01, -E02, -E03, and -E04, -F02, -F03, and -F05
  - UNK538—ALF04GWD02
  - UNK543—ALF04GWA02 and -D02
  - UNK571—ALF04GWB03, -C03, -D03, and -E02
  - UNK578—ALF04GWB03, D03, and -E02
  - UNK585—ALF04GWA04 and -C04

- Phase I Soil
  - Antimony—EBA03SF001, -02, -03, -04, -05, -06, -07, -08, -09, -10, -11, -12, -13, -14, -15, and -16
  - Arsenic—ALF04BHD02
  - Selenium—EBA03SF001, -02, -03, -04, -05, -06, -07, -08, -09, -10, -11, -12, -13, -14, -15, and -16; ALF04BHA01, -A01D, -A02, -A03, C01, C02, -C03, -C03D, -D01, -D02, -D02D, and -D03
  - Atrazine—ALF04BHC03 and -D03
  - Beta-endosulfan—ALF04BHA01, -A02, -A03,-B01, -C01, - C02, -C03, -D01, -D02, and -D03
  - Benzyl alcohol—ALF04BHA02, -A03, -C01, -C02, and -D03
  - Benzo(k)fluoranthene—ALF04BHA01, -A02, -A03,-B01, -C01, - C02, -C03, -D01, -D02, and -D03
  - 4-Chloroaniline—ALF04BHB01, -C03, -C03D, -D01, -D02, -D02D, and -D03
  - 4-Chlorophenylmethyl sulfoxide—ALF04BHA02, -A03, -C01, -C02, and -D03
  - 3,5-Dinitroaniline—ALF04BHB01, -C03, -D01, -D02, and -D03
  - 2,4-Dinitrophenol—ALF04BHA01, -A02, -A03, -C01, and -C02
  - 2,6-Dinitrotoluene—ALF04BHC03 and -D03
  - Indeno (1,2,3-cd) pyrene—ALF04BHA01, -C03, and -D03
  - PCBs (1016, 1221, 1232, 1242, 1248, 1254, 1260, and 1262)—ALF04BHA01, -A01D, -A02, -A03, -B01, -C01, -C02, -C03, -C03D, -D01, -D02, -D02D, and -D03
  - 2,3,6-Trichlorophenol—ALF04BHC03 and -D03
  - Toxaphene—ALF04BHA01, -A02, -A03, -B01, -C01, -C02, -C03, -D01, -D02, and -D03

For supplemental groundwater monitoring several VOCs (acetone, 2-butanone, 2-hexanone), were rejected due to low relative response factors. Chloromethane was rejected due to low laboratory control sample recoveries. Bromochloromethane, 1,2-dichloroethane, 1,1,2-trichloroethane, 1,2-dichloropropane, bromoform, carbon tetrachloride, and vinyl acetate), SVOCs (2,4-dinitrophenol and hexachlorocyclopentadiene), and thallium were rejected due to low method reporting limit continuing calibration verification (MRL CCV) results. ONote only compounds not detected were rejected due to QC deficiencies. The following list identifies rejected sample results.

- acetone - S3/4MW01-04, S3/4MW01-03, S3/4MW01-01, S3/4MW01-02, S3/4MW01-54, S3/4MW93-20, S3/4MW93-21, S3/4MW93-22, S3/4MW-93-23, S3/4MW95-06
- 2-butanone - S3/4MW01-04, S3/4MW01-03, S3/4MW01-01, S3/4MW01-02, S3/4MW01-54, S3/4MW93-20, S3/4MW93-21, S3/4MW93-22, S3/4MW93-23, S3/4MW95-06
- 2-hexanone S3/4MW01-04, S3/4MW01-03, S3/4MW01-01
- chloromethane S3/4MW01-04, S3/4MW01-03, S3/4MW01-01
- dibromochloromethane S3/4MW01-04
- 1,2-Dichloroethane S3/4MW01-04

- 1,1,2-Trichloroethane S3/4MW01-03
- 1,2-Dichloropropane S3/4MW01-03
- bromoform S3/4MW01-03
- carbontetrachloride S3/4MW01-04
- vinyl acetate S3/4MW01-04, S3/4 MW93-23
- 2,4-Dinitrophenol S3/4MW01-04, S3/4MW01-03, S3/4MW01-01, S3/4MW01-02, S3/4MW95-06, S3/4MW93-23, S3/4MW93-22, S3/4MW93-21, S3/4MW93-20, S3/4MW01-54
- hexachlorocyclopentadiene S3/4MW01-04
- thallium S3/4MW01-03, S3/4MW01-01

8.4.1.3 Evaluation of Non-Detected Values. A comparison was made between the USEPA Region 5 DQLs and the project CRLs for chemicals that were analyzed for but not detected in environmental media at this site. No exceedances for SVOCs, explosives, or metals were found.

Several groundwater VOCs had reported non-detected values from one to three orders of magnitude greater than the DQLs for at least one event and one location. However, these were limited to less than half the sampling events; acceptable CRLs were achieved at the other site wells for the same VOCs during the same events. Therefore, none of the VOCs warranted identification as having exceeded the DQLs.

Supplemental groundwater monitoring method reporting limits for VOCs, SVOCs, explosives and metals are sufficiently low to meet MCLs in the Supplemental Groundwater Monitoring Quality Assurance Project Plan.

8.4.2 Data Quality Summary

Positive results were changed to nondetects ("U") for a number of metals analyzed in groundwater during Phase II. In particular, beryllium and cadmium results were affected by blank contamination. Most of the detections in the affected samples, however, were below quantitation limits. Most of the Phase I surface soil antimony and selenium results were rejected, but there were sufficient Phase II surface soil results to adequately characterize the extent of antimony and selenium contamination. **Although additional antimony data would likely add to the overall hazard, it would not likely affect the remedial action decision. (EPA 97).** The antimony detection limits for Phase I soil samples that were not rejected (primarily boring samples from the Abandoned Landfill trench) exceed the Region 9 residential soil PRG; therefore, antimony contamination is not well characterized in the area of the trench. Analysis of Phase II soil samples confirmed the absence of explosives in surface soil.

In summary, the number of samples, the comprehensiveness of the parameter list, and the quality of the data (with the exception of antimony in the area of the trench) (EPA 97) are adequate for characterizing the nature and magnitude of soil and groundwater contamination at Site 3 and Site 4.

For supplemental groundwater monitoring only nickel was qualified "U" not detected due to blank contamination. The VOCs, SVOCs, and thallium rejected were generally not compounds of concern at the sites and will not negatively impact the overall use of the data.

8.4.3 Background Screening

8.4.3.1 Surface Soil. For the purposes of the background sample comparison, site samples were divided into those from Sites 3 and 4 and those from the New Burn Area. Within Sites 3 and 4, samples from the trench (BHA01, -B01, -C01, -D01, and SF025) were segregated from those of the remainder of the site. Within the New Burn Area, samples were separated into those from the Burn Area (BHB01, -B02, -C01, -C02, SF005, SF006, and SF007) and those from the remainder of the New Burn Site. The background screening protocol is described in Section ~~5.1.4.5~~5.1.4.5.2. The site samples were compared to the background for the Rossmoyne soil series.

The results of the background screening for Sites 3 and 4 are presented in Table 8-~~1~~2a. The background screening process for the New Burn Site is presented in Table 8-2b. There were sufficient samples analyzed for inorganic constituents to perform the t-test or Mann-Whitney test where appropriate. As shown in Table 8-~~1~~2a, aluminum, antimony, barium, cadmium, chromium, cobalt, lead, mercury, nickel, silver, tin, and zinc are above background in trench surface soil. Aluminum, barium, boron, cadmium, cobalt, copper, lead, manganese, mercury, molybdenum, nickel, silver, thallium, tin, and zinc are above background in surface soil at the remainder of Sites 3 and 4. At the New Burn Site (Table 8-2b) barium, boron, chromium, copper, lead, manganese, mercury, nickel, silver, tin, and zinc are above background in the Burn Area. Within the remainder of the New Burn Site aluminum, arsenic, barium, beryllium, chromium, cobalt, copper, lead, manganese, mercury, nickel, vanadium, and zinc are above background. The metals above background in surface soil in each of the areas of concern are therefore carried forward to the COPC selection process.

Chlorinated dioxins and furans were also detected in surface soils at the New Burn Site. Because these compounds are frequently encountered in the environment as anthropogenic background, site dioxins/furans were compared to background dioxins/furans to determine if the congeners detected in soil at this site are elevated and likely related to site activities or are consistent with anthropogenic background.~~ This comparison was performed in two ways.~~**The selection of anthropogenic background sites is discussed in Section 5. (EPA 30)**

First, the profiles of the congeners within the individual samples collected at the site (i.e., the relative magnitudes of the various detected congeners) were compared to the profiles of the congeners in the five background samples (BKG51SF036, -37, -38, -38, and -40). In general, the lower chlorinated congeners degrade quickly in the environment, leaving behind the higher chlorinated congeners which can persist for hundreds of years (Bumb et al. 1980; Nestrick *et al.* 1986; Smith et al. 1983). For comparison purposes, bar graphs, which are presented in Figures 8-8a through ~~8-8k~~8-8e, were constructed using *total* concentrations of each of the various congeners within a sample. The graphs are presented only to illustrate the overall

pattern of the congener distribution within the samples, not to compare total dioxin/furan concentrations among the samples. The background samples show the typical pattern in which the hepta- and octa-congeners predominate (see Section 5.1.4.5.3). Within the Burn Area, the hepta- and octa-congeneres predominate in all samples, although sample NBS97SF006 shows a pattern more consistent with site-related contamination. In the samples from the remainder of the New Burn Site, the congener patterns are suggestive of background anthropogenic contamination and not more recent site-related activities.

For the second type of comparison, the concentrations of each of the congeners were converted into 2,3,7,8-TCDD equivalent concentrations using USEPA-recommended TEFs, as described in Section 5.1.6.3.1. The 2,3,7,8-TCDD-equivalent detected concentrations were then summed to derive a total 2,3,7,8-TCDD-equivalent concentration for each sample. There were sufficient samples to perform the t-test, which demonstrated that the dioxin/furan concentrations in each of the site databases are consistent with anthropogenic background. Dioxins are therefore retained in surface soil as preliminary COPCs; however, their presence is judged not to be a result of facility-related activities.

8.4.3.2 Subsurface Soil. The only subsurface samples at Sites 3 and 4 were taken from the Abandoned Landfill trench. At the New Burn Site, four subsurface samples were taken from the Burn Area (BHB03, -B04, -C03, and -C04) and two were taken from the remainder of the site. There were sufficient samples analyzed for inorganic constituents to perform the t-test or Mann-Whitney test, where appropriate. As shown in Table 8-~~1~~2a, the following metals were above background in subsurface soil at the trench and therefore are carried forward to the COPC selection process: aluminum, arsenic, barium, beryllium, chromium, cobalt, copper, mercury, nickel, silver, vanadium, and zinc. At the New Burn Site, the following metals were above background in subsurface soil at the Burn Area (Table 8-2b): aluminum, boron, chromium, copper, mercury, molybdenum, nickel, silver, and tin. In surface soil at the remainder of the New Burn Site, aluminum, chromium, copper, manganese, nickel, tin, and zinc are above background.

Chlorinated dioxins and furans were also detected in subsurface soils at the New Burn Site. The profiles of the congeners within the individual samples collected at the site were compared to the profiles of the congeners in the five background samples. Bar graphs using *total* concentrations of each of the various congeners within a sample are presented in Figures ~~8-11a~~ 8-8f through ~~8-11k~~8-8k. Within the Burn Area, sample NBS97BHB03 shows a pattern consistent with what would be expected for site-related contamination. Samples from borehole C within the Burn Area are consistent with background. In the subsurface samples from the remainder of the New Burn Site, the congener patterns are suggestive of background anthropogenic contamination and not more recent site-related activities.

As for surface soil, the concentrations of each of the congeners were converted into 2,3,7,8-TCDD equivalent concentrations using USEPA-recommended TEFs and were then summed to derive a total 2,3,7,8-TCDD-equivalent concentration for each sample. Within the Burn Area, there were sufficient samples to perform the t-test, which demonstrated that the dioxin/furan concentrations are consistent with anthropogenic background. Since there were

only two subsurface samples for the remainder of the New Burn Site, the maximum dioxin concentration was compared to the background threshold. This showed that dioxins were within background at the remainder of the site. Dioxins are retained in subsurface soil as preliminary COPCs; however, their presence may or may not be a result of facility-related activities

8.4.3.3 Groundwater. Because there were only three downgradient groundwater monitoring well locations (MW93-20, MW93-21, and MW95-06) sampled during the RI, the average maximum detected concentration of each inorganic in site groundwater was compared to the groundwater background threshold value (Table 8-3). The four rounds of Phase II sample results from each of these wells were averaged to derive a single data point for each chemical for each well. ~~Since there were only three site samples, the maximum concentration of each inorganic constituent detected in groundwater was compared to the background screening threshold (see Section 5.1.4.5.2). Table 8-3 documents the groundwater background screening at Site 4.~~ As shown in the table, aluminum, antimony, arsenic, boron, chromium, cobalt, copper, lead, manganese, molybdenum, nickel, selenium, vanadium, and zinc are above background; therefore, these inorganic constituents are carried through the groundwater COPC selection process.

8.4.4 Summary of Analytical Results

Table 8-4 presents the metals results for surface and subsurface soil samples collected during Phase I and Phase II at Sites 3/4, and the New Burn Site. Table 8-5 presents a summary of the organic contaminants detected in soil samples from these sites. Tables 8-6 and 8-7 present the results for metals and organic contaminants detected in groundwater, respectively, at Sites 3/4, and the New Burn Site. Included are those analytes that were detected in at least one sample for a particular media. The complete set of analytical results, including a list of nondetected analytes, is found in Appendix N.

8.5 NATURE AND EXTENT OF CONTAMINATION

8.5.1 Geophysical Survey

The Phase I geophysical survey results are summarized in Appendix C (EPA 25). The trench identified by the geophysical survey is shown in Figure 8-1. The existence of a landfill trench was later confirmed by the presence of landfill debris encountered in borehole B. The second geophysical survey conducted in the area of the landfill by another contractor, HFA, for the purpose of identifying potential UXO, resulted in the identification of a second burn area containing buried debris located immediately to the west of the Abandoned Landfill and Explosives Burning Area. In September 1997, Rust E&I and EODT further defined the extent of this ~~potential~~ New Burn Area using a hand-held magnetometer. As a result, EODT identified a much larger area of buried debris. However, what appears to be a former narrow trench within this debris area, corresponds well with the suspected burn area described by

HFA. The outline of the area containing buried debris and the outline of the suspected burn trench are presented in Figure 8-7.

8.5.2 Soils

8.5.2.1 Surface Soils. Evaluation of Site 3 surface soils data indicates that silver was detected in 28 of the 36 samples collected (Table 8-4). Silver was not detected in the background samples collected for the Rossmoyne Soil Group present in the Site 3 area. However, none of the samples contained silver at a concentration exceeding USEPA Region 9 PRGs~~criteria~~. Numerous other metals were found to be present at above-background concentrations, including aluminum (10 samples), antimony (10 samples), arsenic (17 samples), barium (32 samples), beryllium (24 samples), boron (30 samples), cadmium (9 samples), chromium (15 samples), cobalt (27 samples), copper (33 samples), lead (31 samples), manganese (21 samples), mercury (13 samples), molybdenum (18 samples), nickel (29 samples), sodium (1 sample), thallium (2 samples), tin (9 samples), vanadium (9 samples), and zinc (35 samples). Lead was detected above background levels in the surface-soil samples in concentrations ranging from 25 to 1,300 µg/g with three samples exceeding the USEPA Region 9 criteria of 400 µg/g.

Other metals that were present in concentrations exceeding USEPA Region 9 criteria include aluminum (up to 31,800 µg/g), barium (one sample at 5,900 µg/g), cadmium (up to 12.4 µg/g), chromium (up to 121 µg/g), and manganese (two samples at 3,800 and 9,800 µg/g, respectively). The distribution of the major metal contaminants detected in surface soils at Sites 3/4 is shown in Figure 8-9. Based on the geophysical survey and the distribution of elevated metals, the Explosives Burn Area does appear to correspond with the suspected location evaluated during the Phase I investigation. No explosive compounds were detected in any of the samples collected from the area suspected to be the Explosives Burning Area. **(EPA 35)**

For the New Burning ~~area~~ Site immediately west of the landfill, surface soil samples were found to contain several SVOCs (primarily PAHs), dioxins/furans, and lead that exceed USEPA Region 9 criteria. Surface sample 5 (Figure ~~8-13a~~8-9a) was also found to contain antimony at 2,160 µg/g (70 times USEPA risk-based criteria). Lead concentrations from surface soils within the burn trench were 331 µg/g (sample 5), 510 µg/g (sample 6), 142 µg/g (sample 6), 414 µg/g (borehole B), and 461 µg/g (borehole C). Samples collected outside of the trench contained above-background concentrations of lead but at levels well below risk-based criteria (ranging from 23.2 to 63.3 µg/g).

PAHs detected in the new burning area were generally at low concentrations with the exception of boreholes B and C located in the trench where benzo[a]anthracene (4.01 µg/g and 4.29 µg/g), benzo[a]pyrene (3.56 µg/g and 3.30 µg/g), and benzo[b]flouranthene (4.68 µg/g and 4.29 µg/g) exceed their corresponding USEPA risk-based criteria. The explosive compound tetryl was detected at a very low concentration (0.239 µg/g) in sample 6.

From the surface soil sample results, it appears that four separate areas within Sites 3/4 contain metals contamination exceeding background and Region 9 risk-based criteria. These areas correspond to the ~~former~~ Abandoned Landfill trench, to ~~a burn area~~ the Explosives Burn Area in the west-central portion of the ~~landfill~~site , to an area in the northern portion of the ~~landfill area~~site, and to the New Burn site trench west of the Abandoned Landfill (see Figures 8-9 and ~~8-10~~8-9a).

8.5.2.2 Borehole Soils. The results of the VOC analyses for the soil samples collected from four Phase I soil borings drilled around the ~~former~~ Abandoned Landfill trench indicated that solvent contamination (trichloroethene) was present in the subsurface at borehole A (sample from 9.4 to 9.9 feet deep, 0.32 µg/g), at the surface in borehole B (sample from 1.0 to 1.5 feet deep, 0.25 µg/g), and at the surface in borehole C (sample from 0.8 to 1.3 feet deep, 0.68 µg/g) (see Table 8-5). **(EPA 36)** Borehole B was not sampled except at the surface because landfill debris encountered was not amenable to split-spoon sampling. However, a PID reading taken at the top of the boring while the hole was open to 6 feet deep indicated a total of 36 ppm total VOCs. Analysis for SVOCs in borehole soil samples revealed that dimethylphthalate (0.11 µg/g) was detected in the near surface sample in borehole B. Also, di-n-butyl phthalate and benzyl alcohol were detected in the 10.0-to-10.5-foot sample in borehole D (3.0 µg/g and 0.069 µg/g, respectively). The benzyl alcohol is not an uncommon material in landfills and may be related to photographic film development. ~~There were n~~No explosives compounds were detected in ~~any of~~ the borehole samples.

Evaluation of the results of metals analyses for the Phase I soil boring samples revealed that several anomalous metals concentrations were detected. Silver was detected in nine soil boring samples, whereas no silver was present in the background data set for JPG. The highest concentrations of 6.0 ppm and 1.7 ppm were present in the near surface soils of boreholes C and D, respectively. These concentrations were similar to the sample results noted around the Sewage Sludge Application Areas (Site 27) and may be related to burning or disposal of film wastes at the landfill. None of the silver concentrations, however, exceeded USEPA Region 9 criteria.

Other metals present at concentrations exceeding their screening value for background soils include aluminum (8 samples), arsenic (6 samples), barium (5 samples), beryllium (8 samples), boron (4 samples), cadmium (1 sample), chromium (9 samples), cobalt (9 samples), copper (9 samples), manganese (3 samples), mercury (5 samples), nickel (10 samples), lead (5 samples), tin (4 samples), vanadium (7 samples), and zinc (9 samples).

The metals in subsurface soils from soil borings that exceeded the USEPA Region 9 action level criteria are aluminum (nine samples from 16,100 to 38,995µg/g), arsenic (two samples at 10.6 and 23.6 µg/g), barium (one sample at 5,900 µg/g), beryllium (two samples at 0.56 and 2.78 µg/g), cadmium (one sample at 12.4 µg/g), chromium (six samples from 31.3 to 54.4 µg/g), copper (one sample at 408 µg/g), and lead (one sample at 800µg/g). Borehole C at a depth of 10 feet (sample ALF04BHC03) contained the highest concentrations of arsenic and manganese exceeding USEPA Region 9 criteria. This sample also contained elevated barium, beryllium, cobalt, and nickel relative to background and the other Site 4 samples. The

highest barium and lead concentrations were found in borehole B in the near surface sample (sample ALF04BHB01). This sample also had elevated cadmium, chromium, cobalt, copper, and zinc relative to background and the other Site 4 samples.

The soil boring samples collected in the New Burning Area west of the landfill were found to contain lead exceeding the USEPA risk-based level of 400 µg/g. Borehole B was found to contain lead contamination at the surface (414 µg/g), 1 foot (87µg/g), 3 feet (733 µg/g), and 5 feet (278µg/g). Borehole C contained lead exceeding criteria (461 µg/g) at the surface only, and the 1-, 3-, and 5-foot intervals contained lead at background concentrations. Dioxins/furans were detected at all depths to 5 feet in the two borings augered within the burn trench.

8.5.3 Groundwater

8.5.3.1 Geoprobe Field-Screening Survey. The Geoprobe field-screening survey conducted during Phase I began with the first four probeholes being placed around borehole B (see Figure 8-5). These probeholes resulted in detection of contaminated groundwater and soil near the bedrock/glacial till contact, which prompted the investigation to proceed outward from the landfill trench and downgradient to the north toward a branch of Harberts Creek. A total of 22 **(EPA 37)** soil samples and 17 groundwater samples were collected from 22 probeholes (~~Figures 8-14a and 8-14b~~Figure 8-5). The diminishing concentrations in the probeholes on the periphery of the landfill indicate that contamination has not migrated far beyond the landfill boundary. The contamination appears to be moving toward the creek located about 200 feet north of Engineers Road; however, detectable groundwater contamination does not appear to have traveled as far as the road. Thus, the creek does not appear to be in immediate danger of being contaminated by groundwater migrating along the bedrock/glacial till contact toward the stream.

The VOC contamination in groundwater and soil near the bedrock/glacial till interface appears to be confined to the vicinity of the former landfill trench. There was abundant groundwater in and near the trench at the time of the screening survey, but groundwater samples were very difficult to obtain from the glacial till at distances of over 25 feet from the trench, indicating that the undisturbed soil is retarding lateral transport of groundwater. The soil in the trench is probably holding the groundwater, and the dense silty clay soil surrounding the area is retarding groundwater flow; thus, the undisturbed soil is acting as a barrier to contaminant migration in the soil. However, considering that VOC contamination is present in soil and groundwater immediately above bedrock, it is possible that groundwater moving into the bedrock along joints and fractures could be carrying contamination into the bedrock aquifer.

8.5.3.2 Monitoring Wells. Groundwater samples collected from the monitoring wells during Phase I were analyzed for explosives, metals, VOCs, and SVOCs (Tables 8-6 and 8-7). ~~No explosives were detected in any of the Phase I groundwater samples.~~ Analysis for total metals revealed that aluminum, antimony, barium, beryllium, boron, cadmium, chromium, cobalt, iron, lead, molybdenum, potassium, manganese, nickel, selenium, thallium, and vanadium were detected in the groundwater at concentrations above their background values for

groundwater (Table 8-6). However, there were no metals exceeding USEPA Region 9 criteria. Analyses for VOCs and SVOCs revealed that one well, MW93-20, located south of the landfill trench contained acetone at 150 µg/L (Table 8-7). ~~The USEPA Region 9 action level criteria for the acetone is 610 µg/L; thus, the acetone concentration is well below this criteria. There is no MCL for acetone.~~ SVOC contaminants were detected in two Phase I wells, but the data were considered suspect and additional sampling was determined to be necessary to confirm the presence of SVOC compounds. No explosives were detected in any of the Phase I groundwater samples.

Phase II sampling was conducted in four rounds beginning in the fall of 1995 and ending in the winter of 1996. The results show that the same suite of metals above background in Phase I samples were found to exceed background concentrations during Phase II (see Table 8-6). ~~Of these metals, antimony (one sample), beryllium (four samples), calcium (one sample), cobalt (four samples), lead (four samples), and thallium (one sample) were detected in concentrations exceeding their corresponding MCLs.~~

As shown in Table 8-7, SVOCs detected during Phase II included pyrene in MW93-20 at 0.35 µg/L (round 3) and in MW93-23 at 0.46 µg/L and 0.30 µg/L (rounds 3 and 4, respectively). Dimethyl phthalate was detected in MW95-06 at a concentration of 3.5 µg/g. Other tentatively identified SVOCs were detected in all four wells during Phase II sampling. No SVOC contaminant exceeded USEPA Region 9 criteria.

Monitoring well MW93-21 was found to contain the explosive compound 4-Amino-2,6-DinitroToluene at a concentration of 0.206 µg/L during round 2. MW93-23 contained tentatively identified VOCs during rounds 2 and 4. Well MW95-06 was found to contain the ~~volatiles~~ VOCs 1,1,1-trichloroethane, 1,2-dichloroethene, carbon disulfide, and toluene during the first round of sampling in the fall of 1995. However, none of these contaminants were detected in the subsequent four rounds of sampling, and no VOC contaminant detected during Phase II exceeded USEPA Region 9 criteria.

Supplemental groundwater monitoring was performed in June 2001 following the installation of four additional monitoring wells in May 2001. A total of nine wells were sampled at Sites 3 and 4. Similar to historical results, the recent analysis for total metals revealed that aluminum, antimony, barium, beryllium, boron, cadmium, chromium, cobalt, iron, lead, molybdenum, potassium, manganese, nickel, selenium, thallium, and vanadium were detected in the groundwater at concentrations above their background values for groundwater (Table 8-6)

Bis(2-ethylhexyl)phthalate (11 ug/L) was detected in the sample collected from well MW01-02, downgradient and southwest of the Explosives Burning Area. No other SVOCs were detected in the nine wells at Sites 3 and 4 during the June 2001 sampling.

VOCs were detected in the sample collected from monitoring well MW01-03, located at the northern site boundary (Figure 8-10). Trichloroethene (26 ug/L) and 1,1-DCE (2.9 µg/L) exceeded the PRG at well MW01-03. Other VOCs detected at well MW01-03 included 1,1,1-

trichloroethane (40 ug/L), 1,1-dichloroethane (21 µg/L), cis-1,2-dichloroethene (68 ug/L), and trans-1,1-dichloroethene (2 µg/L) along with estimated quantities of tetrachloroethene, chloroethane, and trichlorofluoromethane. The occurrence of trichloroethene, tetrachloroethene, and 1,1,1-trichloroethane in association with daughter products suggests that natural attenuation by reductive dechlorination may be occurring at this location. Also, the detection of chlorinated VOCs at well MW01-03 is apparently localized because VOCs were not detected at the remaining eight monitoring wells at the site. (New Work)

8.6 HUMAN HEALTH RISK ASSESSMENT

8.6.1 Selection of the Contaminants of Potential Concern at Sites 3 and 4

8.6.1.1 Surface Soil.

8.6.1.1.1 Data Grouping. For the purposes of this risk assessment, the five surface soil samples collected in the vicinity of the **Abandoned Landfill** trench (ALF04BHA01, -B01, -C01, -D01, and EBA03SF025) were grouped together for evaluation. The remaining 35 surface soil samples were grouped together as "remainder of site." At the New Burn Site, the samples collected at the Burn Area (NBS97BHB01, -B02, -C01, -C02, SF005, SF006, and SF007) were grouped together for evaluation, and the remaining nine samples were grouped together as "remainder of site**."** **The samples used for human health risk assessment are identified in the data evaluation discussion of this section (i.e., 8.4). All acceptable analytical data were used in the risk assessments (EPA17)**

8.6.1.1.2 Frequency of Detection. Evaluation of frequency of detection was not undertaken for the area around the trench or the New Burn Site because of too few samples. For the remainder of Sites 3 and 4, only one analyte, thallium, was detected in fewer than 5 percent of the 35 samples. However, since thallium could be expected to be present in site soils, and because there were some high detection limits for this metal, it was retained in the preliminary COPC database.

8.6.1.1.3 Nutrient Screening. With the exception of iron in surface soil at the remainder of Sites 3 and 4, the maximum value of each of the nutrients detected in surface soil at all four areas of concern was less than the corresponding nutrient screening value:

- Trench
  - Calcium—maximum: 350,000 µg/g; screening value: 1,000,000 µg/g
  - Iron—maximum: 31,100 µg/g; screening value: 70,000 µg/g
  - Magnesium—maximum: 46,300 µg/g; screening value: 1,000,000 µg/g
  - Potassium—maximum: 1,460 µg/g; screening value: 150,000 µg/g
  - Sodium—maximum: 136 µg/g; screening value: 1,000,000 µg/g

- Remainder of site
  - Calcium—maximum: 440,000 µg/g; screening value: 1,000,000 µg/g

  - Iron—maximum: 86,000 µg/g; screening value: 70,000 µg/g
  - Magnesium—maximum: 105,000 µg/g; screening value: 1,000,000 µg/g
  - Potassium—maximum: 2,180 µg/g; screening value: 150,000 µg/g
  - Sodium—maximum: 405 µg/g; screening value: 1,000,000 µg/g

- Burn Area of New Burn Site
  - Calcium—maximum: 190,500 µg/g; screening value: 1,000,000 µg/g
  - Iron—maximum: 22,700 µg/g; screening value: 70,000 µg/g
  - Magnesium—maximum: 49,350 µg/g; screening value: 1,000,000 µg/g
  - Potassium—maximum: 1,450 µg/g; screening value: 150,000 µg/g
  - Sodium—maximum: 186 µg/g; screening value: 1,000,000 µg/g

- Remainder of New Burn Site
  - Calcium—maximum: 3,670 µg/g; screening value: 1,000,000 µg/g
  - Iron—maximum: 23,900 µg/g; screening value: 70,000 µg/g
  - Magnesium—maximum: 1,660 µg/g; screening value: 1,000,000 µg/g
  - Potassium—maximum: 1,430 µg/g; screening value: 150,000 µg/g
  - Sodium—maximum: 25.8 µg/g; screening value: 1,000,000 µg/g

Iron was therefore retained in the preliminary surface soil COPC database for the remainder of Sites 3 and 4.

8.6.1.1.4 Summary of Preliminary COPCs. Tables 8-8 and 8-9 summarize the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95 percent UCL of the **arithmetic** mean **(UCL95)**, and the exposure point concentration for each preliminary COPC in surface soil at Sites 3 and 4 and at the New Burn Site, respectively. Preliminary surface soil COPCs are those chemicals detected above background (or nutrient screening values) in more than 5 percent of surface soil samples.

8.6.1.1.5 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for each preliminary soil COPC was compared to the chemical-specific Region 9 residential soil PRG (Table 8-10, Sites 3 and 4; and Table 8-11, New Burn Site). One-tenth of the PRG was used for noncarcinogens, with the exception of lead and organic chemicals with a PRG based on saturation limits or maximum limits; for these chemicals the full PRG was used. As a result of the screening, aluminum, barium, cadmium, chromium, and lead are ***retained*** as COPCs in surface soil at the trench. At the remainder of Sites 3 and 4, aluminum, manganese, and thallium are ***retained*** as COPCs in surface soil. At the Burn Area of the New Burn Site, barium, chromium, lead, manganese, zinc, dioxins/furans, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, DDE, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene are ***retained*** as COPCs in surface soil. COPCs in surface soil at the remainder of the New Burn Site include aluminum, arsenic, beryllium, manganese, dioxins/furans, and benzo(a)pyrene.

8.6.1.2 Air.

8.6.1.2.1 Summary of Preliminary COPCs. Ambient air concentrations to which future receptors at this site might be exposed were estimated using air emission/dispersion modeling, as described in Appendix R. In the site-specific conceptual model, discussed below in Section 8.6.2.1, Sites 3 and 4 and the adjacent New Burn Site are evaluated under two future site-specific scenarios: as a future residential/agricultural site and as leased agricultural land. For determining ambient air concentrations in the future residential scenario for the facility, all sites were assumed to be residential except for the five sites designated agricultural. It was assumed that particulate emissions from the strictly residential sites would be negligible because the home sites would be covered with dense vegetation (lawns) and pavement. Therefore, under the residential scenario only the agricultural sites contribute to the air concentrations at all of the sites. The list of preliminary air COPCs is therefore the same for every site, although the concentrations vary. Table R-6 in Appendix R presents the estimated ambient air concentrations at Sites 3 and 4 under the future residential land use scenario.

Under the leased agricultural land use scenario, the consumers of livestock products from animals fed crops grown at this site are assumed to live far enough distant from the site that their exposure to site-related air contaminants would be negligible. The air pathway was therefore not evaluated for these future off-site receptors.

8.6.1.2.2 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for each preliminary air COPC at Sites 3 and 4 in the future residential scenario was compared to the chemical-specific Region 9 air PRG (Table 8-12). One-tenth of the PRG was used for noncarcinogens. The exception was lead, for which the full PRG was used. As a result of the screening, aluminum, chromium, manganese, thallium, silver, vanadium, and zinc are retained as air COPCs for future residents at Sites 3 and 4 and the adjacent New Burn Site.

8.6.1.3 Surface/Subsurface Soil Combined.

8.6.1.3.1 Data Grouping. The only subsurface samples collected at Sites 3 and 4 were taken in the vicinity of the **Abandoned Landfill** trench. The surface and subsurface samples from the trench were therefore grouped together for the purposes of the risk assessment. At the New Burn Site, the seven surface and four subsurface samples from the Burn Area were grouped together. The database for the combined surface/subsurface soil at the remainder of the New Burn Site consists of the nine surface samples and the two subsurface samples.

8.6.1.3.2 Frequency of Detection. Evaluation of frequency of detection was not undertaken for the area around the trench at Sites 3 and 4 or at the New Burn Site because of too few samples.

8.6.1.3.3 Nutrient Screening. The maximum value of each of the nutrients detected in surface/subsurface soil at the trench at Sites 3 and 4 and at the New Burn Site was less than the corresponding nutrient screening value. All nutrients were, therefore, eliminated as preliminary COPCs for surface/subsurface soil combined at the trench.

- Trench at Sites 3 and 4
  - Calcium—maximum: 350,000 µg/g; screening value: 1,000,000 µg/g
  - Iron—maximum: 58,300 µg/g; screening value: 70,000 µg/g
  - Magnesium—maximum: 46,300 µg/g; screening value: 1,000,000 µg/g
  - Potassium—maximum: 1,820 µg/g; screening value: 150,000 µg/g
  - Sodium—maximum: 139.5 µg/g; screening value: 1,000,000 µg/g

- Burn Area at New Burn Site
  - Calcium—maximum: 190,500 µg/g; screening value: 1,000,000 µg/g
  - Iron—maximum: 31,700 µg/g; screening value: 70,000 µg/g
  - Magnesium—maximum: 49,350 µg/g; screening value: 1,000,000 µg/g
  - Potassium—maximum: 1,450 µg/g; screening value: 150,000 µg/g
  - Sodium—maximum: 203 µg/g; screening value: 1,000,000 µg/g

- Remainder of New Burn Site
  - Calcium—maximum: 3,670 µg/g; screening value: 1,000,000 µg/g
  - Iron—maximum: 23,900 µg/g; screening value: 70,000 µg/g
  - Magnesium—maximum: 1,660 µg/g; screening value: 1,000,000 µg/g
  - Potassium—maximum: 1,430 µg/g; screening value: 150,000 µg/g
  - Sodium—maximum: 25.8 µg/g; screening value: 1,000,000 µg/g

8.6.1.3.4 Summary of Preliminary COPCs. Tables 8-8 and 8-9 summarize the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, **UCL**95 ~~percent UCL of the mean~~, and the exposure point concentration for each preliminary COPC in surface/subsurface soil combined at Sites 3 and 4 and at the New Burn Site, respectively. Preliminary surface/subsurface soil COPCs are those chemicals detected above background (or nutrient screening values) in more than 5 percent of surface soil samples.

8.6.1.3.5 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for each preliminary soil COPC was compared to the chemical-specific Region 9 residential soil PRG (Table 8-10, Sites 3 and 4; Table 8-11, New Burn Site). One-tenth of the PRG was used for noncarcinogens, with the exception of lead and organic chemicals with a PRG based on saturation limits; for these chemicals the full PRG was used. As a result of the screening, aluminum, arsenic, barium, beryllium, cadmium, chromium, copper, and lead are ***retained*** as COPCs in surface/subsurface soil combined at the trench. At the Burn Area of the New Burn Site, aluminum, barium, chromium, copper, lead, manganese, zinc, dioxins/furans, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, DDE, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene are ***retained*** COPCs in surface/subsurface soil combined. At the remainder of the New Burn Site, aluminum, arsenic, beryllium, manganese, dioxins/furans, and benzo(a)pyrene are ***retained*** COPCs.

8.6.1.4 Groundwater.

8.6.1.4.1a Data Grouping. Four to five rounds of data from each of the three downgradient wells (MW93-20, MW93-21, and MW95-06) were averaged to derive a single data point for each well.

8.6.1.4.1b Frequency of Detection. Evaluation of frequency of detection was not undertaken because of too few groundwater ~~samples~~ locations.

8.6.1.4.2 Nutrient Screening. With the exception of iron, the maximum value of each of the nutrients detected in groundwater at Site 4 was less than its groundwater nutrient screening value:

- Calcium—maximum: 198 mg/L; screening value: 510 mg/L
- Iron—maximum: 10.2 mg/L; screening value: 9.4 mg/L
- Magnesium—maximum: 115 mg/L; screening value: 200 mg/L
- Potassium—maximum: 9.0 mg/L; screening value: 20 mg/L
- Sodium—maximum: 33.1 mg/L; screening value: 730 mg/L

Since the maximum iron concentration also exceeded the background threshold value of 1.5 mg/L, iron was retained as a preliminary COPC in groundwater.

8.6.1.4.3 Summary of Preliminary COPCs. Table 8-13 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, **UCL**95 ~~percent UCL of the mean~~, and the exposure point concentration for each preliminary COPC in groundwater at Site 4. Preliminary groundwater COPCs are those chemicals detected above background (or nutrient screening values) in more than 5 percent of groundwater samples.

8.6.1.4.4 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for each preliminary groundwater COPC was compared to the chemical-specific Region 9 tap water PRG (Table 8-14). One-tenth of the PRG was used for noncarcinogens, with the exception of lead, for which the full PRG was used. As a result of the screening, aluminum, antimony, arsenic, chromium, iron, lead, manganese, molybdenum, and 4-amino-2,6-dinitrotoluene are retained as COPCs in groundwater.

8.6.2 Exposure Assessment

8.6.2.1 Site Conceptual Model. As described in Section 5.1.4.6, no people specifically work at Sites 3 and 4 and access is restricted. As a result, current receptors would most likely be trespassers and off-facility rural residents. These receptor populations are addressed on a facility-wide basis rather than by single units (see Sections 28 and 29). Also addressed on a facility-wide basis is the future hunter at JPG.

Therefore, this site-specific conceptual model only addresses future land use development. Sites 3 and 4 and the adjacent New Burn Area have two potential future land uses forwarded for evaluation:

- Agricultural
- Residential

Agricultural Use. Under this future land use scenario, Sites 3 and 4 and the adjacent New Burn Site are assumed to be leased to a nearby farmer for the purpose of cultivating cash crops. The most likely receptor population would therefore consist of individuals residing in nearby communities who consume beef and milk products obtained from cattle fed crops harvested at JPG.

Residential Use. Under the future residential land use scenario, these sites were assumed to be developed as homesteads, with the supposition that a family would build a house directly on or within this area of potential concern. Since Sites 3 and 4 are residential/agricultural sites, it was assumed that these receptors could raise beef and dairy cattle on their property.

With respect to a risk assessment analysis, resident populations were assumed to consist of both adults and toddlers. Each individual would be expected to come in contact with site contaminants through the following pathways at Sites 3 and 4 and the adjacent New Burn Site:

- Inhalation of VOCs and fugitive particulates from soils
- Dermal contact with soil (both surface and surface/subsurface combined) while gardening/playing outdoors
- Incidental ingestion of soil (both surface and surface/subsurface combined) while gardening/playing outdoors
- Ingestion of fresh homegrown fruits and vegetables (grown in both surface soil and surface/subsurface soil combined)
- Ingestion of home-produced beef
- Ingestion of home-produced milk
- Ingestion/dermal contact with groundwater
- Inhalation of VOCs while showering/bathing

8.6.2.2 Exposure Point Concentrations.

8.6.2.2.1 Air. The estimated ambient air concentrations of COPCs at these sites for the future on-site resident are presented in Table 8-12.

8.6.2.2.2 Soil. The concentrations of COPCs in surface soil and surface/subsurface soil combined at these sites are presented in Table 8-11. Four sub-areas of potential concern were identified—the trench at Sites 3 and 4, the remainder of Sites 3 and 4, the burn area at the New Burn Site, and the remainder of the New Burn Site. It was assumed a future resident could build a home in any of these sub-areas of potential concern, but that crops (corn) could be grown over the entire site, including the New Burn Site. Therefore, for the purpose of modeling uptake into corn, site-wide average concentrations of soil COPCs at these sites were calculated. A site-wide area-weighted concentration for each surface soil COPC was calculated by multiplying the concentration of the COPC in soil in the sub-area of potential concern by a modifying factor. The modifying factor was calculated as the area of the sub-area of potential concern divided by the area of the entire site. The modified concentrations were then summed to derive a site-wide concentration for each surface soil COPC. These site-wide area-weighted concentrations are presented in Table 8-15.

8.6.2.2.3 Fruits, Vegetables, and Crops. COPC concentrations in homegrown fruits and vegetables and crops (corn) grown for livestock consumption were estimated using the methods described in Section 5.1.5.2.8. Appendix U, Table U-3, documents the calculation of contaminant concentrations in fruits, vegetables, and crops at Sites 3 and 4 and the adjacent New Burn Site.

8.6.2.2.4 Beef and Milk. COPC concentrations in beef and milk were estimated using the methods described in Section 5.1.5.2.9 and 5.1.5.2.10, respectively. Table U-3, Appendix U, documents the calculation of contaminant concentrations in beef and milk at Sites 3 and 4 and the adjacent New Burn Site.

8.6.2.2.5 Groundwater. The concentrations of COPCs in groundwater at Sites 3 and 4 are presented in Table 8-14.

8.6.2.2.6 Shower Air. There are no VOC COPCs in groundwater at these sites. Therefore, this pathway is incomplete for Sites 3 and 4 and the adjacent New Burn Site.

8.6.2.3 Human Exposure Doses.

8.6.2.3.1 Inhalation of Contaminated Air. Inhalation of airborne contaminants (VOCs and particulates) is a potential route of exposure for future on-site residents (adults and children) at these sites. The equation used for calculating human exposure doses of contaminants of potential concern due to inhalation of volatile and dust-bound contaminants is provided in Section 5.1.5.3.1, Table 5-**11**~~12~~. Table V-3, Appendix V, documents the calculation of human exposure doses due to inhalation of contaminated air.

8.6.2.3.2 Incidental Ingestion of Contaminated On-site Soil. Mouthing behavior (toddlers) and incidental ingestion of soil with recreational or work-related activities may expose human

receptors to contaminated soil at a site via the oral route of exposure. The equation used to calculate the human exposure dose due to incidental ingestion of contaminated soil is presented in Section 5.1.5.3.2, Table 5-**12**~~13~~. This pathway was assumed to be complete at Sites 3 and 4 and the adjacent New Burn Area for future on-site residents (adults and children). Table V-3, Appendix V, documents the calculation of human exposure doses due to incidental ingestion of soil at these sites.

8.6.2.3.3 Dermal Contact with Contaminated On-site Soil. The chemicals in contaminated soil also may be absorbed into a receptor's body through dermal contact. The equation used to calculate chemical doses due to dermal contact with contaminated soil is presented in Section 5.1.5.3.3, Table 5-**13**~~14~~. This pathway is relevant for future on-site residents (adults and children) at Sites 3 and 4 and the adjacent New Burn Site. Table V-3, Appendix V, documents the calculation of human exposure doses due to dermal contact with soil at these sites.

8.6.2.3.4 Ingestion of Contaminated Fruits and Vegetables. Consumption of contaminated homegrown fruits and vegetables may be a source of chemical exposure for future on-site residents (adults and children). The equation used to calculate human exposure doses due to ingestion of contaminated fruits and vegetables is provided in Section 5.1.5.3.11, Table 5-22~~23~~. Table U-3, Appendix U, documents the calculation of human exposure doses due to ingestion of contaminated fruits and vegetables grown in surface soil and surface/subsurface soil combined at these sites.

8.6.2.3.5 Ingestion of Contaminated Beef and Milk. Ingestion of contaminated beef and milk may be significant pathways of chemical exposure for future on-site residents and future off-site residents (adults and children) who consume these products from cattle fed corn (silage) harvested from fields at Sites 3 and 4 and the adjacent New Burn Site. The equation used to calculate human exposure doses due to ingestion of contaminated beef is provided in Section 5.1.5.3.12, Table 5-**23**~~24~~. The equation used to calculate human exposure doses due to ingestion of contaminated milk is provided in Section 5.1.5.3.13, Table 5-**24**~~25~~. Table U-3,

Appendix U, documents the calculation of the human exposure doses due to ingestion of contaminated beef and milk from cattle fed corn (silage) grown in fields at these sites.

8.6.2.3.6 Ingestion of Contaminated Groundwater. Contaminated drinking water may be a source of chemical exposure for future on-site residents (adults and children) and future workers. The equation used to calculate human exposure doses due to ingestion of contaminated drinking water is provided in Section 5.1.5.3.4, Table 5-**14**~~15~~. Table V-3, Appendix V, documents the calculation of human exposure doses at these sites due to ingestion of contaminated groundwater.

8.6.2.3.7 Dermal Contact with Contaminated Groundwater. Exposure via dermal contact with chemicals in groundwater may occur when receptors (future residents) shower or bathe. The equation used to calculate daily chemical doses due to dermal contact with contaminated groundwater is provided in Section 5.1.5.3.5, Table 5-**15**~~16~~. Table V-3, Appendix V,

documents the calculation of human exposure doses at these sites due to dermal contact with contaminated groundwater.

8.6.3 Risk Characterization

8.6.3.1 Chronic Health Hazards. The noncancer daily exposure doses calculated in the exposure assessment were used to calculate HQs for each of the COPCs possessing RfDs. Pathway-specific and overall HIs were then calculated for each receptor. The calculations of HQs and HIs are described in Section 5.1.7.1. If an overall HI is calculated to be greater than 1.0 for a particular receptor, then the exposure pathway(s) primarily responsible for the result is identified as a "critical pathway(s)." For each critical pathway, those chemical contaminants responsible for the majority of the HI are listed as COCs. Table W-3, Appendix W, documents the calculation of the pathway- and chemical-specific HQs for the human receptors at Sites 3 and 4 and the adjacent New Burn Site. The pathway-specific and overall HIs are summarized in Tables 8-16a, 8-16b, and 8-16c.

8.6.3.1.1 Future On-Site Residents.

Sites 3 and 4 – Trench. If future receptors build a home at the location of the trench and are exposed to COPCs in surface soil only, the overall HIs for the future on-site adult and toddler residents are calculated to **6.6** ~~9.0~~ and **22** ~~28~~, respectively. Both of these HIs exceed the USEPA's risk management criterion of 1.0. Ingestion of groundwater and inhalation of fugitive dusts are critical exposure pathways for both receptors. I~~ron is the primary COC in groundwater and m~~Manganese is the primary COC in dusts. Incidental ingestion of soil and ingestion of fruits/vegetables are also critical pathways for the child receptor. Barium and cadmium are noncarcinogenic COCs in soil;~~, and aluminum,~~ arsenic **and chromium (VI)** ~~, and manganese~~ are additional COCs in groundwater for the child receptor. ~~Aluminum is also a noncarcinogenic COC for the inhalation pathway for the child.~~

There are currently no USEPA health criteria for lead. The comparison of calculated soil lead concentrations to the OSWER soil lead screening level of 400 ppm (USEPA 1994d) was therefore used to assess hazard to the various receptor populations in this risk assessment. Sites 3 and 4 have soil exposure point concentrations of lead that exceed 400 ppm. The exposure point concentration for lead in surface soil and in surface/subsurface soil combined in the trench is 800 mg/kg. Therefore, it is concluded that lead may pose a hazard to future residents at this sub-area of concern from contact with soil. ~~Additionally, the concentration of lead in groundwater at this site, 6.7 µg/L, exceeds the Region 9 tap water PRG for this chemical of 4.0 µg/L.~~

If subsurface soil is assumed to be mixed and dispersed with surface soil across the ground surface at the home-site at the location of the trench, the overall HIs for the future adult and toddler are calculated to be **6.4**~~8.9~~ and **22**~~28~~, respectively. This excavation scenario has the same critical pathways and noncarcinogenic COCs as the scenario in which these receptors are exposed to surface soil only, with the exception that cadmium is no longer a noncarcinogenic COC for the fruit/vegetable ingestion pathway for the child.

Sites 3 and 4 - Remainder of Site. If future receptors build a home on the remainder of Sites 3 and 4 and are exposed to COPCs in surface soil only, the overall HIs for the future on-site adult and toddler residents are calculated to **5.6** ~~8.3~~ and **18.4** ~~25.7~~, respectively. Both of these HIs exceed the USEPA's risk management criterion of 1.0. Ingestion of groundwater and inhalation of fugitive dusts are critical exposure pathways for both receptors. ~~Iron is the primary COC in groundwater and~~ **M**~~m~~anganese is the primary COC in dusts. ~~Ingestion of fruits and vegetables is also a critical exposure pathway for the toddler, with manganese being the noncarcinogenic COC. Aluminum, a~~Arsenic **and chromium (VI)**~~, and manganese~~ are additional COCs in groundwater for the toddler.~~, and aluminum is also a noncarcinogenic COC for the inhalation pathway for the child.~~

New Burn Site - Burn Area. If future receptors build a home at the burn area of the New Burn Site and are exposed to COPCs in surface soil only, the overall HIs for the adult and toddler residents are calculated to be **7.4**~~9.9~~ and **20.8**~~27.4~~, respectively. Both of these HIs exceed the USEPA's risk management criterion of 1.0. **Ingestion of fruits/vegetables** ~~Ingestion of groundwater~~ and inhalation of fugitive dusts are critical exposure pathways for both receptors. ~~Iron is the primary COC in groundwater and m~~ **Zinc is the primary COC in fruits/vegetable and m**anganese is the primary COC in dusts. **Ingestion of groundwater**~~Ingestion of fruits/vegetables~~ is also a critical pathway for both receptors.~~, with zinc being the noncarcinogenic COC.~~ ~~Aluminum, a~~**A**rsenic **and chromium (VI) are**~~, and manganese are additional~~ the primary COCs in groundwater for the child receptor. ~~Aluminum is also a noncarcinogenic COC for the inhalation pathway for the child.~~

If subsurface soil is assumed to be mixed and dispersed with surface soil across the ground surface at the home-site at the burn area, the overall HIs for the future adult and toddler are calculated to be **7.4**~~9.9~~ and **20.8** ~~27.5~~, respectively. This excavation scenario has the same critical pathways and noncarcinogenic COCs as the scenario in which these receptors are exposed to surface soil only.

There are currently no USEPA health criteria for lead. The comparison of calculated soil lead concentrations to the Office of Solid Waste and Emergency Response (OSWER) soil lead screening level of 400 ppm (USEPA 1994d) was therefore used to assess hazard to the various receptor populations in this risk assessment. The burn area at the New Burn Site has soil exposure point concentrations of lead that exceed 400 ppm. The exposure point concentration for lead in surface soil in the burn area is 426 µg/g; the exposure point concentration in surface/subsurface soil is 420 µg/g. These values only slightly exceed the screening level. Therefore, it is concluded that lead may pose a slight hazard to future residents at this sub-area of concern from contact with soil. ~~Additionally, the concentration of lead in groundwater at this site, 6.7 µg/L, exceeds the Region 9 tap water PRG for this chemical of 4.0 µg/L.~~

New Burn Site - Remainder of Site. If future receptors build a home on the remainder of the New Burn Site and are exposed to COPCs in surface soil only, the overall HIs for the future on-site adult and toddler residents are calculated to **5.6** ~~8.2~~ and **18.7** ~~25.7~~, respectively. Both of these HIs exceed the USEPA's risk management criterion of 1.0. Ingestion of groundwater

and inhalation of fugitive dusts are the critical exposure pathways for both receptors. ~~Iron is the primary COC in groundwater and m~~Manganese is the primary COC in dusts. ~~Aluminum, a~~**A**rsenic **and chromium (VI)**~~, and manganese~~ are additional COCs in groundwater for the toddler.~~, and aluminum is also a noncarcinogenic COC for the inhalation pathway for this receptor.~~

If subsurface soil is assumed to be mixed and dispersed with surface soil across the ground surface at the home-site on the remainder of the site, the overall HIs for the future adult and toddler are calculated to be **5.6** ~~8.2~~ and **18.6** ~~25.6~~, respectively. This excavation scenario has the same critical pathways and noncarcinogenic COCs as the scenario in which these receptors are exposed to surface soil only.

At Sites 3 and 4 and the New Burn Site, fugitive dust emissions and the beef and milk pathways are based on site-wide average concentrations. A review of the data shows that following percentages of the chemical-specific HQs for these pathways can be attributed to the four areas of concern at these sites:

- Trench at Sites 3/4
  - ~~Aluminum: 5.2%~~
  - Arsenic: 0%
  - Barium: 93%
  - Cadmium: 100%
  - Manganese: 0%
  - Zinc: 0%
  - Dioxins/furans: 0%

- Remainder of Sites 3/4
  - ~~Aluminum: 91%~~
  - Arsenic: 0%
  - Barium: 0%
  - Cadmium: 0%
  - Manganese: 97%
  - Zinc: 0%
  - Dioxins/furans: 0%

- Burn Area at the New Burn Site
  - ~~Aluminum: 0%~~
  - Arsenic: 0%
  - Barium: 7%
  - Cadmium: 0%
  - Manganese: <1%
  - Zinc: 100%
  - Dioxins/furans: 60%

- Remainder of New Burn Site

- ~~Aluminum: 3.4%~~
- Arsenic: 100%
- Barium: 0%
- Cadmium: 0%
- Manganese: 2.4%
- Zinc: 0%
- Dioxins/furans: 40%

The noncarcinogenic COCs aluminum, manganese, barium, cadmium, and zinc are present naturally in Rossmoyne soils at the facility. The relative contributions of background soil concentrations of these constituents to the hazards at this site were estimated by comparing the average soil background concentrations of these chemicals to the average concentration in site soils. The range of background concentrations contributing to total soil concentrations in the different areas of concern for surface soil and surface/subsurface soil combined are: aluminum—35 to 75 percent, manganese—16 to 53 percent, barium—4 to 52 percent, cadmium—9 to 52 percent, and zinc—3 to 20 percent.

The hazards associated with inhalation of fugitive dusts at the trench at Sites 3/4 are due almost entirely to emissions from surface soils at the remainder of Sites 3/4. The background concentrations of barium and cadmium would contribute approximately 1 percent to the total soil pathway hazards estimated for the trench in both the surface soil only and excavation scenarios.

For the remainder of Sites 3/4, background concentrations of aluminum and manganese in surface soils would contribute 5 percent and 14 percent, respectively, to the total soil pathway hazards calculated for this site.

Hazards associated with inhalation of fugitive dusts at the Burn Area of the New Burn Site are due almost entirely to emissions from surface soils at the remainder of Sites 3/4. Background concentrations of zinc would contribute less than 1 percent to the total soil pathways hazards estimated for the Burn Area in both the surface soil only and combined excavation scenarios.

Hazards associated with inhalation of fugitive dusts at the remainder of the New Burn Site are due almost entirely to emissions from surface soils at the remainder of Sites 3/4.

Background concentrations of iron in groundwater contribute 9 percent to the total iron concentration in this medium, and background concentrations of aluminum contribute 3 percent to the total groundwater concentration of this metal. Background concentrations of manganese contribute 72.4 percent to the total concentration of manganese in groundwater.

Background concentrations of aluminum, iron, and manganese would contribute less than 1 percent, 1 percent, and 10 percent, respectively, to the total hazards estimated for the groundwater exposure pathways at Sites 3/4 and the New Burn Site.

8.6.3.1.2 Future Off-Site Consumers of Beef and Milk. The overall HIs for the future off-site adult and toddler consumers of beef and milk products obtained from cattle fed crops (corn) harvested at Sites 3 and 4 and the adjacent New Burn Site are calculated to be **0.32** ~~0.40~~ and **0.66** ~~1.0~~, respectively. Both of these HIs are less ~~or equal to~~ than the USEPA's risk management criterion of 1.0. Therefore, no critical exposure pathways or noncarcinogenic COCs are identified for these receptors.

8.6.3.2 Excess Lifetime Cancer Risks. The cancer risks for each receptor were determined from the pathway-specific exposure doses and the route-specific SFs, as described in Section 5.1.7.2. To assess the simultaneous exposure of a receptor population to multiple carcinogens from multiple exposure routes, all of the cancer risks calculated for a receptor population were summed. Each overall receptor cancer risk was then compared to USEPA's target risk range (1.0E-06 to 1.0E-04). If the total cancer risk for a receptor from all exposure pathways is less than 1.0E-04, then it is concluded that the site(s) does not pose a significant risk to that receptor. If the overall cancer risk exceeds the target risk range, any chemical that individually is associated with a risk level greater than 1.0E-05 is identified as a COC. COCs represent the primary contributors to the potential cancer risk for the receptor-specific exposure pathway under evaluation. Table W-3, Appendix W, documents the calculation of the pathway-specific and chemical-specific cancer risks for the human receptors **at Sites 3 and 4 and the adjacent New Burn Site**.~~at Sites 2 and 27~~. The pathway-specific and overall cancer risks are summarized in **Tables 8-16a, 8-16b, and 8-16c**.~~Tables 8-Za, 8-Zb, and 8-Zc.~~

8.6.3.2.1 Future On-Site Residents.

Sites 3 and 4 – Trench. If future receptors build a home at the location of the trench and are exposed to COPCs in surface soil only, the overall cancer risks for the future on-site adult and toddler residents are calculated to be 8.6E-05 and 4.1E-05, respectively. Both of these cancer risks are within the USEPA's target risk range of 1.0E-06 to 1.0E-04. Therefore, no critical exposure pathways or carcinogenic COCs are identified for these receptors.

If subsurface soil is assumed to be mixed and dispersed with surface soil across the ground surface at the home-site at the location of the trench, the overall cancer risk for the future adult receptor is calculated to be **1.2** ~~1.3~~E-04. This cancer risk exceeds the USEPA's target risk range of 1.0E-6 to 1.0E-04. The critical exposure pathways are incidental ingestion of soil, ingestion of homegrown fruits and vegetables, and ingestion of groundwater. Arsenic is the carcinogenic COC for all of these pathways. The toddler's cancer risk is within the target risk range, with a calculated value of **7.3** ~~8.4~~E-05. No critical pathways or carcinogenic COCs are therefore identified for the toddler receptor in the excavation scenario.

Sites 3 and 4 - Remainder of Site. If future receptors build a home on the remainder of Sites 3 and 4 and are exposed to COPCs in surface soil only, the overall cancer risks 8.6E-05 and 4.1E-05, respectively. Both of these cancer risks are less than the USEPA's target risk range of 1.0E-06 to 1.0E-04, respectively. Therefore, no critical exposure pathways or carcinogenic COCs are identified for these receptors.

New Burn Site - Burn Area. If future receptors build a home on the burn area of the New Burn Site and are exposed to COPCs in surface soil only, the overall cancer risks for the adult and toddler residents are calculated to be 2.4E-04 and 1.6E-04, respectively. Both of these cancer risks exceed the USEPA's target risk range of 1.0E-06 to 1.0E-04. Incidental ingestion of soil, ingestion of homegrown fruits and vegetables, and ingestion of groundwater are critical exposure pathways for both of these receptors. Benzo(a)pyrene is the primary carcinogenic COC in soil, and arsenic is the COC in groundwater. For the adult receptors, 2,3,7,8-TCDD, benzo(a)anthracene, benzo(b)fluoranthene, and dibenzo(a,h)anthracene are also carcinogenic COCs for the fruit and vegetable ingestion pathway.

If subsurface soil is assumed to be mixed and dispersed with surface soil across the ground surface at the home-site at the burn area, the overall cancer risks for the future adult and toddler are calculated to be 2.7E-04 and 1.8E-04, respectively. This excavation scenario has the same critical pathways and carcinogenic COCs as the scenario in which these receptors are exposed to surface soil only, with the exception that 2,3,7,8-TCDD is also a carcinogenic COC for the adult receptor for the soil ingestion pathway.

New Burn Site - Remainder of Site. If future receptors build a home on the remainder of the New Burn Site and are exposed to COPCs in surface soil only, the overall cancer risks for the future on-site adult and toddler residents are calculated to be 1.2E-04 and 7.4E-05, respectively. No critical exposure pathways are identified for the toddler resident. The cancer risk for the adult resident exceeds the USEPA's target risk range of 1.0E-06 to 1.0E-04. Arsenic is the carcinogenic COC for this receptor in the critical exposure pathways of ingestion of homegrown fruits and vegetables, and ingestion of groundwater.

If subsurface soil is assumed to be mixed and dispersed with surface soil across the ground surface at the home-site on the remainder of the site, the overall cancer risks for the future adult and toddler are calculated to be 1.2E-04 and **6.9** ~~7.3~~E-05, respectively. This excavation scenario has the same critical pathways and carcinogenic COCs for the adult receptor as the scenario in which exposure is to COPCs in surface soil only.

The concentrations of naturally occurring arsenic contributing to total soil arsenic range from 54 to 70 percent at the areas of concern at Sites 3/4 and the New Burn Site. At the Burn Area of the New Burn Site, background dioxins/furans account for 43 percent of the total soil concentrations of these constituents.

Anthropogenic background dioxins/furans would contribute approximately 8 percent to the total soil pathway cancer risks calculated for both the surface soil only and excavation scenarios at the Burn Area at the New Burn Site.

Background concentrations of arsenic would contribute approximately 40 percent to the total soil pathway cancer risks calculated for the remainder of the New Burn Site in both the surface soil only and excavation scenarios.

Background groundwater concentrations of arsenic contribute 74 percent to the total concentration of arsenic in this medium, and would contribute 74 percent to the total cancer risk calculated for the groundwater exposure pathways for Sites 3/4 and the New Burn Site.

8.6.3.2.2 Future Off-Site Consumers of Beef and Milk. The overall cancer risks for the future off-site adult and toddler consumers of milk and beef fed products obtained from cattle fed crops (corn) harvested from Sites 3 and 4 fields and the adjacent New Burn Site are calculated to be 6.9E-06 to 3.7E-06, respectively. Both of these cancer risks are within the USEPA's target risk range of 1.0E-06 to 1.0E-04. Therefore, no critical exposure pathways or carcinogenic COCs are identified for these receptors.

8.6.3.3 Uncertainty Analysis. The numerical risks/hazards calculated for Sites 3 and 4 represent *conditional* estimates of risk based on various simplifying assumptions concerning contaminant exposure and toxicity. These estimates are derived using a series of conservative procedures that address contaminant concentrations at the site, their fate in the environment, how someone currently or in the future might be exposed to these contaminants, and the toxicity of each chemical toward humans. The uncertainty analysis is designed to specify, when appropriate, the critical assumptions made for the site so that the site-specific results can be interpreted in proper context by risk managers.

To assist the risk managers in this project, a qualitative uncertainty analysis has been performed. This qualitative uncertainty analysis (1) itemizes the major areas of uncertainty in the site-specific risk assessment and (2) demonstrates that the assessment overall has been conservatively performed (i.e., that the potential risks/hazards at the site have not likely been underestimated, but may have been significantly overestimated).

The qualitative uncertainty analysis for this site is presented in Table 8-17. Based on this analysis, it can be concluded that this risk assessment is conservative. Some of the major uncertainties in this study that are most influential to the risks/hazards that were calculated include:

- Use of RDA values as toxicity criteria for iron and zinc
- Receptors' exposure time (24 hours/day) and exposure frequency (350 days/year)
- Air dispersion modeling and food-chain concentration modeling of exposure point concentrations
- Maximum detected soil concentrations used

In addition, Phase I analytical results for antimony were rejected in accordance with EPA CLP functional guidelines for data review; these rejected data were not used *quantitatively* in this risk assessment. The lack of antimony results may underestimate risk to human health and ecological receptors. (EPA 103)

8.7 ECOLOGICAL RISK ASSESSMENT

8.7.1 Ecological Site Description

The Explosive Burn Area and Abandoned Landfill consist of infrequently maintained grassland, which was periodically burned until 1995. The grassland extends south for some distance. **At present, the area near the Abandoned Landfill is fenced and relatively undisturbed. Consequently, the grassland is a potential habitat for the Henslow's sparrow, which is not a Federally- listed threatened or endangered (T & E) species. (EPA-201)** Species observed in 1993 included broomsedge, ragweed, goldenrod, clover, plantain, yarrow, and common milkweed. **Refer to Figure 5.3-13 for a map of habitat types at JPG. (EPA184)** Other than perimeter fencing, no structures are present at these sites. The area was cleared in November 1992 to facilitate access for geophysical surveys performed as part of the RI. The open field is surrounded by early successional flatwoods to the east, north, and west. The early successional forest located to the east, north, and west is unusual in that it is approximately 90 percent black locust. Wildlife species observed included numerous butterflies, white-tailed deer, rabbit, and bobwhite. **Refer to Table 8.7-a1 for a summary of Site 3/4 ecological habitat characteristics identified during site visits. (EPA184)**

8.7.2 Site 3/4 Investigations

For convenience to the reader, summary statistics, EPCs, risk driver HQs, total RME, and CT HIs are provided in this section. All intakes and other non risk-driving HQs are located in Appendix AA**. The COPCs for each medium were evaluated in the DERA are presented on the EPC tables in this section. Refer to Appendix AA for details pertaining to the specific data sets (e.g., sample numbers, depths, dates, etc.) used in the risk assessment for Sites 3, 4, and the New Burn Site. (EPA-179)**

8.7.2.1 Phase I Activities. The Phase I data for Site 3 are summarized in Table 8.7-1. Table 8.7-2 provides the EPCs for Site 3. The Phase I data for Site 4 are summarized in Table 8.7-3; the EPCs for this site are presented in Table 8.7-4.

8.7.2.2 Phase II Activities. The Phase II data for Site 3 are summarized in Table 8.7-5. Table 8.7-6 provides the EPCs for Site 3. Phase II data were not collected at Site 4.

8.7.2.3 Phase III Activities. In September 1997, sampling activities to support the ecological risk assessment were conducted. These activities included soil sampling and analysis for metals, cyanide, TOC, and –pH, earthworm toxicity tests, phytotoxicity tests, and soil collection for analysis of soil fauna community structure. These activities were focused in the area identified in Figure 8.7-1, which encompassed parts of Site 3 and Site 4, and is thus known as Site 3/4 in the Phase III sampling effort.

In September 1997, additional soil sampling to assess the nature and extent of contamination was conducted in an area of approximately 0.2 acre. This new area, referred to as the New Burn Site (see Figure 8-7), is located across the gravel road immediately to the west of Sites 3 and 4. While Sites 3 and 4 are primarily unmown grass fields, this new site is predominantly wooded. The analytical data were evaluated in two separate areas, both inside and outside the ~~trench (or visibly~~ burned~~)~~ area. Analytical data for the DERA were restricted to soil sample depths from 0 to 2 feet.

The Phase III data for Site 3/4 are summarized in Table 8.7-7. Table 8.7-8 provides the EPCs for Site 3/4. The Phase III data for the New Burn Site (Inside the Trench Area) are summarized in Table 8.7-9a, 9b, and 9c; the EPCs for this location are presented in Table 8.7-10. The Phase III data for the New Burn Site (Outside the Trench Area) are summarized in Table 8.7-11a, 11b, and 11c; the EPCs for this location are presented in Table 8.7-12.

8.7.3 Exposure and Ecological Effects Profile

Birds and mammals may be exposed to COPCs by direct contact with or ingestion of soil. No surface water data were available at Sites 3 or 4. To determine the estimated intakes of the COPCs, various key receptor species were selected to evaluate the impacts to area wildlife. The key receptors evaluated for Sites 3 and 4 include mourning dove, chimney swift, American kestrel, wild turkey, white-footed mouse, eastern cottontail, red fox, little brown myotis, plants and soil fauna.

An estimated concentration in biotic media is the product of the bioaccumulation factor (BAF) or bioconcentration factor (BCF) for a given receptor and the measured concentration in a given abiotic medium. Soil exposure point concentrations (EPCs) were used in calculations for terrestrial dietary items. Surface water EPCs were used in calculations for aquatic dietary items. Uptake into tissue was not predicted from sediment data because sediment-tissue partition coefficients are not readily available for many of the COPCs. A zero value for an estimated concentration in biotic media is due to either a lack of partition coefficient (BAF or BCF) or to lack of data for the pertinent exposure medium.(EPA203)

The conceptual site models (CSMs) for Sites 3 and 4 and the New Burn Site provide an overview of the ecological receptors and exposure pathways evaluated in the ecological risk assessment. Refer to Figures 8.7-1a, 8.7-1b, and 8.7-1c for schematics of the CSMs. Multiple lines of evidence were evaluated for the ecological assessment conducted at Sites 3, 4, and the New Burn Site. Terrestrial lines of evidence were evaluated for all three sites. The lines of evidence were primarily hazard quotient (HQ) calculations for a number of different receptors, but for the terrestrial ecosystem toxicity testing was also conducted at Sites 3 and 4. Refer to Table 7.7-11a for a summary of the terrestrial lines of evidence. (EPA180a,b)

The exposure pathways and receptors evaluated at this site are as follows:

- Terrestrial Ecosystem (Phase I, II and III data)
  - All wildlife receptors—soil ingestion
  - All wildlife receptors—dietary ingestion
  - Plants—direct contact with soil
  - Soil fauna—direct contact with soil

8.7.3.1 Selection of COPCs. Inorganic analytes from soil data collected during Phases I, II, and III were compared to the JPG Phase II background data set (Section 5.3.2.1). Analytes that were not statistically elevated relative to background were removed from consideration as COPCs. The COPCs for Sites 3 and 4 in the various media are presented in Tables 8.7-1 through 8.7-12.

Arsenic, beryllium, and vanadium were removed as COPCs for Site 3 Phase I since they were not statistically elevated above background. Selenium was not detected at Site 3 in the Phase I data. No inorganics were removed as COPCs at Site 4 for the Phase I data.

Explosives were not detected in surface soils at Sites 3 or 4, nor were SVOCs detected at Site 4 in the Phase I data. Selenium and vanadium were removed as COPCs at Site 3 for the Phase II data since they were not statistically elevated above background. **Explosives were not detected in surface soil at Site 3 in the Phase II data.**

Molybdenum and thallium were not detected in the ecological study of Site 3/4 in the Phase III data. Lead, antimony, and vanadium were not statistically elevated above background and were subsequently removed as COPCs.

At the New Burn Site (inside ~~Trench~~ **Burn Area**), cobalt, selenium, and thallium were not detected in soil. Aluminum, arsenic, beryllium, iron, and vanadium were not statistically elevated above background and were removed as COPCs. Thallium was not detected at the New Burn Site (outside **Burn** ~~Trench~~**Area**); both antimony and selenium were removed as COPCs since they were not statistically elevated above background.

8.7.3.2 Comparison of Site Data to Reference Area Concentrations. The Phase III data for Site 3/4 were statistically compared to data collected from the reference areas. The Phase I and II data were not compared to the reference area data because the data were not collected concurrently with data collected in the reference areas, and some of the analytical methodology differed between sampling programs. The Phase III EPCs for the chemical data for Site 3/4 are reported in Table 8.7-8. The following is a brief description of the observed statistical results based on ANOVA for the soil samples.

Aluminum was significantly different by site ($p=0.0004$). Site 3/4 had significantly higher aluminum concentrations than at any of the three reference areas. Barium was significantly different ($p=0.0045$). Site 3/4 had obviously higher barium concentrations than those observed at the reference areas. Cobalt was significantly different by location ($p=0.0039$). Sites 3/4 had significantly higher cobalt concentrations than at any of the three reference areas.

Manganese was significantly different by location ($p<0.0001$). Site 3/4 had significantly higher manganese concentrations than at any of the three reference areas or other JPG sites. Nickel was significantly different by location ($p=0.0001$). Site 3/4 had significantly higher concentrations of nickel than at any of the three reference areas.

Zinc was significantly different by location ($p=0.0003$). However, zinc concentrations at most of the JPG sites overlapped or were lower than those at the reference areas, except Site 3/4, which had higher concentrations than at the reference areas. Boron, cadmium, chromium, copper, mercury, and TOC did not differ significantly by location.

TOC of reference area soils ranged from 1920 to 11,500 mg/kg. TOC of Site 3/4 soils ranged from 1740 to 57,400 mg/kg. The upper end of this TOC range is due to only one

sample. The remaining four samples are at or below 6840 mg/kg TOC. Thus, the TOC concentrations of Site 3/4 soils are basically within the range of the TOC concentrations of reference site soils. (EPA192)

The pH of reference area soils ranged from 4.93 to 6.16. The pH of Site 3/4 soils ranged from 6.21 to 8.55. Thus, the pH of Site 3/4 soils is higher than the pH of reference site soils. In general, as pH increases, bioavailability of some micronutrients and heavy metals decreases. Therefore, it is possible that some micronutrients and heavy metals are less bioavailable in Site 3/4 soils than in reference soils, which would reduce their toxicity. (EPA192)

8.7.3.3 Earthworm Toxicity Test. Earthworm mortality at Site 3/4 ranged from 0 to 15 percent ~~(see Appendix Z)~~. **Refer to Table 8.7-12a for results of the earthworm toxicity testing. (EPA191)** The null hypothesis is "the number of dead earthworms is similar among all locations". The χ^2 test statistic was 49.25 with a degree of freedom of 40, which resulted in a p-value of 0.1498. Since this p-value exceeds 0.1, site location may bear no relation to earthworm mortality when this test is used.

ANOVA on the arcsine-transformed data provides a different interpretation. The p-value for ANOVA is 0.0016, indicating a significant difference between the mean mortality from one location to another at the 95 percent confidence level. A 95 percent **LSD multiple range test** indicated that mortality at Site 3/4 overlapped that at the Avonburg, Cobbsfork, and Rossmoyne reference areas. The statistical analysis therefore indicates that earthworm mortality at Site 3/4 was not significantly affected by existing site conditions.

8.7.3.4 Phytotoxicity Test. The phytotoxicity early seedling growth test resulted in data for percent germination and biomass. The results are summarized in Appendix Z. There was little variability in germination rates at Site 3/4 with the exception of Grid 2, where percent germination was only 43 percent. At other grid locations within Site 3/4, the germination rate ranged from 89 to 98 percent. The germination data were neither normal nor log-normal. The biomass data on a wet-weight basis were lognormal. ANOVA was used on the germination data despite the shape of the distribution.

ANOVA of the germination data resulted in a p-value of 0.1480, which is greater than 0.05, indicating that location does not have a statistically significant effect on germination at the 95 percent confidence level. ANOVA of the biomass data resulted in a p-value of 0.0037, indicating site location has a significant effect on wet weight biomass at the 95 percent confidence level. The lowest biomass observed in the study was the biomass for the Cobbsfork reference area. **An LSD** multiple range test revealed that Avonburg and Cobbsfork reference areas had significantly lower biomass than Rossmoyne reference area, Site 9, and Site 25. The biomass for all other JPG sites overlapped (was not significantly different from) the biomass measurements from the Cobbsfork and Avonburg reference areas.

The one low germination appears aberrant, and may be due to chance alone. However, exploration of the analytical data indicated barium and TOC were highest. The biomass data

indicate that existing site conditions at this location will not significantly decrease plant growth at this location relative to effects observed in controls. In order to be conservative, it was assumed that barium at 320 mg/kg was phytotoxic.

8.7.3.5 Soil Fauna Community Structure. The number of individuals per sample (density) was log-normal. The number of species was neither normal nor log-normal. Diversity ranged from 0 to 97 percent at the reference areas, indicating that this parameter is so inherently variable at JPG that it probably cannot be used to identify contaminant-related effects. The number of individuals was not significantly different by location when the log transformed data were analyzed by ANOVA. The number of invertebrate species was not statistically significantly different at the 95 percent confidence level when analyzed by the Kruskal-Wallis test. There does not appear to be any effect of site location on soil invertebrates., although community similarity will be examined in a later version of this report.

8.7.4 Risk Characterization

8.7.4.1 Risk Estimation. The HIs are summarized for each sampling event and receptor below. The HIs have been grouped by order of magnitude for discussion purposes. HIs based on RME and CT exposure parameters are presented. In addition, a conservative NOAEL-based TRV and a dose at which population-level effects may occur (LOAEL-based TRV) were used to establish the lower and upper bounds on toxicity, respectively. These values define the risk boundaries. There are thus four sets of HI values for each location and sampling event (NOAEL-RME, NOAEL-CT, LOAEL-RME, and LOAEL-CT). The HQs are presented in Appendix AA. Figures 8.7-2 through 8.7-25 show the total NOAEL- and LOAEL-based HI risks for both the RME and CT exposure scenarios by receptor. The reference area RME-NOAEL HIs were presented graphically only on the RME-NOAEL site graphs due to the low risks generally observed. The reference area His were overlayed on those figures where an HI was greater than 1 for one or more receptors. Figures 8.7-26 through 8.7-35 provide total RME NOAEL HI risks for all Phase III ecological study sites for each key receptor based on the Fall 1997 ecological sampling.

<u>**Site 3**</u>

Phase I RME NOAEL HIs
(See Figure 8.7-2)
<u>Key Receptors with HI range 0-1</u>: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Red Fox
<u>HI Range 1.1-10</u>: Little Brown Myotis
<u>HI Range 10.1-100</u>: White-footed Mouse, Eastern Cottontail
<u>HI Range 100.1-1000:</u> Plants, Soil Fauna

Phase I RME LOAEL HIs
(See Figure 8.7-3)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Red Fox, Little Brown Myotis
HI Range 1.1-10: Eastern Cottontail, Soil Fauna
HI Range 10.1-100: White-footed Mouse, Plants
HI Range 100.1-1000: None

Phase I CT NOAEL HIs
(See Figure 8.7-4)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Red Fox
HI Range 1.1-10: Little Brown Myotis
HI Range 10.1-100: White-footed Mouse, Eastern Cottontail
HI Range 100.1-1000: None

Phase I CT LOAEL HIs
(See Figure 8.7-5)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Red Fox, Little Brown Myotis
HI Range 1.1-10: White-footed Mouse, Eastern Cottontail
HI Range 10.1-100: None
HI Range 100.1-1000: None

Site 4

Phase I RME NOAEL HIs
(See Figure 8.7-6)
Key Receptors with HI range 0-1: Wild Turkey
HI Range 1.1-10: Mourning Dove, American Kestrel, Red Fox
HI Range 10.1-100: Chimney Swift, Little Brown Myotis
HI Range 100.1-1000: White-footed Mouse, Eastern Cottontail, Plants, Soil Fauna

Phase I RME LOAEL HIs
(See Figure 8.7-7)
Key Receptors with HI range 0-1: Mourning Dove, Wild Turkey, American Kestrel, Red Fox
HI Range 1.1-10: Chimney Swift, Little Brown Myotis
HI Range 10.1-100: White-footed Mouse, Eastern Cottontail, Plants, Soil Fauna
HI Range 100.1-1000: None

Phase I CT NOAEL HIs
(See Figure 8.7-8)
Key Receptors with HI range 0-1: Wild Turkey, Red Fox
HI Range 1.1-10: Mourning Dove, Chimney Swift, American Kestrel
HI Range 10.1-100: Eastern Cottontail, Little Brown Myotis

HI Range 100.1-1000: White-footed Mouse

Phase I CT LOAEL HIs
(See Figure 8.7-9)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Red Fox
HI Range 1.1-10: Little Brown Myotis
HI Range 10.1-100: White-footed Mouse, Eastern Cottontail
HI Range 100.1-1000: None

Site 3

Phase II RME NOAEL HIs
(See Figure 8.7-10)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Red Fox
HI Range 1.1-10: Little Brown Myotis
HI Range 10.1-100: Eastern Cottontail
HI Range 100.1-1000: White-footed Mouse, Plants, Soil Fauna

Phase II RME LOAEL HIs
(See Figure 8.7-11)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Red Fox, Little Brown Myotis
HI Range 1.1-10: Eastern Cottontail, Soil Fauna
HI Range 10.1-100: White-footed Mouse, Plants
HI Range 100.1-1000: None

Phase II CT NOAEL HIs
(See Figure 8.7-12)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Red Fox
HI Range 1.1-10: Little Brown Myotis
HI Range 10.1-100: White-footed Mouse, Eastern Cottontail
HI Range 100.1-1000: None

Phase II CT LOAEL HIs
(See Figure 8.7-13)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Red Fox, Little Brown Myotis
HI Range 1.1-10: Eastern Cottontail
HI Range 10.1-100: White-footed Mouse
HI Range 100.1-1000: None

Site 3/4

Phase III RME NOAEL HIs
(See Figure 8.7-14)
Key Receptors with HI range 0-1: Mourning Dove, Wild Turkey
HI Range 1.1-10: Chimney Swift, American Kestrel, Red Fox
HI Range 10.1-100: Eastern Cottontail, Little Brown Myotis, Soil Fauna
HI Range 100.1-1000: White-footed Mouse, Plants

Phase III RME LOAEL HIs
(See Figure 8.7-15)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Red Fox
HI Range 1.1-10: Soil Fauna, Little Brown Myotis
HI Range 10.1-100: White-footed Mouse, Eastern Cottontail, Plants
HI Range 100.1-1000: None

Phase III CT NOAEL HIs
(See Figure 8.7-16)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Red Fox
HI Range 1.1-10: Little Brown Myotis
HI Range 10.1-100: White-footed Mouse, Eastern Cottontail
HI Range 100.1-1000: None

Phase III CT LOAEL HIs
(See Figure 8.7-17)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Red Fox
HI Range 1.1-10: Eastern Cottontail, Little Brown Myotis
HI Range 10.1-100: White-footed Mouse
HI Range 100.1-1000: None

New Burn Site (Inside Trench Area)

Phase III RME NOAEL HIs
(See Figure 8.7-18)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Red Fox, Little Brown Myotis
HI Range 1.1-10: Eastern Cottontail
HI Range 10.1-100: Soil Fauna
HI Range 100.1-1000: White-footed Mouse, Plants

Phase III RME LOAEL HIs
(See Figure 8.7-19)

Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Eastern Cottontail, Red Fox, Little Brown Myotis
HI Range 1.1-10: Soil Fauna, Plants
HI Range 10.1-100: None
HI Range 100.1-1000: White-footed Mouse

Phase III CT NOAEL HIs
(See Figure 8.7-20)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Eastern Cottontail, Red Fox, Little Brown Myotis
HI Range 1.1-10: None
HI Range 10.1-100: White-footed Mouse
HI Range 100.1-1000: None

Phase III CT LOAEL HIs
(See Figure 8.7-21)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Eastern Cottontail, Red Fox, Little Brown Myotis
HI Range 1.1-10: None
HI Range 10.1-100: White-footed Mouse
HI Range 100.1-1000: None

New Burn Site (Outside Trench Area)

Phase III RME NOAEL HIs
(See Figure 8.7-22)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Red Fox, Little Brown Myotis
HI Range 1.1-10: Eastern Cottontail
HI Range 10.1-100: Soil Fauna
HI Range 100.1-1000: White-footed Mouse, Plants

Phase III RME LOAEL HIs
(See Figure 8.7-23)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Red Fox, Little Brown Myotis
HI Range 1.1-10: Eastern Cottontail, Soil Fauna
HI Range 10.1-100: White-footed Mouse, Plants
HI Range 100.1-1000: None

Phase III CT NOAEL HIs
(See Figure 8.7-24)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Red Fox, Little Brown Myotis
HI Range 1.1-10: Eastern Cottontail

HI Range 10.1-100: White-footed Mouse
HI Range 100.1-1000: None

Phase III CT LOAEL HIs
(See Figure 8.7-25)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Eastern Cottontail, Red Fox, Little Brown Myotis
HI Range 1.1-10: None
HI Range 10.1-100: White-footed Mouse
HI Range 100.1-1000: None

8.7.4.2 Risk Description. Few analytes were statistically elevated at Site 3/4 relative to the reference areas with the exception of aluminum, barium, cobalt, manganese, nickel, and zinc. All other COPCs within Site 3/4 appeared to be within the ambient concentrations predicted by the data from the reference areas.

The soils at Site 3/4 did not produce elevated levels of mortality in earthworms, nor was the soil fauna diversity obviously affected. Plant germination and biomass were not significantly different at Site 3/4 than at the reference areas; however, at one location (Grid 2), plant germination was much lower than at the other grids or at the reference areas. The only anomalous COPC at this location was barium; the highest concentration of barium detected in the Phase III sampling event (320 mg/kg) was detected at Grid 2.

At Site 3 for the Phase I data, HIs are highest for the white-footed mouse, eastern cottontail, plants, and soil fauna. The HIs for plants and soil fauna exceeded NOAEL HIs for all three reference locations (Figure 8.7-2). The total HIs for each reference area and the inherent JPG Phase II background risks can be found in Section 32.

Risks based on Phase I data at Site 4 (Figure 8.7-6) were higher than those at Site 3 for all terrestrial receptors. Risk estimates for the white-footed mouse, eastern cottontail, plants, and soil fauna exceeded those at the reference areas.

At Site 3 for the Phase II data, HIs are highest for the white-footed mouse, eastern cottontail, plants, and soil fauna. Total RME-NOAEL-based risks to the little brown myotis approached 5. The HIs for plants and soil fauna exceeded NOAEL HIs for all three reference locations (Figure 8.7-10).

At ecological study Site 3/4 for the Phase III data, HIs are highest for the white-footed mouse, eastern cottontail, plants, and soil fauna. Total RME-NOAEL-based risks to the little brown myotis approached 15, while low risks (less than 2) were observed for the chimney swift, American kestrel, and red fox. The HIs for plants and soil fauna exceeded NOAEL HIs for all three reference locations (Figure 8.7-14).

HIs at the New Burn Site were elevated for the white-footed mouse, eastern cottontail, plants, and soil fauna both inside and outside of the trench area (Figures 8.7-18 and 8.7-22). With the

exceptions of plants and soil fauna, white-footed mouse (New Burn **Site** - Inside Trench **Area** and Site 4), and eastern cottontail (Site 4), risks at Site 3/4 are less than or equal to the RME-NOAEL HIs for the reference areas (Figures 8.7-26 through 8.7-35), indicating that relative risk at Site 3/4 based on the Phase III data is not significantly elevated. The results also suggest that the TRVs are overly conservative for this site, since ambient levels of inorganics in the reference areas produce high risk estimates.

Given that few analytes statistically exceed those at reference areas, that HIs are not significantly higher than HIs at the reference areas, and that the biometric data, in general, did not detect adverse effects in plants and soil fauna in direct contact with soils from Site 3/4, it appears that contamination at Site 3/4 is not a likely threat to ecological health at JPG. One exception to this evaluation of risk is the barium concentrations observed at Grid 2.

8.7.4.2.1 Risk Drivers/Summary of Lines of Evidence. Risk drivers associated with Sites 3 and 4, and the New Burn Site are summarized in Tables 8.7-13 through 8.7-24. A COPC was categorized as a risk driver if it produced an HQ greater than or equal to 1 for any exposure pathway. With the exception of 2,3,7,8-tetrachlorodibenzofuran (2378TCDF) at the New Burn Site, Inside ~~Trench~~ **Burn Area** (Table 8.7-21), all risk drivers were inorganic COPCs.

In addition, to provide an overall summary of the multiple lines of evidence that were evaluated for the Site, a summary table was developed. The lines of evidence were primarily hazard quotient (HQ) calculations for a number of different receptors, but for the terrestrial ecosystem, toxicity testing was also conducted for Sites 3 and 4. Refer to Table 7.7-11a for a summary of the lines of evidence. A number of measurement endpoints were assessed for the terrestrial ecosystem. An evaluation was made of which measurement endpoints were most sensitive in determining the potential for an ecological concern by ecosystem. (EPA180a,b)

Terrestrial Ecosystem

The most sensitive of the terrestrial measurement endpoints for all three sites are plants and white-footed mice. The highest reasonable maximum exposure (RME) no observed adverse effect level (NOAEL)-based hazard indices (HIs) for each of these receptors are as described below.

For Site 3, the HIs are: 375 (plants) and 159 (white-footed mice). The primary contributor of risk to plants is aluminum (RME NOAEL HQ of 349) from direct contact with soil. This HQ was derived using Phase I data. The primary contributors of risk to white-footed mice are selenium (RME NOAEL HQ of 81) and arsenic (RME NOAEL HQ of 26) from dietary ingestion. These HQs were derived using Phase III data.

For Site 4, the HIs are: 621 (white-footed mice) and 574 (plants). The primary contributors of risk to white-footed mice are selenium (RME NOAEL HQ of 187) and barium (RME NOAEL HQ of 100) from dietary ingestion. Note that these HQs are based on soil sample data from a combined Site 3/4 data set. The primary contributor

of risk to plants is aluminum (RME NOAEL HQ of 504) from direct contact with soil. These HQs were derived using Phase I data.

For the New Burn Site-Outside Trench, the HIs are: 309 (plants) and 136 (white-footed mice). The primary contributor of risk to plants is aluminum (RME NOAEL HQ of 278) from direct contact with soil. The primary contributors of risk to white-footed mice are vanadium (RME NOAEL HQ of 60) through direct contact with soil and arsenic (RME NOAEL HQ of 34) from dietary ingestion. These HIs were derived using Phase III data.

For the New Burn Site-Inside Trench, the HIs are: 580 (white-footed mice) and 228 (plants). The primary contributor of risk to white-footed mice is antimony (RME NOAEL HQ of 438) through dietary ingestion. The primary contributor of risk to plants also is antimony (RME NOAEL HQ of 182) from direct contact with soil. These HQs were derived using Phase III data.

Of the metals listed as primary contributors to ecological risk, only aluminum and barium are present at concentrations that exceed reference area concentrations. Thus, antimony, arsenic, selenium, and vanadium would not be expected to contribute to ecological risk exceeding that in the reference areas. (EPA180a,b) Based on Figure 8-9, the highest aluminum concentrations at Sites 3/4 are primarily located along the southern and eastern borders of Grid 28 and on the central border of Grids 29 and 30. Based on Figure 8-9, the highest barium concentrations at Sites 3/4 are primarily located in the northeast corners of Grids 24, 28, and 29. Based on Figure 8-9a, the highest barium concentrations at the New Burn Site are adjacent to and north of the Old Gravel Road at SF6 and SF7.

Although the HIs for white-footed mice and plants exceeded 1 for Site 3 and the New Burn Site, they are similar to HIs calculated for reference areas. The HIs for white-footed mice and plants at Site 4 are above the HIs calculated for reference areas, but they are within an order of magnitude of the reference area HIs. Based on conservative assumptions, barium may be toxic to plants at 320 mg/kg at one sample location. The next highest value (181 mg/kg) at Site 3/4 was not associated with phytotoxicity since germination was at the same levels as observed at reference areas. (EPA180a,b)

8.7.4.3 Uncertainty Analysis. The collection of Phase I, II, and III data at Site 3 helps to reduce the uncertainty associated with the risk assessment results for this location. Although only Phase I and III data were collected at Site 4, the number of samples collected in the general area of Site 3/4 should provide adequate coverage and reduce overall uncertainty.

Uncertainty in the exposure estimates is due primarily to:

- Variability in the exposure parameters, which produce a natural distribution of the variables in the intake equations for each of the receptors;

- Exposure parameters, which are derived from the literature and were not measured on site;
- Uncertainty in the dietary ingestion pathway, which utilized BAFs to predict dietary concentrations;
- Variation in the concentrations of COPCs in the environment;
- Uncertainty as to whether the most conservative pathways have been addressed and evaluated.

The predicted effect of each of these sources of uncertainty on the risk assessment is as follows:

Variability in the exposure parameters— Because both the average and RME scenarios were quantitatively addressed, this source of uncertainty is expected to have no overall effect on the risk assessment results.

Exposure parameters derived from literature—Because so many ecological receptors were quantitatively considered in the ecological risk assessment, this source of uncertainty is expected to have no overall effect on the risk assessment.

Uncertainty in the dietary ingestion pathway—The use of literature-based BAFs or BCFs is expected to overestimate as opposed to underestimate concentrations in the dietary pathway. This is because under laboratory conditions, animals are chronically exposed on a daily basis and supposedly reach steady state. In the wild, as animals move in and out of contaminated areas, metabolism and excretion are expected to reduce the body burden. Use of field-based BAFs from TEAD is not expected to overestimate or underestimate risk for these analytes, since these data were measured in conjunction with co-located soil samples.

Variation in the concentrations of COPCs in the environment—This uncertainty is not expected to bias the risk assessment towards underestimation of risk since maximum or UCL95 concentrations were used in all exposure scenarios to estimate the EPCs.

Uncertainty as to whether the most conservative pathways have been addressed—The receptors were considered carefully by the DSG, and typically have high exposure rates due to their life-histories (i.e., ground-feeding or burrowing). Therefore, this source of uncertainty is not expected to impact the risk assessment.

Uncertainty in the ecological analysis is less than the uncertainty in the exposure estimates, because these data were gathered as part of a site-specific, controlled field study. There were sufficient samples collected at each site (n=5) to identify within and between site variability. The data identify the potential for adverse effects to species that form the basis of the JPG food web, that is, the plants and soil fauna.

The effects data indicate a potential for phytotoxicity at Grid 2. There are two analytes that are different at this grid. This grid had the highest barium concentration observed in the Phase III Eco data (320 mg/kg) and the highest TOC. This suggests that barium concentrations at this level can produce phytotoxicity, and that site-specific PRGs should be below this value.

8.7.5 Ecological Risk Assessment Summary

The conceptual site models(CSMs) for Sites 3 and 4 and the New Burn Site provide an overview of the ecological receptors and exposure pathways evaluated in the ecological risk assessment. Refer to Figures 8.7-1a, 8.7-1b, and 8.7-1c for schematic of the CSMs. Sites 3 and 4 and the New Burn Site will likely be used for agricultural purposes in the future. This future land use will alter the current CSMs.

Multiple lines of evidence were evaluated for the ecological assessment conducted at these sites. For all three sites, terrestrial lines of evidence were evaluated. The lines of evidence were primarily hazard quotient (HQ) calculations for a number of different receptors, but for the terrestrial ecosystem, toxicity testing was also conducted for Sites 3 and 4. Refer to Table 7.7-11a for a summary of the terrestrial ecosystem lines of evidence. (EPA180a,b)

The following summary is **an overall summary of the key results of the ecological risk assessment for Sites 3 and 4 and the New Burn Site**.based on an initial review of the data. A full evaluation of whether or not the data meet all DQOs, and further statistical examination, will be made prior to finalizing these results for the next version of this report.

- Based on the ecological effects data, there are few **adverse** ecological effects at this site.

- Based on the analytical data, there are few COPCs statistically elevated above those at the reference areas. Aluminum, barium, cobalt, manganese, nickel, and zinc are the only analytes that are statistically elevated at Site 3/4 relative to the reference areas.

- Barium may be toxic to plants at 320 mg/kg based on results of the plant toxicity test. The next highest value (181 mg/kg) at Site 3/4 was not associated with phytotoxicity since germination was at the same levels as observed at reference areas. However, the germination results may have nothing to do with soil barium concentrations at this location. It is possible that the germination results are due to chance alone based on ANOVA. It is conservative, however, to assume that phytotoxicity is occurring at this one grid. There is no suggestion of population level effects, since spatially there is only one potentially affected grid among the five tested.

- HIs are within the same order of magnitude or lower than those observed at the reference areas. The two receptors with HIs exceeding reference area HIs the greatest were plants and white-footed mouse.

8.8 CONCLUSIONS AND RECOMMENDATIONS

Three distinct areas of contamination were characterized for the Explosive Burn Area (Site 3) and Abandoned Landfill (Site 4). The ~~first area~~ **Site 3**, the **E**xplosive **B**urn **A**rea, consists of surface soil contamination that contains a variety of metals that exceed background concentrations. In addition to exceeding background, aluminum, manganese, and thallium also were present in concentrations exceeding USEPA Region 9 PRGs.

The ~~second area~~ **Site 4**, the **A**bandoned **L**andfill, consists of a buried trench that contains soils contaminated with metals, SVOCs, and one VOC (trichloroethene). Aluminum, arsenic, barium, beryllium, cadmium, chromium, copper, and lead were found to exceed USEPA Region 9 PRGs and were retained as COPCs in soils. Groundwater collected downgradient of the landfill **in the bedrock aquifer** contained elevated metals, **and infrequent detections of** low concentrations of VOCs and SVOCs, and one explosive compound, 4-amino-2,6-dinitrotoluene (4A26DT). ~~Aluminum, arsenic, barium, beryllium, cadmium, chromium, copper, and lead were found to exceed USEPA Region 9 PRGs and were retained as COPCs in soils.~~

The third area consists of a narrow ~~trench~~ **burn area** that appears to have been a burn site located adjacent to Sites 3/4. Surface and subsurface soil samples from the ~~trench~~ **burn** area indicate that a variety of contaminants are present, including metals, SVOCs, pesticides, and dioxins/furans. Of these contaminants, lead was found to be at levels exceeding the USEPA cleanup goal of 400 µg/g. In addition, barium, chromium, manganese, and zinc also were found to exceed USEPA Region 9 PRGs. Dioxins/furans, several PAH-related SVOCs, and the pesticide DDE exceeded their respective PRGs and were retained as COPCs.

Groundwater downgradient of Sites 3 and 4 was found to contain several metals exceeding their respective background concentrations and minor ~~solvent-related~~ **organic** contamination ~~(i.e., 1,2-dichloroethylene, 1,2-dimethylbenzene, and toluene), and one explosive compound (4-amino-2,6-dinitrotoluene)~~. Of these contaminants, aluminum, antimony, arsenic, cobalt, iron, lead, manganese, molybdenum, and 4-amino-2,6-dinitrotoluene were retained as COPCs for groundwater. **Groundwater in well MW01-03, screened at the till/bedrock interface adjacent to bedrock well MW93-23, contained several VOCs, including trichloroethene and 1,1-dichloroethene that exceeded their PRGs. Well MW93-23, which is nested with MW01-03, contained no PRG exceedances for metals or detections of VOCs.**

The results of the human health risk assessment for the Site 4 trench area show that chronic health hazard estimates exceed the USEPA HI goal of 1.0 for future on-site residents due primarily to ingestion of metals in soil (child resident), metals in homegrown produce (child resident), ingestion of metals in groundwater (adult and child), and inhalation of VOC and fugitive dust (adult and child). Carcinogenic risks for the future on-site resident at the Site 4 trench are within the USEPA target range of 1E-04 to 1E-06 with the exception of the adult resident using results for surface and subsurface soil combined. The total adult risk was

estimated at 1.26E-04 due to the ingestion of arsenic in soil, homegrown produce, and groundwater.

For the remainder of the site (including the Site 3 **explosives** burn area), the future on-site resident chronic health hazard estimates exceed USEPA risk management criteria. For the adult resident, the hazards are due primarily to ingestion of iron in groundwater and inhalation of VOCs and manganese in fugitive dusts. For the child resident, the hazards are due primarily to ingestion of manganese in homegrown produce; ingestion of aluminum, arsenic, iron, and manganese in groundwater; and inhalation of aluminum and manganese in fugitive dust. For carcinogenic risks, the estimates for the adult and child resident are within the USEPA target range of 1E-04 to 1E-06.

For the new burn site adjacent to Sites 3/4, carcinogenic risks for both the adult and child resident exceed the USEPA target range. For the adult carcinogenic risks, the primary exposure pathways are ingestion of benzo(a)pyrene in soil and ingestion of dioxins, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene and dibenzo(a,h)anthracene in homegrown produce. For the child resident carcinogenic risks, the primary exposure pathways are ingestion of benzo(a)pyrene in soil, benzo(a)pyrene in homegrown produce, and arsenic in groundwater. Both the adult and child chronic health hazard estimates exceed the USEPA HI goal of 1.0 due primarily to ingestion of zinc in homegrown produce; ingestion of aluminum, arsenic, iron, and manganese in groundwater; and inhalation of aluminum and manganese in fugitive dust.

The results of the ecological risk assessment indicate that the soils of Site 3/4 did not produce levels of mortality in earthworms and the soil fauna diversity was not affected by soil contaminants. The highest estimated HIs were for the white-footed mouse, eastern cottontail, plants, and soil fauna. Lower risks were observed for the chimney swift and little brown myotis. However, with the exceptions of plants and soil fauna, estimated risks for Site 3/4 fall within the same order of magnitude as those of the reference areas for all receptors. This indicates that relative risk to ecological receptors is not significantly elevated. It appears that contamination at Sites 3/4 is not likely to cause a threat to the ecological health of JPG. One exception to this evaluation is one grid location containing elevated barium that could produce higher risks to ecological receptors than other locations throughout Site 3/4.

Since all three areas have human health risks and hazards exceeding USEPA risk management criteria, it is recommended that Site 3/4 be carried forward to the FS process. Due to the large amount of data collected during the Phase I and Phase II investigations, it appears that no further investigation of these sites is warranted under the RI.

The extent of contamination at the New Burn Site was not determined during the Phase II RI. It is recommended that additional soil borings be installed within the trench area during the remedial design phase for remedial action at Site 3/4~~. These borings are needed~~ to evaluate the total depth of contamination. ~~and to determine if a potential for groundwater contamination exists. Depending on the results of the additional subsurface soil sampling, installation of an additional downgradient groundwater monitoring wells may be warranted.~~ ~~[ ]~~

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TABLES

TABLE 8-1a

Groundwater Monitoring Well Information Summary
Sites 3 - Explosives Burn Area and 4 - Abandoned Landfill Area
Jefferson Proving Ground
South of the Firing Line
Madison, Indiana

Site	Well ID	Date Installed	Location (ft) Northing	Location (ft) Easting	Elevation (ft) TOC	Elevation (ft) Ground	Well Depth (ft)	Depth to Top of Rock (ft)	Well Diameter (In)	Screen Length (ft)	Screen Interval (ft)	Screened Unit	Gradient Relation
Site 3 and 4	MW93-20	04/30/93	479631.66	569730.60	864.78	862.77	51.0	13.0	4.0	10.3	40.7-51	Laurel Dm.	Up/Side
	MW93-21	05/01/93	479913.37	569600.15	859.21	857.07	47.0	9.0	4.0	10.3	36.7-47	Laurel Dm.	Down/Side
	MW93-22	05/01/93	479916.57	569821.18	856.29	853.94	43.0	7.5	4.0	10.3	32.7-43.0	Laurel Dm.	Down/Side
	MW93-23	05/02/93	480023.91	569823.80	851.57	849.36	39.0	6.0	4.0	10.5	28.5-39	Laurel Dm.	Down
	MW95-06	11/06/95	479852.49	569538.48	861.83	NR	23.0	11.0	4.0	10.3	12.7-23.0	Laurel Dm.	Down
	MW01-01	05/23/01	479820.07	569354.91	863.34	860.93	42.0	10.0	2.0	5.0	37-42	Laurel Dm.	Down
	MW01-02	05/23/01	479744.94	569396.38	863.09	860.34	42.0	10.5	2.0	5.0	37-42	Laurel Dm.	Down
	MW01-03	05/22/01	480014.53	569819.14	852.66	849.51	11.0	6.5	2.0	5.0	6-11	Till/Bedrock	Down
	MW01-04	05/24/01	480026.38	569729.98	854.14	851.24	10.5	7.5	2.0	5.0	5.5-10.5	Till/Bedrock	Down

Notes:
1. Information summarized in this table was taken from the Draft Phase II Remedial Investigation (RI) by Rust Environmental and Infrastructure dated August 1998.
2. Horizontal coordinates relative to Indiana State Coordinates - East Zone, 1927. Vertical coordinate tied to JPG monuments relative to NAD1929.
3. NR = Information not reported in the Draft Phase II RI.
4. Well location and elevation data for sites 12A and 12B are from a December 2001 survey performed by Classickle Inc.

TABLE 8-1b

Summary of Monitoring Well Survey Data and Groundwater Elevations
Sites 3 - Explosives Burn Area and 4 - Abandoned Landfill Area
Jefferson Proving Ground
Madison, Indiana

	MW93-20	MW93-21	MW93-22	MW93-23	MW95-06	MW01-01	MW01-02	MW01-03	MW01-04
Elevations									
Top of Casing	864.78	859.21	856.29	851.57	861.83	863.34	863.09	852.66	854.14
Land Surface	862.77	857.07	853.94	849.36	NR	860.93	860.34	849.51	851.24
Top of Screen	822.1	820.4	821.2	820.9	NA	823.9	823.3	843.5	845.7
Well Bottom	811.8	810.1	810.9	810.4	NA	818.9	818.3	838.5	840.7
Top of Rock	849.8	848.1	846.4	843.4	NA	850.9	849.8	843.0	843.7
Well Depth	51.0	47.0	43.0	39.0	23.0	42.0	42.0	11.0	10.5
Screen Length	10.3	10.3	10.3	10.5	10.3	5.0	5.0	5.0	5.0
Top of Rock (ft)	13.0	9.0	7.5	6.0	11.0	10.0	10.5	6.5	7.5

Date — **Depth to Groundwater Below Top of Casing, In Feet**

Date	MW93-20	MW93-21	MW93-22	MW93-23	MW95-06	MW01-01	MW01-02	MW01-03	MW01-04
11/19/95	18.81	13.58	9.93	5.18	16.39				
02/11/96	17.45	11.88	8.28	3.64	14.67				
06/19/96	18.26	12.99	9.38	4.58	15.8				
11/25/96	16.98	11.99	8.31	3.57	14.81				
06/05/01	19.20	13.83	10.26	5.50	16.63	18.62	18.24	8.84	(dry)
11/30/01	16.30	11.02	7.47	2.79	13.81	15.82	15.46	3.39	4.38
01/25/02	16.32	11.22	7.60	2.91	14.00	15.94	15.60	4.11	9.59

Date — **Groundwater Elevation, in Feet above MSL**

Date	MW93-20	MW93-21	MW93-22	MW93-23	MW95-06	MW01-01	MW01-02	MW01-03	MW01-04
11/19/95	845.97	845.63	846.36	846.39	845.44				
02/11/96	847.33	847.33	848.01	847.93	847.16				
06/19/96	846.52	846.22	846.91	846.99	846.03				
11/25/96	847.80	847.22	847.98	848.00	847.02				
06/05/01	845.58	845.38	846.03	846.07	845.20	844.72	844.85	843.82	NA
11/30/01	848.48	848.19	848.82	848.78	848.02	847.52	847.63	849.27	849.76
01/25/02	848.46	847.99	848.69	848.66	847.83	847.40	847.49	848.55	844.55

Notes:
1. All elevations recorded in Mean Sea Level (MSL) datum.
2. All depth measurements in feet.
3. NA = Data not available. Measurements were not collected on this day.
4. NR = Information not reported in the Draft Phase II RI.

TABLE 8-1c

Vertical Hydraulic Gradients at Well Nests
Site 3 - Explosives Burn Area and 4 - Abandoned Landfill
Jefferson Proving Ground
Madison, Indiana

Site	Well Nest (Shallow)	(Deep)	Gradient 05-Jun-01	Gradient 30-Nov-01	Gradient 25-Jan-02
3/4	MW01-03	MW93-23	0.089	-0.019	0.004

Notes:
1. A negative sign (-) indicates a downward gradient.
2. NA = Water level data not available for this date.

TABLE 8-2a

Background Screening of Inorganic Chemicals Detected in Soil
Site 3 - Explosive Burn Area and Site 4 - Abandoned Landfill
Jefferson Proving Ground
Madison, Indiana

Chemical	Location	Frequency of Detection[a]	Maximum Detected Value (µg/g)	Avg. Conc. (µg/g)	Median Conc. (µg/g)	Background Threshold (µg/g)	Data Distribution	Test Performed	p value	Site > Bkgd?
Surface Soil										
Aluminum	Trench	5/5	25,200	15,862	16,100		Normal	t test	0.03	**YES**
	Remainder of Site	35/35	23,400	11,766	10,830		Normal	t test	0.02	**YES**
	Background	**5/5**	**9,760**	**7,704**	**7,670**	**10,900**	**Normal**			
Antimony	Trench	1/1[b]	1.29	NA	NA		Neither	Extreme value	NA	**YES**
	Remainder of Site	9/19	1.73	0.66	0.50		Neither	NA[c]	NA	No
	Background	**4/5**	**0.64**	**0.52**	**0.54**	**0.76**	**Normal**			
Arsenic	Trench	5/5	11.5	8.3	7.8		Normal	Mann-Whitney	0.06	No
	Remainder of Site	32/35	14.5	6.1	6.2		Normal	Mann-Whitney	0.22	No
	Background	**5/5**	**6.82**	**5.1**	**5.1**	**7.34**	**Lognormal**			
Barium	Trench	5/5	5,900	1,450	577		Lognormal	t test	0.048	**YES**
	Remainder of Site	35/35	3,200	385	157		Neither	Mann-Whitney	<0.001	**YES**
	Background	**5/5**	**62.2**	**53.4**	**50.5**	**66.0**	**Lognormal**			
Beryllium	Trench	2/5	0.722	0.58	0.70		Neither	Mann-Whitney	0.3	No
	Remainder of Site	25/35	1.48	0.64	0.61		Neither	Mann-Whitney	0.08	No
	Background	**5/5**	**0.38**	**0.35**	**0.36**	**0.43**	**Neither**			
Boron	Trench	0/5	NA	NA	NA		NA	NA	NA	NA
	Remainder of Site	3/35	113	9.7	6.8		Neither	NA	NA	**YES**
	Background	**0/5**	NA	**NA**	**NA**	**NA**	**NA**			

TABLE 8-2a

Background Screening of Inorganic Chemicals Detected in Soil
Site 3 - Explosive Burn Area and Site 4- Abandoned Landfill
Jefferson Proving Ground
Madison, Indiana

Chemical	Location	Frequency of Detection[a]	Maximum Detected Value (µg/g)	Avg. Conc. (µg/g)	Median Conc. (µg/g)	Background Threshold (µg/g)	Data Distribution	Test Performed	p value	Site > Bkgd?
Surface Soil (cont'd.)										
Cadmium	Trench	2/5	12.4	3.9	3.0		Lognormal	t test	0.004	**YES**
	Remainder of Site	5/35	2.2	0.67	0.6		Neither	Mann-Whitney	0.007	**YES**
	Background	**3/5**	**0.53**	**0.34**	**0.25**	**0.67**	**Lognormal**			
Chromium (total)	Trench	5/5	54.5	30.9	27.5		Lognormal	t test	0.002	**YES**
	Remainder of Site	35/35	121	20.1	16.5		Lognormal	t test	0.17	No
	Background	**5/5**	**14.2**	**12.2**	**11.2**	**15.7**	**Lognormal**			
Cobalt	Trench	4/5	18	11.7	10.8		Lognormal	Mann-Whitney	0.005	**YES**
	Remainder of Site	31/35	36.3	9.85	9.25		Neither	Mann-Whitney	0.006	**YES**
	Background	**5/5**	**3.2**	**2.7**	**2.8**	**3.8**	**Normal**			
Copper	Trench	4/5	408	122	62.5		Lognormal	Mann-Whitney	0.06	No
	Remainder of Site	29/35	462	39.7	15.1		Neither	Mann-Whitney	0.001	**YES**
	Background	**3/5**	**6.5**	**4.3**	**4.8**	**7.7**	**Normal**			
Lead	Trench	5/5	800	230	114		Lognormal	t test	0.04	**YES**
	Remainder of Site	35/35	1,300	81.5	28		Neither	Mann-Whitney	0.005	**YES**
	Background	**5/5**	**20.5**	**16.5**	**15.9**	**21.5**	**Lognormal**			
Manganese	Trench	5/5	733	448	523		Normal	Mann-Whitney	0.09	No
	Remainder of Site	35/35	9,800	1,279	830		Neither	Mann-Whitney	<0.001	**YES**
	Background	**5/5**	**234**	**186**	**199**	**316**	**Neither**			
Mercury	Trench	4/5	0.136	0.08	0.072		Normal	NA	NA	**YES**
	Remainder of Site	12/35	0.18	0.05	0.05		Neither	NA	NA	**YES**
	Background	**0/5**	**NA**	**NA**	**NA**	**NA**	**NA**			

TABLE 8-2a

Background Screening of Inorganic Chemicals Detected in Soil
Site 3 - Explosive Burn Area and Site 4- Abandoned Landfill
Jefferson Proving Ground
Madison, Indiana

Chemical	Location	Frequency of Detection[a]	Maximum Detected Value (µg/g)	Avg. Conc. (µg/g)	Median Conc. (µg/g)	Background Threshold (µg/g)	Data Distribution	Test Performed	p value	Site > Bkgd?
Surface Soil (cont'd.)										
Molybdenum	Trench	1/5	2.0	NA	NA		Lognormal	Extreme value	NA[c]	No
	Remainder of Site	10/35	3.95	NA	NA		Neither	Extreme value	NA	**YES**
	Background	2/2[d]	**2.2**	**1.8**	**1.8**	**3.0**	NA			
Nickel	Trench	4/5	12.8	10.2	10.0		Normal	Mann-Whitney	0.005	**YES**
	Remainder of Site	35/35	36.7	11.5	11.2		Neither	Mann-Whitney	<0.001	**YES**
	Background	**2/5**	**5.6**	**3.4**	**2.8**	**6.54**	**Lognormal**			
Selenium	Trench	½	0.65	0.45	0.45		NA	Extreme value	NA	No
	Remainder of Site	9/19	1.1	0.50	0.25		Neither	NA[c]	NA	No
	Background	**4/5**	**0.73**	**0.51**	**0.54**	**0.85**	**Normal**			
Silver	Trench	5/5	6.0	2.5	1.7		Lognormal	NA	NA	**YES**
	Remainder of Site	29/35	5.23	0.74	0.50		Neither	NA	NA	**YES**
	Background	**0/5**	**NA**	**NA**	**NA**	**NA**	**NA**			
Thallium	Trench	0/5	NA	NA	NA		NA	NA	NA	NA
	Remainder of Site	1/35	0.69	NA	NA		NA	Extreme value		**YES**
	Background	**1/1**[e]	**0.43**	**NA**	**NA**	**0.43**	**NA**			
Tin	Trench	3/5	15.8	12.2	14.2		Lognormal	NA	NA	**YES**
	Remainder of Site	7/35	32.5	6.7	5.0		Neither	NA	NA	**YES**
	Background	**0/5**	**NA**	**NA**	**NA**	**NA**	**NA**	NA	NA	
Vanadium	Trench	4/5	40.4	27.6	30.6		Normal	Mann-Whitney	0.06	No
	Remainder of Site	34/35	55.8	25.6	25.8		Normal	Mann-Whitney	0.17	No
	Background	**5/5**	**25.9**	**22.6**	**23.0**	**27.2**	**Lognormal**			

TABLE 8-2a

Background Screening of Inorganic Chemicals Detected in Soil
Site 3 - Explosive Burn Area and Site 4- Abandoned Landfill
Jefferson Proving Ground
Madison, Indiana

Chemical	Location	Frequency of Detection[a]	Maximum Detected Value (µg/g)	Avg. Conc. (µg/g)	Median Conc. (µg/g)	Background Threshold (µg/g)	Data Distribution	Test Performed	p value	Site > Bkgd?
Surface Soil (cont'd.)										
Zinc	Trench	5/5	457	212	127		Lognormal	t test	0.02	**YES**
	Remainder of Site	35/35	2,300	136.8	72.2		Neither	Mann-Whitney	<0.001	**YES**
	Background	**5/5**	**20.3**	**19.4**	**19.2**	**20.5**	**Lognormal**			
Subsurface Soil										
Aluminum	Trench	6/6	38,995	27,473	26,150		Normal	t test	0.001	**YES**
	Background	**5/5**	**9,760**	**7,704**	**7,670**	**10,900**	**Normal**			
Antimony	Trench	0/5	NA	NA	NA		NA	NA	NA	No
	Background	**4/5**	**0.64**	**0.52**	**0.54**	**0.76**	**Normal**			
Arsenic	Trench	6/6	20.0	10.5	7.0		Lognormal	t test	0.024	**YES**
	Background	**5/5**	**6.82**	**5.1**	**5.1**	**7.34**	**Lognormal**			
Barium	Trench	6/6	890	230	106		Lognormal	t test	0.04	**YES**
	Background	**5/5**	**62.2**	**53.4**	**50.5**	**66.0**	**Lognormal**			
Beryllium	Trench	6/6	2.78	1.3	1.2		Lognormal	Mann-Whitney	0.003	**YES**
	Background	**5/5**	**0.38**	**0.35**	**0.36**	**0.43**	**Neither**			
Boron	Trench	0/6	NA	NA	NA		NA	NA	NA	NA
	Background	**0/5**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	
Cadmium	Trench	0/6	NA	NA	NA		NA	NA	NA	NA
	Background	**3/5**	**0.53**	**0.34**	**0.25**	**0.67**	**Lognormal**			

TABLE 8-2a

Background Screening of Inorganic Chemicals Detected in Soil
Site 3 - Explosive Burn Area and Site 4- Abandoned Landfill
Jefferson Proving Ground
Madison, Indiana

Chemical	Location	Frequency of Detection[a]	Maximum Detected Value (µg/g)	Avg. Conc. (µg/g)	Median Conc. (µg/g)	Background Threshold (µg/g)	Data Distribution	Test Performed	p value	Site > Bkgd?
Subsurface Soil (cont'd)										
Chromium	Trench	6/6	32.5	28.2	30		Normal	Mann-Whitney	0.003	**YES**
(total)	**Background**	**5/5**	**14.2**	**12.2**	**11.2**	**15.7**	**Lognormal**			
Cobalt	Trench	6/6	39.8	12.6	6.4		Lognormal	Mann-Whitney	0.003	**YES**
	Background	**5/5**	**3.2**	**2.7**	**2.8**	**3.8**	**Normal**			
Copper	Trench	6/6	22.8	14.9	14.3		Lognormal	Mann-Whitney	0.003	**YES**
	Background	**3/5**	**6.5**	**4.3**	**4.8**	**7.7**	**Normal**			
Lead	Trench	6/6	33.0	16.1	13.5		Normal	NA[c]	NA	No
	Background	**5/5**	**20.5**	**16.5**	**15.9**	**21.5**	**Lognormal**			
Manganese	Trench	6/6	9,894	2,023	434		Lognormal	Mann-Whitney	0.29	No
	Background	**5/5**	**234**	**186**	**199**	**316**	**Neither**			
Mercury	Trench	2/6	0.069	0.039	0.025		Neither	NA	NA	**YES**
	Background	**0/5**	**NA**	**NA**	**NA**	**NA**	**NA**			
Molybdenum	Trench	0/6	NA	NA	NA		NA	NA	NA	NA
	Background	**2/2**[f]	**2.2**	**1.8**	**1.8**	**3.0**	NA			
Nickel	Trench	6/6	39.6	19.8	17.2		Lognormal	Mann-Whitney	0.003	**YES**
	Background	**2/5**	**5.6**	**3.4**	**2.8**	**6.54**	**Lognormal**			
Selenium	Trench	0/6	NA	NA	NA		NA	NA	NA	NA
	Background	**4/5**	**0.73**	**0.51**	**0.54**	**0.85**	**Normal**			

TABLE 8-2a

Background Screening of Inorganic Chemicals Detected in Soil
Site 3 - Explosive Burn Area and Site 4- Abandoned Landfill
Jefferson Proving Ground
Madison, Indiana

Chemical	Location	Frequency of Detection[a]	Maximum Detected Value (µg/g)	Avg. Conc. (µg/g)	Median Conc. (µg/g)	Background Threshold (µg/g)	Data Distribution	Test Performed	p value	Site > Bkgd?
Subsurface Soil (cont'd)										
Silver	Trench	5/6	0.066	0.043	0.05		Normal	NA	NA	**YES**
	Background	**0/5**	**NA**	**NA**	**NA**	**NA**	**NA**			
Thallium	Trench	0/6	NA	NA	NA		NA	NA	NA	NA
	Background	**1/1**[e]	**0.43**	**NA**	**NA**	**0.43**	**NA**			
Tin	Trench	0/6	NA	NA	NA		NA	NA	NA	NA
	Background	**0/5**	**NA**	**NA**	**NA**	**NA**	**NA**			
Vanadium	Trench	6/6	49.3	36.6	36.9		Lognormal	t test	<0.001	**YES**
	Background	**5/5**	**25.9**	**22.6**	**23.0**	**27.2**	**Lognormal**			
Zinc	Trench	6/6	210	69.4	40.5		Lognormal	t test	<0.008	**YES**
	Background	**5/5**	**20.3**	**19.4**	**19.2**	**20.5**	**Lognormal**			

Notes:
ug/g = microgram per gram (parts per million)
NA = Not applicable.

Footnotes:
(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Four samples with high detection limits were not included.
(c) The Mann-Whitney test was not performed because the site median is less than the background median.
(d) Because the molybdenum nondetect values (½ of detection limit) were higher than the maximum detected value, only the two detected values were used to calculate the background threshold value.
(e) Because the thallium nondetect values (½ of detection limit) were higher than the maximum detected value, only the one detect value was used to determine the background threshold value.

TABLE 8-2b

Background Screening of Inorganic Chemicals and Dioxins/Furans Detected in Soil
New Burn Site Adjacent to Sites 3 and 4
Jefferson Proving Ground
Madison, Indiana

Chemical	Location	Frequency of Detection[(a)]	Maximum Detected Value (µg/g)	Avg. Conc. (µg/g)	Median Conc. (µg/g)	Background Threshold (µg/g)	Data Distribution	Test Performed	p value	Site > Bkgd?
Surface Soil										
Aluminum	Burn Area	7/7	16,500	10,603	11,600		Normal	t test	0.10[(b)]	No
	Remainder of Site	9/9	15,700	13,116	12,700		Lognormal	Mann-Whitney	0.001	**YES**
	Background	**5/5**	**9,760**	**7,704**	**7,670**	**10,900**	**Normal**			
Antimony	Burn Area	6/7	2,160	70.9	1.5		Lognormal	Mann-Whitney	0.08[(c)]	No
	Remainder of Site	7/9	1.69	0.58	0.41		Lognormal	NA[(d)]	NA	No
	Background	**4/5**	**0.64**	**0.52**	**0.54**	**0.76**	**Normal**			
Arsenic	Burn Area	7/7	11.5	6.9	6.6		Lognormal	t test	0.08[(e)]	No
	Remainder of Site	9/9	12.5	7.87	7.45		Lognormal	t test	0.002	**YES**
	Background	**5/5**	**6.82**	**5.1**	**5.1**	**7.34**	**Lognormal**			
Barium	Burn Area	7/7	1,600	600	388		Lognormal	t test	<0.001	**YES**
	Remainder of Site	9/9	178	114	106		Lognormal	t test	<0.001	**YES**
	Background	**5/5**	**62.2**	**53.4**	**50.5**	**66.0**	**Lognormal**			
Beryllium	Burn Area	6/7	0.56	0.33	0.30		Lognormal	NA[(d)]	NA	No
	Remainder of Site	9/9	1.1	0.72	0.65		Lognormal	Mann-Whitney	0.001	**YES**
	Background	**5/5**	**0.38**	**0.35**	**0.36**	**0.43**	**Neither**			
Boron	Burn Area	2/7	8.4	7.0	6.0		Lognormal	NA	NA	**YES**
	Remainder of Site	0/7	NA	NA	NA		NA	NA	NA	No
	Background	**0/5**	**NA**	**NA**	**NA**	**NA**	**NA**			
Cadmium	Burn Area	6/7	3.47	0.90	0.67		Lognormal	t test	0.14[(f)]	No
	Remainder of Site	9/9	1.12	0.40	0.25		Lognormal	t test	0.46[(g)]	No
	Background	**3/5**	**0.53**	**0.34**	**0.25**	**0.67**	**Lognormal**			

TABLE 8-2b

Background Screening of Inorganic Chemicals and Dioxins/Furans Detected in Soil
New Burn Site Adjacent to Sites 3 and 4
Jefferson Proving Ground
Madison, Indiana

Chemical	Location	Frequency of Detection[a]	Maximum Detected Value (µg/g)	Avg. Conc. (µg/g)	Median Conc. (µg/g)	Background Threshold (µg/g)	Data Distribution	Test Performed	p value	Site > Bkgd?
Surface Soil (cont'd)										
Chromium (total)	Burn Area	7/7	40.5	24.0	23.5		Lognormal	t test	0.02	**YES**
	Remainder of Site	9/9	28.6	18.7	18.3		Lognormal	t test	0.001	**YES**
	Background	**5/5**	**14.2**	**12.2**	**11.2**	**15.7**	**Lognormal**			
Cobalt	Burn Area	0/7	NA	NA	NA		NA	NA	NA	No
	Remainder of Site	5/9	11.9	7.1	8.3		Normal	t test	0.008	**YES**
	Background	**5/5**	**3.2**	**2.7**	**2.8**	**3.8**	**Normal**			
Copper	Burn Area	7/7	239	81.3	58.8		Lognormal	Mann-Whitney	0.002	**YES**
	Remainder of Site	9/9	62.5	17.7	15.1		Neither	Mann-Whitney	0.001	**YES**
	Background	**3/5**	**6.5**	**4.3**	**4.8**	**7.7**	**Normal**			
Lead	Burn Area	7/7	510	285	331		Normal	Mann-Whitney	0.004	**YES**
	Remainder of Site	9/9	86.2	40.7	32.5		Lognormal	t test	0.003	**YES**
	Background	**5/5**	**20.5**	**16.5**	**15.9**	**21.5**	**Lognormal**			
Manganese	Burn Area	7/7	638	438	432		Lognormal	Mann-Whitney	0.002	**YES**
	Remainder of Site	9/9	1,340	784	775		Lognormal	Mann-Whitney	0.001	**YES**
	Background	**5/5**	**234**	**186**	**199**	**316**	**Neither**			
Mercury	Burn Area	2/7	0.27	0.08	0.19		Neither	NA	NA	**YES**
	Remainder of Site	4/9	0.17	0.07	0.05		Neither	NA	NA	**YES**
	Background	**0/5**	**NA**	**NA**	**NA**	**NA**	**NA**			
Molybdenum	Burn Area	1/7	2.06	NA[i]	NA[i]		Neither	Extreme value	NA	No
	Remainder of Site	1/9	2.41	NA[i]	NA[i]		Neither	Extreme value	NA	No
	Background	**2/2[h]**	**2.2**	**1.8**	**1.8**	**3.0**	NA			

TABLE 8-2b

Background Screening of Inorganic Chemicals and Dioxins/Furans Detected in Soil
New Burn Site Adjacent to Sites 3 and 4
Jefferson Proving Ground
Madison, Indiana

Chemical	Location	Frequency of Detection[a]	Maximum Detected Value (µg/g)	Avg. Conc. (µg/g)	Median Conc. (µg/g)	Background Threshold (µg/g)	Data Distribution	Test Performed	p value	Site > Bkgd?
Surface Soil (cont'd)										
Nickel	Burn Area	7/7	55.3	14.7	9.1		Lognormal	t test	0.003	**YES**
	Remainder of Site	9/9	16.3	10.1	10.2		Lognormal	t test	<0.001	**YES**
	Background	**2/5**	**5.6**	**3.4**	**2.8**	**6.54**	**Lognormal**			
Selenium	Burn Area	0/7	NA	NA	NA		NA	NA	NA	No
	Remainder of Site	3/9	0.37	0.28	0.25		Neither	NA[d]	NA	No
	Background	**4/5**	**0.73**	**0.51**	**0.54**	**0.85**	**Normal**			
Silver	Burn Area	3/7	0.57	0.51	0.50		Lognormal	NA	NA	**YES**
	Remainder of Site	0/9	NA	NA	NA		NA	NA	NA	No
	Background	**0/5**	**NA**	**NA**	**NA**	**NA**	**NA**			
Tin	Burn Area	1/7	2.75	4.7	5.7		Neither	NA	NA	**YES**
	Remainder of Site	0/9	NA	NA	NA		NA	NA	NA	No
	Background	**0/5**	**NA**	**NA**	**NA**	**NA**	**NA**			
Vanadium	Burn Area	7/7	33.7	23.0	23.1		Normal	Mann-Whitney	0.34	No
	Remainder of Site	9/9	33.5	28.1	27.9		Lognormal	t test	0.002	**YES**
	Background	**5/5**	**25.9**	**22.6**	**23.0**	**27.2**	**Lognormal**			
Zinc	Burn Area	7/7	2,360	741	391		Lognormal	t test	<0.001	**YES**
	Remainder of Site	9/9	731	173	90.3		Lognormal	t test	<0.001	**YES**
	Background	**5/5**	**20.3**	**19.4**	**19.2**	**20.5**	**Lognormal**			
Dioxins	Burn Area	7/7	6.3E-05	1.9E-05	1.4E-05		Lognormal	t test	0.46[j]	No
	Remainder of Site	9/9	1.5E-05	5.4E-06	4.6E-06		Lognormal	NA[k]	NA	No
	Background	**5/5**	**1.9E-05**	**8.1E-06**	**6.7E-06**	**2.0E-05**	**Lognormal**			

TABLE 8-2b

Background Screening of Inorganic Chemicals and Dioxins/Furans Detected in Soil
New Burn Site Adjacent to Sites 3 and 4
Jefferson Proving Ground
Madison, Indiana

Chemical	Location	Frequency of Detection[(a)]	Maximum Detected Value (µg/g)	Avg. Conc. (µg/g)	Median Conc. (µg/g)	Background Threshold (µg/g)	Data Distribution	Test Performed	p value	Site > Bkgd?
Subsurface Soil										
Aluminum	Burn Area	4/4	10,045	9,830	10,000		Neither	Mann-Whitney	<0.01	**YES**
	Remainder of Site	2/2	12,800	12,600	12,600		NA	Extreme value	NA	**YES**
	Background	**5/5**	**9,760**	**7,704**	**7,670**	**10,900**	**Normal**			
Antimony	Burn Area	3/4	10.2	2.3	0.60		Lognormal	Mann-Whitney	0.26	No
	Remainder of Site	½	0.37	0.31	0.31		NA	Extreme value	NA	No
	Background	**4/5**	**0.64**	**0.52**	**0.54**	**0.76**	**Normal**			
Arsenic	Burn Area	4/4	28.9	16.0	15.0		Lognormal	t test	0.10[(l)]	No
	Remainder of Site	2/2	5.3	4.4	4.4		NA	Extreme value	NA	No
	Background	**5/5**	**6.82**	**5.1**	**5.1**	**7.34**	**Lognormal**			
Barium	Burn Area	4/4	373	125	64.0		Lognormal	t test	0.15[(m)]	No
	Remainder of Site	2/2	52.0	49.7	49.7		NA	Extreme value	NA	No
	Background	**5/5**	**62.2**	**53.4**	**50.5**	**66.0**	**Lognormal**			
Beryllium	Burn Area	3/4	0.33	0.27	0.26		Lognormal	NA[(d)]	NA	No
	Remainder of Site	2/2	0.37	0.33	0.33		NA	Extreme value	NA	No
	Background	**5/5**	**0.38**	**0.35**	**0.36**	**0.43**	**Neither**			
Boron	Burn Area	3/4	16.2	8.9	7.5		Lognormal	NA	NA	**YES**
	Remainder of Site	0/2	NA	NA	NA		NA	NA	NA	No
	Background	**0/5**	**NA**	**NA**	**NA**	**NA**	**NA**			
Cadmium	Burn Area	2/4	2.53	0.81	0.39		Lognormal	t test	0.40[(n)]	No
	Remainder of Site	0/2	NA	NA	NA		NA	NA	NA	No
	Background	**3/5**	**0.53**	**0.34**	**0.25**	**0.67**	**Lognormal**			
Chromium (total)	Burn Area	4/4	54.0	28.5	24.1		Lognormal	t test	0.02	**YES**
	Remainder of Site	2/2	15.9	14.2	14.2		NA	Extreme value	NA	**YES**
	Background	**5/5**	**14.2**	**12.2**	**11.2**	**15.7**	**Lognormal**			

TABLE 8-2b

Background Screening of Inorganic Chemicals and Dioxins/Furans Detected in Soil
New Burn Site Adjacent to Sites 3 and 4
Jefferson Proving Ground
Madison, Indiana

Chemical	Location	Frequency of Detection[a]	Maximum Detected Value (µg/g)	Avg. Conc. (µg/g)	Median Conc. (µg/g)	Background Threshold (µg/g)	Data Distribution	Test Performed	p value	Site > Bkgd?
Subsurface Soil										
Cobalt	Burn Area	1/4	2.77	NA[i]	NA[i]		Normal	Extreme value	NA	No
	Remainder of Site	0/2	NA	NA	NA		NA	NA	NA	No
	Background	**5/5**	**3.2**	**2.7**	**2.8**	**3.8**	**Normal**			
Copper	Burn Area	4/4	1,212	333	88.8		Lognormal	Mann-Whitney	0.01	**YES**
	Remainder of Site	2/2	7.83	6.9	6.9		NA	Extreme value	NA	**YES**
	Background	**3/5**	**6.5**	**4.3**	**4.8**	**7.7**	**Normal**			
Lead	Burn Area	4/4	802.5	300	145.6		Lognormal	t test	0.13[o]	No
	Remainder of Site	2/2	9.9	9.5	9.5		NA	Extreme value	NA	No
	Background	**5/5**	**20.5**	**16.5**	**15.9**	**21.5**	**Lognormal**			
Manganese	Burn Area	4/4	430.5	195	136.5		Lognormal	NA[d]	NA	No
	Remainder of Site	2/2	406	250	250		NA	Extreme value	NA	**YES**
	Background	**5/5**	**234**	**186**	**199**	**316**	**Neither**			
Mercury	Burn Area	1/4	0.08	0.06	0.05		Neither	NA	NA	**YES**
	Remainder of Site	0/2	NA	NA	NA		NA	NA	NA	No
	Background	**0/5**	**NA**	**NA**	**NA**	**NA**	**NA**			
Molybdenum	Burn Area	2/4	3.08	4.0	4.0		Lognormal	Extreme value	NA	**YES**
	Remainder of Site	0/2	NA	NA	NA		NA	NA	NA	No
	Background	**2/2[h]**	**2.2**	**1.8**	**1.8**	**3.0**	NA			
Nickel	Burn Area	4/4	22.8	11.2	9.3		Lognormal	t test	0.02	**YES**
	Remainder of Site	2/2	7.4	7.0	6.0		NA	Extreme value	NA	**YES**
	Background	**2/5**	**5.6**	**3.4**	**2.8**	**6.54**	**Lognormal**			
Silver	Burn Area	2/4	11.0	2.5	0.68		Lognormal	NA	NA	**YES**
	Remainder of Site	0/2	NA	NA	NA		NA	NA	NA	No
	Background	**0/5**	**NA**	**NA**	**NA**	**NA**	**NA**			

TABLE 8-2b

Background Screening of Inorganic Chemicals and Dioxins/Furans Detected in Soil
New Burn Site Adjacent to Sites 3 and 4
Jefferson Proving Ground
Madison, Indiana

Chemical	Location	Frequency of Detection[a]	Maximum Detected Value (µg/g)	Avg. Conc. (µg/g)	Median Conc. (µg/g)	Background Threshold (µg/g)	Data Distribution	Test Performed	p value	Site > Bkgd?
Subsurface Soil										
Tin	Burn Area	2/4	27.0	9.7	5.0		Neither	NA	NA	**YES**
	Remainder of Site	½	2.1	NA[i]	NA[i]I		NA	NA	NA	**YES**
	Background	**0/5**	**NA**	**NA**	**NA**	**NA**	**NA**			
Vanadium	Burn Area	4/4	31.4	23.6	21.3		Lognormal	t test	0.38[p]	No
	Remainder of Site	2.2	26.4	24.4	24.4		NA	Extreme value	NA	No
	Background	**5/5**	**25.9**	**22.6**	**23.0**	**27.2**	**Lognormal**			
Zinc	Burn Area	4/4	890	265	110		Lognormal	t test	0.08[q]	No
	Remainder of Site	2/2	33.6	28.0	28.0		NA	Extreme value	NA	**YES**
	Background	**5/5**	**20.3**	**19.4**	**19.2**	**20.5**	**Lognormal**			
Dioxins	Burn Area	4/4	2.9E-04	7.0E-05	1.9E-05		Lognormal	t test	0.38[r]	No
	Remainder of Site	2/2	7.3E-06	5.9E-06	5.9E-06		NA	Extreme value	NA	No
	Background	**5/5**	**1.9E-05**	**8.1E-06**	**6.7E-06**	**2.0E-05**	**Lognormal**			

Notes:
- ug/g – microgram per gram (parts per million)
- NA = Not available

Footnotes:
(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) The 95% confidence interval for the difference between the aluminum means is -1864 to 7661.
(c) The high antimony detection of 2,160 ug/g was not treated as a hot spot because site history does not indicate antimony contamination would be present, the sample in which this high concentration was detected was not consistently high in other metals, and nonparametric statistics indicate that in general the antimony detections in the burn area are consistent with background.
(d) The Mann-Whitney test was not performed because the site median is less than the background median.
(e) The 95% confidence interval for the difference between the means of the log-transformed arsenic values is -0.13 to 0.65.
(f) The 95% confidence interval for the difference between the means of the log-transformed cadmium values is -0.44 to 1.6.
(g) The 95% confidence interval for the difference between the means of the log-transformed cadmium values is -0.76 to 0.70.

TABLE 8-2b

Background Screening of Inorganic Chemicals and Dioxins/Furans Detected in Soil
New Burn Site Adjacent to Sites 3 and 4
Jefferson Proving Ground
Madison, Indiana

Footnotes:

(h) Because the molybdenum nondetect values (½ of the detection limit) were higher than the maximum detected value, only the two detected values were used to calculate the background threshold value.

(i) Not calculated due to high detection limits for nondetections.

(j) The 95% confidence interval for the difference between the means of the log-transformed dioxin values is -0.79 to 0.75.

(k) The t test was not performed because the site average concentration is less than the background average concentration.

(l) The 95% confidence interval for the difference between the means of the log-transformed arsenic values is -0.74 to 2.4.

(m) The 95% confidence interval for the difference between the means of the log-transformed barium values is -1.1 to 2.1.

(n) The 95% confidence interval for the difference between the means of the log-transformed cadmium values is -2.5 to 2.6.

(o) The 95% confidence interval for the difference between the means of the log-transformed lead values is -1.9 - 5.0.

(p) The 95% confidence interval for the difference between the means of the log-transformed vanadium values is -0.27 to 0.34.

(q) The 95% confidence interval for the difference between the means of the log-transformed zinc values is -1.2 to 4.5.

(r) The 95% confidence interval for the difference between the means of the log-transformed dioxin values is -0.27 to 0.21.

TABLE 8-3

Background Screening of Inorganic Chemicals Detected in Groundwater
Site 4 - Abandoned Landfill
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Average Maximum Detected Value (µg/L)[b]	Groundwater Background Screening Value[c] (µg/L)	Exceeds Groundwater Background?
Aluminum, Total	3/3	17,045	553	**YES**
Antimony, Total	2/3	4.93	--- [d]	**YES**
Arsenic, Total	2/3	4.41	2.6	**YES**
Barium, Total	3/3	486.5	509.3	No
Boron, Total	3/3	266.8	140	**YES**
Chromium, Total	3/3	44.5	6.24	**YES**
Cobalt, Total	1/3	5.3	---	**YES**
Copper	1/3	9.1	---	**YES**
Lead, Total	1/3	6.68	1.71	**YES**
Manganese, Total	3/3	370	290	**YES**
Mercury, Total	1/3	0.031	0.056	No
Molybdenum, Total	2/3	35.6	9.67	**YES**
Nickel, Total	2/3	31.1	---	**YES**
Selenium, Total	1/3	2.97	---	**YES**
Tin, Total	1/3	50.4	55.7	No
Vanadium	2/3	17.5	2.89	**YES**
Zinc, Total	3/3	22.9	---	**YES**

Footnotes:

(a) Number of locations in which the analyte was detected/total number of locations sampled. The three downgradient wells at this site (MW93-20, MW93-21, and MW95-06) were used in the background screening analysis.
(b) Micrograms per liter.
(c) See Section 5.1.4.5.2 for an explanation of how the groundwater background screening values were calculated.
(d) No screening value.

TABLE 8-4

Analytical Results for Metals in Surface and Subsurface Soil Samples
Site 3 - Explosive Burn Area and Site 4 - Abandoned Landfill, and New Burn Site
Jefferson Proving Ground
Madison, Indiana

Sample ID Sample Date Depth (feet) Analyte	EBA03SF001 11/17/92 0.0	EBA03SF002 11/17/92 0.0	EBA03SF003 11/17/92 0.0	EBA03SF004 11/17/92 0.0	EBA03SF005 11/17/92 0.0	EBA03SF006 11/17/92 0.0	EBA03SF007 11/17/92 0.0	EBA03SF008 11/17/92 0.0	Background (µg/g)[(a)]
Aluminum	23,400	23,300	16,700	2,670	9,020	3,760	14,600	17,000	16,600
Antimony	LT[(b)] 19.6 R[(c)]	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	0.44
Arsenic	4.66	4.03	8.98	LT 2.50 R	3.01	LT 2.50 R	6.66	4.09	6.30
Barium	162	163	412	455	147	56.2	237	137	95.0
Beryllium	0.888	0.584	LT 0.427	LT 0.427	LT 0.427	LT 2.10	0.659	0.591	0.48
Boron	16.1	14.4	LT 6.64	13.7	9.92	15.5	9.60	9.73	0
Cadmium	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 6.00	LT 1.20	LT 1.20	0
Calcium	1,890	4,910	440,000	50,000	230,000	280,000	3,560	2,190	588
Chromium	24.5	30.3	20.6	16.7	10.2	5.32	21.4	21.0	18.0
Cobalt	9.68	7.79	9.25	LT 2.50	4.50	13.0	9.41	8.02	5.60
Copper	64.4	231	83.6	23.1	11.1	LT 14.0	4.62	14.8	5.71
Iron	24,000	33,000	25,800	6,120	8,860	5,200	25,800	21,100	11,800
Lead	44.0	28.0	63.0	28.0	26.0	9.00	40.0	31.0	16.2
Magnesium	1,740	2,660	105,000	50,000	27,400	57,000	1,470	1,530	1,000
Manganese	905	464	1,210	600	673	558	695	753	718
Mercury	LT 0.05	LT 0.05	LT 0.05	LT 0.05	0.18	LT 0.05	LT 0.05	LT 0.05	0
Molybdenum	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	72.0	LT 14.3	LT 14.3	0
Nickel	11.4	11.9	21.3	4.72	8.04	4.37	11.2	11.7	6.31
Potassium	2,180	1,660	1,730	587	936	995	737	920	2,360
Selenium	LT 0.45 R	LT 0.45 R	LT 0.45 R	LT 0.45 R	LT 0.45 R	LT 0.45 R	LT 0.45 R	LT 0.45 R	1.21
Silver	0.316	0.143	1.20	0.550	1.40	0.079	0.280	0.386	0
Sodium	77.7	LT 38.7	405	214	185	278	LT 38.7	LT 38.7	377
Thallium	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	0
Tin	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	37.0	LT 7.43	LT 7.43	0
Vanadium	42.1	42.2	24.8	4.53	14.0	LT 7.00	31.7	31.6	31.7
Zinc	77.0	214	111	36.7	79.2	14.8	2,300	55.2	23.9

TABLE 8-4

Analytical Results for Metals in Surface and Subsurface Soil Samples
Site 3 - Explosive Burn Area and Site 4 - Abandoned Landfill, and New Burn Site
Jefferson Proving Ground
Madison, Indiana

Sample ID Sample Date Depth (feet) Analyte	EBA03SF009 11/17/92 0.0	EBA03SF010 11/17/92 0.0	EBA03SF011 11/17/92 0.0	EBA03SF012 11/17/92 0.0	EBA03SF013 11/17/92 0.0	EBA03SF014 11/17/92 0.0	EBA03SF015 11/17/92 0.0	EBA03SF016 11/17/92 0.0	EBA03SF017 05/11/96 0.0	Background (µg/g)
Aluminum	21,900	11,400	3,250	4,710	17,500	17,600	20,600	23,200	13,000	16,600
Antimony	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 1.00	0.44
Arsenic	14.5	6.15	LT 2.50 r	3.54	5.12	10.7	3.74	4.44	8.46	6.30
Barium	164	277	355	107	3,200	1,090	555	367	86.9	95.0
Beryllium	LT 0.427	LT 0.427	LT 0.427	LT 0.427	LT 0.427	1.15	1.48	1.26	0.615	0.48
Boron	LT11.5	LT 6.64	LT 12.6	LT 6.64	LT 6.64	LT 6.64	LT 11.7	LT 6.64	15.4	0
Cadmium	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.00	0
Calcium	1,140	78,000	250,000	290,000	110,000	40,500	13,800	3,260	1,740	588
Chromium	17.2	14.3	8.75	7.22	17.3	18.7	28.3	21.3	15.4	18.0
Cobalt	10.5	7.63	LT 2.50	LT 2.50	9.20	36.3	30.5	23.3	10.9	5.60
Copper	7.36	48.7	16.9	33.8	23.0	21.7	26.0	15.9	13.6	5.71
Iron	22,000	22,400	9,330	6,220	17,500	55,000	86,000	39,600	18,900	11,800
Lead	36.0	53.0	31.0	51.0	1,300	27.0	18.0	30.0	28.0	16.2
Magnesium	1,250	17,100	59,000	51,400	25,700	8,720	3,560	1,810	1,630	1,000
Manganese	1,090	715	580	767	1,400	9,800	3,800	3,100	620	718
Mercury	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	0.0717	0
Molybdenum	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 13.6	0
Nickel	11.4	12.4	6.18	4.67	13.3	36.7	29.2	24.5	10.8	6.31
Potassium	791	464	422	483	1,770	481	605	616	944	2,360
Selenium	LT 0.45 R	LT 0.45 R	LT 0.45 R	LT 0.45 R	LT 0.45 R	LT 0.45 R	LT 0.45 R	LT 0.45 R	0.639	1.21
Silver	0.147	0.100	1.60	0.460	0.150	0.290	0.100	0.120	0.401	0
Sodium	LT 38.7	LT 38.7	45.4	LT 38.7	LT 38.7	LT 38.7	LT 38.7	LT 38.7	31.8	377
Thallium	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 1.00	0
Tin	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 10.0	0
Vanadium	30.2	19.4	5.72	4.70	22.6	55.8	52.6	33.9	31.6	31.7
Zinc	35.4	100	85.0	143	137	84.2	87.7	72.6	47.1	23.9

TABLE 8-4

Analytical Results for Metals in Surface and Subsurface Soil Samples
Site 3 - Explosive Burn Area and Site 4 - Abandoned Landfill, and New Burn Site
Jefferson Proving Ground
Madison, Indiana

Sample ID Sample Date Depth (feet) Analyte	EBA03SF018 05/11/96 0.0	EBA03SF019 05/11/96 0.0	EBA03SF20 05/11/96 0.0	EBA03SF021 05/11/96 0.0	EBA03SF022 05/11/96 0.0	EBA03SF023 05/11/96 0.0	EBA03SF024 05/11/96 0.0	EBA03SF025 05/11/96 0.0	Background (µg/g)
Aluminum	7,060	11,700	10,600	12,900	14,700	1,870	1,770	15,400	16,600
Antimony	LT 1.00	1.11	1.73	0.634	LT 1.00	0.511	LT 1.00	1.29	0.44
Arsenic	5.03	8.23	5.79	7.57	10.3	3.57	7.71	7.77	6.30
Barium	191	355	3,120	180	118	111	80.8	577	95.0
Beryllium	0.450	0.520	0.488	0.917	0.738	LT 0.553	0.292	0.698	0.48
Boron	13.6	15.8	15.8	13.1	16.4	12.7	13.2	21.9	0
Cadmium	LT 0.678	LT 0.752	2.17	0.362	LT 1.00	LT 1.20	LT 1.20	3.06	0
Calcium	20,300	3,550	84,700	1,460	1,930	281,000	234,000	36,700	588
Chromium	9.17	16.1	121	15.0	20.3	58.2	6.68	27.5	18.0
Cobalt	5.09	11.8	9.53	10.9	9.83	2.95	1.87	10.8	5.60
Copper	LT 11.7	33.2	67.5	14.0	15.1	25.3	LT 7.57	62.5	5.71
Iron	9,770	21,700	16,500	16,800	22,700	5,350	4,930	22,600	11,800
Lead	21.4	61.5	565	28.7	38.8	21.2	12.0	114	16.2
Magnesium	6,210	1,290	8,200	1,280	1,740	36,700	69,000	6,120	1,000
Manganese	718	1,040	830	1,270	955	467	484	523	718
Mercury	0.0512	LT 0.10	0.101	LT 0.10	0.0793	LT 0.10	LT 0.10	0.0978	0
Molybdenum	LT 13.6	LT 15.0	3.89	0.867	13.1	3.95	3.48	2.00	0
Nickel	6.71	12.2	11.6	12.2	11.2	10.3	4.19	11.6	6.31
Potassium	705	833	789	854	1,520	530	331	1,150	2,360
Selenium	0.604	0.614	LT 0.50	0.517	1.13	LT 0.50	LT 0.50	LT 0.50	1.21
Silver	LT 1.00	1.27	3.64	0.904	0.498	LT 1.00	LT 1.00	3.30	0
Sodium	39.4	33.5	72.2	34.3	41.3	139	203	89.8	377
Thallium	LT 1.00	LT 1.00	LT 1.43	LT 1.00	LT 10.0	LT 1.00	LT 10.0	LT 1.00	0
Tin	5.85	LT 10.0	7.38	LT 10.0	LT 10.0	28.2	34.5	8.85	0
Vanadium	17.8	30.5	24.8	28.9	34.2	9.83	7.40	30.6	31.7
Zinc	72.2	88.0	139	53.4	71.4	38.3	26.5	127	23.9

TABLE 8-4

Analytical Results for Metals in Surface and Subsurface Soil Samples
Site 3 - Explosive Burn Area and Site 4 - Abandoned Landfill, and New Burn Site
Jefferson Proving Ground
Madison, Indiana

Sample ID Sample Date Depth (feet) Analyte	EBA03SF026 05/11/96 0.0	EBA03SF027 05/11/96 0.0	EBA03SF028 05/11/96 0.0	EBA03SF029 05/11/96 0.0	EBA03SF030 05/11/96 0.0	EBA03SF031 05/11/96 0.0	EBA03SF032 05/11/96 0.0	EBA03SF033 05/11/96 0.0	Background (µg/g)
Aluminum	16,600	10,100	9,150	8,460	1,110	10,300	12,700	10,800	16,600
Antimony	LT 1.00	0.822	LT 1.00	LT 1.00	0.814	0.593	0.561	LT 1.00	0.44
Arsenic	6.79	7.13	6.04	4.85	2.52	7.18	15.1	5.38	6.30
Barium	94.9	143	138	73.8	42.8	59.7	297	113	95.0
Beryllium	0.614	0.882	0.833	0.406	0.293	0.705	1.42	0.947	0.48
Boron	14.1	13.9	13.1	12.5	17.2	14.2	16.8	14.2	0
Cadmium	LT 1.00	LT 0.673	LT 1.00	0.276	0.885	LT 1.00	LT 1.00	LT 1.00	0
Calcium	1,070	4,120	1,180	21,100	266,000	1,120	904	1,100	588
Chromium	19.6	14.9	11.8	11.2	4.23	26.1	18.1	10.3	18.0
Cobalt	11.1	12.7	8.98	3.66	0.548	7.23	11.2	8.41	5.60
Copper	12.5	15.6	LT 12.7	LT 6.88	6.72	LT 13.4	24.5	LT 10.2	5.71
Iron	18,800	16,700	13,600	11,700	5,050	20,200	23,700	10,600	11,800
Lead	19.1	42.1	27.8	13.0	8.64	14.0	35.6	21.2	16.2
Magnesium	1,460	1,390	790	4,510	84,600	991	929	845	1,000
Manganese	821	1,510	1,040	323	392	412	2,140	1,210	718
Mercury	LT 0.10	0.0704	0.0564	0.0457	LT 0.10	LT 0.10	0.0697	LT 0.10	0
Molybdenum	LT 10.0	LT 13.5	LT 13.1	0.721	2.54	1.20	LT 14.8	LT 10.0	0
Nickel	12.0	11.8	8.34	6.04	2.20	10.3	14.0	9.09	6.31
Potassium	1,040	716	758	462	352	559	877	844	2,360
Selenium	LT 0.50	1.01	LT 0.50	LT 0.50	LT 0.50	LT 0.50	0.941	LT 0.50	1.21
Silver	0.476	0.409	LT 1.00	LT 1.00	LT 1.00	LT 1.00	0.561	LT 1.00	0
Sodium	45.5	31.6	26.1	50.0	251	32.2	39.0	30.0	377
Thallium	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 10.0	LT 1.00	LT 1.48	LT 1.00	0
Tin	LT 10.0	LT 10.0	LT 10.0	4.94	20.2	LT 10.0	LT 10.0	LT 10.0	0
Vanadium	31.1	24.6	25.8	21.3	5.86	36.3	39.3	22.0	31.7
Zinc	36.2	134	83.7	28.7	24.6	28.8	124	52.3	23.9

TABLE 8-4

Analytical Results for Metals in Surface and Subsurface Soil Samples
Site 3 - Explosive Burn Area and Site 4 - Abandoned Landfill, and New Burn Site
Jefferson Proving Ground
Madison, Indiana

Sample ID Sample Date Depth (feet) Analyte	EBA03SF034 05/11/96 0.0	EBA03SF035 05/11/96 0.0	EBA03SF036 05/11/96 0.0	ALF04BHA01 11/23/92 0.4	ALF04BHA02 11/23/92 4.4	ALF04BHA03 11/23/92 9.4	ALF04BHB01 11/23/92 0.5	ALF04BHC01 11/23/92 0.3	ALF04BHC02 11/23/92 4.5	Background (μg/g)
Aluminum	10,400	9,750	13,400	18,400	24,300	27,100	16,100	25,200	24,600	16,600
Antimony	LT 1.00	0.653	0.797	LT 19.6	LT 19.6	LT 19.6	LT 19.6	LT 19.6	LT 19.6	0.44
Arsenic	6.44	6.48	9.80	11.5	7.77	20.0	10.6	7.75	5.56	6.30
Barium	235	157	142	63.9	118	158	5,900	682	93.6	95.0
Beryllium	0.747	0.871	1.07	LT 0.427	0.895	2.78	LT 0.427	0.722	0.559	0.48
Boron	13.9	13.3	16.1	LT 12.2	LT 6.64	LT 6.64	LT 8.51	LT 13.8	LT 6.64	0
Cadmium	LT 1.00	LT 1.00	LT 1.00	LT 1.20	LT 1.20	LT 1.20	12.4	LT 1.20	LT 1.20	0
Calcium	2,600	3,190	1,900	3,590	1,180	4,730	37,900	2,550	921	588
Chromium	12.9	11.5	18.0	20.5	29.0	31.3	54.5	40.5	32.5	18.0
Cobalt	10.6	21.9	12.1	6.17	13.9	6.94	17.5	18.0	5.77	5.60
Copper	13.1	13.6	13.4	15.3	17.5	22.8	408	124	9.79	5.71
Iron	14,700	14,000	22,700	31,200	38,200	58,300	24,900	29,600	24,200	11,800
Lead	25.0	36.3	26.4	1.46	33.0	23.7	800	210	12.0	16.2
Magnesium	1,020	1,360	1,430	2,400	1,880	2,380	10,600	1,820	1,360	1,000
Manganese	1,400	1,380	1,240	187	696	1,150	733	613	124	718
Mercury	0.0695	0.0601	0.0478	0.0706	LT 0.05	0.0691	0.0719	0.136	LT 0.05	0
Molybdenum	1.14	0.644	0.796	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	0
Nickel	8.94	9.65	12.3	9.50	14.3	26.7	9.80	12.8	9.55	6.31
Potassium	602	594	613	972	1,602	928	856	1,460	1,130	2,360
Selenium	0.66	LT 0.50	LT 0.50	LT 0.45 R	LT 0.45 R	LT 0.45 R	0.645	LT 0.45 R	LT 0.45 R	1.21
Silver	0.580	0.465	0.719	0.318	LT 0.0124	0.0663	0.970	6.00	0.0646	0
Sodium	31.4	29.4	37.9	LT 38.7	103	122	98.5	60.2	110	377
Thallium	LT 1.00	LT 1.00	LT 1.00	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	0
Tin	2.56	LT 10.0	LT 10.0	LT 7.43	LT 7.43	LT 7.43	14.2	15.8	LT 7.43	0
Vanadium	27.4	23.7	34.9	34.6	34.0	37.9	27.3	40.4	40.2	31.7
Zinc	42.3	39.9	46.8	43.8	41.7	210	457	411	36.3	23.9

TABLE 8-4

Analytical Results for Metals in Surface and Subsurface Soil Samples
Site 3 - Explosive Burn Area and Site 4 - Abandoned Landfill, and New Burn Site
Jefferson Proving Ground
Madison, Indiana

Sample ID	ALF04BHC03	ALF04BHD01	ALF04BHD02	ALF04BHD03	NBS97SF001	NBS97SF002	NBS97SF003	NBS97SF004	NBS97SF005	Background
Sample Date	11/23/92	11/23/92	11/23/92	11/23/92	09/20/97	09/20/97	09/20/97	09/20/97	09/20/97	(µg/g)
Depth (feet)	9.4	0.9	4.7	9.5	0.0	0.0	0.0	0.0	0.0	
Analyte										
Aluminum	20,000	2,310	26,800	37,800	11,100	13,700	12,600	13,200	16,500	16,600
Antimony	LT 19.6	98.0	LT 19.6	LT 19.6	0.408	0.337	0.652	0.353	2,160	0.44
Arsenic	10.9	3.82	LT 2.50 R	6.30	6.63	7.04	6.21	12.5	8.68	6.30
Barium	1,700	24.4	64.5	65.5	98.4	92.0	79.6	178	388	95.0
Beryllium	1.64	LT 2.10	LT 0.588	1.50	0.642	0.679	0.469	1.10	0.560	0.48
Boron	LT 6.64	LT 23.6	LT 6.64	LT 6.64	LT 10.0	LT 10.0	LT 10.0	LT 10.0	17.3	0
Cadmium	LT 1.20	LT 1.20	LT 1.20	LT 1.20	0.251	0.169	0.156	0.788	0.459	0
Calcium	2,050	350,000	1,140	678	1,380	881	1,740	3,670	4,360	588
Chromium	36.7	11.0	23.3	31.9	14.1	19.8	16.4	18.3	37.2	18.0
Cobalt	75.6	LT 13.0	3.95	5.09	7.97	7.50	7.07	9.65	8.88	5.60
Copper	23.6	LT 2.84	7.13	11.1	10.5	9.20	17.6	62.5	71.9	5.71
Iron	47,800	4,770	20,100	24,300	13,000	15,600	16,800	23,900	22,700	11,800
Lead	15.0	18.0	5.60	15.0	38.0	31.0	23.2	86.2	331	16.2
Magnesium	1,610	46,300	1,560	2,220	995	1,140	1,350	1,100	2,050	1,000
Manganese	19,000	201	125	172	763	777	484	1,340	582	718
Mercury	LT 0.05	LT 0.05	LT 0.05	0.0633	0.170	0.0571	LT 0.05	0.112	LT 0.05	0
Molybdenum	LT 14.3	72.0	LT 14.3	LT 14.3	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0	0
Nickel	52.3	LT 14.0	9.53	20.0	7.37	9.49	9.00	16.3	12.7	6.31
Potassium	1,670	1,090	1,190	1,820	719	886	957	935	1,450	2,360
Selenium	LT 0.45 R	LT 0.45 R	LT 0.45 R	LT 0.45 R	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	1.21
Silver	0.0464	1.70	0.0217	0.0429	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	0
Sodium	148	LT 136	LT 38.7	133	7.11	18.8	11.1	10.7	80.0	377
Thallium	LT 34.3	170	LT 34.3	LT 34.3	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	0
Tin	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0	0
Vanadium	46.8	LT 7.00	37.0	30.6	25.8	30.7	25.5	25.3	33.7	31.7
Zinc	71.2	21.3	29.1	62.7	90.3	88.0	74.7	183	713	23.9

TABLE 8-4

Analytical Results for Metals in Surface and Subsurface Soil Samples
Site 3 - Explosive Burn Area and Site 4 - Abandoned Landfill, and New Burn Site
Jefferson Proving Ground
Madison, Indiana

Sample ID Sample Date Depth (feet) Analyte	NBS97SF006 09/20/97 0.0	NBS97SF007 09/20/97 0.0	NBS97SF008 09/20/97 0.0	NBS97SF009 09/20/97 0.0	NBS97SF010 09/20/97 0.0	NBS97BHA01 09/20/97 0.0	NBS97BHA02 09/20/97 1.0	NBS97BHA03 09/20/97 3.0	NBS97BHA04 09/20/97 5.0	Background (µg/g)
Aluminum	10,600	3,470	13,900	12,600	15,700	12,600	12,600	12,400	12,800	16,600
Antimony	4.17	1.30	0.523	LT 0.05	LT 0.05	1.69	0.849	LT 0.05	0.365	0.44
Arsenic	11.5	3.07	7.87	8.10	9.02	7.45	5.82	3.53	5.34	6.30
Barium	968	1,380	98.4	106	120	119	136	52.0	47.4	95.0
Beryllium	LT 0.50	0.187	0.523	0.506	0.645	0.926	0.978	0.365	0.290	0.48
Boron	19.5	17.1	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0	0
Cadmium	3.47	0.272	0.113	1.12	0.340	0.466	0.226	LT 0.20	LT 0.20	0
Calcium	74,600	204,000	2,130	2,150	1,780	2,040	1,370	601	405	588
Chromium	40.5	9.23	19.5	17.4	28.6	19.9	13.7	12.5	15.9	18.0
Cobalt	7.85	5.61	7.86	8.31	11.9	9.27	10.3	6.27	5.00	5.60
Copper	239	26.7	16.5	15.1	17.3	11.8	8.05	5.95	7.83	5.71
Iron	22,500	6,150	18,100	16,600	19,800	16,400	13,100	12,300	16,000	11,800
Lead	510	142	32.2	63.3	45.1	32.5	15.5	9.13	9.92	16.2
Magnesium	26,800	62,600	1,660	1,480	1,540	1,040	928	906	993	1,000
Manganese	638	398	532	531	775	824	1,030	406	94.7	718
Mercury	0.104	LT 0.10	LT 0.10	LT 0.10	LT 0.10	0.0639	LT 0.10	LT 0.10	LT 0.10	0
Molybdenum	LT 10.0	LT 10.0	LT 10.0	2.41	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0	0
Nickel	55.3	6.63	10.5	6.30	11.3	11.3	10.2	6.50	7.39	6.31
Potassium	862	349	1,070	1,010	1,430	931	642	405	643	2,360
Selenium	LT 0.50	LT 0.50	0.366	0.310	LT 0.50	LT 0.50	LT 0.50	LT 0.50	LT 0.50	1.21
Silver	LT 1.00	0.483	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	0
Sodium	186	129	7.33	5.70	25.8	9.88	LT 20.0	LT 20.0	LT 20.0	377
Thallium	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	0
Tin	2.75	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0	2.12	LT 10.0	0
Vanadium	22.3	8.37	29.8	27.9	33.5	28.8	24.0	22.3	26.4	31.7
Zinc	2,360	161	56.1	731	87.1	227	141	33.6	22.3	23.9

TABLE 8-4

Analytical Results for Metals in Surface and Subsurface Soil Samples
Site 3 - Explosive Burn Area and Site 4 - Abandoned Landfill, and New Burn Site
Jefferson Proving Ground
Madison, Indiana

Sample ID Sample Date Depth (feet) Analyte	NBS97BHB01 09/20/97 0.0	NBS97BHB02 09/20/97 1.0	NBS97BHB03 09/20/97 3.0	NBS97BHB04 09/20/97 5.0	NBS97BHC01 09/20/97 0.0	NBS97BHC02 09/20/97 1.0	NBS97BHC03 09/20/97 3.0	NBS97BHC04 09/20/97 5.0	Background (µg/g)
Aluminum	11,600	5,240	8,990	10,000	12,300	14,000	14,100	10,000	16,600
Antimony	LT	1.47	10.8	0.578	7.50	0.488	0.421	0.625	0.44
Arsenic	4.68	5.86	6.82	28.9	7.13	6.63	5.36	3.56	6.30
Barium	248	302	324	80.9	498	75.9	48.1	40.7	95.0
Beryllium	0.401	0.220	0.242	0.238	0.347	0.298	0.328	LT 0.50	0.48
Boron	11.9	10.0	15.1	7.50	8.40	5.62	7.39	LT 0.50	0
Cadmium	0.716	0.674	2.73	0.684	0.770	LT 0.20	LT 0.20	LT 0.20	0
Calcium	41,200	124,000	69,000	10,400	32,200	1,960	1,030	788	588
Chromium	24.6	13.2	44.4	30.0	23.5	18.0	18.7	12.4	18.0
Cobalt	5.30	5.00	6.51	6.13	5.63	5.53	5.00	5.00	5.60
Copper	58.8	35.7	484	165	121	11.1	7.74	5.30	5.71
Iron	10,400	8,540	18,700	31,700	14,700	18,000	17,100	15,200	11,800
Lead	414	87.5	733	278	461	17.3	10.6	13.2	16.2
Magnesium	11,100	18,100	13,600	1,710	5,290	1,470	1,380	706	1,000
Manganese	374	304	418	160	432	275	106	113	718
Mercury	LT 0.10	LT 0.10	0.0893	LT 0.10	0.265	LT 0.10	LT 0.10	LT 0.10	0
Molybdenum	LT 10.0	LT 10.0	3.38	LT 10.0	LT 10.0	LT 10.0	2.35	LT 10.0	0
Nickel	13.7	9.10	18.3	12.1	7.56	5.81	7.55	3.50	6.31
Potassium	1,140	630	144	465	1,020	1,290	1,400	578	2,360
Selenium	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	1.21
Silver	0.565	0.537	10.6	0.870	LT 1.00	LT 1.00	LT 1.00	LT 1.00	0
Sodium	87.1	113	184	29.9	42.6	9.88	14.4	8.27	377
Thallium	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	0
Tin	LT 10.0	LT 10.0	10.7	4.59	LT 10.0	LT 10.0	LT 10.0	LT 10.0	0
Vanadium	22.1	13.8	20.0	20.5	27.8	30.9	29.6	20.5	31.7
Zinc	391	251	800	196	1,030	48.0	28.8	20.9	23.9

TABLE 8-4

Analytical Results for Metals in Surface and Subsurface Soil Samples
Site 3 - Explosive Burn Area and Site 4 - Abandoned Landfill, and New Burn Site
Jefferson Proving Ground
Madison, Indiana

Note:
The first series of letters in the sample ID numbers indicates site (i.e., EBA = Explosive Burn Area, ALF = Abandoned Landfill, and NBS = New Burn Site) and the second series of letters distinguishes surface (SF) from borehole (BH).

Footnotes:
(a) Micrograms per gram; all values are in µg/g.
(b) Not detected, value is less than the reporting limit.
(c) Rejected, unusable due to quality control deficiencies.

TABLE 8-5

Analytical Results for Organic Contaminants Detected in Soil Samples
Site 3 - Explosive Burn Area and Site 4 - Abandoned Landfill, and New Burn Site
Jefferson Proving Ground
Madison, Indiana

	Sample ID	Contaminant	Concentration (µg/g)[(a)]	Sample Date	Depth (feet)
Sites 3 and 4	ALF04BHA03	Trichloroethylene	0.320	11/23/92	9.4
	ALF04BHB01	Dimethyl phthalate	0.110	11/23/92	0.5
		Trichloroethylene	0.250		
	ALF04BHC01	Trichloroethylene	0.680	11/23/92	0.3
	ALF04BHD03	Benzyl alcohol	0.069	11/23/92	9.5
		Di-n-butyl phthalate	LT 3.0		
New Burn Site	NBS97SF001	1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	0.00003530	09/20/97	0.0
		1,2,3,4,6,7,8-Heptachlorodibenzofuran	0.00000470		
		1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin	0.00000118		
		1,2,3,4,7,8-Hexachlorodibenzofuran	0.00000235		
		Octachlorodibenzodioxin	0.00247000		
		2,3,7,8-Tetrachlorodibenzofuran	0.00000235		
	NBS97SF002	2,3,4,6,7,8-Hexachlorodibenzofuran	0.00000113	09/20/97	0.0
		1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	0.00003390		
		1,2,3,4,6,7,8-Heptachlorodibenzofuran	0.00000226		
		1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin	0.00000113		
		1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin	0.00000226		
		1,2,3,4,7,8-Hexachlorodibenzo-*p*-dioxin	0.00000113		
		1,2,3,4,7,8-Hexachlorodibenzofuran	0.00000113		
		Octachlorodibenzodioxin	0.00271000		
		Octachlorodibenzofuran	0.00000226		
		2,3,7,8-Tetrachlorodibenzofuran	0.00000113		
	NBS97SF003	2,3,4,6,7,8-Hexachlorodibenzofuran	0.00000115	09/20/97	0.0
		1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	0.00003450		
		1,2,3,4,6,7,8-Heptachlorodibenzofuran	0.00000345		
		1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin	0.00000115		

TABLE 8-5

Analytical Results for Organic Contaminants Detected in Soil Samples
Site 3 - Explosive Burn Area and Site 4 - Abandoned Landfill, and New Burn Site
Jefferson Proving Ground
Madison, Indiana

Sample ID	Contaminant	Concentration (µg/g)[(a)]	Sample Date	Depth (feet)
NBS97SF003	1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin	0.00000115	09/20/97	0.0
	1,2,3,4,7,8-Hexachlorodibenzofuran	0.00000115		
	Octachlorodibenzodioxin	0.00368000		
	2,3,7,8-Tetrachlorodibenzofuran	0.00000115		
NBS97SF004	2,3,4,6,7,8-Hexachlorodibenzofuran	0.00000590	09/20/97	0.0
	2,3,4,7,8-Pentachlorodibenzofuran	0.00000354		
	1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	0.00013000		
	1,2,3,4,6,7,8-Heptachlorodibenzofuran	0.00003540		
	1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin	0.00000590		
	1,2,3,6,7,8-Hexachlorodibenzofuran	0.00000472		
	1,2,3,4,7,8,9-Heptachlorodibenzofuran	0.00000472		
	1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin	0.00000708		
	1,2,3,4,7,8-Hexachlorodibenzo-*p*-dioxin	0.00000354		
	1,2,3,4,7,8-Hexachlorodibenzofuran	0.00001180		
	1,2,3,7,8-Pentachlorodibenzo-*p*-dioxin	0.00000236		
	1,2,3,7,8-Pentachlorodibenzofuran	0.00000354		
	Octachlorodibenzodioxin	0.00354000		
	Octachlorodibenzofuran	0.00002360		
	2,3,7,8-Tetrachlorodibenzo-*p*-dioxin	0.00000118		
	2,3,7,8-Tetrachlorodibenzofuran	0.00001180		
NBS97SF005	2,3,4,6,7,8-Hexachlorodibenzofuran	0.00001050	09/20/97	0.0
	2,3,4,7,8-Pentachlorodibenzofuran	0.00000785		
	1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	0.00010500		
	1,2,3,4,6,7,8-Heptachlorodibenzofuran	0.00002620		
	1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin	0.00000785		
	1,2,3,6,7,8-Hexachlorodibenzofuran	0.00000524		
	1,2,3,4,7,8,9-Heptachlorodibenzofuran	0.00000393		
	1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin	0.00001050		
	1,2,3,7,8,9-Hexachlorodibenzofuran	0.00000131		
	1,2,3,4,7,8-Hexachlorodibenzo-*p*-dioxin	0.00000393		
	1,2,3,4,7,8-Hexachlorodibenzofuran	0.00001310		
	1,2,3,7,8-Pentachlorodibenzofuran	0.00000393		
	Octachlorodibenzodioxin	0.00550000		
	Octachlorodibenzofuran	0.00001310		
	2,3,7,8-Tetrachlorodibenzofuran	0.00001310		

TABLE 8-5

Analytical Results for Organic Contaminants Detected in Soil Samples
Site 3 - Explosive Burn Area and Site 4 - Abandoned Landfill, and New Burn Site
Jefferson Proving Ground
Madison, Indiana

Sample ID	Contaminant	Concentration (µg/g)[(a)]	Sample Date	Depth (feet)
NBS97SF006	2,3,4,6,7,8-Hexachlorodibenzofuran	0.00002190	09/20/97	0.0
	2,3,4,7,8-Pentachlorodibenzofuran	0.00001090		
	1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	0.00033900		
	1,2,3,4,6,7,8-Heptachlorodibenzofuran	0.00013100		
	1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin	0.00004370		
	1,2,3,6,7,8-Hexachlorodibenzofuran	0.00001090		
	1,2,3,4,7,8,9-Heptachlorodibenzofuran	0.00000656		
	1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin	0.00004370		
	1,2,3,7,8,9-Hexachlorodibenzofuran	0.00000109		
	1,2,3,4,7,8-Hexachlorodibenzo-*p*-dioxin	0.00001090		
	1,2,3,4,7,8-Hexachlorodibenzofuran	0.00003280		
	1,2,3,7,8-Pentachlorodibenzofuran	0.00000765		
	Octachlorodibenzodioxin	0.00273000		
	Octachlorodibenzofuran	0.00005460		
	2,3,7,8-Tetrachlorodibenzofuran	0.00032800		
	Tetryl	0.239		
NBS97SF007	2,3,4,6,7,8-Hexachlorodibenzofuran	0.00000328	09/20/97	0.0
	2,3,4,7,8-Pentachlorodibenzofuran	0.00000215		
	1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	0.00008740		
	1,2,3,4,6,7,8-Heptachlorodibenzofuran	0.00001090		
	1,2,3,6,7,8-Hexachlorodibenzofuran	0.00000219		
	1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin	0.00000322		
	1,2,3,4,7,8-Hexachlorodibenzofuran	0.00000656		
	1,2,3,7,8-Pentachlorodibenzofuran	0.00000107		
	Octachlorodibenzodioxin	0.00109000		
	Octachlorodibenzofuran	0.00001090		
	2,3,7,8-Tetrachlorodibenzofuran	0.00000437		
NBS97SF008	2,3,4,6,7,8-Hexachlorodibenzofuran	0.00000116	09/20/97	0.0
	1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	0.00006980		
	1,2,3,4,6,7,8-Heptachlorodibenzofuran	0.00000698		
	Octachlorodibenzodioxin	0.00594000		
	2,3,7,8-Tetrachlorodibenzofuran	0.00001160		
NBS97SF009	1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	0.00004590	09/20/97	0.0
	1,2,3,4,6,7,8-Heptachlorodibenzofuran	0.00000459		
	1,2,3,4,7,8-Hexachlorodibenzofuran	0.00000230		

TABLE 8-5

Analytical Results for Organic Contaminants Detected in Soil Samples
Site 3 - Explosive Burn Area and Site 4 - Abandoned Landfill, and New Burn Site
Jefferson Proving Ground
Madison, Indiana

Sample ID	Contaminant	Concentration (µg/g)[(a)]	Sample Date	Depth (feet)
NBS97SF009	Octachlorodibenzodioxin	0.00425000	09/20/97	0.0
	2,3,7,8-Tetrachlorodibenzofuran	0.00000230		
NBS97SF010	2,3,4,6,7,8-Hexachlorodibenzofuran	0.00000222	09/20/97	0.0
	1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	0.00004440		
	1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin	0.00000222		
	Octachlorodibenzodioxin	0.00355000		
	2,3,7,8-Tetrachlorodibenzofuran	0.00000333		
NBS97BHA01	2,3,4,6,7,8-Hexachlorodibenzofuran	0.00000226	09/20/97	0.0
	1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	0.00004510		
	1,2,3,4,6,7,8-Heptachlorodibenzofuran	0.00000677		
	1,2,3,6,7,8-Hexachlordibenzo-*p*-dioxin	0.00000113		
	1,2,3,4,7,8-Hexachlorodibenzofuran	0.00000451		
	1,2,3,7,8-Pentachlorodibenzofuran	0.00000339		
	Octachlorodibenzodioxin	0.00214000		
	Octachlorodibenzofuran	0.00000564		
	2,3,7,8-Tetrachlorodibenzofuran	0.00000339		
	9-Hexadecanoic acid	0.225		
	Acenaphthylene	0.011		
	Anthracene	0.012		
	Benzo[a]anthracene	0.135		
	Benzo[b]fluoranthene	0.180		
	Benzoic acid	0.135		
	Benzo[ghi]perylene	0.107		
	Benzo[k]fluoranthene	0.064		
	Hexadecane	0.449		
	Nonadecane	0.337		
	Chrysene	0.146		
	Dibenzo[ah]anthracene	0.028		
	Di-n-butyl phthalate	0.753		
	1-Eicosanol	0.337		
	Fluoranthene	0.315		
	Indeno[1,2,3-C,D]pyrene	0.112		
	Phenanthrene	0.169		
	Pyrene	0.236		
	Steroids	1.010		
NBS97BHA02	1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	0.00003310	09/20/97	1.0
	Octachlorodibenzodioxin	0.00220000		
	Benzo[a]anthrancene	0.014		
	Benzoic acid	0.090		
	Myristic acid	0.110		
	Palmitic acid	1.100		
	Nonadecane	0.331		
	Chrysene	0.010		

TABLE 8-5

Analytical Results for Organic Contaminants Detected in Soil Samples
Site 3 - Explosive Burn Area and Site 4 - Abandoned Landfill, and New Burn Site
Jefferson Proving Ground
Madison, Indiana

Sample ID	Contaminant	Concentration (µg/g)[a]	Sample Date	Depth (feet)
NBS97BHA02	Di-n-butyl phthalate	0.739	09/20/97	1.0
	1-Eicosanol	0.220		
	Fluoranthene	0.021		
	Stearic acid	0.551		
NBS97BHA03	1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	0.00003310	09/20/97	3.0
	Octachlorodibenzodioxin	0.00408000		
	Benzoic acid	0.074		
	Di-n-butyl phthalate	0.742		
NBS97BHA04	1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	0.00004510	09/20/97	5.0
	Octachlorodibenzodioxin	0.00695000		
	Benzoic acid	0.137		
	Di-n-butyl phthalate	0.765		
NBS97BHB01	2,3,4,6,7,8-Hexachlorodibenzofuran	0.00000557	09/20/97	0.0
	2,3,4,7,8-Pentachlorodibenzofuran	0.00000334		
	1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	0.00010000		
	1,2,3,4,6,7,8-Heptachlorodibenzofuran	0.00005570		
	1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin	0.00001110		
	1,2,3,6,7,8-Hexachlorodibenzofuran	0.00000334		
	1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin	0.00001000		
	1,2,3,4,7,8-Hexachlorodibenzofuran	0.00001110		
	1,2,3,7,8-Pentachlorodibenzo-*p*-dioxin	0.00000223		
	1,2,3,7,8-Pentachlorodibenzofuran	0.00000223		
	Octachlorodibenzodioxin	0.00301000		
	Octachlorodibenzofuran	0.00002230		
	2,3,7,8-Tetrachlorodibenzofuran	0.00001110		
	2-Methylnaphthalene	0.022		
	2-Phenylnaphthalene	0.445		
	Acenaphthene	0.557		
	Anthracene	0.958		
	Benzo[a]anthracene	4.010		
	Benzo[a]pyrene	3.560		
	Benzo[b]fluoranthene	4.680		
	Benzoic acid	0.065		
	Benzo[e]pyrene	2.230		
	Benzo[ghi]perylene	2.670		
	Benzo[k]fluoranthene	1.220		
	Benzo[b]naphtho[2,1-D]thiophene	0.891		
	Carbazole	0.223		
	Chrysene	3.560		
	Dibenz[ah]anthracene	0.557		
	Dibenzofuran	0.145		
	1-Eicosanol	0.445		
	Fluoranthene	8.910		

TABLE 8-5

Analytical Results for Organic Contaminants Detected in Soil Samples
Site 3 - Explosive Burn Area and Site 4 - Abandoned Landfill, and New Burn Site
Jefferson Proving Ground
Madison, Indiana

Sample ID	Contaminant	Concentration (µg/g)[a]	Sample Date	Depth (feet)
NBS97BHB01	γ-Sitosterol	0.445	09/20/97	0.0
	Indeno[1,2,3-C,D]pyrene	2.670		
	Naphthalene	0.029		
	Phenanthrene	4.450	09/20/97	0.0
	DDE	2.230		
	DDT	1.110		
	Pyrene	7.350		
NBS97BHB02	2,3,4,6,7,8-Hexachlorodibenzofuran	0.00000542	09/20/97	1.0
	2,3,4,7,8-Pentachlorodibenzofuran	0.00000217		
	1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	0.00016300		
	1,2,3,4,6,7,8-Heptachlorodibenzofuran	0.00015200		
	1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin	0.00003250		
	1,2,3,6,7,8-Hexachlorodibenzofuran	0.00000217		
	1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin	0.00002170		
	1,2,3,4,7,8-Hexachlorodibenzo-*p*-dioxin	0.00000433		
	1,2,3,4,7,8-Hexachlorodibenzofuran	0.00000542		
	1,2,3,7,8-Pentachlorodibenzo-*p*-dioxin	0.00000433		
	1,2,3,7,8-Pentachlorodibenzofuran	0.00000108		
	Octachlorodibenzodioxin	0.00141000		
	Octachlorodibenzofuran	0.00004330		
	2,3,7,8-Tetrachlorodibenzofuran	0.00000325		
	Benzo[a]anthracene	0.0496		
	Benzo[a]pyrene	0.0647		
	Benzo[b]fluoranthene	0.0777		
	Benzoic acid	0.0604		
	Benzo[ghi]perylene	0.1250		
	Benzo[k]fluoranthene	0.0259		
	Chrysene	0.0475		
	Fluoranthene	0.0712		
	Indeno[1,2,3-C,D]pyrene	0.1060		
	Phenanthrene	0.0388		
	Pyrene	0.0690		
NBS97BHB03	2,3,4,6,7,8-Hexachlorodibenzofuran	0.00028900	09/20/97	3.0
	2,3,4,7,8-Pentachlorodibenzofuran	0.00020000		
	1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	0.00041100		
	1,2,3,4,6,7,8-Heptachlorodibenzofuran	0.00063300		
	1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin	0.00006660		
	1,2,3,6,7,8-Hexachlorodibenzofuran	0.00014400		
	1,2,3,4,7,8,9-Heptachlorodibenzofuran	0.00005550		

TABLE 8-5

Analytical Results for Organic Contaminants Detected in Soil Samples
Site 3 - Explosive Burn Area and Site 4 - Abandoned Landfill, and New Burn Site
Jefferson Proving Ground
Madison, Indiana

Sample ID	Contaminant	Concentration (µg/g)[a]	Sample Date	Depth (feet)
NBS97BHB03	1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin	0.00011100	09/20/97	3.0
	1,2,3,7,8,9-Hexachlorodibenzofuran	0.00000888		
	1,2,3,4,7,8-Hexachlorodibenzo-*p*-dioxin	0.00004440		
	1,2,3,4,7,8-Hexachlorodibenzofuran	0.00044400		
	1,2,3,7,8-Pentachlorodibenzo-*p*-dioxin	0.00004440		
	1,2,3,7,8-Pentachlorodibenzofuran	0.00011100		
	Octachlorodibenzodioxin	0.00233000		
	Octachlorodibenzofuran	0.00011100		
	2,3,7,8-Tetrachlorodibenzo-*p*-dioxin	0.00000888		
	2,3,7,8-Tetrachlorodibenzofuran	0.00053300		
	2,4-Dinitrotoluene	0.1730		
	Anthracene	0.0121		
	Benzo[a]anthracene	0.0189		
	Benzo[a]pyrene	0.0156		
	Benzo[b]fluoranthene	0.0189		
	Benzo[ghi]perylene	0.0364		
	Benzo[k]fluoranthene	0.0144		
	Chrysene	0.0144		
	Diethyl phthalate	0.0178		
	Di-n-butyl phthalate	0.7440		
	Fluoranthene	0.0244		
	Indeno[1,2,3-C,D]pyrene	0.0287		
	Phenanthrene	0.0211		
	Pyrene	0.0289		
NBS97BHB04	2,3,4,6,7,8-Hexachlorodibenzofuran	0.00002200	09/20/97	5.0
	2,3,4,7,8-Pentachlorodibenzofuran	0.00001100		
	1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	0.00004410		
	1,2,3,4,6,7,8-Heptachlorodibenzofuran	0.00005000		
	1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin	0.00000661		
	1,2,3,6,7,8-Hexachlorodibenzofuran	0.00001100		
	1,2,3,4,7,8,9-Heptachlorodibenzofuran	0.00000441		
	1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin	0.00001100		
	1,2,3,4,7,8-Hexachlorodibenzo-*p*-dioxin	0.00000441		
	1,2,3,4,7,8-Hexachlorodibenzofuran	0.00003300		
	1,2,3,7,8-Pentachlorodibenzo-*p*-dioxin	0.00000330		
	1,2,3,7,8-Pentachlorodibenzofuran	0.00000771		
	Octachlorodibenzodioxin	0.00154000		
	Octachlorodibenzofuran	0.00001100		
	2,3,7,8-Tetrachlorodibenzo-*p*-dioxin	0.00000110		
	2,3,7,8-Tetrachlorodibenzofuran	0.00003300		
	Benzo[a]anthracene	0.0501		
	Di-n-butyl phthalate	0.7450		
	Fluoranthene	0.0111		

TABLE 8-5

Analytical Results for Organic Contaminants Detected in Soil Samples
Site 3 - Explosive Burn Area and Site 4 - Abandoned Landfill, and New Burn Site
Jefferson Proving Ground
Madison, Indiana

Sample ID	Contaminant	Concentration (µg/g)[a]	Sample Date	Depth (feet)
NBS97BHC01	2,3,4,6,7,8-Hexachlorodibenzofuran	0.00000769	09/20/97	0.0
	1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	0.00007690		
	1,2,3,4,6,7,8-Heptachlorodibenzofuran	0.00008790		
	1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin	0.00000549		
	1,2,3,6,7,8-Hexachlorodibenzofuran	0.00000440		
	1,2,3,4,7,8,9-Heptachlorodibenzofuran	0.00000220		
	1,2,3,4,7,8-Hexachlorodibenzo-*p*-dioxin	0.00000220		
	1,2,3,4,7,8-Hexachlorodibenzofuran	0.00001100		
	1,2,3,7,8-Pentachlorodibenzo-*p*-dioxin	0.00000220		
	Octachlorodibenzodioxin	0.00407000		
	Octachlorodibenzofuran	0.00003300		
	2,3,7,8-Tetrachlorodibenzo-*p*-dioxin	0.00000220		
	2,3,7,8-Tetrachlorodibenzofuran	0.00002200		
	2-methylpyrene	0.5500		
	2-phenylnaphthalene	0.3300		
	Acenaphthene	0.2310		
	Anthracene	0.8580		
	Benzo[a]anthracene	4.2900		
	Benzo[a]pyrene	3.3000		
	Benzo[b]fluoranthene	4.2900		
	Benzoic acid	0.0341		
	Benzo[e]pyrene	2.2000		
	Benzo[ghi]perylene	2.3100		
	Benzo[j]fluoranthene	0.6600		
	Benzo[k]fluoranthene	1.7600		
	Carbazole	0.2200		
	Chrysene	3.6300		
	Dibenz[ah]anthracene	0.5390		
	Dibenzofuran	0.0891		
	Dibenzothiophene	0.2200		
	Di-n-butyl phthalate	0.7370		
	Fluoranthene	7.9200		
	Fluorene	0.2200		
	γ-Sitosterol	0.9900		
	Indeno[1,2,3-C,D]pyrene	2.5300		
	Naphthalene	0.0132		
	Phenanthrene	3.5200		
	Pyrene	7.7000		
NBS97BHC02	2,3,4,6,7,8-Hexachlorodibenzofuran	0.00005580	09/20/97	1.0
	Octachlorodibenzodioxin	0.01220000		
	Di-n-butyl phthalate	0.7430		
	Fluoranthene	0.0144		
	Pyrene	0.0211		

TABLE 8-5

Analytical Results for Organic Contaminants Detected in Soil Samples
Site 3 - Explosive Burn Area and Site 4 - Abandoned Landfill, and New Burn Site
Jefferson Proving Ground
Madison, Indiana

Sample ID	Contaminant	Concentration (µg/g)[(a)]	Sample Date	Depth (feet)
NBS97BHC03	2,3,4,6,7,8-Hexachlorodibenzofuran	0.00000226	09/20/97	3.0
	1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	0.00005650		
	1,2,3,4,6,7,8-Heptachlorodibenzofuran	0.00000339		
	1,2,3,6,7,8-Hexachlorodibenzofuran	0.00000226		
	Octachlorodibenzodioxin	0.01330000		
	2,3,7,8-Tetrachlorodibenzofuran	0.00000339		
	Benzo[a]anthracene	0.1250		
	Di-n-butyl phthalate	0.7620		
NBS97BHC04	2,3,4,6,7,8-Hexachlorodibenzofuran	0.00000112	09/20/97	5.0
	1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	0.00002250		
	1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin	0.00000112		
	1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin	0.00000112		
	Octachlorodibenzodioxin	0.00258000		
	2,3,7,8-Tetrachlorodibenzofuran	0.00000112		
	Benzoic acid	0.1120		
	Di-n-butyl phthalate	0.7480		

Footnotes:
(a) Micrograms per gram.

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TABLE 8-6

Analytical Results for Metals in Groundwater Samples
Site 3 - Explosive Burn Area and Site 4 - Abandoned Landfill
Jefferson Proving Ground
Madison, Indiana

				Metals (ug/L)																									
Field Identification	Location Identification	Sample Date	Sample Type	Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Tin	Vanadium	Zinc
JPG-S3/4MW93-20	**MW93-20**	6/16/1993	N	295	LT 60.0	LT 2.35	388	LT 1.12	292	LT 6.78	92,800	LT 16.8	LT 25.0	LT 18.8	279	LT 4.47	40,700	864	LT 0.10	LT 52.7	LT 32.1	3,510	LT 2.53	0.333	23,100	LT 12.5	NA	LT 27.6	LT 18.0
		11/6-7/95	N	1,340	LT 10.0	LT 5.00	696	LT 5.00	250	LT 5.00	83,300	LT 10.0	LT 50.0	LT 20.0	4,410	LT 3.00	39,200	164	LT 0.20	LT 100	LT 40.0	4,340	LT 5.00	LT 10.0	21,800	LT 10.0	LT 100	50	LT 20.0
		2/19-20/96	N	171	LT 10.0	LT 5.00	394	LT 5.00	178	5	84,600	LT 10.0	LT 50.0	LT 20.0	1,890	LT 3.00	37,900	52.5	LT 0.20	LT 100	LT 40.0	3,380	ND 5.00	LT 10.0	21,000	LT 10.0	LT 100	LT 50.0	LT 20.0
		4/27-5/1/96	N	3,400	LT 10.0	LT 5.00	467	5	256	LT 5.00	90,200	36.9	LT 50.0	LT 20.0	4,700	LT 3.00	41,500	130	LT 0.20	12.7	26.9	4,690	LT 5.56	LT 10.0	22,400	LT 11.1	LT 100	2.95	8.44
		6/20-26/96	N	1,260	LT 10.0	LT 5.00	389	LT 5.00	211	3.35	85,300	31.2	LT 50.0	LT 20.0	2,590	LT 3.00	38,100	158	LT 0.20	24.2	28.5	3,510	LT 5.00	LT 10.0	21,500	LT 10.0	LT 100	50	LT 20.0
		6/10/2001	N	50(U/)	5(U/)	5(U/)	405	1(U/)	NA	5(U/)	79,200	10(U/)	10(U/)	20(U/)	3,180	5(U/)	37,800	122	0.2(U/)	NA	6.9(J/10U)	3,300	NA	10(U/)	21,000	10(U/)	NA	10(U/)	20(U/)
JPG-S3/4MW93-21	**MW93-21**	6/16/1993	N	LT 112	LT 60.0	LT 2.35	322	LT 1.12	301	LT 6.78	89,900	LT 16.8	LT 25.0	LT 18.8	149	LT 4.47	39,700	1,130	LT 0.10	LT 52.7	LT 32.1	3,400	LT 2.53	0.333	21,500	LT 12.5	NA	LT 27.6	LT 18.0
		11/6-7/95	N	232	LT 10.0	LT 5.00	606	LT 5.00	211	LT 5.00	81,600	5.1	LT 50.0	LT 20.0	3,230	LT 3.00	39,000	63.3	LT 0.20	LT 100	LT 40.0	3,720	LT 5.00	LT 10.0	20,400	LT 10.0	LT 100	LT 50.0	LT 20.0
		2/19-20/96	N	147	LT 10.0	LT 5.00	356	LT 5.00	209	LT 5.00	77,600	LT 10.0	LT 50.0	LT 20.0	2,880	LT 3.00	35,600	59.4	LT 0.20	LT 100	LT 40.0	2,730	ND 5.00	LT 10.0	21,600	ND 10.0	LT 100	ND 50.0	5.12
		4/27-5/1/96	N	LT 200	2.42	LT 5.00	391	LT 5.00	239	LT 5.00	80,800	LT 10.0	5.68	LT 20.0	2,020	LT 3.00	37,300	59.2	LT 0.20	LT 100	LT 40.0	3,130	LT 5.56	LT 10.0	23,800	LT 11.1	LT 100	50	LT 20.0
		6/20-26/96	N	312	LT 10.0	LT 5.00	350	LT 5.00	208	LT 5.00	82,700	LT 10.0	LT 50.0	LT 20.0	2,360	LT 3.00	37,200	68.8	LT 0.20	100	40	3,000	LT 5.00	LT 10.0	20,900	LT 10.0	LT 100	LT 50.0	LT 20.0
		6/9/2001	N	255	5(U/)	5(U/)	1,160(/J)	1(U/)	NA	5(U/)	106,000	10(U/)	10(U/)	3.1(J/20U)	1,460	5(U/)	49,200	91.8	0.2(U/)	NA	10.6(/100U)	2,000(/U)	NA	10(U/)	70,200(/J)	10(U/)	NA	10(U/)	11.3(J/20U)
JPG-S3/4MW01-54	**MW93-21**	6/9/2001	N	50(U/)	5(U/)	5(U/)	311	1(U/)	NA	5(U/)	84,800	10(U/)	10(U/)	20(U/)	1,470	5(U/)	39,500	96.3	0.2(U/)	NA	5.4(/10U)	3,090(/U)	NA	10(U/)	20,900(/J)	10(U/)	NA	10(U/)	20(U/)
JPG-S3/4MW93-22	**MW93-22**	6/16/1993	N	LT 112	LT 60.0	LT 2.35	324	LT 1.12	250	LT 6.78	92,700	LT 16.8	LT 25.0	LT 18.8	368	LT 4.47	40,000	772	LT 0.10	LT 52.7	LT 32.1	3,340	LT 2.53	0.333	23,200	LT 12.5	NA	LT 27.6	LT 18.0
		11/6-7/95	N	397	10	LT 5.00	428	LT 5.00	209	LT 5.00	87,600	5	LT 50.0	LT 20.0	1,670	LT 3.00	38,800	69.5	LT 0.20	LT 100	LT 40.0	3,160	LT 5.00	LT 10.0	22,200	LT 10.0	LT 100	LT 50.0	LT 20.0
		2/19-20/96	N	3,470	LT 10.0	LT 5.00	323	LT 5.00	182	1.09	82,000	9.02	LT 50.0	LT 20.0	3,270	2.7	36,800	167	LT 0.20	LT 100	11.1	4,060	ND 5.00	LT 10.0	20,200	ND 10.0	LT 100	3.61	12.8
		4/27-5/1/96	N	521	LT 10.0	LT 5.00	310	LT 5.00	185	LT 5.00	87,700	5.12	LT 50.0	LT 20.0	813	LT 3.00	38,500	45.2	LT 0.20	9.6	LT 40.0	3,890	LT 5.00	LT 10.0	22,000	LT 11.1	100	LT 50.0	LT 20.0
		6/20-26/96	N	121	LT 10.0	LT 5.00	301	LT 5.00	184	LT 5.00	84,600	LT 10.0	LT 50.0	LT 20.0	936	LT 3.00	37,400	53.2	LT 0.20	100	LT 40.0	3,070	LT 5.00	LT 10.0	21,500	LT 10.0	LT 100	LT 50.0	LT 20.0
		6/10/2001	N	78.7	5(U/)	5(U/)	304	1(U/)	NA	5(U/)	78,100	10(U/)	10(U/)	12.6(J/20U)	697	1.2(J/5U)	37,700	24.2	0.2(U/)	NA	15.3(/U)	3,680(/U)	NA	10(U/)	21,200	10(U/)	NA	10(U/)	15.1(J/20U)
JPG-S3/4MW93-23	**MW93-23**	6/16/1993	N	163	LT 60.0	LT 2.35	330	LT 1.12	255	LT 6.78	94,200	LT 16.8	LT 25.0	LT 18.8	526	LT 4.47	41,000	528	LT 0.10	LT 52.7	LT 32.1	2,810	LT 2.53	0.333	22,600	LT 12.5	NA	LT 27.6	LT 18.0
		11/6-7/95	N	2,470	LT 10.0	LT 5.00	434	LT 5.00	189	LT 5.00	87,400	4.7	LT 50.0	LT 20.0	1,000	LT 3.00	39,300	112	LT 0.20	LT 100	LT 40.0	3,800	LT 5.00	LT 10.0	21,300	LT 10.0	LT 100	6.9	LT 20.0
		2/19-20/96	N	1,360	LT 10.0	LT 5.00	321	LT 5.00	172	LT 5.00	81,900	4.28	LT 50.0	LT 20.0	904	LT 3.00	36,300	106	LT 0.20	100	LT 40.0	3,580	ND 5.00	LT 10.0	19,700	ND 10.0	100	3.33	6.56
		4/27-5/1/96	N	4,760	2.59	LT 5.00	345	5	198	LT 5.00	84,500	23.4	5.71	LT 20.0	2,150	2.71	38,100	101	LT 0.20	LT 100	10.8	3,680	5	LT 10.0	21,000	LT 11.1	LT 100	50	LT 20.0
		6/20-26/96	N	1,370	LT 10.0	LT 5.00	297	LT 5.00	183	LT 5.00	80,100	LT 10.0	8.31	LT 20.0	991	LT 3.00	35,500	79.3	LT 0.20	100	LT 40.0	1,770	LT 5.00	LT 10.0	19,800	LT 10.0	LT 100	LT 50.0	LT 20.0
		6/10/2001	N	50(U/)	5(U/)	5(U/)	318	1(U/)	NA	5(U/)	86,000	10(U/)	10(U/)	8.8(J/20U)	284	5(U/)	39,000	29.2	0.2(U/)	NA	10(U/)	3,120	NA	10(U/)	21,700	10(U/)	NA	10(U/)	10.4(J/20U)
JPG-S3/4MW95-06	**MW95-06**	11/6-7/95	N	31,200	5.3	LT 5.00	282	LT 5.00	296	LT 5.00	364,000	83.8	5.3	LT 20.0	**22,500**	12.4	204,000	761	LT 0.20	38	40.9	14,100	4.1	LT 10.0	30,600	LT 10.0	LT 100	39	50
		2/19-20/96	N	12,500	4.42	LT 5.00	199	LT 5.00	245	LT 5.00	145,000	31.7	LT 50.0	LT 20.0	6,940	5.7	91,200	255	LT 0.20	100	20.2	8,730	ND 5.00	LT 10.0	33,000	ND 10.0	LT 100	13.4	15.8
		4/27-5/1/96	N	17,400	LT 10.0	LT 5.00	209	LT 5.00	266	LT 5.00	121,000	33.5	LT 50.0	LT 20.0	6,410	4.37	72,500	182	LT 0.20	37.5	23.7	6,550	LT 5.56	LT 10.0	35,000	LT 10.0	51.6	4.63	13.6
		6/20-26/96	N	7,080	LT 10.0	LT 5.00	225	LT 5.00	260	LT 5.00	162,000	28.8	LT 50.0	LT 20.0	4,770	4.23	92,500	53.3	LT 0.20	31.2	39.5	6,420	LT 5.00	LT 10.0	33,900	LT 10.0	LT 100	12.8	12.2
		6/9/2001	N	1,600	5(U/)	**1.88(J/5U)**	202	1(U/)	NA	5(U/)	67,900	5.1(J/10U)	10(U/)	20(U/)	718	5(U/)	54,600	61.4	0.2(U/)	NA	15.6(/100U)	4,550	NA	10(U/)	34,600	10(U/)	NA	10(U/)	20(U/)
JPG-S3/4MW01-01	**MW01-01**	6/13/2001	N	1,340	2.24 (J/5U)	**1.88 (J/5U)**	181	0.4 (J/1U)	NA	5.0 (U/)	90,200	16.2	5.4 (J/10U)	2.5 (J/20U)	966	2.7 (J/5U)	52,100	393	0.2(U/)	NA	55	8,310	1.84 (J/5U)	10(U/)	21,400	**6.3 (J/10U)**	NA	10(U/)	113
JPG-S3/4MW01-02	**MW01-02**	6/10/2001	N	906	5.0 (U/)	**2.61 (J/5U)**	159	1(U/)	NA	5.0 (U/)	88,800	3.4 (J/10U)	10(U/)	1.7 (J/20U)	396	2.1 (J/5U)	43,800	75.9	0.2(U/)	NA	11.1 (U/)	5,340	NA	10(U/)	19,900	10(U/)	NA	3.3(J/10U)	14.6(J/20U)
JPG-S3/4MW01-03	**MW01-03**	6/13/2001	N	1,630	5.0 (U/)	5.0 (U/)	50.6	1(U/)	NA	5.0 (U/)	68,800	10(U/)	10(U/)	20(U/)	229	5(U/)	25,100	14.5	0.2(U/)	NA	10(U/)	1,260 (J/2,2000U)	5(U/)	10(U/)	12,100	10(U/)	NA	10(U/)	45.9
JPG-S3/4MW01-04	**MW01-04**	6/11/2001	N	7,950	5.0 (U/)	**3.64 (J/5U)**	275	1	NA	5.0 (U/)	857,000	24.7	12.9	20(U/)	**20,700**	**25.8**	316,000	2,540	0.2(U/)	NA	18.7 (/U)	7,330	2.32 (J/)	10(U/)	3,630	10(U/)	NA	22	145
			PRGs (1)	36,000	15	0.045	2,600	73	3,300	18	NSE	110 (2)	2,200	1,400	11,000	15	NSE	880	1.1	180	730	NSE	180	180	NSE	2.4	22,000	260	11,000

General Notes:
1. (LF / VF) = Lab Flag / Validation Flag
2. ug/L = Micrograms per liter
3. Sample Types:
"N" = Normal field Sample
5. LT = Less than the reporting limit as presented by Earthtech
6. PRGs = Preliminary Remediation Goals
7. R = Result rejected
8. U = Compound was not detected
9. J = Estimated value. The result is less than the reporting limit, but greater than the maximum detection limit.
10. ND = Not detected
11. NA = Not analyzed
12. NSE = No standard established
13. Bolded results indicate a PRG exceedance

Footnotes:
(1) PRGs = Preliminary Remediation Goals from US EPA Region 9 for Tap Water
(2) The PRG listed is for Chromium VI, because it is the most conservative value. However, chromium in groundwater was analyzed for total chromium.

TABLE 8-7

Analytical Results for Organic Contaminants Detected in Phase II Groundwater Samples
Site 3 - Explosives Burn Area and Site 4 - Abandoned Landfill Area
Jefferson Proving Ground
Madison, Indiana

				VOCs (ug/L)												SVOCs (ug/L)			Explosives (ug/L)
Field Identification	**Location Identification**	**Sample Date**	**Sample Type**	TOLUENE	TOTAL XYLENES	1,1,1-TRICHLOROETHANE	1,1-DICHLOROETHANE	1,1-DICHLOROETHENE	CHLOROETHANE	cis-1,2-DICHLOROETHYLENE	TETRACHLORO-ETHYLENE (PCE)	trans-1,2-DICHLORO-ETHENE	CARBON DISULFIDE	TRICHLOROETHYLENE (TCE)	TRICHLOROFLUORO-METHANE	DIMETHYLPHTHALATE	bis(2-ETHYLHEXYL) PHTHALATE	PYRENE	4-AMINO-2,6-DINITROTOLUENE
JPG-S3/4MW93-20	**MW93-20**	6/16/1993	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
		11/7/1995	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
		2/14/1996	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
		4/27/1996	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.35	ND
		6/22/1996	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
		6/10/2001	N	1(U/)	2(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	9.4(U/)	9.4(U/)	9.4(U/)	2(U/)
JPG-S3/4MW93-21	**MW93-21**	6/16/1993	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
		11/8/1995	N	0.37	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.061
		2/15/1996	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
		5/1/1996	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
		6/26/1996	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
		6/9/2001	N	1(U/)	2(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	9.4(U/)	9.4(U/)	9.4(U/)	2(U/)
JPG-S3/4MW93-22	**MW93-22**	6/16/1993	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
		11/7/1995	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
		2/20/1996	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
		5/1/1996	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
		6/26/1996	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
		6/10/2001	N	1(U/)	2(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	9.4(U/)	9.4(U/)	9.4(U/)	2(U/)
JPG-S3/4MW93-23	**MW93-23**	6/16/1993	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
		11/7/1995	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
		2/20/1996	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
		4/26/1996	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.46	ND
		6/22/1996	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.3	ND
		6/10/2001	N	1(U/)	2(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/UJ)	1(U/)	1(U/)	1(U/)	1(U/)	9.5(U/)	9.5(U/)	9.5(U/)	2(U/)
JPG-S3/4MW95-06	**MW95-06**	11/9/1995	N	0.78	ND	1	ND	ND	ND	0.26	ND	ND	0.7	ND	ND	3.5	ND	ND	ND
		2/20/1996	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
		5/1/1996	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
		6/26/1996	N	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
		6/9/2001	N	1(U/)	2(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	9.4(U/)	9.4(U/)	9.4(U/)	2(U/)
JPG-S3/4MW01-01	**MW01-01**	6/13/2001	N	1(U/)	2(U/)	1(U/)	1(U/)	1(U/J)	1(U/UJ')	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	11(U/UJ)	11(U/UJ)	11(U/UJ)	2(U/)
JPG-S3/4MW01-02	**MW01-02**	6/10/2001	N	1(U/)	2(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	9.4(U/)	**11**	9.4(U/)	2(U/)
JPG-S3/4MW01-03	**MW01-03**	6/13/2001	N	1(U/)	2(U/)	40	21	**2.9(J)**	0.76(J/1U,UJ')	**68**	0.23(J/1U)	2	1(U/)	**26**	0.53(J/1U)	9.4(U/)	9.4(U/)	9.4(U/)	2(U/)
JPG-S3/4MW01-04	**MW01-04**	6/11/2001	N	1(U/)	2(U/)	1(U/)	1(U/)	1(U/)	1(U/UJ)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	1(U/)	11(U/)	11(U/)	11(U/)	NA
			PRGs (1)	720	1400 (2)	540	810	0.046	4.6	61	1.1	120	1,000	1.6	1,300	360,000	4.8	180	0.1

General Notes:

1. (LF / VF) = Lab Flag / Validation Flag
2. Only compounds detected are listed in this table
3. ug/L = Micrograms per liter
4. VOCs = Volatile organic compounds
5. SVOCs = Semivolatile organic compounds
6. Sample Types:
   "N" = Normal field Sample
7. PRGs = Preliminary Remediation Goals
8. U = Compound was not detected
9. J = Estimated value. The result is less than the reporting limit, but greater than the maximum detection limit
10. Bolded results indicate a PRG exceedance
11. NA = Not analyzed
12. ND = Not detected as presented by Earthtech

Footnotes:

(1) PRGs = Preliminary Remediation Goals from US EPA Region 9 for Tap Water
(2) Listed PRG is for total xylenes (m,p- and o-xylenes combined)

TABLE 8-8

Soil Exposure Point Concentrations of Contaminants of Potential Concern
Site 3 –Explosive Burn Area and Site 4 - Abandoned Landfill
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[(a)]	Range of Detected Values (µg/g)[(b)]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[(c)] (µg/g)
Surface Soil - Trench						
Aluminum	5/5	2,310 - 25,200	NA[(d)]	15,862	23,991	23,991
Antimony	1/5	1.29	19.6 - 98.0	16.5	1,152	1.29
Barium	5/5	24.4 - 5,900	NA	1,448	1.9E+08	5,900
Cadmium	2/5	3.06 - 12.4	1.2 - 6.0	3.8	257	12.4
Chromium	5/5	11.0 - 54.5	NA	31.2	101	54.5
Cobalt	4/5	5.6 - 18.0	13.0	11.7	29.5	18.0
Dimethylphthalate	1/4	0.11	0.063	0.05	0.29	0.11
Lead	5/5	10.6 - 800	NA	239	7.2E+05	800
Mercury	4/5	0.068 - 0.136	0.05	0.08	0.12	0.12
Nickel	4/5	9.8 - 12.8	14.0	10.2	12.3	12.3
Silver	5/5	0.59 - 6.0	NA	2.5	27.1	6.0
Tin	3/5	8.85 - 15.8	7.43 - 37.0	12.2	17.9	15.8
Trichloroethene	2/4	0.25 - 0.68	0.23	0.28	5.9	0.68
Zinc	5/5	21.3 - 457	NA	227	26,193	457

TABLE 8-8

Soil Exposure Point Concentrations of Contaminants of Potential Concern
Site 3 –Explosive Burn Area and Site 4 - Abandoned Landfill
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/g)[b]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[c] (µg/g)
Surface Soil - Remainder of Site						
Aluminum	35/35	1,110 - 23,400	NA	11,767	13,541	13,541
Barium	35/35	42.8 - 3,200	NA	310	472	472
Boron	3/35	15.2 - 113	6.64 - 17.2	8.1	10.2	10.2
Cadmium	5/35	0.28 - 2.17	0.673 - 6.0	0.65	0.75	0.75
Cobalt	31/35	0.55 - 36.3	2.5 - 13.0	10.7	15.9	15.9
Copper	29/35	6.72 - 462	6.88 - 14.0	31	49.7	49.7
Iron	35/35	4,705 - 86,000	NA	19,766	25,280	25,280
Lead	35/35	8.64 - 1,300	NA	50.5	75.9	75.9
Manganese	35/35	323 - 9,800	NA	1,168	1,503	1,503
Mercury	12/35	0.046 - 0.18	0.05 - 0.10	0.05	0.06	0.06
Molybdenum	10/35	0.64 - 3.95	10.0 - 72.0	6.6	9.4	3.95
Nickel	35/35	2.2 - 36.7	NA	11.5	14.0	14.0
Silver	29/35	0.079 - 5.23	1.0	0.70	1.0	1.0
Thallium	1/35	0.688	1.0 - 170	14.2	44.6	0.688
Tin	7/35	2.56 - 32.5	7.43 - 37.0	6.3	7.7	7.7
Zinc	35/35	14.8 - 2,300	NA	97	138	138

TABLE 8-8

Soil Exposure Point Concentrations of Contaminants of Potential Concern
Site 3 –Explosive Burn Area and Site 4 - Abandoned Landfill
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[(a)]	Range of Detected Values (µg/g)[(b)]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[(c)] (µg/g)
Surface/Subsurface Soil Combined - Trench						
Aluminum	11/11	2,310 - 38,995	NA	22,195	28,125	28,125
Antimony	1/11	1.29	19.6 - 98.0	12.6	27.3	1.29
Arsenic	11/11	3.82 - 20.0	NA	9.5	13.4	13.4
Barium	11/11	24.4 - 5,900	NA	591	6,277	5,900
Benzyl alcohol	1/7	0.069	0.032	0.02	0.042	0.042
Beryllium	8/11	0.56 - 2.78	0.427 - 2.1	0.99	1.95	1.95
Cadmium	2/11	3.06 - 12.4	1.2 - 6.0	1.7	5.2	5.2
Chromium	11/11	11.0 - 54.5	NA	29.7	39.6	39.6
Cobalt	10/11	4.36 - 39.8	13.0	11.9	20.8	20.8
Copper	10/11	7.05 - 408	2.84	56	507	408
Dimethylphthalate	1/10	0.11	0.063	0.04	0.05	0.05
Di-n-butyl phthalate	1/10	3.0	1.3	0.89	1.32	1.32
Lead	11/11	3.12 - 800	NA	86	903	800
Mercury	6/11	0.063 - 0.136	0.05	0.057	0.077	0.077
Nickel	10/11	8.72 - 39.6	14.0	15.2	22.6	22.6

TABLE 8-8

Soil Exposure Point Concentrations of Contaminants of Potential Concern
Site 3 –Explosive Burn Area and Site 4 - Abandoned Landfill
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[(a)]	Range of Detected Values (µg/g)[(b)]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[(c)] (µg/g)
Surface/Subsurface Soil Combined - Trench (cont'd)						
Silver	10/11	0.022 - 6.0	0.012	1.5	156	6.0
Tin	3/11	8.85 - 15.8	7.43 - 37.0	7.6	10.8	10.8
Trichloroethylene	3/10	0.25 - 0.68	0.23	0.20	0.34	0.34
Vanadium	10/11	25.9 - 49.3	7.0	32.5	39.0	39.0
Zinc	11/11	21.3 - 457	NA	127	405	405

Footnotes:
(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Micrograms per gram.
(c) The 95% UCL (upper confidence limit of the mean) or the maximum detected value, whichever is lower (USEPA 1989).
(d) Not applicable.

TABLE 8-9

Soil Exposure Point Concentrations of Preliminary Contaminants of Potential Concern
New Burn Site Adjacent to Sites 3 and 4
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[(a)]	Range of Detected Values (µg/g)[(b)]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[(c)] (µg/g)
Surface Soil - Burn Area						
Barium	7/7	75.9 - 1,600	NA[(d)]	600	2,890	1,600
Boron	2/7	5.62 - 8.4	10 - 19.5	7.0	8.9	8.4
Chromium	7/7	9.62 - 40.5	NA	24.0	43.3	40.5
Copper	7/7	11.1 - 239	NA	81.3	459	239
Lead	7/7	17.3 - 510	NA	285	426	426
Manganese	7/7	275 - 638	NA	438	590	590
Mercury	2/7	0.10 - 0.27	0.10	0.08	0.19	0.19
Nickel	7/7	5.81 - 55.3	NA	14.7	40.7	40.7
Silver	3/7	0.48 - 0.57	1.0	0.51	0.53	0.53
Tin	1/7	2.75	10	4.7	5.7	2.75
Zinc	7/7	48 - 2,360	NA	741	11,977	2,360
Dioxins/furans	7/7	4.8E-06 - 6.3E-05	NA	1.9E-05	5.3E-05	5.3E-05
2-Methylnaphthalene	1/4	0.02	0.67 - 1.34	0.34	0.65	0.02
Acenaphthene	2/4	0.23 - 0.56	0.67 - 1.34	0.45	0.68	0.56

TABLE 8-9

Soil Exposure Point Concentrations of Preliminary Contaminants of Potential Concern
New Burn Site Adjacent to Sites 3 and 4
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/g)[b]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[c] (µg/g)
Surface Soil - Burn Area (cont'd)						
Anthracene	2/4	0.86 - 0.96	0.67 - 1.34	0.71	1.03	0.96
Benzoic acid	3/4	0.03 - 0.06	3.3	0.32	89,856	0.06
Benzo(a)anthracene	3/4	0.05 - 4.29	0.67	2.9	3.8E+08	4.29
Benzo(a)pyrene	3/4	0.06 - 2.9	0.67	1.8	1.6E+06	2.9
Benzo(b)fluoranthene	3/4	0.08 - 4.68	0.67	2.9	5.0E+07	4.68
Benzo(g,h,i)perylene	3/4	0.13 - 2.67	0.67	1.5	11,154	2.67
Benzo(k)fluoranthene	3/4	0.03 - 1.76	0.67	0.84	1.8	1.76
Carbazole	2/2	0.22	NA	0.22	0.22	0.22
Chrysene	3/4	0.05 - 3.63	0.67	2.5	9.0E+07	3.63
DDE	1/1	2.23	NA	NA	NA	2.23
DDT	1/1	1.11	NA	NA	NA	1.11
Dibenzofuran	2/4	0.09 - 0.15	0.67 - 1.34	0.31	7.8	0.15
Dibenzo(a,h)anthracene	2/4	0.54 - 0.56	0.67 - 1.34	0.53	0.69	0.56
Fluoranthene	4/4	0.01 - 8.91	NA	7.22	6.0E+09	8.91
Fluorene	2/4	0.22 - 0.40	0.67 - 1.34	0.41	1.11	0.40
Indeno(1,2,3-cd)pyrene	3/4	0.11 - 2.67	0.67	1.6	37,652	2.67

TABLE 8-9

Soil Exposure Point Concentrations of Preliminary Contaminants of Potential Concern
New Burn Site Adjacent to Sites 3 and 4
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/g)[b]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[c] (µg/g)
Surface Soil - Burn Area (cont'd)						
Naphthalene	2/4	0.01 - 0.03	0.67 - 1.34	0.29	4.0E+05	0.03
Phenanthrene	3/4	0.04 - 4.45	0.67	2.85	1.8E+09	4.45
Pyrene	4/4	0.02 - 7.7	NA	5.94	1.2E+09	7.7
Tetryl	1/7	0.24	0.20	0.12	0.16	0.16
Surface Soil - Remainder of Site						
Aluminum	9/9	11,100 - 15,700	NA	13,116	13,951	13,951
Arsenic	9/9	5.82 - 12.5	NA	7.9	9.3	9.3
Barium	9/9	79.1 - 178	NA	114	136	136
Beryllium	9/9	0.47 - 1.1	NA	0.72	0.91	0.91
Chromium	9/9	13.7 - 28.6	NA	18.7	21.9	21.9
Cobalt	5/9	8.31 - 11.9	5.58 - 7.97	7.1	9.24	9.24
Copper	9/9	8.05 - 62.5	NA	17.7	30.4	30.4
Lead	9/9	15.5 - 86.2	NA	40.7	64.2	64.2
Manganese	9/9	469.5 - 1,340	NA	784	1,014	1,014
Mercury	4/9	0.06 - 0.17	0.10	0.07	0.10	0.10
Nickel	9/9	6.3 - 16.3	NA	10.1	12.4	12.4

TABLE 8-9

Soil Exposure Point Concentrations of Preliminary Contaminants of Potential Concern
New Burn Site Adjacent to Sites 3 and 4
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[(a)]	Range of Detected Values (µg/g)[(b)]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[(c)] (µg/g)
Surface Soil - Remainder of Site (cont'd)						
Vanadium	9/9	24 - 33.5	NA	28.1	30.1	30.1
Zinc	9/9	56.1 - 731	NA	173	391	391
Dioxins/furans	9/9	2.5E-06 - 1.5E-05	NA	5.4E-06	8.2E-06	8.2E-06
Acenaphthylene	½	0.01	0.67	0.17	1.2	0.01
Anthracene	½	0.01	0.67	0.17	1.2	0.01
Benzoic acid	2/2	0.09 - 0.14	NA	0.11	0.25	0.14
Benzo(a)anthracene	2/2	0.01 - 0.14	NA	0.07	0.46	0.14
Benzo(a)pyrene	½	0.14	0.67	0.24	0.87	0.14
Benzo(b)fluoranthene	½	0.18	0.67	0.26	0.75	0.18
Benzo(g,h,i)perylene	½	0.11	0.67	0.22	0.94	0.11
Benzo(k)fluoranthene	½	0.06	0.67	0.20	1.1	0.06
Chrysene	2/2	0.01 - 0.15	NA	0.08	0.51	0.15
Dibenzo(a,h)anthracene	½	0.03	0.67	0.18	1.2	0.03
Fluoranthene	2/2	0.02 - 0.32	NA	0.17	1.1	0.32
Indeno(1,2,3-cd)pyrene	½	0.11	0.67	0.22	0.93	0.11
Phenanthrene	½	0.17	0.67	0.25	0.78	0.17

TABLE 8-9

Soil Exposure Point Concentrations of Preliminary Contaminants of Potential Concern
New Burn Site Adjacent to Sites 3 and 4
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/g)[b]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[c] (µg/g)
Surface Soil - Remainder of Site (cont'd)						
Pyrene	½	0.24	0.67	0.29	0.60	0.24
Surface/Subsurface Soil Combined - Burn Area						
Aluminum	11/11	3,980 - 16,500	NA	10,322	12,252	12,252
Barium	11/11	40.7 - 1,600	NA	437	1,867	1,600
Boron	5/11	5.62 - 16.2	10 - 19.5	7.7	9.72	9.72
Chromium	11/11	9.62 - 54	NA	25.7	38.5	38.5
Copper	11/11	5.3 - 1,212	NA	157	1,573	1,212
Lead	11/11	10 - 802	NA	282	420	420
Manganese	11/11	96.0 - 638	NA	351	450	450
Mercury	3/11	0.08 - 0.27	0.10	0.07	0.11	0.11
Molybdenum	3/11	2.06 - 3.08	10	4.4	5.4	3.08
Nickel	11/11	3.5 - 55.3	NA	13.5	25.8	25.8
Silver	5/11	0.48 - 11.0	1.0	1.0	2.6	2.6
Tin	3/11	2.75 - 27.0	10	6.3	9.6	9.6
Zinc	11/11	20.9 - 2,360	NA	649	6,469	2,360
Dioxins/furans	11/11	3.3E-06 - 2.9E-04	NA	3.3E-05	1.3E-04	1.3E-04

TABLE 8-9

Soil Exposure Point Concentrations of Preliminary Contaminants of Potential Concern
New Burn Site Adjacent to Sites 3 and 4
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/g)[b]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[c] (µg/g)
Surface/Subsurface Soil Combined - Burn Area (cont'd)						
2-Methylnaphthalene	1/8	0.02	0.67 - 1.34	0.34	0.45	0.02
2,4-Dinitrotoluene	1/11	0.17	0.10	0.06	0.08	0.08
Acenaphthene	2/8	0.23 - 0.56	0.67 - 1.34	0.39	0.52	0.52
Anthracene	3/8	0.01 - 0.96	0.67 - 1.34	0.48	0.69	0.69
Benzoic acid	6/8	0.03 - 0.13	3.3	0.38	9.0	0.13
Benzo(a)anthracene	4/8	0.03 - 4.29	0.67	1.2	68.8	4.29
Benzo(a)pyrene	4/8	0.03 - 2.9	0.67	0.94	30.9	2.9
Benzo(b)fluoranthene	4/8	0.03 - 4.68	0.67	1.3	59.7	4.68
Benzo(g,h,i)perylene	4/8	0.04 - 2.67	0.67	0.82	12.4	2.67
Benzo(k)fluoranthene	4/8	0.02 - 1.76	0.67	0.71	27.3	1.76
Carbazole	2/2	0.22	NA	0.22	0.22	0.22
Chrysene	4/8	0.03 - 3.63	0.67	1.1	58.8	3.63
DDE	1/1	2.23	NA	NA	NA	2.23
DDT	1/1	1.11	NA	NA	NA	1.11
Dibenzofuran	2/8	0.09 - 0.15	0.67 - 1.34	0.33	0.64	0.15
Dibenzo(a,h)anthracene	2/8	0.54 - 0.56	0.67 - 1.34	0.43	0.52	0.52

TABLE 8-9

Soil Exposure Point Concentrations of Preliminary Contaminants of Potential Concern
New Burn Site Adjacent to Sites 3 and 4
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[(a)]	Range of Detected Values (µg/g)[(b)]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[(c)] (µg/g)
Surface/Subsurface Soil Combined - Burn Area (cont'd)						
Diethyl phthalate	1/8	0.02	0.67 - 1.34	0.38	0.52	0.02
Fluoranthene	6/8	0.01 - 8.9	0.67	2.22	12,444	8.9
Fluorene	2/8	0.22 - 0.40	0.67 - 1.34	0.37	0.48	0.40
Indeno(1,2,3-cd)pyrene	4/8	0.03 - 2.67	0.67	0.87	16.0	2.67
Naphthalene	2/8	0.01 - 0.03	0.67 - 1.34	0.30	0.44	0.03
Phenanthrene	4/8	0.04 - 4.45	0.67	1.2	56.5	4.45
Pyrene	5/8	0.02 - 7.7	0.67	1.9	780	7.7
Tetryl	1/11	0.24	0.20	0.11	0.13	0.13
Surface/Subsurface Soil Combined - Remainder of Site						
Aluminum	11/11	11,100 - 15,700	NA	13,030	13,680	13,680
Arsenic	11/11	3.53 - 12.5	NA	7.3	9.0	9.0
Barium	11/11	47.4 - 178	NA	102	123	123
Beryllium	11/11	0.29 - 1.1	NA	0.65	0.87	0.87
Chromium	11/11	12.5 - 28.6	NA	18.0	20.6	20.6
Cobalt	5/11	8.31 - 11.9	5.0 - 8.0	6.4	9.95	9.95
Copper	11/11	5.95 - 62.5	NA	15.7	26.0	26.0

TABLE 8-9

Soil Exposure Point Concentrations of Preliminary Contaminants of Potential Concern
New Burn Site Adjacent to Sites 3 and 4
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[(a)]	Range of Detected Values (µg/g)[(b)]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[(c)] (µg/g)
Surface/Subsurface Soil Combined - Remainder of Site (cont'd)						
Lead	11/11	9.15 - 86.2	NA	35.5	65.9	65.9
Manganese	11/11	94.7 - 1,340	NA	686	868	868
Mercury	4/11	0.06 - 0.17	0.10	0.07	0.09	0.09
Nickel	11/11	6.3 - 16.3	NA	9.5	11.4	11.4
Tin	1/11	2.12	10.0	4.8	5.6	2.12
Vanadium	11/11	22.3 - 33.5	NA	27.4	29.3	29.3
Zinc	11/11	22.3 - 731	NA	147	383	383
Dioxins/furans	11/11	2.5E-06 - 1.5E-05	NA	5.5E-06	7.7E-06	7.7E-06
Acenaphthylene	1/4	0.01	0.67	0.36	34,694	0.01
Anthracene	1/4	0.01	0.67	0.35	23,541	0.01
Benzoic acid	4/4	0.07 - 0.14	NA	0.11	0.18	0.14
Benzo(a)anthracene	2/4	0.01 - 0.14	0.67	0.20	0.39	0.14
Benzo(a)pyrene	1/4	0.14	0.67	0.29	0.77	0.14
Benzo(b)fluoranthene	1/4	0.18	0.67	0.30	0.53	0.18
Benzo(g,h,i)perylene	1/4	0.11	0.67	0.28	1.2	0.11

TABLE 8-9

Soil Exposure Point Concentrations of Preliminary Contaminants of Potential Concern
New Burn Site Adjacent to Sites 3 and 4
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/g)[b]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[c] (µg/g)
Surface/Subsurface Soil Combined - Remainder of Site (cont'd)						
Benzo(k)fluoranthene	1/4	0.06	0.67	0.28	5.6	0.06
Chrysene	2/4	0.01 - 0.15	0.67	0.21	0.39	0.15
Dibenz(a,h)anthracene	1/4	0.03	0.67	0.30	144	0.03
Fluoranthene	2/4	0.02 - 0.32	0.67	0.25	0.43	0.32
Indeno(1,2,3-cd)pyrene	1/4	0.11	0.67	0.28	1.1	0.11
Phenanthrene	1/4	0.17	0.67	0.30	0.56	0.17
Pyrene	1/4	0.24	0.67	0.31	0.40	0.24

Note:
NA = Not applicable.

Footnotes:
(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Micrograms per gram.
(c) The 95% UCL (upper confidence limit of the mean) or the maximum detected value, whichever is lower (USEPA 1989).
(d) Not applicable.

TABLE 8-10

Selection of Contaminants of Potential Concern (COPC) in Soil Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 3 – Explosive Burn Area and Site 4 - Abandoned Landfill
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Residential PRG (µg/g)[(a)]**	**Exposure Point Conc. (µg/g)**	**Retained as Soil COPC?**
Surface Soil - Trench			
Aluminum	7,667	23,991	**YES**
Antimony	3.0	1.29	No
Barium	527	5,900	**YES**
Cadmium	3.8	12.4	**YES**
Chromium	30.0	54.5	**YES**
Cobalt	457	18.0	No
Dimethylphthalate	100,000[(b)]	0.11	No
Lead	400[(c)]	800	**YES**
Mercury	2.3	0.12	No
Nickel	153	12.3	No
Silver	38.3	6.0	No
Tin	4,600	15.8	No
Trichloroethylene	3.16	0.68	No
Zinc	2,300	457	No
Surface Soil - Remainder of Site			
Aluminum	7,667	13,541	**YES**
Barium	527	472	No
Boron	586	10.2	No
Cadmium	3.8	0.75	No
Cobalt	457	15.9	No
Copper	285	49.7	No
Iron	70,000	25,280	No

TABLE 8-10

Selection of Contaminants of Potential Concern (COPC) in Soil Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 3 – Explosive Burn Area and Site 4 - Abandoned Landfill
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Residential PRG (µg/g)[(a)]**	**Exposure Point Conc. (µg/g)**	**Retained as Soil COPC?**
Surface Soil - Remainder of Site (cont'd)			
Lead	400[(c)]	75.9	No
Manganese	318	1,503	**YES**
Mercury	2.3	0.06	No
Molybdenum	38.3	3.95	No
Nickel	153	14.0	No
Silver	38.3	1.0	No
Thallium	0.61[(d)]	0.688	**YES**
Tin	4,600	7.7	No
Zinc	2,300	138	No
Surface/Subsurface Soil Combined - Trench			
Aluminum	7,667	28,125	**YES**
Antimony	3.0	1.29	No
Arsenic	0.38	13.4	**YES**
Barium	527	5,900	**YES**
Benzyl alcohol	1,955	0.042	No
Beryllium	0.143	1.95	**YES**
Cadmium	3.8	5.2	**YES**
Chromium	30.0	39.6	**YES**
Cobalt	457	20.8	No
Copper	285	408	**YES**
Dimethylphthalate	100,000[(b)]	0.05	No
Di-n-butyl phthalate	651	1.32	No

TABLE 8-10

Selection of Contaminants of Potential Concern (COPC) in Soil Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 3 – Explosive Burn Area and Site 4 - Abandoned Landfill
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Residential PRG (µg/g)[a]**	**Exposure Point Conc. (µg/g)**	**Retained as Soil COPC?**
Surface/Subsurface Soil Combined - Trench (cont'd)			
Lead	400[c]	800	**YES**
Mercury	2.3	0.077	No
Nickel	153	22.6	No
Silver	38.3	6.0	No
Tin	4,600	10.8	No
Trichloroethylene	3.16	0.34	No
Vanadium	54.0	39.0	No
Zinc	2,300	405	No

Note:

PRGs were taken directly from the Region 9 PRG Table (USEPA 1998) except as noted in the footnotes. Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:

(a) Micrograms per gram.
(b) Full value used for PRGs based on saturation limits.
(c) Full PRG used for lead.
(d) Value for thallium sulfate.

TABLE 8-11

Selection of Contaminants of Potential Concern (COPC) in Soil Based on USEPA Region 9 Preliminary Remediation Goals (PRG's) New Burn Site Adjacent to Sites 3 and 4 Jefferson Proving Ground Madison, Indiana

Chemical	USEPA Region 9 PRG Screening Data		
	Residential PRG (µg/g)[a]	Exposure Point Conc. (µg/g)	Retained as Soil COPC?
Surface Soil - Burn Area			
Barium	527	1,600	**YES**
Boron	586	8.4	No
Chromium	30.1	40.5	**YES**
Copper	284.8	239	No
Lead	400[b]	426	**YES**
Manganese	318	590	**YES**
Mercury	2.3[c]	0.19	No
Nickel	153	40.7	No
Silver	38.3	0.53	No
Tin	4,600	2.75	No
Zinc	2,300	2,360	**YES**
Dioxins/furans	3.77E-06	5.3E-05	**YES**
2-Methylnaphthalene	240[d][e]	0.02	No
Acenaphthene	110[e]	0.56	No
Anthracene	5.7[e]	0.96	No
Benzoic acid	100,000[f]	0.06	No
Benzo(a)anthracene	0.61	4.29	**YES**
Benzo(a)pyrene	0.06	2.9	**YES**
Benzo(b)fluoranthene	0.61	4.68	**YES**
Benzo(g,h,i)perylene	100[e],[g]	2.67	No
Benzo(k)fluoranthene	6.1	1.76	No
Carbazole	22	0.22	No
Chrysene	7.2[e]	3.63	No

TABLE 8-11
Selection of Contaminants of Potential Concern (COPC) in Soil Based on USEPA Region 9 Preliminary Remediation Goals (PRG's)
New Burn Site Adjacent to Sites 3 and 4
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screening Data		
Chemical	**Residential PRG (µg/g)[(a)]**	**Exposure Point Conc. (µg/g)**	**Retained as Soil COPC?**
Surface Soil - Burn Area (cont'd)			
DDE	1.31	2.23	**YES**
DDT	1.31	1.11	No
Dibenzofuran	140[(e)]	0.15	No
Dibenz(a,h)anthracene	0.06	0.56	**YES**
Fluoranthene	261	8.91	No
Fluorene	90[(e)]	0.40	No
Indeno(1,2,3-cd)pyrene	0.61	2.67	**YES**
Naphthalene	240[(e)]	0.03	No
Phenanthrene	100[(e)(g)]	4.45	No
Pyrene	100[(e)]	7.7	No
Tetryl	65	0.16	No
Surface Soil - Remainder of Site			
Aluminum	7,667	13,951	**YES**
Arsenic	0.38	9.3	**YES**
Barium	527	136	No
Beryllium	0.14	0.91	**YES**
Chromium	30.1	21.9	No
Cobalt	456.5	9.24	No
Copper	284.8	30.4	No
Lead	400[(b)]	64.2	No
Manganese	318	1,014	**YES**
Mercury	2.3	0.10	No
Nickel	153	12.4	No
Vanadium	53.7	30.1	No
Zinc	2,300	391	No

TABLE 8-11

Selection of Contaminants of Potential Concern (COPC) in Soil Based on USEPA Region 9 Preliminary Remediation Goals (PRG's) New Burn Site Adjacent to Sites 3 and 4 Jefferson Proving Ground Madison, Indiana

	USEPA Region 9 PRG Screening Data		
Chemical	**Residential PRG (µg/g)[(a)]**	**Exposure Point Conc. (µg/g)**	**Retained as Soil COPC?**
Surface Soil - Remainder of Site (cont'd)			
Dioxins/furans	3.77E-06	8.2E-06	**YES**
Acenaphthylene	100[(e)(g)]	0.01	No
Anthracene	5.7[(e)]	0.01	No
Benzoic acid	100,000[(f)]	0.14	No
Benzo(a)anthracene	0.61	0.14	No
Benzo(a)pyrene	0.06	0.14	**YES**
Benzo(b)fluoranthene	0.61	0.18	No
Benzo(g,h,i)perylene	100[(e)(g)]	0.11	No
Benzo(k)fluoranthene	6.1	0.06	No
Chrysene	7.2[(e)]	0.15	No
Dibenz(a,h)anthracene	0.06	0.03	No
Fluoranthene	261	0.32	No
Indeno(1,2,3-cd)pyrene	0.61	0.11	No
Phenanthrene	100[(e)(g)]	0.17	No
Pyrene	100[(e)]	0.24	No
Surface/Subsurface Soil Combined - Burn Area			
Aluminum	7,667	12,252	**YES**
Barium	527	1,600	**YES**
Boron	586	9.72	No
Chromium	30.1	38.5	**YES**
Copper	284.8	1,212	**YES**
Lead	400[(b)]	420	**YES**
Manganese	318	450	**YES**
Mercury	2.3[(c)]	0.11	No

TABLE 8-11

Selection of Contaminants of Potential Concern (COPC) in Soil Based on USEPA Region 9 Preliminary Remediation Goals (PRG's) New Burn Site Adjacent to Sites 3 and 4 Jefferson Proving Ground Madison, Indiana

Chemical	USEPA Region 9 PRG Screening Data		
	Residential PRG (µg/g)[a]	Exposure Point Conc. (µg/g)	Retained as Soil COPC?
Surface/Subsurface Soil Combined - Burn Area (cont'd)			
Molybdenum	38.3	3.08	No
Nickel	153	25.8	No
Silver	38.3	2.6	No
Tin	4,600	9.6	No
Zinc	2,300	2,360	**YES**
Dioxins/furans	3.77E-06	1.3E-04	**YES**
2-Methylnaphthalene	240[d][e]	0.02	No
2,4-Dinitrotoluene	13.0	0.08	No
Acenaphthene	110[e]	0.52	No
Anthracene	5.7[e]	0.69	No
Benzoic acid	100,000[f]	0.13	No
Benzo(a)anthracene	0.61	4.29	**YES**
Benzo(a)pyrene	0.06	2.9	**YES**
Benzo(b)fluoranthene	0.61	4.68	**YES**
Benzo(g,h,i)perylene	100[e][g]	2.67	No
Benzo(k)fluoranthene	6.1	1.76	No
Carbazole	22	0.22	No
Chrysene	7.2[e]	3.63	No
DDE	1.31	2.23	**YES**
DDT	1.31	1.11	No
Dibenzofuran	140	0.15	No
Dibenz(a,h)anthracene	0.06	0.52	**YES**
Diethyl phthalate	5,214	0.02	No
Fluoranthene	261	8.9	No

TABLE 8-11

Selection of Contaminants of Potential Concern (COPC) in Soil Based on USEPA Region 9 Preliminary Remediation Goals (PRG's)
New Burn Site Adjacent to Sites 3 and 4
Jefferson Proving Ground
Madison, Indiana

Chemical	USEPA Region 9 PRG Screening Data		
	Residential PRG (μg/g)[(a)]	Exposure Point Conc. (μg/g)	Retained as Soil COPC?
Burn Area (cont'd.)			
Fluorene	90[(e)]	0.40	No
Indeno(1,2,3-cd)pyrene	0.61	2.67	**YES**
Naphthalene	240[(e)]	0.03	No
Phenanthrene	100[(e)(g)]	4.45	No
Pyrene	100[(e)]	7.7	No
Tetryl	65	0.13	No
Surface/Subsurface Soil Combined - Remainder of Site			
Aluminum	7,667	13,680	**YES**
Arsenic	0.38	9.0	**YES**
Barium	527	123	No
Beryllium	0.14	0.87	**YES**
Chromium	30.1	20.6	No
Cobalt	456.5	9.95	No
Copper	284.8	26.0	No
Lead	400[(b)]	65.9	No
Manganese	318	868	**YES**
Mercury	2.3[(c)]	0.09	No
Nickel	153	11.4	No
Tin	4,600	2.12	No
Vanadium	53.7	29.3	No
Zinc	2,300	383	No
Dioxins/furans	3.77E-06	7.7E-06	**YES**
Acenaphthylene	100[(e)(g)]	0.01	No
Anthracene	5.7[(e)]	0.01	No

TABLE 8-11

Selection of Contaminants of Potential Concern (COPC) in Soil Based on USEPA Region 9 Preliminary Remediation Goals (PRG's)
New Burn Site Adjacent to Sites 3 and 4
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screening Data		
Chemical	Residential PRG (µg/g)[(a)]	Exposure Point Conc. (µg/g)	Retained as Soil COPC?
Surface/Subsurface Soil Combined - Remainder of Site (cont'd)			
Benzoic acid	100,000[(f)]	0.14	No
Benzo(a)anthracene	0.61	0.14	No
Benzo(a)pyrene	0.06	0.14	**YES**
Benzo(b)fluoranthene	0.61	0.18	No
Benzo(g,h,i)perylene	100[(e)(g)]	0.11	No
Benzo(k)fluoranthene	6.1	0.06	No
Chrysene	7.2[(e)]	0.15	No
Dibenz(a,h)anthracene	0.06	0.03	No
Fluoranthene	261	0.32	No
Indeno(1,2,3-cd)pyrene	0.61	0.11	No
Phenanthrene	100[(e)(g)]	0.17	No
Pyrene	100[(e)]	0.24	No

Note:

PRGs were taken directly from the Region 9 PRG Table (USEPA 1998) except as noted in the footnotes. Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:

(a) Micrograms per gram.
(b) Value for lead is the full PRG.
(c) Value for mercuric chloride.
(d) Value for naphthalene.
(e) Value is full PRG based on saturation limits.
(f) Value is full PRG based on ceiling limit.
(g) Value for pyrene.

TABLE 8-12

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRG's)
Site 3 – Explosive Burn Area and Site 4 - Abandoned Landfill and New Burn Site
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Ambient Air PRG (µg/m^3)[(a)]**	**Exposure Point Conc. (µg/m^3)**	**Retained as Air COPC?**
Residential Scenario			
Aluminum	NA[(b)]	2.57E+00	**YES**
Arsenic	4.5E-04	6.25E-05	No
Barium	5.2E-02	3.54E-02	No
Beryllium	8.0E-04	5.81E-06	No
Cadmium	1.1E-03	6.89E-05	No
Chromium	2.3E-05	3.82E-04	**YES**
Lead	1.5E+00[(c)]	5.10E-03	No
Manganese	5.1E-03	2.67E-01	**YES**
Silver	NA	1.61E-05	**YES**
Thallium	NA	1.21E-04	**YES**
Vanadium	NA	1.46E-06	**YES**
Zinc	NA	3.52E-03	**YES**
Dioxins/Furans	4.5E-08	1.31E-10	No
Benzo(a)anthracene	9.2E-03	6.33E-06	No
Benzo(a)pyrene	9.2E-04	5.60E-06	No
Benzo(b)fluoranthene	9.2E-03	7.47E-06	No
DDE	2.0E-02	3.73E-06	No
Dibenz(a,h)anthracene	9.2E-04	7.45E-07	No
Dieldrin	4.2E-04	NA	No
Indeno(1,2,3-cd)pyrene	9.2E-03	3.70E-06	No
1,1-Dichloroethene	3.8E-02	7.73E-10	No
Chlorobenzene	2.1E+00	2.11E-06	No

Note:

PRGs were taken directly from the Region 9 PRG Table (USEPA 1998). Values for noncarcinogens are 1/10 of the Region 9 PRG.

EPCs are calculated and presented in Tables R-4 and R-6 in Appendix R.

Footnotes:

(a) Micrograms per cubic meter.
(b) Not applicable
(c) Federal ambient air quality criterion for lead.

TABLE 8-13

Groundwater Exposure Point Concentrations of Contaminants of Potential Concern (COPC)
Site 4 - Abandoned Landfill
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[(a)]	Range of Detected Values (µg/L)[(b)]	Range of Reporting Limits (µg/L)	Arithmetic Mean Concentration (µg/L)	95% UCL Concentration (µg/L)	Exposure Point Concentration[(c)] (µg/L)
Aluminum	3/3	197.8 - 17,045	NA[(d)]	6,262	1.69E+25	17,045
Antimony	2/3	2.42 - 4.93	10.0	4.12	28.6	4.93
Arsenic	2/3	3.2 - 4.4	5.0	3.4	7.8	4.4
Boron	3/3	216 - 267	NA	236	307	267
Chromium	3/3	5.0 - 44.5	NA	23	1.95E+06	44.5
Cobalt	1/3	5.3	50	18.4	3.77E+04	5.3
Copper	1/3	9.1	20	9.7	10.8	9.1
Iron	3/3	2,622 - 10,155	NA	5,300	1.2E+06	10,155
Lead	1/3	6.68	3.0	3.2	4,581	6.68
Manganese	3/3	62.7 - 370	NA	186	3.57E+05	370
Molybdenum	2/3	18.5 - 35.6	100	34.7	597	35.6
Nickel	2/3	23.9 - 31.0	40	24.9	48	31
Selenium	1/3	2.97	5.0	2.7	3.2	2.97
Vanadium	2/3	2.95 - 17.5	50	15.1	6.41E+06	17.5
Zinc	3/3	5.12 - 22.9	NA	12.1	3,695	22.9

TABLE 8-13

Groundwater Exposure Point Concentrations of Contaminants of Potential Concern (COPC)
Site 4 - Abandoned Landfill
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/L)[b]	Range of Reporting Limits (µg/L)	Arithmetic Mean Concentration (µg/L)	95% UCL Concentration (µg/L)	Exposure Point Concentration[c] (µg/L)
1,2-Dichloroethene (mixed isomers)	1/3	0.26	1.0	0.42	1.7	0.26
1,2-Dimethylbenzene (*o*-xylene)	1/3	0.11	1.0	0.37	627	0.11
4-Amino-2,6-dinitrotoluene	1/3	0.149	0.26	0.14	0.16	0.149
Carbon disulfide	1/3	0.55	1.0	0.52	0.58	0.55
Dimethylphthalate	1/3	3.5	10	4.5	8.3	3.5
Methylene chloride	1/3	0.543	1.0	0.51	0.56	0.543
Pyrene	1/3	0.35	10	3.5	4.83E+10	0.35
Toluene	2/3	0.37	1.0	0.48	0.92	0.37
Xylene	1/3	0.39	1.0	0.46	0.65	0.39

Footnotes:

(a) Number of locations in which the analyte was detected/total number of locations sampled. Data from the three downgradient wells (MW93-20, MW93-21, and MW95-06) were used in the calculations.
(b) Micrograms per liter.
(c) The 95% UCL (upper confidence limit of the mean) or the maximum detected value, whichever is lower (USEPA 1989).
(d) Not applicable.

TABLE 8-14

Selection of Contaminants of Potential Concern (COPC) in Groundwater Based on USEPA Region 9 Preliminary Remediation Goals (PRG's) Site 4 - Abandoned Landfill Jefferson Proving Ground Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	Tap Water PRG (µg/L)[(a)]	Exposure Point Conc. (µg/L)	Retained as GW COPC?
Aluminum, Total	3,650	17,045	**YES**
Antimony, Total	1.46	4.93	**YES**
Arsenic, Total	0.045	4.4	**YES**
Boron, Total	328.5	267	No
Chromium, Total	18.3	44.5	**YES**
Cobalt, Total	219	5.3	No
Copper, Total	135.6	9.1	No
Iron, Total	9,400[(b)]	10,155	**YES**
Lead, Total	4.0[(c)]	6.68	**YES**
Manganese, Total	170.3	370	**YES**
Molybdenum, Total	18.3	35.6	**YES**
Nickel, Total	73	31	No
Selenium, Total	18.3	2.97	No
Vanadium, Total	25.6	17.5	No
Zinc, Total	1,095	22.9	No
1,2-Dichloroethylene	5.48	0.26	No
1,2-Dimethylbenzene (*o*-xylene)	143	0.11	No
4-Amino-2,6-dinitrotoluene	NA[(d)]	0.149	**YES**
Carbon disulfide	2.1	0.55	No
Dimethylphthalate	36,500	3.5	No
Methylene chloride	4.28	0.543	No
Pyrene	18.3	0.35	No
Toluene	72.3	0.37	No
Xylene	143[(e)]	0.39	No

Note:
PRGs were taken directly from the Region 9 PRG Table (USEPA 1998) except as noted in the footnotes. Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:
(a) Nutrient screening value for iron.
(b) Micrograms per liter.
(c) Full PRG used for lead.
(d) No PRG available.
(e) Value for mixed xylenes.

TABLE 8-15

Site-Wide Area-Weighted Concentrations of Surface Soil Contaminants of Potential Concern (COPCs)
Site 3 - Explosive Burn Area, Site 4 – Abandoned Landfill, and New Burn Site
Jefferson Proving Ground
Madison, Indiana

Chemical	Soil Concentration[a] (µg/g)[b]				Area-Weighted Concentration in Sub-Area of Concern[c] (µg/g)				Site-Wide Area-Weighted Concentration (µg/g)
	Sites 3/4		New Burn Site Adjacent to Sites 3/4		Sites 3/4		New Burn Site Adjacent to Sites 3/4		
	Trench	Remainder of Sites 3/4	Burn Area	Remainder of New Burn Site	Trench (MF[d] = 0.03)	Remainder of Sites 3/4 (MF = 0.927)	Burn Area (MF = 0.008)	Remainder of New Burn Site (MF = 0.034)	
Aluminum	23,991	13,541	NA[e]	13,951	719.73	12,553	NA	474	13,747
Arsenic	NA	NA	NA	9.3	NA	NA	NA	0.32	0.32
Barium	5,900	NA	1,600	NA	177	NA	13	NA	190
Beryllium	NA	NA	NA	0.91	NA	NA	NA	0.03	0.03
Cadmium	12.4	NA	NA	NA	0.37	NA	NA	NA	0.37
Chromium	54.5	NA	40.5	NA	1.6	NA	0.3	NA	2.0
Lead	800	NA	426	NA	24	NA	3.4	NA	27.4
Manganese	NA	1,503	590	1,014	NA	1,393	4.72	34.48	1,432
Thallium	NA	0.688	NA	NA	NA	0.64	NA	NA	0.64
Zinc	NA	NA	2,360	NA	NA	NA	18.9	NA	18.9
Dioxins/furans	NA	NA	5.30E-05	8.20E-06	NA	NA	4.24E-07	2.79E-07	7.03E-07
Benzo(a)anthracene	NA	NA	4.29	NA	NA	NA	0.034	NA	0.034
Benzo(a)pyrene	NA	NA	2.9	0.14	NA	NA	0.023	0.005	0.03

TABLE 8-15

Site-Wide Area-Weighted Concentrations of Surface Soil Contaminants of Potential Concern (COPCs)
Site 3 - Explosive Burn Area, Site 4 –Abandoned Landfill, and New Burn Site
Jefferson Proving Ground
Madison, Indiana

Chemical	Soil Concentration[(a)] (µg/g)[(b)]				Area-Weighted Concentration in Sub-Area of Concern[(c)] (µg/g)				
	Sites 3/4		New Burn Site Adjacent to Sites 3/4		Sites 3/4		New Burn Site Adjacent to Sites 3/4		
Chemical	Trench	Remainder of Sites 3/4	Burn Area	Remainder of New Burn Site	Trench (MF[(d)] = 0.03)	Remainder of Sites 3/4 (MF = 0.927)	Burn Area (MF = 0.008)	Remainder of New Burn Site (MF = 0.034)	Site-Wide Area-Weighted Concentration (µg/g)
Benzo(b)fluoranthene	NA	NA	4.68	NA	NA	NA	0.04	NA	0.04
DDE	NA	NA	2.23	NA	NA	NA	0.02	NA	0.02
Dibenz(a,h)anthracene	NA	NA	0.56	NA	NA	NA	0.004	NA	0.004
Indeno(1,2,3-cd)pyrene	NA	NA	2.67	NA	NA	NA	0.02	NA	0.02

Footnotes:

(a) The maximum concentration or the 95% UCL on the mean, whichever is lower (USEPA 1989)
(b) Micrograms per gram.
(c) The soil concentration times the modifying factor (MF).
(d) Modifying factor.
(e) Not applicable, chemical not a COPC in sub-area of concern.

TABLE 8-16a

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 3 - Explosive Burn Area and Site 4 - Abandoned Landfill and Adjacent New Burn Site
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Chemicals of Concern	Pathway-specific Hazard Index	Noncarcinogenic Chemicals of Concern
	Future On-site Resident Adult (Trench - surface soil only)			
Incidental ingestion of soil	NA[a]		0.1573	
Dermal contact with soil	NA		0.0131	
Ingestion of homegrown fruits/vegetables	NA		1.0677	
Ingestion of beef	5.64E-06		0.2264	
Ingestion of milk	1.22E-06		0.0953	
Ingestion of groundwater	7.75E-05	Arsenic (100%)	1.3410	
Dermal contact with groundwater	1.41E-07		0.0024	
Inhalation of VOCs[b] and fugitive dusts	1.35E-06		3.6710	Manganese (99.9%)
Total	8.59E-05		6.5742	
	Future On-site Resident Child (Trench - surface soil only)			
Incidental ingestion of soil	NA		1.4684	Barium (73%)
Dermal contact with soil	NA		0.0379	
Ingestion of homegrown fruits/vegetables	NA		2.5931	Barium (46%), cadmium (52%)
Ingestion of beef	2.33E-06		0.2483	
Ingestion of milk	1.40E-06		0.4158	
Ingestion of groundwater	3.62E-05	Arsenic (100%)	3.1289	Arsenic (30%), Chromium VI (30%)

TABLE 8-16a

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 3 - Explosive Burn Area and Site 4 - Abandoned Landfill and Adjacent New Burn Site
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Chemicals of Concern	Pathway-specific Hazard Index	Noncarcinogenic Chemicals of Concern
Dermal contact with groundwater	2.68E-08		0.0023	
Inhalation of VOCs and fugitive dusts	1.02E-06		13.8289	Manganese (99.9%)
Total	4.10E-05		21.7236	
Future On-site Resident Adult (Trench - surface/subsurface soil combined)				
Incidental ingestion of soil	1.18E-05	Arsenic (100%)	0.2032	
Dermal contact with soil	2.96E-06		0.0272	
Ingestion of homegrown fruits/vegetables	1.78E-05	Arsenic (100%)	0.8429	
Ingestion of beef	5.64E-06		0.2264	
Ingestion of milk	1.22E-06		0.0953	
Ingestion of groundwater	7.75E-05	Arsenic (100%)	1.3410	
Dermal contact with groundwater	1.41E-07		0.0024	
Inhalation of VOCs and fugitive dusts	1.35E-06		3.6710	Manganese (99.9%)
Total	1.18E-04		6.4094	
Future On-site Resident Child (Trench - surface/subsurface soil combined)				
Incidental ingestion of soil	2.20E-05	Arsenic (100%)	1.8964	Barium (57%)
Dermal contact with soil	1.70E-06		0.0783	
Ingestion of homegrown fruits/vegetables	8.59E-06		2.0276	Barium (60%)

TABLE 8-16a

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 3 - Explosive Burn Area and Site 4 - Abandoned Landfill and Adjacent New Burn Site
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Chemicals of Concern	Pathway-specific Hazard Index	Noncarcinogenic Chemicals of Concern
Ingestion of beef	2.33E-06		0.2483	
Ingestion of milk	1.40E-06		0.4158	
Ingestion of groundwater	3.62E-05	Arsenic (100%)	3.1289	Arsenic (30%), Chromium VI (30%)
Dermal contact with groundwater	2.68E-08		0.0023	
Inhalation of VOCs and fugitive dusts	1.02E-06		13.8289	Manganese (99.9%)
Total	7.33E-05		21.6265	
Future On-site Resident Adult (Remainder of Site - surface soil only)				
Incidental ingestion of soil	NA		0.0265	
Dermal contact with soil	NA		0.0022	
Ingestion of homegrown fruits/vegetables	NA		0.2299	
Ingestion of beef	5.64E-06		0.2264	
Ingestion of milk	1.22E-06		0.0953	
Ingestion of groundwater	7.75E-05	Arsenic (100%)	1.3410	
Dermal contact with groundwater	1.41E-07		0.0024	
Inhalation of VOCs and fugitive dusts	1.35E-06		3.6710	Manganese (99.9%)
Total	8.59E-05		5.5947	

TABLE 8-16a

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 3 - Explosive Burn Area and Site 4 - Abandoned Landfill and Adjacent New Burn Site
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Chemicals of Concern	Pathway-specific Hazard Index	Noncarcinogenic Chemicals of Concern
		Future On-site Resident Child (Remainder of Site - surface soil only)		
Incidental ingestion of soil	NA		0.2472	
Dermal contact with soil	NA		0.0064	
Ingestion of homegrown fruits/vegetables	NA		0.5396	Manganese (99%)
Ingestion of beef	2.33E-06		0.2483	
Ingestion of milk	1.40E-06		0.4158	
Ingestion of groundwater	3.62E-05	Arsenic (100%)	3.1289	Arsenic (30%), Chromium VI (30%)
Dermal contact with groundwater	2.68E-08		0.0023	
Inhalation of VOCs and fugitive dusts	1.35E-06		13.8289	Manganese (99.9%)
Total	4.13E-05		18.4174	

Note:
Numbers in parentheses are the percent of the total pathway risk/hazard attributable to the chemical of concern (COC).

Footnotes:
(a) Not available or not applicable.
(b) Volatile organic compounds.

PZ/PB
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TABLE 8-16b

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
New Burn Site Adjacent to Site 3 and Site 4
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Chemicals of Concern	Pathway-specific Hazard Index	Noncarcinogenic Chemicals of Concern
		Future On-site Resident Adult (Burn Area - surface soil only)		
Incidental ingestion of soil	2.49E-05	B(a)P[(a)] (50%)	0.0664	
Dermal contact with soil	1.95E-06		0.0055	
Ingestion of homegrown fruits/vegetables	1.30E-04	2,3,7,8-TCDD (10%), B(a)A (11%), B(a)P (48%), B(b)B (10%), DBA (11%)	2.0163	Zinc (88%)
Ingestion of beef	5.64E-06		0.2264	
Ingestion of milk	1.22E-06		0.0953	
Ingestion of groundwater	7.75E-05	Arsenic (100%)	1.3410	
Dermal contact with groundwater	1.41E-07		0.0024	
Inhalation of VOCs[(b)] and fugitive dusts	1.35E-06		3.6710	Manganese (99.9%)
Total	2.43E-04		7.4243	
		Future On-site Resident Child (Burn Area - surface soil only)		
Incidental ingestion of soil	4.65E-05	B(a)P (50%)	0.5644	
Dermal contact with soil	1.12E-06		0.0145	
Ingestion of homegrown fruits/vegetables	7.18E-05	B(a)P (48%)	2.6340	Zinc (78%)
Ingestion of beef	2.33E-06		0.2483	
Ingestion of milk	1.40E-06		0.4158	
Ingestion of groundwater	3.62E-05	Arsenic (100%)	3.1289	Arsenic (30%), Chromium VI (30%)

TABLE 8-16b

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
New Burn Site Adjacent to Site 3 and Site 4
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Chemicals of Concern	Pathway-specific Hazard Index	Noncarcinogenic Chemicals of Concern
Dermal contact with groundwater	2.68E-08		0.0023	
Inhalation of VOCs and fugitive dusts	1.02E-06		13.8289	Manganese (99.9%)
Total	1.60E-04		20.8371	
Future On-site Resident Adult (Burn Area - surface/subsurface soil combined)				
Incidental ingestion of soil	3.15E-05	2,3,7,8-TCDD (36%), B(a)P (39%)	0.0641	
Dermal contact with soil	4.78E-06		0.0054	
Ingestion of homegrown fruits/vegetables	1.47E-04	2,3,7,8-TCDD (21%), B(a)A (10%), B(a)P (42%), B(b)B (9%), DBA (9%)	1.9943	Zinc (89%)
Ingestion of beef	5.64E-06		0.2264	
Ingestion of milk	1.22E-06		0.0953	
Ingestion of groundwater	7.75E-05	Arsenic (100%)	1.3410	
Dermal contact with groundwater	1.41E-07		0.0024	
Inhalation of VOCs and fugitive dusts	1.35E-06		3.6710	Manganese (99.9%)
Total	2.69E-04		7.3999	
Future On-site Resident Child (Burn Area - surface/subsurface soil combined)				
Incidental ingestion of soil	5.89E-05	2,3,7,8-TCDD (36%), B(a)P (39%)	0.5431	
Dermal contact with soil	2.75E-06		0.0140	
Ingestion of homegrown fruits/vegetables	8.11E-05	2,3,7,8-TCDD (21%), B(a)P (42%)	2.5821	Zinc (80%)
Ingestion of beef	2.33E-06		0.2483	

TABLE 8-16b

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
New Burn Site Adjacent to Site 3 and Site 4
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Chemicals of Concern	Pathway-specific Hazard Index	Noncarcinogenic Chemicals of Concern
Ingestion of milk	1.40E-06		0.4158	
Ingestion of groundwater	3.62E-05	Arsenic (100%)	3.1289	Arsenic (30%), Chromium VI (30%)
Dermal contact with groundwater	2.68E-08		0.0023	
Inhalation of VOCs and fugitive dusts	1.02E-06		13.8289	Manganese (99.9%)
Total	1.84E-04		20.7634	
	Future On-site Resident Adult (Remainder of Site - surface soil only)			
Incidental ingestion of soil	9.51E-06		0.0530	
Dermal contact with soil	2.35E-06		0.0115	
Ingestion of homegrown fruits/vegetables	1.72E-05	Arsenic (72%)	0.2183	
Ingestion of beef	5.64E-06		0.2264	
Ingestion of milk	1.22E-06		0.0953	
Ingestion of groundwater	7.75E-05	Arsenic (100%)	1.3410	
Dermal contact with groundwater	1.41E-07		0.0024	
Inhalation of VOCs and fugitive dusts	1.35E-06		3.6710	Manganese (99.9%)
Total	1.15E-04		5.6189	

TABLE 8-16b

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
New Burn Site Adjacent to Site 3 and Site 4
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Chemicals of Concern	Pathway-specific Hazard Index	Noncarcinogenic Chemicals of Concern
	Future On-site Resident Child (Remainder of Site - surface soil only)			
Incidental ingestion of soil	1.78E-05	Arsenic (86%)	0.4948	
Dermal contact with soil	1.36E-06		0.0332	
Ingestion of homegrown fruits/vegetables	8.66E-06		0.5170	
Ingestion of beef	2.33E-06		0.2483	
Ingestion of milk	1.40E-06		0.4158	
Ingestion of groundwater	3.62E-05	Arsenic (100%)	3.1289	Arsenic (30%), Chromium VI (30%)
Dermal contact with groundwater	2.68E-08		0.0023	
Inhalation of VOCs and fugitive dusts	1.35E-06		13.8289	Manganese (99.9%)
Total	6.91E-05		18.6692	
	Future On-site Resident Adult (Remainder of Site - surface/subsurface soil combined)			
Incidental ingestion of soil	9.20E-06		0.0502	
Dermal contact with soil	2.27E-06		0.0111	
Ingestion of homegrown fruits/vegetables	1.67E-05	Arsenic (71%)	0.1940	
Ingestion of beef	5.64E-06		0.2264	
Ingestion of milk	1.22E-06		0.0953	
Ingestion of groundwater	7.75E-05	Arsenic (100%)	1.3410	
Dermal contact with groundwater	1.41E-07		0.0024	

TABLE 8-16b

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
New Burn Site Adjacent to Site 3 and Site 4
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Chemicals of Concern	Pathway-specific Hazard Index	Noncarcinogenic Chemicals of Concern
Inhalation of VOCs and fugitive dusts	1.35E-06		3.6710	Manganese (99.9%)
Total	1.14E-04		5.5914	
Future On-site Resident Child (Remainder of Site - surface/subsurface soil combined)				
Incidental ingestion of soil	1.72E-05	Arsenic (86%)	0.4684	
Dermal contact with soil	1.31E-06		0.0318	
Ingestion of homegrown fruits/vegetables	8.41E-06		0.4599	
Ingestion of beef	2.33E-06		0.2483	
Ingestion of milk	1.40E-06		0.4158	
Ingestion of groundwater	3.62E-05	Arsenic (100%)	3.1289	Arsenic (30%), Chromium VI (30%)
Dermal contact with groundwater	2.68E-08		0.0023	
Inhalation of VOCs and fugitive dusts	1.02E-06		13.8289	Manganese (99.9%)
Total	6.79E-05		18.5843	

Note:
2,3,7,8-TCDD = 2,3,7,8-tetrachlorodibenzo-p-dioxin equivalents; B(a)A = benzo(a)anthracene; B(a)P = benzo(a)pyrene; B(b)B - benzo(b)fluoranthene; DBA = Dibenz(a,h)anthracene. Numbers in parenthese are the percent of the total pathway risk/hazard atrributable to the COC.

Footnotes:
(a) Benzo(a)pyrene
(b) Volatile organic compounds.

TABLE 8-16c

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 3 - Explosive Burn Area, Site 4 - Abandoned Landfill, and Adjacent New Burn Site
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Chemicals of Concern	Pathway-specific Hazard Index	Noncarcinogenic Chemicals of Concern
	Future Off-site Adult Consumer of Beef and Milk			
Ingestion of beef	5.64E-06		0.2264	
Ingestion of milk	1.22E-06		0.0953	
Total	6.86E-06		0.3217	
	Future Off-site Child Consumer of Beef and Milk			
Ingestion of beef	2.33E-06		0.2483	
Ingestion of milk	1.40E-06		0.4158	
Total	3.73E-06		0.6641	

PZ/PB
N:\Jobs\244\0025\01\wp\tbl\Table 8-16c.doc

TABLE 8-17

Qualitative Uncertainty Analysis
Site 3 - Explosive Burn Area and Site 4 - Abandoned Landfill
Jefferson Proving Ground
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Overestimation	Comments
A. Human Behavior				
Future receptors' exposure duration	30 years	Medium	Medium	National upper-bound time (90th percentile) at one residence
Future receptors' exposure frequency	350 days/year	Medium	Medium	High-end value
Future receptors' exposure time	24 hours/day	Low	High	Maximum possible value
Future receptors' water ingestion rate	2 Liters/day	Low	High	Water consumption rates are high-end values obtained from published distribution data
Exclusion of certain exposure pathways in the quantitative analysis	NA[(a)]	Low	Low	Pathways eliminated are those that have low possibility of contributing risk to these receptors
B. Chemical Fate/Transport in the Environment				
Soil exposure point concentration of COC[(b)]	Maximum detected value	Low	High	Site average would be lower

TABLE 8-17

Qualitative Uncertainty Analysis
Site 3 - Explosive Burn Area and Site 4 - Abandoned Landfill
Jefferson Proving Ground
Madison, Indiana

		Potential for:		
Key Assumption/ Input Parameter	**Selected Value**	**Underestimation**	**Overestimation**	**Comments**
Use of chemical property data (e.g., Kow[c]) to predict chemical behavior in terrestrial foodchain	NA	Low	High	Generic model based on chlorinated compounds only
Use of air dispersion modeling to predict air concentrations	NA	Low	High	Conservative assumptions and input parameters
C. Chemical Toxicity				
Assumption that USEPA[d] reference doses truly represent toxicological thresholds	Manganese inhalation RfD[e]	Low	Medium	IRIS[f] value; high degree of conservativeness utilized by USEPA in deriving RfDs from toxicological literature
	(1.4E-05 mg/kg-d [d]) Aluminum inhalation RfD (1.4E-03 mg/kg-d)	Low	High	Provisional value
		Low	High	Value for child is recommended daily allowance (RDA)
	Zinc oral RfD (6.6E-01 mg/kg-d) Iron oral RfD (2.6E-01 mg/kg-d)	Low	High	Value is recommended daily allowance (RDA)
Assumption that USEPA carcinogenic slope factors truly represent dose-response phenomena	NA	Low-moderate	Moderate-high	Use of linearized, multi-stage mathematical model to predict cancer incidence at low exposure levels is USEPA policy; not currently supported by scientific data

TABLE 8-17

Qualitative Uncertainty Analysis
Site 3 - Explosive Burn Area and Site 4 - Abandoned Landfill
Jefferson Proving Ground
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
Assumption of risk/hazard additivity	NA	Moderate	Moderate	Summation of chemical-specific risks/hazards may over- or under-predict risks/hazards to receptors
Screening out of certain contaminants based on USEPA criteria	NA	Low	Low	Chemicals present in concentrations less than USEPA criteria eliminated

Footnotes:
(a) Not applicable.
(b) Contaminant of concern.
(c) Octanol-water partition coefficient.
(d) United States Environmental Protection Agency.
(e) Reference dose.
(f) Integrated Risk Information System.
(g) Milligram per kilogram-day.

TABLE 8.7-a1
Habitat Summary
Site 3/4
Jefferson Proving Ground
Madison, Indiana

Site 3/4 - Burn Area/ Abandoned Landfill -
Date: 4/22/93; 5/28/93; 6/10/93
Acreage: 10
Soils mapping unit: NA
Vegetation mapping unit: Infrequently maintained grassland

General site conditions: Open field; no building or industrial
Slope: Rolling 0-5 degrees
Aspect: North
Drainages: Small road ditch along north boundary
Surface water/wetlands: None
Evidence of flood/fire: Fire recent; field is burned periodically
Description of surrounding area: Open field surrounded by early successional flatwoods to the east, north and west; south is open grassland for some distance; this early successional forest is somewhat unusual in that it's 90% black locust; north of the site, across Engineer's Road, is a mid-succession flatwoods

Soils
Surface layer texture: Typical, several large sink holes and several sink holes forming
Surface color: Typical

Vegetation
Ground cover description: Infrequently burned/maintained grassland
Species: Typical; however many areas are poorly vegetation with lots of bare ground and weedy, sparse vegetation
Canopy cover: None
Species: NA
Successional status: Maintained grassland
Vegetation condition: Poor to good

Wildlife
Habitat type: Open grassland
Species observations: None
Sign Observations: At north central boundary, another possible deer lick exists; lots of deer track and again white, cloudy, water

Remarks: Depending upon quality of soil at deer lick, may be "naturally occurring" or contaminated material; stressed (curled onion tops) are frequently occurring at site; this may be a result of recent burning (this spring) or contamination of soil; I suspect burning is cause; sink holes may create problems with erosion, etc; question is whether the poor vegetative material on site is due to lack of topsoil from landfill operations, or possibly some contamination; possible pathways

TABLE 8.7-1

Summary Statistics For Metals in Surface Soil
Site 3 - Phase I
Jefferson Proving Ground
Madison, Indiana

Site	Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Std. Deviation	UCL 95 [(a)]	EPC µg/g [(b)]	Exceed Background (Bkg)?	Retain as COPC[(c)]?	Comment
03	Silver	16	16	100	0.08	1.60	0.47	0.49	0.68	0.68	Yes(Y)	Y	Not detected in Bkg.
03	Aluminum	16	16	100	2670	23400	14244	7365	17472	17472	Y	Y	
03	Arsenic	13	16	81.25	1.25	15	5.3	3.6	6.9	6.9	No(N)	N	
03	Barium	16	16	100	56.20	3200	492.8	764.0	827.6	827.6	Y	Y	
03	Boron	0	16	0	NC[(d)]	NC	NC	NC	NC	NC	N	N	Not a COPC
03	Cadmium	0	16	0	NC	NC	NC	NC	NC	NC	NA[(e)]	N	Not a COPC
03	Cobalt	12	16	75	1	36	11	10	15	15	Y	Y	
03	Chromium	16	16	100	5.32	30.30	17.69	7.20	20.85	20.85	Y	Y	
03	Copper	15	16	93.75	7.0	462	68	118	120	120	Y	Y	
03	Iron	16	16	100	5200	86000	25496	20962	34682	34682	Y	Y	
03	Mercury	1	16	6.25	0.03	0.18	0.03	0.04	0.05	0.05	Y	Y	Not detected in Bkg.
03	Manganese	16	16	100	464.0	9800	1694	2358	2728	2728	Y	Y	
03	Molybdenum	0	16	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
03	Nickel	16	16	100	4.37	36.7	13.94	9.33	18.03	18.03	Y	Y	
03	Lead	16	16	100	9.00	1300	113.1	316.8	251.9	251.9	Y	Y	
03	Tin	0	16	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
03	Tellurium	0	16	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
03	Thallium	0	16	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
03	Vanadium	15	16	93.75	3.50	55.80	26.21	16.92	33.62	33.62	N	N	
03	Zinc	16	16	100	14.8	2300	227.1	554.8	470.2	470.2	Y	Y	

Note:

Calcium, magnesium, sodium and potassium were not included in risk assessment as they are macronutrients.

Footnotes:

(a) Upper 95% confidence limit.
(b) Exposure point concentration, micrograms per gram, equivalent to parts per million.
(c) Contaminant of potential concern.
(d) Not calculated. Not a COPC.
(e) Not applicable or not evaluated.

TABLE 8.7-2

Summary of Contaminants of Potential Concern (COPC) Exposure Point Concentrations by Medium
Site 3 - Phase I
Jefferson Proving Grounc
Madison, Indiana

	Measured Concentrations in Abiotic Media				Estimated Concentrations in Biotic Medi							
Analyte Name	Filtered Surface Water (µg/L) [(a)]	Sediment (mg/kg) [(b)]	Unfiltered Surface Water (mg/L) [(c)]	Soil (mg/kg)	Plant (mg/kg)	Invertebrate (mg/kg)	Mouse (mg/kg)	Swift (mg/kg)	Aquatic Plants (mg/kg)	Benthic Invertebrate (mg/kg)	Fish (mg/kg)	Frogs (mg/kg)
Aluminum				17472	6.99E+01	1.92E+02	4.80E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Barium				827.6	1.22E+02	2.98E+01	1.48E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium				20.85	2.50E-01	5.42E-01	4.07E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt				15.49	2.79E-01	5.42E-01	7.20E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper				120.0	1.19E+01	1.06E+02	9.17E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Iron				34682	1.39E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead				251.9	3.28E+01	1.76E+01	2.42E-02	1.32E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Manganese				2728	1.01E+02	1.04E+02	3.14E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury				0.05	1.03E-04	7.44E-02	4.75E-02	9.69E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel				18.03	7.93E-01	9.01E-01	3.62E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Silver				0.68	3.26E-02	8.15E-02	5.87E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc				470.2	2.59E+02	3.10E+02	1.91E+01	3.59E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Notes:
An estimated concentration in biotic media is the product of the bioaccumulation factor (BAF) or bioconcentration factor (BCF) for a given receptor and the measured concentration in a given abiotic medium. Soil exposure point concentrations (EPCs) were used in calculations for terrestrial dietary items. Surface water EPCs were used in calculations for aquatic dietary items. Uptake into tissue was not predicted from sediment data because sediment-tissue partition coefficients are not readily available for many of the COPCs. A zero value for an estimated concentration in biotic media is due to either a lack of partition coefficient (BAF or BCF) or to lack of data for the pertinent exposure medium.

Footnotes:
(a) Micrograms per liter, equivalent to parts per billion.
(b) Milligrams per kilogram, equivalent to parts per million.
(c) Milligrams per liter, equivalent to parts per million.

TABLE 8.7-3

Summary Statistics For Contaminants of Potential Concern (COPC) Metals and Organics in Surface Soil
Site 4 - Phase I
Jefferson Proving Ground
Madison, Indiana

Site	Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Std. Deviation	UCL 95 [(a)]	EPC µg/g [(b)]	Exceed Background (Bkg)?	Retain as COPC[(c)]?	Comment
04	Silver	4	4	100	0.59	6.00	2.31	2.50	5.26	5.26	Yes (Y)	Y	Not detected in Bkg.
04	Aluminum	4	4	100	2310	25200	15978	9841	27556	25200	Y	Y	
04	Arsenic	4	4	100	3.82	11.50	8.42	3.46	12.48	11.50	Y	Y	
04	Boron	0	4	0	NC[(d)]	NC	NC	NC	NC	NC	NA[(e)]	No (N)	Not a COPC
04	Barium	4	4	100	24.40	5900	1668	2837	5006	5006	Y	Y	
04	Beryllium	1	4	25	0.21	1.05	0.55	0.41	1.03	1.03	Y	Y	
04	Cadmium	1	4	25	0.60	12.40	5.33	6.24	12.67	12.40	Y	Y	
04	Cobalt	3	4	75	5.60	18.00	11.90	6.77	19.86	18.00	Y	Y	
04	Chromium	4	4	100	11.00	54.50	31.74	19.50	54.69	54.50	Y	Y	
04	Copper	3	4	75	1.42	408.0	137.2	188.7	359.2	359.2	Y	Y	
04	Iron	4	4	100	4770	31100	22593	12172	36912	31100	Y	Y	
04	Mercury	3	4	75	0.03	0.14	0.08	0.05	0.13	0.13	Y	Y	Not detected in Bkg.
04	Manganese	4	4	100	167.50	733.0	428.6	286.7	766.0	733.0	Y	Y	
04	Molybdenum	0	4	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
04	Nickel	3	4	75	7.00	12.80	9.89	2.37	12.67	12.67	Y	Y	
04	Lead	4	4	100	10.63	800.0	259.7	371.9	697.2	697.2	Y	Y	
04	Antimony	0	4	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
04	Selenium	1	1	100	0.65	0.65	0.65	NA	NA	0.65	Y	Y	
04	Tellurium	0	4	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
04	Thallium	0	4	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
04	Tin	2	4	50	3.72	18.50	13.05	6.47	20.67	18.50	Y	Y	Not detected in Bkg.
04	Vanadium	3	4	75	3.50	40.40	26.88	16.52	46.31	40.40	Y	Y	
04	Zinc	4	4	100	21.30	457.0	233.5	232.5	507.0	457.0	Y	Y	
04	Trichloroethene	2	2	100	0.25	0.68	0.47	0.30	1.82	0.47	Y	Y	Not analyzed in Bkg.
04	Dimethyl phthalate	1	4	25	0.03	0.11	0.05	0.04	0.11	0.11	Y	Y	Not analyzed in Bkg.

Note:

Calcium, magnesium, sodium and potassium were not included in risk assessment as they are macronutrients.

All other analytes in soil have been included if they were detected in one or more samples.

Footnotes:

(a) Upper 95% confidence limit.

(b) Exposure point concentration, micrograms per gram, equivalent to parts per million.

(c) Contaminant of potential concern.

(d) Not calculated. Not a COPC.

(e) Not applicable or not evaluated.

TABLE 8.7-4

Summary of Contaminants of Potential Concern (COPC) Exposure Point Concentrations by Medium
Site 4 - Phase I
Jefferson Proving Grounc
Madison, Indiana

	Measured Concentrations in Abiotic Medi				Estimated Concentrations in Biotic Medi							
Analyte Name	Filtered Surface Water (µg/L) [(a)]	Sediment (mg/kg) [(b)]	Unfiltered Surface Water (mg/L) [(c)]	Soil (mg/kg)	Plant (mg/kg)	Invertebrate (mg/kg)	Mouse (mg/kg)	Swift (mg/kg)	Aquatic Plants (mg/kg)	Benthic Invertebrate (mg/kg)	Fish (mg/kg)	Frogs (mg/kg)
Aluminum				25200	1.01E+02	2.77E+02	6.93E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic				11.50	2.42E-01	1.30E+00	2.00E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Barium				5006	7.36E+02	1.80E+02	8.93E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beryllium				1.03	4.13E-03	1.14E-02	2.84E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium				12.40	4.96E+00	4.61E+01	6.19E-02	9.48E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium				54.50	6.54E-01	1.42E+00	1.06E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt				18.00	3.24E-01	6.30E-01	8.37E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper				359.2	3.56E+01	3.16E+02	2.75E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dimethyl phthalate				0.11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Iron				31100	1.24E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead				697.2	9.06E+01	4.88E+01	6.69E-02	3.64E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Manganese				733.0	2.71E+01	2.79E+01	8.43E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury				0.13	2.58E-04	1.86E-01	1.19E-01	2.42E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel				12.67	5.57E-01	6.34E-01	2.55E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Selenium				0.65	6.11E+00	5.06E+00	1.17E+00	6.66E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Silver				5.26	2.52E-01	6.31E-01	4.54E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tin				18.50	5.55E-01	0.00E+00	6.28E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Trichloroethene				0.47	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Vanadium				40.40	1.21E-01	3.64E-01	5.04E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc				457.0	2.51E+02	3.02E+02	1.86E+01	3.49E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Footnotes:
(a) Micrograms per liter, equivalent to parts per billion.
(b) Milligrams per kilogram, equivalent to parts per million.
(c) Milligrams per liter, equivalent to parts per million.

TABLE 8.7-5

Summary Statistics for Analytes in Surface Soil
Site 3 - Phase II
Jefferson Proving Ground
Madison, Indiana

Site	Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Std. Deviation	UCL 95 [(a)]	EPC µg/g [(b)]	Exceed Background (Bkg)?	Retain as COPC[(c)]?	Comment
03	Silver	14	20	70	0.40	3.64	0.97	1.02	1.36	1.36	Yes(Y)	Y	Not detected in Bkg.
03	Aluminum	20	20	100	1110	16600	9966	4274	11618	11618	Y	Y	
03	Arsenic	20	20	100	2.52	11.20	6.86	2.18	7.70	7.70	Y	Y	
03	Boron	3	20	15	6.25	60.70	10.44	11.94	15.06	15.06	Y	Y	Not detected in Bkg.
03	Barium	20	20	100	42.80	3120	307.9	672.8	568.0	568.0	Y	Y	
03	Beryllium	19	20	95	0.28	1.19	0.68	0.26	0.78	0.78	Y	Y	
03	Cadmium	6	20	30	0.28	3.06	0.71	0.68	0.98	0.98	Y	Y	
03	Cobalt	20	20	100	0.55	21.90	8.97	4.67	10.77	10.77	Y	Y	
03	Chromium	20	20	100	4.23	121.00	22.38	25.81	32.36	32.36	Y	Y	
03	Copper	15	20	75	3.44	67.50	17.94	17.67	24.77	24.77	Y	Y	
03	Iron	20	20	100	4705	23450	15376	5967	17683	17683	Y	Y	
03	Mercury	12	20	60	0.05	0.10	0.06	0.02	0.07	0.07	Y	Y	Not detected in Bkg.
03	Manganese	20	20	100	323.0	1630	908.6	413.1	1068	1068	Y	Y	
03	Molybdenum	11	20	55	0.64	7.50	3.88	2.54	4.86	4.86	Y	Y	
03	Nickel	20	20	100	2.20	12.20	9.64	2.86	10.75	10.75	Y	Y	
03	Lead	20	20	100	8.64	565.0	57.89	121.5	104.9	104.9	Y	Y	
03	Antimony	10	20	50	0.50	1.73	0.69	0.33	0.82	0.82	Y	Y	
03	Tin	8	20	40	2.56	32.45	8.52	8.28	11.72	11.72	Y	Y	Not detected in Bkg.
03	Thallium	1	20	5	0.50	5.00	1.20	1.64	1.83	1.83	Y	Y	
03	Zinc	20	20	100	24.60	139.00	64.11	36.67	78.29	78.29	Y	Y	

Note:
Calcium, magnesium, sodium and potassium were not included in risk assessment as they are macronutrients.
No explosives were detected in surface soil.

Footnotes:
(a) Upper 95% confidence limit.
(b) Exposure point concentration, micrograms per gram, equivalent to parts per million.
(c) Contaminant of potential concern.

TABLE 8.7-6

Summary of Contaminants of Potential Concern (COPC) Exposure Point Concentrations by Medium
Site 3 - Phase II
Jefferson Proving Ground
Madison, Indiana

	Measured Concentrations in Abiotic Media				Estimated Concentrations in Biotic Media							
Analyte Name	Filtered Surface Water (µg/L) [(a)]	Sediment (mg/kg) [(b)]	Unfiltered Surface Water (mg/L) [(c)]	Soil (mg/kg)	Plant (mg/kg)	Invertebrate (mg/kg)	Mouse (mg/kg)	Swift (mg/kg)	Aquatic Plants (mg/kg)	Benthic Invertebrate (mg/kg)	Fish (mg/kg)	Frogs (mg/kg)
Aluminum				11618	4.65E+01	1.28E+02	3.20E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Antimony				0.82	2.16E-01	1.57E-01	1.88E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic				7.70	1.62E-01	8.70E-01	1.34E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Barium				568.0	8.35E+01	2.04E+01	1.01E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beryllium				0.78	3.12E-03	8.59E-03	2.15E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Boron				15.06	6.02E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium				0.98	3.90E-01	3.63E+00	4.87E-03	7.47E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium				32.36	3.88E-01	8.41E-01	6.31E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt				10.77	1.94E-01	3.77E-01	5.01E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper				24.77	2.45E+00	2.18E+01	1.89E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Iron				17683	7.07E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead				104.9	1.36E+01	7.34E+00	1.01E-02	5.47E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Manganese				1068	3.95E+01	4.06E+01	1.23E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury				0.07	1.35E-04	9.73E-02	6.21E-02	1.27E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Molybdenum				4.86	1.22E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel				10.75	4.73E-01	5.37E-01	2.16E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Silver				1.36	6.54E-02	1.64E-01	1.18E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium				1.83	7.32E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tin				12.19	3.66E-01	0.00E+00	4.14E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc				78.29	4.31E+01	5.17E+01	3.18E+00	5.98E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Footnotes:

(a) Micrograms per liter, equivalent to parts per billion.

(b) Milligrams per kilogram, equivalent to parts per million.

(c) Milligrams per liter, equivalent to parts per million.

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TABLE 8.7-7

Summary Statistics for Analytes in Surface Soil
Sites 3 and 4 - Phase III
Jefferson Proving Ground
Madison, Indiana

Site	Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Std. Deviation	UCL 95 [(a)]	EPC µg/g [(b)]	Exceed Background (Bkg)?	Retain as COPC[(c)]?	Comment
03	Silver	1	5	20	0.31	0.50	0.46	0.08	0.54	0.50	Yes(Y)	Y	Not detected in Bkg.
03	Aluminum	5	5	100	7470	17800	12734	3696	16258	16258	Y	Y	
03	Arsenic	5	5	100	4.63	10.20	7.22	2.08	9.20	9.20	Y	Y	
03	Boron	5	5	100	4.55	8.83	5.82	1.78	7.51	7.51	Y	Y	
03	Barium	5	5	100	55.70	320.00	130.76	108.62	234.32	234.32	Y	Y	
03	Beryllium	5	5	100	0.34	0.66	0.47	0.12	0.58	0.58	Y	Y	
03	Cadmium	2	5	40	0.10	0.32	0.18	0.11	0.29	0.29	Y	Y	
03	Cobalt	2	5	40	2.38	11.25	5.26	3.85	8.93	8.93	Y	Y	
03	Chromium	5	5	100	14.40	24.10	19.30	4.53	23.62	23.62	Y	Y	
03	Copper	5	5	100	5.92	161.00	40.73	67.35	104.95	104.95	Y	Y	
03	Cyanide	0	5	0	NC[(d)]	NC	NC	NC	NC	NC	NA[(e)]	No (N)	Not a COPC
03	Iron	5	5	100	10100	22800	17180	5388	22317	22317	Y	Y	
03	Mercury	1	5	20	0.05	0.05	0.05	0.00	0.05	0.05	Y	Y	Not detected in Bkg.
03	Manganese	5	5	100	220.00	850.00	554.80	290.63	831.90	831.90	Y	Y	
03	Molybdenum	0	5	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
03	Nickel	5	5	100	7.61	10.60	9.31	1.17	10.42	10.42	Y	Y	
03	Lead	5	5	100	11.20	38.40	20.46	11.01	30.96	30.96	N	N	
03	Antimony	3	5	60	0.25	0.45	0.35	0.10	0.44	0.44	N	N	
03	Selenium	2	5	40	0.25	0.29	0.26	0.02	0.28	0.28	Y	Y	
03	Tin	0	5	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
03	Thallium	0	5	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
03	Vanadium	5	5	100	17.10	37.00	27.68	7.18	34.52	34.52	N	N	
03	Zinc	5	5	100	26.60	78.10	43.98	21.37	64.35	64.35	Y	Y	

Note:
Calcium, magnesium, sodium and potassium were not included in risk assessment as they are macronutrients.

Footnotes:
(a) Upper 95% confidence limit.
(b) Exposure point concentration, micrograms per gram, equivalent to parts per million.
(c) Contaminant of potential concern.
(d) Not calculated. Not a COPC.
(e) Not applicable or not evaluated.

TABLE 8.7-8

Summary of Contaminants of Potential Concern (COPC) Exposure Point Concentrations (EPCs) by Medium
Sites 3 and 4 - Phase III
Jefferson Proving Ground
Madison, Indiana

	Measured Concentrations in Abiotic Media				Estimated Concentrations in Biotic Media							
Analyte Name	Filtered Surface Water (µg/L) [a]	Sediment (mg/kg) [b]	Unfiltered Surface Water (mg/L) [c]	Soil (mg/kg)	Plant (mg/kg)	Invertebrate (mg/kg)	Mouse (mg/kg)	Swift (mg/kg)	Aquatic Plants (mg/kg)	Benthic Invertebrate (mg/kg)	Fish (mg/kg)	Frogs (mg/kg)
Aluminum				16258	6.50E+01	1.79E+02	4.47E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic				9.20	1.93E-01	1.04E+00	1.60E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Barium				234.3	3.44E+01	8.44E+00	4.18E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beryllium				0.58	2.32E-03	6.38E-03	1.60E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Boron				7.51	3.00E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium				0.29	1.16E-01	1.08E+00	1.45E-03	2.22E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium				23.62	2.83E-01	6.14E-01	4.61E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt				8.93	1.61E-01	3.13E-01	4.15E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper				105.0	1.04E+01	9.24E+01	8.02E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Iron				22317	8.93E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Manganese				831.9	3.08E+01	3.16E+01	9.57E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury				0.05	1.00E-04	7.20E-02	4.59E-02	9.37E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel				10.42	4.58E-01	5.21E-01	2.09E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Selenium				0.28	2.65E+00	2.20E+00	5.08E-01	2.89E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Silver				0.50	2.40E-02	6.00E-02	4.32E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc				64.35	3.54E+01	4.25E+01	2.61E+00	4.92E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Footnotes:
(a) Micrograms per liter, equivalent to parts per billion.
(b) Milligrams per kilogram, equivalent to parts per million.
(c) Milligrams per liter, equivalent to parts per million.

TABLE 8.7-9a

Summary Statistics for Semivolatile Organic Compounds in Surface Soil
New Burn Site (Inside Burn Area) - Phase III
Jefferson Proving Ground
Madison, Indiana

Site	Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Std. Deviation	UCL 95 [(a)]	EPC µg/g [(b)]
NBS	2-Methylnaphthalene	1	4	25	0.02	0.67	0.34	0.26	0.65	0.65
NBS	2-Methylpyrene	1	1	100	0.55	0.55	0.55	NA	NA	0.55
NBS	2-Phenylnaphthalene	2	2	100	0.33	0.45	0.39	0.08	0.75	0.45
NBS	Acenaphthene	2	4	50	0.23	0.67	0.45	0.20	0.68	0.67
NBS	Anthracene	2	3	67	0.67	0.96	0.83	0.15	1.08	0.96
NBS	Benzo[a]anthracene	3	4	75	0.05	4.29	2.17	2.29	4.87	4.29
NBS	Benzo[a]pyrene	3	4	75	0.06	3.56	1.81	1.87	4.02	3.56
NBS	Benzo[b]fluoranthene	3	4	75	0.08	4.68	2.35	2.48	5.26	4.68
NBS	Benzoic acid	3	4	75	0.03	1.65	0.45	0.80	1.39	1.39
NBS	Benzo[e]pyrine	2	2	100	2.20	2.23	2.22	0.02	2.31	2.23
NBS	Benzo[ghi]perylene	3	4	75	0.13	2.67	1.36	1.32	2.91	2.67
NBS	Benzo[j]fluoranthene	1	1	100	0.66	0.66	0.66	NA	NA	0.66
NBS	Benzo[k]fluoranthene	3	4	75	0.03	1.76	0.84	0.80	1.77	1.76
NBS	Benzo[b]naphtho[2,1-D]thiophene	1	1	100	0.89	0.89	0.89	NA	NA	0.89
NBS	Carbazole	2	2	100	0.22	0.22	0.22	0.00	0.23	0.22
NBS	Chrysene	3	4	75	0.05	3.63	1.89	1.97	4.21	3.63
NBS	Dibenz[ah]anthracene	2	4	50	0.34	0.67	0.53	0.14	0.69	0.67
NBS	Dibenzofuran	2	4	50	0.09	0.67	0.31	0.26	0.62	0.62
NBS	Dibenzothiophene	1	1	100	0.22	0.22	0.22	NA	NA	0.22
NBS	1-Eicosanol	1	1	100	0.45	0.45	0.45	NA	NA	0.45
NBS	Fluoranthene	4	4	100	0.01	8.91	4.23	4.85	9.94	8.91
NBS	Fluorene	2	4	50	0.22	0.67	0.41	0.19	0.63	0.63
NBS	Indeno[1,2,3-C,D]pyrene	3	4	75	0.11	2.67	1.41	1.38	3.03	2.67
NBS	Naphthalene	2	4	50	0.01	0.67	0.26	0.31	0.63	0.63
NBS	Polynuclear aromatic hydrocarbons	4	4	100	0.55	1.23	0.91	0.31	1.28	1.23
NBS	Phenanthrene	3	4	75	0.04	4.45	2.09	2.23	4.71	4.45
NBS	2,2-Bis(p-chlorophenyl)-1,1-dichloroethene	1	1	100	2.23	2.23	2.23	NA	NA	2.23
NBS	2,2-Bis(p-chlorophenyl)-1,1,1-trichloroethane	1	1	100	1.11	1.11	1.11	NA	NA	1.11
NBS	Pyrene	4	4	100	0.02	7.70	3.79	4.32	8.87	7.70

General Note:

1.Calcium, magnesium, sodium and potassium were not included in risk assessment as they are macronutrients.

All other analytes in soil have been included if they were detected in one or more samples.

Footnotes:

(a) Upper 95% confidence limit.

(b) Exposure point concentration, micrograms per gram, equivalent to parts per million.

TABLE 8.7-9b

Summary Statistics for Metals in Surface Soil
New Burn Site (Inside Burn Area) - Phase III
Jefferson Proving Ground
Madison, Indiana

Site	Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Standard Deviation	UCL [(a)] 95	EPC[(b)] µg/g	Exceed Background (Bkg)?	Retain as COPC[(c)]?	Comment
NBS	Silver	3	7	43	0.49	0.57	0.51	0.03	0.53	0.53	Yes (Y)	Y	Not detected in Bkg.
NBS	Aluminum	7	7	100	3980	16500	10603	4524	13925	13925	No (N)	N	
NBS	Arsenic	7	7	100	3.63	11.50	6.87	2.62	8.80	8.80	N	N	
NBS	Boron	2	7	29	5.00	9.75	7.23	1.78	8.53	8.53	Y	Y	
NBS	Barium	7	7	100	75.90	1600	582.8	528.5	971.0	971.0	Y	Y	
NBS	Beryllium	6	7	86	0.21	0.56	0.33	0.12	0.42	0.42	N	N	
NBS	Cobalt	0	7	0	NC[(d)]	NC	NC	NC	NC	NC	NA[(e)]	N	Not a COPC
NBS	Cadmium	6	7	86	0.10	3.47	0.93	1.14	1.77	1.77	Y	Y	
NBS	Chromium	7	7	100	9.62	40.50	23.80	11.59	32.32	32.32	Y	Y	
NBS	Copper	7	7	100	11.10	239.0	80.54	78.60	138.3	138.3	Y	Y	
NBS	Iron	7	7	100	6550	22700	14770	6564	19591	19591	N	N	
NBS	Mercury	2	7	29	0.05	0.27	0.09	0.08	0.15	0.15	Y	Y	
NBS	Manganese	7	7	100	275.0	638.0	437.4	135.2	536.8	536.8	Y	Y	
NBS	Molybdenum	1	7	14	3.53	5.00	4.79	0.56	5.20	5.00	Y	Y	
NBS	Nickel	7	7	100	5.81	55.30	15.90	17.61	28.84	28.84	Y	Y	
NBS	Lead	7	7	100	17.30	510.0	284.6	193.2	426.5	426.5	Y	Y	
NBS	Antimony	6	7	86	0.25	2160	310.7	815.5	909.6	909.6	Y	Y	
NBS	Selenium	0	7	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
NBS	Tin	1	7	14	2.75	5.00	4.68	0.85	5.30	5.00	Y	Y	
NBS	Thallium	0	7	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
NBS	Vanadium	7	7	100	9.59	33.70	23.03	8.80	29.49	29.49	N	N	
NBS	Zinc	7	7	100	48.00	2360	704.1	806.8	1297	1297	Y	Y	

General Note:

1.Calcium, magnesium, sodium and potassium were not included in risk assessment as they are macronutrients.

All other analytes in soil have been included if they were detected in one or more samples.

Footnotes:

(a) Upper 95% confidence limit.

(b) Exposure point concentration, micrograms per gram, equivalent to parts per million.

(c) COPC = Contaminant of Potential Concern

(d) Not calculated. Not a COPC.

(e) Not applicable or not evaluated.

TABLE 8.7-9c

Summary Statistics for Dioxins/Furans in Surface Soil
New Burn Site (Inside Trench Area) - Phase III
Jefferson Proving Ground
Madison, Indiana

Site	Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Standard Deviation	UCL 95[(a)]	EPC µg/g[(b)]
NBS	2,3,4,6,7,8-Hexachlorodibenzofuran	6	7	86	5.00E-07	2.19E-05	7.67E-06	7.09E-06	1.29E-05	1.29E-05
NBS	2,3,4,7,8-Pentachlorodibenzofuran	5	7	71	5.00E-07	1.09E-05	3.80E-06	4.03E-06	6.76E-06	6.76E-06
NBS	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	7	7	100	5.58E-05	3.39E-04	1.29E-04	9.96E-05	2.02E-04	2.02E-04
NBS	1,2,3,4,6,7,8-Heptachlorodibenzofuran	6	7	86	5.00E-07	1.52E-04	6.63E-05	5.93E-05	1.10E-04	1.10E-04
NBS	1,2,3,4,7,8,9-Heptachlorodibenzofuran	3	7	43	5.00E-07	6.56E-06	2.49E-06	2.10E-06	4.03E-06	4.03E-06
NBS	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	5	7	71	5.00E-07	4.37E-05	1.31E-05	1.53E-05	2.43E-05	2.43E-05
NBS	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	4	7	57	5.00E-07	1.09E-05	3.41E-06	3.62E-06	6.07E-06	6.07E-06
NBS	1,2,3,7,8-Pentachlorodibenzo-p-dioxin	3	7	43	5.00E-07	4.33E-06	2.07E-06	1.45E-06	3.13E-06	3.13E-06
NBS	1,2,3,7,8-Pentachlorodibenzofuran	5	7	71	5.00E-07	7.65E-06	2.53E-06	2.54E-06	4.39E-06	4.39E-06
NBS	Octachlorodibenzodioxin - nonspecific	7	7	100	1.08E-03	1.22E-02	4.29E-03	3.80E-03	7.08E-03	7.08E-03
NBS	Octachlorodibenzofuran - nonspecific	6	7	86	5.00E-07	5.46E-05	2.51E-05	1.95E-05	3.94E-05	3.94E-05
NBS	2,3,7,8-Tetrachlorodibenzodioxin	1	7	14	5.00E-07	2.20E-06	7.43E-07	6.43E-07	1.21E-06	1.21E-06
NBS	2,3,7,8-Tetrachlorodibenzofuran	5	7	71	5.00E-07	3.28E-04	5.42E-05	1.21E-04	1.43E-04	1.43E-04

Footnotes:

(a) Upper 95% confidence limit.

(b) Exposure point concentration, micrograms per gram, equivalent to parts per million.

TABLE 8.7-10

Summary of COPC Exposure Point Concentrations by Medium
New Burn Site - Inside Trench - Phase III
Jefferson Proving Ground
Madison, Indiana

	Measured Concentrations in Abiotic Media				Estimated Concentrations in Biotic Media							
Analyte Name	Filtered Surface Water (µg/L) [(a)]	Sediment (mg/kg) [(b)]	Unfiltered Surface Water (mg/L) [(c)]	Soil (mg/kg)	Plant (mg/kg)	Invertebrate (mg/kg)	Mouse (mg/kg)	Swift (mg/kg)	Aquatic Plants (mg/kg)	Benthic Invertebrate (mg/kg)	Fish (mg/kg)	Frogs (mg/kg)
2-Methylnaphthalene				6.52E-01	8.47E-03	0.00E+00	2.69E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2-Methylpyrene				5.50E-01	7.15E-03	0.00E+00	2.27E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2-Phenylnaphthalene				4.45E-01	5.78E-03	0.00E+00	1.84E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,3,4,6,7,8-Hexachlorodibenzofuran				1.29E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,3,4,7,8-Pentachlorodibenzofuran				6.76E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin				2.02E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,2,3,4,6,7,8-Heptachlorodibenzofuran				1.10E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,2,3,4,7,8,9-Heptachlorodibenzofuran				4.03E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,2,3,7,8,9-Hexachlorodibenzo-p dioxin				2.43E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,2,3,4,7,8-Hexachlorodibenzo-p dioxin				6.07E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,2,3,7,8-Pentachlorodibenzo-p-dioxin				3.13E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,2,3,7,8-Pentachlorodibenzofuran				4.39E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Acenaphthene				0.67	8.71E-03	0.00E+00	2.77E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Anthracene				0.96	1.25E-02	0.00E+00	3.95E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Antimony				909.6	2.39E+02	1.74E+02	2.09E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo[a]anthracene				4.29	5.58E-02	0.00E+00	1.77E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Barium				971.0	1.43E+02	3.50E+01	1.73E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo[b]fluoranthene				4.68	6.08E-02	0.00E+00	1.93E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo(a)pyrene				3.56	4.63E-02	0.00E+00	1.47E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzoic Acid				1.39	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE 8.7-10

Summary of COPC Exposure Point Concentrations by Medium
New Burn Site - Inside Trench - Phase III
Jefferson Proving Ground
Madison, Indiana

	Measured Concentrations in Abiotic Media				Estimated Concentrations in Biotic Media							
Analyte Name	Filtered Surface Water (µg/L) [(a)]	Sediment (mg/kg) [(b)]	Unfiltered Surface Water (mg/L) [(c)]	Soil (mg/kg)	Plant (mg/kg)	Invertebrate (mg/kg)	Mouse (mg/kg)	Swift (mg/kg)	Aquatic Plants (mg/kg)	Benthic Invertebrate (mg/kg)	Fish (mg/kg)	Frogs (mg/kg)
Benzo[e]pyrene				2.23	2.90E-02	0.00E+00	9.20E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo[ghi]perylene				2.67	3.47E-02	0.00E+00	1.10E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo[j]fluoranthene				0.66	8.58E-03	0.00E+00	2.72E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo[k]fluoranthene				1.76	2.29E-02	0.00E+00	7.26E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo[b]naphtho[2,1-D]thiophene				0.89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Boron				8.53	3.41E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium				1.77	7.08E-01	6.58E+00	8.84E-03	1.35E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Carbazole				0.22	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium				32.32	3.88E-01	8.40E-01	6.30E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chrysene				3.63	4.72E-02	0.00E+00	1.50E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper				138.3	1.37E+01	1.22E+02	1.06E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dibenz[ah]anthracene				0.67	8.71E-03	0.00E+00	2.77E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dibenzofuran				0.62	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dibenzothiophene				0.22	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1-Eicosanol				0.45	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fluoranthene				8.91	1.16E-01	0.00E+00	3.68E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fluorene				0.63	8.20E-03	0.00E+00	2.60E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Indeno[1,2,3-C,D]pyrene				2.67	3.47E-02	0.00E+00	1.10E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead				426.5	5.54E+01	2.99E+01	4.09E-02	2.23E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Manganese				536.8	1.99E+01	2.04E+01	6.17E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury				0.15	3.00E-04	2.16E-01	1.38E-01	2.81E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Molybdenum				5.00	1.25E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Naphthalene				0.63	8.14E-03	0.00E+00	2.58E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel				28.84	1.27E+00	1.44E+00	5.80E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Octachlorodibenzodioxin - nonspecific				7.08E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Octachlorodibenzofuran - nonspecific				3.94E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Polynuclear aromatic hydrocarbons				1.23	1.59E-02	0.00E+00	5.06E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE 8.7-10

Summary of COPC Exposure Point Concentrations by Medium
New Burn Site - Inside Trench - Phase III
Jefferson Proving Ground
Madison, Indiana

	Measured Concentrations in Abiotic Media				Estimated Concentrations in Biotic Media							
Analyte Name	Filtered Surface Water (µg/L) (a)	Sediment (mg/kg) (b)	Unfiltered Surface Water (mg/L) (c)	Soil (mg/kg)	Plant (mg/kg)	Invertebrate (mg/kg)	Mouse (mg/kg)	Swift (mg/kg)	Aquatic Plants (mg/kg)	Benthic Invertebrate (mg/kg)	Fish (mg/kg)	Frogs (mg/kg)
Phenanthrene				4.45	5.78E-02	0.00E+00	1.84E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,2-Bis(p-chlorophenyl)-1,1-dichloroethene				2.23	2.23E-02	4.42E+00	1.02E+00	4.21E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,2-Bis(p-chlorophenyl)-1,1,1-trichloroethane				1.11	1.11E-02	2.20E+00	5.07E-01	2.09E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pyrene				7.70	1.00E-01	0.00E+00	3.18E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Silver				0.53	2.54E-02	6.36E-02	4.57E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,3,7,8-Tetrachlorodibenzodioxin				1.21E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,3,7,8-Tetrachlorodibenzofuran				1.43E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tin				5.00E+00	1.50E-01	0.00E+00	1.70E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc				1.30E+03	7.13E+02	8.56E+02	5.27E+01	9.91E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Footnotes:

(a) Micrograms per liter, equivalent to parts per billion.

(b) Milligrams per kilogram, equivalent to parts per million.

(c) milligrams per liter, equivalent ot parts per million

TABLE 8.7-11a

Summary Statistics for Dioxins/Furans in Surface Soil
New Burn Site (Outside Trench Area) - Phase III
Jefferson Proving Ground
Madison, Indiana

Site	Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Standard Deviation	UCL 95 [(a)]	EPC µg/g [(b)]
NBS	2,3,4,6,7,8-Hexachlorodibenzofuran	6	9	67	5.00E-07	5.90E-06	1.81E-06	1.64E-06	2.83E-06	2.83E-06
NBS	2,3,4,7,8-Pentachlorodibenzofuran	1	9	11	5.00E-07	3.54E-06	8.38E-07	1.01E-06	1.47E-06	1.47E-06
NBS	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	9	9	100	3.31E-05	1.30E-04	5.24E-05	3.13E-05	7.18E-05	7.18E-05
NBS	1,2,3,4,6,7,8-Heptachlorodibenzofuran	7	9	78	1.00E-06	3.54E-05	7.33E-06	1.07E-05	1.40E-05	1.40E-05
NBS	1,2,3,4,7,8,9-Heptachlorodibenzofuran	1	9	11	5.00E-07	4.72E-06	1.39E-06	1.30E-06	2.19E-06	2.19E-06
NBS	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	3	9	33	5.00E-07	7.08E-06	1.69E-06	2.09E-06	2.98E-06	2.98E-06
NBS	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	2	9	22	5.00E-07	3.54E-06	1.07E-06	9.63E-07	1.67E-06	1.67E-06
NBS	1,2,3,7,8-Pentachlorodibenzo-p-dioxin	1	9	11	5.00E-07	2.36E-06	7.07E-07	6.20E-07	1.09E-06	1.09E-06
NBS	1,2,3,7,8-Pentachlorodibenzofuran	2	9	22	5.00E-07	3.54E-06	1.16E-06	1.31E-06	1.97E-06	1.97E-06
NBS	Octachlorodibenzodioxin - nonspecific	9	9	100	2.14E-03	5.94E-03	3.37E-03	1.20E-03	4.12E-03	4.12E-03
NBS	Octachlorodibenzofuran - nonspecific	3	9	33	1.00E-06	2.36E-05	4.72E-06	7.21E-06	9.19E-06	9.19E-06
NBS	2,3,7,8-Tetrachlorodibenzodioxin	1	9	11	5.00E-07	1.18E-06	5.76E-07	2.27E-07	7.16E-07	7.16E-07
NBS	2,3,7,8-Tetrachlorodibenzofuran	7	9	78	5.00E-07	1.18E-05	2.82E-06	3.47E-06	4.98E-06	4.98E-06

General Note:

1. Calcium, magnesium, sodium and potassium were not included in risk assessment as they are macronutrients.

All other analytes in soil have been included if they were detected in one or more samples.

Footnotes:

(a) Upper 95% confidence limit.

(b) Exposure point concentration, micrograms per gram, equivalent to parts per million.

TABLE 8.7-11b

Summary Statistics for Metals in Surface Soil
New Burn Site (Outside Trench) - Phase III
Jefferson Proving Ground
Madison, Indiana

Site	Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Standard Deviation	UCL 95	EPC ug/g	Exceed Background (Bkg)?	Retain as COPC[c]?	Comment
NBS	Silver	0	9	0	NC[d]	NC	NC	NC	NC	NC	NA[e]	No (N)	Not a COPC
NBS	Aluminum	9	9	100	11100	15700	13122	1259	13903	13903	Yes (Y)	Y	
NBS	Arsenic	9	9	100	5.82	12.50	7.91	1.96	9.12	9.12	Y	Y	
NBS	Boron	0	9	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
NBS	Barium	9	9	100	79.10	178.0	114.1	29.35	132.3	132.3	Y	Y	
NBS	Beryllium	9	9	100	0.47	1.10	0.72	0.23	0.86	0.86	Y	Y	
NBS	Cadmium	9	9	100	0.11	1.12	0.40	0.34	0.61	0.61	Y	Y	
NBS	Cobalt	5	9	56	3.16	11.90	7.14	3.40	9.25	9.25	Y	Y	
NBS	Chromium	9	9	100	13.70	28.60	18.74	4.35	21.43	21.43	Y	Y	
NBS	Copper	9	9	100	8.05	62.50	18.62	16.81	29.05	29.05	Y	Y	
NBS	Iron	9	9	100	13000	23900	17100	3362	19184	19184	Y	Y	
NBS	Mercury	4	9	44	0.05	0.17	0.07	0.042	0.098	0.098	Y	Y	Not detected in Bkg.
NBS	Manganese	9	9	100	469.5	1340	782.4	273.5	951.9	951.9	Y	Y	
NBS	Molybdenum	1	9	11	2.41	5.00	4.71	0.86	5.25	5.00	Y	Y	
NBS	Nickel	9	9	100	6.30	16.30	10.08	2.92	11.89	11.89	Y	Y	
NBS	Lead	9	9	100	15.50	86.20	40.76	21.76	54.25	54.25	Y	Y	
NBS	Antimony	7	9	78	0.25	1.69	0.59	0.46	0.88	0.88	N	N	
NBS	Selenium	3	9	33	0.25	0.37	0.27	0.04	0.30	0.30	N	N	
NBS	Tin	0	9	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
NBS	Thallium	0	9	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
NBS	Vanadium	9	9	100	24.00	33.50	28.0	3.0	29.9	29.9	Y	Y	
NBS	Zinc	9	9	100	56.10	731.00	186.1	211.9	317.5	317.5	Y	Y	

General Note:

1. Calcium, magnesium, sodium and potassium were not included in risk assessment as they are macronutrients.

All other analytes in soil have been included if they were detected in one or more samples.

Footnotes:

(c) Contaminant of potential concern.

(d) Not calculated. Not a COPC.

(e) Not applicable or not evaluated.

TABLE 8.7-11c

Summary Statistics for SVOCs in Surface Soil
New Burn Site (Outside Trench Area) - Phase III
Jefferson Proving Ground
Madison, Indiana

Site	Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Standard Deviation	UCL[(a)] 95	EPC [(b)] ug/g
NBS	Acenaphthylene	1	2	50	0.01	0.34	0.17	0.23	1.20	0.34
NBS	Anthracene	1	2	50	0.01	0.34	0.17	0.23	1.19	0.34
NBS	Benzo[a]anthracene	2	2	100	0.01	0.14	0.07	0.09	0.46	0.14
NBS	Benzo[a]pyrene	1	2	50	0.14	0.34	0.24	0.14	0.87	0.34
NBS	Benzo[b]fluoranthene	1	2	50	0.18	0.34	0.26	0.11	0.75	0.34
NBS	Benzoic acid	2	2	100	0.09	0.14	0.11	0.03	0.25	0.14
NBS	Benzo[ghi]perylene	1	2	50	0.11	0.34	0.22	0.16	0.94	0.34
NBS	Benzo[k]fluoranthene	1	2	50	0.06	0.34	0.20	0.19	1.06	0.34
NBS	Myristic acid	1	1	100	0.11	0.11	0.11	NA	NA	0.11
NBS	Palmitic acid	2	2	100	0.45	1.10	0.77	0.46	2.83	1.10
NBS	Nonadecane	1	1	100	0.34	0.34	0.34	NA	NA	0.34
NBS	Chrysene	2	2	100	0.01	0.15	0.08	0.10	0.51	0.15
NBS	Dibenz[ah]anthracene	1	2	50	0.03	0.34	0.18	0.22	1.15	0.34
NBS	1-Eicosanol	2	2	100	0.22	0.34	0.28	0.08	0.65	0.34
NBS	Fluoranthene	2	2	100	0.02	0.32	0.17	0.21	1.10	0.32
NBS	Indeno[1,2,3-C,D]pyrene	1	2	50	0.11	0.34	0.22	0.16	0.93	0.34
NBS	Stearic acid	1	1	100	0.55	0.55	0.55	NA	NA	0.55
NBS	Phenanthrene	1	2	50	0.17	0.34	0.25	0.12	0.78	0.34
NBS	Pyrene	1	2	50	0.24	0.34	0.29	0.07	0.60	0.34

General Note:

1. Calcium, magnesium, sodium and potassium were not included in risk assessment as they are macronutrients.
All other analytes in soil have been included if they were detected in one or more samples.

Footnotes:

(a) Upper 95% confidence limit.
(b) Exposure point concentration, micrograms per gram, equivalent to parts per million.
(c) Not applicable or not evaluated.

TABLE 8.7-12

Summary of Contaminants of Potential Concern Exposure Point Concentrations by Medium
New Burn Site - Outside Trench - Phase III
Jefferson Proving Ground
Madison, Indiana

	Measured Concentrations in Abiotic Media				Estimated Concentrations in Biotic Media								
Analyte Name	**Filtered Surface Water (µg/L)** [a]	**Sediment (mg/kg)** [b]	**Unfiltered Surface Water (mg/L)** [c]	**Soil (mg/kg)**	**Plant (mg/kg)**	**Invertebrate (mg/kg)**	**Mouse (mg/kg)**	**Swift (mg/kg)**	**Aquatic Plants (mg/kg)**	**Benthic Invertebrate (mg/kg)**	**Fish (mg/kg)**	**Frogs (mg/kg)**
2,3,4,6,7,8-Hexachlorodibenzofuran				2.83E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,3,4,7,8-Pentachlorodibenzofuran				1.47E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin				7.18E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,2,3,4,6,7,8-Heptachlorodibenzofuran				1.40E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,2,3,4,7,8,9-Heptachlorodibenzofuran				2.19E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin				2.89E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin				1.67E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,2,3,7,8-Pentachlorodibenzo-p-dioxin				1.09E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,2,3,7,8-Pentachlorodibenzofuran				1.97E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Acenaphthene				0.34	4.35E-03	0.00E+00	1.38E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Aluminum				13903	5.56E+01	1.53E+02	3.82E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Anthracene				0.34	4.35E-03	0.00E+00	1.38E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic				9.12	1.92E-01	1.03E+00	1.59E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo[a]anthracene				0.14	1.75E-03	0.00E+00	5.57E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Barium				132.3	1.94E+01	4.76E+00	2.36E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo[b]fluoranthene				0.34	4.35E-03	0.00E+00	1.38E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo(a)pyrene				0.34	4.35E-03	0.00E+00	1.38E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzoic Acid				0.14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beryllium				0.86	3.44E-03	9.46E-03	2.37E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo[ghi]perylene				0.34	4.35E-03	0.00E+00	1.38E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo[k]fluoranthene				0.34	4.35E-03	0.00E+00	1.38E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium				0.61	2.44E-01	2.27E+00	3.05E-03	4.67E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium				21.46	2.58E-01	5.58E-01	4.18E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chrysene				0.15	1.90E-03	0.00E+00	6.03E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt				9.25	1.67E-01	3.24E-01	4.30E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper				29.05	2.88E+00	2.56E+01	2.22E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dibenz[ah]anthracene				0.34	4.35E-03	0.00E+00	1.38E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1-Eicosanol				0.34	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fluoranthene				0.32	4.09E-03	0.00E+00	1.30E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Indeno[1,2,3-C,D]pyrene				0.34	4.35E-03	0.00E+00	1.38E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Iron				19184	7.67E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead				54.25	7.05E+00	3.80E+00	5.21E-03	2.83E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Manganese				951.93	3.52E+01	3.62E+01	1.09E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury				0.10	2.00E-04	1.44E-01	9.19E-02	1.87E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Molybdenum				5.00	1.25E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE 8.7-12

Summary of Contaminants of Potential Concern Exposure Point Concentrations by Medium
New Burn Site - Outside Trench - Phase III
Jefferson Proving Ground
Madison, Indiana

	Measured Concentrations in Abiotic Media				Estimated Concentrations in Biotic Media							
Analyte Name	**Filtered Surface Water (µg/L) (a)**	**Sediment (mg/kg) (b)**	**Unfiltered Surface Water (mg/L) (c)**	**Soil (mg/kg)**	**Plant (mg/kg)**	**Invertebrate (mg/kg)**	**Mouse (mg/kg)**	**Swift (mg/kg)**	**Aquatic Plants (mg/kg)**	**Benthic Invertebrate (mg/kg)**	**Fish (mg/kg)**	**Frogs (mg/kg)**
Myristic acid				0.11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel				11.89	5.23E-01	5.95E-01	2.39E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nonadecane				0.34	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Octachlorodibenzodioxin - nonspecific				4.12E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Octachlorodibenzofuran - nonspecific				9.19E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Stearic acid				0.55	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Palmitic acid				1.10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Phenanthrene				0.34	4.35E-03	0.00E+00	1.38E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pyrene				0.34	4.35E-03	0.00E+00	1.38E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,3,7,8-Tetrachlorodibenzodioxin				7.16E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,3,7,8-Tetrachlorodibenzofuran				4.98E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Vanadium				29.85	8.96E-02	2.69E-01	3.73E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc				317.5	1.75E+02	2.10E+02	1.29E+01	2.43E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Footnotes:

(a) Micrograms per liter, equivalent to parts per billion.

(b) Milligrams per kilogram, equivalent to parts per million.

(c) Milligrams per liter, equivalent to parts per million.

TABLE 8.7-12a
Earthworm Toxicity Test Summary
Jefferson Proving Ground
Madison, Indiana

Site ID	Grid	% Worm Mortality
3/4	2	15
3/4	13	10
3/4	15	10
3/4	23	5
3/4	11	0
9	15	20
9	6	15
9	12	15
9	4	5
9	23	5
11	18	5
11	5	0
11	8	0
11	12	0
11	15	0
14/15	11	10
14/15	5	0
14/15	7	0
14/15	14	0
14/15	18	0
25	14	10
25	3	5
25	18	5
25	7	0
25	21	0
39	14	35
39	2	15
39	5	10
39	12	10
39	16	10
Reference Sites		
Avon	23	5
Avon	24	5
Avon	2	0
Avon	13	0
Avon	20	0
Cobb	2	10
Cobb	10	5
Cobb	16	5
Cobb	13	0
Cobb	23	0
Ross	24	15
Ross	3	10
Ross	11	10
Ross	14	10
Ross	16	0

General Notes:
This table summarizes the results of the in-situ earthworm toxicity tests conducted at Sites 3/4, 9, 11, 14/15, 25, 39, and the 3 reference sites.

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TABLE 8.7-13

Summary of DERA RME Risk Drivers
Site 3 - Phase 1
Jefferson Proving Ground
Madison, Indiana

3	NOAEL-Based HQs Due to Soil Ingestion or Direct Contact - RME				NOAEL-Based HQs Due to Dietary Ingestion - RME		Total NOAEL-Based HQs Summed Across Pathways - RME			
Parameter	**White-footed Mouse**	**Eastern Cottontail**	**Plants**	**Soil Fauna**	**White-footed Mouse**	**Eastern Cottontail**	**White-footed Mouse**	**Eastern Cottontail**	**Plants**	**Soil Fauna**
Aluminum	13.27	10.33	349.44	6.99	4.88		18.15	10.95	349.44	6.99
Barium	3.02	2.35	1.66		13.54	5.14	16.56	7.49	1.66	
Chromium			4.17	52.12					4.17	52.12
Cobalt	2.35	1.83			3.05		5.40	2.32		
Copper			1.20	1.43	5.75		5.99		1.20	1.43
Iron	9.01	7.02		34.68			9.89	7.43		34.68
Lead	1.64	1.28	1.41		8.02	2.47	9.65	3.74	1.41	
Manganese			5.46				1.01		5.46	
Zinc			9.40	4.70	6.39	1.37	6.61	1.54	9.40	4.70
HI_NOAEL	**29.29**	**22.80**	**372.73**	**99.92**	**41.63**	**8.98**	**73.26**	**33.47**	**372.73**	**99.92**

3	LOAEL-Based HQs Due to Soil Ingestion - RME				LOAEL-Based HQs Due to Dietary Ingestion - RME	Total LOAEL-Based HQs Summed Across Pathways - RME			
Parameter	**White-footed Mouse**	**Eastern Cottontail**	**Plants**	**Soil Fauna**	**White-footed Mouse**	**White-footed Mouse**	**Eastern Cottontail**	**Plants**	**Soil Fauna**
Aluminum	6.73	5.24	23.93	6.24	2.47	9.20	5.55	23.93	6.24
Iron	4.51	3.51				4.95	3.72		
Zinc			1.24		1.07	1.10		1.24	
HI_LOAEL	**11.23**	**8.75**	**25.17**	**6.24**	**3.54**	**15.25**	**9.27**	**25.17**	**6.24**

Note:

1. NOAEL = No Observed Adverse Effect Level
2. HQ = Hazard Quotient
3. HI = Hazard Index
4. LOAEL = Lowest Observed Adverse Effect Level
5. CT = Central Tendency
6. DERA = Detailed Ecological Risk Assessment
7. RME = Reasonable Maximum Exposure

TABLE 8.7-14

Summary of DERA CT Risk Drivers
Site 3 - Phase 1
Jefferson Proving Ground
Madison, Indiana

3	NOAEL-Based HQs Due to Soil Ingestion - CT		NOAEL-Based HQs Due to Dietary Ingestion - CT		Total NOAEL-Based HQs Summed Across Pathways - CT	
Parameter	**White-footed Mouse**	**Eastern Cottontail**	**White-footed Mouse**	**Eastern Cottontail**	**White-footed Mouse**	**Eastern Cottontail**
Aluminum	8.21	4.19	3.02		11.23	4.44
Barium	1.87		8.38	2.09	10.25	3.04
Cobalt	1.45		1.89		3.34	
Copper			3.56		3.71	
Iron	5.58	2.85			6.12	3.02
Lead	1.01		4.96	1.00	5.98	1.52
Zinc			3.96		4.09	
HI_NOAEL	**18.13**	**7.04**	**25.77**	**3.09**	**44.72**	**12.02**

3	LOAEL-Based HQs Due to Soil Ingestion - CT		LOAEL-Based HQs Due to Dietary Ingestion - CT	Total LOAEL-Based HQs Summed Across Pathways - CT	
Parameter	**White-footed Mouse**	**Eastern Cottontail**	**White-footed Mouse**	**White-footed Mouse**	**Eastern Cottontail**
Aluminum	4.17	2.13	1.53	5.70	2.25
Iron	2.79	1.42		3.06	1.51
HI_LOAEL	**6.95**	**3.55**	**1.53**	**8.76**	**3.76**

General Notes:

1. NOAEL = No Observed Adverse Effect Level
2. HQ = Hazard Quotient
3. HI = Hazard Index
4. LOAEL = Lowest Observed Adverse Effect Level
5. CT = Central Tendency
6. DERA =Detailed Ecological Risk Assessment

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TABLE 8.7-15

Summary of DERA RME Risk Drivers
Site 4 - Phase 1
Jeffersaon Proving Ground
Madison, Indiana

4	NOAEL-Based HQs Due to Soil Ingestion or Direct Contact - RME							NOAEL-Based HQs Due to Dietary Ingestion - RME					Total NOAEL-Based HQs Summed Across Pathways - RME						
Parameter	Chimney Swift	American Kestrel	White-footed Mouse	Eastern Cottontail	Little Brown Myotis	Plants	Soil Fauna	Chimney Swift	American Kestrel	White-footed Mouse	Eastern Cottontail	Little Brown Myotis	Chimney Swift	American Kestrel	White-footed Mouse	Eastern Cottontail	Little Brown Myotis	Plants	Soil Fauna
Aluminum			19.14	14.90		504.00	10.08			7.04					26.18	15.79	1.22	504.00	10.08
Arsenic			9.96	7.75		1.15				32.70	2.42	2.29			42.65	10.18	2.70	1.15	
Barium			18.27	14.22		10.01				81.90	31.09	1.34		1.01	100.17	45.32	2.10	10.01	
Cadmium						4.13	1.38	6.51	1.55	65.04	2.98	4.88	6.71	1.90	65.68	3.49	4.90	4.13	1.38
Chromium						10.90	136.25											10.90	136.25
Cobalt			2.73	2.12						3.54					6.27	2.69			
Copper						3.59	4.29			17.22		1.29			17.94	1.38	1.32	3.59	4.29
Iron			8.08	6.29			31.10								8.87	6.66			31.10
Lead			4.53	3.53		3.89	1.15			22.19	6.82				26.72	10.35		3.89	1.15
Manganese						1.47												1.47	
Mercury							1.29												1.29
Selenium										187.02	48.36	7.04			187.46	48.70	7.05		
Silver						2.63												2.63	
Tin			28.61	22.27	1.19					21.03	9.94				49.64	32.21	1.19		
Vanadium	2.73	4.68	62.98	49.03	2.62	20.20	2.02			18.51	2.19	1.15	2.94	4.73	81.49	51.22	3.77	20.20	2.02
Zinc						9.14	4.57			6.21	1.33				6.42	1.50		9.14	4.57
HI_NOAEL	**2.73**	**4.68**	**154.29**	**120.13**	**3.80**	**571.12**	**192.12**	**6.51**	**1.55**	**462.38**	**105.14**	**17.98**	**9.66**	**7.63**	**619.48**	**229.49**	**24.25**	**571.12**	**192.12**

4	LOAEL-Based HQs Due to Soil Ingestion - RME				LOAEL-Based HQs Due to Dietary Ingestion - RME		Total LOAEL-Based HQs Summed Across Pathways - RME				
Parameter	White-footed Mouse	Eastern Cottontail	Plants	Soil Fauna	White-footed Mouse	Eastern Cottontail	White-footed Mouse	Eastern Cottontail	Little Brown Myotis	Plants	Soil Fauna
Aluminum	9.71	7.56	34.52	9.00	3.57		13.27	8.01		34.52	9.00
Arsenic					2.58		3.37				
Iron	4.04	3.15					4.44	3.33			
Lead			1.41							1.41	
Selenium					12.47	3.22	12.50	3.25			
Tin	1.31	1.02					2.27	1.48			
Vanadium	20.99	16.34			6.17		27.16	17.07	1.26		
Zinc			1.21		1.04		1.07			1.21	
HI_LOAEL	**36.05**	**28.07**	**37.14**	**9.00**	**25.82**	**3.22**	**64.08**	**33.13**	**1.26**	**37.14**	**9.00**

General Notes:

1. NOAEL = No Observed Adverse Effect Level
2. HQ = Hazard Quotient
3. HI = Hazard Index
4. LOAEL = Lowest Observed Adverse Effect Level
5. CT = Central Tendency
6. DERA = Detailed Ecological Risk Assessment
7. RME = Reasonable Maximum Exposure

TABLE 8.7-16

Summary of DERA CT Risk Drivers
Site 4 - Phase 1
Jefferson Proving Ground
Madison, Indiana

4	NOAEL-Based HQs Due to Soil Ingestion - CT				NOAEL-Based HQs Due to Dietary Ingestion - CT					Total NOAEL-Based HQs Summed Across Pathways - CT				
Parameter	**Chimney Swift**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**
Aluminum		11.85	6.05				4.35					16.20	6.41	1.15
Arsenic		6.16	3.15				20.24		2.16			26.40	4.13	2.55
Barium		11.31	5.77				50.69	12.62	1.26			62.00	18.39	1.98
Cadmium					5.49	3.23	40.25	1.21	4.60	5.66	3.27	40.65	1.41	4.63
Cobalt		1.69					2.19					3.88	1.09	
Copper							10.66		1.21			11.10		1.24
Iron		5.00	2.55									5.49	2.70	
Lead		2.80	1.43				13.73	2.77				16.54	4.20	
Selenium							115.75	19.62	6.63			116.02	19.76	6.65
Silver														
Tin		17.71	9.04	1.12			13.01	4.03				30.72	13.07	1.12
Vanadium	2.30	38.98	19.89	2.47			11.46		1.09	2.48		50.44	20.78	3.55
Zinc							3.84					3.97		
HI_NOAEL	**2.30**	**95.50**	**47.88**	**3.59**	**5.49**	**3.23**	**286.19**	**40.25**	**16.96**	**8.14**	**3.27**	**383.42**	**91.94**	**22.87**

4	LOAEL-Based HQs Due to Soil Ingestion - CT		LOAEL-Based HQs Due to Dietary Ingestion - CT		Total LOAEL-Based HQs Summed Across Pathways - CT		
Parameter	**White-footed Mouse**	**Eastern Cottontail**	**White-footed Mouse**	**Eastern Cottontail**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**
Aluminum	6.01	3.07	2.21		8.22	3.25	
Arsenic			1.60		2.08		
Iron	2.50	1.28			2.75	1.35	
Selenium			7.72	1.31	7.73	1.32	
Tin					1.41		
Vanadium	12.99	6.63	3.82		16.81	6.93	1.18
HI_LOAEL	**21.50**	**10.97**	**15.34**	**1.31**	**39.00**	**12.84**	**1.18**

Notes:

1. NOAEL = No Observed Adverse Effect Level
2. HQ = Hazard Quotient
3. HI = Hazard Index
4. LOAEL = Lowest Observed Adverse Effect Level
5. CT = Central Tendency
6. DERA = Detailed Ecological Risk Assessment

TABLE 8.7-17

Summary of DERA RME Risk Drivers
Site 3 - Phase II
Jefferson Proving Ground
Madison, Indiana

3	NOAEL-Based HQs Due to Soil Ingestion or Direct Contact - RME				NOAEL-Based HQs Due to Dietary Ingestion - RME			Total NOAEL-Based HQs Summed Across Pathways - RME				
Parameter	**White-footed Mouse**	**Eastern Cottontail**	**Plants**	**Soil Fauna**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**Plants**	**Soil Fauna**
Aluminum	8.83	6.87	232.37	4.65	3.24			12.07	7.28		232.37	4.65
Arsenic	6.67	5.19			21.90	1.62	1.53	28.57	6.82	1.81		
Barium	2.07	1.61	1.14		9.29	3.53		11.37	5.14		1.14	
Boron					9.02	4.26		9.11	4.33			
Cadmium					5.12			5.17				
Chromium			6.47	80.90							6.47	80.90
Cobalt	1.63	1.27			2.12			3.75	1.61			
Copper					1.19			1.24				
Iron	4.59	3.58		17.68				5.04	3.79			17.68
Lead					3.34	1.03		4.02	1.56			
Manganese			2.14								2.14	
Mercury												
Molybdenum					2.58			3.00				
Tin	18.85	14.68			13.86	6.55		32.71	21.23			
Zinc			1.57		1.06			1.10			1.57	
HI_NOAEL	**42.65**	**33.20**	**243.68**	**103.23**	**72.72**	**16.99**	**1.53**	**117.15**	**51.76**	**1.81**	**243.68**	**103.23**

3	LOAEL-Based HQs Due to Soil Ingestion - RME				LOAEL-Based HQs Due to Dietary Ingestion - RME		Total LOAEL-Based HQs Summed Across Pathways - RME			
Parameter	**White-footed Mouse**	**Eastern Cottontail**	**Plants**	**Soil Fauna**	**White-footed Mouse**	**Eastern Cottontail**	**White-footed Mouse**	**Eastern Cottontail**	**Plants**	**Soil Fauna**
Aluminum	4.48	3.48	15.92	4.15	1.64		6.12	3.69	15.92	4.15
Arsenic					1.73		2.26			
Boron					4.51	2.13	4.56	2.17		
Iron	2.30	1.79					2.52	1.89		
Tin							1.50			
HI_LOAEL	**6.77**	**5.27**	**15.92**	**4.15**	**7.88**	**2.13**	**16.95**	**7.75**	**15.92**	**4.15**

Notes:

1. NOAEL = No Observed Adverse Effect Level
2. HQ = Hazard Quotient
3. HI = Hazard Index
4. LOAEL = Lowest Observed Adverse Effect Level
5. CT = Central Tendency
6. DERA = Detailed Ecological Risk Assessment
7. RME = Reasonable Maximum Exposure

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TABLE 8.7-18

Summary of DERA CT Risk Drivers
Site 3 - Phase II
Jefferson Proving Ground
Madison, Indiana

3	NOAEL-Based HQs Due to Soil Ingestion - CT		NOAEL-Based HQs Due to Dietary Ingestion - CT			Total NOAEL-Based HQs Summed Across Pathways - CT		
Parameter	**White-footed Mouse**	**Eastern Cottontail**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**
Aluminum	5.46	2.79	2.01			7.47	2.95	
Arsenic	4.13	2.11	13.56		1.45	17.68	2.77	1.71
Barium	1.28		5.75	1.43		7.03	2.09	
Boron			5.58	1.73		5.64	1.76	
Cadmium			3.17			3.20		
Cobalt	1.01		1.31			2.32		
Iron	2.84	1.45				3.12	1.54	
Lead			2.07			2.49		
Molybdenum			1.60			1.86		
Tin	11.67	5.95	8.58	2.66		20.24	8.61	
HI_NOAEL	**26.40**	**12.30**	**43.62**	**5.82**	**1.45**	**71.06**	**19.71**	**1.71**

3	LOAEL-Based HQs Due to Soil Ingestion - CT		LOAEL-Based HQs Due to Dietary Ingestion - CT	Total LOAEL-Based HQs Summed Across Pathways - CT	
Parameter	**White-footed Mouse**	**Eastern Cottontail**	**White-footed Mouse**	**White-footed Mouse**	**Eastern Cottontail**
Aluminum	2.77	1.41	1.02	3.79	1.50
Arsenic			1.07	1.40	
Boron			2.79	2.82	
Iron	1.42			1.56	
HI_LOAEL	**4.19**	**1.41**	**4.88**	**9.56**	**1.50**

Notes:
1. NOAEL = No Observed Adverse Effect Level
2. HQ = Hazard Quotient
3. HI = Hazard Index
4. LOAEL = Lowest Observed Adverse Effect Level
5. CT = Central Tendency
6. DERA = Detailed Ecological Risk Assessment

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TABLE 8.7-19

Summary of DERA RME Risk Drivers
Sites 3 and 4 - Phase III
Jefferson Proving Ground
Madison, Indiana

3/4	NOAEL-Based HQs Due to Soil Ingestion or Direct Contact - RME					NOAEL-Based HQs Due to Dietary Ingestion - RME			Total NOAEL-Based HQs Summed Across Pathways - RME				
Parameter	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**Plants**	**Soil Fauna**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**Plants**	**Soil Fauna**
Aluminum	12.35	12.73	1.03	325.16	6.50	4.54			16.89	13.49	1.58	325.16	6.50
Arsenic	7.97	8.21				26.16	2.56	3.66	34.12	10.78	4.33		
Barium						3.83	1.93		4.69	2.81			
Boron						4.50	2.81		4.54	2.86			
Cadmium						1.52			1.54				
Chromium				4.72	59.05							4.72	59.05
Cobalt	1.35	1.39				1.76			3.11	1.77			
Copper				1.05	1.25	5.03			5.24			1.05	1.25
Iron	5.80	5.98			22.32				6.37	6.33			22.32
Manganese				1.66								1.66	
Selenium						81.19	27.79	6.11	81.38	27.99	6.12		
Zinc				1.29								1.29	
HI_NOAEL	**27.47**	**28.31**	**1.03**	**333.89**	**89.12**	**128.52**	**35.09**	**9.77**	**157.88**	**66.01**	**12.03**	**333.89**	**89.12**

3/4	LOAEL-Based HQs Due to Soil Ingestion - RME				LOAEL-Based HQs Due to Dietary Ingestion - RME		Total LOAEL-Based HQs Summed Across Pathways - RME			
Parameter	**White-footed Mouse**	**Eastern Cottontail**	**Plants**	**Soil Fauna**	**White-footed Mouse**	**Eastern Cottontail**	**White-footed Mouse**	**Eastern Cottontail**	**Plants**	**Soil Fauna**
Aluminum	6.26	6.45	22.27	5.81	2.30		8.56	6.84	22.27	5.81
Arsenic					2.06		2.69			
Boron					2.25	1.41	2.27	1.43		
Iron	2.90	2.99					3.18	3.17		
Selenium					5.41	1.85	5.43	1.87		
HI_LOAEL	**9.16**	**9.44**	**22.27**	**5.81**	**12.03**	**3.26**	**22.14**	**13.30**	**22.27**	**5.81**

Note:

1. NOAEL = No Observed Adverse Effect Level
2. HQ = Hazard Quotient
3. HI = Hazard Index
4. LOAEL = Lowest Observed Adverse Effect Level
5. CT = Central Tendency
6. DERA = Detailed Ecological Risk Assessment
7. RME = Reasonable Maximum Exposure

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TABLE 8.7-20

Summary of DERA CT Risk Drivers
Sites 3 and 4 - Phase III
Jefferson Proving Ground
Madison, Indiana

3/4	NOAEL-Based HQs Due to Soil Ingestion - CT		NOAEL-Based HQs Due to Dietary Ingestion - CT			Total NOAEL-Based HQs Summed Across Pathways - CT		
Parameter	**White-footed Mouse**	**Eastern Cottontail**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**
Aluminum	7.64	7.80	2.81			10.45	8.27	1.49
Arsenic	4.93	5.03	16.19	1.57	3.46	21.12	6.61	4.08
Barium			2.37	1.18		2.90	1.72	
Boron			2.78	1.73		2.81	1.75	
Cobalt			1.09			1.93	1.08	
Copper			3.11			3.24		
Iron	3.59	3.66				3.94	3.88	
Selenium			50.25	17.03	5.76	50.37	17.16	5.78
HI_NOAEL	**16.16**	**16.50**	**78.61**	**21.51**	**9.22**	**96.76**	**40.47**	**11.34**

3/4	LOAEL-Based HQs Due to Soil Ingestion - CT		LOAEL-Based HQs Due to Dietary Ingestion - CT		Total LOAEL-Based HQs Summed Across Pathways - CT	
Parameter	**White-footed Mouse**	**Eastern Cottontail**	**White-footed Mouse**	**Eastern Cottontail**	**White-footed Mouse**	**Eastern Cottontail**
Aluminum	3.88	3.96	1.42		5.30	4.19
Arsenic			1.28		1.67	
Boron			1.39		1.41	
Iron	1.79	1.83			1.97	1.94
Selenium			3.35	1.14	3.36	1.14
HI_LOAEL	**5.67**	**5.79**	**7.44**	**1.14**	**13.70**	**7.28**

Note:
1. NOAEL = No Observed Adverse Effect Level
2. HQ = Hazard Quotient
3. HI = Hazard Index
4. LOAEL = Lowest Observed Adverse Effect Level
5. CT = Central Tendency
6. DERA = Detailed Ecological Risk Assessment

N:\244\0025\01\wp\tbl\Table 8.7-19 thru 8.7-20_Phase 2 RI.xls (CT-RISK)

TABLE 8.7-21

Summary of DERA RME Risk Drivers
New Burn Site Inside Trench (NBS-in)
Jefferson Proving Ground
Madison, Indiana

NBS-in	NOAEL-Based HQs Due to Soil Ingestion or Direct Contact - RME			NOAEL-Based HQs Due to Dietary Ingestion - RME		Total NOAEL-Based HQs Summed Across Pathways - RME			
Parameter	**White-footed Mouse**	**Plants**	**Soil Fauna**	**White-footed Mouse**	**Eastern Cottontail**	**White-footed Mouse**	**Eastern Cottontail**	**Plants**	**Soil Fauna**
Antimony	39.38	181.91		438.07	1.11	477.46	1.39	181.91	
Barium	3.54	1.94		15.89		19.43		1.94	
Boron				5.11		5.16			
Cadmium				9.28		9.38			
Chromium		6.46	80.80					6.46	80.80
Copper		1.38	1.65	6.63		6.90		1.38	1.65
Lead	2.77	2.38		13.57		16.34		2.38	
Manganese		1.07						1.07	
Mercury			1.50						1.50
Molybdenum				2.65		3.09			
Nickel		1.15						1.15	
2,3,7,8-Tetrachlorodibenzofuran	1.86					1.86			
Tin	7.73			5.68		13.42			
Zinc		25.93	12.97	17.62		18.22		25.93	12.97
HI_NOAEL	**55.29**	**222.2**	**96.92**	**514.5**	**1.11**	**571.2**	**1.39**	**222.2**	**96.92**

NBS-in	LOAEL-Based HQs Due to Soil Ingestion - RME			LOAEL-Based HQs Due to Dietary Ingestion - RME	Total LOAEL-Based HQs Summed Across Pathways - RME		
Parameter	**White-footed Mouse**	**Plants**	**Soil Fauna**	**White-footed Mouse**	**White-footed Mouse**	**Plants**	**Soil Fauna**
Antimony	13.13			146.02	159.15		
Boron				2.56	2.58		
Zinc		3.42	1.50	2.94	3.04	3.42	1.50
HI_LOAEL	**13.13**	**3.42**	**1.50**	**151.5**	**164.8**	**3.42**	**1.50**

Note:
1. NOAEL = No Observed Adverse Effect Level
2. HQ = Hazard Quotient
3. HI = Hazard Index
4. LOAEL = Lowest Observed Adverse Effect Level
5. CT = Central Tendency
6. DERA = Detailed Ecological Risk Assessment
7. RME = Reasonable Maximum Exposure

N:\244\0025\01\wp\tbl\Table 8.7-21 and 8.7-22_Phase 2 RI.xls (RME-RISK)

TABLE 8.7-22

Summary of DERA CT Risk Drivers
New Burn Site Inside Trench (NBS-in)
Jefferson Proving Ground
Madison, Indiana

NBS-in	NOAEL-Based HQs Due to Soil Ingestion - CT	NOAEL-Based HQs Due to Dietary Ingestion - CT	Total NOAEL-Based HQs Summed Across Pathways - CT
Parameter	**White-footed Mouse**	**White-footed Mouse**	**White-footed Mouse**
Antimony	4.24	47.18	51.43
Barium		1.71	2.09
Cadmium			1.01
Lead		1.46	1.76
Tin			1.44
Zinc		1.90	1.96
HI_NOAEL	**4.24**	**52.25**	**59.70**

NBS-in	LOAEL-Based HQs Due to Soil Ingestion - CT	LOAEL-Based HQs Due to Dietary Ingestion - CT	Total LOAEL-Based HQs Summed Across Pathways - CT
Parameter	**White-footed Mouse**	**White-footed Mouse**	**White-footed Mouse**
Antimony	1.41	15.73	17.14
HI_LOAEL	**1.41**	**15.73**	**17.14**

Note:
1. NOAEL = No Observed Adverse Effect Level
2. HQ = Hazard Quotient
3. HI = Hazard Index
4. LOAEL = Lowest Observed Adverse Effect Level
5. CT = Central Tendency
6. DERA = Detailed Ecological Risk Assessment

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TABLE 8.7-23

Summary of Detailed Ecological Risk Assessment Reasonable Maximum Exposure (RME) Risk Drivers
New Burn Site (Outside Trench)
Jefferson Proving Ground
Madison, Indiana

NBS-out	NOAEL [(a)]-Based HQs [(b)] Due to Soil Ingestion or Direct Contact - RME				NOAEL-Based HQs Due to Dietary Ingestion - RME	Total NOAEL-Based HQs Summed Across Pathways - RME			
Parameter	White-footed Mouse	Eastern Cottontail	Plants	Soil Fauna	White-footed Mouse	White-footed Mouse	Eastern Cottontail	Plants	Soil Fauna
Aluminum	10.56		278.05	5.56	3.88	14.44		278.05	5.56
Arsenic	7.90				25.93	33.83			
Barium					2.16	2.65			
Cadmium					3.20	3.23			
Chromium			4.29	53.65				4.29	53.65
Cobalt	1.40				1.82	3.22			
Copper					1.39	1.45			
Iron	4.98			19.18		5.47			19.18
Lead					1.73	2.08			
Manganese			1.90					1.90	
Mercury				1.00					1.00
Molybdenum					2.65	3.09			
Vanadium	46.53	2.25	14.93	1.49	13.68	60.21	2.35	14.93	1.49
Zinc			6.35	3.18	4.32	4.46		6.35	3.18
HI[(d)]_NOAEL	**71.38**	**2.25**	**305.5**	**84.06**	**60.76**	**134.1**	**2.35**	**305.5**	**84.06**

NBS-out	LOAEL [(c)]-Based HQs Due to Soil Ingestion - RME			LOAEL-Based HQs Due to Dietary Ingestion - RME	Total LOAEL-Based HQs Summed Across Pathways - RME		
Parameter	White-footed Mouse	Plants	Soil Fauna	White-footed Mouse	White-footed Mouse	Plants	Soil Fauna
Aluminum	5.35	19.04	4.97	1.97	7.32	19.04	4.97
Arsenic				2.05	2.67		
Iron	2.49				2.74		
Vanadium	15.51			4.56	20.07		
HI _LOAEL	**23.36**	**19.04**	**4.97**	**8.57**	**32.80**	**19.04**	**4.97**

Footnotes:

(a) NOAEL = No Observed Adverse Effect Level

(b) HQ = Hazard Quotient

(c) LOAEL = Lowest Observed Adverse Effect Level

(d) HI = Hazard Index

TABLE 8.7-24

Summary of Detailed Ecological Risk Assessment
Central Tendency (CT) Risk Drivers
New Burn Site (Outside Trench)
Jefferson Proving Ground
Madison, Indiana

NBS-out	NOAEL [(a)]-Based HQs [(b)] Due to Soil Ingestion - CT	NOAEL-Based HQs Due to Dietary Ingestion - CT	Total NOAEL-Based HQs Summed Across Pathways - CT
Parameter	**White-footed Mouse**	**White-footed Mouse**	**White-footed Mouse**
Aluminum	6.54	2.40	8.94
Arsenic	4.89	16.05	20.94
Barium		1.34	1.64
Cadmium		1.98	2.00
Cobalt		1.13	1.99
Iron	3.08		3.39
Lead		1.07	1.29
Molybdenum		1.64	1.91
Vanadium	28.80	8.47	37.27
Zinc		2.67	2.76
HI[(d)]_NOAEL	**46.11**	**38.26**	**84.37**

NBS-out	LOAEL [(c)]-Based HQs Due to Soil Ingestion - CT	LOAEL-Based HQs Due to Dietary Ingestion - CT	Total LOAEL-Based HQs Summed Across Pathways - CT
Parameter	**White-footed Mouse**	**White-footed Mouse**	**White-footed Mouse**
Aluminum	3.31	1.22	4.53
Arsenic		1.27	1.65
Iron	1.54		1.69
Vanadium	9.60	2.82	12.42
HI _LOAEL	**15.03**	**6.34**	**21.37**

Footnotes:

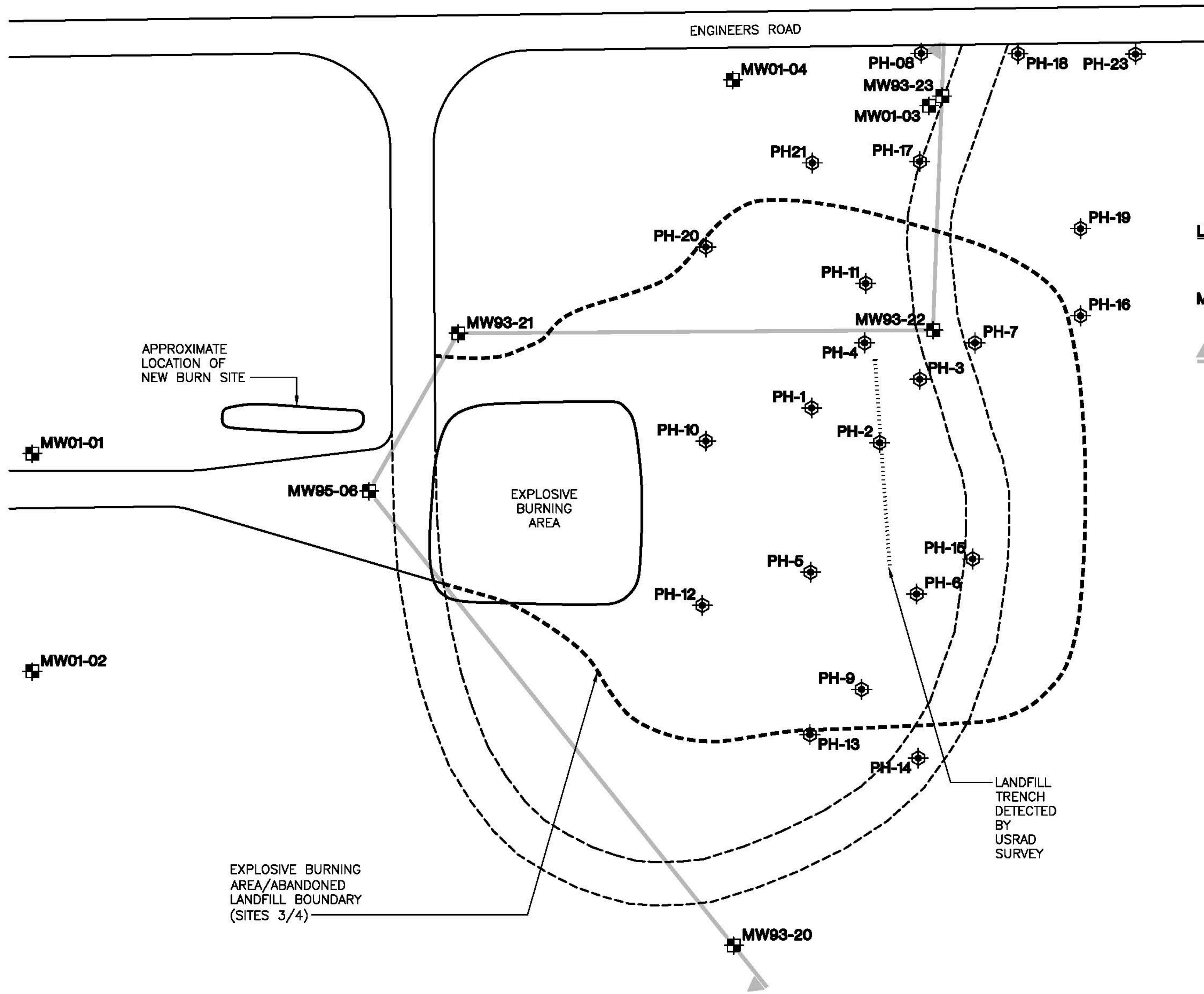
(a) NOAEL = No Observed Adverse Effect Level

(b) HQ = Hazard Quotient

(c) LOAEL = Lowest Observed Adverse Effect Level

(d) HI = Hazard Index

FIGURES



LEGEND

PH-08 — HYDRAULIC PROBE LOCATION AND NUMBER

MW93-20 — MONITORING WELL LOCATION AND NUMBER

LINE OF CROSS SECTION

NOTES

1. BASE MAP DEVELOPED FROM FIGURE 8–1 FROM A REPORT BY RUST ENVIRONMENT & INFRASTRUCTURE, DATED: 4–13–98.
2. HYDRAULIC PROBE LOCATIONS TAKEN FROM FIGURE 8–5, SAMPLING LOCATIONS AT THE EXPLOSIVE BURN AREA (SITE 3) AND ABANDONED LANDFILL (SITE 4), PREPARED BY RUST E&I, DATED 8–5–98.
3. CROSS SECTION SHOWN ON FIGURE 8–2, "CROSS SECTION SITE 4 ABANDONED LANDFILL", PREPARED BY EARTHTECH.

north

0 50 100

SCALE IN FEET

QUALITY CONTROL		
Graphic Standards DLF 2–21–02	Technical Review LAB 3–18–02	Management Review
Lead Professional TEM 2–21–02	Project Manager	Other

Developed By TEM | Drawn By DLF

Approved By | Date

Reference 2440025.040201–B3

Revisions

SAMPLING LOCATION MAP
EXPLOSIVE BURN AREA (SITE 3) AND ABANDONED LANDFILL (SITE 4)
SOUTH OF THE FIRING LINE
JEFFERSON PROVING GROUND
MADISON, INDIANA

Drawing Number 2440025 010102 **B24**

MWH MONTGOMERY WATSON HARZA

FIGURE 8-1

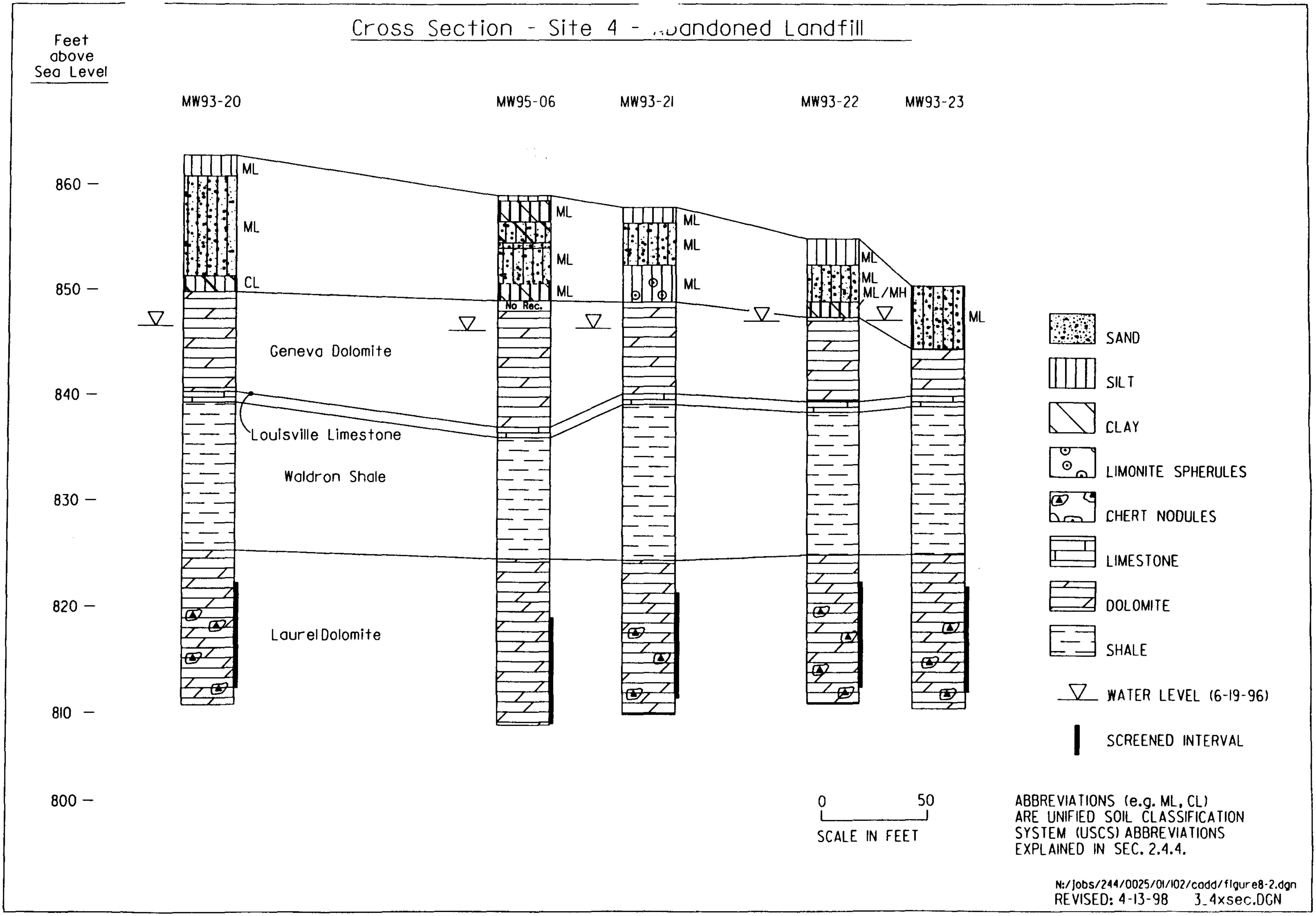


Figure 8-2. Cross Section of Abandoned Landfill (Site 4), Using Monitoring Well Data

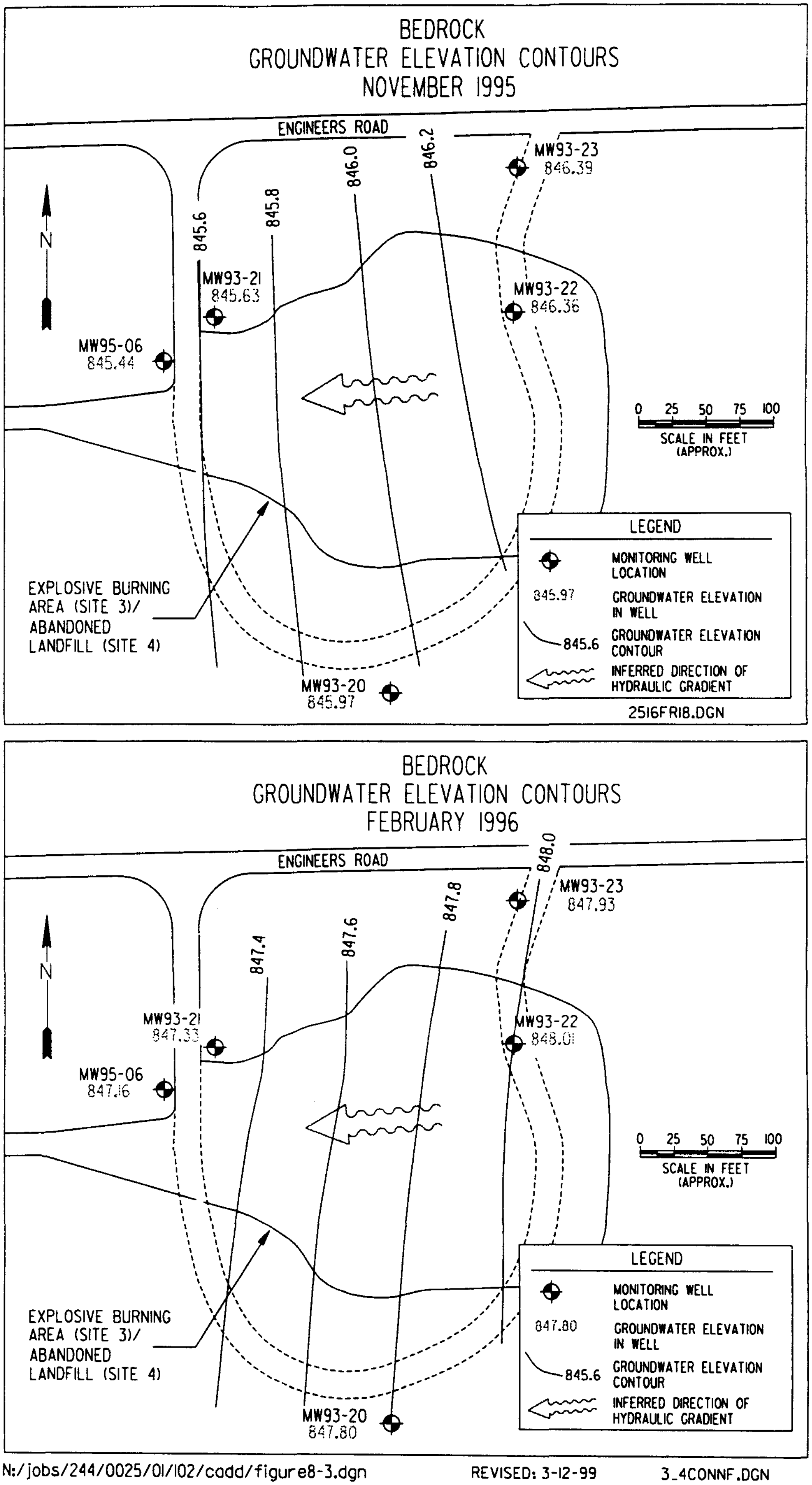
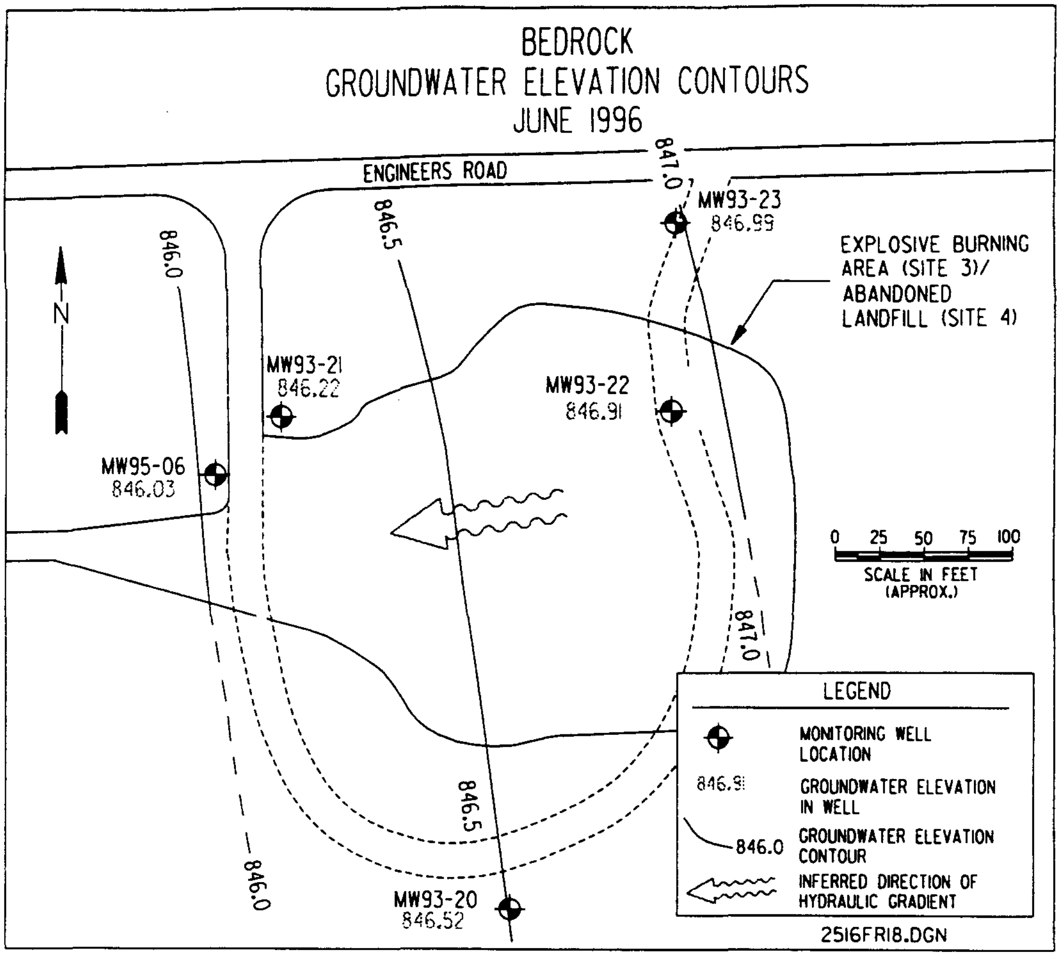


Figure 8-3. Bedrock Potentiometric Contour Map, November 1995 and February 1996, Explosive Burn Area (Site 3) and Abandoned Landfill (Site 4)



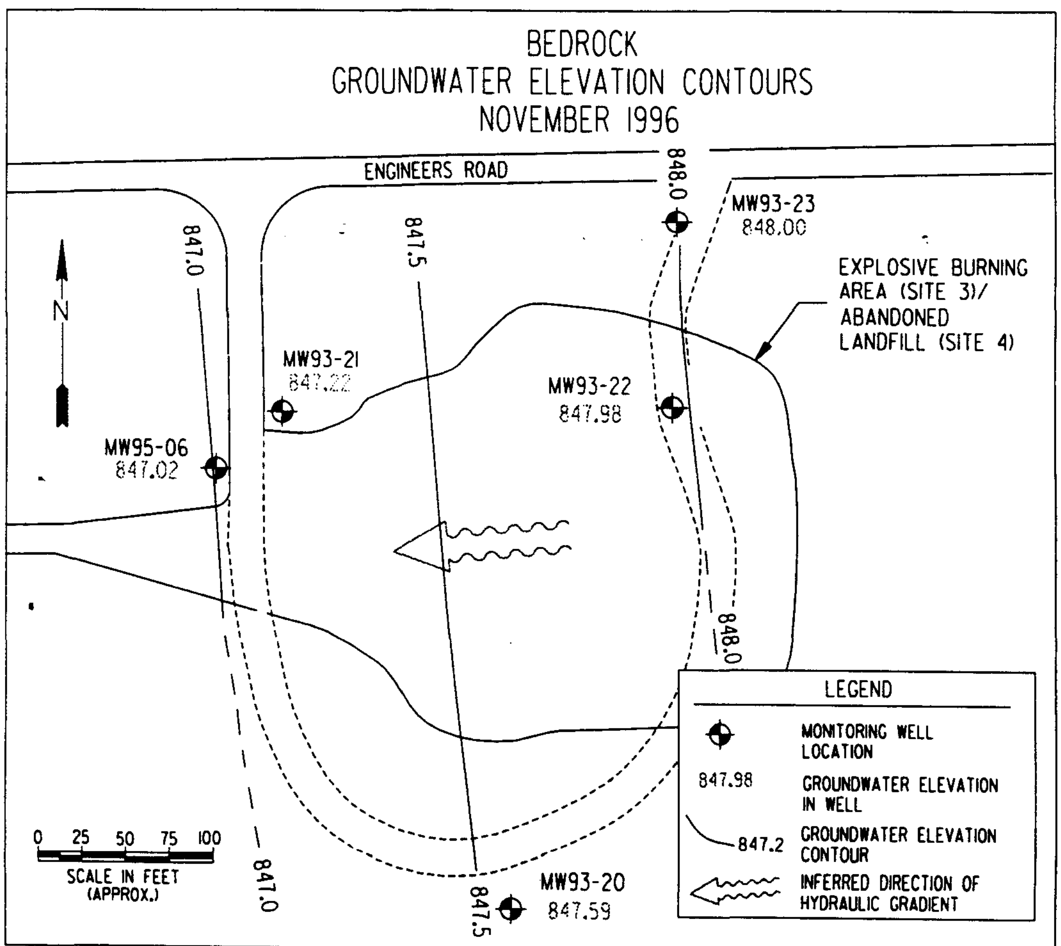


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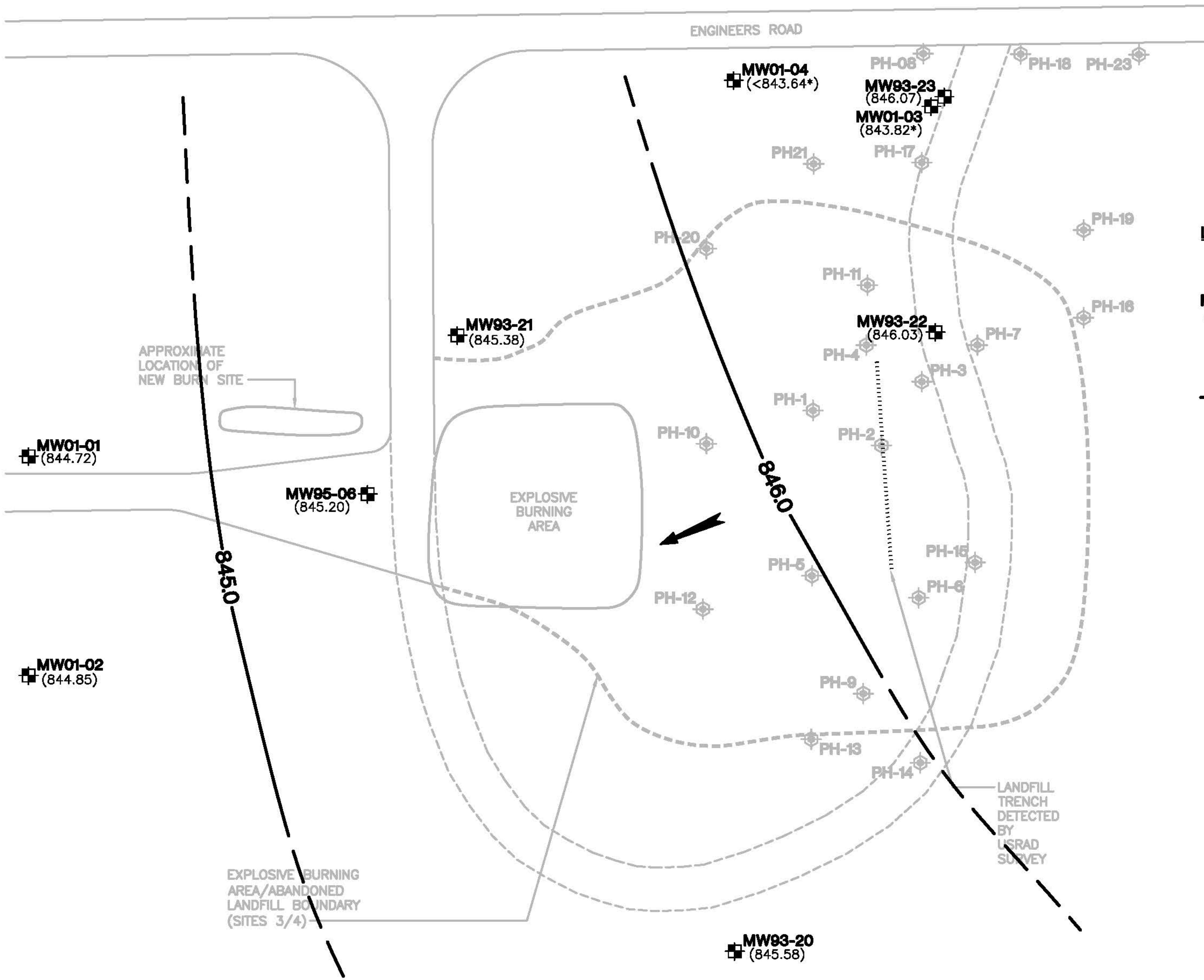
Figure 8-4. Bedrock Potentiometric Contour Map, June and November 1996, Explosive Burn Area (Site 3) and Abandoned Landfill (Site 4)



LEGEND

- PH-08 — HYDRAULIC PROBE LOCATION AND NUMBER
- MW93-20 (845.58) — MONITORING WELL LOCATION, NUMBER, AND GROUNDWATER POTENTIOMETRIC SURFACE ELEVATION, IN FEET ABOVE MEAN SEA LEVEL
- —845.0— POTENTIOMETRIC SURFACE CONTOUR (CONTOUR INTERVAL: 1.0 FT)
- ESTIMATED GROUNDWATER FLOW DIRECTION

NOTES

1. BASE MAP DEVELOPED FROM FIGURE 8–1 FROM A REPORT BY RUST ENVIRONMENT & INFRASTRUCTURE, DATED: 4–13–98.
2. HYDRAULIC PROBE LOCATIONS TAKEN FROM FIGURE 8–5, SAMPLING LOCATIONS AT THE EXPLOSIVE BURN AREA (SITE 3) AND ABANDONED LANDFILL (SITE 4), PREPARED BY RUST E&I, DATED 8–5–98.
3. GROUNDWATER ELEVATIONS DENOTED BY AN "*" ARE NOT INCLUDED IN THE INTERPRETATION OF THE CONTOURED SURFACE.

FIGURE 8-4a

POTENTIOMETRIC SURFACE MAP (JUNE 5, 2001) - EXPLOSIVE BURN AREA (SITE 3) AND ABANDONED LANDFILL (SITE 4)

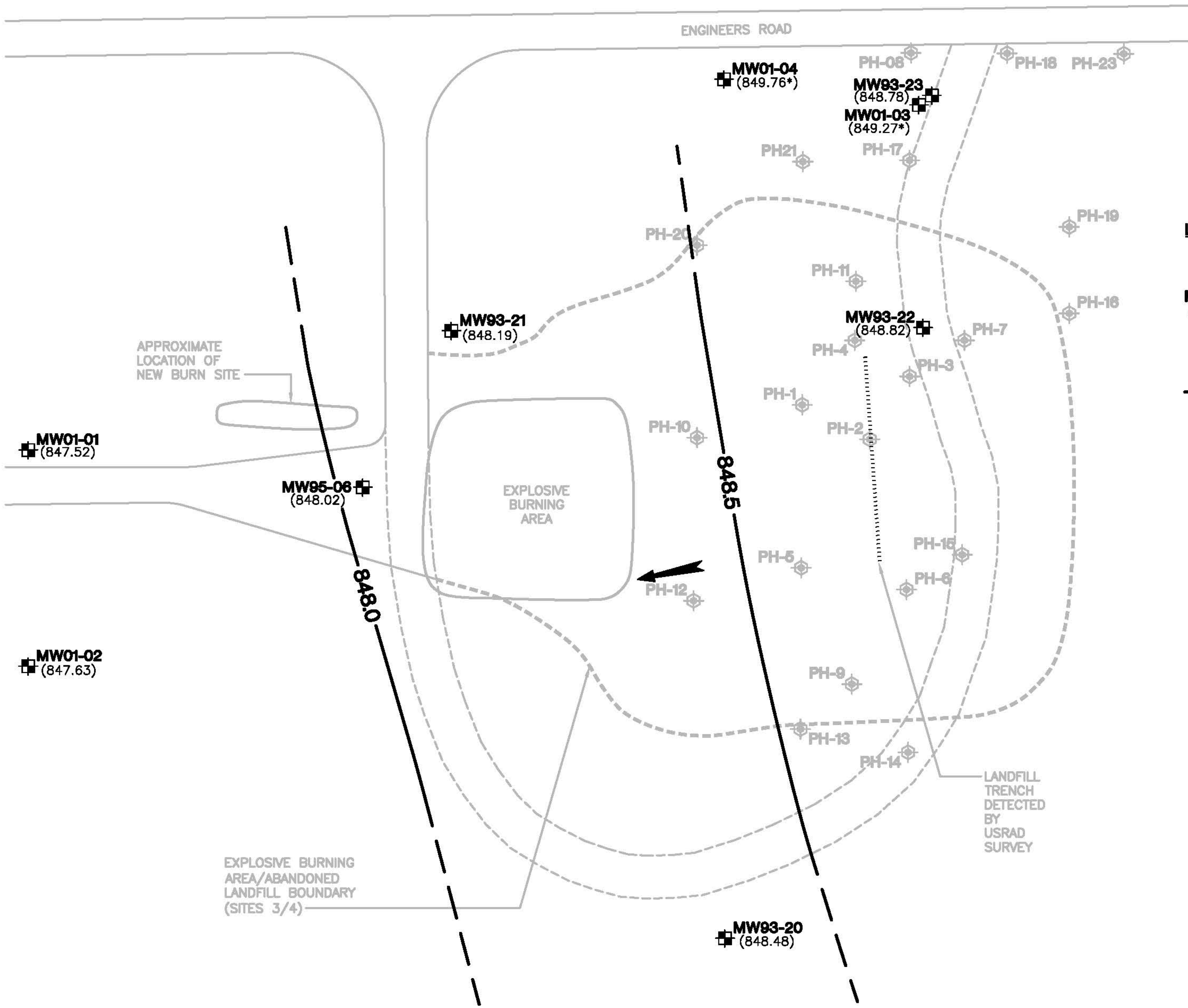
SOUTH OF THE FIRING LINE
JEFFERSON PROVING GROUND
MADISON, INDIANA

Developed By TAPB | Drawn By DLF
Approved By | Date
Reference 2440025.040201–B3
Revisions

Drawing Number 2440025 010102 B2

MWH MONTGOMERY WATSON HARZA

QUALITY CONTROL: Graphic Standards DLF 2–19–02; Lead Professional TAPB 2–22–02; Technical Review LAB; Project Manager 3–18–02; Management Review; Other



LEGEND

- PH-08 — HYDRAULIC PROBE LOCATION AND NUMBER
- MW93-20 (848.48) — MONITORING WELL LOCATION, NUMBER, AND GROUNDWATER POTENTIOMETRIC SURFACE ELEVATION, IN FEET ABOVE MEAN SEA LEVEL
- —848.0— POTENTIOMETRIC SURFACE CONTOUR (CONTOUR INTERVAL: 0.5 FT, DASHED WHERE INFERRED)
- ESTIMATED GROUNDWATER FLOW DIRECTION

NOTES

1. BASE MAP DEVELOPED FROM FIGURE 8–1 FROM A REPORT BY RUST ENVIRONMENT & INFRASTRUCTURE, DATED: 4–13–98.
2. HYDRAULIC PROBE LOCATIONS TAKEN FROM FIGURE 8–5, SAMPLING LOCATIONS AT THE EXPLOSIVE BURN AREA (SITE 3) AND ABANDONED LANDFILL (SITE 4), PREPARED BY RUST E&I, DATED 8–5–98.
3. GROUNDWATER ELEVATIONS DENOTED BY AN "*" ARE NOT INCLUDED IN THE INTERPRETATION OF THE CONTOURED SURFACE.

north

0 50 100

SCALE IN FEET

FIGURE 8-4b

QUALITY CONTROL				
Graphic Standards	DLF	2–19–02	Technical Review	LAB
Lead Professional	TAPB	2–22–02	Project Manager	3–18–02
Management Review			Other	

Developed By TAPB
Drawn By DLF
Approved By
Date
Reference 2440025.040201–B3
Revisions

POTENTIOMETRIC SURFACE MAP (NOVEMBER 30, 2001) - EXPLOSIVE BURN AREA (SITE 3) AND ABANDONED LANDFILL (SITE 4)

SOUTH OF THE FIRING LINE
JEFFERSON PROVING GROUND
MADISON, INDIANA

Drawing Number 2440025 010102 **B3**

MWH MONTGOMERY WATSON HARZA

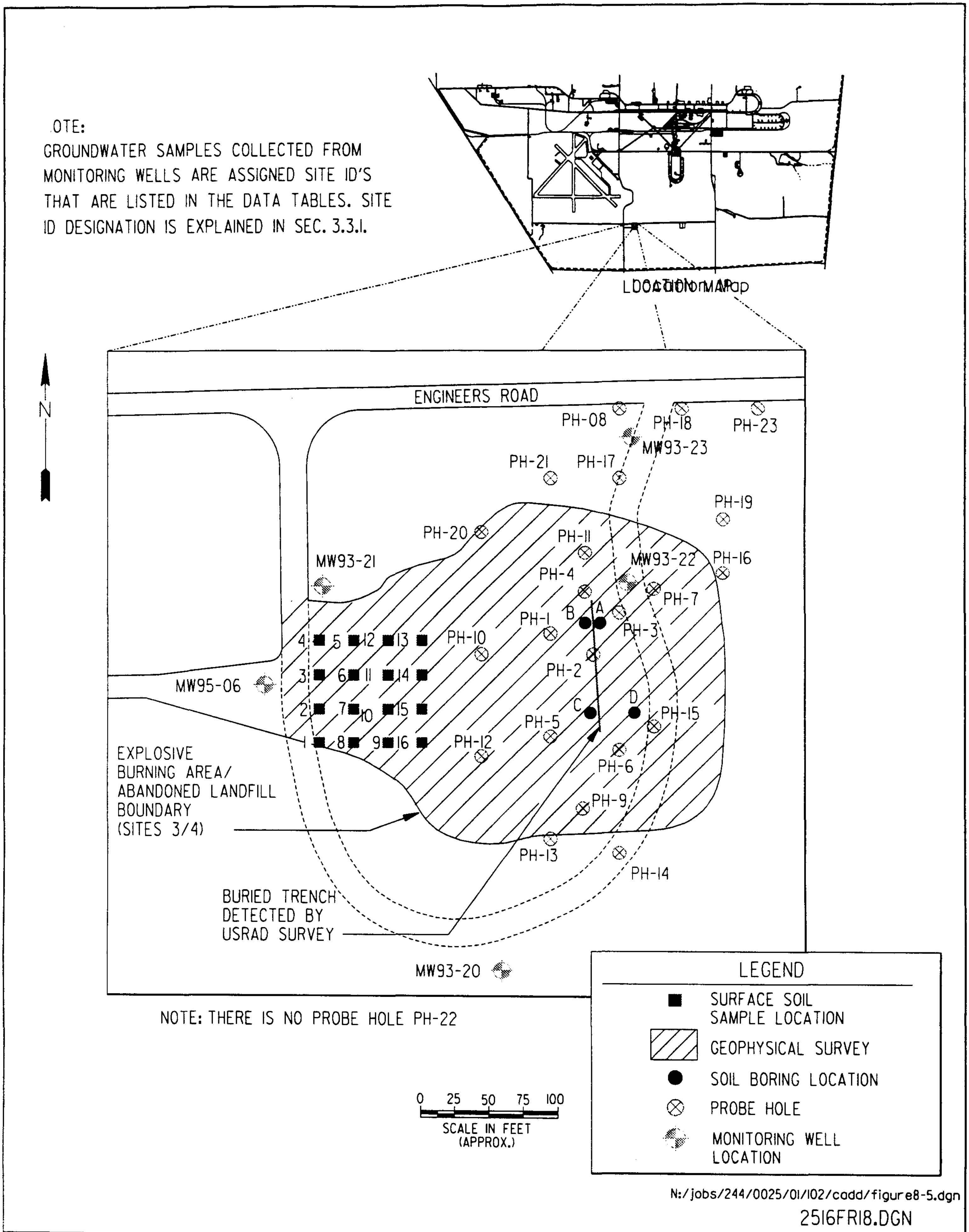
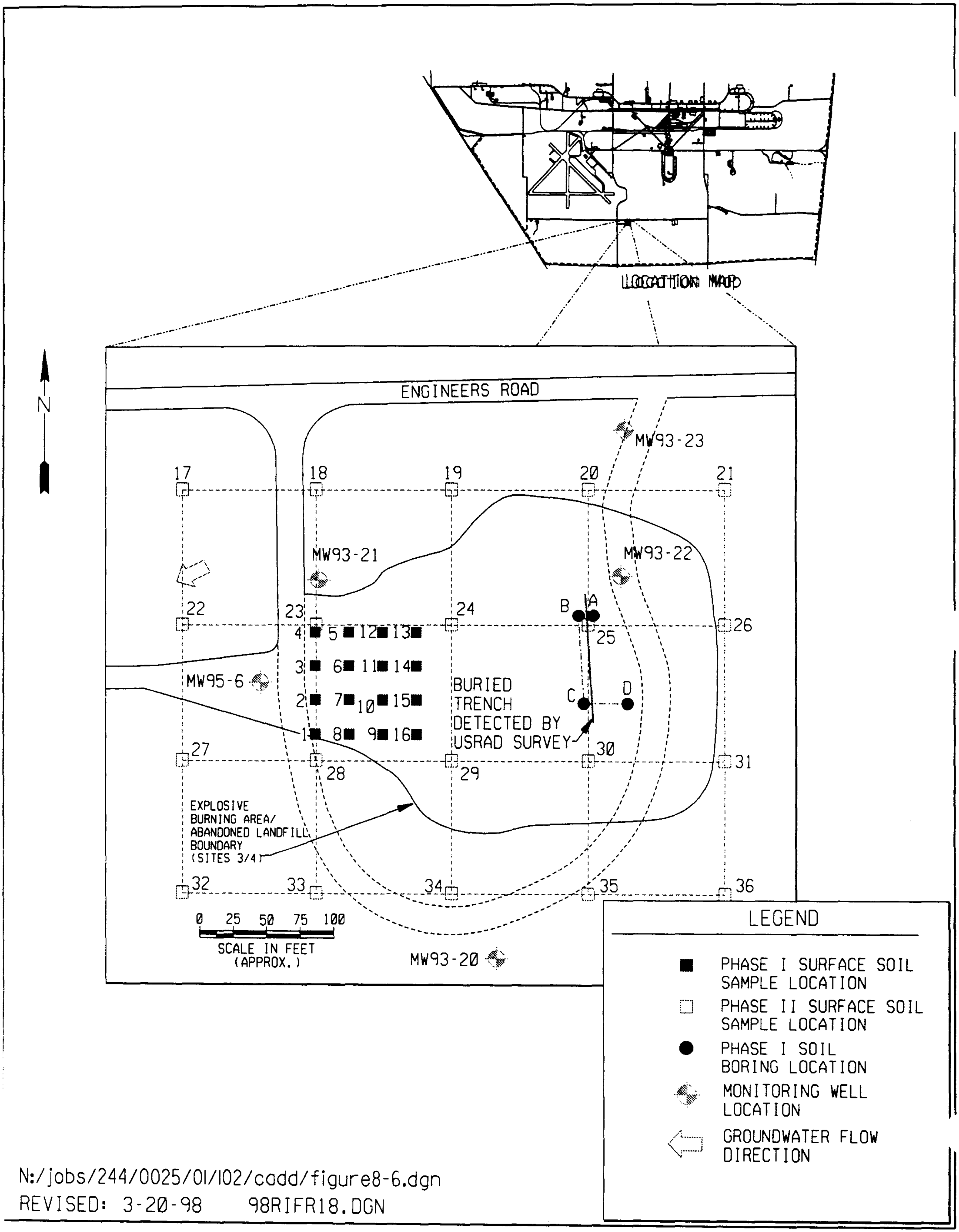


Figure 8-5. Sampling Location Map of the Explosive Burn Area (Site 3) and Abandoned Landfill (Site 4)



N:/jobs/244/0025/01/102/cadd/figure8-6.dgn

REVISED: 3-20-98 98RIFR18.DGN

Figure 8-6. Phase I and Phase II Sampling Locations at the Explosive Burn Area (Site 3) and Abandoned Landfill (Site 4)

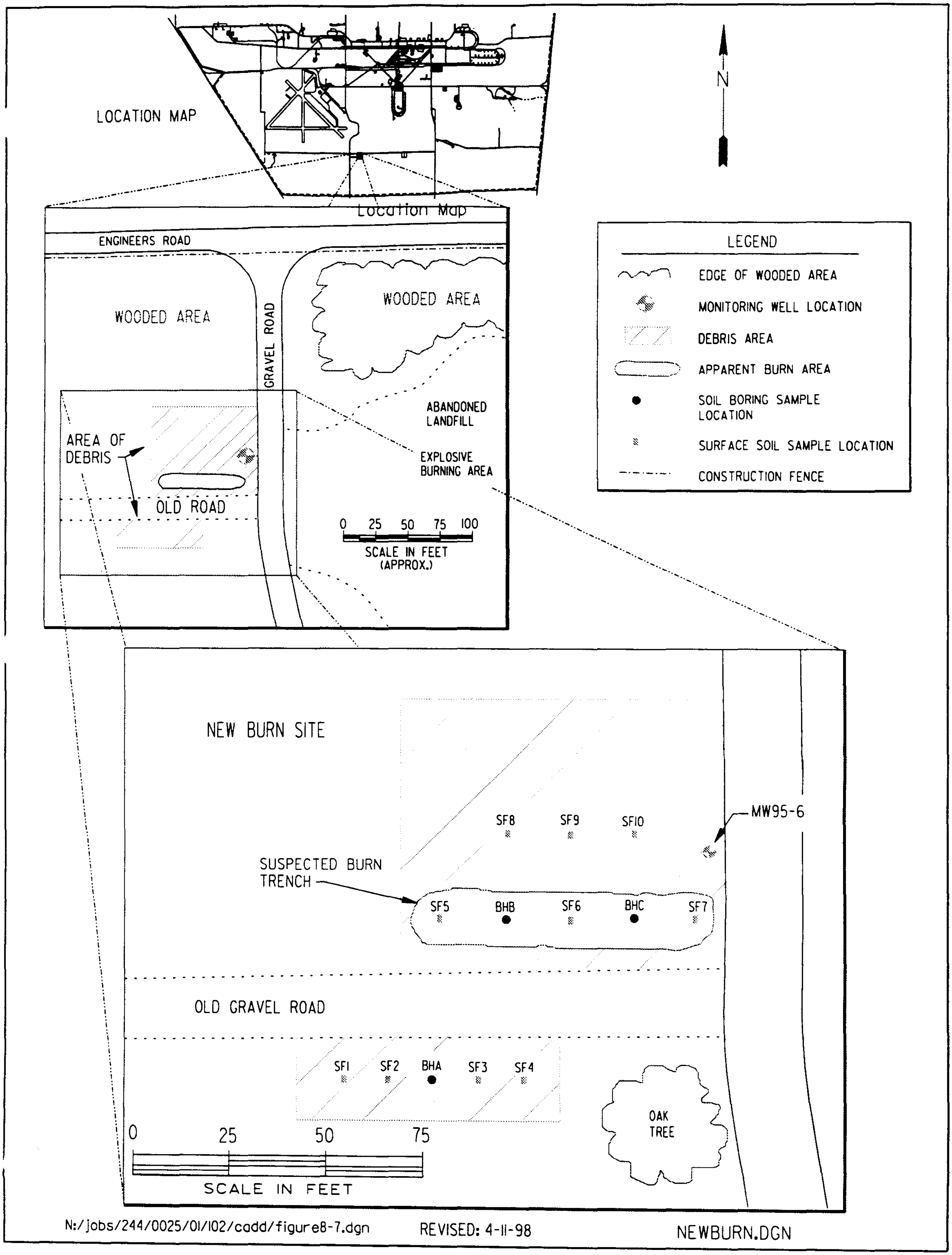


Figure 8-7. Phase II Sampling Locations at the New Burn Site

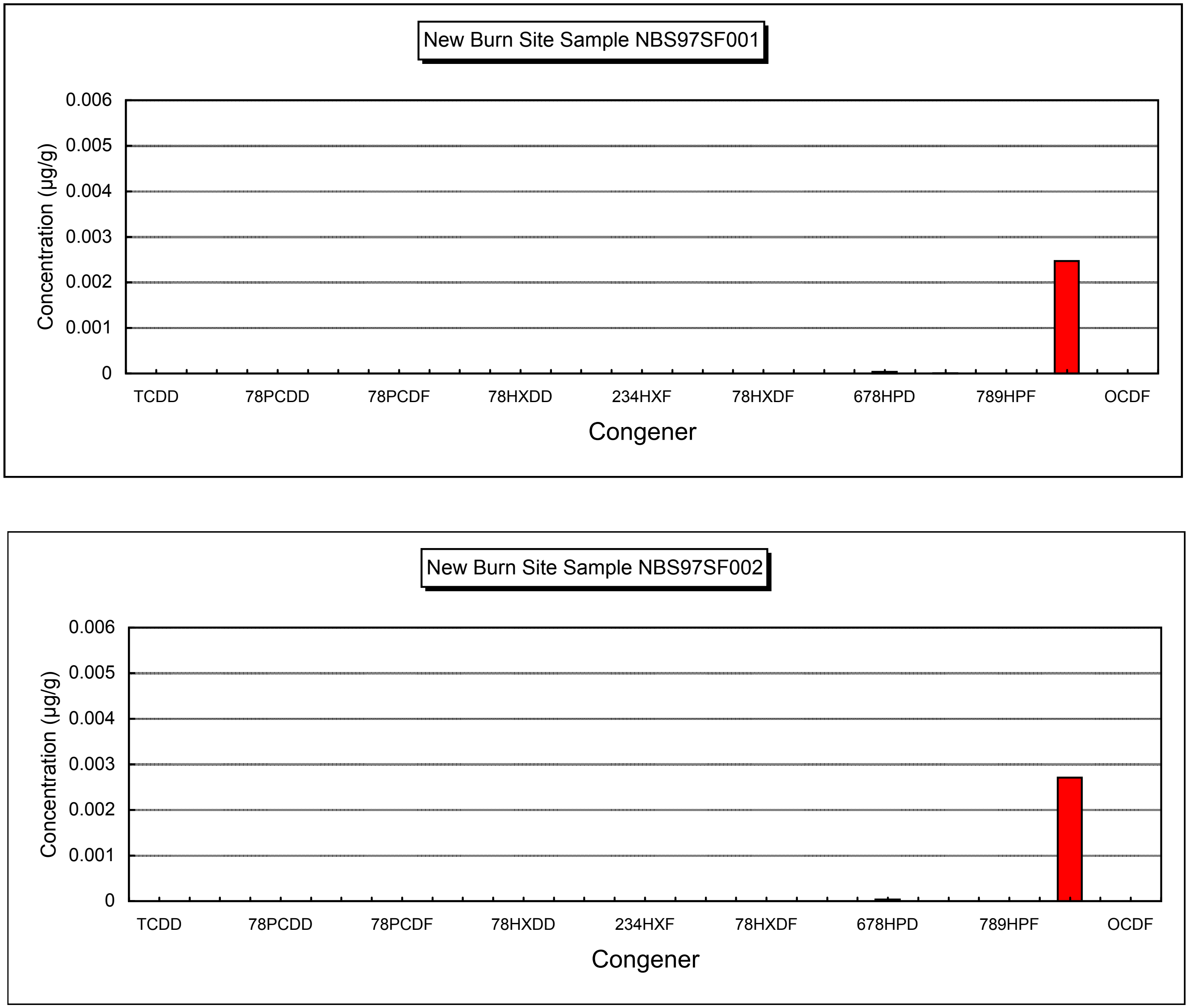
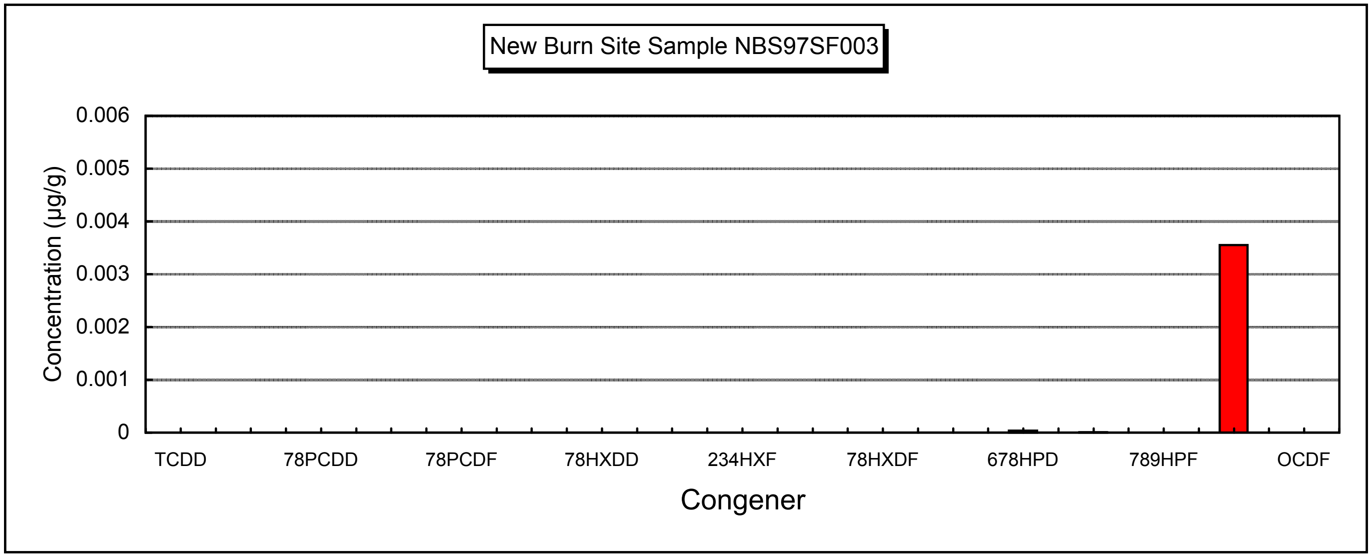


Figure 8-8a. Distribution of Dioxin/Furan Congeners at the New Burn Site - Samples NBS97SF001 and -002



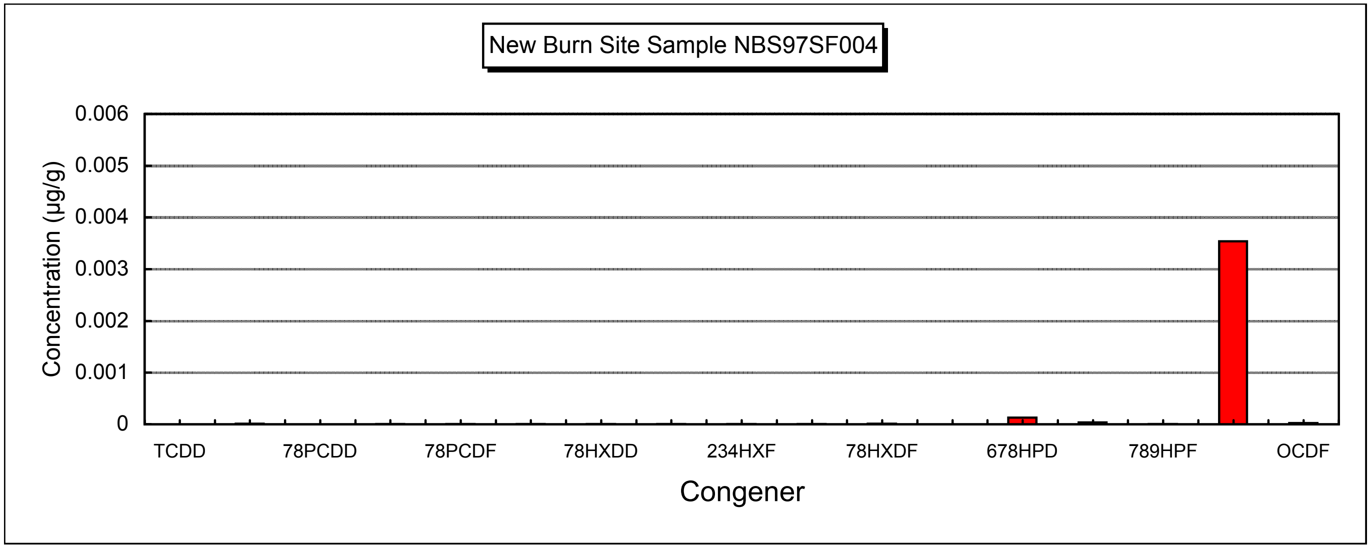
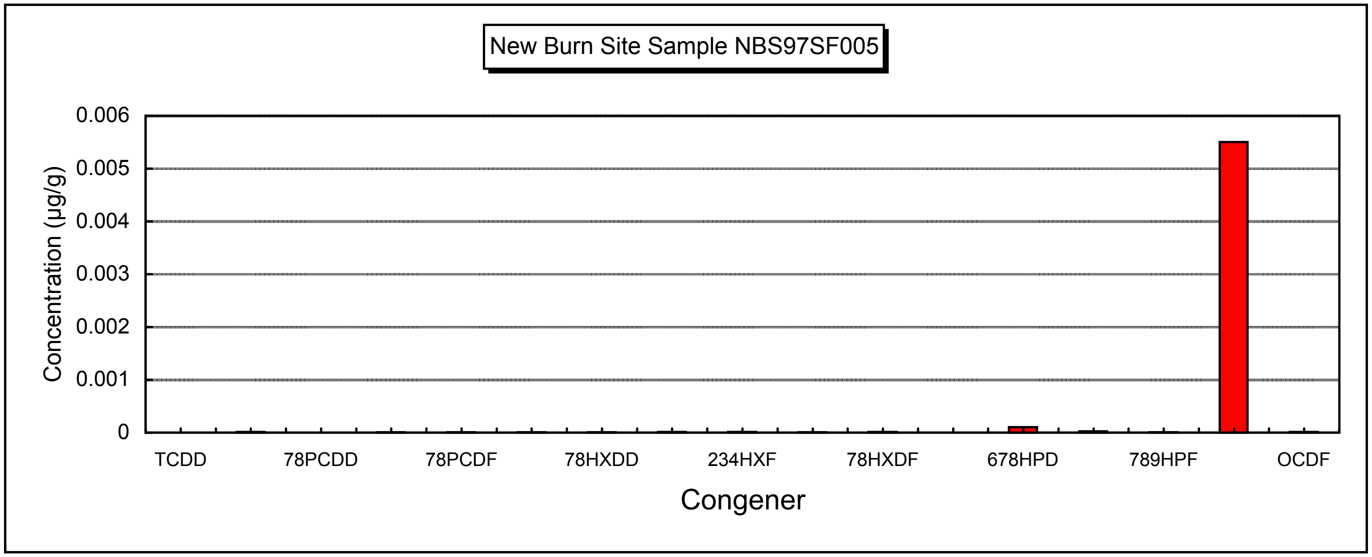


Figure 8-8b. Distribution of Dioxin/Furan Congeners at the New Burn Site - Samples NBS97SF003 and -004



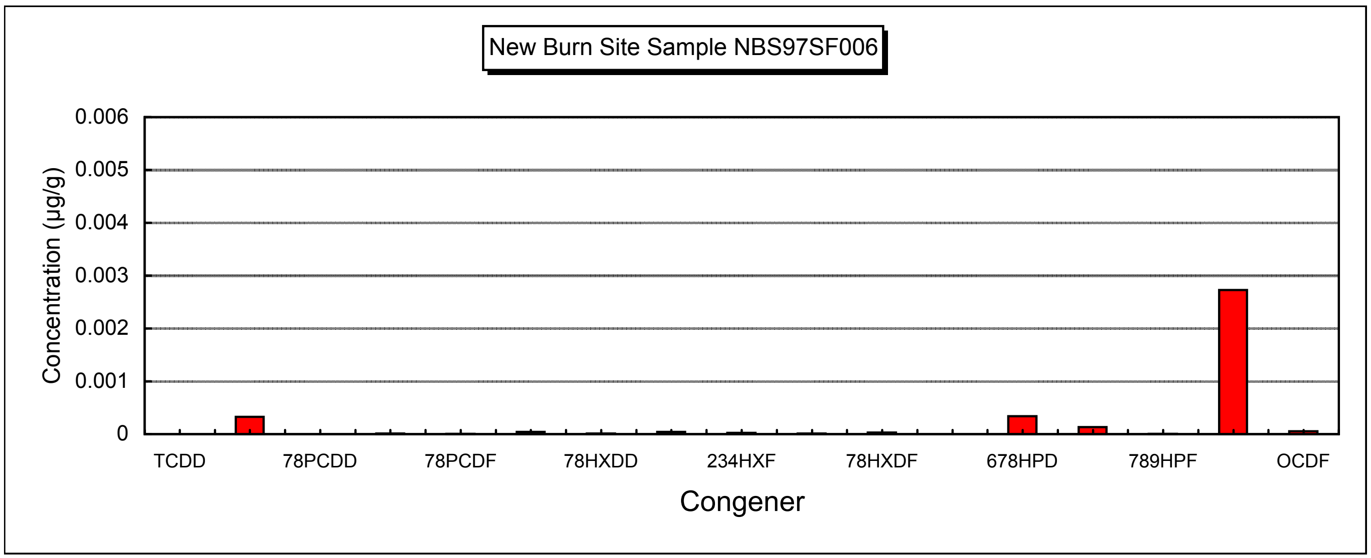
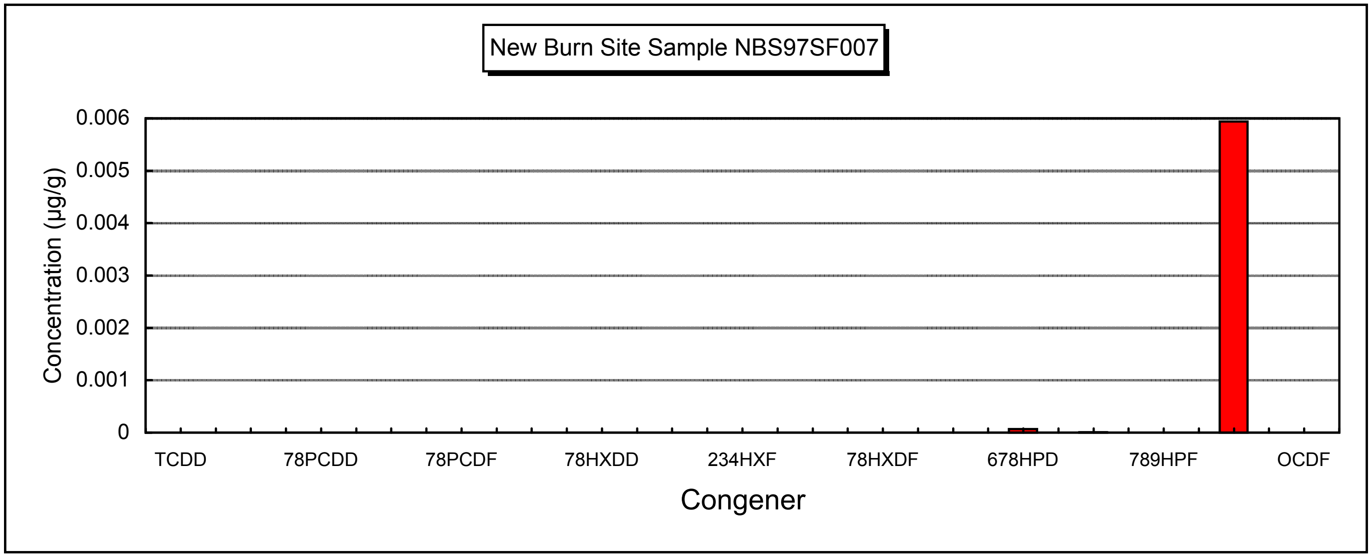


Figure 8-8c. Distribution of Dioxin/Furan Congeners at the New Burn Site - Samples NBS97SF005 and -006



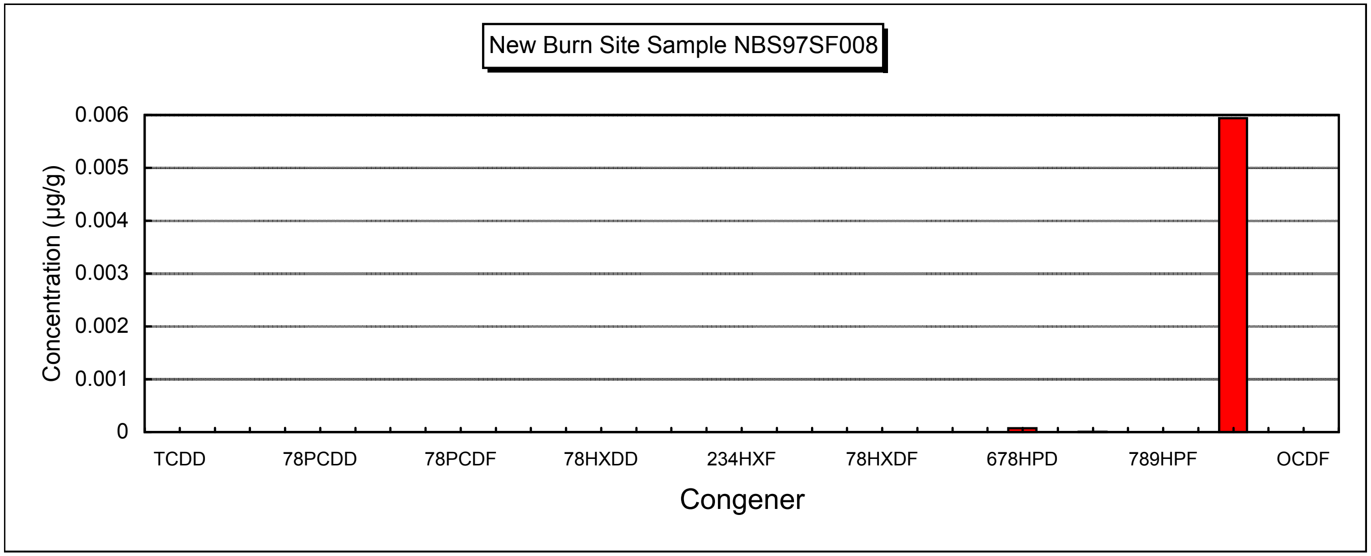


Figure 8-8d. Distribution of Dioxin/Furan Congeners at the New Burn Site - Samples NBS97SF007 and -008

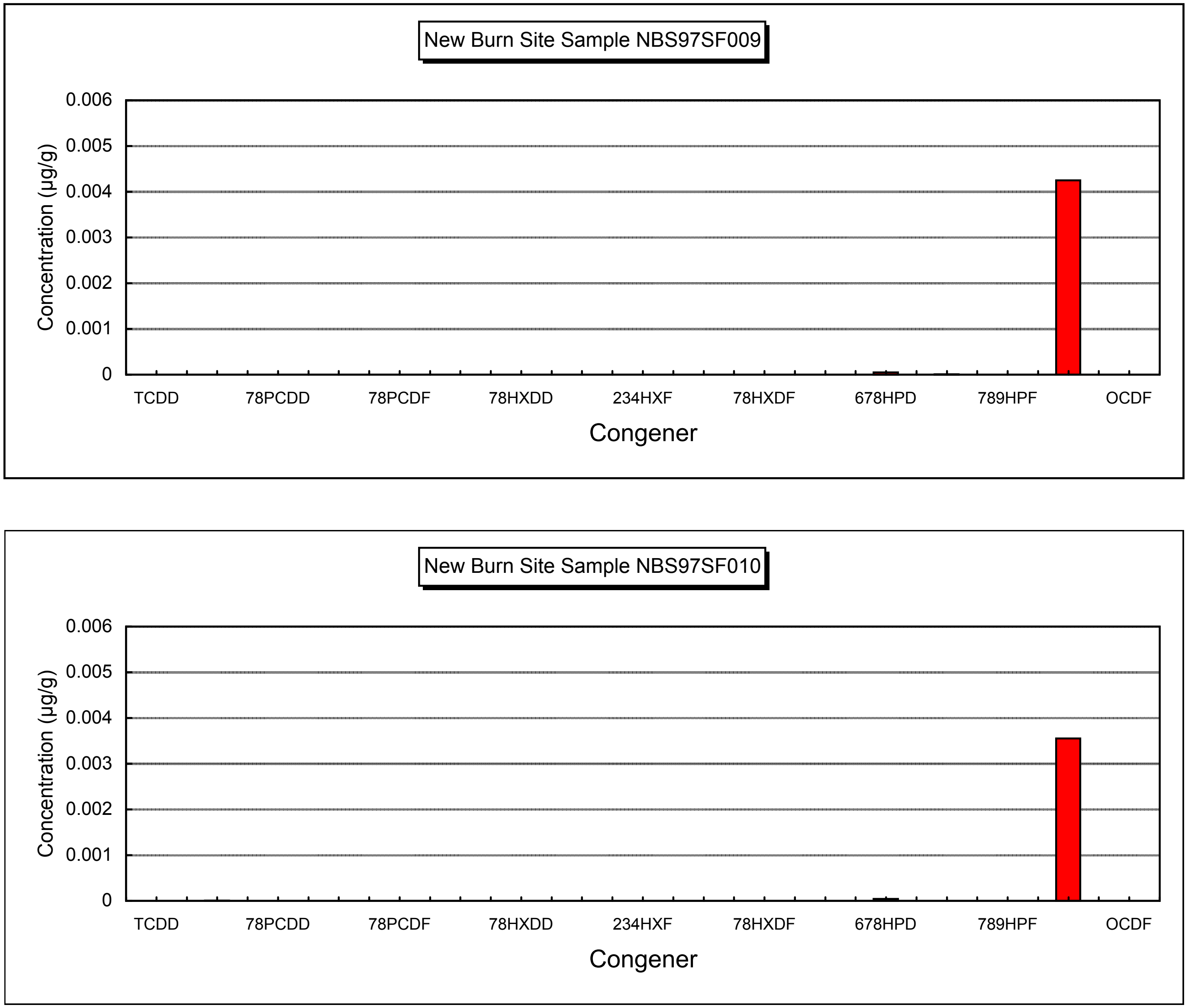
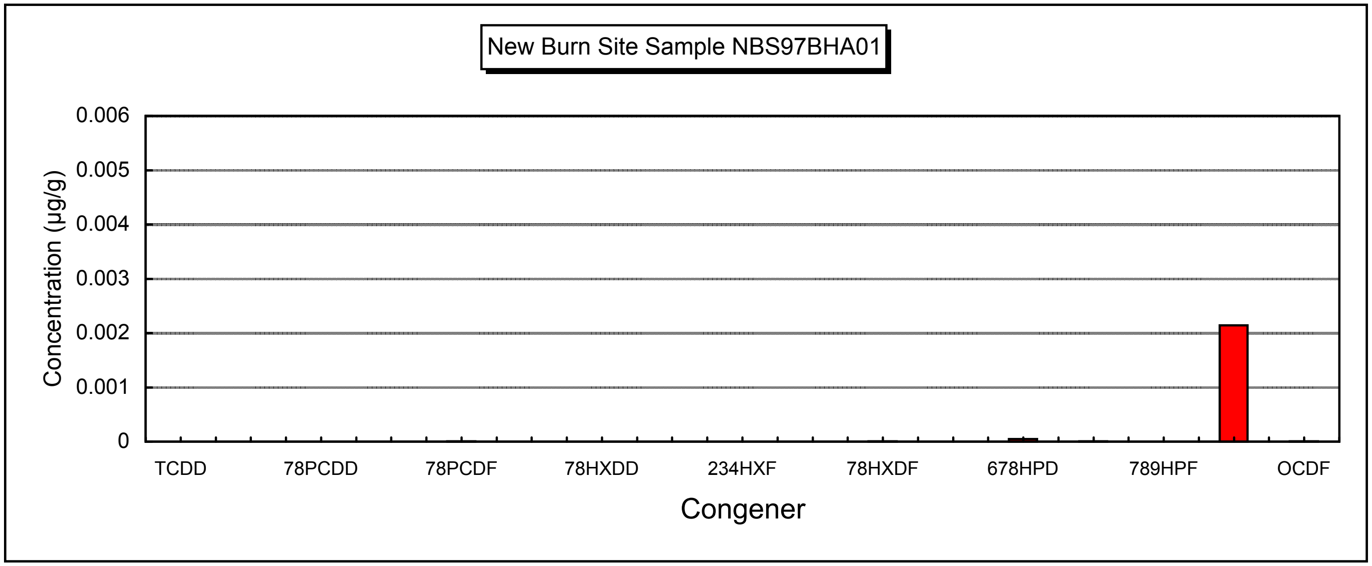


Figure 8-8e. Distribution of Dioxin/Furan Congeners at the New Burn Site - Samples NBS97SF009 and -010



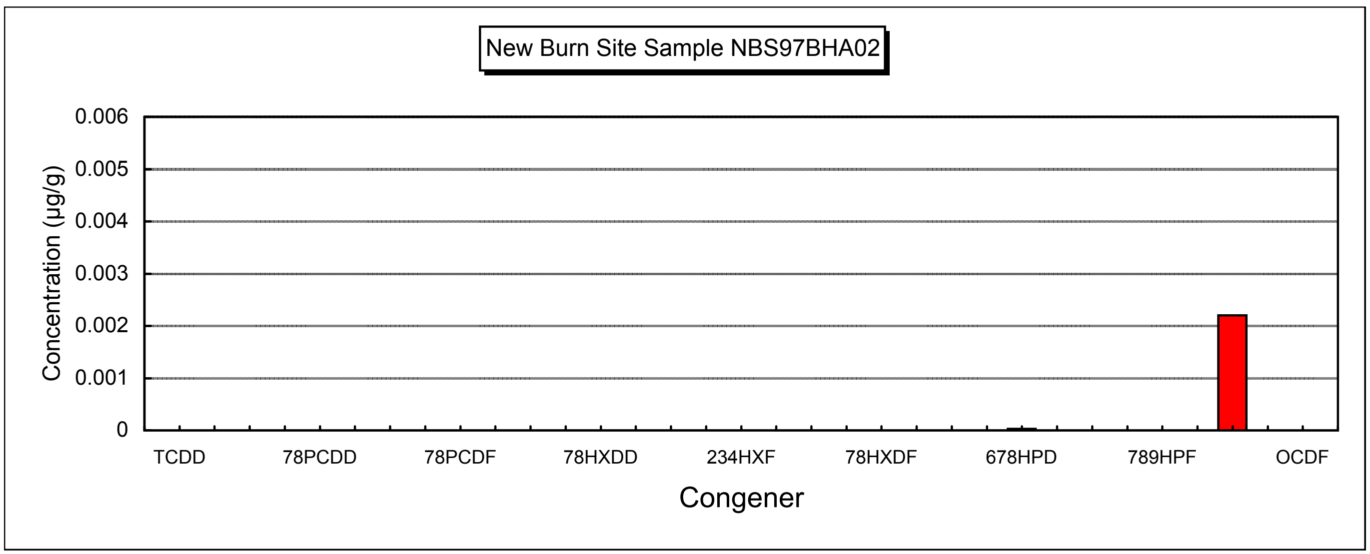
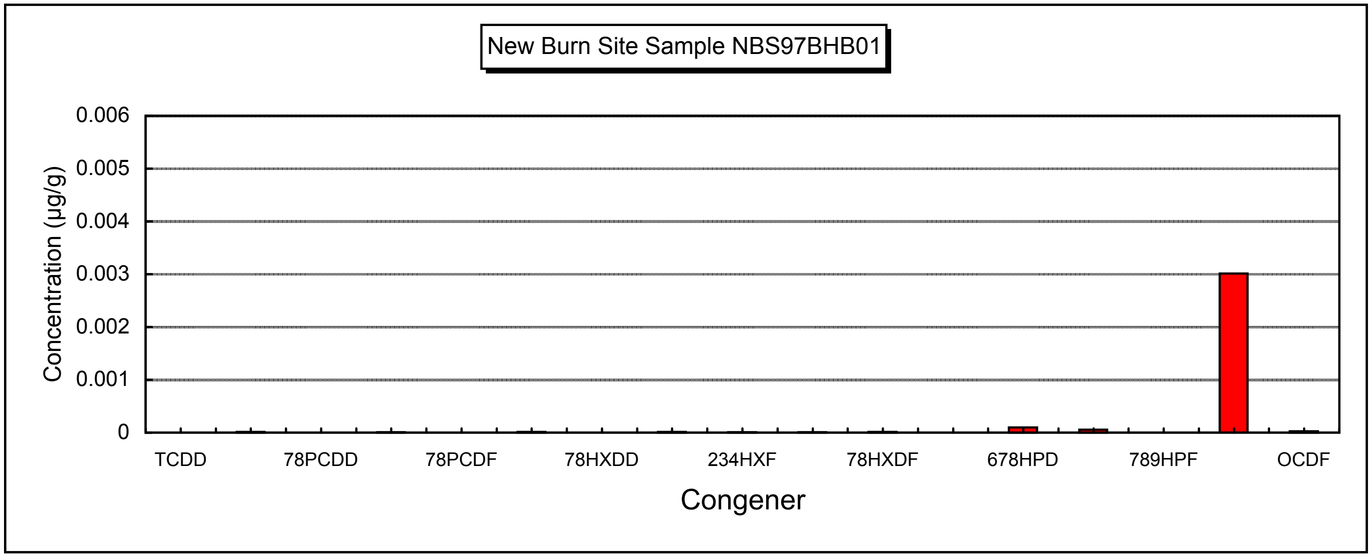


Figure 8-8f. Distribution of Dioxin/Furan Congeners at the New Burn Site - Samples NBS97BHA01 and -AO2



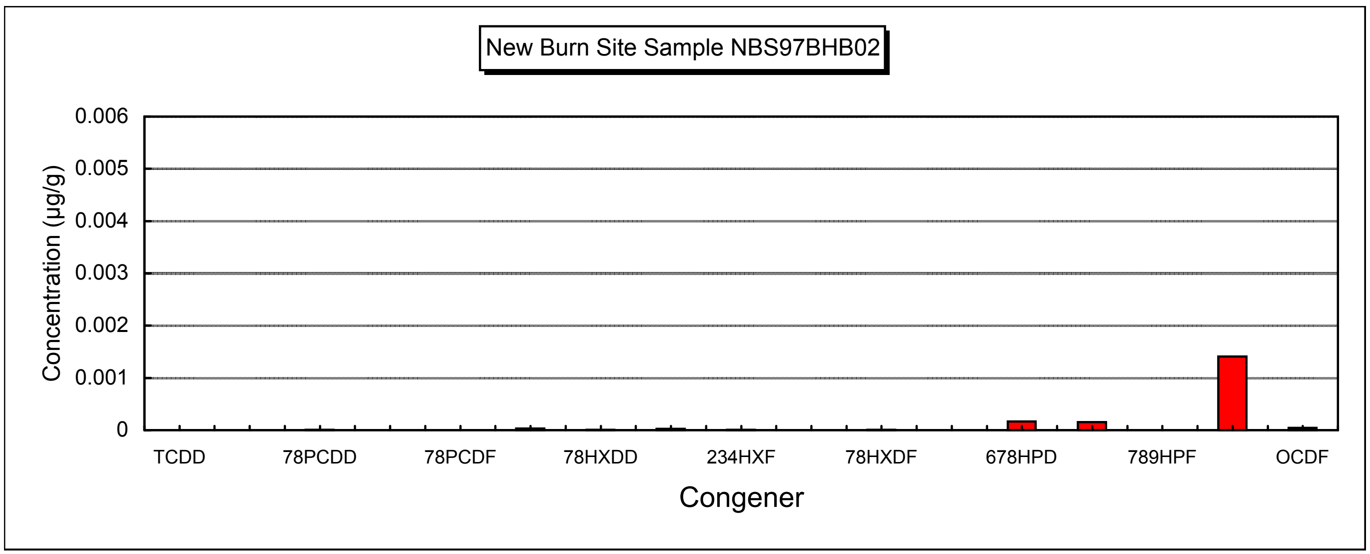
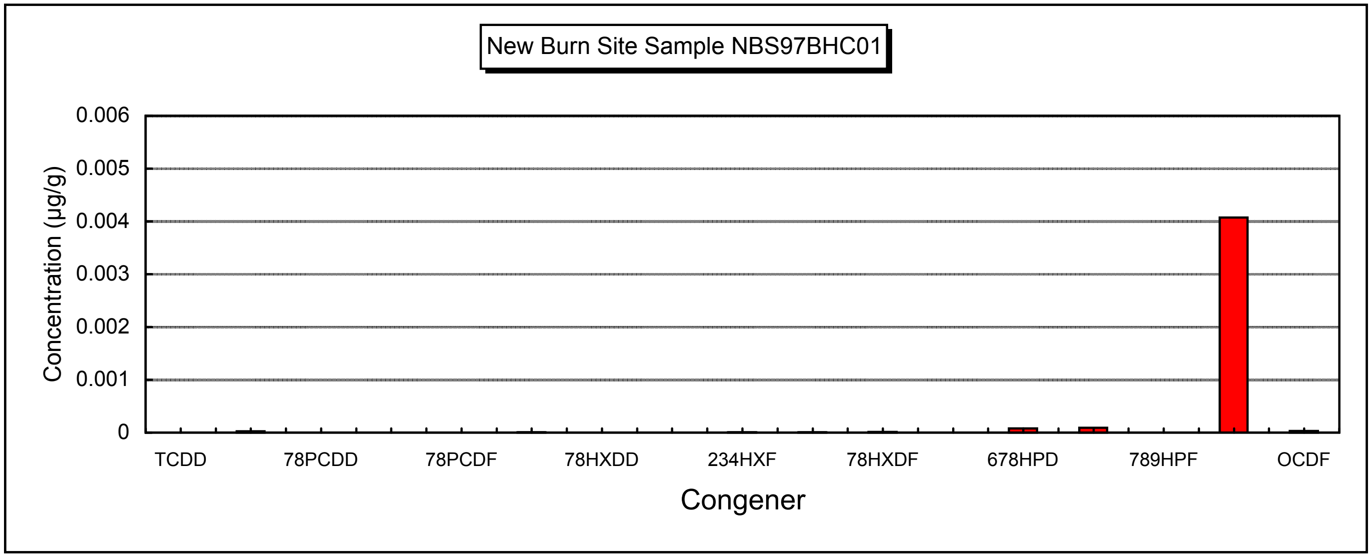


Figure 8-8g. Distribution of Dioxin/Furan Congeners at the New Burn Site - Samples NBS97BHB01 and -BO2



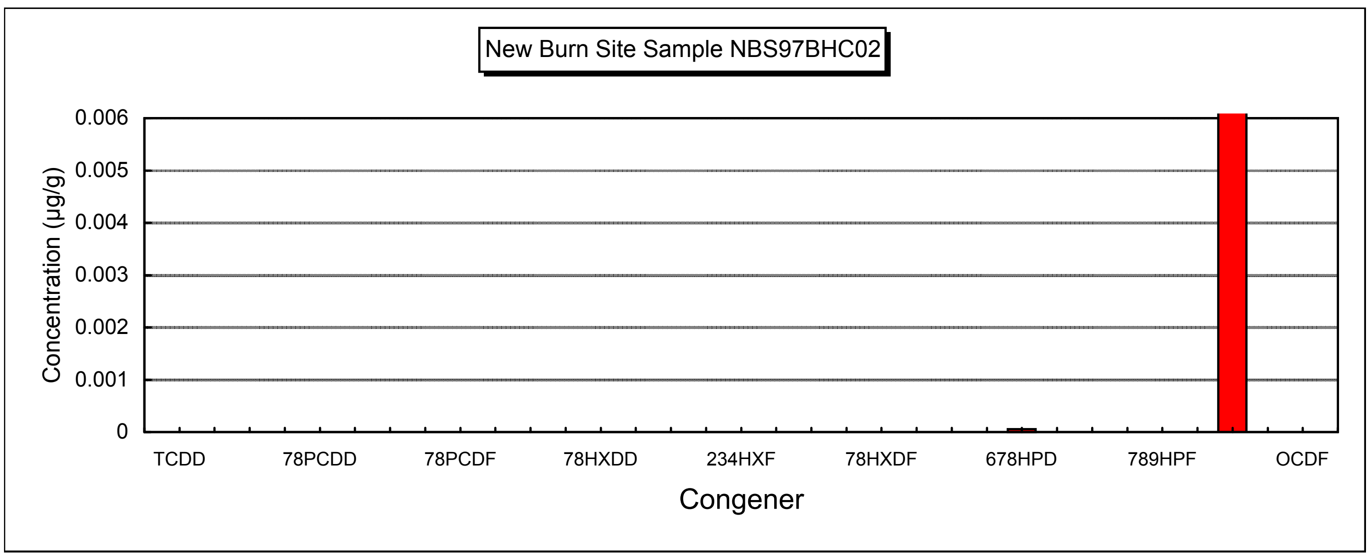
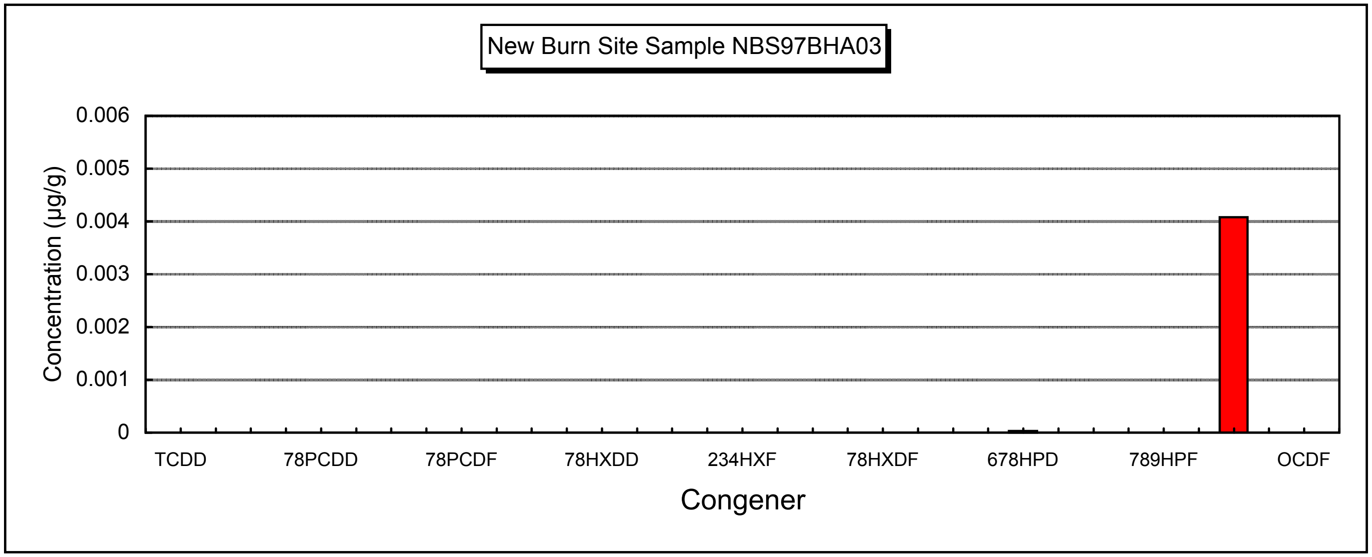


Figure 8-8h. Distribution of Dioxin/Furan Congeners at the New Burn Site - Samples NBS97BHC01 and -CO2



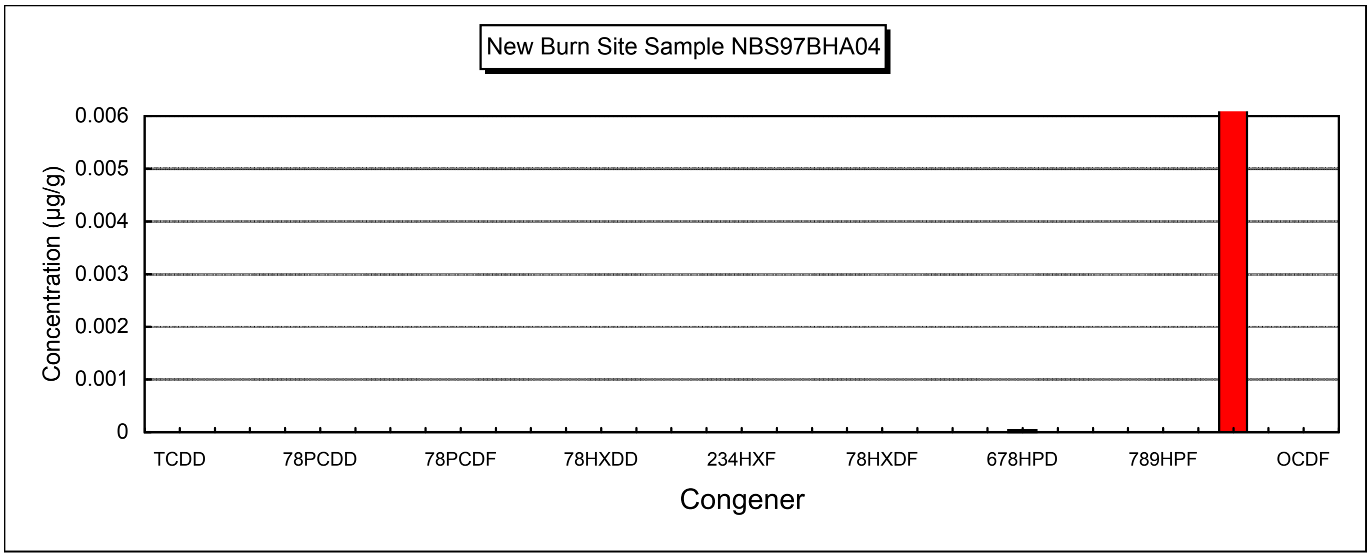
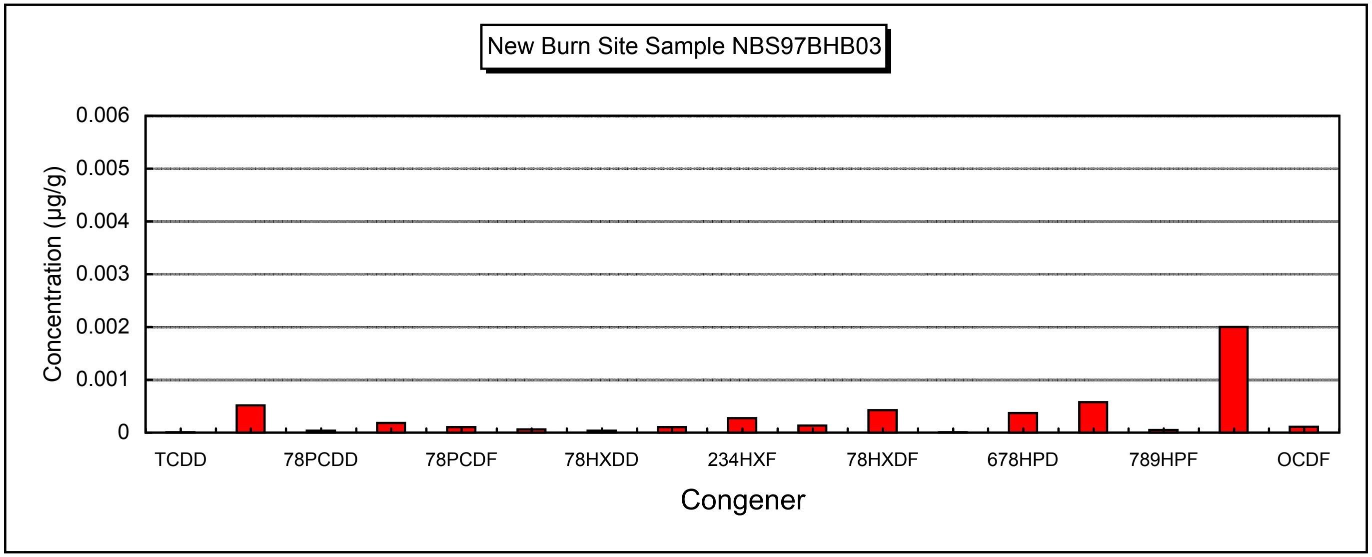


Figure 8-8i. Distribution of Dioxin/Furan Congeners at the New Burn Site - Samples NBS97BHA03 and -AO4



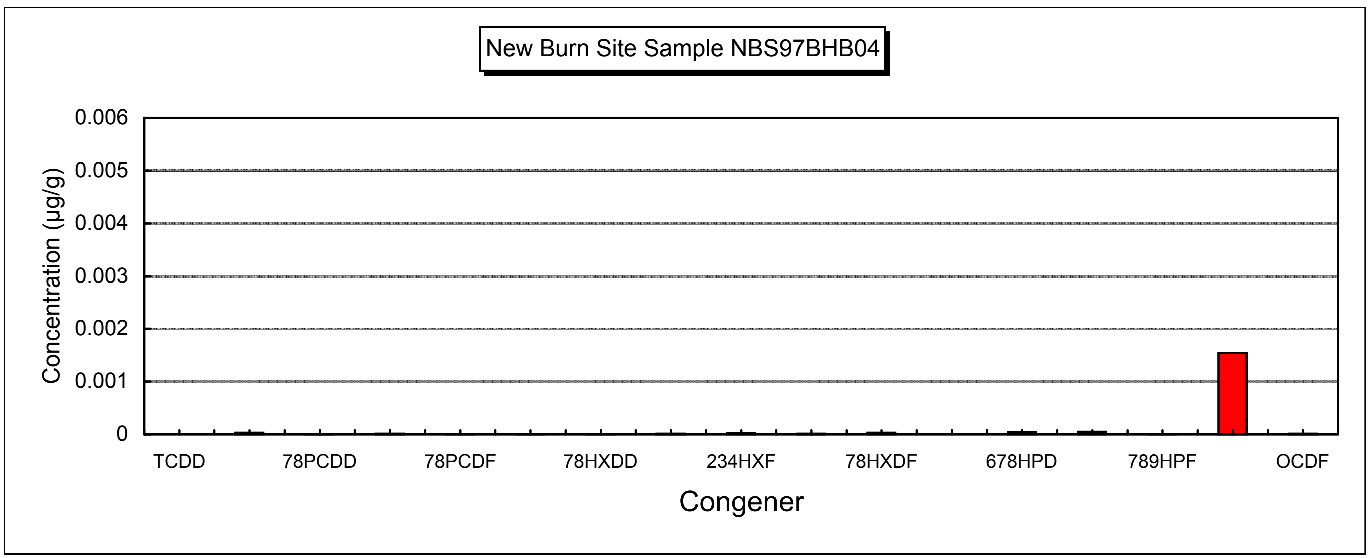


Figure 8-8j. Distribution of Dioxin/Furan Congeners at the New Burn Site - Samples NBS97BHB03 and -B04

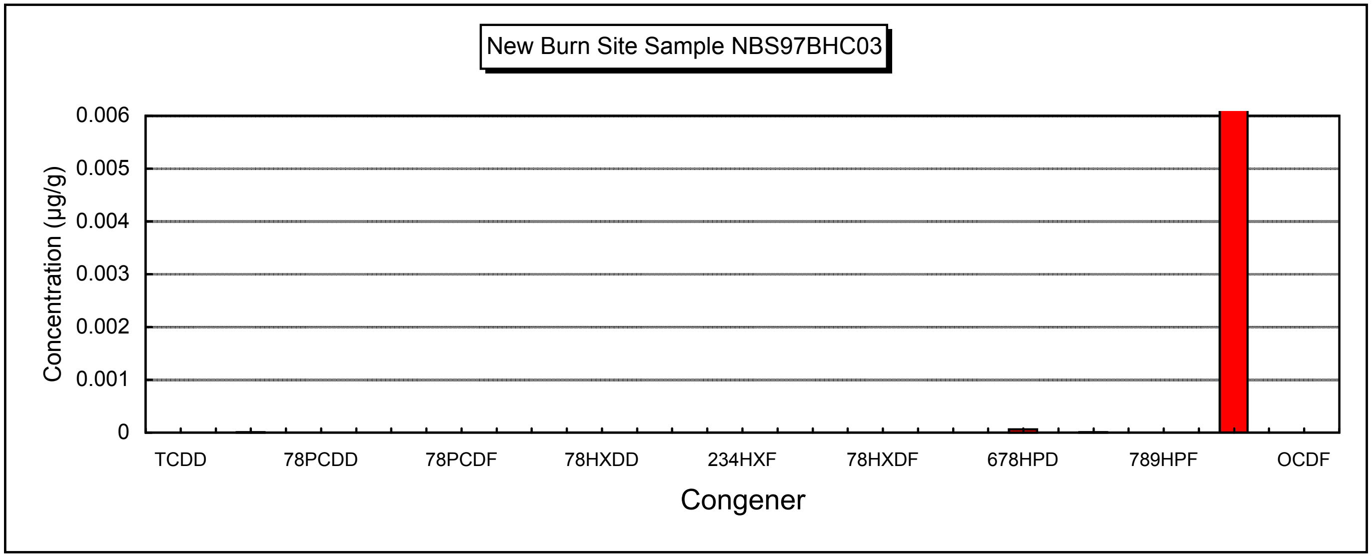


Figure 8-8k. Distribution of Dioxin/Furan Congeners at the New Burn Site - Samples NBS97BHC03 and -C04

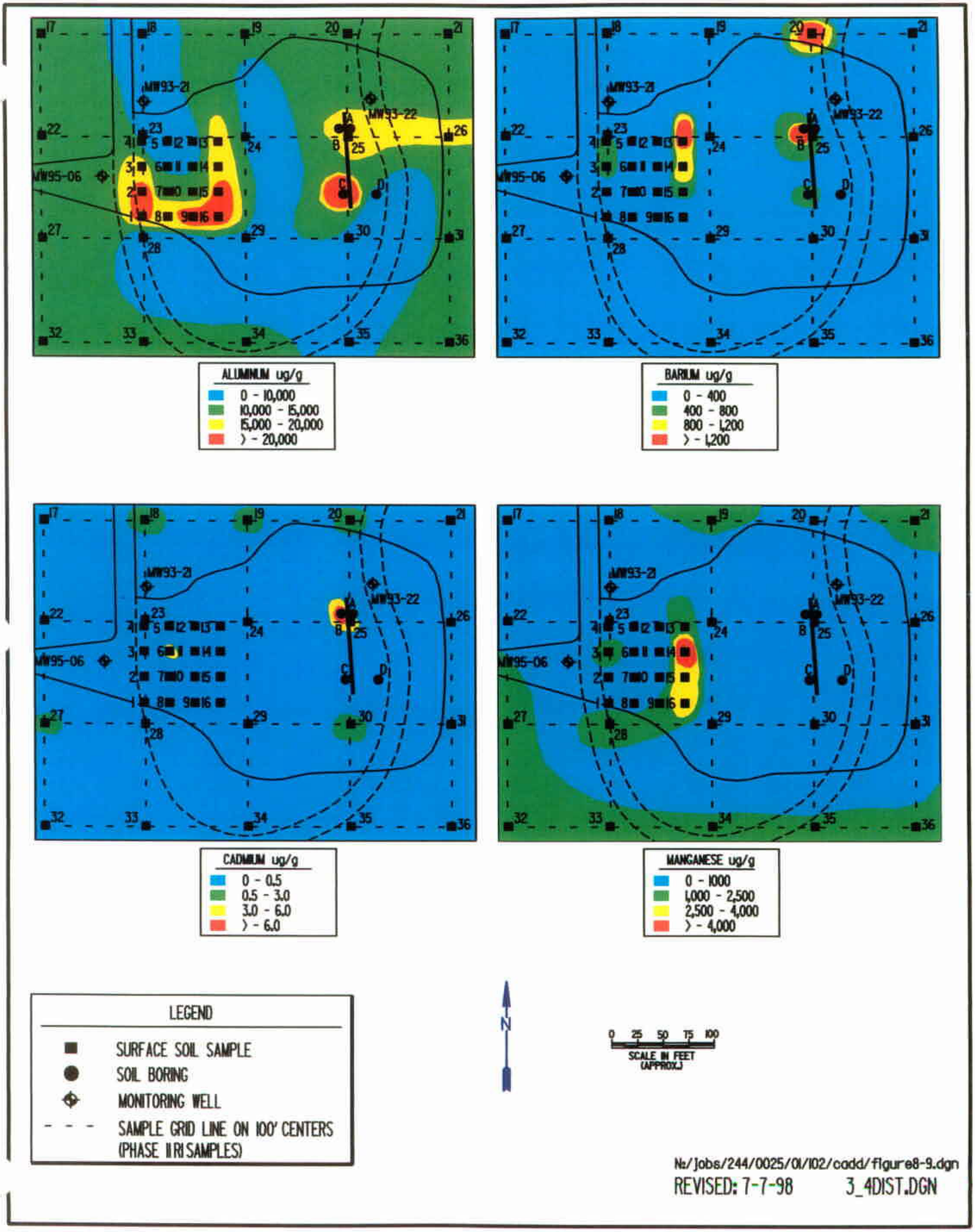


Figure 8-9. Contaminant Distribution Maps for Surface Soils at Sites 3/4

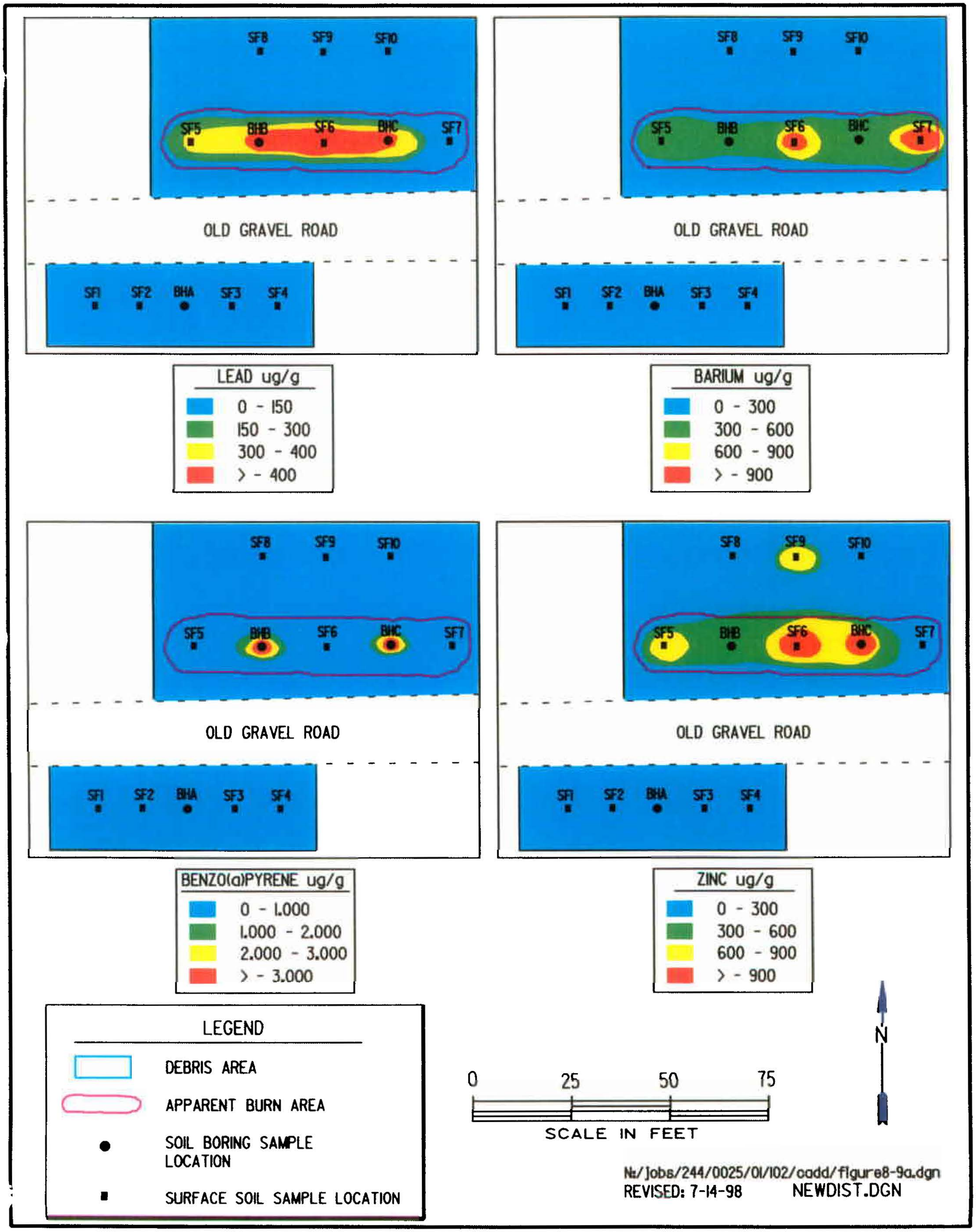
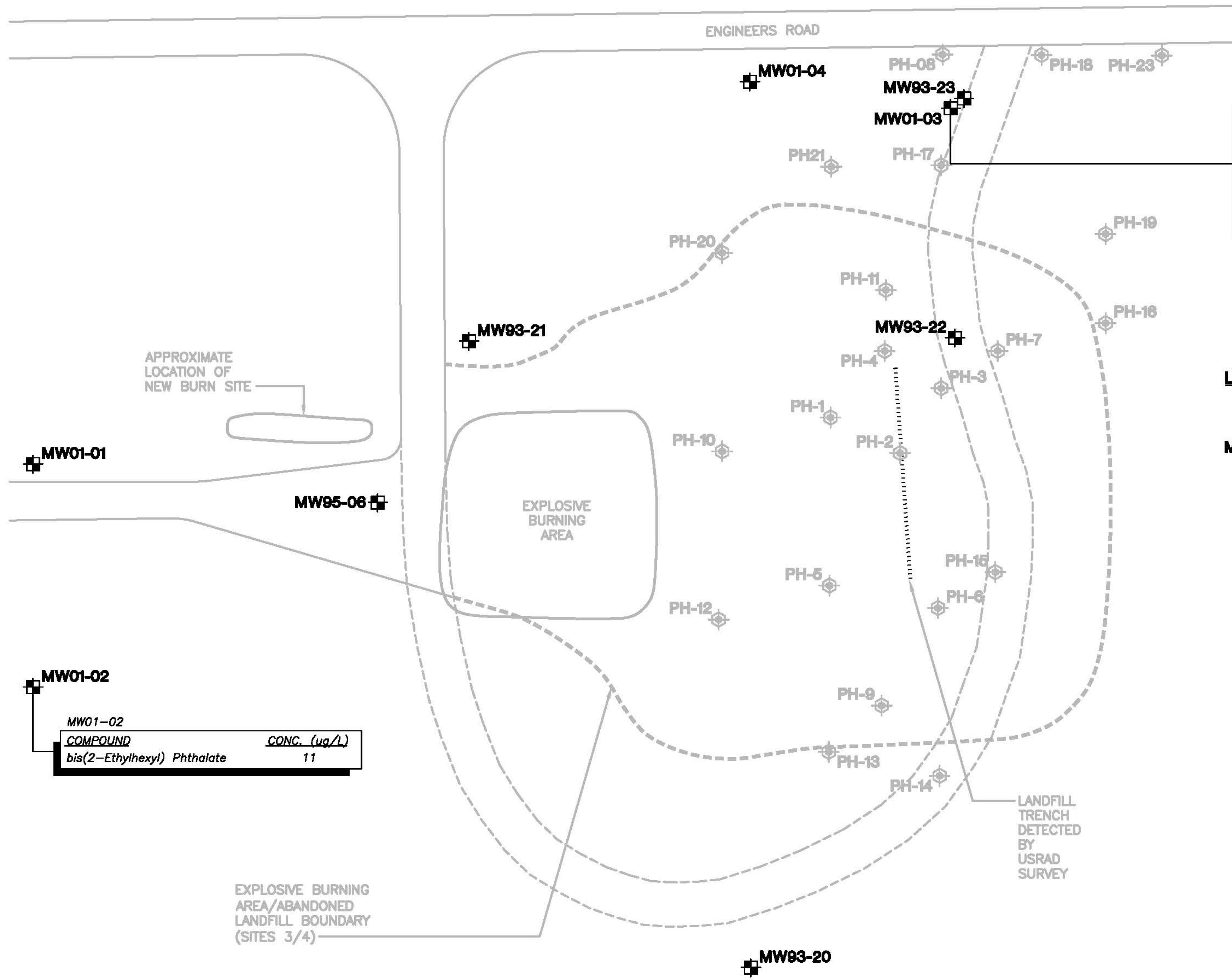


Figure 8-9a. Contaminant Distribution Maps for Surface Soils at the New Burn Site



MW01-03

COMPOUND	CONC. (ug/L)
1,1,1-Trichloroethane	40
1,1-Dichloroethane	21
1,1-Dichloroethene	2.9
Chloroethane	0.76 (J/1U,UJ')
cis-1,2-Dichloroethylene	68
Tetrachloroethylene (PCE)	0.23 (J/1U)
trans-1,2-Dichloroethene	2
Trichloroethylene (TCE)	**26**
Trichlorofluoromethane	0.53 (J/1U)

MW01-02

COMPOUND	CONC. (ug/L)
bis(2-Ethylhexyl) Phthalate	11

LEGEND

PH-08 — HYDRAULIC PROBE LOCATION AND NUMBER

MW93-20 — MONITORING WELL LOCATION AND NUMBER

NOTES

1. BASE MAP DEVELOPED FROM FIGURE 8-1 FROM A REPORT BY RUST ENVIRONMENT & INFRASTRUCTURE, DATED: 4-13-98.
2. HYDRAULIC PROBE LOCATIONS TAKEN FROM FIGURE 8-5, SAMPLING LOCATIONS AT THE EXPLOSIVE BURN AREA (SITE 3) AND ABANDONED LANDFILL (SITE 4), PREPARED BY RUST E&I, DATED 8-5-98.
3. MW01 SERIES WELLS WERE INSTALLED DURING 2001 UNDER THE SUPERVISION OF MWH.
4. ONLY COMPOUNDS WHICH WERE DETECTED ARE SHOWN ON THE MAP. SEE ANALYTICAL LABORATORY REPORT FOR PARAMETER LIST, DETECTION LIMITS, AND EXPLANATION OF LABORATORY NOTES.
5. MCL EXCEEDANCES ARE BOLDED.

north

0 50 100

SCALE IN FEET

FIGURE 8-10

VOC AND SVOC CONCENTRATIONS IN GROUNDWATER (JUNE 2001) - EXPLOSIVE BURN AREA (SITE 3) AND ABANDONED LANDFILL (SITE 4)

SOUTH OF THE FIRING LINE
JEFFERSON PROVING GROUND
MADISON, INDIANA

Developed By TAPB | Drawn By DLF | Approved By | Date | Reference 2440025.040201-B3 | Revisions

Drawing Number 2440025 010102 **B4**

MWH MONTGOMERY WATSON HARZA

QUALITY CONTROL: Graphic Standards DLF 2-19-02; Lead Professional TAPB 2-22-02; Technical Review LAB; Project Manager 3-18-02; Management Review; Other

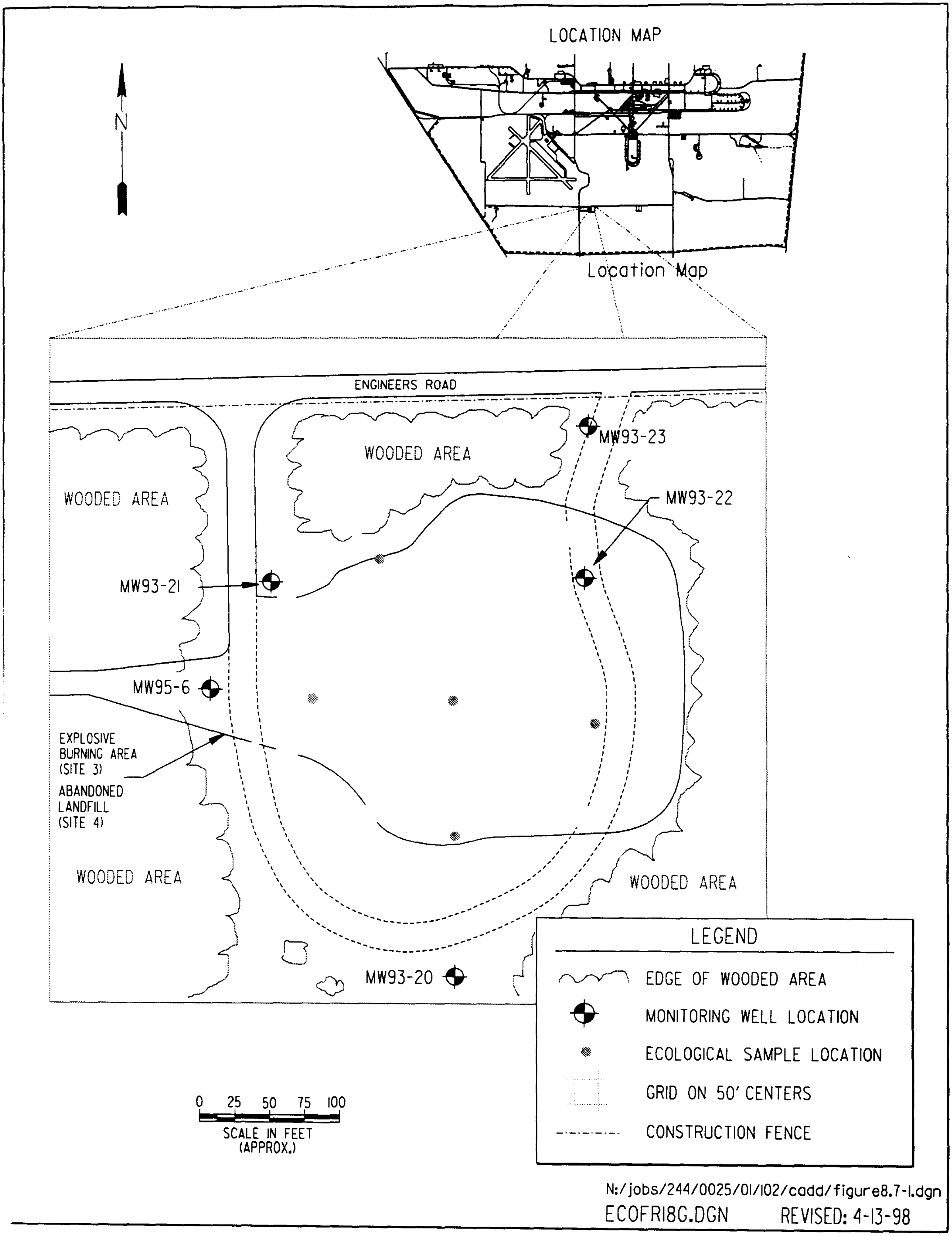
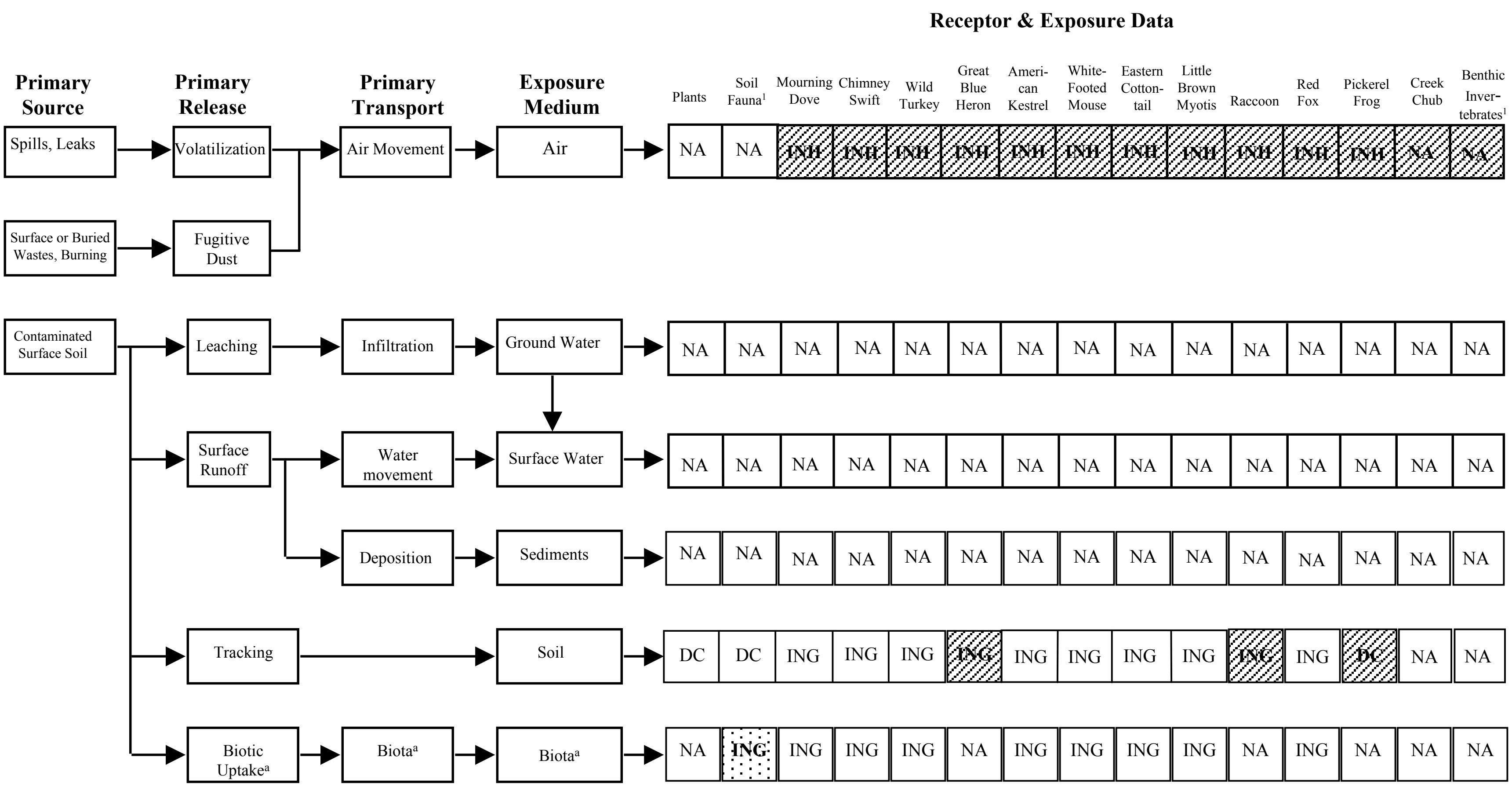


Figure 8.7-1. Ecological Study Area for Explosive Burn Area and Abandoned Landfill (Sites 3/4)



(dotted box) Pathway may be significant; not evaluated because toxicity criteria lacking

(hatched box) Insignificant pathway; not quantitatively evaluated

NA Not Applicable

ING Ingestion

INH Inhalation

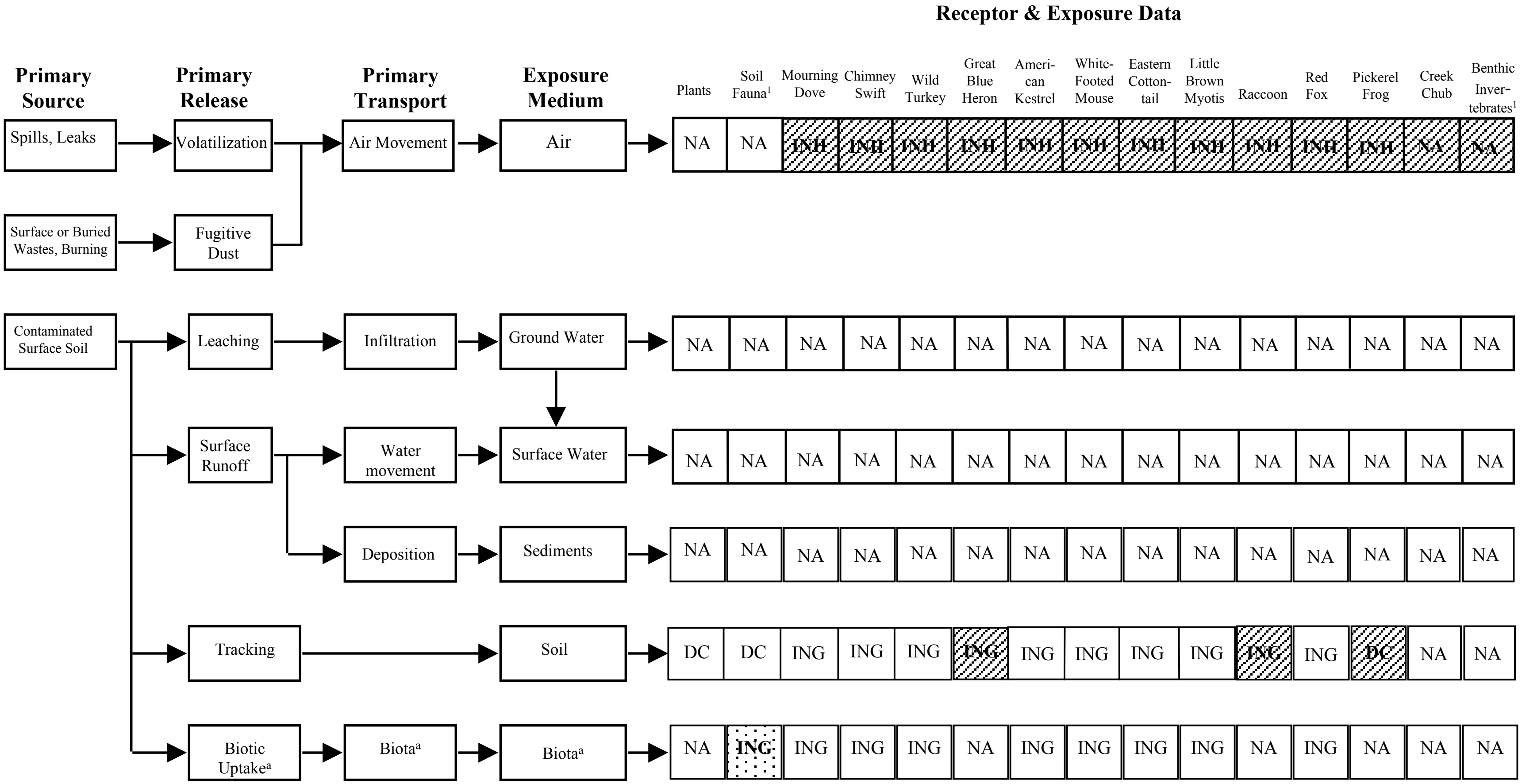
DC Direct Contact

1 Includes the terrestrial or aquatic crayfish

a Refer to JPG Food Web (Figure 5.3-5)

Figure 8.7-1a
JPG Conceptual Site Model
Site 3

N:Jobs\244\0025\01\102\cadd\figure8.7-1a.ppt



Pathway may be significant; not evaluated because toxicity criteria lacking

Insignificant pathway; not quantitatively evaluated

NA Not Applicable

ING Ingestion

INH Inhalation

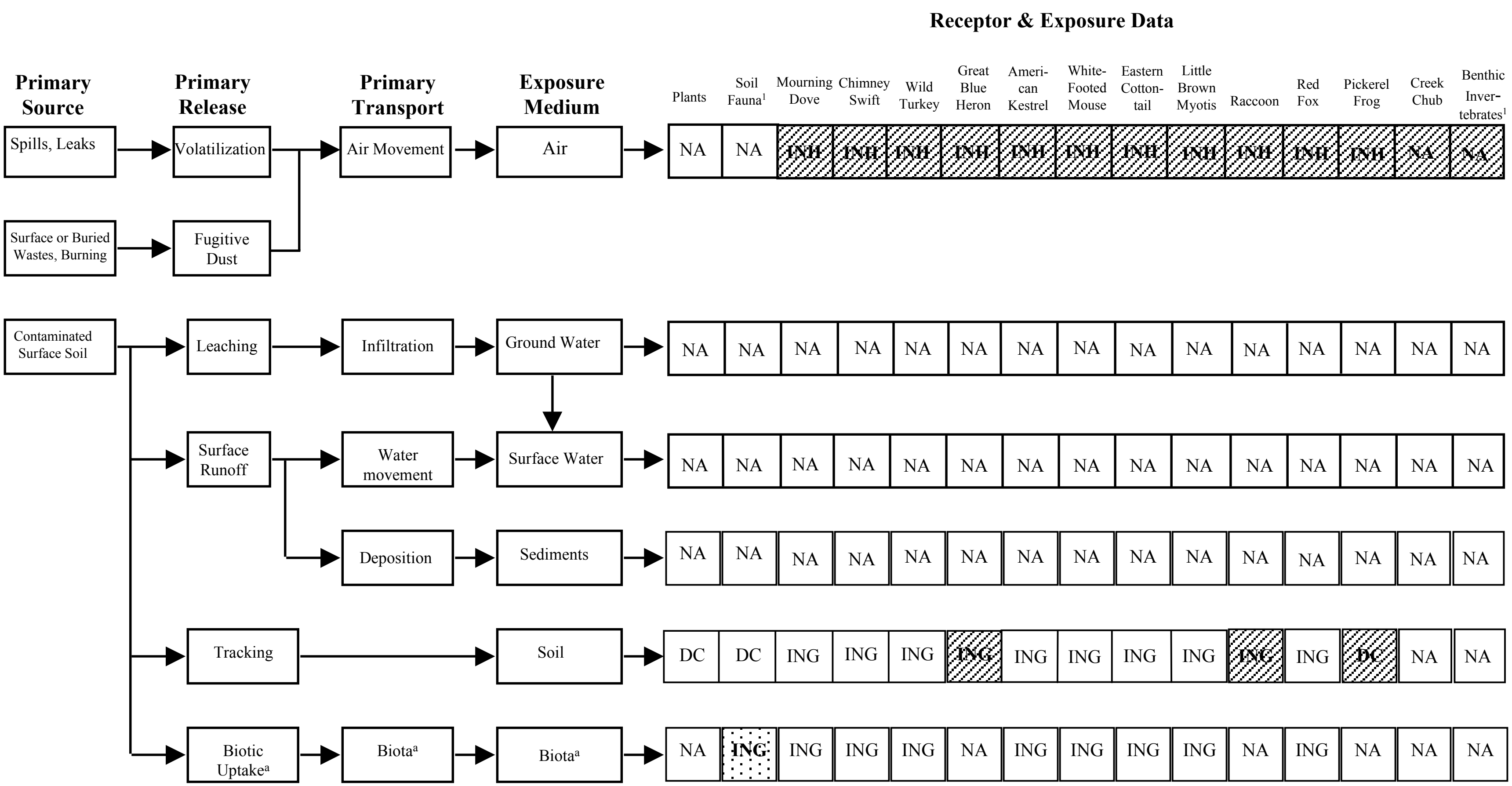
DC Direct Contact

1 Includes the terrestrial or aquatic crayfish

a Refer to JPG Food Web (Figure 5.3-5)

Figure 8.7-1b
JPG Conceptual Site Model
Site 4

N:Jobs\244\0025\01\102\cadd\figure8.7-1b.ppt



Exposure Medium	Plants	Soil Fauna[1]	Mourning Dove	Chimney Swift	Wild Turkey	Great Blue Heron	American Kestrel	White-Footed Mouse	Eastern Cottontail	Little Brown Myotis	Raccoon	Red Fox	Pickerel Frog	Creek Chub	Benthic Invertebrates[1]
Air	NA	NA	INH	INH	INH	INH	INH	INH	INH	INH	INH	INH	INH	NA	NA
Ground Water	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface Water	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sediments	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Soil	DC	DC	ING	ING	ING	ING	ING	ING	ING	ING	ING	ING	DC	NA	NA
Biota[a]	NA	ING	ING	ING	ING	NA	ING	ING	ING	ING	NA	ING	NA	NA	NA

Pathway may be significant; not evaluated because toxicity criteria lacking (dotted)

Insignificant pathway; not quantitatively evaluated (hatched)

NA Not Applicable

ING Ingestion

INH Inhalation

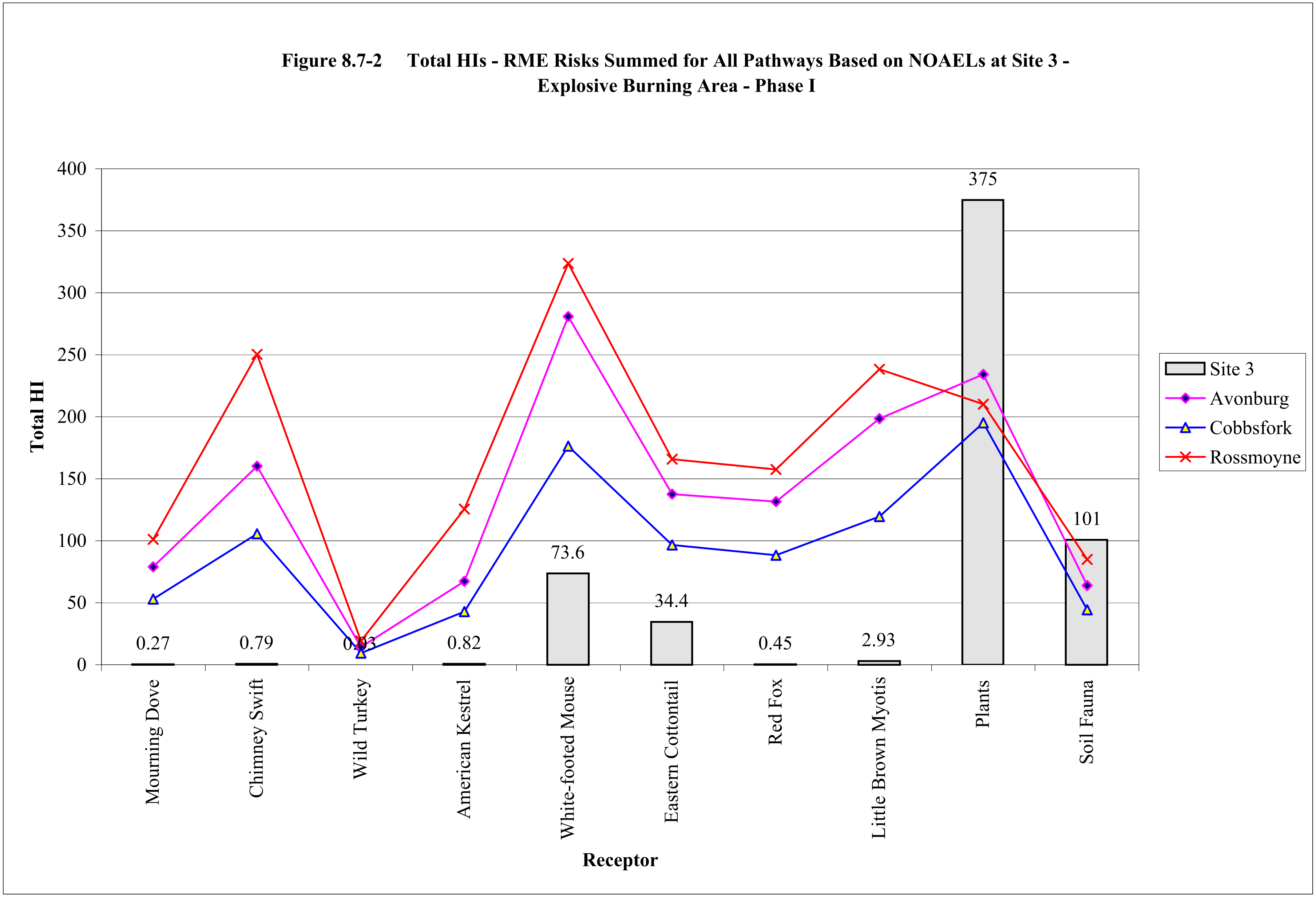
DC Direct Contact

1 Includes the terrestrial or aquatic crayfish

a Refer to JPG Food Web (Figure 5.3-5)

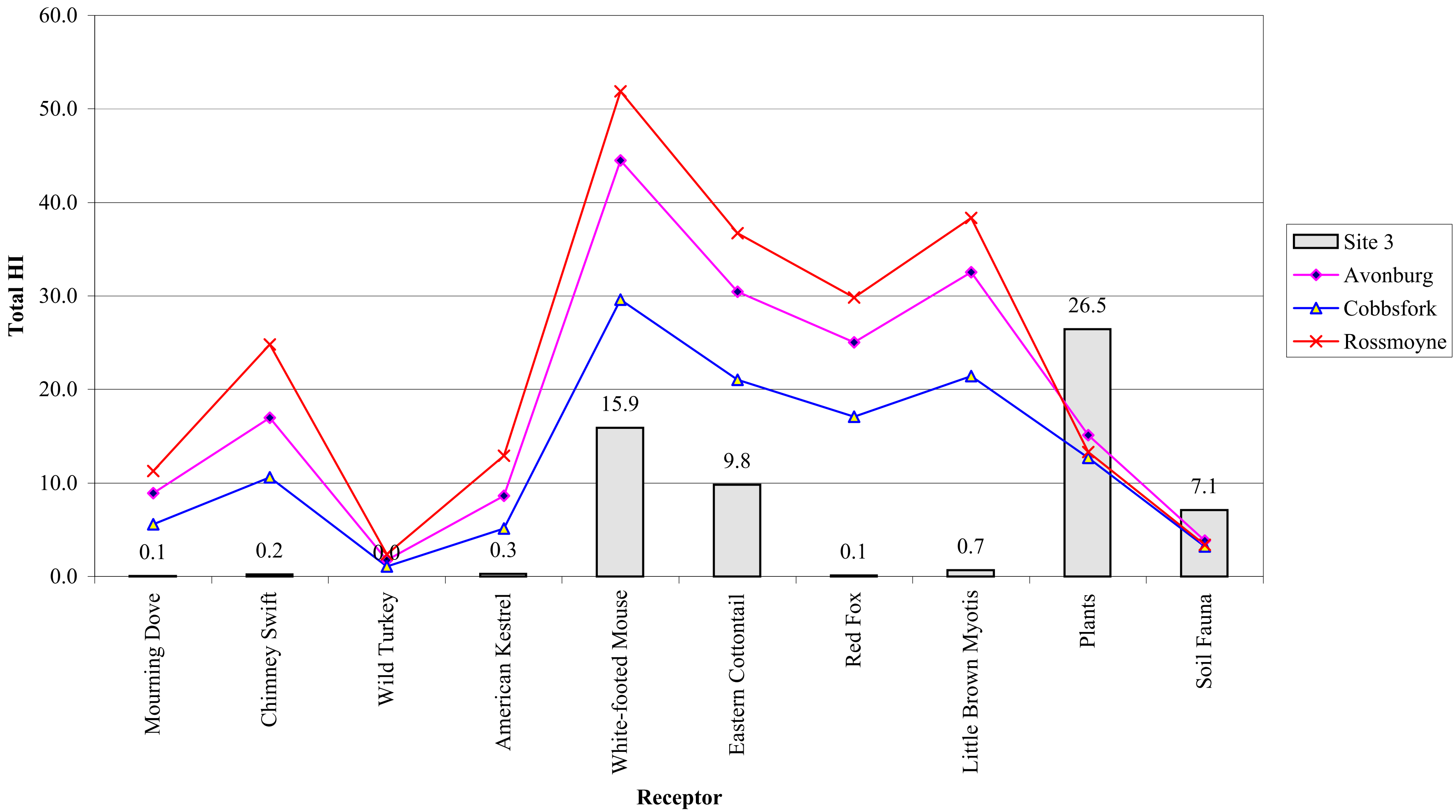
Figure 8.7-1c
JPG Conceptual Site Model
New Burn Site

N:Jobs\244\0025\01\102\cadd\figure8.7-1c.ppt



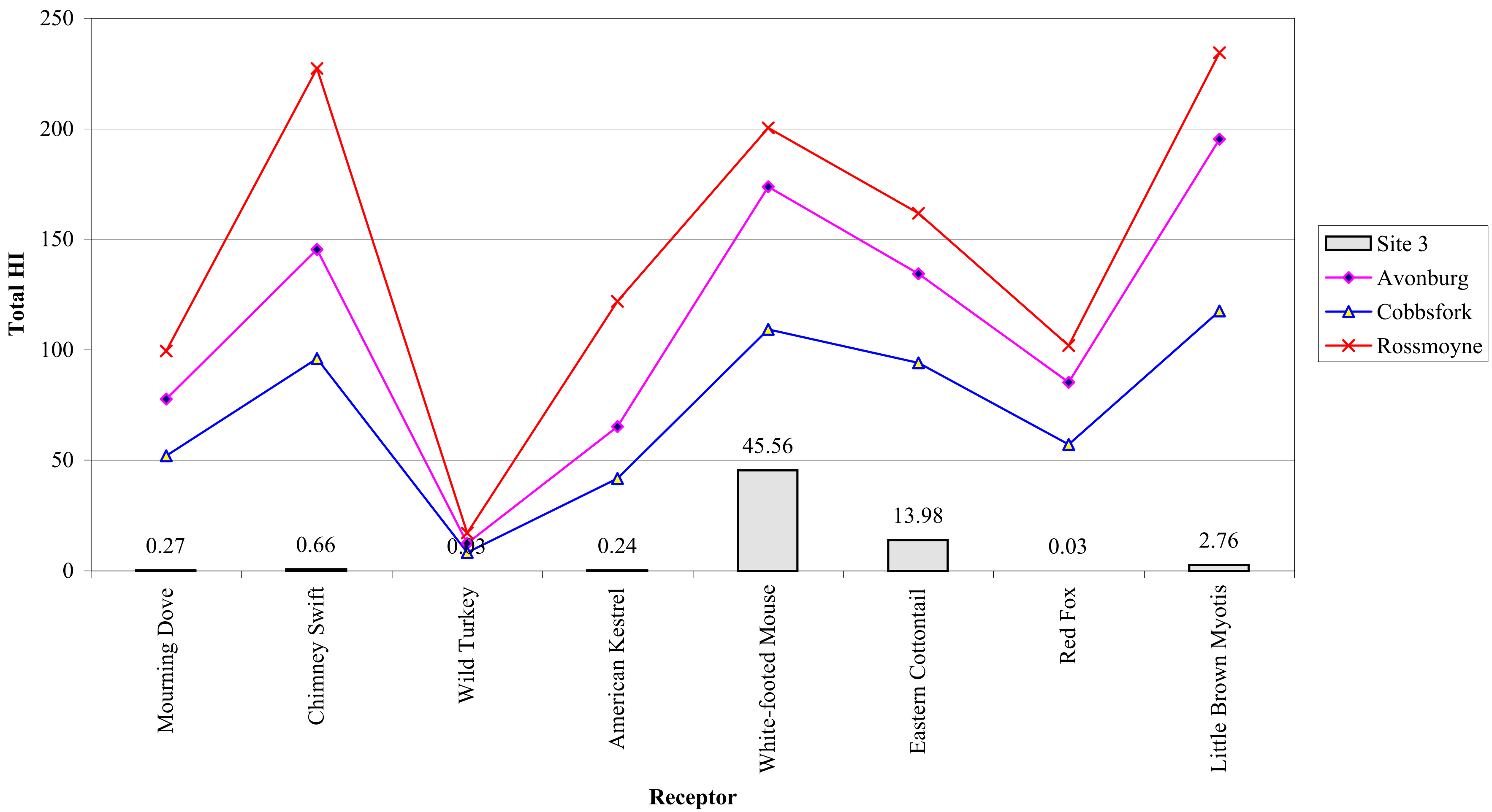
N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase 1\Risk2\P1era_3MWH.xls Figure 8.7-2

Figure 8.7-3 Total HIs - RME Risks Summed for All Pathways Based on LOAELs at Site 3 - Explosive Burning Area - Phase I



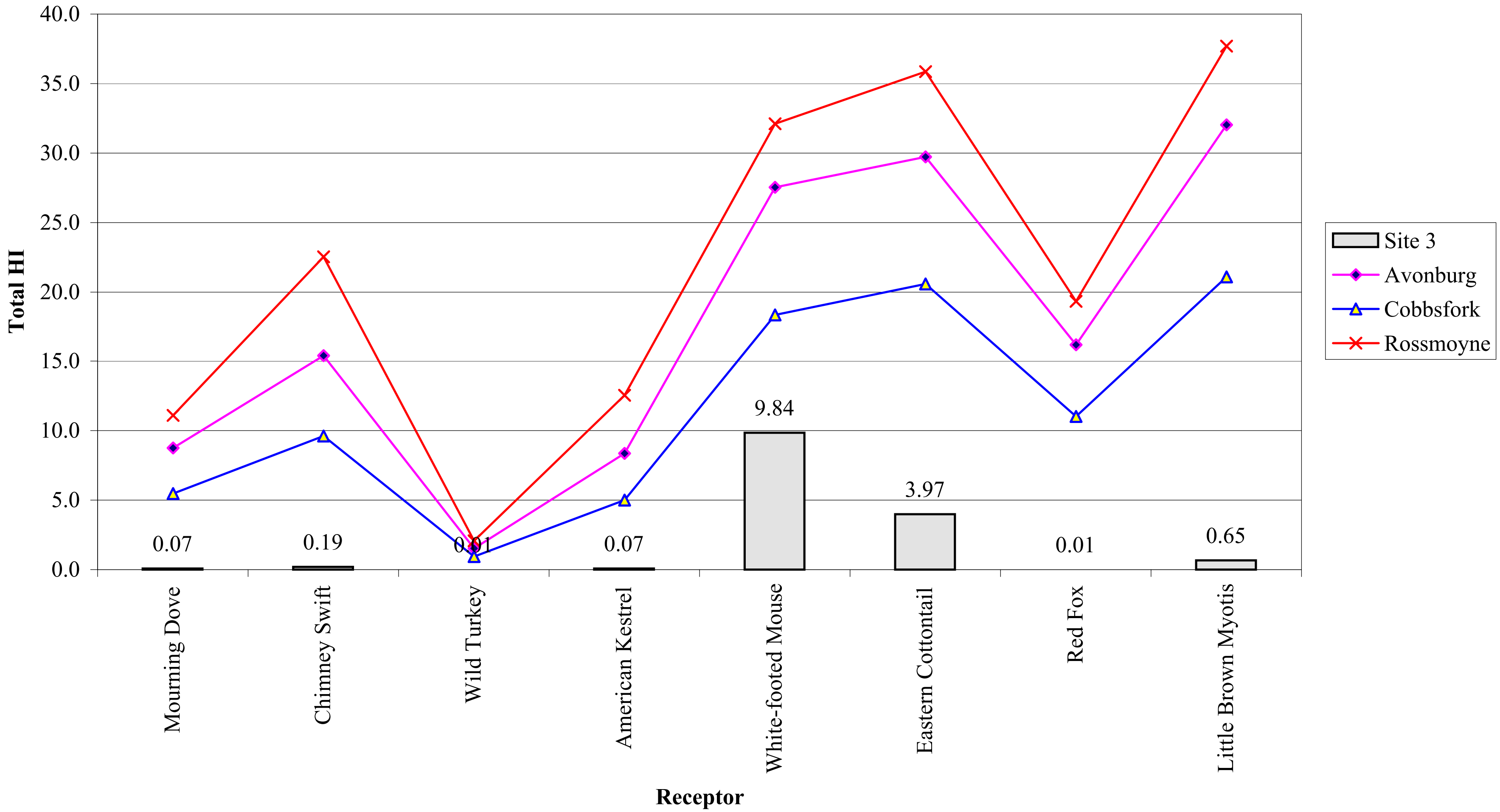
N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase 1\Risk2\P1era_3MWH.xls Figure 8.7-3

Figure 8.7-4 Total HIs - CT Risks Summed for All Pathways Based on NOAELs at Site 3 - Explosive Burning Area - Phase I



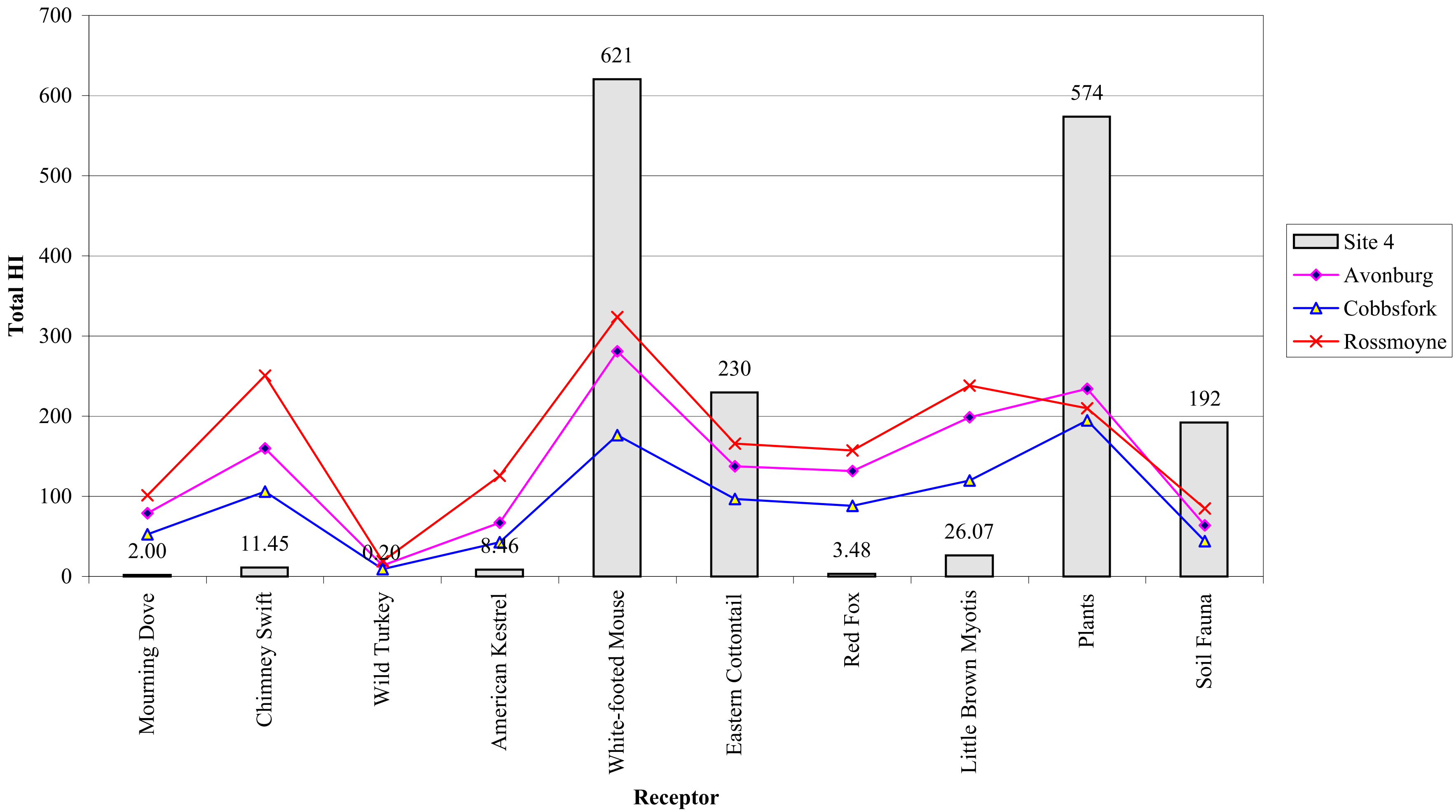
N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase 1\Risk2\P1era_3MWH.xls Figure 8.7-4

Figure 8.7-5 Total HIs - CT Risks Summed for All Pathways Based on LOAELs at Site 3 - Explosive Burning Area - Phase I

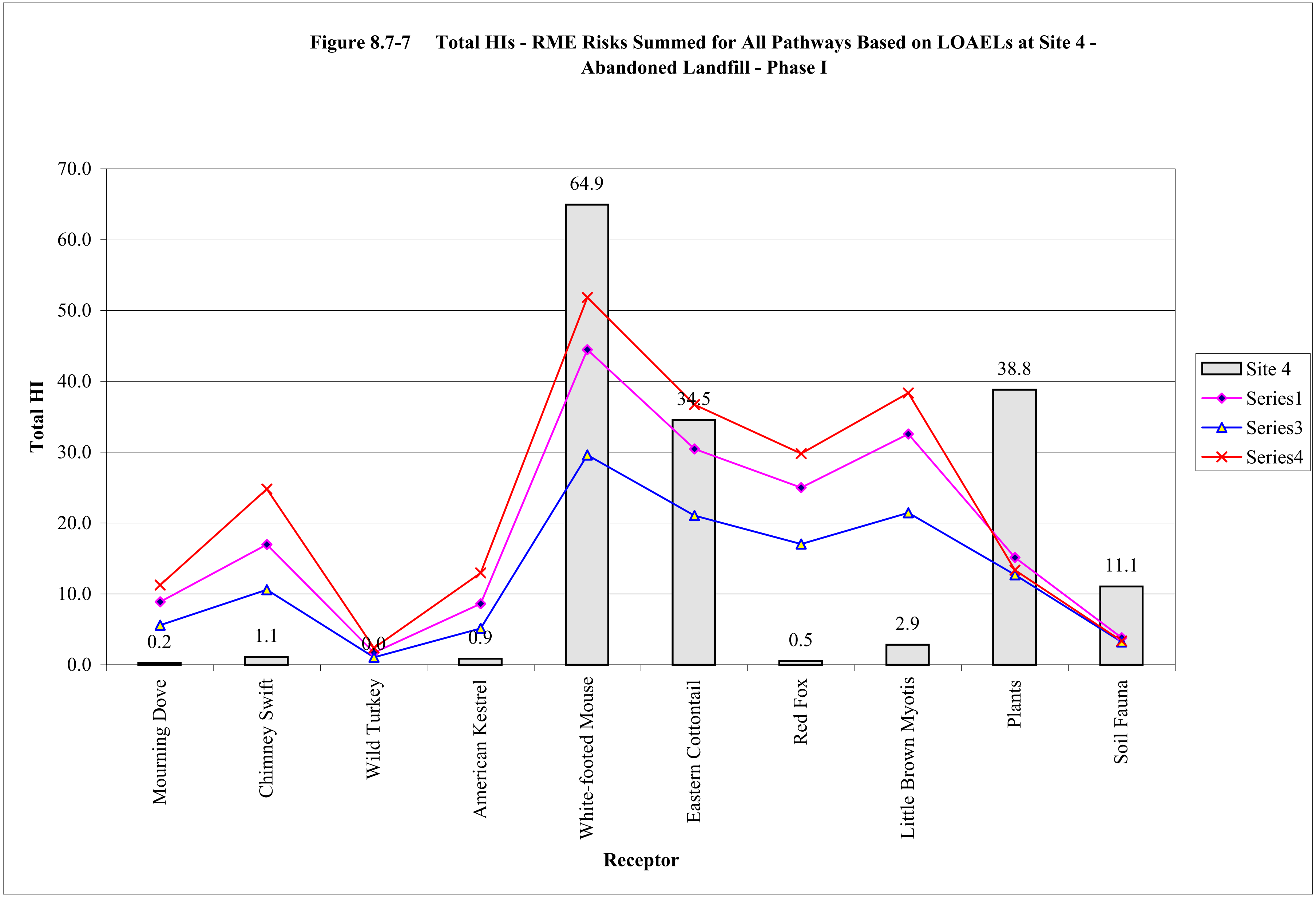


N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase 1\Risk2\P1era_3MWH.xls Figure 8.7-5

Figure 8.7-6 Total HIs - RME Risks Summed for All Pathways Based on NOAELs at Site 4 - Abandoned Landfill - Phase I

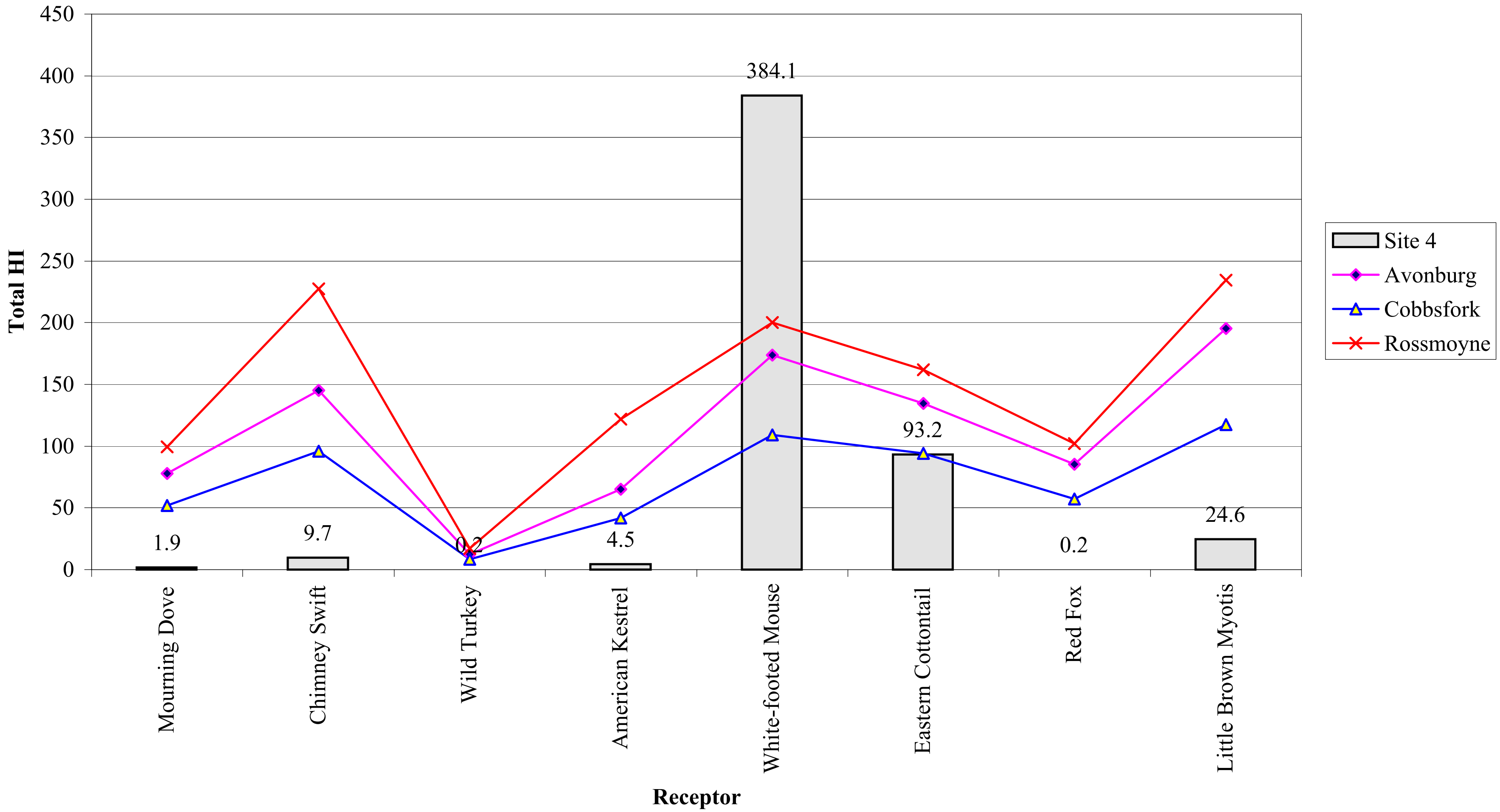


N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase 1\Risk2\P1era_4MWH.xls Figure 8.7-6



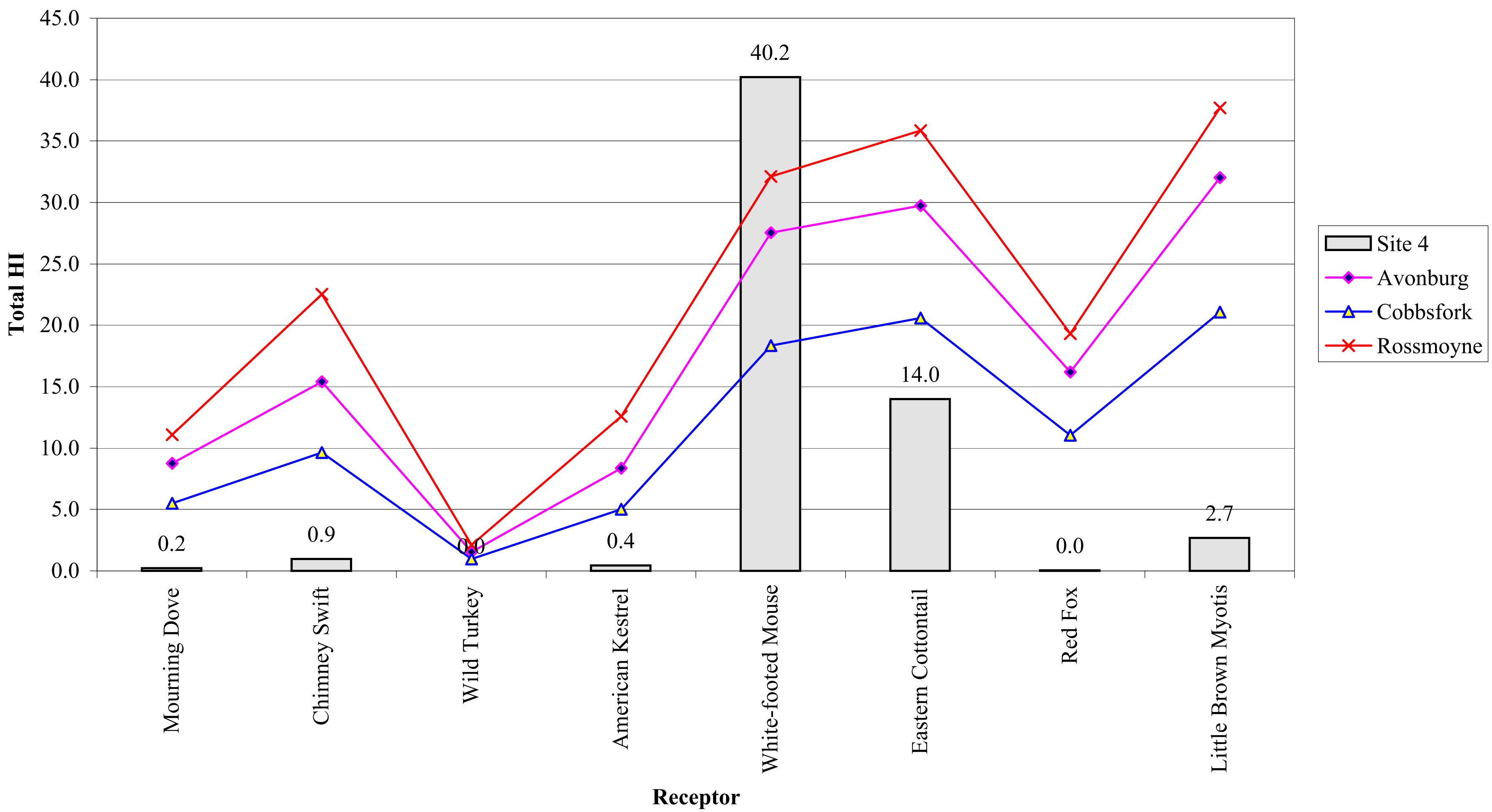
N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase 1\Risk2\P1era_4MWH.xls Figure 8.7-7

Figure 8.7-8 Total HIs - CT Risks Summed for All Pathways Based on NOAELs at Site 4 - Abandoned Landfill - Phase I



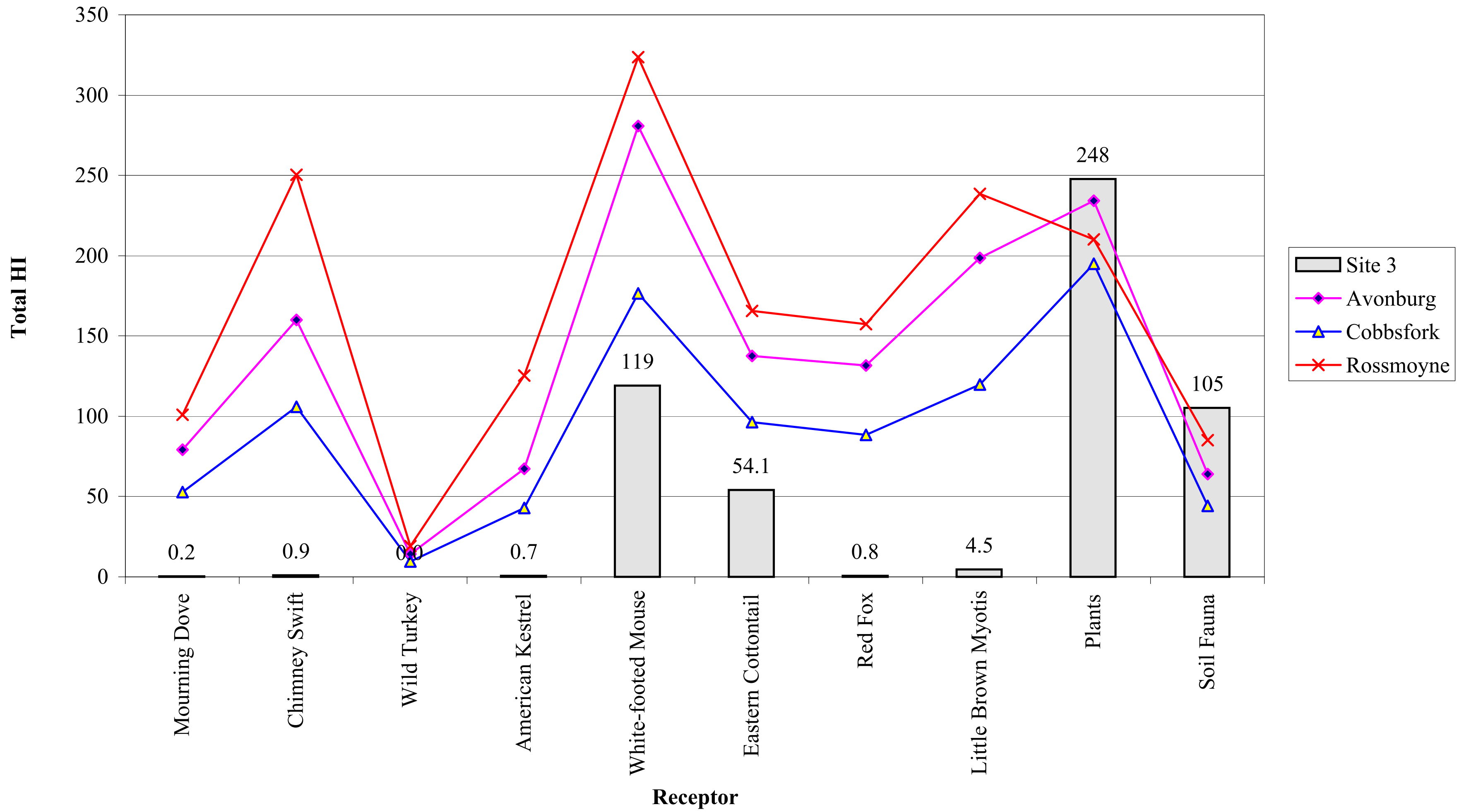
N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase 1\Risk2\P1era_4MWH.xls Figure 8.7-8

Figure 8.7-9 Total HIs - CT Risks Summed for All Pathways Based on LOAELs at Site 4 - Abandoned Landfill - Phase I



N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase 1\Risk2\P1era_4MWH.xls Figure 8.7-9

Figure 8.7-10 Total HIs - RME Risks Summed for All Pathways Based on NOAELs at Site 3 - Explosive Burning Area - Phase II



N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase 2\Risk2\P2era_3MWH.xls Figure 8.7-10

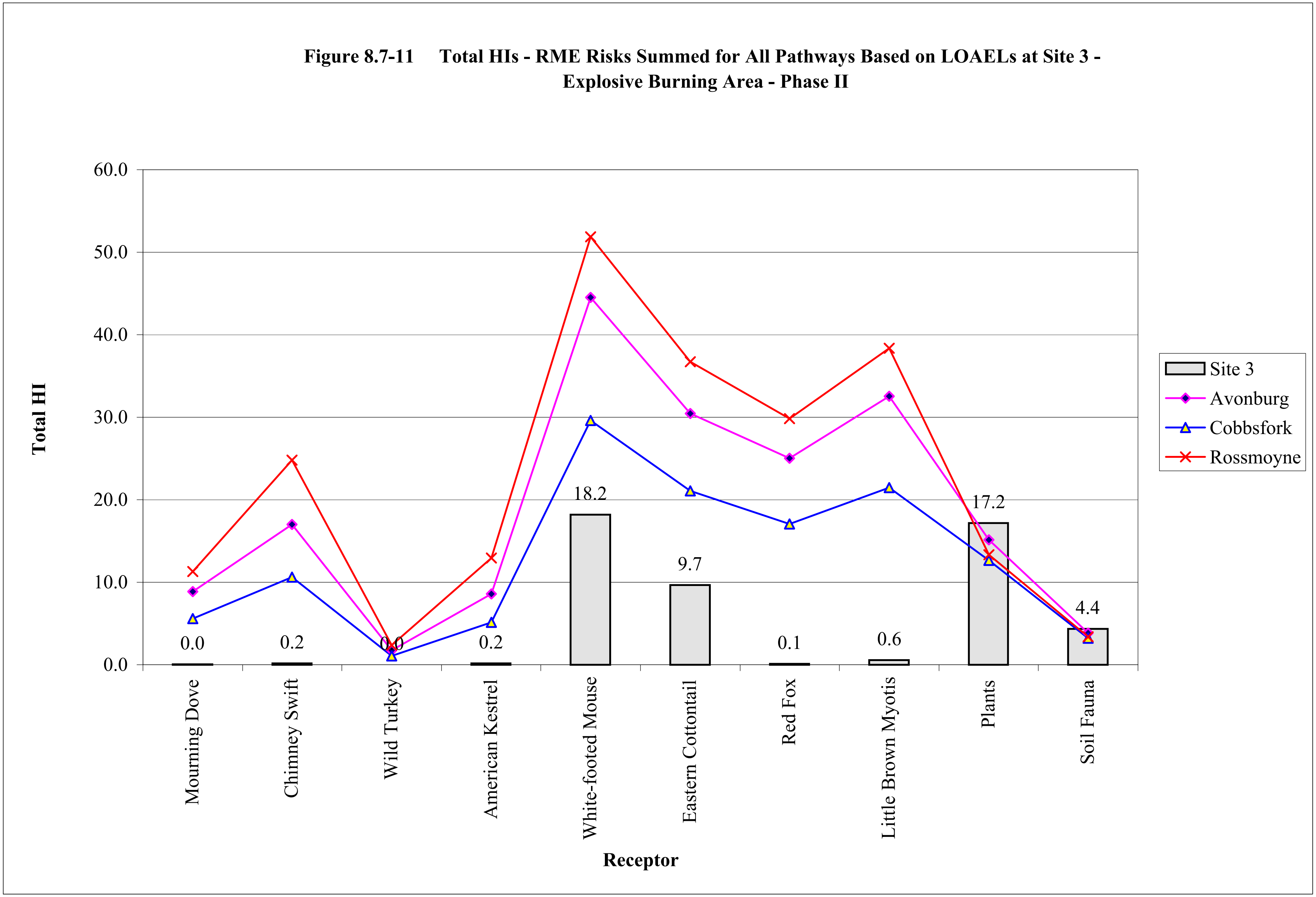


Figure 8.7-11 Total HIs - RME Risks Summed for All Pathways Based on LOAELs at Site 3 - Explosive Burning Area - Phase II
Total HI
Receptor
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Site 3
Avonburg
Cobbsfork
Rossmoyne
0.0
0.2
0.0
0.2
18.2
9.7
0.1
0.6
17.2
4.4
Mourning Dove
Chimney Swift
Wild Turkey
American Kestrel
White-footed Mouse
Eastern Cottontail
Red Fox
Little Brown Myotis
Plants
Soil Fauna

Figure 8.7-12 Total HIs - CT Risks Summed for All Pathways Based on NOAELs at Site 3 - Explosive Burning Area - Phase II

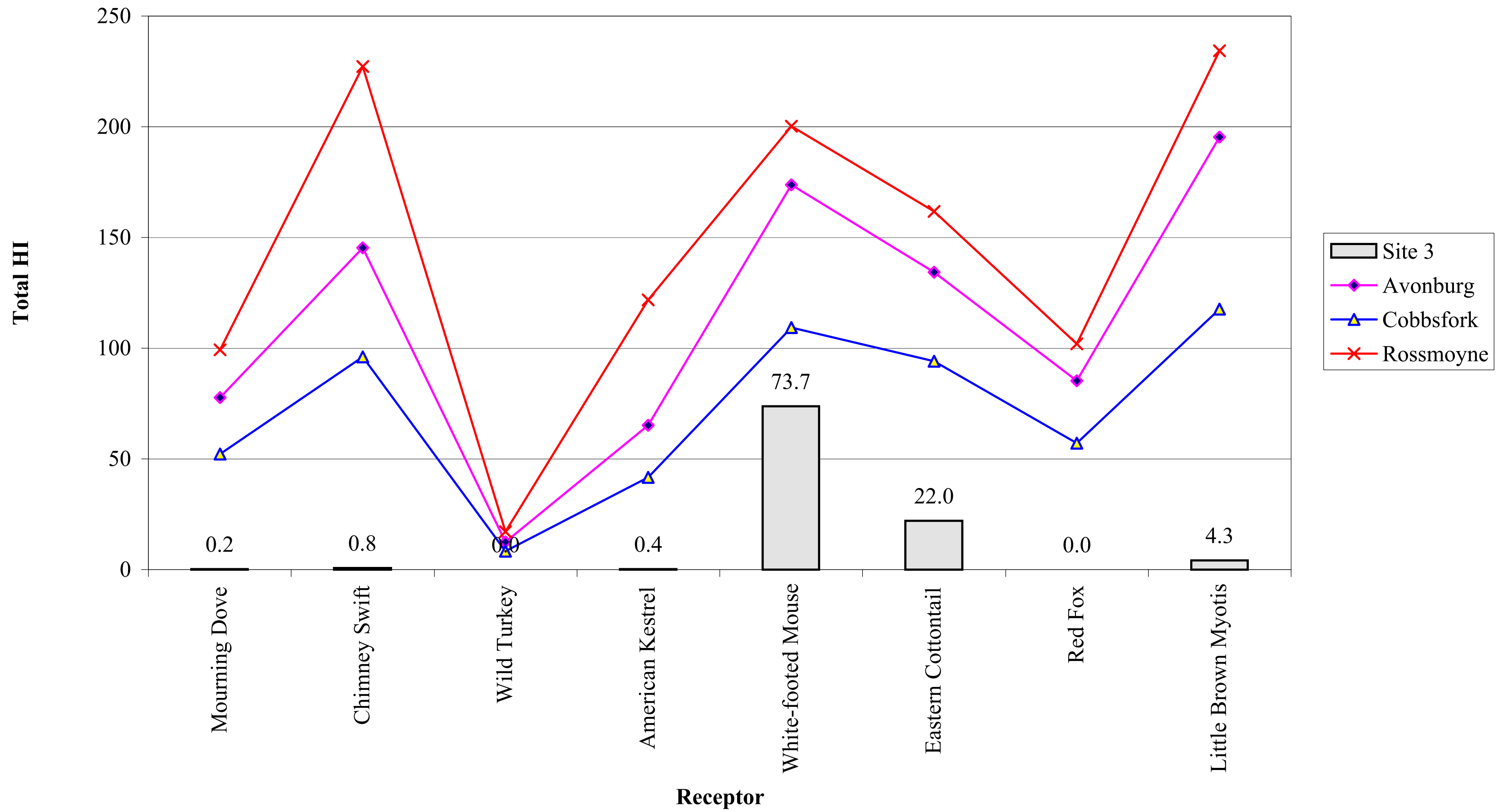


Figure 8.7-13 Total HIs - CT Risks Summed for All Pathways Based on LOAELs at Site 3 - Explosive Burning Area - Phase II

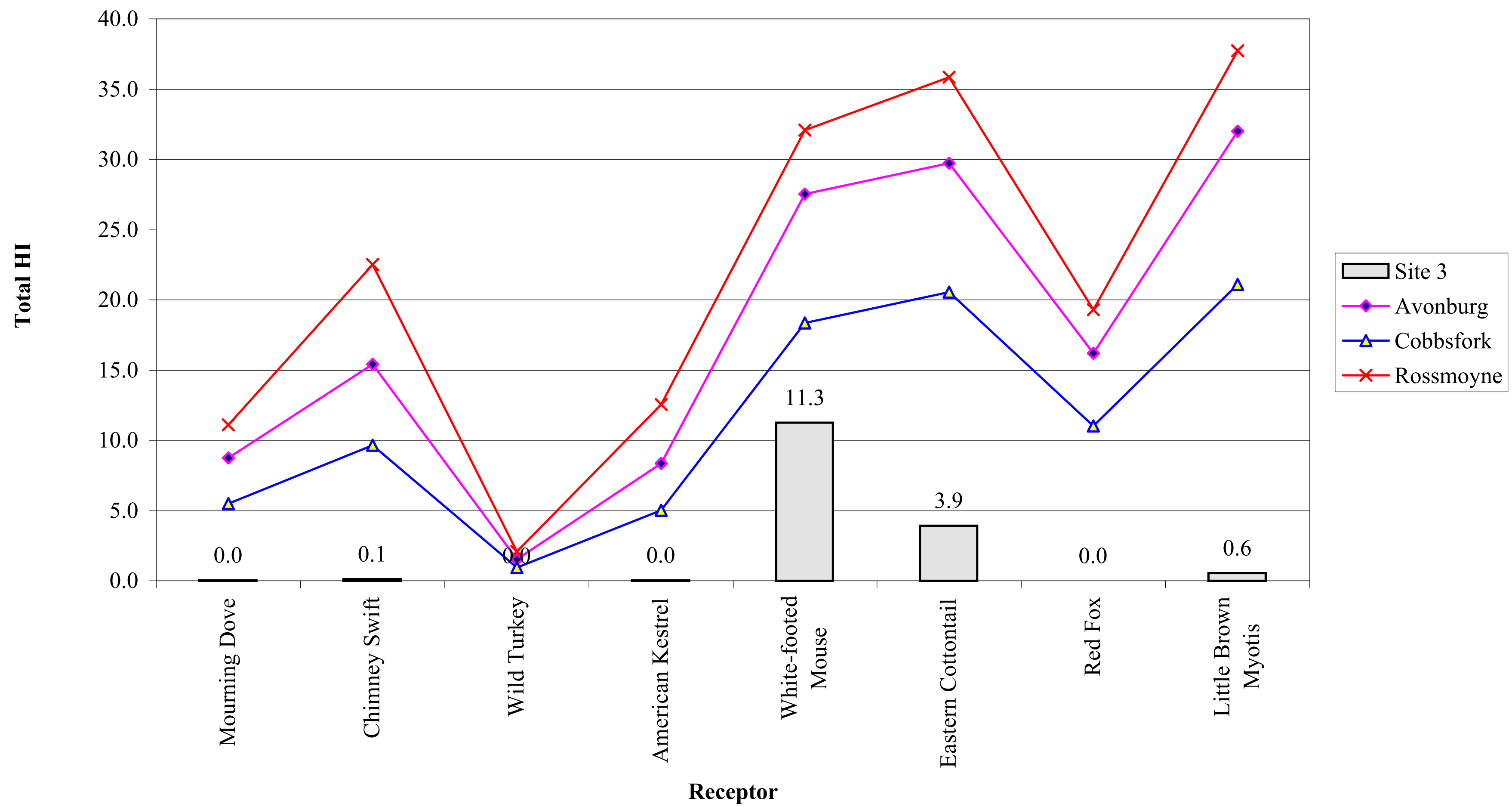


Figure 8.7-14 Total HIs-RME Risks Summed for All Pathways Based on NOAELs at Eco Site 3/4- Phase III

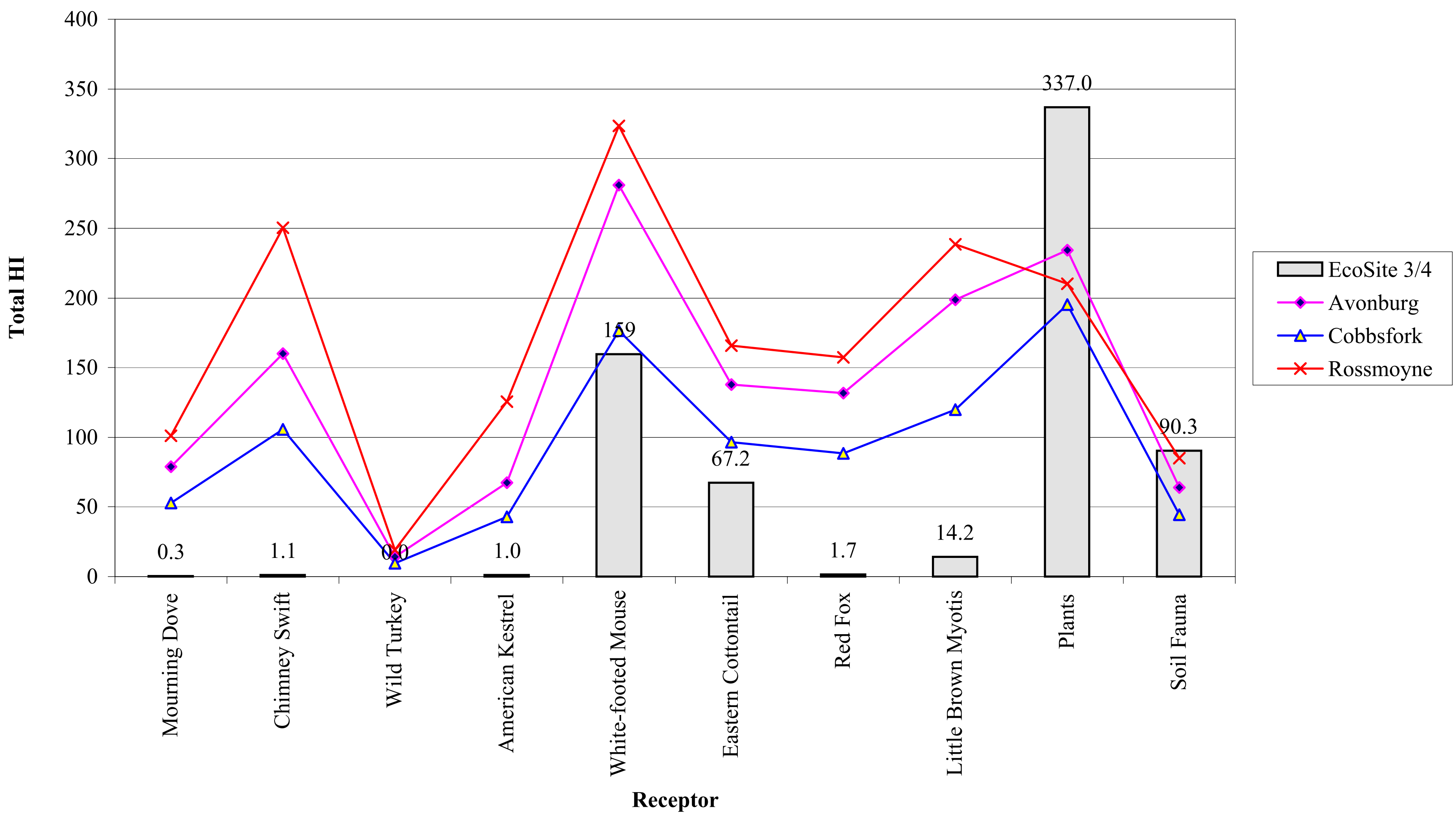
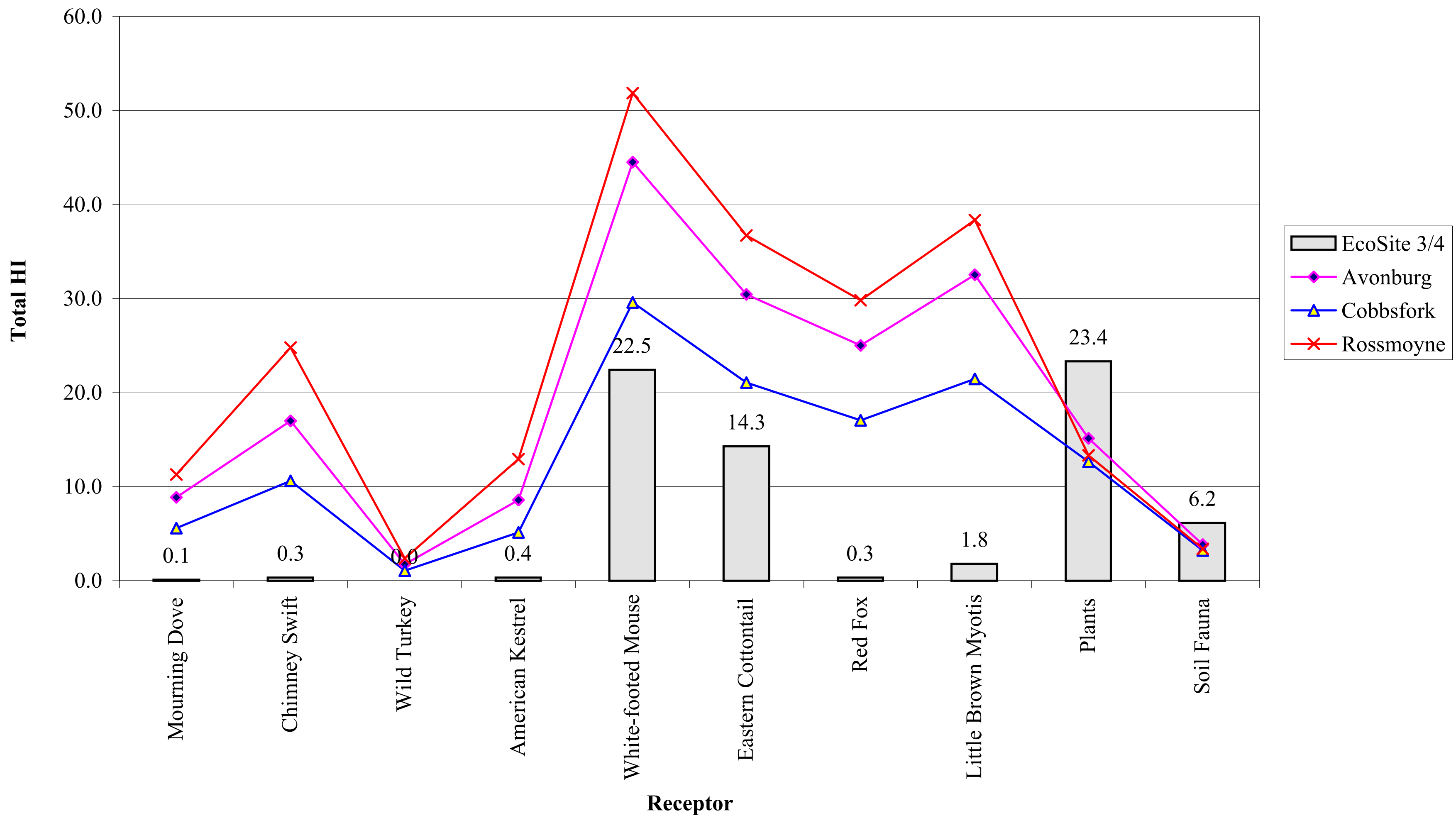
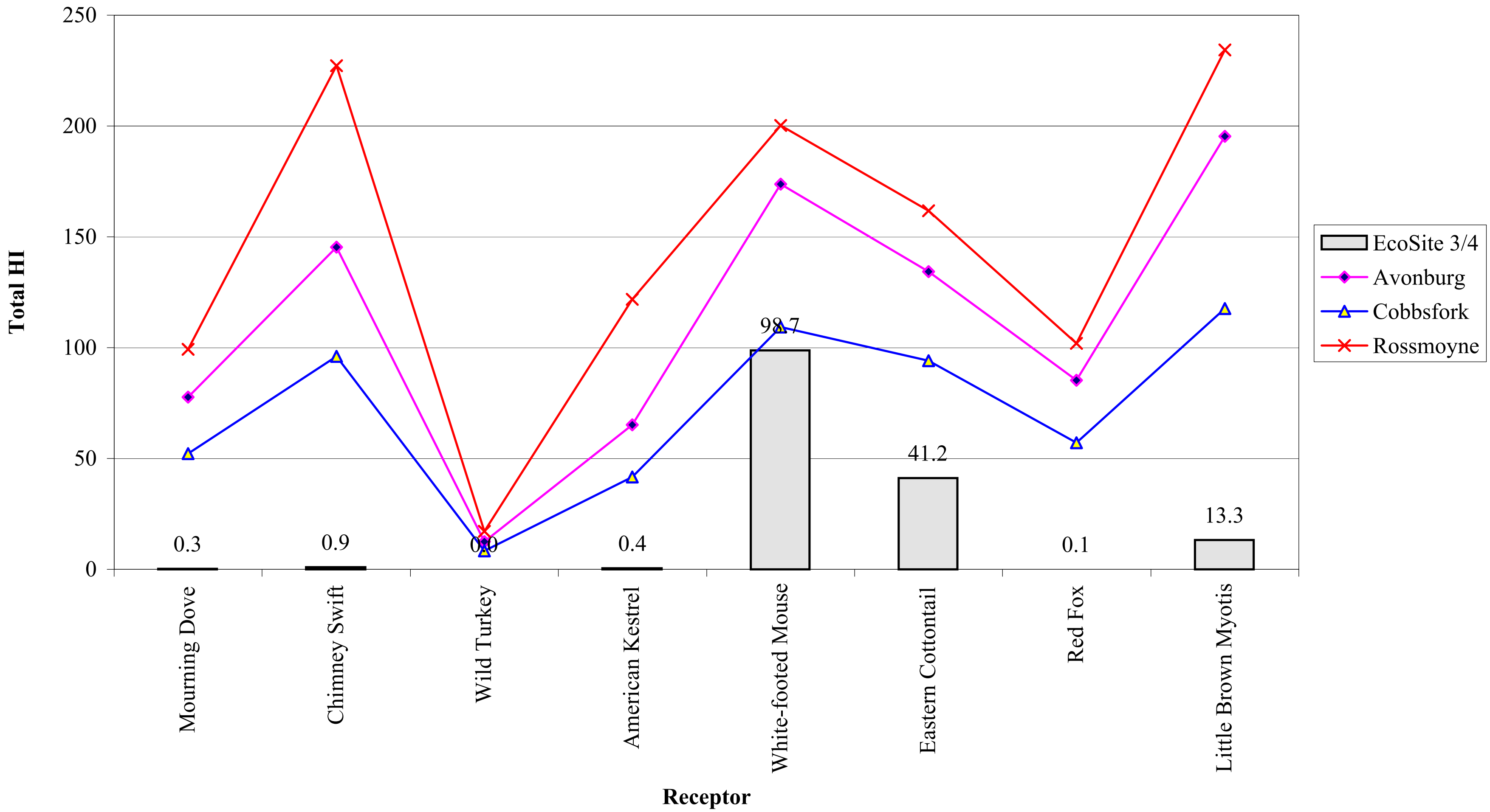


Figure 8.7-15 Total HIs-RME Risks Summed for All Pathways Based on LOAELs at Eco Site 3/4- Phase III



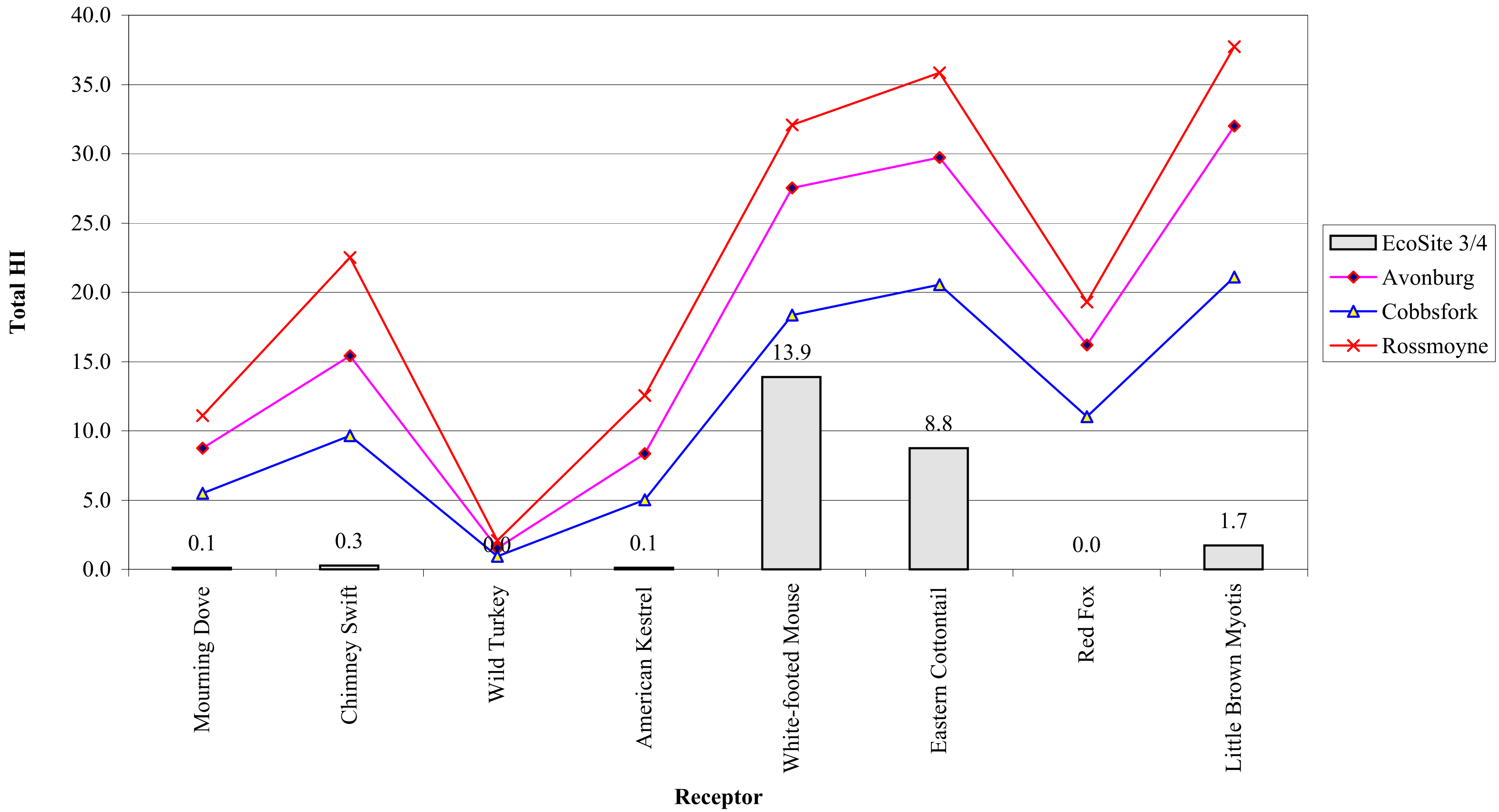
N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase 3\Risk2\P3era_3MWH.xls Figure 8.7-15

Figure 8.7-16 Total HIs-CT Risks Summed for All Pathways Based on NOAELs at Eco Site 3/4 - Phase III



N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase 3\Risk2\P3era_3MWH.xls Figure 8.7-16

Figure 8.7-17 Total HIs-CT Risks Summed for All Pathways Based on LOAELs at Eco Site 3/4 - Phase III



N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase 3\Risk2\P3era_3MWH.xls Figure 8.7-17

Figure 8.7-18 Total HIs - RME Risks Summed for All Pathways Based on NOAELs at New Burn Site - Inside Trench - Phase III

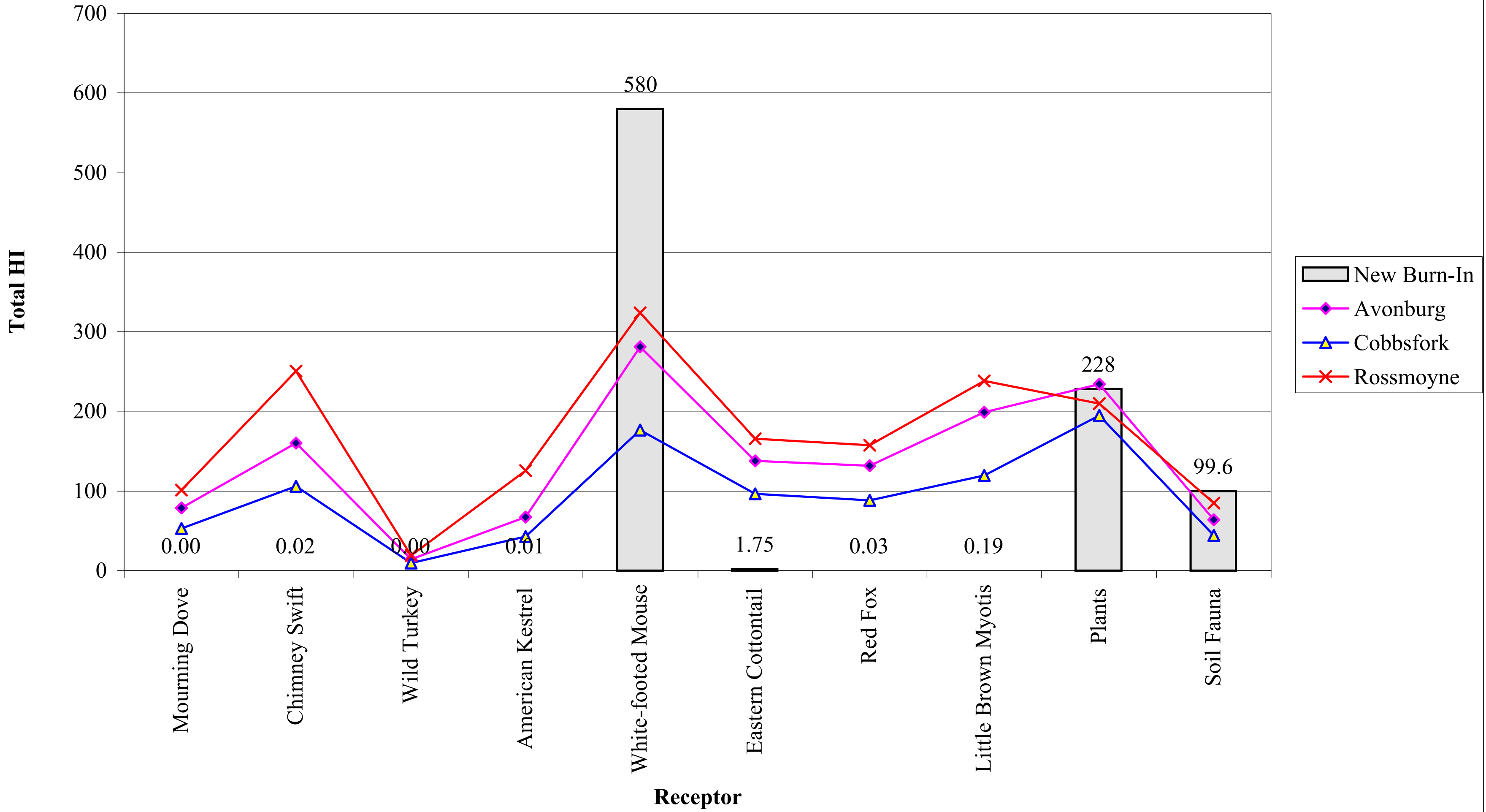
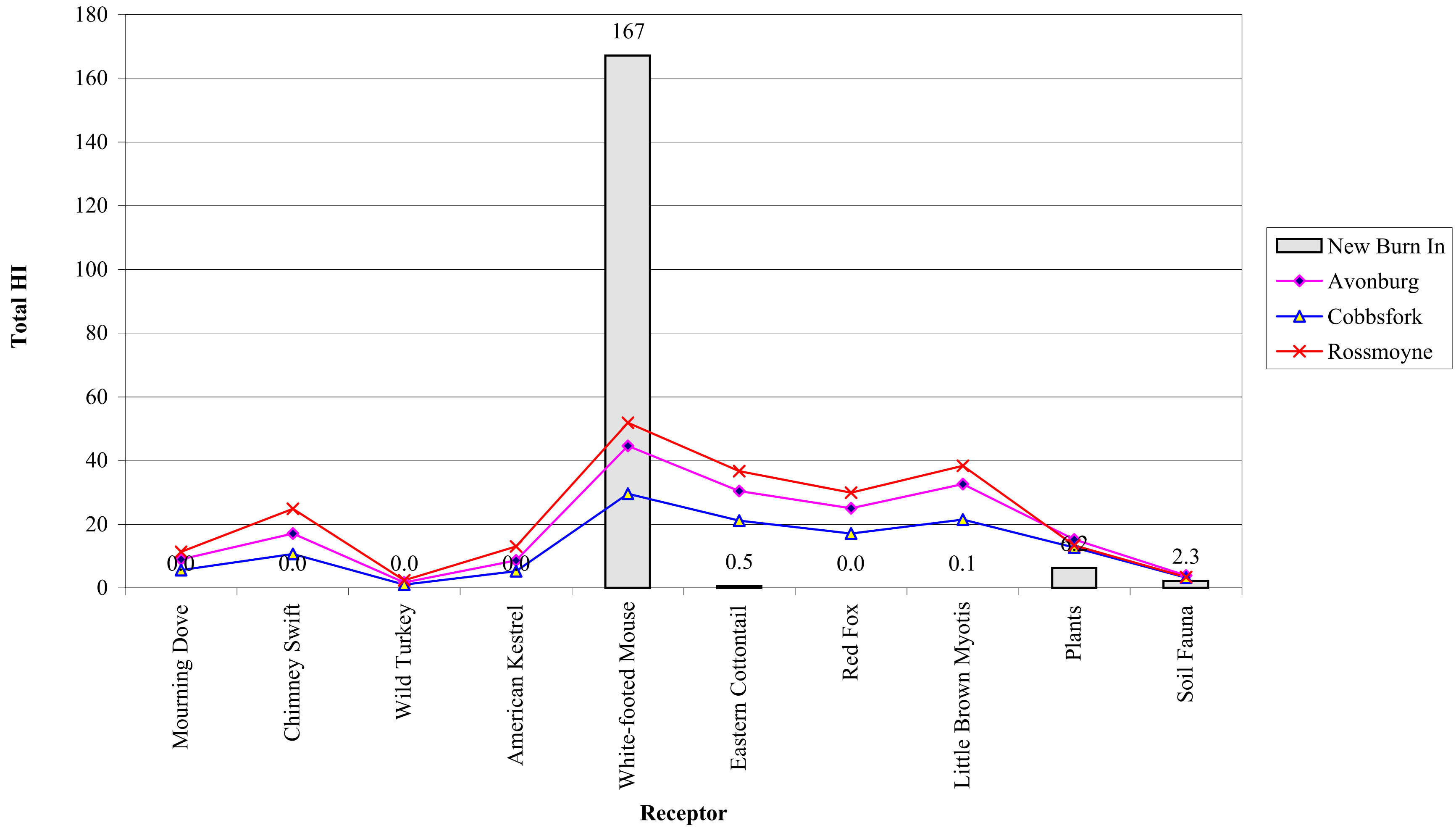
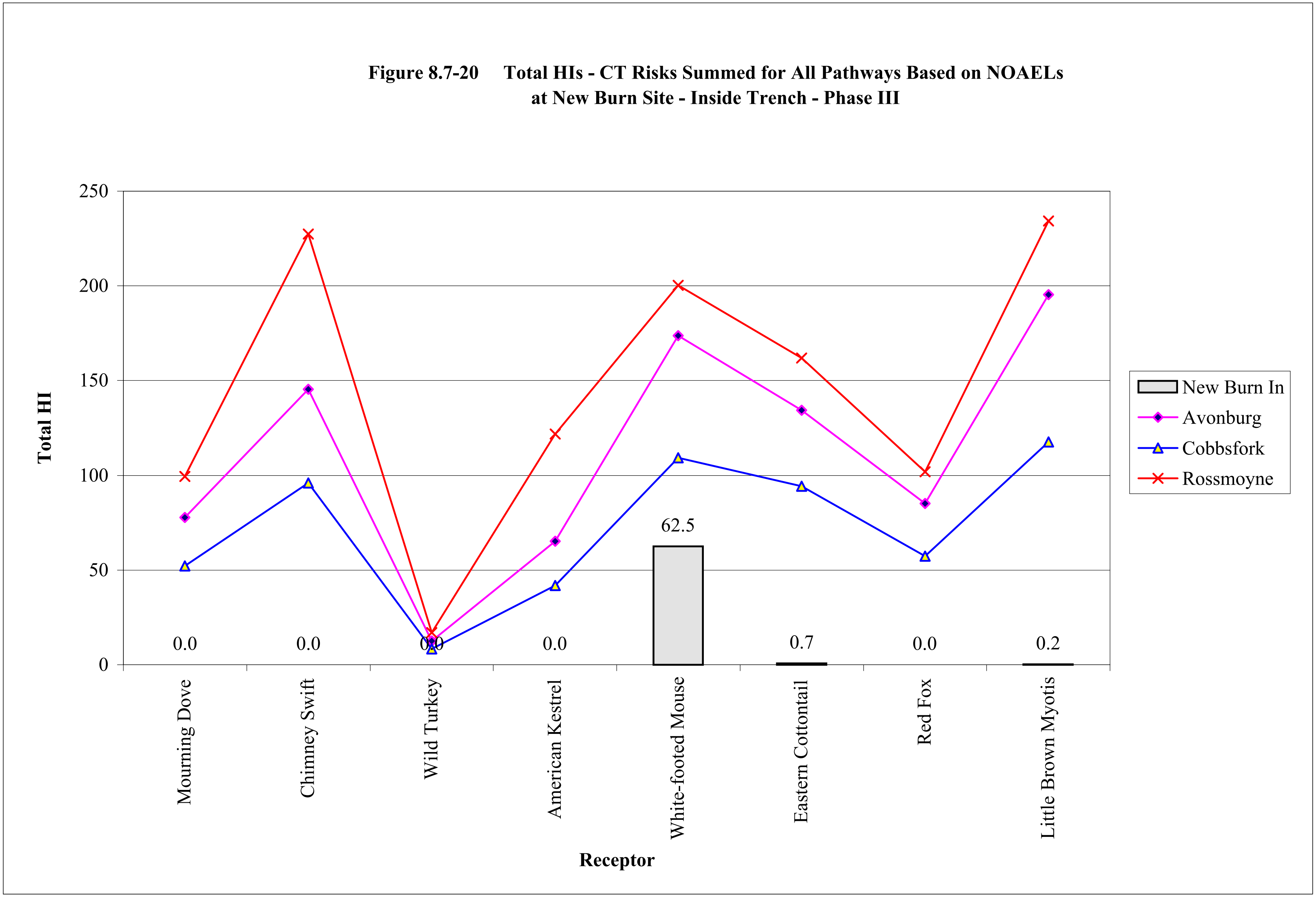


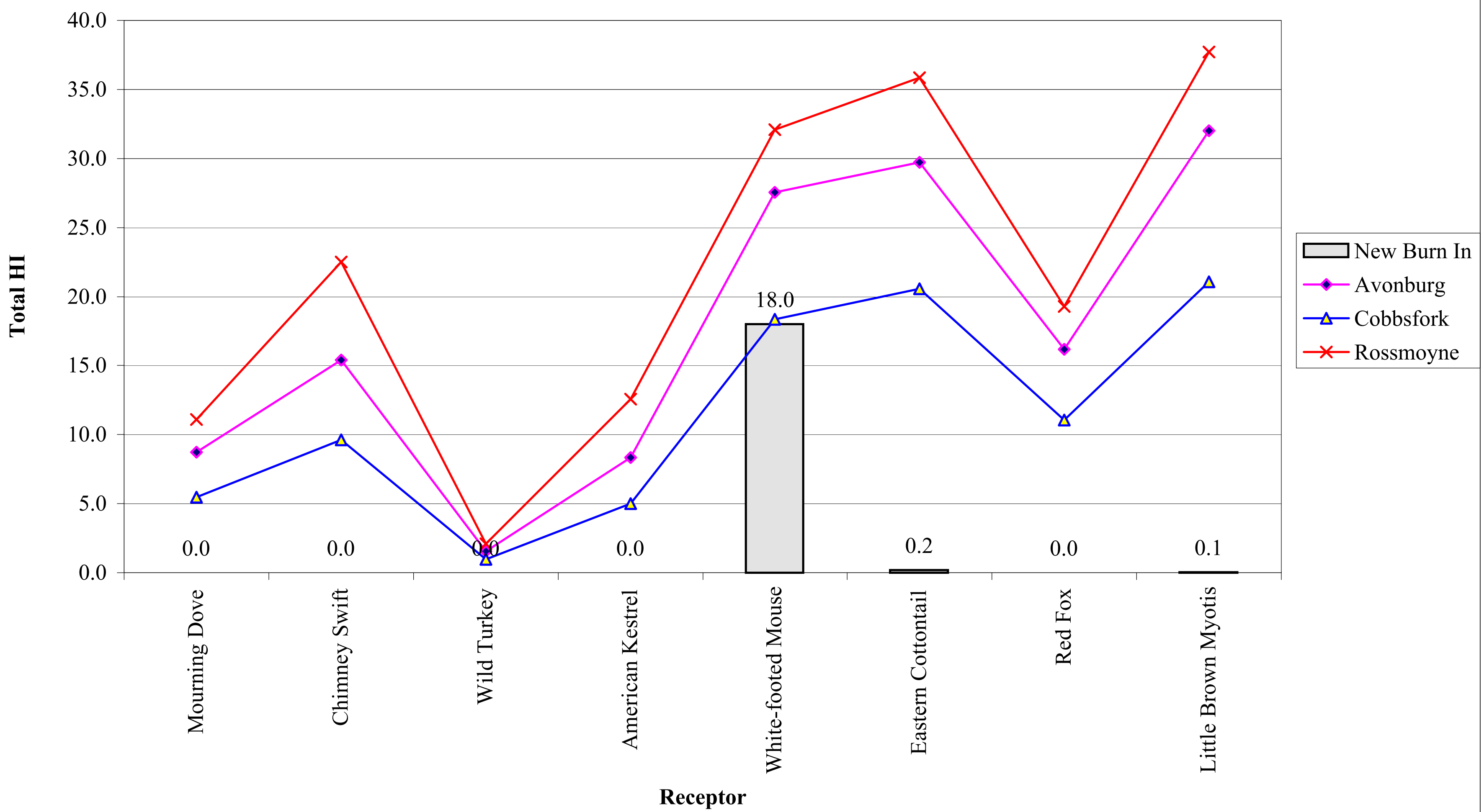
Figure 8.7-19 Total HIs - RME Risks Summed for All Pathways Based on LOAELs at New Burn Site - Inside Trench - Phase III





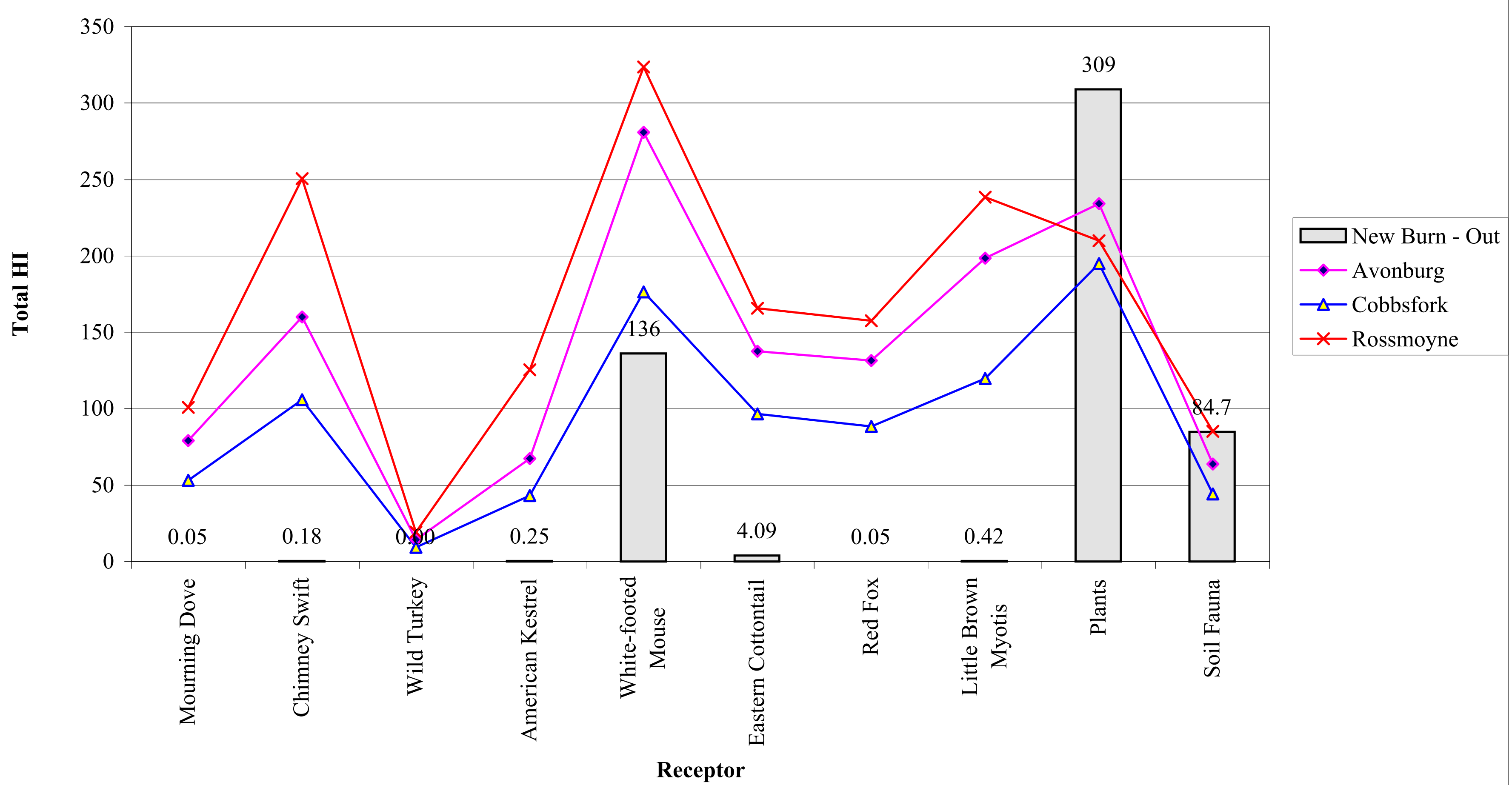
N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase 3\Newburn\Risk2\P3eranbi_MWH.xls Figure 8.7-20

Figure 8.7-21 Total HIs - CT Risks Summed for All Pathways Based on LOAELs at New Burn Site - Inside Trench - Phase III



N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase 3\Newburn\Risk2\P3eranbi_MWH.xls Figure 8.7-21

Figure 8.7-22 Total HIs - RME Risks Summed for All Pathways Based on NOAELs at New Burn Site - Outside Trench - Phase III



N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase 3\Newburn\Risk2\P3eranbo_MWH.xls Figure 8.7-22

Figure 8.7-23 Total HIs - RME Risks Summed for All Pathways Based on LOAELs at New Burn Site - Outside Trench - Phase III

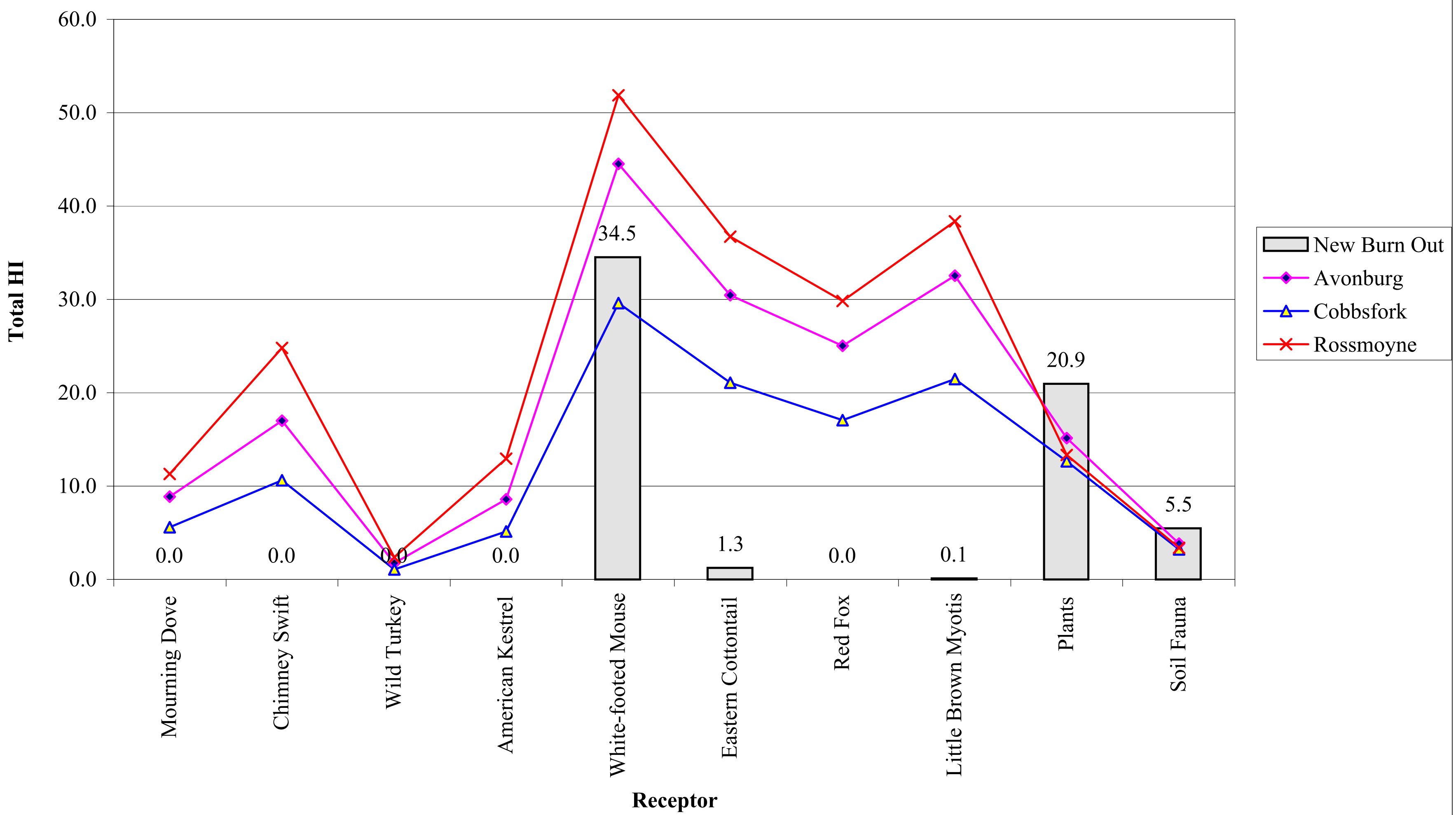
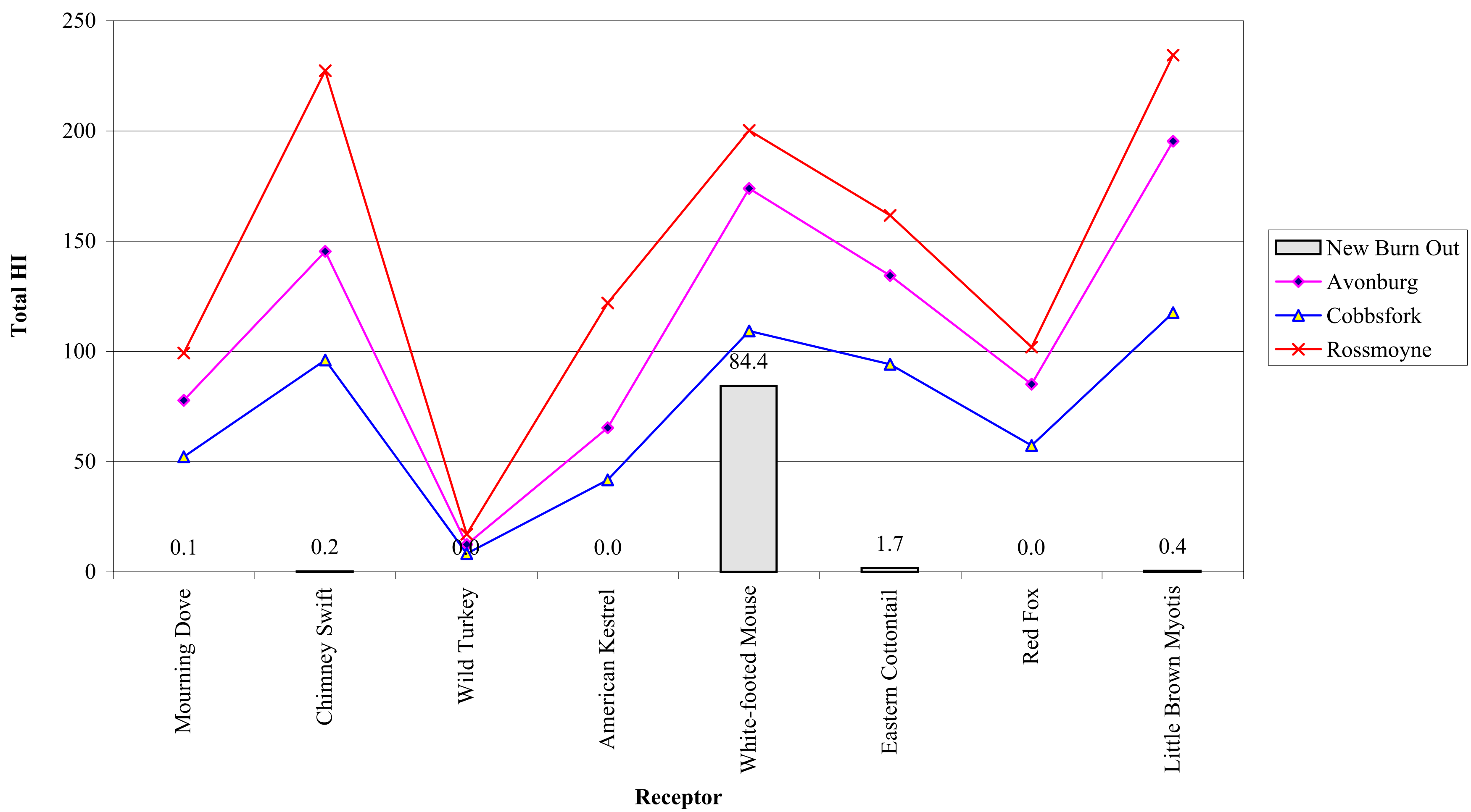
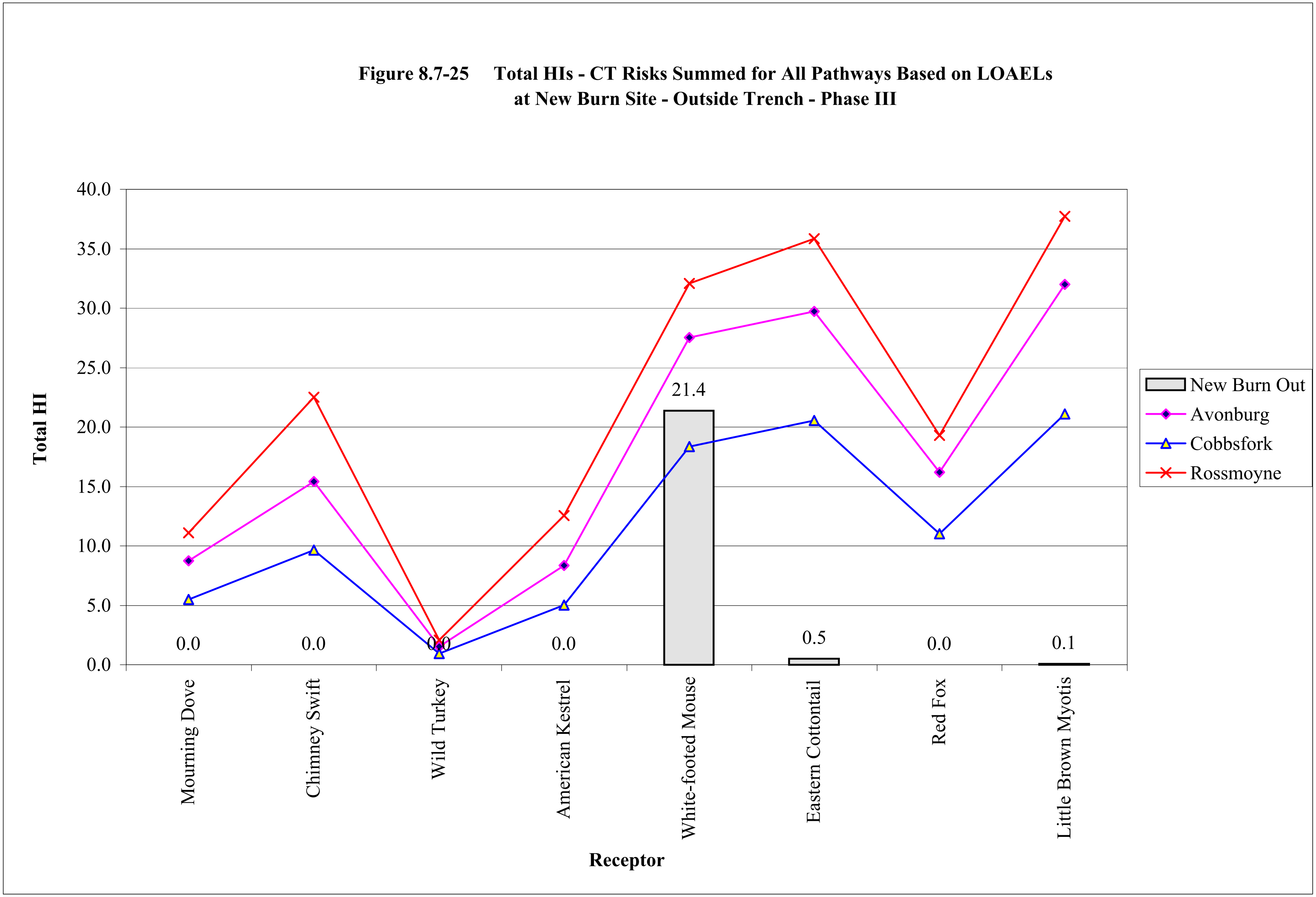


Figure 8.7-24 Total HIs - CT Risks Summed for All Pathways Based on NOAELs at New Burn Site - Outside Trench - Phase III



N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase 3\Newburn\Risk2\P3eranbo_MWH.xls Figure 8.7-24



N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase 3\Newburn\Risk2\P3eranbo_MWH.xls Figure 8.7-25

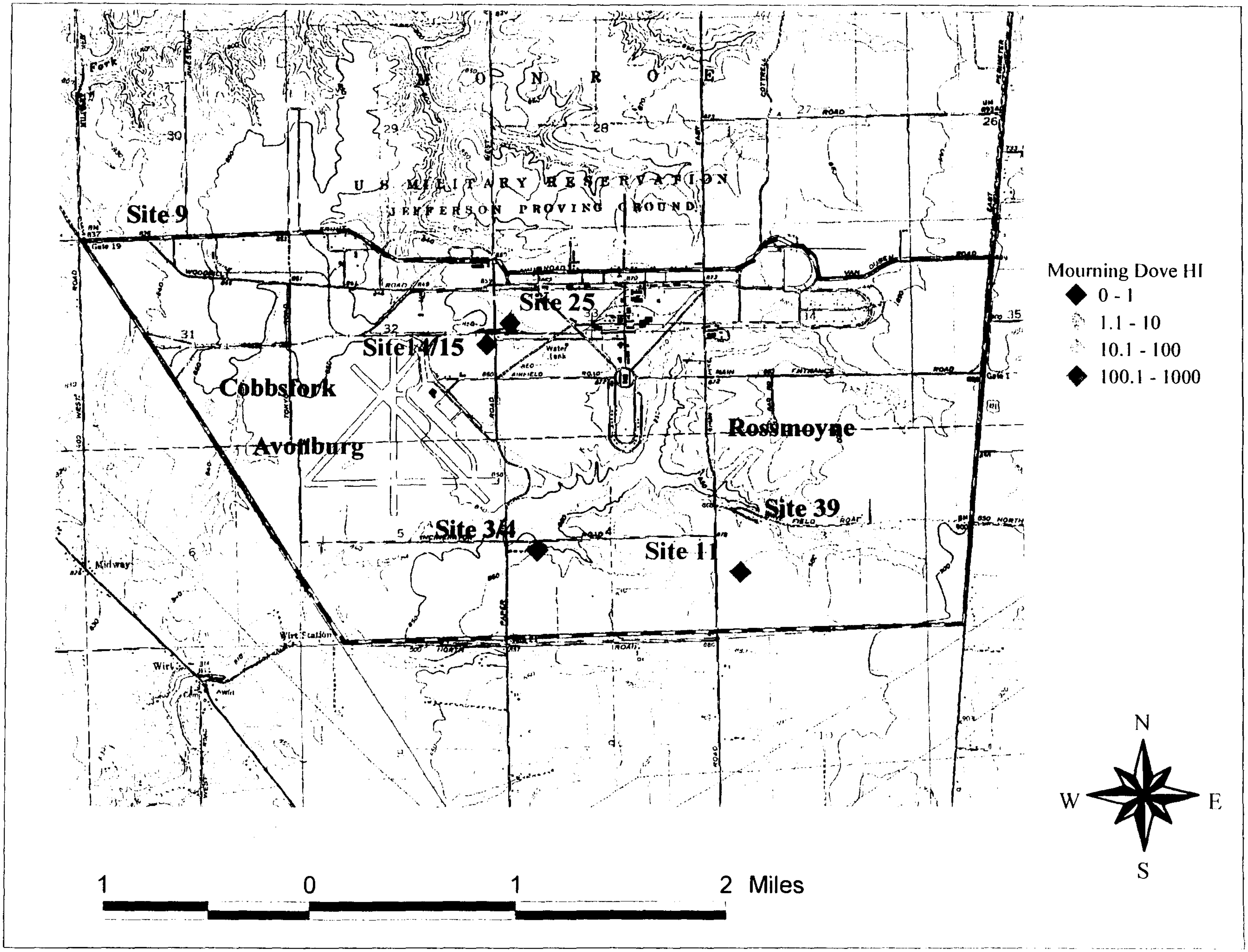


Figure 8.7-26. RME NOAEL HIs by Site for Mourning Dove

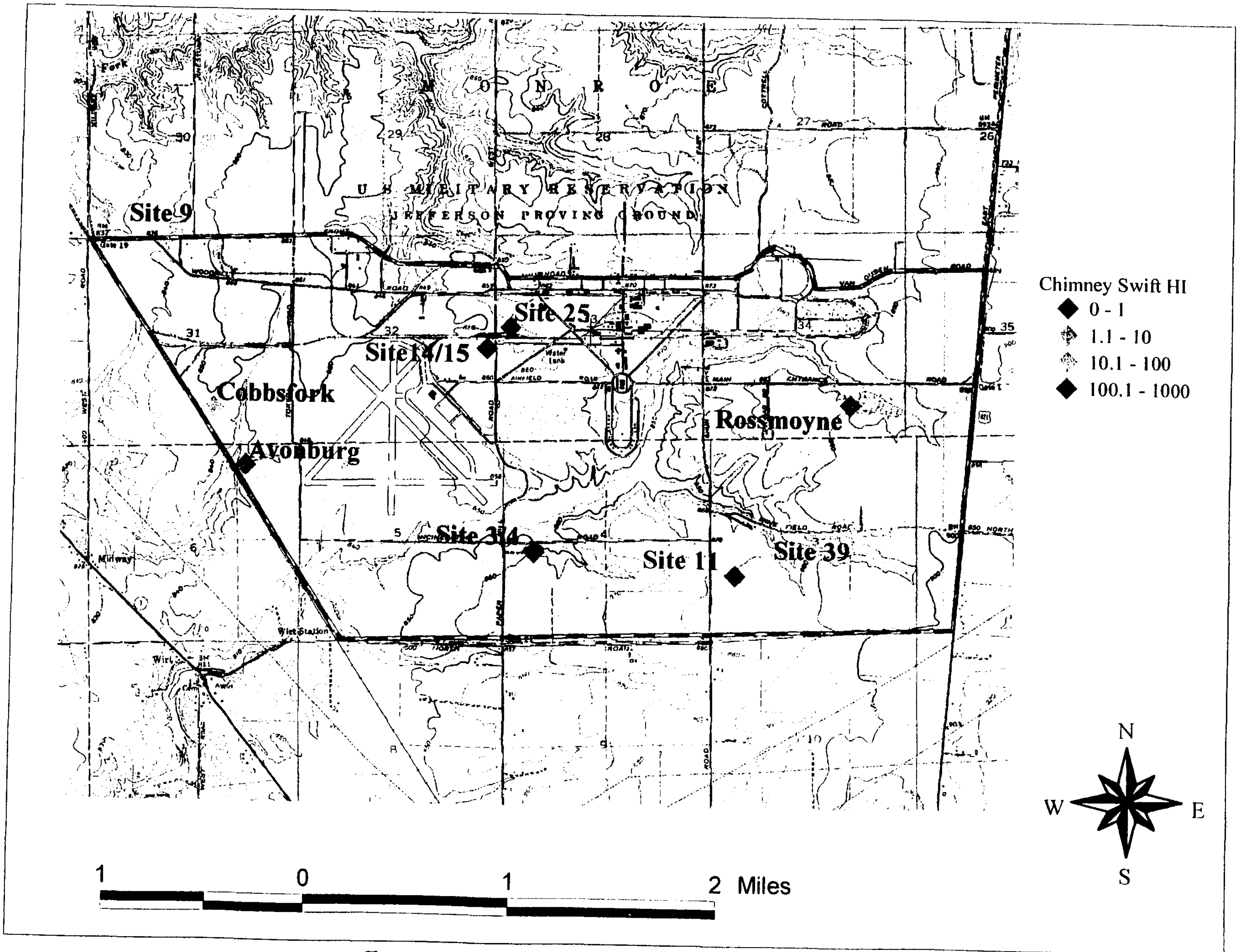


Figure 8.7-27. RME NOAEL HIs by Site for Chimney Swift

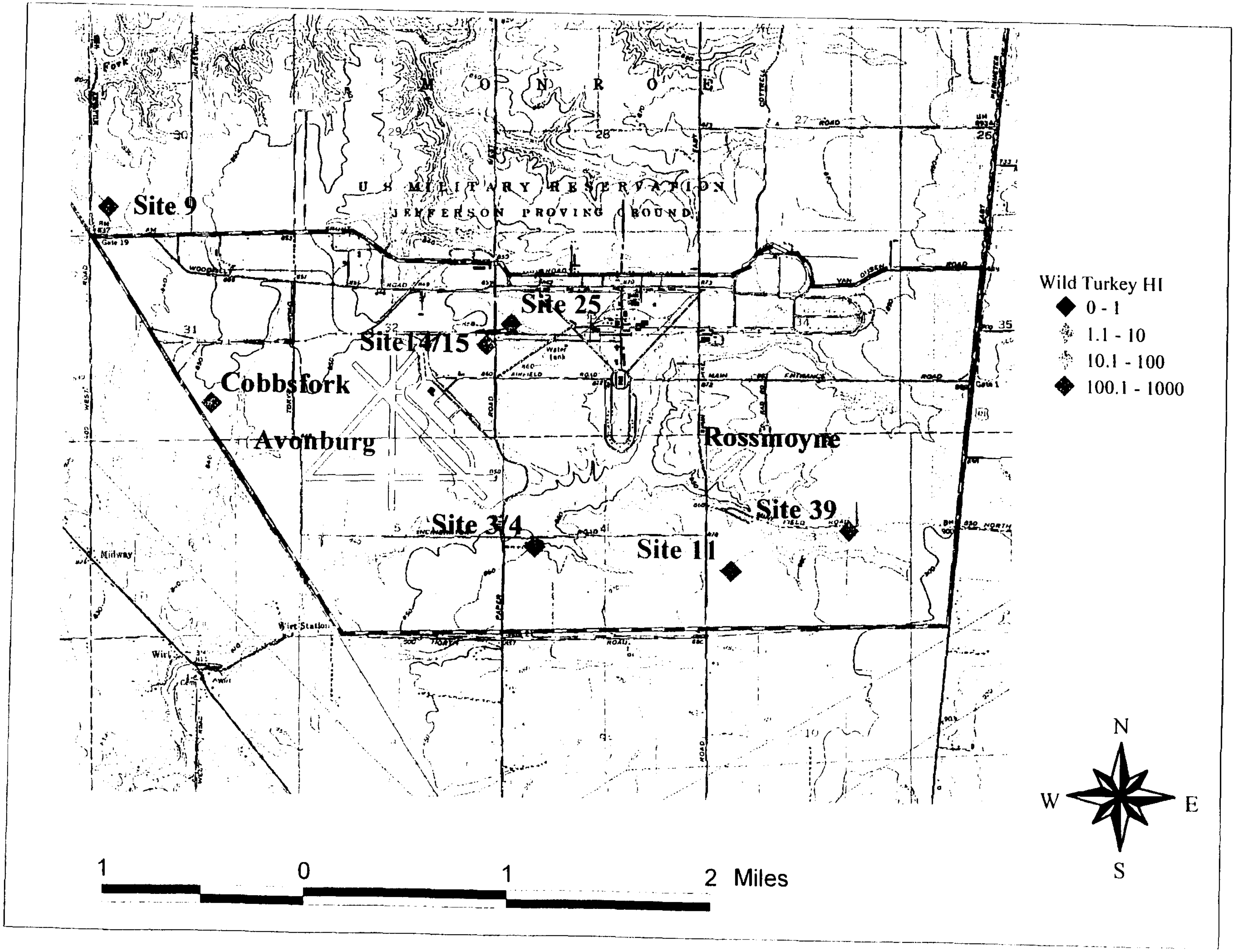


Figure 8.7-28. RME NOAEL HIs by Site for Wild Turkey

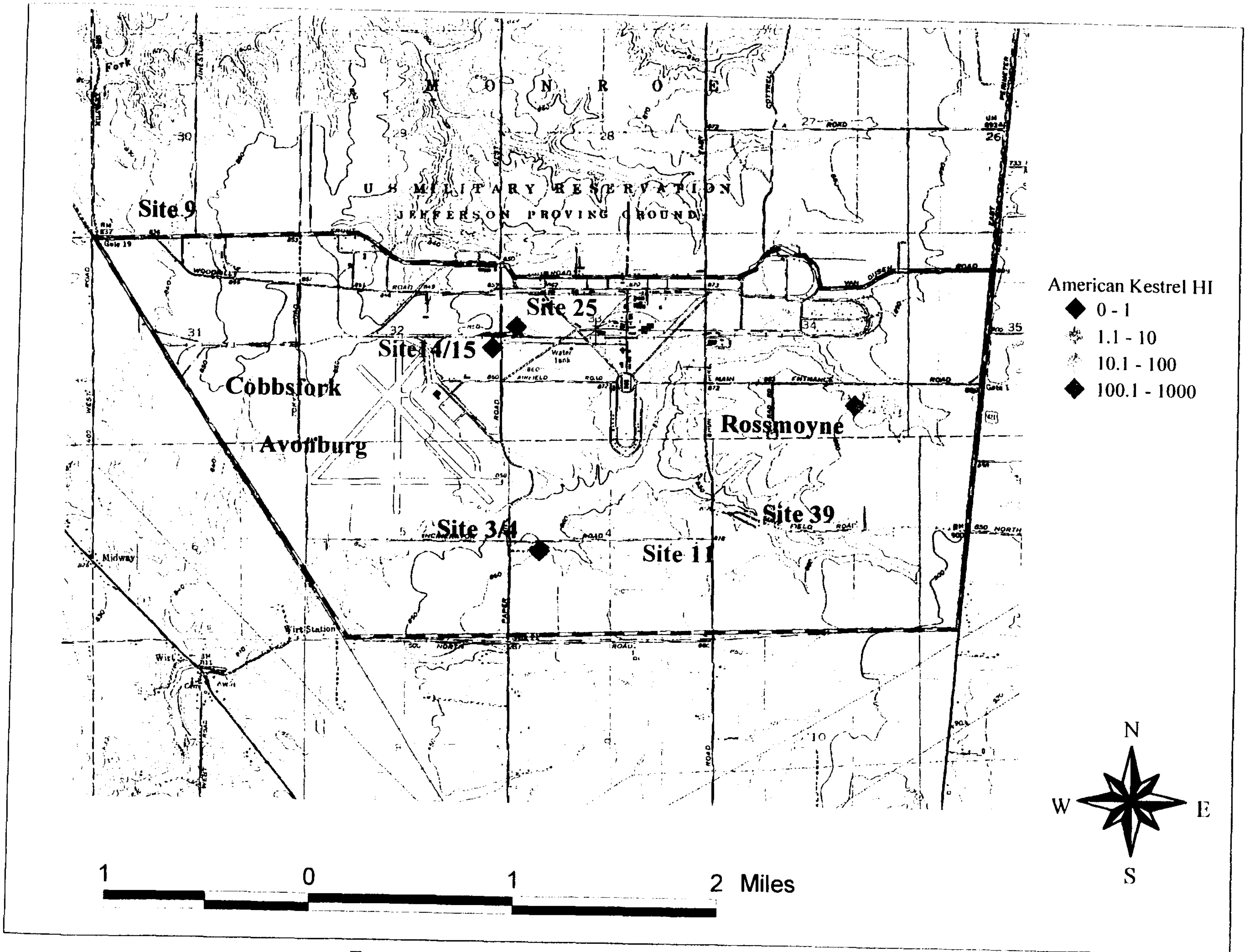


Figure 8.7-29. RME NOAEL HIs by Site for American Kestrel

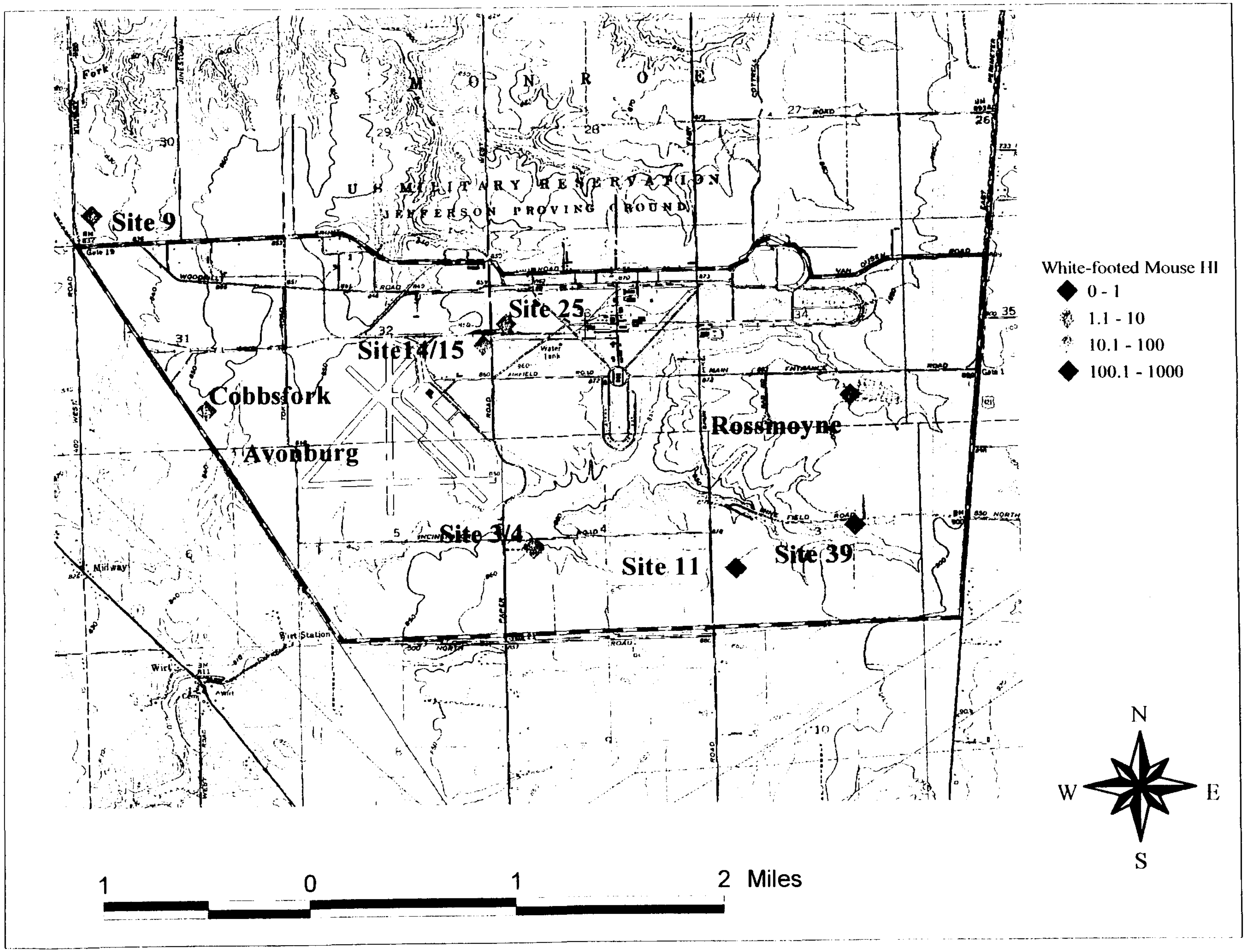


Figure 8.7-30. RME NOAEL HIs by Site for White-footed Mouse

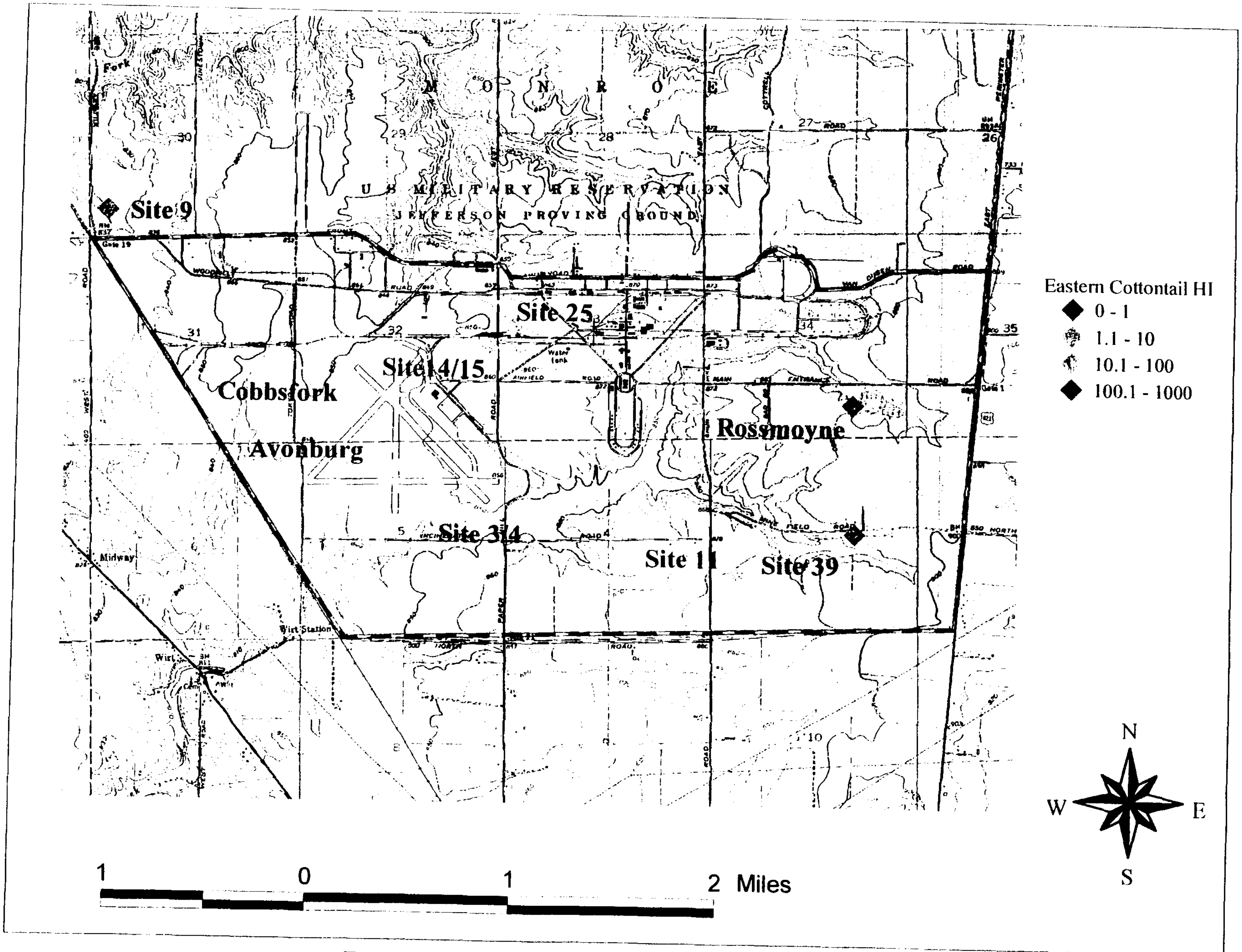


Figure 8.7-31. RME NOAEL HIs By Site for Eastern Cottontail

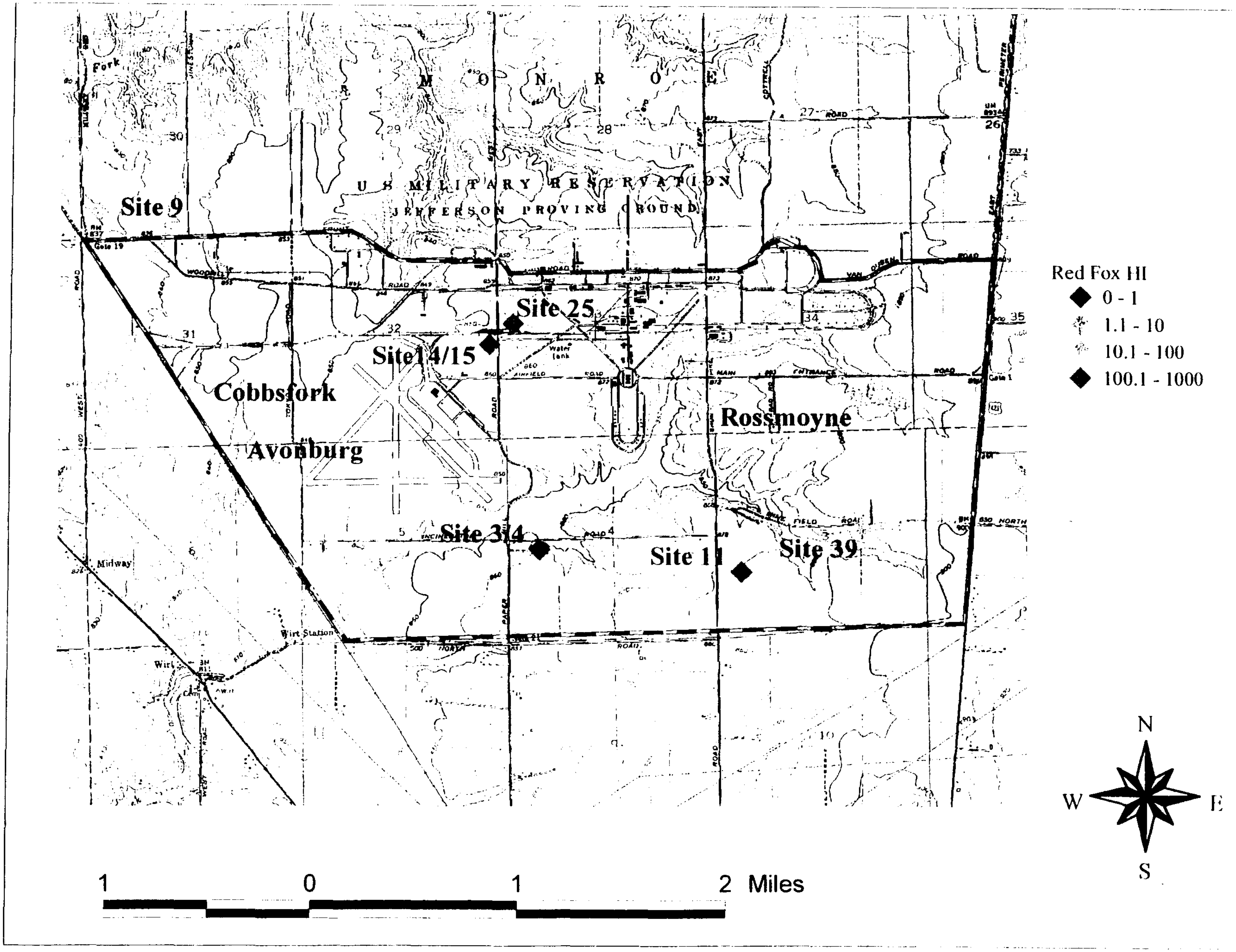


Figure 8.7-32. RME NOAEL HIs by Site for Red Fox

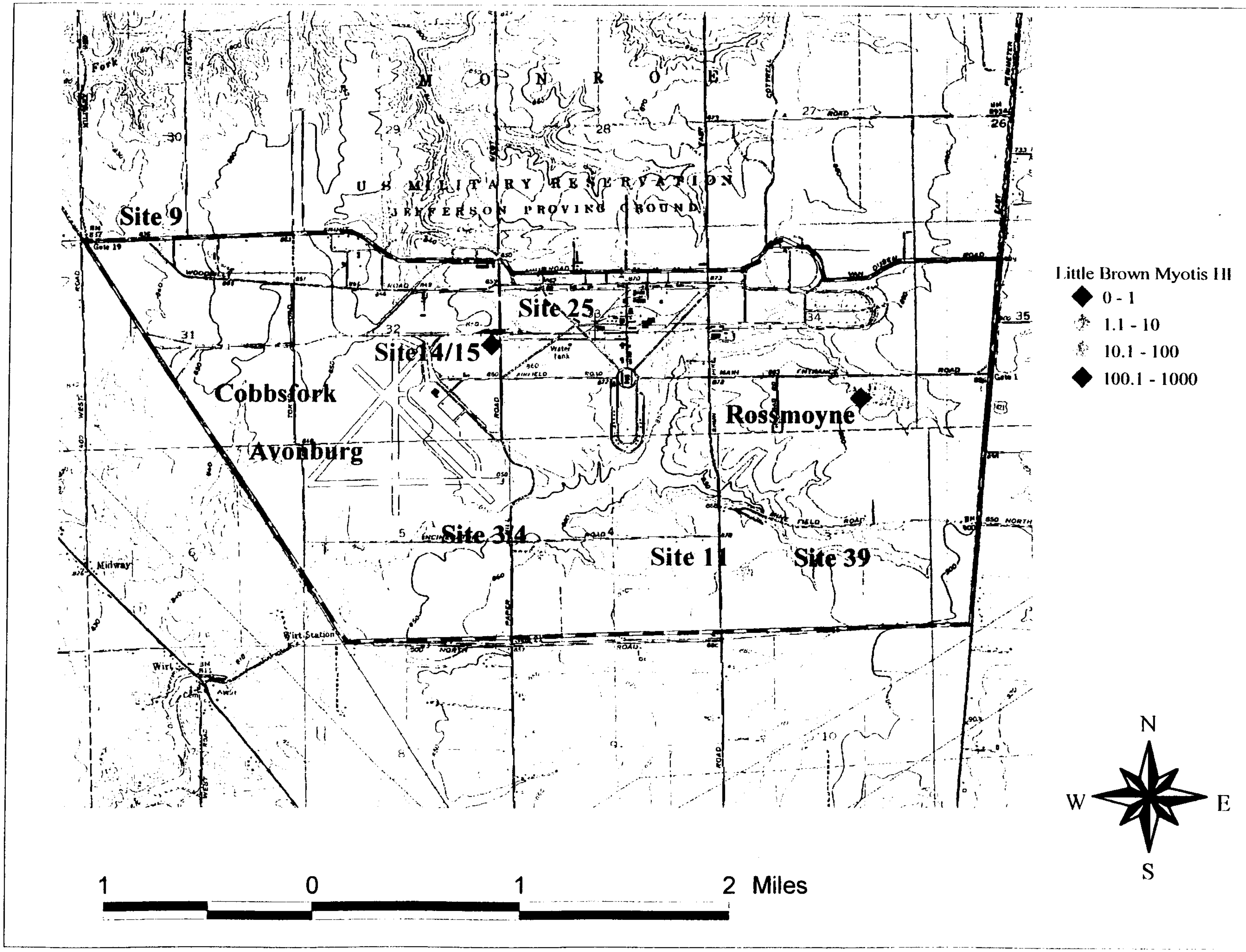


Figure 8.7-33. RME NOAEL HIs by Site for Little Brown Myotis

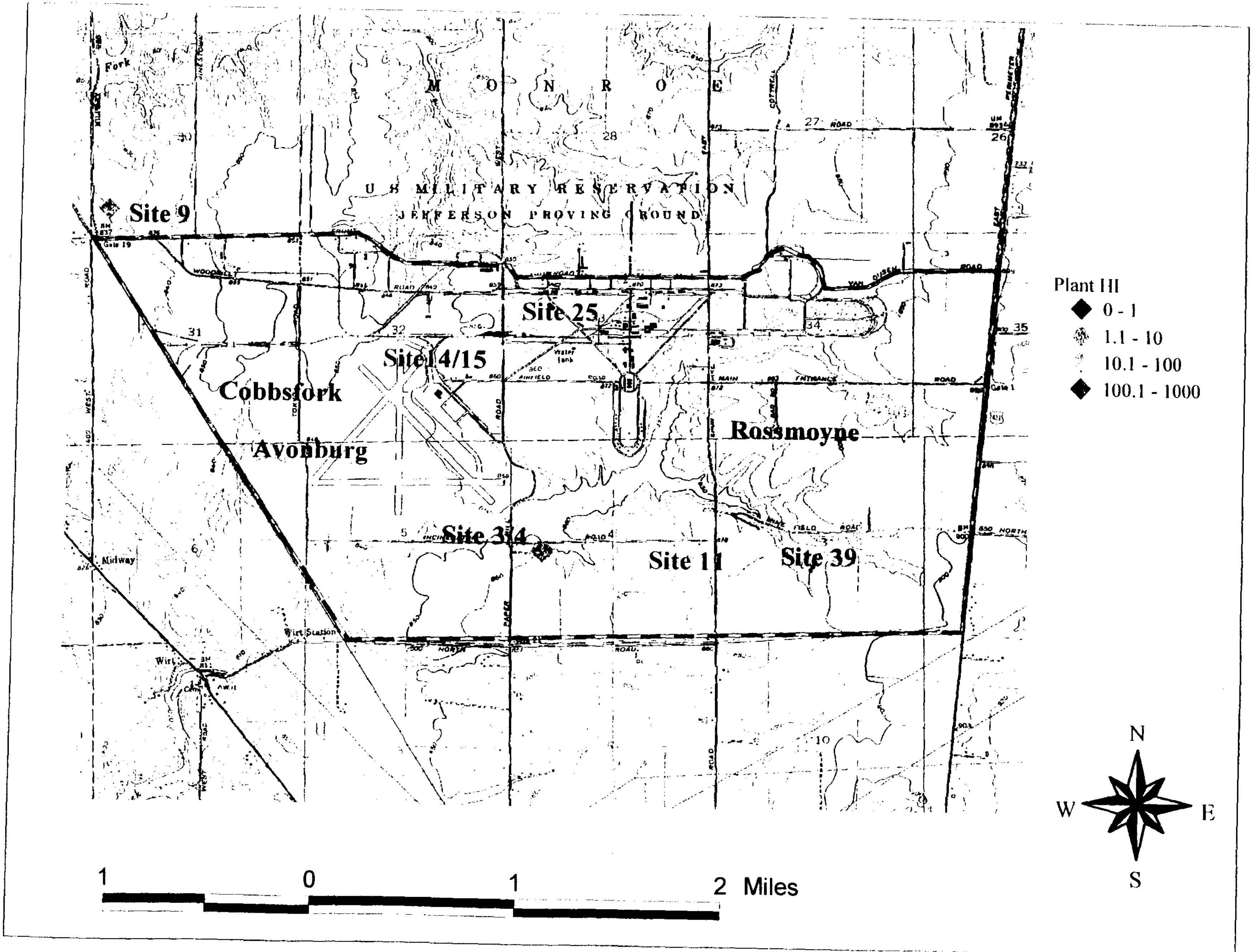


Figure 8.7-34. RME NOAEL HIs by Site for Plants

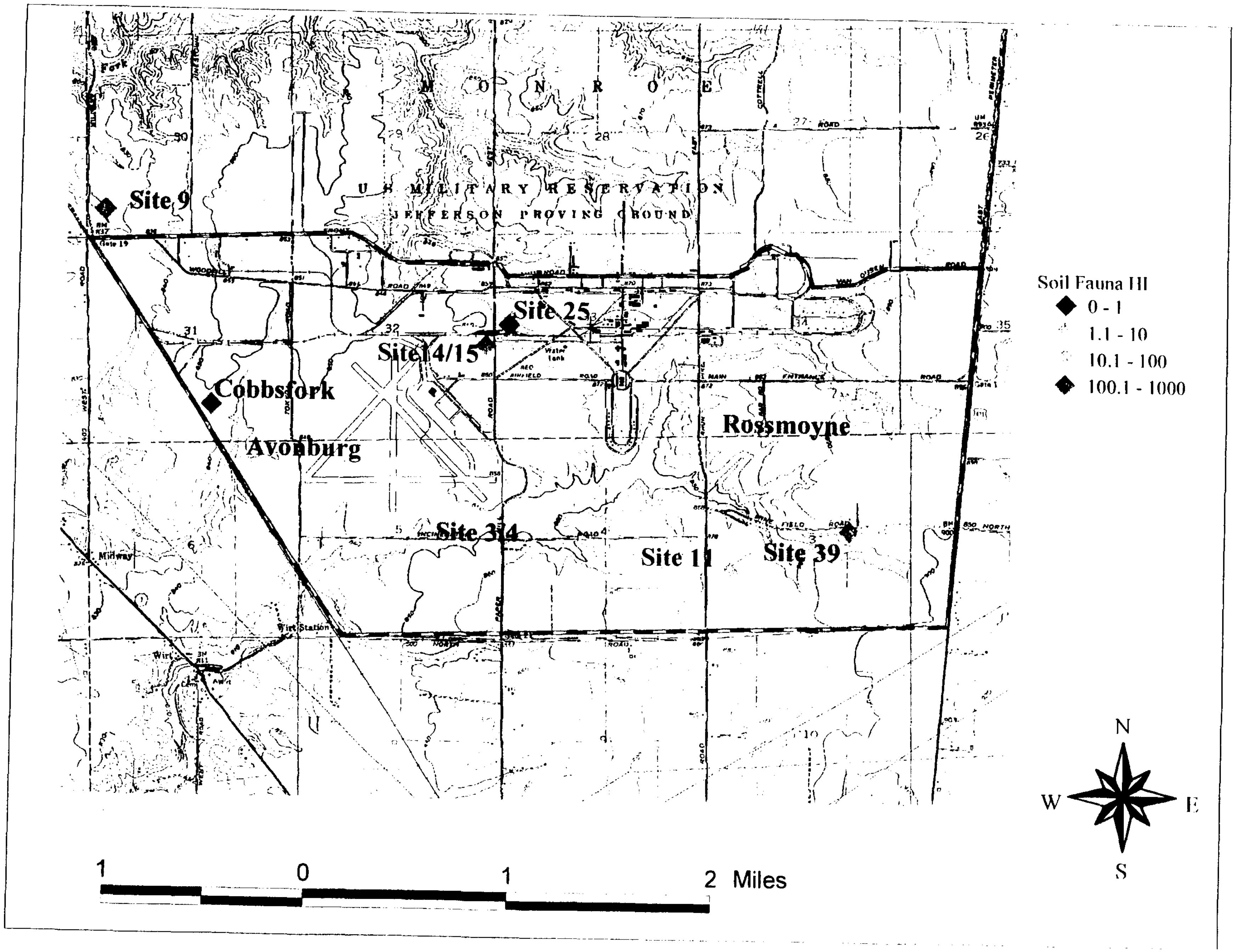


Figure 8.7-35. RME NOAEL HIs by Site for Soil Fauna

9.0 WOOD-STORAGE PILE (SITE 5) AND WOOD-BURNING AREA (SITE 6)

Since the Draft RI was submitted to the agencies, a No Further Action (NFA) Decision Document was finalized proposing NFA for industrial use of the sites. An Addendum was finalized in August 2001 proposing NFA for residential use. Refer to Section 9.8 for additional information. (EPA10, IN15)

9.1 SITE CHARACTERISTICS

These two sites are located near the western side of the former airport at JPG on two abandoned airport runways (Figure 9-1). At the time of the initial site visit, the Wood-Storage Pile consisted of a 10-foot-high used-wood stockpile covering approximately 300 square feet on an abandoned airport runway. The stockpile consisted of wood debris, plywood struts, boxes, pallets, and used crates that had been placed on the runway since about 1975. The second wood pile, referred to as the Wood-Burning Area, was an open-waste pile on the abandoned runway that received pentachlorophenol (PCP)-treated wood from about 1975 through 1993. The size of the pile varied as portions of it were periodically removed for off-site disposal. A portion of the PCP-treated wood pile was reportedly burned as a result of a lightning strike. Thus, it was suspected that residual PCP and dioxin may be present in areas where the wood had burned. Also, an accumulation of ash and subsequent reports by facilities personnel indicated that previous burning of the wood pile had occurred. A more recent practice for PCP-contaminated wood at JPG was to crush the wood and dispose of it in an off-site disposal facility. By the time the facility was closed in 1995, ~~all~~ the previously stored wood debris had been removed from the two sites.

The area is very flat, and surface water runoff is directed into the storm sewer drainage system underlying the airport. The storm water eventually drains south into Harberts Creek (Figure 2-1). The storm sewer outfall into Harberts Creek is a few hundred feet upstream from the Sewage Treatment plant outfall. The area alongside the abandoned runways in the vicinity of the two former woodpile sites is grass covered. There is no regular mowing; however, some of the grassy areas were sometimes included in the previous open burning program at JPG.

The sites are located in an area with soils belonging to the Cobbsfork soil series. The depth to bedrock is unknown because no soil borings or wells were drilled near this area. Based on geologic cross sections, it is projected that the glacial till is about 30 feet thick in this area and is resting on either the Jeffersonville Limestone or Geneva Dolomite, both of Devonian age.

Human activities at the Wood-Storage Pile (Site 5) area during the Phase I RI were intermittent and restricted to personnel loading or unloading scrap lumber at the PCP-treated wood pile. The PCP wood pile was periodically removed to an off-site disposal facility. Use of the other area, the Wood Burning Area (Site 6), had been discontinued by the time of the RI. Currently, the wood piles have been removed and there are no known activities being conducted at either of the two sites.

9.2 PREVIOUS INVESTIGATIONS

Prior to the RI, no known sample data existed for the two wood-storage sites. These sites are listed in the *Enhanced PA Report* (Ebasco 1990a) as SWMUs 7 and 8. This previous investigation included visual site inspections, records searches, and JPG personnel interviews. Based on the initial site characterization, the *Master Environmental Plan* (Ebasco 1990b) recommended that no further action was needed for these two locations. However, because contaminants may have been released and transported to surface soils alongside the abandoned runways via storm water runoff, surface-soil samples were collected at the edge of the runways for confirmation.

9.3 STUDY AREA INVESTIGATIONS

9.3.1 Phase I RI Field Activities

9.3.1.1 Surface Soils. During Phase I of the RI, two surface soil samples were collected adjacent to the runway, one to the north and one south of the wood-storage pile, to determine if a contaminant release had occurred as a result of the storage of contaminated and/or potentially contaminated wood (Figure 9-1). Also, two surface soil samples were collected adjacent to the runway to the west of the wood-burning area to determine if contaminants had migrated to the soils. The four samples were analyzed for VOCs, SVOCs, and dioxins.

Low concentrations of dioxins were present in Phase I surface samples. In addition, SVOCs were detected but the data were found to be suspect due to problems with method sensitivity.

No subsurface soil samples or groundwater samples were collected during Phase I of the RI.

9.3.2 Phase II RI Field Activities

9.3.2.1 Surface Soils. Three additional surface soil samples (and one duplicate) were collected during the Phase II field investigation at locations near the previous samples (Figure 9-1). The Phase II samples were analyzed for dioxins and for SVOCs.

No subsurface soil samples were collected at this site, and no monitoring wells were installed.

9.4 DATA EVALUATION

For Sites 5 and 6, dioxin data were not validated during Phase I. These Phase I data therefore were not included quantitatively in this risk assessment. During Phase II, a Tier 1 review was performed

for the dioxin results. This review showed that ~~all~~ the electronic data results were incorrect because they were corrected twice for percent moisture values. The database was subsequently corrected.

9.4.1 Data Validation Results

9.4.1.1 Blank Assessment. The USEPA has determined that when blank contamination exists, the investigative results must exceed the blank result by a factor of 5 (all compounds) or 10 (common laboratory contaminants such as phthalates) in order to be considered positive. When appropriate, specific sample results associated with blank contamination were changed to nondetects ("U"). None of the Phase I results were qualified not detected. During Phase II, the following results were qualified not detected:

- Soil
  - Di-n-butyl phthalate—BWP06SF003
  - 12378 PeCDD—BWP06SF003

9.4.1.2 Rejected Results. Results for seven SVOCs and the PCBs were rejected during Phase I due to calibration problems. The Phase I SVOC results were not used for the risk assessment other than for qualitative information. During Phase II, one SVOC compound (kepone) was rejected due to low response in the calibration. Non-target (unknown) SVOC compounds were rejected in several analyses due to blank contamination.

The following list identifies rejected sample results:

- Soil

Phase I

- 2,4-Dinitrophenol—BWP06SF001, 002; WDP05SF001, -002
- 2-Chlorophenol—BWP06SF001, -002; WDP05SF001, -002
- Atrazine—BWP06SF001, -002; WDP05SF001, -002
- beta-Endosulfan—BWP06SF001, -002; WDP05SF001, -002
- Chlordane—BWP06SF001, -002; WDP05SF001, -002
- Phenol—BWP06SF001, -002; WDP05SF001, -002
- PCBs (1016, 1221, 1232, 1242, 1248, 1254, 1260, and 1262)—BWP06SF001, -002;WDP05SF001, -002
- Toxaphene—BWP06SF001, -002; WDP05SF001, -002

Phase II

- Kepone—WDP05SF004; BWP06SF003
- Unknown (UNK)536—WDP05SF004; BWP06SF003
- UNK537—WDP05SF003, -04
- UNK538—WDP05SF003, -04

9.4.1.3 Evaluation of Non-Detected Values. A comparison was made between the USEPA Region 5 DQLs and the project CRLs for chemicals that were analyzed for but not detected in environmental media at this site, and no exceedances were identified.

9.4.2 Data Quality Summary

A number of Phase I soil sample SVOC, ~~results (including~~ PCBs, and some pesticides ~~)~~ results were rejected due to calibration problems. Resampling and analysis for these compounds during Phase II showed that, with the exception of low concentrations of a few noncarcinogenic PAHs and di-n-butyl phthalate, SVOCs are not present in soils at this site. Therefore, the rejected SVOC data do not significantly impact the conclusions of the risk assessment. Blank contamination also does not impact the conclusions of the risk assessment.

In summary, the number of samples, the comprehensiveness of the parameter list, and the quality of the data are adequate to characterize the nature and magnitude of soil contamination at the exposure areas addressed in the risk assessment.

9.4.3 Background Screening

9.4.3.1 Surface Soil. None of the samples collected in soil at this site were analyzed for inorganic constituents. Background screening was therefore not required for metals. Because chlorinated dioxins and furans were detected in surface soils at Sites 5 and 6, a comparison was made between site concentrations of these compounds and background concentrations to determine if the congeners detected in soil at this site are likely related to site activities or are consistent with anthropogenic background in the area. This comparison was performed in two steps.

First, the profiles of the congeners within the individual samples collected at this site were compared to the profiles of the congeners in the five background samples (BKG51SF036, -37, -38, -38, and -40). In general, the lower chlorinated congeners degrade quickly in the environment, leaving behind the higher chlorinated congeners which can persist for hundreds of years (Bumb *et al.* 1980; Nestrick *et al.* 1986; Smith *et al.* 1983). For comparison purposes, bar graphs, which are presented in Figures 9-2a, 9-2b, 9-2c, and 9-2d, were constructed using *total* concentrations of each of the various congeners within a sample. Although the graph scale is different for each sample, the graphs are presented only to illustrate the overall pattern of the congener distribution within the samples, not to compare total dioxin/furan concentrations among the samples. The background samples show the typical pattern in which the hepta- and octa-congeners predominate. In the site samples, the hepta-congeners predominate with few octa-congeners, somewhat different than background.

For the second type of comparison, the concentrations of each of the congeners were converted into 2,3,7,8-TCDD-equivalent concentrations using USEPA-recommended TEFs, as described in Section 5.1.6.3.1. The 2,3,7,8-TCDD-equivalent detected concentrations were then summed to derive a total 2,3,7,8-TCDD-equivalent concentration for each sample. Since there were seven site samples that were analyzed for dioxins/furans, the t-test was used to compare the concentrations of

TCDD-equivalents detected in site surface soil to the concentrations detected in background. The results of the background screening procedure for dioxins/furans in surface soil at Sites 5 and 6 are shown in Table 9-1. This test indicates that the concentrations of dioxins/furans in soil at these sites are similar to the concentrations of these analytes found in background soils at the facility.

As a result of the background screening, dioxins are retained in surface soil as preliminary COPCs; however, their presence may or may not be a result of facility-related activities.

9.4.3.2 Other Environmental Media. No other environmental media at Site 1 are considered to be potentially impacted by the previous activities at the Wood Storage Pile and Wood Burning Area.

9.4.4 Summary of Analytical Results

Table 9-2 summarizes the Phase I analytical results for surface soil samples collected at Sites 5 and 6. Table 9-3 summarizes the Phase II analytical results for surface soil samples collected at Sites 5 and 6. These tables include only contaminants that were detected in at least one sample for a specific media. A comprehensive~~plete~~ listing of ~~all~~ analytical results, including nondetected and below reporting limit analytes, is presented in Appendix N.

9.5 NATURE AND EXTENT OF CONTAMINATION

9.5.1 Surface Soil

The two samples collected for the Wood Burning Pile during Phase I contained several dioxin compounds~~, all~~ at very low concentrations (Table 9-2). Although it was not detected in ~~any of~~ the samples, only TCDD has an USEPA Region 9 criteria (0.0000038 µg/g). TCDD equivalent concentrations for the OCDDs detected at this site (0.010 and 0.0061 µg/g) can be obtained using the USEPA dioxin TEFs (USEPA 1989g). This conversion yields concentrations of 0.000010 and 0.0000061 µg/g, respectively. The result from sample 2 (0.0000061 µg/g) is comparable to USEPA Region 9 criteria for TCDD. The concentration detected in sample 1 (0.000010 µg/g) is higher than this criteria. However, OCDD was also detected in the method blank associated with sample 1 at 0.00043 µg/g. This method blank concentration does not ~~warrant~~necessitate eliminating that data for sample 1 but does indicate that 0.010 µg/g may be elevated due to interferences associated with laboratory operations. Subtracting the concentration detected in the method blank from 0.010 µg/g would yield a TCDD equivalent concentration of 0.0000096 µg/g for sample 1 OCDD, which is comparable to the Region 9 TCDD criteria. Additionally, congener pattern and concentrations measured in these samples are both similar to background dioxins in uncontaminated areas (Section 5.1.4.5.3). Samples 1 and 2 also contained low levels of di-n-butyl phthalate. ~~There were no~~ VOCs were not detected in these samples.

As mentioned above, two Phase I samples collected for the Wood Storage Pile contained a dioxin compound, octachlorodibenzodioxin (OCDD), at concentrations of 0.0052 and 0.0053 µg/g. TCDD

equivalent concentrations for these OCDD levels can be obtained using the USEPA dioxin TEFs (USEPA 1989g). When this conversion is made, concentrations of 0.0000052 and 0.0000053 µg/g are obtained. These levels are then comparable to USEPA Region 9 criteria for TCDD. The presence of OCDD may indicate that either treated wood had been burned at this site or that ash from the Wood Burning Pile may have blown into the area. However, the levels observed are less than the USEPA criterion. Another dioxin compound, 1,2,3,4,5,6,7,8-heptachlorodibenzo-*p*-dioxin, was detected in sample 2 at a concentration of 0.0002 µg/g. Conversion of this concentration to TCDD equivalents leads to a soil level of 0.000002 µg/g. This too is below the Region 9 criteria for TCDD. Di-n-butyl phthalate was detected in sample 2 at a low level but no USEPA Region 9 criteria exist for this compound.

Results for the four additional surface soil samples collected during Phase II (see Figure 9-1) show that OCDD concentrations (ranging from 0.00809 to 0.0157) exceed the equivalent USEPA Region 9 criteria for TCDD. One detection of OCDF also just exceeded the equivalent TCDD criteria. It should be noted, however, that similar concentrations of OCDD were found in the background samples collected for dioxins at JPG (Table 9-3).

In summary, ~~no~~ VOCs were not detected in ~~any of~~ the seven samples from these two sites and none of the SVOCs detected exceeded regulatory criteria. Although dioxins were detected in ~~all~~ the seven samples, these congeners are consistent with background concentration. Additionally, TCDD-equivalent concentrations for these cogeners for three of the samples fall below USEPA Region 9 criteria, while the fourth sample is just above this criteria. It is important to note that the only Phase I sample that exceeded this criteria also showed a dioxin concentration in the associated method blank. Given the concentrations (0.0052 to 0.0061 µg/g) that are similar to background levels, it is unlikely that there is a dioxin contamination problem at these sites.

9.6 HUMAN HEALTH RISK ASSESSMENT

Since the Draft RI was submitted to the agencies, a No Further Action (NFA) Decision Document was finalized proposing NFA for industrial use of the sites. An Addendum was finalized in August 2001 proposing NFA for residential use. Based on these Decision Documents, no additional work is required at Sites 5 and 6, and so the sites will not go forward to the FS stage. Considering this, the results of the risk assessment have not been revised since the Draft RI. Rather any additional risk assessment work since the Draft RI is documented in the Decision Documents. Refer to Section 9.8 for additional information concerning the NFA Decision document.

9.6.1 Selection of the Contaminants of Potential Concern for Sites 5 and 6

9.6.1.1 Surface Soil.

9.6.1.1.1 Data Grouping. For the purposes of the risk assessment, the seven samples collected at Site 5 and Site 6 were grouped together. No obvious hot spots of contamination were evident.

9.6.1.1.2 Frequency of Detection. Evaluation of frequency of detection was not undertaken at this site because of too few samples.

9.6.1.1.3 Nutrient Screening. Surface soil samples at this site were not analyzed for inorganic constituents. Therefore, no nutrient screening was required.

9.6.1.1.4 Summary of Preliminary COPCs. Table 9-4 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95% UCL of the mean, and the exposure point concentration for each preliminary COPC in soil at Sites 5 and 6. Preliminary COPCs are constituents that are detected above background in more than 5 percent of samples.

9.6.1.1.5 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for each preliminary soil COPC was compared to the chemical-specific Region 9 residential soil PRG (Table 9-5). One-tenth of the PRG was used for most noncarcinogens. The exceptions were values for noncarcinogens that were based on soil saturation limits. For these noncarcinogenic chemicals the full PRG was used. As a result of the screening, only dioxins/furans were ***retained*** as COPCs in surface soil at Sites 5 and 6 (Figure 9-3).

9.6.1.2 Air.

9.6.1.2.1 Summary of Preliminary COPCs. Ambient air concentrations, to which future receptors at these sites might be exposed, were estimated using air emission/dispersion modeling, as described in Appendix R. In the site-specific conceptual model, discussed below in Section 9.6.2.1, Sites 5 and 6 are evaluated under two future site-specific scenarios: as a residential site and as an industrial site.

In the future industrial land use scenario for the facility, ~~all~~ the sites were assumed to be industrial, except for the five sites designated agricultural sites. Each site with particulate-bound COPCs in surface soil (metals, SVOCs, and dioxins/furans) and/or volatile COPCs in surface/subsurface soil combined was assumed to contribute to the air concentrations at ~~all of~~ the sites. In the future residential scenario for the facility, ~~all~~ the sites were assumed to be residential except for the five sites designated agricultural. It was assumed that particulate and VOC emissions from the strictly residential sites would be negligible because the home sites would be covered with dense vegetation (lawns) and pavement. Therefore, under this residential scenario only the five agricultural sites contribute to the air concentrations at ~~all of~~ the sites. The list of preliminary air COPCs is therefore the same for every site for a given scenario, but the concentrations of the COPCs vary. Tables R-4 and R-6 in Appendix R present the estimated ambient air concentrations at Sites 5 and 6 under the future industrial and residential scenarios, respectively.

9.6.1.2.2 Region 9 Preliminary Remediation Goal Screening. The exposure point concentrations for each preliminary air COPC at Sites 5 and 6 in the future residential scenario and the future industrial scenario were compared to chemical-specific Region 9 air PRGs (Table 9-6). One-tenth

of the PRG was used for noncarcinogens. The exception was lead, for which the full PRG was used. As a result of the screening, aluminum, chromium, silver, thallium, vanadium, and zinc are retained as COPCs in air for future on-site residents. For future on-site workers, the following chemicals were retained as COPCs in air: aluminum, chromium, silver, thallium, vanadium, and zinc.

9.6.2 Exposure Assessment

9.6.2.1 Site Conceptual Model. There are no people known to ~~who~~ specifically work at or frequent Sites 5 and 6. There are, however, several types of individuals who could potentially be affected by the existing contamination at the facility. These are current trespassers to JPG, off-facility (nearby) rural residents, and future hunters. In each case, these individuals would most likely be impacted simultaneously by multiple sites rather than by single units. Because of this, these current receptor populations are addressed on a facility-wide, cumulative basis rather than by specific sites (see Sections 28 and 29).

Therefore, this site-specific exposure scenario only addresses future land use development. Sites 5 and 6 have two potential future land uses forwarded for evaluation:

- Residential
- Industrial

Residential Use. Under the future residential land use scenario, these sites are assumed to be developed for residential purposes, with the supposition that a family would build a house directly on or within this area of potential concern.

With respect to a risk assessment analysis, resident populations were assumed to consist of both adults and toddlers. Each individual would be expected to come in contact with site contaminants via the following pathways at Sites 5 and 6:

- Inhalation of VOCs and fugitive particulates from soils
- Dermal contact with soil while gardening/playing outdoors
- Incidental ingestion of soil while gardening/playing outdoors
- Ingestion of fresh homegrown fruits and vegetables

On-site Worker. Industrial land use is considered to be a plausible future option for this site at JPG. On-site industrial workers (adult males and females) are assumed to be individuals who could be exposed directly to contaminated media through the following pathways at Sites 5 and 6:

- Inhalation of VOCs and fugitive particulates from soils

- Incidental ingestion/dermal contact with soil

9.6.2.2 Exposure Point Concentrations.

9.6.2.2.1 Air. The estimated ambient air concentrations of COPCs at these sites for the future on-site residents and the future on-site workers are presented in Table 9-6.

9.6.2.2.2 Soil. The concentrations of COPCs in surface soil at these sites are presented in Table 9-5. No subsurface samples were collected at Sites 5 and 6.

9.6.2.2.3 Fruits, Vegetables, and Crops. COPC concentrations in homegrown fruits and vegetables were estimated using the methods described in Section 5.1.5.2.8. Appendix U, Table U-4, documents the calculation of contaminant concentrations in fruits and vegetables at Sites 5 and 6.

9.6.2.3 Human Exposure Doses.

9.6.2.3.1 Inhalation of Contaminated Air. Inhalation of airborne contaminants (VOCs and particulates) is a potential route of exposure for future on-site residents (adults and children) and future on-site workers at this site. The equation used for calculating human exposure doses of contaminants of potential concern due to inhalation of volatile and dust-bound contaminants is provided in Section 5.1.5.3.1, Table ~~5-12~~5-11. Table V-4, Appendix V, documents the calculation of human exposure doses at Sites 5 and 6 due to inhalation of contaminated air.

9.6.2.3.2 Incidental Ingestion of Contaminated On-site Soil. Mouthing behavior (toddlers) and incidental ingestion of soil with recreational or work-related activities may expose human receptors to contaminated soil at a site via the oral route of exposure. The equation used to calculate the human exposure dose due to incidental ingestion of contaminated soil is presented in Section 5.1.5.3.2, Table ~~5-13~~5-12. This pathway was assumed to be complete at Sites 5 and 6 for future on-site residents (adults and children) and future on-site workers. Table V-4, Appendix V, documents the calculation of human exposure doses due to incidental ingestion of soil at Sites 5 and 6.

9.6.2.3.3 Dermal Contact with Contaminated On-site Soil. The chemicals in contaminated soil also may be absorbed into a receptor's body through dermal contact. The equation which was used to calculate chemical doses due to dermal contact with contaminated soil is presented in Section 5.1.5.3.3, Table ~~5-14~~5-13. This pathway is relevant for future on-site residents (adults and children) and future on-site workers at Sites 5 and 6. Table U-4, Appendix U, documents the calculation of human exposure doses due to dermal contact with soil at Sites 5 and 6.

9.6.2.3.4 Ingestion of Contaminated Fruits and Vegetables. Consumption of contaminated homegrown fruits and vegetables may be a source of chemical exposure for future on-site residents

(adults and children). The equation used to calculate human exposure dose due to ingestion of contaminated fruits and vegetables is provided in Section 5.1.5.3.11, Table ~~5-23~~5-22. Table U-4, Appendix U, documents the calculation of human exposure doses due to ingestion of contaminated fruits and vegetables grown in surface soil at Sites 5 and 6.

9.6.3 Risk Characterization

9.6.3.1 Chronic Health Hazards. The noncancer daily exposure doses calculated in the exposure assessment were used to calculate HQ for each of the COPCs possessing RfDs. Pathway-specific and overall HIs were then calculated for each receptor. The calculations of HQs and HIs are described in Section 5.1.7.1. If an overall HI is calculated to be greater than 1.0 for a particular receptor, then the exposure pathway(s) primarily responsible for the result is identified as a "critical pathway(s)." For each critical pathway, those chemical contaminants responsible for the majority of the HI are listed as COCs. Table W-4, Appendix W, documents the calculation of the pathway- and chemical-specific HQs for the human receptors at Sites 5 and 6. The pathway-specific and overall HIs are summarized in Table 9-7.

9.6.3.1.1 Future On-Site Residents. The overall HIs for the future on-site adult and toddler residents at Sites 5 and 6 are calculated to be 0.004 and 0.02, respectively. Both of these HIs are less than USEPA's risk management criterion. Thus, no critical exposure pathways or chemicals of concern are identified for these receptors. The existing contamination at Sites 5 and 6 would not present a chemical hazard to future on-site resident adults or toddlers.

9.6.3.1.2 Future On-Site Workers. The overall HI for the future on-site worker at Sites 5 and 6 is calculated to be 0.001, which is less than USEPA's risk management criterion. Thus, no critical exposure pathways or chemicals of concern are identified for this receptor population. The existing contamination at Sites 5 and 6 would not present a chemical hazard to future on-site workers.

9.6.3.2 Excess Lifetime Cancer Risks. The cancer risks for each receptor were determined from the pathway-specific exposure doses and the route-specific SFs, as described in Section 5.1.7.2. To assess the simultaneous exposure of a receptor population to multiple carcinogens from multiple exposure routes, ~~all~~ the~~of the~~ cancer risks calculated for a receptor population were summed. Each overall receptor cancer risk was then compared to USEPA's target risk range (1.0E-06 to 1.0E-04). If the total cancer risk for a receptor from ~~all~~ the exposure pathways is less than 1.0E-04, then it is concluded that the site(s) does not pose a significant risk to that receptor. If the overall cancer risk exceeds the target risk range, a~~ny~~ chemical individually associated with a risk level greater than 1.0E-05 is identified as a COC. COCs represent the primary contributors to the potential cancer risk for the receptor-specific exposure pathway under evaluation. Table W-4, Appendix W, documents the calculation of the pathway- and chemical-specific cancer risks for the human receptors at Sites 5 and 6. The pathway-specific and overall cancer risks are summarized in Table ~~9-4~~9-7.

9.6.3.2.1 Future On-Site Residents. The overall cancer risks calculated for the future adults and toddlers living at Sites 5 and 6 are 1.2E-05 and 1.0E-05, respectively. Since these cancer risks are

within USEPA's target risk range of 1.0E-06 to 1.0E-04, no critical exposure pathways or chemicals of concern are identified for these receptors.

9.6.3.2.2 Future On-Site Workers. The overall cancer risk calculated for the future workers at Sites 5 and 6 is 9.6E-07. Since this estimated cancer risk is below USEPA's target risk range of 1.0E-06 to 1.0E-04, no critical exposure pathways or chemicals of concern are identified for future workers.

9.6.3.3 Uncertainty/Sensitivity Analysis. The numerical risks/hazards that are calculated for Sites 5 and 6 represent *conditional* estimates of risk based on various simplifying assumptions concerning contaminant exposure and toxicity. These estimates of risk/hazard are derived using a series of conservative procedures that address contaminant concentrations at the site, their fate in the environment, how someone currently or in the future might be exposed to these contaminants, and the toxicity of each chemical toward humans. The uncertainty analysis specifies, when appropriate, the critical assumptions made for the site so that the site-specific results can be interpreted in a proper context by risk managers.

To assist the risk managers in this project, a qualitative uncertainty analysis has been performed. The qualitative uncertainty analysis (1) itemizes the major areas of uncertainty in the site-specific risk assessment and (2) demonstrates that the assessment overall has been conservatively performed (i.e., that the potential risks/hazards at the site have not likely been underestimated, but may have been significantly overestimated).

The qualitative uncertainty analysis for this site is presented in Table 9-8. Based on this analysis, it can be concluded that this risk assessment is conservative. Some of the major, calculated uncertainties in this study that are most influential to the risks/hazards include:

- Assumptions regarding receptors' exposure time (24 hours/day) and exposure frequency (350 days/year)
- Assumptions regarding receptors' food-chain ingestion rates (95th percentile of U.S. population)
- Maximum soil concentrations used

9.7 ECOLOGICAL RISK ASSESSMENT

Based on protocols established in the PERA (Rust E&I 1997g), there were no ecological risks determined for Sites 5/6. As a result, no further ecological risk analysis has been undertaken.

9.8 CONCLUSIONS AND RECOMMENDATIONS

Surface soil sample results from the Wood-Storage Pile (Site 5) and Wood-Burning Area (Site 6) indicate that SVOCs and dioxins/furans are present. A review of the dioxins/furans against background concentrations indicates that these contaminants are consistent with anthropogenic levels and may represent background contamination rather than site-related contamination. The SVOCs are at low concentrations below their respective USEPA Region 9 PRGs. Only dioxins/furans were retained as COPCs for the human health risk assessment.

Results of the human health risk assessment indicate that no the risks or hazards for the future on-site worker do not exceed the USEPA risk management criteria. Additionally, no the risks or hazards to the hypothetical future resident do not exceed risk criteria. During the Phase I RI, it was determined that there were no ecological risks associated with Sites 5 and 6.

Based on the human health and ecological risk assessment results, a No Further Action (NFA) technical memorandum for Sites 5 and 6 was produced in October 1998 for regulatory and public review so that these sites can be removed from the RI/FS process. (IN15) (EPA10) The Final Decision Document was submitted March 1999. That document proposed NFA based on future industrial use. A Decision Document Addendum was prepared in October 2000 to support a NFA proposal for future residential use. The Final Decision Document Addendum was submitted in August 2001 after addressing agency comments (New Work).

No additional work is required at Sites 5 and 6, the sites will not go forward to the FS stage.

TABLES

TABLE 9-1

Background Screening of Dioxins Detected in Surface Soil
Site 5 - Wood Storage Pile and Site 6 - Wood-Burning Area
Jefferson Proving Ground
Madison, Indiana

Chemical	Location	Frequency of Detection[a]	Maximum Detected Value (µg/g)[b]	Average Concentration (µg/g)	Median Concentration (µg/g)	Background(Bkgd.) Threshold (µg/g)	Data Distribution	Test Performed	P value	Site > Bkgd?
2,3,7,8-TCDD equivalents	Site	7/7	3.24E-05	1.52E-05	1.64E-05		Lognormal	t test	0.07[c]	No
	Background	**5/5**	**1.85E-05**	**8.26E-06**	**6.72E-06**	**2.03E-05**	**Lognormal**			

Footnotes:

(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Micrograms per gram.
(c) The 95% confidence interval for the difference between the means of the logtransformed data is: -0.26 to 1.5

TABLE 9-2

Analytical Results for Phase I Surface Soil Samples
Site 5 - Wood Storage Pile and Site 6 - Wood Burning Area
Jefferson Proving Ground
Madison, Indiana

Sample ID	Contaminant	Concentration (µg/g)[(a)]	Sample Date
WDP05SF001	Octachlorodibenzodioxin	0.0052	11/17/92
WDP05SF002	1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	0.0002	11/17/92
	Octachlorodibenzodioxin	0.0053	
	Di-n-butyl phthalate	5.10	
BWP06SF001	1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	0.00064	11/17/92
	1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin	0.000033	
	Octachlorodibenzodioxin	0.010	
	Octachlorodibenzofuran	0.000210	
	Di-n-butyl phthalate	4.90	
	Pentachlorophenol	4.40	
BWP06SF002	1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	0.000092	11/17/92
	Octachlorodibenzodioxin	0.0061	
	Di-n-butyl phthalate	6.20	

General Note:

1. Sample depths are at 0 feet. (EPA 18)

Footnotes:

(a) Micrograms per gram.S

TABLE 9-3

Analytical Results for Phase II Surface Soil Samples
Site 5 - Wood Storage Pile and Site 6 - Burning Area
Jefferson Proving Ground
Madison, Indiana

Sample ID Analyte	WDP05SF003 (µg/g)[a]	WDP05SF004 (µg/g)	BWP06SF003 (µg/g)
2,3,4,6,7,8-Hexachlorodibenzofuran	LT[b] 0.00000362	0.00000291	0.00000442
2,3,4,7,8-Pentachlorodibenzofuran	0.00000124	0.00000102	0.00000106
1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	0.00032800	0.00025900	0.00043400
1,2,3,4,6,7,8-Heptachlorodibenzofuran	0.00005140	0.00003620	0.00008170
1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin	0.00001320	0.00001120	0.00001610
1,2,3,6,7,8-Hextachlorodibenzofuran	0.00000650	LT 0.00000204	0.00000257
1,2,3,4,7,8,9-Heptachlorodibenzofuran	LT 0.00000282	0.00000323	0.00000474
1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin	0.00001420	0.00001040	0.00001390
1,2,3,7,8,9-Hexachlorodibenzofuran	LT 0.00000049	0.00000041	0.00000065
1,2,3,4,7,8-Hexachlorodibenzo-*p*-dioxin	0.00000450	0.00000399	0.00000447
1,2,3,4,7,8-Hexachlorodibenzofuran	0.00000335	LT 0.00000346	0.00000302
1,2,3,7,8-Pentachlorodibenzo-*p*-dioxin	0.00000344	0.00000254	LT 0.00000350
1,2,3,7,8-Pentachlorodibenzofuran	0.00000141	0.00000112	0.00000166
Octachlorodibenzodioxin	0.00809000	0.00832000	0.01150000
Octachlorodibenzofuran	0.00015100	0.00009380	0.00040200
2,3,7,8-Tetrachlorodibenzo-*p*-dioxin	LT 0.00000061	0.00000027	0.00000043
Fluoranthene	0.0506	LT 0.67	LT 0.67
Phenanthrene	0.0303	LT 0.67	LT 0.67
Pyrene	0.0632	LT 0.67	LT 0.67
Di-n-butyl phthalate	LT 0.67	LT 0.67	LT 0.860

General Note:

1. Sample depths are at 0 feet. WDP05SF003 and WDP05SF004 were sampled on 5/10/96; BWP06SF003 was sampled on 5/12/96. (EPA 18)

Footnotes:

(a) Micrograms per gram.
(b) Less than the reporting limit.

TABLE 9-4

Soil Exposure Point Concentrations of Preliminary Contaminants of Potential Concern
Site 5 – Wood Storage Pile and Site 6 - Wood Burning Area
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/g)[b]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[c] (µg/g)
Surface Soil						
Di-n-butyl phthalate	1/3	0.088	0.670	0.253	87.4	0.088
Fluoranthene	1/3	0.051	0.670	0.240	19,101	0.051
Phenanthrene	1/3	0.030	0.670	0.233	2.4E+07	0.030
Pyrene	1/3	0.063	0.670	0.244	2,207	0.063
2,3,7,8-TCDD equivalents	7/7	5.20E-06 - 3.24E-05	NA[d]	1.54E-05	3.55E-05	3.24E-05

Footnotes:

(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Micrograms per gram.
(c) The 95% UCL (upper confidence limit of the mean) or the maximum detected value, whichever is lower (USEPA 1989b).
(d) Not applicable.

TABLE 9-5

Selection of Contaminants of Potential Concern (COPC) in Soil Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 5 - Wood Storage Pile and Site 6 –Wood Burning Area
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Residential PRG (µg/g)[a]**	**Exposure Point Conc. (µg/g)**	**Retained as Soil COPC?**
Surface Soil			
Di-n-butyl phthalate	651	0.088	No
Fluoranthene	261	0.051	No
Phenanthrene	100[b] [c]	0.030	No
Pyrene	100[c]	0.063	No
2,3,7,8-TCDD equivalents	3.77E-06	3.24E-05	**YES**

General Note:

1. PRGs were taken directly from the Region 9 PRG Table (USEPA 1996c) except as noted in the footnotes. Values for noncarcinogens are 1/10 of the Region 9 PRG, except for values based on soil saturation limits, for which the full PRG was used.

Footnotes:

(a) Micrograms per gram.
(b) Value for pyrene.
(c) Based on soil saturation limits; full PRG used

TABLE 9-6

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs) Site 5 - Wood Storage Pile and Site 6 – Wood Burning Area Jefferson Proving Ground Madison, Indiana

Chemical	USEPA Region 9 PRG Screen		
	Ambient Air PRG ($\mu g/m^3$)[(a)]	Exposure Point Conc. ($\mu g/m^3$)	Retained as Air COPC?
Residential Scenario			
Aluminum	NA[(b)]	2.77E-02	**YES**
Arsenic	4.5E-04	1.46E-05	No
Barium	5.2E-02	2.36E-05	No
Beryllium	8.0E-04	1.14E-06	No
Cadmium	1.1E-03	4.59E-08	No
Chromium	2.3E-05	3.84E-05	**YES**
Lead	1.5E+00[(c)]	3.40E-06	No
Manganese	5.1E-03	1.96E-03	No
Silver	NA	8.10E-05	**YES**
Thallium	NA	5.15E-06	**YES**
Vanadium	NA	7.33E-06	**YES**
Zinc	NA	2.34E-06	**YES**
Dioxins/Furans	4.5E-08	2.02E-13	No
Benzo(a)anthracene	9.2E-03	4.22E-09	No
Benzo(a)pyrene	9.2E-04	8.96E-09	No
Benzo(b)fluoranthene	9.2E-03	1.66E-08	No
DDE	2.0E-02	2.48E-09	No
Dibenz(a,h)anthracene	9.2E-04	4.96E-10	No
Dieldrin	4.2E-04	NA	No
Indeno(1,2,3-cd)pyrene	9.2E-03	2.50E-09	No
1,1-Dichloroethylene	3.8E-02	3.03E-09	No
Chlorobenzene	2.1E+00	5.49E-05	No

TABLE 9-6 (Continued)

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 5 - Wood Storage Pile and Site 6 – Wood Burning Area
Madison, Indiana

Chemical	USEPA Region 9 PRG Screen		
	Ambient Air PRG (µg/m^3)[(a)]	Exposure Point Conc. (µg/m^3)	Retained as Air COPC?
Industrial Scenario			
Aluminum	NA	3.11E-02	**YES**
Arsenic	4.5E-04	1.65E-05	No
Barium	5.2E-02	2.42E-05	No
Beryllium	8.0E-04	1.83E-06	No
Cadmium	1.1E-03	1.59E-06	No
Chromium	2.3E-05	7.21E-05	**YES**
Lead	1.5E+00[(c)]	3.40E-06	No
Manganese	5.1E-03	2.16E-03	No
Silver	NA	8.10E-05	**YES**
Thallium	NA	5.15E-06	**YES**
Vanadium	NA	3.88E-05	**YES**
Zinc	NA	1.68E-03	**YES**
Dioxins/Furans	4.5E-08	5.08E-09	No
Benzo(a)anthracene	9.2E-03	4.22E-09	No
Benzo(a)pyrene	9.2E-04	9.05E-09	No
Benzo(b)fluoranthene	9.2E-03	1.66E-08	No
DDE	2.0E-02	2.48E-09	No
Dibenz(a,h)anthracene	9.2E-04	4.96E-10	No
Dieldrin	4.2E-04	3.69E-09	No
Indeno(1,2,3-cd)pyrene	9.2E-03	2.48E-09	No
1,1-Dichloroethylene	3.8E-02	3.03E-09	No
Chlorobenzene	2.1E+00	5.49E-05	No

General Note:

1. PRGs were taken directly from the Region 9 PRG Table (USEPA 1996c). Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:

(a) Micrograms per cubic meter.
(b) Not applicable.
(c) Federal ambient air quality criterion for lead.

TABLE 9-7

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 5 –Wood Storage Pile and Site 6 - Wood Burning Area
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Chemicals of Concern	Pathway-specific Hazard Index	Noncarcinogenic Chemicals of Concern
	Future On-site Resident Adult			
Incidental ingestion of soil	2.85E-06		NA[a]	
Dermal contact with soil	1.19E-06		NA	
Ingestion of homegrown fruits/vegetables	7.53E-06		NA	
Inhalation of VOCs[b] and fugitive dusts	1.33E-07		0.0039	
Total	1.17E-05		0.0039	
	Future On-site Resident Child			
Incidental ingestion of soil	5.33E-06		NA	
Dermal contact with soil	6.86E-07		NA	
Ingestion of homegrown fruits/vegetables	4.15E-06		NA	
Inhalation of VOCs and fugitive dusts	9.99E-08		0.0147	
Total	1.03E-05		0.0147	
	Future On-site Worker			
Incidental ingestion of soil	6.11E-07		NA	
Dermal contact with soil	3.04E-07		NA	
Inhalation of VOCs and fugitive dusts	4.94E-08		0.0010	
Total	9.64E-07		0.0010	

Footnotes:

(a) Not applicable.
(b) Volatile organic compounds.

TABLE 9-8

Qualitative Uncertainty Analysis
Site 5 - Wood Storage Pile and Site 6 - Wood Burning Area
Jefferson Proving Ground
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
A. Human Behavior				
Future receptors' exposure duration	30 years	Medium	Medium	National upper-bound time (90th percentile) at one residence
Future receptors' exposure frequency	350 days/year	Medium	Medium	High-end value
Future receptors' exposure time	24 hours/day	Low	High	Maximum possible value
Future receptors' foodchain ingestion rates	NA[a]	Low	High	Nearly impossible for an average weight receptor to ingest daily the 95th percentile U.S. population consumption amounts
Exclusion of certain exposure pathways in the quantitative analysis	NA	Low	Low	Pathways eliminated are those that have low possibility of contributing risk to these receptors
B. Chemical Fate/Transport in the Environment				
Calculation of exposure point concentration of COC [b]/foodchain modeling	NA	Low	High	Conservative assumptions and input parameters
Use of air dispersion modeling to predict air concentrations	NA	Low	High	Conservative assumptions and input parameters

TABLE 9-8 (Continued)

Qualitative Uncertainty Analysis
Site 5 - Wood Storage Pile and Site 6 - Wood Burning Area
Jefferson Proving Ground
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
C. Chemical Toxicity				
Assumption that USEPA[c] reference doses truly represent toxicological thresholds	NA	Low	High	High degree of conservativeness utilized by USEPA in deriving RfDs[d] from toxicological literature
Assumption that USEPA carcinogenic slope factors truly represent dose-response phenomena	NA	Low-moderate	Moderate-high	Use of linearized, multi-stage mathematical model to predict cancer incidence at low exposure levels is USEPA policy; not currently supported by scientific data
Assumption of risk/hazard additivity	NA	Moderate	Moderate	Summation of chemical-specific risks/hazards may over- or under-predict risks/hazards to receptors
Screening out of certain contaminants based on USEPA criteria	NA	Low	Low	Chemicals present in concentrations less than Region 9 criteria eliminated

Footnotes:

(a) Not applicable.
(b) Contaminant of concern.
(c) United States Environmental Protection Agency.
(d) Reference doses.

FIGURES

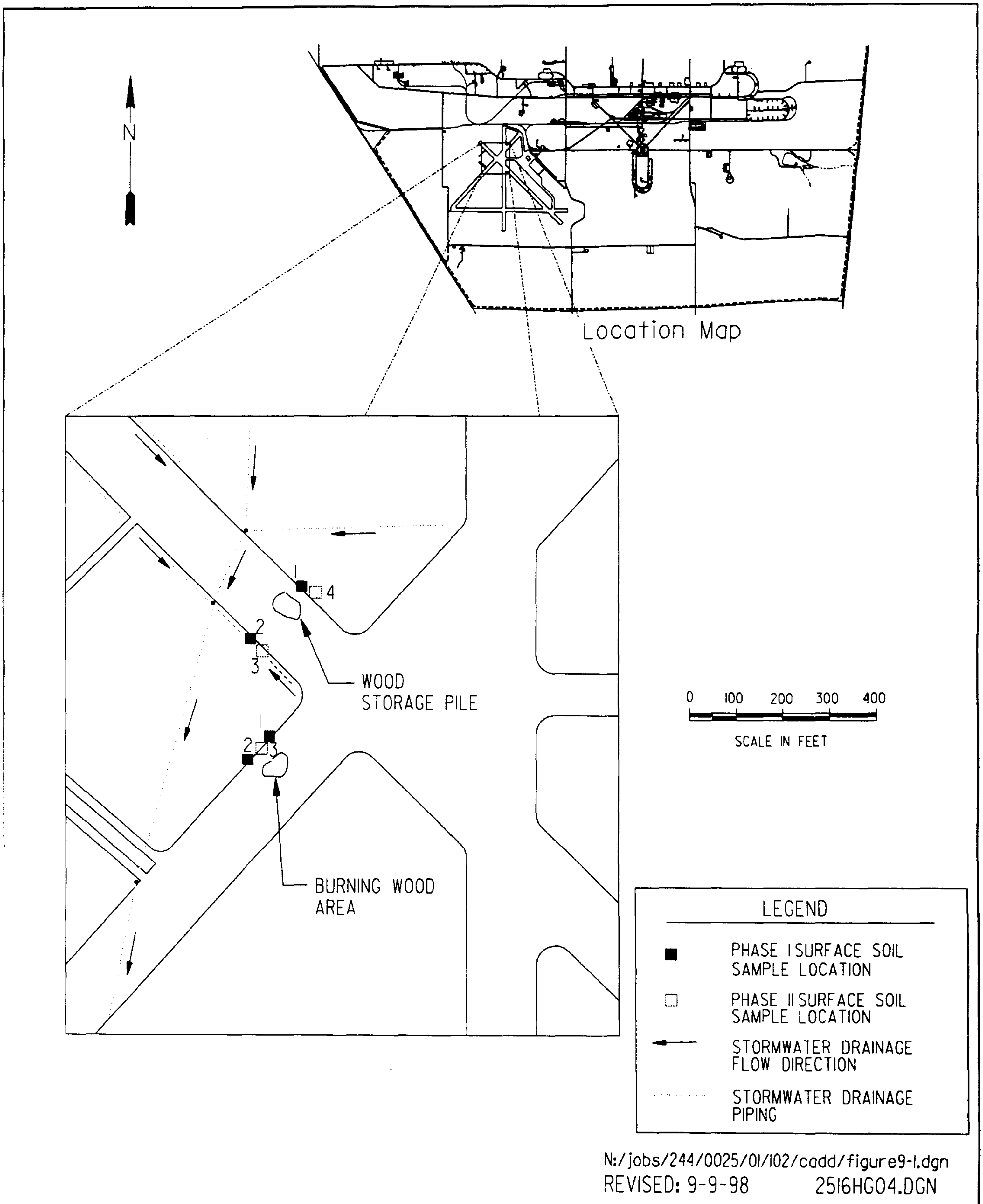
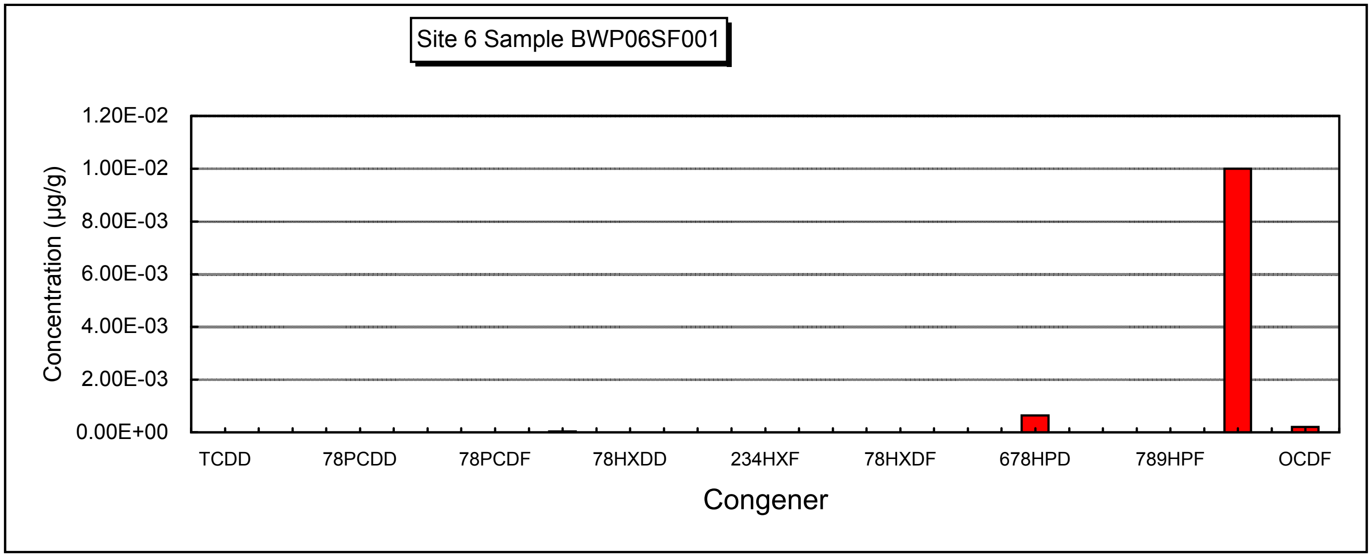


Figure 9-1. Sampling Locations at the Wood Storage Pile (Site 5) and Wood Burning Area (Site 6)



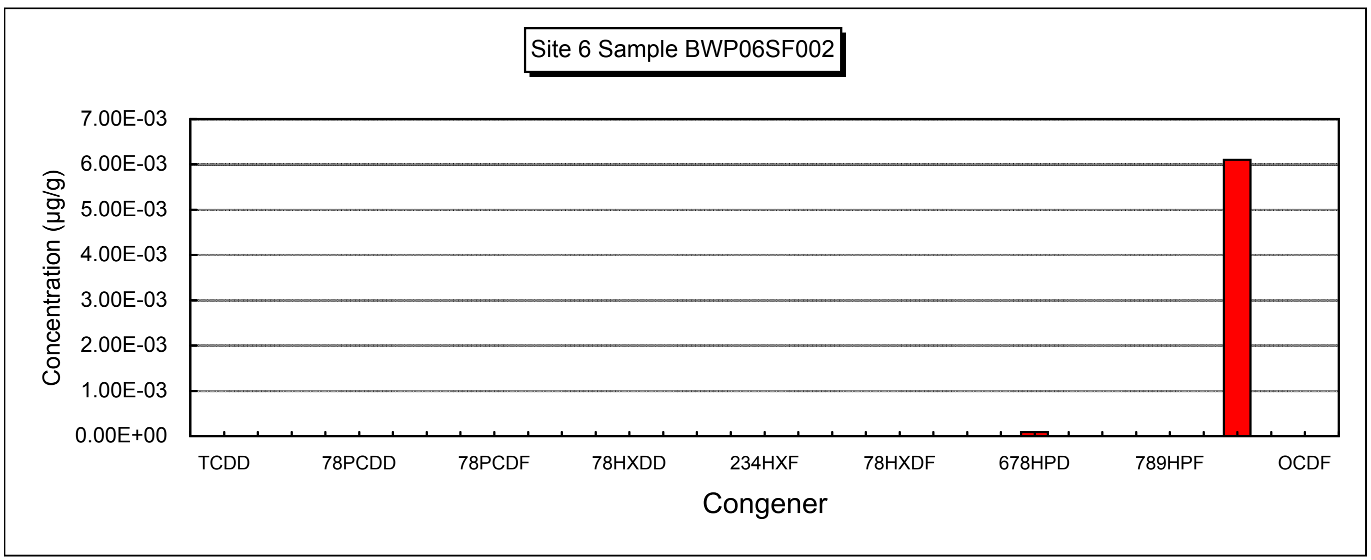
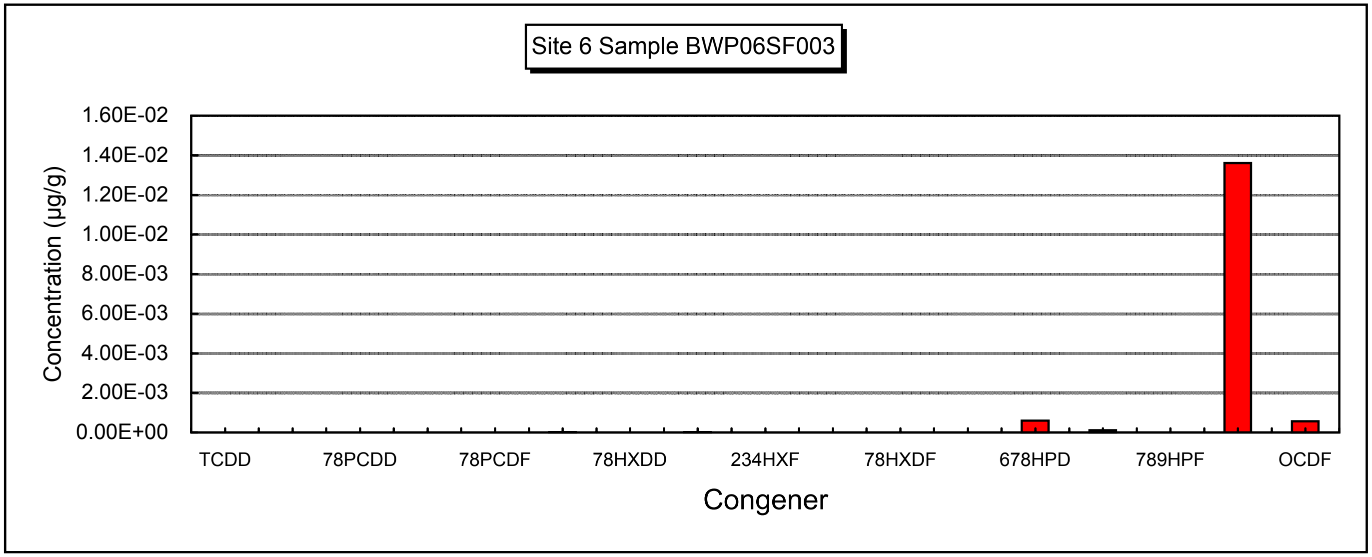


Figure 9-2a. Distribution of Dioxin/Furan Congeners at Sites 5 and 6

n:\jobs\244\0025\01\wp\figures\excel figures\Fig9-2.xls



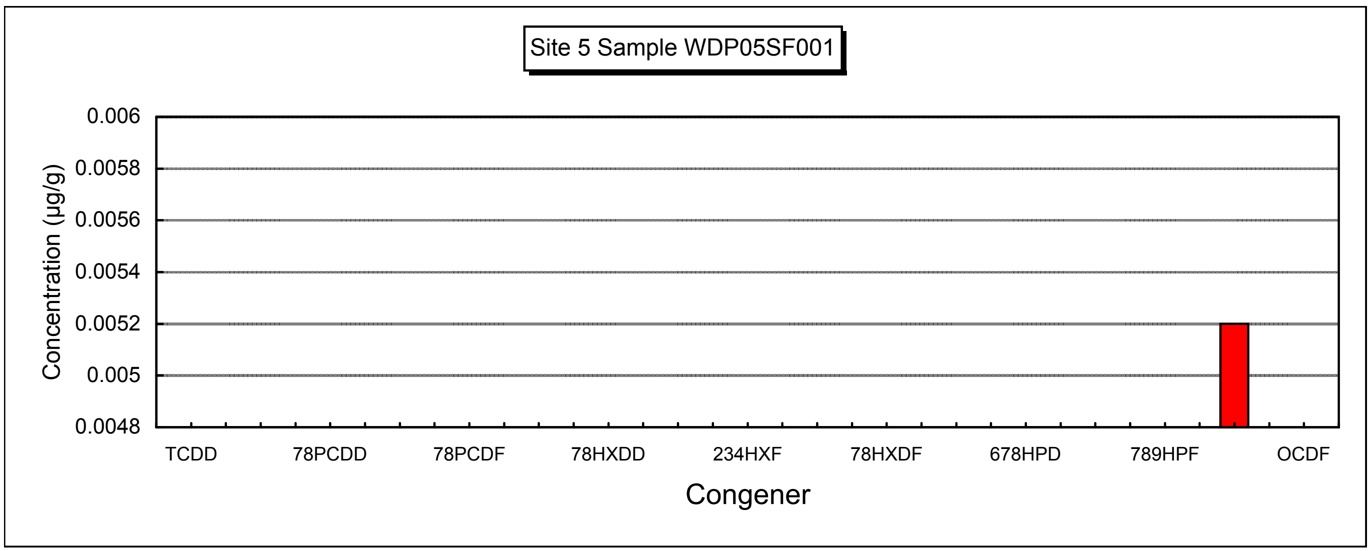
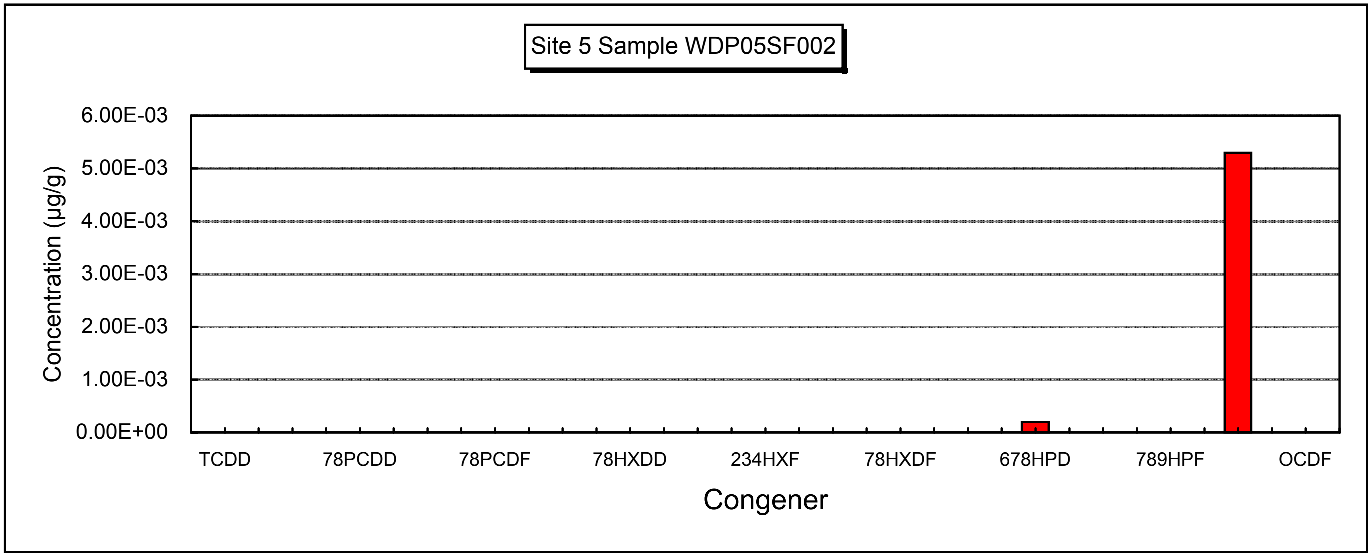


Figure 9-2b. Distribution of Dioxin/Furan Congeners at Sites 5 and 6



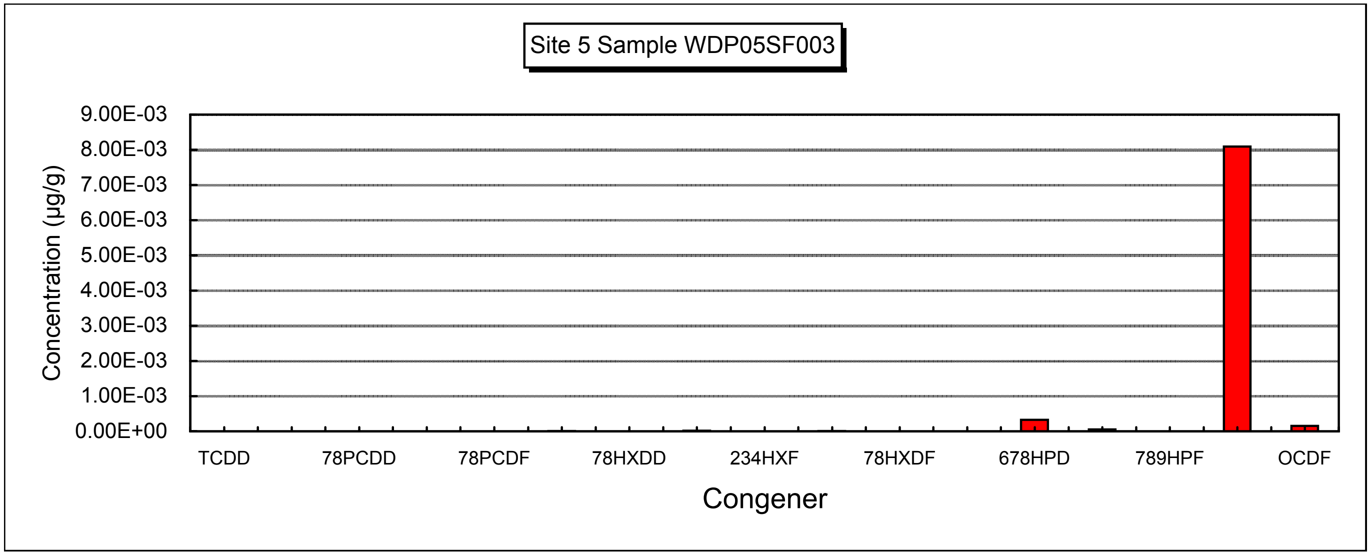


Figure 9-2c. Distribution of Dioxin/Furan Congeners at Sites 5 and 6

Figure 9-2d. Distribution of Dioxin/Furan Congeners at Sites 5 and 6

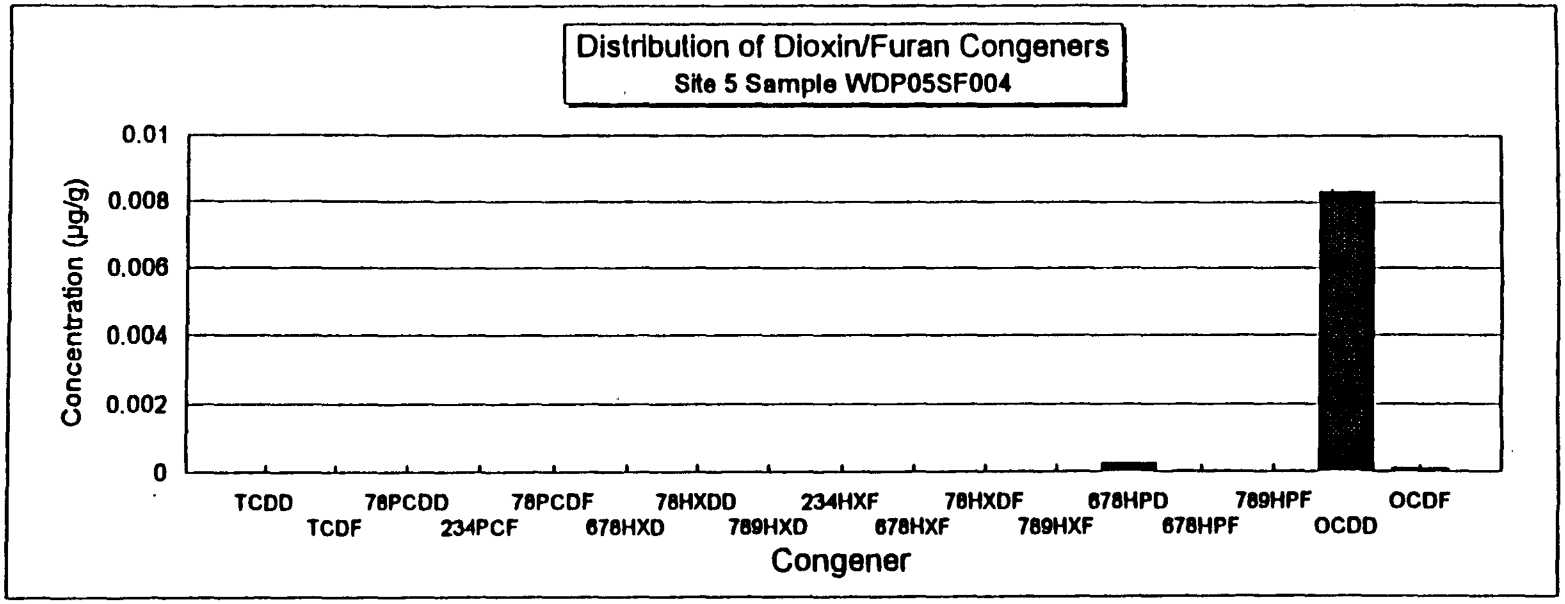
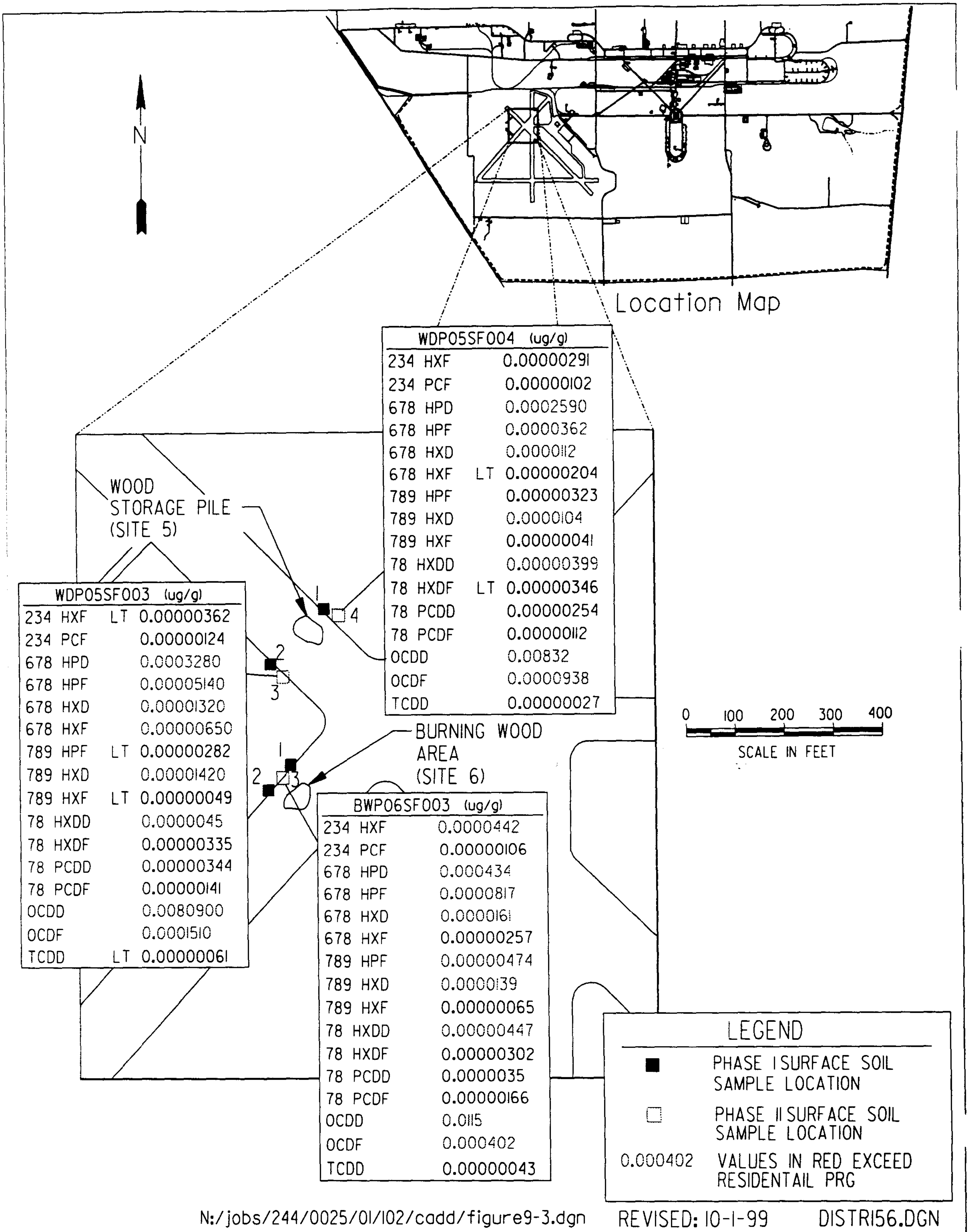


Figure 9-2d. Distribution of Dioxin/Furan Congeners at Sites 5 and 6



WDP05SF004 (ug/g)		
234 HXF		0.0000291
234 PCF		0.00000102
678 HPD		0.0002590
678 HPF		0.0000362
678 HXD		0.0000112
678 HXF	LT	0.00000204
789 HPF		0.00000323
789 HXD		0.0000104
789 HXF		0.00000041
78 HXDD		0.00000399
78 HXDF	LT	0.00000346
78 PCDD		0.00000254
78 PCDF		0.00000112
OCDD		0.00832
OCDF		0.0000938
TCDD		0.00000027

WDP05SF003 (ug/g)		
234 HXF	LT	0.00000362
234 PCF		0.00000124
678 HPD		0.0003280
678 HPF		0.00005140
678 HXD		0.00001320
678 HXF		0.00000650
789 HPF	LT	0.00000282
789 HXD		0.00001420
789 HXF	LT	0.00000049
78 HXDD		0.0000045
78 HXDF		0.00000335
78 PCDD		0.00000344
78 PCDF		0.00000141
OCDD		0.0080900
OCDF		0.0001510
TCDD	LT	0.00000061

BWP06SF003 (ug/g)	
234 HXF	0.0000442
234 PCF	0.00000106
678 HPD	0.000434
678 HPF	0.0000817
678 HXD	0.0000161
678 HXF	0.00000257
789 HPF	0.00000474
789 HXD	0.0000139
789 HXF	0.00000065
78 HXDD	0.00000447
78 HXDF	0.00000302
78 PCDD	0.0000035
78 PCDF	0.00000166
OCDD	0.0115
OCDF	0.000402
TCDD	0.00000043

Figure 9-3. Summary of Dioxin Contaminants in Soilat Sites 5 and 6

10.0 RED LEAD DISPOSAL AREA (SITE 7) AND TEMPORARY METHYLENE CHLORIDE STORAGE AREA AT BUILDING 211 (SITE 21B)

10.1 SITE CHARACTERISTICS

Building 211 is located along Woodfill Road just west of the intersection with Meridian Road (Figure ~~10~~2-1). It had been previously used for the loading of inert ordnance. Both the Red Lead Disposal Area and the Methylene Chloride Disposal Area are located south of Building 211 near the west end of the building (Figure 10-1). At the time of the RI, there was red staining in the area between the building and the railroad tracks and also in one place on the gravel between the railroad tracks. Red lead (also known as lead tetroxide) was used as an oxidizer in pyrotechnics and as an ingredient in some explosives.

Activities at Building 211 at the time of the Phase I RI were confined mostly to the interior of the building where the inert loading was taking place. It did not appear that personnel frequented the outside of the building, especially the back side toward the railroad tracks. There may have been intermittent access by utilities personnel as some utilities do run through the area. Following the Phase I RI, the Red Lead Disposal Area (Site 7) was identified for interim remedial action. Cleanup of the area began in the summer of 1996 and was completed in October 1996 with a closure report being submitted to the regulatory agencies in June 1997. Cleanup involved the excavation and removal of contaminated soil, off-site disposal, and backfilling with clean soil. The excavated soil was placed in two roll-off boxes; one box was disposed as a special waste and one as a hazardous waste, after exceeding the RCRA 90-day storage requirements. (IN16) Confirmation samples within the excavated area were collected and the results are summarized in the following sections. The excavation was then backfilled with crushed stone aggregate and graded.

The area around Building 211 is generally flat except where there is a shallow narrow ditch between the railroad tracks and Building 211. Surface water collects in this ditch and probably infiltrates into the soil. It is possible that if enough runoff enters the ditch, the water might run west and enter the storm-water drains. The drains in this part of the installation eventually discharge into Middle Fork Creek (Figure 2-1). ~~The area between the railroad track and Building 211 is practically devoid of vegetation and there is no regular mowing.~~

The site is located in an area with soils belonging to the Cobbsfork soil series. The glacial till is about 40 feet thick and is underlain by the Laurel Dolomite. The monitoring well cross section shows the soil types, the bedrock formations, screened intervals, water levels, and sampled intervals (Figure 10-2). Three groundwater-monitoring wells were installed at this site during Phase I (MW93-10, MW93-11, and MW93-44) with total depths ranging from 48 to 52 feet bgs. ~~All~~ The three wells were screened across the glacial till-bedrock interface, which is located approximately 40 feet bgs. As shown in Figure 10-2, the wells are screened mostly in the Laurel Dolomite, with the top 1 foot of screen in the glacial till. A fourth well was installed in the downgradient direction during Phase II (MW95-04). Like the Phase I wells, the new well was screened across the glacial

till-bedrock interface at approximately 42 feet bgs. During 2001, four additional monitoring wells were installed in the downgradient direction to further evaluate potential contaminant migration (MW01-05, MW01-06, MW01-07, and MW01-08). The four wells were installed as two well nest pairs with the shallow monitoring wells screened at the bedrock/till interface and the deeper bedrock wells screened in the Laurel Dolomite at a depth of approximately 70 ft below ground surface. A summary of monitoring well information is shown in Table 10-1a.

During the Phase II work, ~~S~~slug tests were performed in each of the four wells in order to determine the hydraulic conductivity of the screened interval. According to the data collected, the hydraulic conductivity at the site ranges from 7.85 x 10^{-5} (MW93-10) to 9.40 x 10^{-5} (MW93-11) cm/sec.

The bedrock groundwater underlying this site is confined as shown by the water level rising about 25 feet above the screened interval. Based on water-level data collected from the groundwater monitoring wells, the depth to the potentiometric surface ranges from 14 to 16 feet bgs (Table 10-1b). Phase II groundwater elevations were measured during November 1995 and February, April, June, September, and November 1996. The Phase II data (1995 and 1996) are presented in Figures 10-3 and 10-4. As shown in these figures, bedrock groundwater flow is generally toward the southwest. The calculated average hydraulic gradient based on the water level measurements is 0.0026 foot/foot.

The additional monitoring wells installed in 2001 added two points (MW01-06 and MW01-08) to interpret the groundwater flow direction at the sites. Water level measurements are presented on Table 10-1b, and potentiometric surface maps for June and November 2001 are presented on Figures 10-4a and 10-4b, respectively. Groundwater flow based on the four original monitoring wells continues to be towards the southwest; however, in the vicinity of the new monitoring well nests, groundwater elevations indicate that the flow may shift more to the west due to a higher groundwater gradient at well MW01-08. Vertical gradients calculated for the two new well nests indicate a consistent downward vertical gradient ranging from 0.001 to 0.049 ft/ft (Table 10-1c).

10.1.1 Red Lead Disposal Area

Repeated site visits by various consulting firm personnel prior to 1990 failed to definitively identify the red lead disposal area(s). On March 20, 1990, Ebasco personnel interviewed a retired JPG employee. This discussion included the possible locations of red lead disposal areas. The retired employee indicated that red lead was used from 1952 to 1958 and from 1961 to 1978. It may also have been used prior to 1952. The red lead was contained in paint residuals and/or inert filler that contained 60 percent lead oxide by weight. Areas identified during the interview as red lead disposal sites included the Gate 19 Landfill (Site 10), the Abandoned Landfill (Site 4), Explosive Burn Area (Site 3), and the gravel between the railroad tracks between Buildings 202 and 148 and behind Building 211. Of those identified as possible red lead disposal sites, only the areas between Buildings 202 and 148 and behind Building 211 were not already included as RI sites. During the RI, careful inspection of the area between Buildings 202 and 148 did not reveal~~ed no~~ evidence of disposal. In contrast, the soil behind Building 211 had red staining indicative of disposal. Therefore,

the red lead site investigation focused in this area. The high lead concentrations present in some of the RI samples indicate that red lead was indeed disposed of at this site.

The red lead area was reportedly used in 1957 to dispose of red lead and barium sulfate. The red lead and barium may have been waste from the inert munitions-loading process conducted in Building 211. Both lead and barium were listed as COCs related to this disposal area. Red lead is an amorphous form of lead oxide called lead tetroxide (Pb_3O_4). Red lead was used as an oxidizer in pyrotechnics and as an ingredient in some explosives. Lead oxide is highly toxic as a dust. Waste contaminated with lead is regulated under RCRA and is considered to be hazardous if the TCLP concentration of lead exceeds 5 mg/L.

10.1.2 Temporary Methylene Chloride Storage Area at Building 211

Building 211 has a concrete floor, and drums of methylene-chloride-contaminated Pelron A&B were previously stored inside the building prior to off-site disposal. Only small amounts of methylene chloride were stored there, and the potential for a release was considered slight except when drums were opened resulting in minor volatilization into air. During a visual site inspection conducted by A.T. Kearney (1992), it was reported by facility personnel that methylene chloride had historically been disposed of on a grassy area south of Building 211, on the south side of the railroad tracks. Also, there were reports that an unspecified small quantity of methylene chloride was dumped between the rails of the railroad tracks south of Building 211. There are no known dates or amounts available on for the disposal of methylene chloride at Building 211.

10.2 PREVIOUS INVESTIGATIONS

No previous data were available for the red lead disposal area or the methylene chloride disposal area prior to the RI; however, red-stained soil between Building 211 and the railroad tracks was assumed to be caused by disposal of red lead. The exact locations of these sites were unknown, but they were believed to be near Building 211 (see Figure 10-1). Previous investigations performed at the red lead disposal site are summarized in the *Enhanced PA Report* (Ebasco 1990a) and the *Master Environmental Plan* (Ebasco 1990b). The *Enhanced PA Report*, which listed this site as SWMU 9, consisted of visual site inspections, records searches, and interviews with JPG personnel. Interviews with JPG employees identified many of the possible red lead disposal areas. The Master Environmental Plan recommended sampling activities for the red lead area, which included surface-soil sampling to identify the contaminated area and groundwater sampling to check for the possible migration of lead. A.T. Kearney, Inc., performed a visual site inspection, records search, and personnel interviews regarding the past activities and existing conditions at the Temporary Storage Area at Building 211 (1992).

10.3 STUDY AREA INVESTIGATIONS

10.3.1 Phase I RI Field Activities

10.3.1.1 Surface and Subsurface Sampling. During the Phase I field investigation, a total of five surface soil samples were collected. Two surface samples (1A, 2A) were collected in areas of obvious staining in the Red Lead Disposal Area and analyzed for total metals (Figure 10-5). Three additional surface-soil samples (1B, 2B, and 3B) were collected from outside of Building 211 to investigate the possible disposal sites of methylene chloride (Figure 10-5) based on past employee interviews. Two of these additional samples were collected from stained soil and the other was collected from an obvious surface-water pathway where runoff from the paved area west of the building intersects the lawn. These soil samples were analyzed for metals, PCB/pesticides, TPH, and SVOCs. No VOC analysis was performed because PID screening of the surface soils indicated no VOCs were present.

The Phase I surface soil samples were not analyzed for VOCs because field screening with a PID indicated that no VOCs were present. However, the lack of laboratory verification (e.g., analytical data for VOCs) was considered a data gap based on regulatory agency review of the Phase I field observations and results. Therefore, three additional soil samples (4B, 5B, and 6B) were collected from areas near Phase I surface soil sample locations during Phase II. No VOCs were detected in these soil samples, however.

During the Phase I field activities, a total of 10 preliminary soil corings were installed along 2 parallel lines located between the railroad tracks and Building 211 to determine the distribution of contamination in the Red Lead Disposal Area. The two parallel lines of corings were located about 10 feet apart. A soil coring was drilled every 20 feet beginning near the southwestern corner of Building 211. The shallow cores were inspected for changes in coloration, staining, layering, or other evidence of previous disposal activities. These soil corings showed the disposal site was limited to two areas of about 25 square feet each, located near the southwestern corner of Building 211. During the Phase I field investigation, four soil-borings were installed at locations based on the results from the preliminary soil-coring study (Figure ~~3-17B~~10-5). The shallowest sample from each of the four soil borings was collected from depths ranging from 0 to 1.4 feet. These Phase I samples were analyzed for lead only in order to determine the lateral distribution of lead in the soil. Two additional surface samples were collected from obviously stained areas. These samples were submitted for metals analysis.

Eight subsurface samples were collected from the previously mentioned four soil borings during Phase I field activities. Borings A and B were drilled with a truck-mounted rig and samples were collected from the surface, 4.4 feet, and 9.5 feet deep. Borings D and C were drilled with a hand auger as overhead steam lines prevented access of the truck-mounted drilling rig. Samples were collected at the surface, at 4 feet, and at auger refusal between 5.5 and 6.5 feet deep. These samples were submitted for lead analysis in order to determine vertical extent of lead contamination in the soil.

10.3.1.2 Monitoring Wells. Since surface evidence of red lead disposal was found, one upgradient monitoring well (MW93-10) and two downgradient monitoring wells (MW93-44 and MW93-11) were installed at the site to monitor groundwater quality during Phase I. Groundwater samples were collected from the wells and were analyzed for metals and anions. ~~However, due to concerns that the existing monitoring wells were not representative of true downgradient conditions, an additional monitoring well (MW95-4) was installed during Phase II (Figure 10-1). Four sampling rounds from all the four site wells were conducted as part of the Phase II RI, with the samples analyzed for total and dissolved metals.~~

10.3.1.3 Wipe Samples. Three wipe samples were also collected from along the south wall inside Building 211 as part of the Phase I Temporary Methylene Chloride Storage Area investigation. The wipe samples were analyzed for metals, explosives, and SVOCs.

10.3.2 Phase II RI Field Activities

10.3.2.1 Groundwater. ~~During Phase II,~~ Due to concerns that the existing Phase I monitoring wells were not representative of true downgradient conditions, an additional monitoring well (MW95-04) was installed during Phase II southwest of Building 211 between existing monitoring wells MW93-11 and MW93-44 (Figure 10-1).~~an additional well (MW95-04) was installed southwest of Building 211 between existing monitoring wells MW93-11 and MW93-44~~. The new well and three existing wells were sampled for ~~metals~~ total and dissolved metals during four ~~additional~~ rounds of sampling.

10.3.2.1a. Soil. During the Phase I, surface soil samples were not analyzed for VOCs because field screening with a PID indicated that no VOCs were present. However, the lack of laboratory verification (e.g., analytical data for VOCs) was considered a data gap based on regulatory agency review of the Phase I field observations and results. Therefore, three additional soil samples (4B, 5B, and 6B) were collected from areas near Phase I surface soil sample locations (1B, 2B, and 3B; respectively) during Phase II. No VOCs were detected in these soil samples.

10.3.2.2 Interim Measures Confirmation Samples

Following excavation of contaminated soils in the ~~read lead area~~Red Lead Area during summer and fall of 1996, ~~nine~~eight confirmation samples (1 to 8) were collected from the excavation and analyzed for VOCs and target analyte metals.

10.3.2.3 Supplemental Groundwater Monitoring

During 2001, four additional monitoring wells were installed in the downgradient direction to further evaluate potential contaminant migration (MW01-05, MW01-06, MW01-07, and MW01-08). The four wells were installed as two well nest pairs with the shallow monitoring wells screened at the bedrock/till interface and the deeper bedrock wells screened in the Laurel Dolomite at a depth of approximately 70 ft below ground surface (Figure 10-1). -Additional groundwater sampling was

performed in June 2001 (the seven site wells) and November 2001 (well MW93-10). Samples were analyzed for VOCs, SVOCs, explosives, and TAL metals.

10.4 DATA EVALUATION

10.4.1 Data Validation Results

Data validation results for soil are summarized only for the Phase I and II samples remaining in the risk assessment database: surface samples STB21SF003, STB21SF006, RLA07BHB01, and RLA07BHC01 and subsurface samples RLA07BHB02, RLA07BHB03, RLA07BHC02, and RLA07BHC03. Phase II soil sample VOC and SVOC results were not found in the data validation report.

Data validation results are summarized for supplemental groundwater monitoring samples collected in June 2001 and November 2001 in the respective QCSRs in Appendix P.

10.4.1.1 Blank Assessment. The USEPA has determined that when blank contamination exists, the investigative results must exceed the blank result by a factor of 5 (all compounds) or 10 (common laboratory contaminants such as phthalates) in order to be considered positive. Based on comparisons to blanks, positive results were changed to nondetects (“U”). The associated sample quantitation limit became either the concentration detected in the sample, if the detected value was above the quantitation limit, or the quantitation limit, if detected results were less than the quantitation limit. Several metals and TPH were reportedly detected in blanks associated with the following soil and groundwater samples:

Phase I

- – Boron—STB21SF003
- – Cadmium—STB21SF003
- – Mercury—STB21SF003

Phase II

- November 1995
  - – Antimony—RLA07GWB05, -C05D, -D04
  - – Chromium—RLA07GWA05, -B05, -D04, -D04D
  - – Cobalt—RLA07GWA05, -C05, -D04
  - – Molybdenum—RLA07GWA05, -B05, -C05
  - – Potassium—RLA07GWA05, -A05D, -B05, -B05D, -C05, -C05D, -D04, -D04D
  - – Vanadium—RLA07GWA05

- February 1996
  - – Cadmium—RLA07GWA02, -C02, -D01, -D01D

- Copper—RLA07GWA02, -C02, -D01
- Thallium—RLA07GWA02, -A02D, -B02, -B02D, -C02, -C02D
- Lead—RLA07GWA02
- Selenium—RLA07GWA02, -B02, -C02
- Mercury—RLA07GWD01, -D01D
- Vanadium—RLA07GWD01

- Spring 1996
  - Cadmium—RLA07GWB03
  - Copper—RLA07GWA03, -D02
  - Molybdenum—RLA07GWD02
  - Nickel—RLA07GWC03, -C03D
  - Potassium—RLA07GWC03, -C03D
  - Selenium—RLA07GWA03, -A03D, -B03, -B03D, -D02, -D02D
  - Mercury—RLA07GWD01, -D01D
  - Tin—RLA07GWB03, -C03, -D02
  - Zinc—RLA07GWA03, -A03D, -B03, -D02

- Summer 1996
  - Beryllium—RLA07GWA04, -A04D, -B04, -B04D, -C04, -C04D, -D03, -D03D
  - Boron—RLA07GWA04, -A04D, -B04, -B04D, -C04, -C04D, -D03
  - Chromium—RLA07GWA04, -A04D, -B04, -C04
  - Mercury—RLA07GWA04, -A04D, -B04, -B04D, -C04, -C04D, -D03, -D03D

- Supplemental Groundwater Monitoring
  - Nickel - S7/21BMW01-53, S7/21BMW93-44, S7/21BMW95-04, S7/21BMW01-05, S7/21BMW01-06, S7/21BMW01-07, S7/21BMW01-08

10.4.1.2 Rejected Results. During Phase I, all antimony and selenium soil results were rejected due to poor MS/MSD and laboratory control sample (LCS) recoveries. Additionally, results for seven SVOCs and all PCBs in soil were rejected as a result of calibration problems. Due to these problems, all SVOC analyses were subjected to the Tier 2 validation.

All results for PCB compounds and toxaphene were rejected because they were not included in the calibration standard. Other low responses were noted, particularly for pesticides. Qualifiers were not assigned unless other calibration information was also unacceptable.

- Phase I
  - Antimony—STB21SF003
  - Selenium—STB21SF003
  - 2,4-Dinitrophenol—STB21SF003
  - 2-Chlorophenol—STB21SF003
  - Atrazine—STB21SF003

- beta-Endosulfan—STB21SF003
- Chlordane—STB21SF003
- PCBs (1016, 1221, 1232, 1242, 1248, 1254, 1260, and 1262)—STB21SF003
- Phenol—STB21SF003
- Toxaphene—STB21SF003

Supplemental groundwater monitoring results for 2-butanone were qualified unusable due to low relative response factors and no detections. 2,4-dinitrophenol was not detected and qualified unusable due to low method reporting limit (MRL) continuing calibration verification (CCV) results. 2-butanone and 2,4-dinitrophenol are not compounds of concern and will not negatively impact the data.

- Supplemental Groundwater Monitoring
  - 2-butanone - S7/21BMW01-05, S7/21BMW01-06, S7/21BMW01-07, S7/21BMW01-08, S7/21BMW01-53, S7/21BMW93-11, S7/21BMW93-44, S7/21BMW95-04
  - 2,4-dinitrophenol - S7/21BMW01-05, S7/21BMW01-06, S7/21BMW01-07, S7/21BMW01-08, S7/21BMW01-53, S7/21BMW93-11, S7/21BMW93-44, S7/21BMW95-04, S7/21BMW93-10
  - Hexachlorocyclopentadiene - S7/21BMW93-10

10.4.1.3 Evaluation of Non-Detected Values. A comparison was made between the USEPA Region 5 DQLs and the project CRLs for chemicals that were analyzed ~~for~~ but not detected in environmental media at this site. No exceedances for metals were found.

~~Several groundwater VOCs had reported non-detected values from one to three orders of magnitude greater than the DQLs for at least one event and one location. However, these were limited to less than half the sampling events; acceptable CRLs were achieved at the other site wells for the same VOCs during the same events. Therefore, none of the VOCs warranted identification as having exceeded the DQLs.~~ ***(Groundwater samples were not collected for VOC analyses during Phase I and II)***

MRLs were reviewed for groundwater samples collected during supplemental groundwater monitoring. MRLs were sufficiently low to meet MCLs as stated in the Supplemental Groundwater Monitoring QAPP.

10.4.2 Data Quality Summary

Positive results were changed to nondetects (“U”) for several metals analyzed in groundwater during Phase II. In addition, nickel was qualified "~~u~~U" not detected in several samples collected during supplemental groundwater monitoring. Most of the detections in the affected samples were below quantitation limits, which were below the Region 9 tap water PRG. Therefore, blank contamination does not significantly impact the conclusions of the risk assessment. Phase II soil samples were ~~not~~ analyzed for VOCs only, not for SVOCs or metals. Therefore, chemicals for which results were

rejected for sample STB21SF003 may not be adequately characterized outside of the remediated area. An interim action was conducted at Site 7 where contaminated soil was excavated and disposed offsite. Confirmation sampling of the sidewalls and base of the excavation during the interim action addressed this potential data gap.(EPA98)

10.4.3 Background Screening

10.4.3.1 Surface Soil. The background screening protocol is described in Section 5.1.4.5.2. The results of the background screening procedure for Sites 7 and 21B are shown in Table 10-1d. Since the site sample area had one sample that was analyzed for inorganics, the single concentration of each inorganic was compared to the calculated background threshold value for the appropriate soil series, in this case the Cobbsfork soil series. As shown in the table, the concentration of every inorganic analyte detected in soil at these sites, with the exceptions of arsenic and vanadium, exceeded the background threshold value. Therefore, all detected inorganics except arsenic and vanadium are considered potential contaminants at these sites and are thus carried through to the COPC selection process.

10.4.3.2 Subsurface Soil. Lead was the only inorganic chemical analyzed for in subsurface soil at these sites. The maximum concentration of lead in subsurface soil was compared to the background threshold value for lead. The maximum detected value slightly exceeded the background threshold; therefore, lead was retained as a COPC in subsurface soil at these sites.

10.4.3.3 Groundwater. Because there were only three downgradient groundwater monitoring well locations (MW93-11, MW93-44, and MW95-4) sampled during the RI, the average maximum detected concentration of each inorganic in site groundwater was compared to the groundwater background threshold value (Table 10-2). The four rounds of Phase II sample results from each of these wells were averaged to derive a single data point for each chemical for each well. As shown in the table, aluminum, arsenic, barium, mercury, and molybdenum are retained as preliminary COPCs in groundwater and carried forward through the COPC selection process.

10.4.4. Summary of Analytical Results

The complete soil analytical database for these two sites thus consists of four Phase I and Phase II surface soil samples and four Phase I subsurface soil samples. The groundwater analytical database consists of the 12 Phase II groundwater samples collected from the downgradient wells. ~~The downgradient wells are MW93-11, MW93-44, and MW95-4. The four sample results from each of these wells were averaged to derive a single data point for each chemical for each well.~~

10.5 NATURE AND EXTENT OF CONTAMINATION

10.5.1 Red Lead Disposal Area

10.5.1.1 Soils. The area of potential red-lead contamination was initially defined by visual observation of shallow-soil corings. Soil samples were then collected from the surface and from soil borings within the delineated red-lead area in order to determine the presence of lead in the soils (Figure 10-5). The results from these samples indicate that some lead concentrations exceed the calculated background value of 14.9 µg/g for Cobbsfork soils (Table 10-3). The sample from borehole C taken from 0 to 6 inches deep contained 73 µg/g lead; however, the samples taken at 4 and 5.5 feet contained 10 and 15.5 µg/g lead, respectively, which are not above the background screening criteria. The sample from borehole D taken from 0 to 6 inches deep contained 4,100 µg/g lead, and the other two samples collected from 4 and 6.5 feet deep contained 46 and 230 µg/g lead, respectively. Thus, all of the lead in soil concentrations for borehole D were above the background screening criteria. Surface-soil sample 1A, collected from a red stained area near the corner of Building 211, had a lead concentration of 13,000 µg/g. TCLP analysis of this sample revealed leachable lead at 100 mg/L, which exceeds the TCLP criteria of 5 mg/L by 20 times. Evidence from the soil coring visual inspection revealed that the extent of red-lead-stained soil was very limited. This observation is supported by the fact that samples collected from surface location 2A and boreholes A and B all had lead concentrations less than the background screening criteria. Other metals that were found to exceed their background values in these areas include barium, chromium, cobalt, copper, nickel, silver, and zinc. Aluminum, barium, and beryllium were metals also found to exceed their respective USEPA Region 9 criteria.

10.5.1.2 Monitoring Wells. The three Phase I wells were sampled five times and the one Phase II well was sampled four times, and the groundwater was analyzed for metals (Table 10-4). Zinc was detected above background in the filtered metal sample (but not in the unfiltered sample) of MW93-44, but the concentration was below the USEPA Region 9 criteria. Measurements for total VOCs obtained with an HNU model 101 PID during drilling and the first round of water sampling indicated that no detectable VOCs were present; thus, no samples were submitted for VOC analysis.

Phase II sample results indicate that arsenic is the primary contaminant in Site 7 wells. Maximum arsenic concentrations include 16.8 µg/L in MW93-10, 23.7 µg/L in MW93-11, 31.6 µg/L in MW93-44, and 33.5 µg/L in MW95-04. A review of the total versus filtered results indicate that the arsenic is present in a dissolved state. These results show that arsenic is on the order of 6 to 13 times background and ~~far~~ exceeds the USEPA Region 9 criteria of 0.045 µg/L for carcinogenic risk. The source of the elevated arsenic levels is unknown since arsenic was at background levels in the soils at Site 7. MW93-10, located upgradient of Site 7, also contained elevated arsenic, indicating that the contamination may be originating from another source area.

Other metals that exceeded background in Site 7 wells included aluminum, barium, cadmium, calcium, chromium, copper, iron, lead, molybdenum, tin, and vanadium. Arsenic and barium were metals with concentrations exceeding USEPA Region 9 criteria. Arsenic was present in concentrations ranging from 6.87 to 32.4 µg/L. The source of the arsenic is unknown. Barium was present in above-background concentrations in all four wells, ranging from 739 to 1,170 µg/L or 1.4 to 2.3 times background. The source of the barium is likely the barium sulfate reportedly disposed of at the site. Lead, the primary contaminant of concern in soils at Site 7, was present in only one

sample at a concentration of 1.8 µg/L, ~~well~~ below the USEPA Region 9 criteria ~~of 4.0 µg/l~~. This indicates that vertical migration of lead in soils was limited.

In 2001, four existing site monitoring wells and the four additional monitoring wells (MW01-05, MW01-06, MW01-07, and MW01-08) were sampled (Figure 10-5a). This supplemental groundwater sampling was performed in June (seven wells) and November 2001 (one well, MW93-10). The analytical results were generally consistent with the historical results previously collected during the Phase II RI (Table 10-4). Arsenic concentrations ranged from nondetect (MW01-05) to 81.2 µg/L (MW93-10), and continued to exceed the PRG in seven of the eight monitoring wells at the site. Traces of three VOCs (1,1,1-trichloroethane, acetone, and toluene) were detected at the site in two monitoring wells (MW01-05 and MW95-04). None of the other six wells had VOC detections (Table 10-4a). Bis(2-ethylhexyl)phthalate was the only SVOC detected at the site, and was detected only in well MW93-11 at a concentration of 79 ug/L, exceeding the PRG.

10.5.1.3 Interim Measures Confirmation Samples. Following the removal of approximately 42 cubic yards of contaminated soil, ~~nine~~ eight confirmation samples (plus one duplicate) were collected from the excavation and analyzed for metals (see Figure 10-5). ~~All c~~Confirmatory samples contained lead concentrations below 400 µg/g except at two locations (S07006 at 1,100 µg/g and S07008 at 510 µg/g) where additional excavation had to be done by hand using shovels rather than a backhoe (Table 10-5). Soil from these two locations was removed to ensure that residual lead contamination is below USEPA criteria. No other metals were found to exceed USEPA Region 9 criteria with the exception of arsenic. However, the arsenic concentrations identified in the confirmation samples are below the background levels established for JPG soils. No VOCs were detected in the eight confirmation samples. The area was backfilled with clean soil and a closure report was prepared (Sverdrup 1997b).

10.5.2 Temporary Storage Area at Building 211

10.5.2.1 Soils. The three soil samples (1B, 2B, and 3B) collected during Phase I to assess the potential methylene chloride spill/disposal sites were collected as shown in Figure 10-~~1~~5. The samples were analyzed for metals, PCB/pesticides, TPH, and SVOCs (see Table 10-3). No VOC analysis was performed because no VOCs were detected using a PID and because methylene chloride would not likely persist in surface soils. However, three additional soil samples (4B, 5B, and 6B) were collected from areas near Phase I surface soil sample locations (1B, 2B, and 3B; respectively) during Phase II, and no VOCs were detected in these soil samples.

TPH was detected at 24 µg/g in sample 1B, where there was a black tarry substance on the soil surface. Sample 3B had 10.8 µg/g of TPH, but none was detected in sample 2B where there was no soil staining. Pesticides detected were aldrin, dieldrin, DDT, and its derivatives DDD and DDE, beta-endosulfan, and endrin. Only dieldrin at 3.5 µg/g was found to exceed USEPA Region 9 criteria. Also, fluoranthene was detected in sample 2B. ~~Di-n-butyl phthalate was detected in samples 1 and 3 at low concentrations.~~ **(Compound was not detected according to results presented in Appendix N)**

The 12 surface soil samples collected during Phase II were found to contain low concentrations of several pesticides, including DDT and its derivatives DDD and DDE, aldrin, chlordane, dibutylchlornedate, dieldrin, endrin, heptachlor, heptachlorepoxide, and tetrachloro-methaxylene. The only pesticide detected during Phase II that exceeded USEPA Region 9 criteria was dieldrin. It was detected at concentrations of 0.028 µg/g in STA21SF10, 0.101 µg/g in STA21SF11, and 0.0505 µg/g in STA21SF12, compared to the criteria of 0.028 µg/g.***(Soil samples referenced in this paragraph are for Site 21A, which is discussed in Section 19)***

Metals detected above their 95th percentile criteria include barium (three samples), beryllium (one sample), cadmium (one sample), chromium (three samples), copper (three samples), lead (three samples), manganese (one sample), mercury (one sample), nickel (three samples), silver (three samples), vanadium (one sample), and zinc (three samples). ***(Insufficient number of samples to apply 95th percentile criteria)*** Of the metals, the ones Based on the results for metals (Table 10-3), soil samples that appear to be present at significantlyhave elevated concentrations include: sample 1B— cadmium at 156 µg/g (four times the USEPA Region 9 action level criterion) and lead at 500 µg/g (above the USEPA criteria of 400 µg/g); and sample 2B—lead at 410 µg/g (just above the USEPA criteria of 400 µg/g). The elevated lead concentrations in samples 1B and 2B appeared to be related to the red lead disposal area. The elevated barium, cadmium, chromium, copper, manganese, nickel, vanadium, and zinc concentrations above background may be related to the disposal of other paint wastes because oxides of many of these metals have historically been used in paints. The barium may also be related to the reported disposal of barium sulfate at the site. None of the metals, except cadmium and lead, were found to exceed their respective USEPA Region 9 criteria.

10.5.2.2 Wipe Samples. The results for the three wipe samples collected indoors indicate that a number of unknown SVOCs are present where samples were collected from surfaces coated with oily residues. The metals detected in the wipe samples are boron, barium, copper, manganese, lead, and zinc. The detection of bis(2-ethylhexyl)phthalate, a common plasticizer, may be related to either the use of a plastic template for the wipe sampling or to laboratory-introduced contamination. No explosives were detected on the wipe samples.

10.6 HUMAN HEALTH RISK ASSESSMENT

10.6.1 Selection of the Contaminants of Potential Concern

10.6.1.1 Surface Soil.

10.6.1.1.1 Data Grouping. Due to the small size of these sites and the absence of any hot spots, the three surface soil samples were grouped together for the risk assessment. The analytical data used in the ecological risk assessments at each site are provided in Appendix AA, and the samples

used for human health risk assessment are identified in the data evaluation discussion of each section. All acceptable analytical data were used in the risk assessments. **(EPA17)**

10.6.1.1.2 Frequency of Detection. Evaluation of frequency of detection was not performed due to inadequate sample size.

10.6.1.1.3 Nutrient Screening. The maximum value of each of the nutrients detected in surface soil at this site was less than the corresponding nutrient screening value: calcium (maximum 35,500 µg/g; screening value 1,000,000 µg/g), iron (maximum 15,700 µg/g; screening value 70,000 µg/g), magnesium (maximum 11,100 µg/g; screening value 1,000,000 µg/g), potassium (maximum 644 µg/g; screening value 150,000 µg/g), and sodium (maximum 100 µg/g; screening value 1,000,000 µg/g). Therefore, all nutrients were eliminated as COPCs in surface soil at Sites 7 and 21B.

10.6.1.1.4 Summary of Preliminary COPCs. Table 10-6 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95% UCL of the mean, and the exposure point concentration for each preliminary COPC in surface soil at Sites 7 and 21B. Preliminary COPCs are chemicals detected above background (or above nutrient screening values) in over 5 percent of the samples.

10.6.1.1.5 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for each preliminary soil COPC was compared to the chemical-specific Region 9 residential soil PRG (Table 10-7). One-tenth of the PRG was used for most noncarcinogens. The exception was lead, for which the full PRGs was used. As a result of the screening, aluminum, barium, beryllium, and manganese were ***retained*** as COPCs in surface soil at Sites 7 and 21B.

10.6.1.2 Surface/Subsurface Soil Combined.

10.6.1.2.1 Data Grouping. All surface/subsurface soil samples were grouped together for the purposes of the risk assessment COPC selection process.

10.6.1.2.2 Frequency of Detection. No chemical was detected in fewer than 5 percent of surface/subsurface samples combined.

10.6.1.2.3 Nutrient Screening. The maximum value of each of the nutrients detected in surface soil at this site was less than the corresponding nutrient screening value: calcium (maximum 35,500 µg/g; screening value 1,000,000 µg/g), iron (maximum 15,700 µg/g; screening value 70,000 µg/g), magnesium (maximum 11,100 µg/g; screening value 1,000,000 µg/g), potassium (maximum 644 µg/g; screening value 150,000 µg/g), and sodium (maximum 100 µg/g; screening value 1,000,000 µg/g). Therefore, all nutrients were eliminated as COPCs in surface/subsurface soil at Sites 7 and 21B.

10.6.1.2.4 Summary of Preliminary COPCs. Table 10-6 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95% UCL of the mean, and the exposure point concentration for each preliminary COPC in surface/ subsurface soil combined at Sites 7 and 21B. Preliminary COPCs are chemicals detected above background in either surface or subsurface soil (or above nutrient screening values) in over 5 percent of the samples.

10.6.1.2.5 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for each preliminary soil COPC was compared to the chemical-specific Region 9 residential soil PRG (Table 10-7). The full PRG was used for lead. As a result of the screening, lead, which was the only preliminary COPC in surface/subsurface soil combined, was eliminated as a COPC in the excavation scenario.

10.6.1.3 Air.

10.6.1.3.1 Summary of Preliminary COPCs. Ambient air concentrations to which future receptors at this site might be exposed were estimated using air emission/dispersion modeling, as described in Appendix R. In the site-specific conceptual model, discussed below in Section 10.6.2, Sites 7 and 21B are evaluated under two future site-specific scenarios: as a residential site and as an industrial site.

In the future industrial land use scenario for the facility, all sites were assumed to be industrial except the five sites designated agricultural sites. Each site with particulate-bound COPCs in surface soil (metals, SVOCs, and dioxins/furans) and/or volatile COPCs in surface/subsurface soil combined was assumed to contribute to the air concentrations at all of the sites. In the future residential scenario, all sites were assumed to be residential except for the five sites designated agricultural. It was assumed that particulate and VOC emissions from the strictly residential sites would be negligible because the home sites would be covered with dense vegetation (lawns) and pavement. Therefore, under the residential scenario only the five agricultural sites contribute to the air concentrations at all of the sites. The list of preliminary air COPCs is therefore the same for every site for a given scenario, but the concentrations of the COPCs vary. Tables R-4 and R-6 in Appendix R present the estimated ambient air concentrations at Sites 7 and 21B under the future industrial and residential scenarios, respectively.

10.6.1.3.2 Region 9 Preliminary Remediation Goal Screening. The exposure point concentrations for each preliminary air COPC at Sites 7 and 21B in the future residential scenario and the future industrial scenario were compared to chemical-specific Region 9 air PRGs (Table 10-8). One-tenth of the PRG was used for noncarcinogens. The exception was lead, for which the full PRG was used. As a result of the screening, aluminum, silver, thallium, vanadium, and zinc were retained as COPCs in air for future on-site residents. For future on-site workers, the following chemicals were retained as COPCs in air: aluminum, chromium, manganese, silver, thallium, vanadium, and zinc.

10.6.1.4 Groundwater.

10.6.1.4.1 Data Grouping. ~~The~~ Four to five rounds of metals data from each of the three downgradient wells (MW93-11, MW93-44, and MW95-04) were averaged to derive a single data point for each well.

10.6.1.4.2 Frequency of Detection. Evaluation of frequency of detection was not undertaken at these sites because of too few sample~~s~~ locations.

10.6.1.4.3 Nutrient Screening. The maximum value of each of the nutrients detected in groundwater at these sites is less than the corresponding nutrient screening value: calcium (maximum 110 mg/L; screening value 510 mg/L), iron (maximum 1.9 mg/L; screening value 9.4 mg/L), magnesium (maximum 49.7 mg/L; screening value 200 mg/L), potassium (maximum 2.4 mg/L; screening value 20 mg/L), and sodium (maximum 59.3 mg/L; screening value 730 mg/L). Nutrients are, therefore, eliminated as COPCs in groundwater at these sites

10.6.1.4.4 Summary of Preliminary COPCs. Table 10-9 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95% UCL of the mean, and the exposure point concentrations for each preliminary COPC in groundwater at Sites 7 and 21B. Groundwater preliminary COPCs are chemicals detected above background (and/or above the nutrient screening value) at a frequency of greater than 5 percent in groundwater samples.

10.6.1.4.5 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for each preliminary groundwater COPC was compared to the chemical-specific Region 9 tap water PRG (Table 10-10). One-tenth of the PRG was used for noncarcinogens. As a result of this screening, arsenic and barium ~~a~~were selected as COPCs in groundwater at these sites.

10.6.2 Exposure Assessment

10.6.2.1 Site Conceptual Model.

As described in Section 5.1.4.6, ~~T~~there are currently no people who specifically work at or frequent Sites 7 and 21B. There are, however, several types of individuals who could potentially be affected by the existing contamination at the facility. These are current trespassers to JPG and off-facility (nearby) rural residents and future hunters. In each case, these individuals would most likely be impacted simultaneously by multiple sites rather than by single units. Because of this, these current and future receptor populations are addressed on a facility-wide, cumulative basis rather than by specific sites (see Sections 28 and 29).

Therefore, this site-specific exposure scenario only addresses future land use development. Sites 7 and 21B have two potential future land uses forwarded for evaluation:

- Residential

- Industrial

Residential Use. Under the future residential land use scenario, this site is assumed to be developed for residential purposes, with the supposition that a family would build a house directly on/within this area of potential concern.

With respect to a risk assessment analysis, resident populations were assumed to consist of both adults and toddlers. Each individual would be expected to come in contact with site contaminants via the following pathways at Sites 7 and 21B:

- Inhalation of VOCs and fugitive particulates from soils
- Dermal contact with soil while gardening/playing outdoors
- Incidental ingestion of soil while gardening/playing outdoors
- Ingestion of fresh homegrown fruits and vegetables
- Ingestion/dermal contact with groundwater
- Inhalation of VOCs while showering/bathing

On-site Worker. Industrial land use is considered to be a plausible future option for this site at JPG. On-site industrial workers ~~(adult males and females)~~ are assumed to be individuals who could be exposed directly to contaminated media through the following pathways at Sites 7 and 21B:

- Inhalation of VOCs and fugitive particulates from soils
- Incidental ingestion/dermal contact with surface soil

10.6.2.2 Exposure Point Concentrations.

10.6.2.2.1 Air. The estimated ambient air concentrations of COPCs at these sites for the future on-site residents and the future on-site workers are presented in Table 10-8.

10.6.2.2.2 Soil. The concentrations of COPCs in surface soil at these sites are presented in Table 10-7. No COPCs were selected in surface/subsurface soil combined at Sites 7 and 21B.

10.6.2.2.3 Fruits and Vegetables. COPC concentrations in homegrown fruits and vegetables were estimated using the methods described in Section 5.1.5.2.8. Appendix U, Table U-5, documents the calculation of contaminant concentrations in fruits and vegetables grown in surface soil at Sites 7 and 21B.

10.6.2.2.4 Groundwater. The concentrations of COPCs in groundwater at Sites 7 and 21B are presented in Table 10-10.

10.6.2.2.5 Shower Air. There are no VOC COPCs in groundwater at Sites 7 and 21B; therefore, inhalation of VOCs in shower air is an incomplete pathway at these sites.

10.6.2.3 Human Exposure Doses.

10.6.2.3.1 Inhalation of Contaminated Air. Inhalation of airborne contaminants (VOCs and particulates) is a potential route of exposure for future on-site residents (adults and children) and future on-site workers at this site. The equation used for calculating human exposure doses of COPCs due to inhalation of volatile and dust-bound contaminants is provided in Section 5.1.5.3.1, Table 5-~~12~~11. Table V-15, Appendix V, documents the calculation of human exposure doses at Sites 7 and 21B due to inhalation of contaminated air.

10.6.2.3.2 Incidental Ingestion of Contaminated On-site Soil. Mouthing behavior (toddlers) and incidental ingestion of soil with recreational or work-related activities may expose human receptors to contaminated soil at a site via the oral route of exposure. The equation used to calculate the human exposure dose due to incidental ingestion of contaminated soil is presented in Section 5.1.5.3.2, Table 5-~~13~~12. This pathway was assumed to be complete at Sites 7 and 21B for future on-site residents (adults and children) and future on-site workers. Table V-5, Appendix V, documents the calculation of human exposure doses due to incidental ingestion of soil at Sites 7 and 21B.

10.6.2.3.3 Dermal Contact with Contaminated On-site Soil. The chemicals in contaminated soil also may be absorbed into a receptor's body through dermal contact. The equation used to calculate chemical doses due to dermal contact with contaminated soil is presented in Section 5.1.5.3.3, Table 5-~~14~~13. This pathway is relevant for future on-site residents (adults and children) and future on-site workers at Sites 7 and 21B. Table V-5, Appendix V, documents the calculation of human exposure doses due to dermal contact with soil at this site.

10.6.2.3.4 Ingestion of Contaminated Fruits and Vegetables. Consumption of contaminated homegrown fruits and vegetables may be a source of chemical exposure for future on-site residents (adults and children). The equation used to calculate human exposure dose due to ingestion of contaminated fruits and vegetables is provided in Section 5.1.5.3.11, Table 5-~~23~~22. Table U-5, Appendix U, documents the calculation of human exposure doses due to ingestion of contaminated fruits and vegetables grown in surface soil at Sites 7 and 21B.

10.6.2.3.5 Ingestion of Contaminated Groundwater. Contaminated drinking water may be a source of chemical exposure for future on-site residents (adults and children) and future workers. The equation used to calculate human exposure doses due to ingestion of contaminated drinking water is provided in Section 5.1.5.3.4, Table 5-~~15~~14. Table V-5, Appendix V, documents the

calculation of human exposure doses at Sites 7 and 21B due to ingestion of contaminated groundwater.

10.6.2.3.6 Dermal Contact with Contaminated Groundwater. Exposure via dermal contact with chemicals in groundwater may occur when receptors (future residents) shower or bathe. The equation used to calculate daily chemical doses due to dermal contact with contaminated groundwater is provided in Section 5.1.5.3.5, Table 5-~~16~~15. Table U-5, Appendix U, documents the calculation of human exposure doses at Sites 7 and 21B due to dermal contact with contaminated groundwater.

10.6.3 Risk Characterization

10.6.3.1 Chronic Health Hazards. The noncancer daily exposure doses calculated in the exposure assessment were used to calculate HQs for each of the COPCs possessing RfDs. Pathway-specific and overall HIs were then calculated for each receptor. The calculations of HQs and HIs are described in Section 5.1.7.1. If an overall HI is calculated to be greater than 1.0 for a particular receptor, then the exposure pathway(s) primarily responsible for the result is identified as a "critical pathway(s)." For each critical pathway, those chemical contaminants responsible for the majority of the HI are listed as COCs. Table W-5, Appendix W, documents the calculation of the pathway- and chemical-specific HQs for the human receptors at Sites 7 and 21B. The pathway-specific and overall HIs are summarized in Table 10-11.

10.6.3.1.1 Future On-Site Residents. The overall HIs for the future on-site adult and toddler residents at Sites 7 and 21B are calculated to be **3.4**~~3.5~~ and **8.0**~~8.5~~, respectively. Both of these HIs exceed the USEPA's risk management criterion of 1.0. The critical exposure pathway for both receptors is ingestion of groundwater, and arsenic is the only noncarcinogenic COC.

10.6.3.1.2 Future On-Site Workers. The overall HI for the future on-site worker at Sites 7 and 21B is calculated to be 1.3, which exceeds the USEPA's risk management criterion of 1.0. The critical exposure pathway for this receptor is ingestion of groundwater, and arsenic is the ~~sole~~only noncarcinogenic COC.

Arsenic is naturally occurring in groundwater at the JPG facility. The relative contributions of background groundwater concentrations of arsenic to the groundwater hazards at this site were estimated by comparing the average groundwater background concentration of arsenic to the average concentration in site groundwater. Background arsenic accounts for approximately 9.3 percent of the total arsenic concentration in groundwater at this site.

Background arsenic in groundwater would contribute 9.3 percent to the total cancer risks estimated for the groundwater exposure pathways at this site.

10.6.3.2 Excess Lifetime Cancer Risks. The cancer risks for each receptor were determined from the pathway-specific exposure doses and the route-specific SFs, as described in Section 5.1.7.2. To

assess the simultaneous exposure of a receptor population to multiple carcinogens from multiple exposure routes, all of the cancer risks calculated for a receptor population were summed. Each overall receptor cancer risk was then compared to USEPA's target risk range (1.0E-06 to 1.0E-04). If the total cancer risk for a receptor from all exposure pathways is less than 1.0E-04, then it is concluded that the site(s) does not pose a significant risk to that receptor. If the overall cancer risk exceeds the target risk range, any chemical individually associated with a risk level greater than 1.0E-05 is identified as a COC. COCs represent the primary contributors to the potential cancer risk for the receptor-specific exposure pathway under evaluation. Table W-5, Appendix W, documents the calculation of the pathway- and chemical-specific cancer risks for the human receptors at Sites 7 and 21B. The pathway-specific and overall cancer risks are summarized in Table 10-11.

10.6.3.2.1 Future On-Site Residents. The overall cancer risks for the future adult and toddler residents at Sites 7 and 21B are calculated to be 5.4E-04 and **2.5E-04**~~2.6E-04~~, respectively. These cancer risks exceed the USEPA's target risk range of 1.0E-06 to 1.0E-04. The critical exposure pathway for both receptors is ingestion of groundwater, and arsenic is the ~~sole~~only carcinogenic COC.

10.6.3.2.2 Future On-Site Workers. The overall cancer risk for the future on-site worker at Sites 7 and 21B is calculated to be **1.6~~3~~E-04**~~1.6E-04~~. This cancer risk exceeds the USEPA's target risk range of 1.0E-06 to 1.0E-04. The critical exposure pathway for this receptor is ingestion of groundwater, and arsenic is the ~~sole~~only carcinogenic COC.

Background arsenic in groundwater would contribute 8.2 percent to the total HI estimated for the groundwater exposure pathways at this site.

10.6.3.3 Uncertainty/Sensitivity Analysis. The numerical risks/hazards that are calculated for Sites 7 and 21B represent *conditional* estimates of risk based on various simplifying assumptions concerning contaminant exposure and toxicity. These estimates of risk/hazard are derived using a series of conservative procedures that address contaminant concentrations at the site, their fate in the environment, how someone currently or in the future might be exposed to these contaminants, and the toxicity of each chemical toward humans. The uncertainty analysis therefore specifies, when appropriate, the critical assumptions made for the site so that the site-specific results can be interpreted in a proper context by risk managers.

To assist the risk managers in this project, a qualitative uncertainty analysis has been performed. The qualitative uncertainty analysis (1) itemizes the major areas of uncertainty in the site-specific risk assessment and (2) demonstrates that the assessment overall has been conservatively performed (i.e., that the potential risks/hazards at the site have not likely been underestimated, but may have been significantly overestimated).

The qualitative uncertainty analysis for this site is presented in Table 10-12. Based on this analysis, it can be concluded that this risk assessment is conservative. Some of the major uncertainties in this study that are most influential to the risks/hazards that were calculated include:

- Receptors' exposure frequency (350 days/year)
- Receptors' groundwater ingestion rate (2 L/day)
- Maximum detected concentration of arsenic in groundwater used

In addition, Phase I antimony results obtained by USATHAMA-certified methods were acceptable under USATHAMA QA/QC guidelines, but were later rejected in accordance with EPA CLP functional guidelines for data review. The rejected data were not used quantitatively in this risk assessment. The absence of antimony analytical data may underestimate risk to human health and ecological receptors. (EPA103)

10.7 ECOLOGICAL RISK ASSESSMENT

10.7.1 Ecological Site Description

Because of ~~recent~~the interim measures and the existence of the piping and railroad tracks, there ~~i~~was little vegetation or wildlife habitat at Building 211 (Site 7/21B). **Refer to Table 10.7-a1 for a summary of Site 21B ecological habitat characteristics identified during site visits. (EPA184)** -Refer to Figure 10-5 for the combined site figure. **Refer to Figure 5.3-13 for a map of habitat types at JPG. (EPA184)**

10.7.2 Site 7/21B Investigations

For convenience to the reader, summary statistics, EPCs, risk driver HQs, total RME and CT HIs are provided in this section. All intakes and other non risk-driving HQs are located in Appendix AA. **The COPCs for each medium evaluated in the DERA are presented on the EPC tables in this section. Refer to Appendix AA for details pertaining to the specific data sets (e.g., sample numbers, depths, dates, etc.) used in the risk assessment for Sites 7 and 21B. (EPA179)**

10.7.2.1 Phase I Activities. The Phase I summary statistics for Site 7 are provided in Table 10.7-1. Table 10.7-2 provides the EPCs for Site 7. The Phase I summary statistics for Site 21B are reported in Table 10.7-3; the EPCs for Site 21B are presented in Table 10.7-4.

10.7.2.2 Phase II Activities. Phase II data were not collected at Site 7. However, Phase II data were collected at Site 21B. Table 10.7-5 reports the summary statistics available for the Phase II sampling for Site 21B; Table 10.7-6 presents the EPCs.

10.7.2.3 Interim Measures and Phase III Activities. IM confirmation sampling data for Site 7/21B are summarized in Table 10.7-7 and the EPCs based on these data presented in Table 10.7-8. **IM confirmation samples were collected from an excavated area from surface to 1 foot in depth**. There were no Phase III sampling activities at this location.

10.7.3 Exposure and Ecological Effects Profile

Birds and mammals may be exposed to COPCs by direct contact with or ingestion of soil. No surface water data were available at Site 7/21B. To determine the estimated intakes of the COPCs, various key receptor species were selected to evaluate the impacts to area wildlife. The key receptors evaluated for Site 7/21B include mourning dove, chimney swift, American kestrel, wild turkey, white-footed mouse, eastern cottontail, red fox, little brown myotis, plants, and soil fauna.

The conceptual site models (CSMs) for Sites 7 and 21B provide an overview of the ecological receptors and exposure pathways evaluated in the ecological risk assessment. Refer to Figures 10.7-1a and 10.7-1b for schematics of the CSMs. Multiple lines of evidence were evaluated for the ecological assessment conducted at Sites 7 and 21B. Terrestrial lines of evidence were evaluated for both sites. The lines of evidence were primarily hazard index (HI) calculations for a number of different receptors. Toxicity testing was not conducted at Sites 7 and 21B. Refer to Table 7.7-11a for a summary of the terrestrial lines of evidence. (EPA180a,b)

The exposure pathways and receptors evaluated at this site are as follows:

- Terrestrial Ecosystem
  - All wildlife receptors—soil ingestion
  - All wildlife receptors—dietary ingestion
  - Plants—direct contact with soil
  - Soil fauna—direct contact with soil

10.7.3.1 Selection of COPCs. Inorganic analytes from soil data collected during Phases I and II and IM confirmation sampling were compared to the JPG Phase II background data set (Section 5.3.2.1). Analytes which were not statistically elevated relative to background were removed from consideration as COPCs. The COPCs for Sites 2/27 in the various media are presented in Tables 10.7-1 through 10.7-8.

Beryllium, cadmium, and selenium were not detected in soil at Site 7 in the Phase I data, nor was selenium detected at Site 21B. All other inorganic analytes were retained as COPCs.

Phase II sampling at Site 21B was limited to organics (i.e., pesticides/PCBs); as such, all organic analytes were retained as COPCs.

Neither beryllium nor selenium was detected in the soil for the IM confirmation sampling data. Aluminum, arsenic, iron, and manganese were removed as COPCs since their soil concentrations were not statistically elevated above background.

10.7.3.2 Comparison of Site Data to Reference Area Concentrations. ~~A comparison of site soil concentrations for Phase I and Phase II to reference area soil concentrations was not performed~~. ~~at the time of this report due to schedule constraints.~~ Statistical comparisons were not performed for site data (Phases I and II) vs. reference soil area soil concentrations; however, risks based on the Phase I and Phase II soil concentration data were compared to Cobbsfork, Rossmayne, and Avonburg reference area sample data; these data were collected in 1997. Phase III data were not included in this comparison. (EPA198)

10.7.4 Risk Characterization

10.7.4.1 Risk Estimation. The HIs are summarized for each sampling event and receptor below. The HIs have been grouped by order of magnitude for discussion purposes. HIs based on RME and CT exposure parameters are presented. In addition, a ~~conservative~~ NOAEL-based TRV and a dose at which population-level effects may occur (LOAEL-based TRV) were used to establish the lower and upper bounds on toxicity, respectively.**(EPA121)** These values define the risk boundaries. There are thus four sets of HI values for each location and sampling event (NOAEL-RME, NOAEL-CT, LOAEL-RME, and LOAEL-CT). The HQs are presented in Appendix AA. Figures 10.7-1 through 10.7-16 show the total NOAEL and LOAEL-based HI risks for both the RME and CT exposure scenarios by receptor. The reference area RME-NOAEL HIs were presented graphically only on the RME-NOAEL site graphs due to the low risks generally observed.

Site 7

Phase I RME NOAEL HIs
(See Figure 10.7-1)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Eastern Cottontail, Red Fox, Little Brown Myotis
HI Range 1.1-10: None
HI Range 10.1-100: Soil Fauna
HI Range 100.1-1000: Plants, White-footed Mouse

Phase I RME LOAEL HIs
(See Figure 10.7-2)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Eastern Cottontail, Red Fox, Little Brown Myotis
HI Range 1.1-10: Soil Fauna
HI Range 10.1-100: Plants, White-footed Mouse
HI Range 100.1-1000: None

Phase I CT NOAEL HIs
(See Figure 10.7-3)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Eastern Cottontail, Red Fox, Little Brown Myotis
HI Range 1.1-10: None
HI Range 10.1-100: White-footed Mouse
HI Range 100.1-1000: None

Phase I CT LOAEL HIs
(See Figure 10.7-4)
Key Receptors with HI range 0-1: Wild Turkey, Red Fox, American Kestrel, Mourning Dove, Chimney Swift, Eastern Cottontail, Little Brown Myotis
HI Range 1.1-10: White-footed Mouse
HI Range 10.1-100: None
HI Range 100.1-1000: None

Site 21B

Phase I RME NOAEL HIs
(See Figure 10.7-5)
Key Receptors with HI range 0-1: Mourning Dove, Wild Turkey, Red Fox, American Kestrel
HI Range 1.1-10: Chimney Swift, Little Brown Myotis, Eastern Cottontail
HI Range 10.1-100: None
HI Range 100.1-1000: Plants, Soil Fauna
HI > 1000: White-footed Mouse

Phase I RME LOAEL HIs
(See Figure 10.7-6)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Eastern Cottontail, Red Fox, Little Brown Myotis
HI Range 1.1-10: None
HI Range 10.1-100: White-footed Mouse, Plants, Soil Fauna
HI Range 100.1-1000: None

Phase I CT NOAEL HIs
(See Figure 10.7-7)
Key Receptors with HI range 0-1: Mourning Dove, Wild Turkey, Red Fox
HI Range 1.1-10: Chimney Swift, American Kestrel, Eastern Cottontail, Little Brown Myotis
HI Range 10.1-100: None
HI Range 100.1-1000: White-footed Mouse

Phase I CT LOAEL HIs
(See Figure 10.7-8)
Key Receptors with HI range 0-1: Wild Turkey, Red Fox, American Kestrel, Mourning Dove, Chimney Swift, Eastern Cottontail, Little Brown Myotis
HI Range 1.1-10: None
HI Range 10.1-100: White-footed Mouse
HI Range 100.1-1000: None

Site 21B

Phase II RME NOAEL HIs
(See Figure 10.7-9)
Key Receptors with HI range 0-1: Mourning Dove, Wild Turkey, Red Fox, Chimney Swift, American Kestrel, Little Brown Myotis, Eastern Cottontail, Plants, Soil Fauna
HI Range 1.1-10: White-footed Mouse
HI Range 10.1-100: None
HI Range 100.1-1000: None

Phase II RME LOAEL HIs
(See Figure 10.7-10)
Key Receptors with HI range 0-1: Mourning Dove, Wild Turkey, Red Fox, Chimney Swift, American Kestrel, Little Brown Myotis, Soil Fauna, White-footed Mouse, Eastern Cottontail, Plants, Soil Fauna
HI Range 1.1-10: None
HI Range 10.1-100: None
HI Range 100.1-1000: None

Phase II CT NOAEL HIs
(See Figure 10.7-11)
Key Receptors with HI range 0-1: Wild Turkey, Red Fox, American Kestrel, Mourning Dove, Chimney Swift, Little Brown Myotis, Eastern Cottontail, White-footed Mouse
HI Range 1.1-10: None
HI Range 10.1-100: None
HI Range 100.1-1000: None

Phase II CT LOAEL HIs
(See Figure 10.7-12)
Key Receptors with HI range 0-1: Wild Turkey, Red Fox, American Kestrel, Mourning Dove, Chimney Swift, Little Brown Myotis, Eastern Cottontail, White-footed Mouse
HI Range 1.1-10: None
HI Range 10.1-100: None
HI Range 100.1-1000: None

Site 7/21B

IM RME NOAEL HIs
(See Figure 10.7-13)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Red Fox, Little Brown Myotis
HI Range 1.1-10: Eastern Cottontail
HI Range 10.1-100: Soil Fauna, Plants
HI Range 100.1-1000: White-footed Mouse

IM RME LOAEL HIs
(See Figure 10.7-14)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Eastern Cottontail, Red Fox, Little Brown Myotis, Soil Fauna
HI Range 1.1-10: Plants
HI Range 10.1-100: White-footed Mouse
HI Range 100.1-1000: None

IM CT NOAEL HIs
(See Figure 10.7-15)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Red Fox, Little Brown Myotis
HI Range 1.1-10: Eastern Cottontail
HI Range 10.1-100: White-footed Mouse
HI Range 100.1-1000: None

IM CT LOAEL HIs
(See Figure 10.7-16)
Key Receptors with HI range 0-1: Wild Turkey, Red Fox, American Kestrel, Mourning Dove, Chimney Swift, Eastern Cottontail, Little Brown Myotis
HI Range 1.1-10: None
HI Range 10.1-100: White-footed Mouse
HI Range 100.1-1000: None

10.7.4.2 Risk Description. HIs are highest for the white-footed mouse, plants, and soil fauna. For the Phase I data, only risks for plants were higher at Site 7 than risks at the reference areas (Figure 10.7-1).

Risks for all receptors except white-footed mouse, plant and soil fauna were below reference area risks for Site 21B Phase I. High risks to the white-footed mouse were observed (HI_{total}=1091) (Figure 10.7-5).

The Site 21B Phase II data were only for pesticides and PCBs in soil. The Phase II data indicated no risk to any ecological receptor except the white-footed mouse. The RME NOAEL-based total HI for the white-footed mouse was just slightly above 1 (Figure 10.7-9).

The IM confirmation sampling data for metals at Site 7/21B indicated little potential for elevated risk (Figure 10.7-13) since HIs for receptors at Site 7/21B were similar to or lower than those at the reference areas.

The HIs for each reference area and the inherent JPG Phase II background risks can be found in Section 32.

10.7.4.2.1 Risk Drivers/Summary of Lines of Evidence. Risk drivers associated with Sites 7 and 21B are summarized in Tables 10.7-9 through 10.7-14. A COPC was categorized as a risk driver if it produced an HQ greater than or equal to 1 for any exposure pathway. There were no risk drivers associated with Phase II organic data collected at Site 21B.

In addition, to provide an overall summary of the multiple lines of evidence that were evaluated for the Sites, a summary table was developed. The lines of evidence were primarily hazard index (HI) calculations for a number of different receptors. Refer to Table 7.7-11a for a summary of the lines of evidence. A number of measurement endpoints were assessed for the terrestrial ecosystem. An evaluation was made of which measurement endpoints were most sensitive in determining the potential for an ecological concern by ecosystem. (EPA180a,b)

Terrestrial Ecosystem

The most sensitive of the terrestrial measurement endpoints for both sites are plants and white-footed mice. The highest reasonable maximum exposure (RME) no observed adverse effect level (NOAEL)-based hazard indices (HIs) for each of these receptors are as described below. For Site 7, the HIs are: 384 (plants) and 104 (white-footed mice). The primary contributor of risk to plants is aluminum (RME NOAEL HQ of 324) from direct contact with soil. This HQ was derived using Phase I data. The primary contributors of risk to white-footed mice are vanadium (RME NOAEL HQ of 30) from direct contact with soil and cadmium (RME NOAEL HQ of 26) from dietary ingestion. These HQs were derived using IM data.

For Site 21B, the HIs are: 1091 (white-footed mice) and 376 (plants). The primary contributors of risk to white-footed mice are cadmium (RME NOAEL HQ of 818) and dieldrin (RME NOAEL HQ of 111) from dietary ingestion. The primary contributor of risk to plants is aluminum (RME NOAEL HQ of 294) from direct contact with soil. These HQs were derived using Phase I data.

Although the HIs for white-footed mice exceeded 1 for Sites 7 and 21B, Site 7 HIs are similar to HIs calculated for reference areas. The HIs for white-footed mice at Site 21B are above the HI calculated for reference areas, but they are within an order of magnitude of the reference area HIs. The HIs for plants at Sites 7 and 21B are above the HIs calculated for reference areas, but they are within an order of magnitude of the reference area HIs. (EPA180a,b)

10.7.4.3 Uncertainty Analysis. The analytical soil data for Site 7 and 21B from Phase I, and Phase II pesticide data at Site 21B, and IM confirmation sampling at Site 7/21B make risk estimates at this location more uncertain. This is because the Phase I data are older than the Phase II and III data and were collected and analyzed by different methodologies. In addition, only pesticides in soil were analyzed at Site 21B in Phase II. The Phase III reference area data are not strictly comparable; however, no other basis of comparison was available. Since there are inherent levels of risk, it is important to compare site risks to reference areas as a reality check on the risk assessment. It is worth noting that the extent of ecological habitat at this location is almost nonexistent.

Uncertainty in the exposure estimates is due primarily to:

- Variability in the exposure parameters, which produce a natural distribution of the variables in the intake equations for each of the receptors;
- Exposure parameters derived from literature, not measured on site;
- Uncertainty in the dietary ingestion pathway, which utilized BAFs to predict dietary concentrations;
- Variation in the concentrations of COPCs in the environment;
- Uncertainty as to whether the most conservative pathways have been addressed and evaluated.

The predicted effect of each of these sources of uncertainty on the risk assessment is as follows:

Variability in the exposure parameters—Because both the average and RME scenarios were quantitatively addressed, this source of uncertainty is expected to have no overall effect on the risk assessment results.

Exposure parameters derived from literature—Because so many ecological receptors were quantitatively considered in the ecological risk assessment, this source of uncertainty is expected to have no overall effect on the risk assessment.

Uncertainty in the dietary ingestion pathway—The use of literature-based BAFs or BCFs is expected to overestimate as opposed to underestimate concentrations in the dietary pathway. This is because under laboratory conditions, animals are chronically exposed on a daily basis and

supposedly reach steady state. In the wild, as animals move in and out of contaminated areas, metabolism and excretion are expected to reduce the body burden. Use of field-based BAFs from TEAD are not expected to overestimate or underestimate risk for these analytes, since these data were measured in conjunction with co-located soil samples.

Variation in the concentrations of COPCs in the environment—This uncertainty is not expected to bias the risk assessment towards underestimation of risk since maximum or UCL95 concentrations were used in all exposure scenarios to estimate the EPCs.

Uncertainty as to whether the most conservative pathways have been addressed—The receptors were considered carefully by the DSG, and typically have high exposure rates due to their life-histories (i.e., ground-feeding or burrowing). Therefore, this source of uncertainty is not expected to impact the risk assessment.

10.7.5 Ecological Risk Assessment Summary

The conceptual site models (CSMs) for Sites 7 and 21B provide an overview of the ecological receptors and exposure pathways evaluated in the ecological risk assessment. Refer to Figures 10.7-1a and 10.7-1b for schematic of the CSMs. Sites 7 and 21B will likely be used for industrial purposes in the future. This future land use will alter the current CSMs.

Multiple lines of evidence were evaluated for the ecological assessment conducted at these sites. For both sites, terrestrial lines of evidence were evaluated. The lines of evidence were primarily hazard index (HI) calculations for a number of different receptors. Toxicity testing was not performed at Site 7/21B. Refer to Table 7.7-11a for a summary of the terrestrial ecosystem lines of evidence. (EPA180a,b)

The following is an overall summary of the key results of the ecological risk assessment for Sites7 and 21B. ~~The following summary is based on an initial review of the data. A full evaluation of whether or not the data meet all DQOs, and further statistical examination, will be made prior to finalizing these results for the next version of this report.~~

Site 21B appeared to pose a threat to ecological health prior to removal actions.

- HIs based on the IM Confirmation Sampling Data are within the same order of magnitude, or lower than, those observed at the reference areas.

- Ecological risk at Site 7/21B ~~has been successfully remediated~~ have been minimized by the remediation activities It should be noted that Site 7/21B is anticipated to be used for industrial purposes. The ecological risk assessment was conducted under the assumption that the Site would be managed as ecological habitat, which is not the case if it becomes industrial property.

10.8 CONCLUSIONS AND RECOMMENDATIONS

~~Metals~~ Lead soil contamination identified during the Phase I RI at the Red Lead Disposal Area (Site 7) was found to exceed USEPA risk-based cleanup criteria and was therefore included in the USACE's interim measures program at JPG. In the summer of 1996, contaminated soils were excavated and properly disposed of off-site. Confirmation samples collected in October 1996 indicated that only two small locations within the excavated area still contained lead contamination exceeding the ~~cleanup goal~~PRG of 400µg/g. These locations were then hand-excavated to remove the remaining contamination.

For the Temporary Storage Area at Building 211 (Site 21B), metals, pesticides, SVOCs, and TPH were detected in surface soil samples. Of these contaminants, only the metals aluminum, barium, beryllium, and manganese were found to exceed USEPA Region 9 PRGs and were retained as COPCs for the human health risk assessment.

Groundwater at Site 7 was found to contain aluminum, arsenic, barium, mercury, molybdenum, and zinc exceeding their respective background concentrations. Of these metals, arsenic and barium were found to exceed USEPA Region 9 PRGs and were retained as COPCs for the human health risk assessment.

Results of the human health risk assessment indicate that carcinogenic risk and chronic health hazard estimates exceed USEPA risk management criteria for both future on-site workers and future on-site residents due to the presence of elevated arsenic in groundwater. For both future exposure scenarios, the critical exposure pathway is ingestion of contaminated groundwater with arsenic being the sole COC.

Results of the ecological risk assessment indicate that contamination at Site 21B appeared to pose a threat to ecological health prior to the interim measures removal action. Utilizing the interim measures sampling results, the estimated HIs for ecological receptors are now within the same order of magnitude, or lower than those of the reference areas. As a result, it appears that Sites 7/21B have been remediated to a point that ecological risk is acceptable for these sites especially considering the sites intended future use is industrial in nature.

Based on the estimated future risks to human health that exceed USEPA risk management criteria, it is recommended that this site be carried forward to the FS process. The source of the elevated arsenic in groundwater is unknown since upgradient groundwater was also found to contain elevated concentrations. **For example, a sample from monitoring well MW93-10, located upgradient of Building 211, was collected and analyzed in November 2001, and was found to have a concentration of arsenic (81.2 µg/L) in excess of the PRG. While in the other site wells the arsenic concentrations (ranging from 16.8 to 32.4 µg/L) are notably higher than those detected in the facility background wells (2.6 µg/L), they are still within the range of natural concentrations commonly observed in groundwater.** ~~Further investigation into the source of~~

~~arsenic in groundwater may be warranted. It is possible that the~~ Therefore, arsenic may be related to a natural source in soils upgradient of the site. **Comparisons between Site 7 and background wells will be periodically made and interpreted. Additional studies of the possible source for arsenic in groundwater as it pertains to potential remedial technologies will be evaluated in the FS. (IN17)** Based on the confirmation sample results for interim measures conducted at the Red Lead Area and on the risk assessment results for soils representing residual contamination, it appears that no unacceptable risks remain at Sites 7 and 21B, ~~if~~ excluding the groundwater pathway. ~~is excluded.~~ It is concluded that no further remedial investigation activities are warranted with the exception of evaluating the potential source of arsenic contamination in groundwater.

TABLES

TABLE 10-1a

Groundwater Monitoring Well Information Summary
Sites 7 - Red Lead Disposal Area and 21B - Temporary Storage Area
Jefferson Proving Ground
South of the Firing Line
Madison, Indiana

Site	Well ID	Date Installed	Location (ft)		Elevation (ft)		Well Depth (ft)	Depth to Top of Rock (ft)	Well Diameter (In)	Screen Length (ft)	Screen Interval (ft)	Screened Unit	Gradient Relation
			Northing	Easting	TOC	Ground							
Site 7 and 21B	MW93-10	04/18/93	486680.23	571942.72	872.68	870.66	48.0	39.5	4.0	10.5	37.7-48	Till/Bedrock	Up
	MW93-11	04/19/93	486537.45	571577.58	871.35	869.16	50.0	41.0	4.0	10.5	39.5-50	Till/Bedrock	Down/Side
	MW93-44	06/23/93	486395.47	571687.74	872.79	870.72	52.5	43.0	4.0	10.5	42-52.5	Till/Bedrock	Down/Side
	MW95-04	10/25/95	486431.15	571565.44	868.86	NR	49.5	39.5	4.0	10.0	39.5-49.5	Till/Bedrock	Down
	MW01-05	05/30/01	486435.18	571423.88	869.25	866.38	70.0	40.0	2.0	5.0	65-70	Laurel Dm.	Down
	MW01-06	05/25/01	486436.84	571441.43	868.69	866.07	44.0	40.0	2.0	10.0	34-44	Till/Bedrock	Down
	MW01-07	05/31/01	486357.30	571442.37	872.55	869.81	67.0	41.0	2.0	5.0	62-67	Laurel Dm.	Down
	MW01-08	06/01/01	486356.31	571425.75	872.32	869.82	47.0	42.0	2.0	10.0	37-47	Till/Bedrock	Down

Notes:
1. Information summarized in this table was taken from the Draft Phase II Remedial Investigation (RI) by Rust Environmental and Infrastructure dated August 1998.
2. Horizontal coordinates relative to Indiana State Coordinates - East Zone, 1927. Vertical coordinate tied to JPG monuments relative to NAD1929.
3. NR = Information not reported in the Draft Phase II RI.
4. Well location and elevation data for sites 12A and 12B are from a December 2001 survey performed by Classickle Inc.

TABLE 10 -1b

Summary of Monitoring Well Survey Data and Groundwater Elevations
Site 7 - Red Lead and Site 21b - Temporary Storage Areas
Jefferson Proving Ground
Madison, Indiana

	MW93-10	MW93-11	MW93-44	MW95-04	MW01-05	MW01-06	MW01-07	MW01-08
Elevations								
Top of Casing	872.68	871.35	872.79	868.86	869.25	868.69	872.55	872.32
Land Surface	870.66	869.16	870.72	NR	866.38	866.07	869.81	869.82
Top of Screen	833.2	829.7	828.7	NA	801.4	832.1	807.8	832.8
Well Bottom	822.7	819.2	818.2	NA	796.4	822.1	802.8	822.8
Top of Rock	831.2	828.2	827.7	NA	826.4	826.1	828.8	827.8
Well Depth	48.0	50.0	52.5	49.5	70.0	44.0	67.0	47.0
Screen Length	10.5	10.5	10.5	10.0	5.0	10.0	5.0	10.0
Top of Rock (ft)	39.5	41.0	43.0	39.5	40.0	40.0	41.0	42.0
Date	**Depth to Groundwater Below Top of Casing, In Feet**							
11/19/95	15.41	15.18	16.43	12.77				
02/11/96	14.03	13.72	14.96	11.29				
06/19/96	13.96	13.68	14.96	11.30				
11/25/96	13.71	13.50	14.75	11.31				
06/05/01	14.73	14.46	15.80	12.08	12.78	11.00	16.02	14.68
11/30/01	12.81	12.53	13.84	10.19	10.89	10.27	14.10	12.89
01/25/02	13.18	12.84	14.15	10.46	11.16	10.56	14.35	13.19
Date	**Groundwater Elevation, in Feet above MSL**							
11/19/95	857.27	856.17	856.36	856.09				
02/11/96	858.65	857.63	857.83	857.57				
06/19/96	858.72	857.67	857.83	857.56				
11/25/96	858.97	857.85	858.04	857.55				
06/05/01	857.95	856.89	856.99	856.78	856.47	857.69	856.53	857.64
11/30/01	859.87	858.82	858.95	858.67	858.36	858.42	858.45	859.43
01/25/02	859.50	858.51	858.64	858.40	858.09	858.13	858.20	859.13

Notes:

1. All elevations recorded in Mean Sea Level (MSL) datum.
2. All depth measurements in feet.
3. NA = Data not available. Measurements were not collected on this day.
4. NR = Information not reported in the Draft Phase II RI.

TABLE 10-1c

Vertical Hydraulic Gradients at Well Nests
Site 7 – Red Disposal Area and Site 21B – Temporary Storage Area
Jefferson Proving Ground
Madison, Indiana

Site	Well Nest (Shallow)	(Deep)	Gradient 05-Jun-01	Gradient 30-Nov-01	Gradient 25-Jan-02
7/21B	MW01-06	MW01-05	-0.043	-0.002	-0.001
	MW01-08	MW01-07	-0.049	-0.044	-0.041

Notes:
1. A negative sign (-) indicates a downward gradient.
2. NA = Water level data not available for this date.

TAPB/tapb/pcl/JAR
N:\Jobs\244\0025\01\wp\tbl\96_Table 10-1c.doc

TABLE 10-1d

Background Screening of Inorganic Chemicals Detected in Soil
Site 7 - Red Lead Disposal Area and Site 21B - Temporary Storage Area
Jefferson Proving Ground
Madison, Indiana

Chemical/Matrix	Frequency of Detection[(a)]	Maximum Detected Value (µg/g)[(b)]	Soil Series Background Screening Value[(c)] (µg/g)	Exceeds Soil Series Background?
Surface Soil				
Aluminum	1/1	13,000	11,000	**YES**
Arsenic	1/1	3.05	9.26	No
Barium	1/1	800	84.5	**YES**
Beryllium	1/1	0.57	0.52	**YES**
Chromium	1/1	17.1	15.1	**YES**
Cobalt	1/1	5.47	3.5	**YES**
Copper	1/1	26.3	5.64	**YES**
Lead	3/3	73	14.9	**YES**
Manganese	1/1	601	302	**YES**
Nickel	1/1	9.02	2.3	**YES**
Silver	1/1	0.058	NA[(d)]	**YES**
Vanadium	1/1	22.7	27.0	No
Zinc	1/1	53.1	19.5	**YES**
Subsurface Soil				
Lead	4/4	15.5	14.9	**YES**

Footnotes:

(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Micrograms per gram.
(c) See Section 5.1.2.4.2 for an explanation of how the soil-series-specific background screening values were calculated.
(d) Not applicable.

TABLE 10-2

Background Screening of Inorganic Chemicals Detected in Groundwater
Site 7 - Red Lead Disposal Area
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[(a)]	Average Maximum Detected Value (µg/L)[(b)]	Groundwater Background Screening Value[(c)] (µg/L)	Exceeds Groundwater Background?
Aluminum, Total	3/3	1,622	553	**YES**
Arsenic, Total	3/3	30.7	2.6	**YES**
Barium, Total	3/3	948.5	509.3	**YES**
Boron, Total	3/3	62	140	No
Chromium, Total	1/3	6.15	6.24	No
Lead, Total	1/3	1.62	1.71	No
Manganese, Total	3/3	109	290	No
Mercury, Total	1/3	0.058	0.056	**YES**
Molybdenum, Total	3/3	12.4	9.67	**YES**
Tin, Total	3/3	53.6	55.7	No
Zinc, Total	2/3	10.4	ND[(d)]	**YES**

Footnotes:

(a) Number of locations in which the analyte was detected/total number of locations sampled. The three downgradient wells at this site (MW93-11, MW93-44, and MW95-4) were used in the background screening analysis.
(b) Micrograms per liter.
(c) See Section 5.1.4.5.2 for an explanation of how the groundwater background screening values were calculated.
(d) No data or not detected.

TABLE 10-3

Summary of Analytical Results for Soil Samples
Site 7 - Red Lead Disposal Area and Site 21B - Temporary Storage Area
Jefferson Proving Ground
Madison, Indiana

Sample ID	Depth (feet)	Analyte Detected	Concentration (µg/g)[(a)]	Sample Date
RLA07SF001 (1A)	0.0-0.5	Aluminum	16,100	11/18/92
		Arsenic	4.03	
		Barium	607	
		Boron	9.57	
		Calcium	10,700	
		Chromium	19.4	
		Cobalt	6.45	
		Copper	20.8	
		Iron	17,400	
		Lead	13,000	
		Magnesium	4,300	
		Manganese	244	
		Nickel	6.98	
		Potassium	821	
		Silver	0.157	
		Sodium	57.9	
		Vanadium	21.9	
		Zinc	32.8	
RLA07SF002 (2A)	0.0-0.5	Aluminum	16,200	11/18/92
		Arsenic	3.45	
		Barium	70.6	
		Boron	12.4	
		Calcium	55,400	
		Chromium	16.3	
		Cobalt	5.03	
		Copper	9.89	
		Iron	17,300	
		Lead	14.0	
		Magnesium	32,300	
		Manganese	221	
		Nickel	3.55	
		Potassium	844	
		Silver	0.0431	
		Sodium	135	
		Vanadium	26.3	
		Zinc	22.5	
RLA07BHA01	0.9-1.4	Lead	9.86	11/21/92
RLA07BHA02	4.4.-4.9	Lead	8.34	11/21/92
RLA07BHA03	9.3-9.8	Lead	11.3	11/21/92
RLA07BHB01	0.9-1.4	Lead	12.1	11/21/92
RLA07BHB02	4.5-5.0	Lead	14.0	11/21/92
RLA07BHB03	9.6-10.1	Lead	7.26	11/21/92
RLA07BHC01	0.0-0.5	Lead	73	12/04/92
RLA07BHC02	4.0-4.5	Lead	10.0	12/04/92
RLA07BHC03	5.5-6.0	Lead	15.5	12/04/92
RLA07BHD01	0.0-0.5	Lead	4,100	12/04/92

TABLE 10-3

Summary of Analytical Results for Soil Samples
Site 7 - Red Lead Disposal Area and Site 21B - Temporary Storage Area
Jefferson Proving Ground
Madison, Indiana

Sample ID	Depth (feet)	Analyte Detected	Concentration (µg/g)[(a)]	Sample Date
RLA07BHD02	4.0-4.5	Lead	46	12/04/92
RLA07BHD03	6.5-7.0	Lead	230	12/04/92
STB21SF001 (1B)	0.0-0.5	Aluminum	14,400	11/18/92
		Arsenic	4.34	
		Barium	195	
		Boron	27.5	
		Cadmium	156	
		Calcium	7,040	
		Chromium	31.6	
		Cobalt	4.55	
		Copper	215	
		Iron	15,400	
		Lead	500	
		Magnesium	2,880	
		Manganese	197	
		Mercury	0.0923	
		Nickel	9.82	
		Potassium	1,660	
		Silver	0.101	
		Sodium	98.0	
		Vanadium	23.5	
		Zinc	135	
		Dieldrin	0.00225	
		ppDDD	0.00339	
		ppDDE	0.00475	
		ppDDT	0.0164	
		TPH[(b)]	23.6	
STB21SF002 (2B)	0.0-0.5	Aluminum	14,600	11/18/92
		Arsenic	3.27	
		Barium	159	
		Boron	13.3	
		Calcium	28,100	
		Chromium	27.6	
		Cobalt	5.9	
		Copper	20.9	
		Iron	19,100	
		Lead	410	
		Magnesium	13,500	
		Manganese	252	
		Nickel	10.1	
		Potassium	925	
		Silver	0.0408	
		Sodium	85.2	
		Vanadium	27.6	
		Zinc	48.0	
		Dieldrin	0.00244	
		ppDDD	0.00414	
		ppDDE	0.00409	
		Fluoranthene	0.038	

TABLE 10-3

Summary of Analytical Results for Soil Samples
Site 7 - Red Lead Disposal Area and Site 21B – Temporary Storage Area
Jefferson Proving Ground
Madison, Indiana

Sample ID	Depth (feet)	Analyte Detected	Concentration (µg/g)[a]	Sample Date
STB21SF003 (3B)	0.0-0.5	Aluminum	13,000	11/18/92
		Arsenic	3.05	
		Barium	800	
		Beryllium	0.57	
		Boron	11.5	
		Calcium	35,500	
		Chromium	17.1	
		Cobalt	5.47	
		Copper	26.3	
		Iron	15,700	
		Lead	38.0	
		Magnesium	11,100	
		Manganese	601	
		Nickel	9.02	
		Potassium	644	
		Silver	0.0579	
		Sodium	100	
		Vanadium	22.7	
		Zinc	53.1	
		Dieldrin	0.00209	
		ppDDE	0.00754	
		ppDDT	0.0146	
		TPH[b]	10.8	

General Notes:

1. Only detected compounds are reported in this table

Footnotes:

(a) Micrograms per gram.
(b) Total petroleum hydrocarbons.

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TABLE 10-4

Analytical Results for Metals in Groundwater Samples
Site 7 - Red Lead Disposal Area and Site 21B - Temporary Storage Area
Jefferson Proving Ground
Madison, Indiana

				Metals (ug/L)																									
Field Identification	**Location Identification**	**Sample Date**	**Sample Type**	**Aluminum**	**Antimony**	**Arsenic**	**Barium**	**Beryllium**	**Boron**	**Cadmium**	**Calcium**	**Chromium**	**Cobalt**	**Copper**	**Iron**	**Lead**	**Magnesium**	**Manganese**	**Mercury**	**Molybdenum**	**Nickel**	**Potassium**	**Selenium**	**Silver**	**Sodium**	**Thallium**	**Tin**	**Vanadium**	**Zinc**
JPG-S7/21MW93-10	**MW93-10**	6/16/1993	N	134	LT 60.0	**6.87**	967	LT 1.12	LT 230	LT 6.78	116,000	LT 16.8	LT 25.0	LT 18.8	519	LT 4.47	45,000	378	LT 0.10	LT 52.7	LT 32.1	LT 1,240	LT 2.53	LT 0.333	62,000	LT 125	LT 59.9	LT 27.6	26.1
		11/7/1995	N	2,320	LT 10.0	**13.1**	1,130	LT 5.00	59	LT 5.00	111,000	LT 5.90	LT 50.0	20	2,930	LT 3.00	44,300	119	0.052	LT 100	LT 40.0	LT 950	LT 5.00	LT 10.0	61,400	LT 10.0	LT 100	3.2	LT 20.0
		2/20/1996	N	401	ND 10.0	**16.8**	1,080	LT 5.00	46	LT 5.00	105,000	4.72	LT 50.0	LT 20.0	1,100	ND 3.00	42,100	62.3	LT 0.20	LT 100	LT 40.0	498	ND 5.00	LT 10.0	61,200	ND 10.0	LT 100	LT 50.0	LT 20.0
		5/1/1996	N	3,660	LT 10.0	**12**	1,170	5	100	LT 5.00	117,000	11.5	LT 50.0	LT 10.0	2,640	LT 3.33	44,100	102	LT 0.20	7.73	LT 40.0	1,570	LT 5.56	LT 10.0	60,400	LT 11.1	66.3	5.02	LT 9.96
		6/26/1996	N	523	LT 10.0	**8.55**	1,090	LT 5.00	LT 59.9	LT 5.00	106,000	LT 10.0	50	LT 20.0	680	LT 3.00	42,100	64.9	LT 0.20	LT 100	LT 40.0	3,000	LT 5.00	LT 10.0	49,300	LT 10.0	LT 100	50	LT 20.0
		11/29/2001	N	200 (U/)	5 (U/)	**81.2(/J)**	1,150(/J)	1 (U/)	NA	5 (U/)	122,000(/J)	20 (U/)	20 (U/)	20 (U/)	6,020(/J)	5 (U/)	47,000(/J)	48.7	0.2 (U/)	NA	20 (U/)	2,000 (U/)	5 (U/)	50 (U/)	58,700(/J)	10 (U/)	NA	10 (U/)	20 (U/)
JPG-S7/21MW93-11	**MW93-11**	6/16/1993	N	LT 112	LT 60.0	**11.3**	677	LT 1.12	LT 230	LT 6.78	110,000	LT 16.8	LT 25.0	LT 18.8	175	LT 4.47	46,100	550	LT 0.10	LT 52.7	LT 32.1	LT 1,630	LT 2.53	LT 0.333	64,000	LT 125	LT 59.9	LT 27.6	LT 18.0
		11/7/1995	N	LT 200	LT 10.0	**18.1**	900	LT 5.00	55	LT 5.00	103,000	LT 10.0	LT 50.0	LT 20.0	834	LT 3.00	43,800	115	LT 0.20	LT 100	LT 40.0	LT 870	LT 5.00	LT 10.0	62,300	LT 10.0	LT 100	LT 50.0	LT 20.0
		2/20/1996	N	LT 200	ND 10.0	**23.2**	832	LT 5.00	38.5	LT 5.00	96,700	LT 10.0	LT 50.0	LT 20.0	390	ND 3.00	41,200	82.1	LT 0.20	LT 100	LT 40.0	585	ND 5.00	LT 10.0	59,300	ND 10.0	100	LT 50.0	LT 20.0
		5/1/1996	N	20.4	LT 10.0	**23.7**	882	LT 5.00	100	LT 5.00	108,000	10	LT 50.0	LT 20.0	455	LT 3.33	43,500	99.7	LT 0.20	6.6	LT 40.0	1,200	LT 5.56	LT 10.0	59,200	LT 11.1	LT 52.3	LT 50.0	LT 20.0
		6/26/1996	N	LT 200	LT 10.0	**21**	739	LT 5.00	LT 61.7	LT 5.00	94,900	LT 10.0	LT 50.0	LT 20.0	193	LT 3.00	40,400	63.3	LT 0.058	100	LT 40.0	3,000	LT 5.00	LT 10.0	56,300	LT 10.0	LT 100	LT 50.0	LT 20.0
		6/9/2001	N	194	5(U/)	**37.8**	1,110	1(U/)	NA	5(U/)	102,000	3(J/10U)	10(U/)	2.7(J/20U)	1,140	5(U/)	47,100	87.3	0.2(U/)	NA	5.2(J/10U)	1,190(J/2,000U)	NA	10(U/)	67,700	10(U/)	NA	2.4 (J/10U)	8.6 (J/20U)
JPG-S7/21MW01-53	**MW93-11**	6/9/2001	FD	65.7	5(U/)	**26.2(/J)**	1,140	1(U/)	NA	5(U/)	104,000	10(U/)	10(U/)	2.6(J/20U)	852	5(U/)	48,200	85.4	0.2(U/)	NA	11.9(/U)	1,410(J/2,000U)	NA	10(U/)	68,900	10(U/)	NA	2.4(J/10U)	8.9(J/20U)
JPG-S7/21MW93-44	**MW93-44**	6/16/1993	N	LT 112	LT 60.0	**13**	721	LT 1.12	LT 230	LT 6.78	100,000	LT 16.8	LT 25.0	LT 18.8	127	LT 4.47	43,200	480	LT 0.10	LT 52.7	LT 32.1	1,520	LT 2.53	LT 0.333	56,000	LT 125	LT 59.9	LT 27.6	LT 18.0
		11/7/1995	N	LT 200	LT 10.0	**28.8**	994	LT 5.00	48	LT 5.00	106,000	LT 10.0	LT 50.0	LT 20.0	1,550	LT 3.00	45,100	40.4	LT 0.20	LT 100	LT 40.0	LT 740	LT 5.00	LT 10.0	65,300	LT 10.0	LT 100	LT 50.0	LT 20.0
		2/20/1996	N	LT 200	ND 10.0	**31.6**	906	LT 5.00	34.1	LT 5.00	96,900	LT 10.0	LT 50.0	LT 20.0	1,050	ND 3.00	41,400	23.1	LT 0.20	LT 100	LT 40.0	3,000	ND 5.00	LT 10.0	58,200	ND 10.0	100	LT 50.0	LT 20.0
		5/1/1996	N	35	LT 10.0	**29.3**	963	5	100	LT 5.00	107,000	LT 10.0	LT 50.0	LT 20.0	1,290	LT 3.33	43,200	30.8	LT 0.20	8.99	LT 40.0	LT 1,060	LT 5.56	LT 10.0	56,800	LT 11.1	LT 61.3	LT 50.0	11.5
		6/26/1996	N	114	LT 10.0	**26.4**	888	LT 5.00	LT 46.8	LT 5.00	95,500	LT 10.0	50	LT 20.0	1,290	LT 3.00	40,600	38.3	LT 0.20	100	LT 40.0	3,000	LT 5.00	LT 10.0	54,900	LT 10.0	LT 100	LT 50.0	LT 20.0
		6/9/2001	N	59.3	5(U/)	**15.6**	576	1(U/)	NA	5(U/)	79,600	5.5(J/10U)	10(U/)	20 (U/)	749	5(U/)	31,200	102	0.2(U/)	NA	12.3	3,330	NA	10(U/)	47,700	10(U/)	NA	10(U/)	20(U/)
JPG-S7/21MW95-04	**MW95-04**	11/7/1995	N	5,930	LT 10.0	**28.4**	801	LT 5.00	84	5	132,000	LT 9.60	LT 50.0	LT 20.0	5,850	1.8	63,900	319	LT 0.20	LT 100	LT 40.0	5,240	LT 5.00	LT 10.0	50,800	LT 10.0	LT 100	50	8.7
		2/20/1996	N	82	ND 10.0	**32.4**	939	LT 5.00	47.2	LT 5.00	98,000	LT 10.0	LT 50.0	20	366	ND 3.00	43,900	31.5	LT 0.20	100	LT 40.0	LT 1,200	ND 5.00	LT 10.0	59,000	ND 10.0	100	LT 50.0	20
		5/1/1996	N	42.2	LT 10.0	**31.2**	1,080	5	100	LT 5.00	111,000	LT 10.0	LT 50.0	LT 20.0	382	LT 3.33	46,700	31.5	LT 0.20	LT 12.4	LT 40.0	1,750	LT 5.56	LT 10.0	61,800	LT 11.1	64.5	LT 50.0	LT 20.0
		6/26/1996	N	435	LT 10.0	**31**	974	LT 5.00	67	LT 5.00	100,000	10	50	LT 20.0	851	LT 3.00	44,200	54.2	LT 0.20	LT 100	LT 40.0	3,000	LT 5.00	LT 10.0	57,800	LT 10.0	LT 100	LT 50.0	LT 20.0
		6/9/2001	N	50 (U/)	5(U/)	**15.2**	1,090	1(U/)	NA	5(U/)	83,000(/J)	4.7(J/10U)	10(U/)	5.5(J/20U)	538	5(U/)	45,400	52.9	0.2(U/)	NA	10.3	1,630(J/2,000U)	NA	10(U/)	70,000	10(U/)	NA	10(U/)	9.4(J/20U)
JPG-S7/21MW01-05	**MW01-05**	6/10/2001	N	415	5(U/)	5(U/)	443	1(U/)	NA	5(U/)	82,000(/J)	9.4(J/10U)	10(U/)	3(J/20U)	601	5(U/)	37,400	130	0.2(U/)	NA	15.4	3,360	NA	10(U/)	50,700	10(U/)	NA	10(U/)	14(J/20U)
JPG-S7/21MW01-06	**MW01-06**	6/10/2001	N	109	5(U/)	**15.2**	612	1(U/)	NA	5(U/)	98,800(/J)	4.9(J/10U)	6.8(J/10U)	2.6(J/20U)	555	1.3 (J/5U)	42,500	241	0.2(U/)	NA	13.6	2,400	NA	4.5(J/10U)	51,800	10(U/)	NA	3.4(J/10U)	20(U/)
JPG-S7/21MW01-07	**MW01-07**	6/10/2001	N	482	5(U/)	**6.98**	524	1(U/)	NA	5(U/)	94,700(/J)	10(U/)	10(U/)	20 (U/)	1,060	1.6(J/5U)	42,600	157	0.2(U/)	NA	13	3,460	NA	10(U/)	47,900	10(U/)	NA	3.3(J/10U)	23
JPG-S7/21MW01-08	**MW01-08**	6/10/2001	N	756	5(U/)	**26.9**	1,270	1(U/)	NA	5(U/)	118,000 (/J)	10(U/)	10(U/)	3(J/20U)	4,430	1.5(J/5U)	51,800	351	0.2(U/)	NA	10.9	1,180(J/2,000U)	NA	10(U/)	71,900	10(U/)	NA	3.3(J/10U)	7(J/20U)
			PRGs (1)	36,000	15	0.045	2,600	73	3,300	18	NSE	110 (2)	2,200	1,400	11,000	15	NSE	880	1.1	180	730	NSE	180	180	NSE	2.4	22,000	260	11,000

General Notes:

1. (LF / VF) = Lab Flag / Validation Flag
2. ug/L = Micrograms per liter
3. Sample Types:
   "N" = Normal field Sample
   "FD" = Field Duplicate Sample
5. LT = Less than the reporting limit as presented by Earthtech
6. PRGs = Preliminary Remediation Goals
7. R = Result rejected
8. U = Compound was not detected
9. J = Estimated value. The result is less than the reporting limit, but greater than the maximum detection limit.
10. ND = Not detected
11. NA = Not analyzed
12. NSE = No standard established
13. Bolded results indicate a PRG exceedance

Footnotes:

(1) PRGs = Preliminary Remediation Goals from US EPA Region 9 for Tap Water
(2) The PRG listed is for Chromium VI which is the most conservative chromium value. However, samples were analyzed for total chromium.

TABLE 10-4a

Summary of Groundwater Analytical Results - Organic Compounds
Site 7 - Red Lead Disposal Area and Site 21B - Temporary Storage Area
Jefferson Proving Grounds
Madison, Indiana

				VOCs (ug/L)			SVOCs (ug/L)
Field Identification	Location Identification	Sample Date	Sample Type	1,1,1-Trichloroethane	Acetone	Toluene	bis(2-ethylhexyl) Phthalate
JPG-S7/21BMW93-10	**MW93-10**	11/29/2001	N	1(U/)	10(U/)	1(U/)	9.7(U/)
JPG-S7/21BMW93-11	**MW93-11**	6/9/2001	N	1(U/)	10(U/)	1(U/)	**79**
JPG-S7/21BMW01-11	**MW93-11**	6/9/2001	FD	1(U/)	10(U/)	1(U/)	**48**
JPG-S7/21BMW93-44	**MW93-44**	6/9/2001	N	1(U/)	10(U/)	1(U/)	9.4(U/)
JPG-S7/21BMW95-04	**MW95-04**	6/9/2001	N	0.57(J/)	10(U/)	1(U/)	9.4(U/)
JPG-S7/21BMW01-05	**MW01-05**	6/10/2001	N	1(U/)	9.8(J/)	0.58(J/)	9.4(U/)
JPG-S7/21BMW01-06	**MW01-06**	6/10/2001	N	1(U/)	10(U/)	1(U/)	9.4(U/)
JPG-S7/21BMW01-07	**MW01-07**	6/10/2001	N	1(U/)	10(U/)	1(U/)	9.6(U/)
JPG-S7/21BMW01-08	**MW01-08**	6/10/2001	N	1(U/)	10(U/)	1(U/)	9.6(U/)
			PRGs (1)	540	610	720	4.8

General Notes:
1. (LF / VF) = Lab Flag / Validation Flag
2. Only compounds detected are listed in this table
3. ug/L = Micrograms per liter
4. VOCs = Volatile organic compounds
5. SVOCs = Semi-Volatile organic compounds
6. Sample Types:
   "N" = Normal field Sample
   "FD" = Field Duplicate
7. PRGs = Preliminary Remediation Goals
8. U = Compound was not detected
9. J = Estimated value. The result is less than the reporting limit, but greater than the maximum detection limit
10. Bolded results indicate a PRG exceedance
11. No explosives were detected during the June and November sampling events

Footnotes:
(1) PRGs = Preliminary Remediation Goals from US EPA Region 9 for Tap Water

TABLE 10-5

Summary of Analytical Results from Interim Measures Confirmation Sampling
Site 7 – Red Lead Disposal Area and Site 21B - Temporary Storage Area
Jefferson Proving Ground
Madison, Indiana

Analyte / Sample ID	S07001 (µg/g)[(a)]	S07201* (µg/g)	S07002 (µg/g)	S07003 (µg/g)	S07004 (µg/g)	S07005 (µg/g)	S07006 (µg/g)	S07007 (µg/g)	S07008 (µg/g)
Aluminum	15,000	11,000	11,000	3,100	2,000	7,400	12,000	7,200	7,200
Arsenic	4.30	4.50	5.20	2.70	5.60	4.10	3.30	2.90	3.80
Boron	3.1 U[(b)]	4.00	4.40	9.20	5.70	22.00	4.10	3.1 U	3.80
Barium	59	54.00	440.00	140.00	76.00	72.00	480.00	100.00	210.00
Beryllium	0.60 U	0.64 U	0.58 U	0.62 U	0.52 U	0.56 U	0.58 U	0.56 U	0.55 U
Calcium	2,900	3,000	8,000	87,000	73,000	97,000	8,700	17,000	7,400
Cadmium	0.17 J	0.16 J	14.00	0.47 J	0.46 J	0.35 J	2.70	0.24 J	0.80 J
Cobalt	2.7 J	3.0 J	6.3 J	3.2 J	2.2 J	2.1 J	5.2 J	4.0 J	5.2 J
Chromium	15	13.00	63.00	23.00	6.30	11.00	24.00	10.00	18.00
Copper	10	11.00	210.00	42.00	19.00	8.40	51.00	11.00	78.00
Iron	11,000	13,000	17,000	8,300	7,600	7,600	13,000	11,000	11,000
Mercury	0.12 U	0.13 U	0.23 U	0.12 U	0.10 U	0.11 U	0.12 U	0.11 U	0.11 U
Potassium	620 U	640 U	720 U	680 U	520 U	1000 U	770 U	560 U	580 U
Magnesium	1,200	1,400	3,400	23,000	68,000	45,000	2,900	3,900	2,800
Manganese	100	140.00	270.00	200.00	270.00	250.00	210.00	190.00	230.00
Molybdenum	0.4 U	0.4 U	2.40	0.58	0.4 U	0.4 U	1.00	0.4 U	0.4 U
Sodium	39 J[(d)]	39 J	40 J	85 J	110 J	150 J	48 J	31 J	33 J
Nickel	4	4.10	11.00	6.70	6.50	5.20	7.40	5.90	9.40
Lead	22	19.00	370.00	97.00	53.00	67.00	1,100	92.00	510.00
Antimony	NA[(c)]	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	0.60 U	0.64 U	0.58 U	0.62 U	0.52 U	0.56 U	0.58 U	0.56 U	0.55 U
Tin	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	1	2.10	1.30	1.20	1.10	1.10	1.00	1.00	1.30
Vanadium	15	19.00	24.00	11.00	7.20	15.00	22.00	14.00	17.00
Zinc	22	21.00	170.00	32.00	21.00	25.00	78.00	55.00	81.00

General Notes:
1. A summary of data qualifiers is located in Appendix N.
2. Samples were collected on 10/16/96 (EPA 13e).

Footnotes:
(a) Micrograms per gram.
(b) Not detected.
(c) Not analyzed
(d) Estimated value
* Duplicate sample

TABLE 10-6

Soil Exposure Point Concentrations of Contaminants of Potential Concern (COPC)
Site 7 – Red Lead Disposal Area and Site 21B - Temporary Storage Area
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[(a)]	Range of Detected Values (µg/g)[(b)]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[(c)] (µg/g)
Surface Soil						
Aluminum	1/1	13,000	NA[(d)]	NC[(e)]	NC	13,000
Barium	1/1	800	NA	NC	NC	800
Beryllium	1/1	0.57	NA	NC	NC	0.57
Chromium	1/1	17.1	NA	NC	NC	17.1
Cobalt	1/1	5.47	NA	NC	NC	5.47
Copper	1/1	26.3	NA	NC	NC	26.3
Lead	3/3	12.1 - 73	NA	41.0	92.6	73
Manganese	1/1	601	NA	NC	NC	601
Nickel	1/1	9.02	NA	NC	NC	9.02
Silver	1/1	0.058	NA	NC	NC	0.058
Vanadium	1/1	22.7	NA	NC	NC	22.7
Zinc	1/1	53.1	NA	NC	NC	53.1
DDE	1/1	0.00754	NA	NC	NC	0.00754
DDT	1/1	0.0146	NA	NC	NC	0.0146
Dieldrin	1/1	0.00209	NA	NC	NC	0.00209
Surface/Subsurface Soil Combined						
Lead	7/7	7.26 - 73	NA	23.2	76	73

Footnotes:

(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Micrograms per gram.
(c) The 95% UCL (upper confidence limit of the mean) or the maximum detected value, whichever is lower (USEPA 1989b).
(d) Not applicable.
(e) Not calculated due to insufficient data.

TABLE 10-7

Selection of Contaminants of Potential Concern (COPC) in Soil Based on USEPA Region 9 Preliminary Remediation Goals (PRGs) Site 7 - Red Lead Disposal Area and Site 21B - Temporary Storage Area Jefferson Proving Ground Madison, Indiana

	USEPA Region 9 PRG Screen		
Contaminant/Matrix	**Residential PRG (µg/g)[(a)]**	**Exposure Point Conc. (µg/g)**	**Retained as Soil COPC?**
Surface Soil			
Aluminum	7,667	13,000	**YES**
Barium	527	800	**YES**
Beryllium	0.14	0.57	**YES**
Chromium	30.1	17.1	No
Cobalt	456	5.47	No
Copper	285	26.3	No
Lead	400[(b)]	73	No
Manganese	318	601	**YES**
Nickel	153	9.02	No
Silver	38.3	0.058	No
Vanadium	53.7	22.7	No
Zinc	2,300	53.1	No
DDE	1.3	0.00754	No
DDT	1.3	0.0146	No
Dieldrin	0.028	0.00209	No
Surface/Subsurface Soil Combined			
Lead	400[(b)]	73.0	No

Note:
PRGs were taken directly from the Region 9 PRG Table (USEPA 1998). Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:
(a) Micrograms per gram.
(b) Full PRG used for lead.

TABLE 10-8

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 7 - Red Lead Disposal Area and Site 21B – Temporary Storage Area
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Contaminant	**Ambient Air PRG (μg/m^3)(a)**	**Exposure Point Conc. (μg/m^3)**	**Retained as Air COPC?**
Residential Scenario			
Aluminum	NA(b)	5.37E-03	**YES**
Arsenic	4.5E-04	1.56E-06	No
Barium	5.2E-02	3.72E-05	No
Beryllium	8.0E-04	1.23E-07	No
Cadmium	1.1E-03	7.24E-08	No
Chromium	2.3E-05	1.07E-05	No
Lead	1.5E+00(c)	5.36E-06	No
Manganese	5.1E-03	4.89E-04	No
Silver	NA	8.32E-06	**YES**
Thallium	NA	2.60E-06	**YES**
Vanadium	NA	7.53E-07	**YES**
Zinc	NA	3.70E-06	**YES**
Dioxins/Furans	4.5E-08	1.55E-13	No
Benzo(a)anthracene	9.2E-03	6.66E-09	No
Benzo(a)pyrene	9.2E-04	2.95E-08	No
Benzo(b)fluoranthene	9.2E-03	6.02E-08	No
DDE	2.0E-02	3.92E-09	No
Dibenz(a,h)anthracene	9.2E-04	7.83E-10	No
Dieldrin	4.2E-04	NA	No
Indeno(1,2,3-cd)pyrene	9.2E-03	3.90E-09	No
1,1-Dichloroethene	3.8E-02	1.17E-09	No
Chlorobenzene	2.1E+00	1.20E-06	No

TABLE 10-8

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 7 - Red Lead Disposal Area and Site 21B – Temporary Storage Area
Jefferson Proving Ground
Madison, Indiana

Contaminant	USEPA Region 9 PRG Screen		
	Ambient Air PRG (µg/m^3)[a]	**Exposure Point Conc. (µg/m^3)**	**Retained as Air COPC?**
Industrial Scenario			
Aluminum	NA	8.31E-01	**YES**
Arsenic	4.5E-04	6.20E-06	No
Barium	5.2E-02	5.04E-02	No
Beryllium	8.0E-04	3.62E-05	No
Cadmium	1.1E-03	1.06E-07	No
Chromium	2.3E-05	3.62E-05	**YES**
Lead	1.5E+00[c]	5.36E-06	No
Manganese	5.1E-03	3.86E-02	**YES**
Silver	NA	8.32E-06	**YES**
Thallium	NA	2.60E-06	**YES**
Vanadium	NA	7.82E-04	**YES**
Zinc	NA	4.04E-05	**YES**
Dioxins/Furans	4.5E-08	1.71E-12	No
Benzo(a)anthracene	9.2E-03	6.66E-09	No
Benzo(a)pyrene	9.2E-04	6.95E-06	No
Benzo(b)fluoranthene	9.2E-03	6.02E-08	No
DDE	2.0E-02	3.92E-09	No
Dibenz(a,h)anthracene	9.2E-04	7.83E-10	No
Dieldrin	4.2E-04	2.52E-07	No
Indeno(1,2,3-cd)pyrene	9.2E-03	3.92E-09	No
1,1-Dichloroethene	3.8E-02	1.17E-09	No
Chlorobenzene	2.1E+00	1.20E-06	No

Note:

PRGs were taken directly from the Region 9 PRG Table (USEPA 1998). Values for noncarcinogens are 1/10 of the Region 9 PRG.
EPCs are calculated and presented in Tables R-4 and R-6 in Appendix R.

Footnotes:

(a) Micrograms per cubic meter.
(b) Not applicable.
(c) Federal ambient air quality criterion for lead.

TABLE 10-9

Groundwater Exposure Point Concentrations of Contaminants of Potential Concern (COPC)
Site 7 - Red Lead Disposal Area
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[(a)]	Range of Detected Values (µg/L)[(b)]	Range of Reporting Limits (µg/L)	Arithmetic Mean Concentration (µg/L)	95% UCL Concentration[(c)] (µg/L)	Exposure Point Concentration (µg/L)
Aluminum	3/3	20.4 - 1,622	NA[(d)]	579	2,107	1,622
Arsenic	3/3	21.5 - 30.7	NA	27.0	35.3	30.7
Barium	3/3	838 - 948	NA	908	1,011	948
Mercury	1/3	0.058	0.20	0.086	0.127	0.058
Molybdenum	3/3	6.6 - 12.4	NA	9.3	14.2	12.4
Zinc	2/3	8.7 - 10.4	20	9.7	11.1	10.4

Footnotes:

(a) Number of locations in which the analyte was detected/total number of locations sampled. Data from the three downgradient wells (MW93-11, MW93-44, and MW95-4) were used in the calculations.
(b) Micrograms per liter.
(c) The 95% UCL (upper confidence limit of the mean) or the maximum detected value, whichever is lower (USEPA 1989b).
(d) Not applicable.

TABLE 10-10

Selection of Contaminants of Potential Concern (COPC) in Groundwater Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 7 - Red Lead Disposal Area
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Tap Water PRG (µg/L)[a]**	**Exposure Point Conc. (µg/L)**	**Retained as GW COPC?**
Aluminum, Total	3,650	1,622	No
Arsenic, Total	0.045	30.7	**YES**
Barium, Total	255.5	948	**YES**
Mercury, Total	1.1	0.058	No
Molybdenum, Total	18.25	12.4	No
Zinc, Total	1,095	10.4	No

Note:

PRGs were taken directly from the Region 9 PRG Table (USEPA 1998) except as noted in the footnotes. Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnote:

(a) Micrograms per liter.

TABLE 10-11

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 7 - Red Lead Disposal Area and Site 21B - Temporary Storage Area
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Chemicals of Concern	Pathway-specific Hazard Index	Noncarcinogenic Chemicals of Concern
		Future On-site Resident Adult		
Incidental ingestion of soil	NA[(a)]		0.0219	
Dermal contact with soil	NA		0.0018	
Ingestion of homegrown fruits/vegetables	NA		0.1607	
Ingestion of groundwater	5.41E-04	Arsenic (100%)	3.1747	Arsenic (88%)
Dermal contact with groundwater	9.81E-07		0.0058	
Inhalation of VOCs[(b)] and fugitive dusts	NA		NA	
Total	5.42E-04		3.3649	
		Future On-site Resident Child		
Incidental ingestion of soil	NA		0.2046	
Dermal contact with soil	NA		0.0053	
Ingestion of homegrown fruits/vegetables	NA		0.3783	
Ingestion of groundwater	2.52E-04	Arsenic (100%)	7.4076	Arsenic (88%)
Dermal contact with groundwater	1.87E-07		0.0055	

TABLE 10-11

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 7 - Red Lead Disposal Area and Site 21B - Temporary Storage Area
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Chemicals of Concern	Pathway-specific Hazard Index	Noncarcinogenic Chemicals of Concern
Inhalation of VOCs and fugitive dusts	NA		NA	
Total	2.52E-04		8.0013	
		Future On-site Worker		
Incidental ingestion of soil	NA		0.0078	
Dermal contact with soil	NA		0.0008	
Ingestion of groundwater	1.61E-04	Arsenic (100%)	1.1338	Arsenic (100%)
Inhalation of VOCs and fugitive dusts	3.53E-08		0.1755	
Total	1.61E-04		1.3179	

Note:
Numbers in parentheses are the percent of the total pathway risk/HI attributable to the contaminant (or chemical) of concern.

Footnotes:
(a) Volatile organic compounds.
(b) Not applicable.

TABLE 10-12

Qualitative Uncertainty Analysis
Site 7 - Red Lead Disposal Area and Site 21B –Temporary Storage Area
Jefferson Proving Ground
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
A. Human Behavior				
Future receptors' exposure duration	30 years	Medium	Medium	National upper-bound time (90th percentile) at one residence
Future receptors' exposure frequency	350 days/year	Medium	Medium	High-end value
Future receptors' water ingestion rate	2 L/day	Low	High	Water consumption rates are high-end values obtained from published distribution data
Exclusion of certain exposure pathways in the quantitative analysis	NA[(a)]	Low	Low	Pathways eliminated are those that have low possibility of contributing risk to these receptors
B. Chemical Fate/Transport in the Environment				
Groundwater exposure point concentration of COC[(b)]	Maximum detected value	Low	High	Site average would be lower
Use of air dispersion modeling to predict air concentrations	NA	Low	High	Conservative assumptions and input parameters

TABLE 10-12

Qualitative Uncertainty Analysis
Site 7 - Red Lead Disposal Area and Site 21B –Temporary Storage Area
Jefferson Proving Ground
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
C. Chemical Toxicity				
Assumption that USEPA[(c)] reference doses truly represent toxicological thresholds	NA	Low	High	High degree of conservativeness utilized by USEPA in deriving RfDs[(d)] from toxicological literature
Assumption that USEPA carcinogenic slope factors truly represent dose-response phenomena	NA	Low-moderate	Moderate-high	Use of linearized, multi-stage mathematical model to predict cancer incidence at low exposure levels is USEPA policy; not currently supported by scientific data
Assumption of risk/hazard additivity	NA	Moderate	Moderate	Summation of chemical-specific risks/hazards may over- or under-predict risks/hazards to receptors
Screening out of certain contaminants based on USEPA criteria	NA	Low	Low	Chemicals present in concentrations less than USEPA criteria eliminated

Footnotes:
(a) Not applicable.
(b) Contaminant of concern.
(c) United States Environmental Protection Agency.
(d) Reference doses.

TABLE 10.7-a1

Habitat Summary
Site 21B - Temporary Storage Area
Jefferson Proving Ground
Madison, Indiana

Site 21b - Bldg. 211(and 204)
Date: 4/16/93; 5/31/93
Acreage: 1.25
Soils mapping unit: Cobbsfork silty loam
Vegetation mapping unit: Frequently mowed grass
General site conditions: Building site, asphalt and concrete paving around Bldg 211.
Slope: Relatively flat
Aspect: None
Drainages: Ditches along road on north; railroad track on south
Surface water/wetlands: None
Evidence of flood/fire: None
Description of surrounding area: Scattered chain of buildings along Woodfill road; open grassland; no woods; building with pavement

Soils
Surface layer texture: Typical
Surface color: Typical

Vegetation

Ground cover description: Mowed grass
Species - Typical
Note - Stressed vegetation at west end of parking lot; mainly weedy composition; also extremely sparse vegetation at Red Lead disposal area - soil appears to be sterile here; Bldg. 204 treated with herbicide around foundation; area closeby is mowed lawn-
Canopy cover: None
Species: NA
Successional status: Primary grassland; artificial “lawn” of a few grasses and weeds
Vegetation condition: NA

Wildlife
Habitat type: Open grassland
Species observations: NA
Sign observations: Observed deer tracks

Remarks: Very sparse and very stressed vegetation at west end of parking lot for Bldg. 211; mainly weedy composition; sparse relatively possible ecological pathway; no vegetation at Red Lead disposal area - soil appears to be sterile in this area; did they also use a soil sterilant in this area along the railroad tracks? possibly they did in other places; Bldg. 204 no apparent spills or surface contamination

TABLE 10.7-1

Summary Statistics For Contaminants of Potential Concern (COPC) - Metals in Soil Phase I
Site 7 - Red Lead Disposal Area
Jefferson Proving Ground
Madison, Indiana

Site	Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Std. Deviation	UCL 95 (a)	EPC µg/g (b)	Exceed Background (Bkg)?	Retain as COPC(c)?	Comment
07	Silver	2	2	100	0.04	0.16	0.10	0.08	0.46	0.16	Yes (Y)	Y	Not Detected in Bkg.
07	Aluminum	2	2	100	16100	16200	16150	71	16466	16200	Y	Y	
07	Arsenic	2	2	100	3.45	4.03	3.74	0.41	5.57	4.03	Y	Y	
07	Boron	0	2	0	NC(d)	NC	NC	NC	NC	NC	NA(e)	No (N)	Not a COPC
07	Barium	2	2	100	70.60	607.0	338.8	379.3	2032	607.0	Y	Y	
07	Beryllium	0	2	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
07	Cadmium	0	2	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
07	Cobalt	2	2	100	5.03	6.45	5.74	1.00	10.22	6.45	Y	Y	
07	Chromium	2	2	100	16.30	19.40	17.85	2.19	27.64	19.40	Y	Y	
07	Copper	2	2	100	9.89	20.80	15.35	7.71	49.79	20.80	Y	Y	
07	Iron	2	2	100	17300	17400	17350	71	17666	17400	Y	Y	
07	Mercury	0	2	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
07	Manganese	2	2	100	221.0	244.0	232.5	16.26	305.1	244.0	Y	Y	
07	Molybdenum	0	2	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
07	Nickel	2	2	100	3.55	6.98	5.27	2.43	16.09	6.98	Y	Y	
07	Lead	6	6	100	9.86	13000	2868	5224	7166	7166	Y	Y	
07	Tin	0	2	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
07	Tellurium	0	2	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
07	Thallium	0	2	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
07	Vanadium	2	2	100	21.90	26.30	24.10	3.11	37.99	26.30	Y	Y	
07	Zinc	2	2	100	22.50	32.80	27.65	7.28	60.17	32.80	Y	Y	

Note:

Calcium, magnesium, sodium and potassium were not included in risk assessment as they are macronutrients.

Footnotes:

(a) Upper 95 percent confidence limit

(b) Exposure point concentration, micrograms per gram, equivalent to parts per million.

(c) Contaminant of potential concern.

(d) Not calculated. Not a COPC.

(e) Not applicable or not evaluated.

TABLE 10.7-2

Summary of Contaminants of Potential Concern Exposure Point Concentrations by Medium (Phase I)
Site 7 - Red Lead Disposal Area
Jefferson Proving Ground
Madison, Indiana

	Measured Concentrations in Abiotic Media				Estimated Concentrations in Biotic Media							
Analyte Name	Filtered Surface Water (µg/L) [(a)]	Sediment (mg/kg) [(b)]	Unfiltered Surface Water (mg/L) [(c)]	Soil (mg/kg)	Plant (mg/kg)	Invertebrate (mg/kg)	Mouse (mg/kg)	Swift (mg/kg)	Aquatic Plants (mg/kg)	Benthic Invertebrate (mg/kg)	Fish (mg/kg)	Frogs (mg/kg)
Aluminum				16200	6.48E+01	1.78E+02	4.46E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic				4.03	8.46E-02	4.55E-01	7.01E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Barium				6.07	8.92E-01	2.19E-01	1.08E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium				19.40	2.33E-01	5.04E-01	3.78E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt				6.45	1.16E-01	2.26E-01	3.00E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper				20.80	2.06E+00	1.83E+01	1.59E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Iron				17400	6.96E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead				7166	9.32E+02	5.02E+02	6.88E-01	3.74E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Manganese				244.0	9.03E+00	9.27E+00	2.81E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel				6.98	3.07E-01	3.49E-01	1.40E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Silver				0.16	7.54E-03	1.88E-02	1.36E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Vanadium				26.30	7.89E-02	2.37E-01	3.28E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc				32.80	1.80E+01	2.16E+01	1.33E+00	2.51E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Footnotes:
(a) Micrograms per liter, equivalent to parts per billion.
(b) Milligrams per kilogram, equivalent to parts per million.
(c) Milligrams per liter, equivalent to parts per million.

TABLE 10.7-3

Summary Statistics For Analytes in Surface Soil (Phase I)
Site 21B - Temporary Storage Area
Jefferson Proving Ground
Madison, Indiana

Site	Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Std. Deviation	UCL 95 [(a)]	EPC (µg/g) [(b)]	Exceed Background (Bkg)?	Retain as COPC[(c)]?	Comment
21	Silver	3	3	100	0.04	0.10	0.07	0.03	0.12	0.10	Yes (Y)	Y	Not detected in Bkg.
21	Aluminum	3	3	100	13000	14600	14000	872	15470	14600	Y	Y	
21	Arsenic	3	3	100	3.05	4.34	3.55	0.69	4.72	4.34	Y	Y	
21	Boron	0	3	0	NC[(d)]	NC	NC	NC	NC	NC	NA[(e)]	No (N)	Not a COPC
21	Barium	3	3	100	159.0	800.0	384.7	360.1	991.8	800.0	Y	Y	
21	Beryllium	1	3	33	0.21	0.57	0.33	0.21	0.68	0.57	Y	Y	
21	Cadmium	1	3	33	0.60	156.00	52.40	89.72	203.7	156.0	Y	Y	
21	Cobalt	3	3	100	4.55	5.90	5.31	0.69	6.47	5.90	Y	Y	
21	Chromium	3	3	100	17.10	31.60	25.43	7.49	38.06	31.60	Y	Y	
21	Copper	3	3	100	20.90	215.0	87.40	110.5	273.8	215.0	Y	Y	
21	Iron	3	3	100	15400	19100	16733	2055	20198	19100	Y	Y	
21	Mercury	1	3	33	0.03	0.09	0.05	0.04	0.11	0.09	Y	Y	Not detected in Bkg.
21	Manganese	3	3	100	197.0	601.0	350.0	219.1	719.4	601.0	Y	Y	
21	Molybdenum	0	3	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
21	Nickel	3	3	100	9.02	10.10	9.65	0.56	10.59	10.10	Y	Y	
21	Lead	3	3	100	38.00	500.0	316.0	244.9	728.9	500.0	Y	Y	
21	Tin	0	3	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
21	Tellurium	0	3	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
21	Thallium	0	3	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
21	Vanadium	3	3	100	22.70	27.60	24.60	2.63	29.03	27.60	Y	Y	
21	Zinc	3	3	100	48.00	135.0	78.70	48.82	161.0	135.0	Y	Y	
21	Aldrin	1	3	33	0.001	0.02	0.01	0.01	0.02	0.02			
21	Endosulfan II	1	3	33	0.0004	0.001	0.001	0.0003	0.001	0.001			
21	Dieldrin	2	3	67	0.00	3.50	1.17	2.02	4.57	3.50			
21	Endrin	2	3	67	0.00	0.06	0.02	0.03	0.08	0.06			
21	2,2-Bis(p-chlorophenyl)-1,1-dichloroethane	2	3	67	0.001	0.004	0.003	0.001	0.005	0.004			
21	2,2-Bis(p-chlorophenyl)-1,1-dichloroethene	3	3	100	0.003	0.20	0.07	0.11	0.26	0.20			
21	2,2-Bis(p-chlorophenyl)-1,1,1-trichloroethane	2	3	67	0.002	0.15	0.05	0.08	0.19	0.15			
21	Total petroleum hydrocarbons	1	3	33	5.00	23.60	13.13	9.52	29.18	23.60			

Note:

Calcium, magnesium, sodium and potassium were not included in risk assessment as they are macronutrients.

Other analytes in soil have been included if they were detected in one or more samples.

Footnotes:

(a) Upper 95% confidence limit.

(b) Exposure point concentration, micrograms per gram, equivalent to parts per million.

(c) Contaminant of potential concern.

(d) Not calculated. Not a COPC.

(e) Not applicable or not evaluated.

TABLE 10.7-4

Summary of Contaminants of Potential Concern Exposure Point Concentrations by Medium (Phase I)
Site 21B - Temporary Storage Area
Jefferson Proving Ground
Madison, Indiana

	Measured Concentrations in Abiotic Media				Estimated Concentrations in Biotic Media							
Analyte Name	Filtered Surface Water (µg/L) (a)	Sediment (mg/kg) (b)	Unfiltered Surface Water (mg/L) (c)	Soil (mg/kg)	Plant (mg/kg)	Invertebrate (mg/kg)	Mouse (mg/kg)	Swift (mg/kg)	Aquatic Plants (mg/kg)	Benthic Invertebrate (mg/kg)	Fish (mg/kg)	Frogs (mg/kg)
Aldrin				0.02	4.77E-04	6.82E-02	6.93E-04	3.33E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Aluminum				14600	5.84E+01	1.61E+02	4.02E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic				4.34	9.11E-02	4.90E-01	7.55E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Barium				800.0	1.18E+02	2.88E+01	1.43E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beryllium				0.57	2.28E-03	6.27E-03	1.57E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium				156.0	6.24E+01	5.80E+02	7.79E-01	1.19E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium				31.60	3.79E-01	8.22E-01	6.16E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt				5.90	1.06E-01	2.07E-01	2.74E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper				215.0	2.13E+01	1.89E+02	1.64E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dieldrin				3.50	1.05E-01	1.50E+01	1.53E-01	7.34E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Endosulfan II				0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Endrin				0.06	1.83E-03	2.62E-01	2.66E-03	1.28E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Iron				19100	7.64E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead				500.0	6.50E+01	3.50E+01	4.80E-02	2.61E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Manganese				601.0	2.22E+01	2.28E+01	6.91E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury				0.09	1.80E-04	1.30E-01	8.27E-02	1.69E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel				10.10	4.44E-01	5.05E-01	2.03E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,2-Bis(p-chlorophenyl)-1,1-dichloroethane				0.004	3.60E-05	7.13E-03	1.64E-03	6.79E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,2-Bis(p-chlorophenyl)-1,1-dichloroethene				0.20	2.00E-03	3.96E-01	9.14E-02	3.77E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,2-Bis(p-chlorophenyl)-1,1,1-trichloroethane				0.15	1.50E-03	2.97E-01	6.85E-02	2.83E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Silver				0.10	4.80E-03	1.20E-02	8.63E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total petroleum hydrocarbons				23.60	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Vanadium				27.60	8.28E-02	2.48E-01	3.44E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc				135.0	7.43E+01	8.91E+01	5.48E+00	1.03E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Footnotes:
(a) Micrograms per liter, equivalent to parts per billion.
(b) Milligrams per kilogram, equivalent to parts per million.
(c) Milligrams per liter, equivalent to parts per million.

TABLE 10.7-5

Summary Statistics for Contaminants of Potential Concern (COPC) Pesticides in Surface Soil (Phase II)
Site 21B - Temporary Storage Area
Jefferson Proving Ground
Madison, Indiana

Site	Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Standard Deviation	UCL 95 [(a)]	EPC(µg/g) [(b)]
21	Aldrin	2	13	15	0.0003	0.0009	0.0008	0.0002	0.0009	0.0009
21	Chlordane	1	13	8	0.0100	0.2990	0.0322	0.0802	0.0718	0.0718
21	Dieldrin	9	13	69	0.0005	0.1010	0.0187	0.0289	0.0330	0.0330
21	Endrin	4	13	31	0.0006	0.0034	0.0016	0.0006	0.0019	0.0019
21	Heptachlor	1	13	8	0.0009	0.0019	0.0009	0.0003	0.0011	0.0011
21	Heptachlor epoxide	4	13	31	0.0001	0.0028	0.0009	0.0006	0.0012	0.0012
21	2,2-Bis(p-chlorophenyl)-1,1-dichloroethene	11	13	85	0.0002	0.0048	0.0015	0.0012	0.0021	0.0021
21	2,2-Bis(p-chlorophenyl)-1,1,1-trichloroethane	8	13	62	0.0004	0.0040	0.0019	0.0012	0.0024	0.0024

Footnotes:

(a) Upper 95% confidence limit.

(b) Exposure point concentration, micrograms per gram, equivalent to parts per million.

TABLE 10.7-6

Summary of Contaminants of Potential Concern (COPC) Exposure Point Concentrations by Medium (Phase II)
Site 21B - Temporary Storage Area
Jefferson Proving Ground
Madison, Indiana

	Measured Concentrations in Abiotic Media				Estimated Concentrations in Biotic Media							
Analyte Name	Filtered Surface Water (µg/L) [(a)]	Sediment (mg/kg) [(b)]	Unfiltered Surface Water (mg/L) [(c)]	Soil (mg/kg)	Plant (mg/kg)	Invertebrate (mg/kg)	Mouse (mg/kg)	Swift (mg/kg)	Aquatic Plants (mg/kg)	Benthic Invertebrate (mg/kg)	Fish (mg/kg)	Frogs (mg/kg)
Aldrin				0.001	2.55E-05	3.65E-03	3.71E-05	1.78E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chlordane				0.07	1.44E-03	3.59E-01	7.27E-03	1.29E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dieldrin				0.03	9.89E-04	1.41E-01	1.44E-03	6.91E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Endrin				0.002	5.83E-05	8.33E-03	8.47E-05	4.07E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Heptachlor				0.001	9.30E-05	1.81E-03	1.07E-04	4.32E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Heptachlor epoxide				0.001	1.02E-04	1.98E-03	1.17E-04	4.72E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,2-Bis(p-chlorophenyl)-1,1-dichloroethene				0.002	2.07E-05	4.11E-03	9.47E-04	3.91E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,2-Bis(p-chlorophenyl)-1,1,1-trichloroethane				0.002	2.44E-05	4.83E-03	1.11E-03	4.60E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Footnotes:
(a) Micrograms per liter, equivalent to parts per billion.
(b) Milligrams per kilogram, equivalent to parts per million.
(c) Milligrams per liter, equivalent to parts per million.

TABLE 10.7-7

Summary Statistics for Contaminants of Potential Concern (COPC)- Metals in Soil
IM Confirmation Sampling Data
Site 7/21B
Jefferson Proving Ground
Madison, Indiana

Site	Analyte	Number of Detects	Number of Samples	Detection Frequency	Minimum	Maximum	Average	Standard Deviation	UCL95 [(a)]	EPC ug/g [(b)]	Exceed Background (Bkg)?	Retain as COPC[(c)]?	Comment
7/21B	Silver	0	9	0	NC[(d)]	NC	NC	NC	NC	NC	NA[(e)]	No (N)	Not a COPC
7/21B	Aluminum	9	9	100	2000	15000	8433	4227	11054	11054	N	N	
7/21B	Arsenic	9	9	100	2.7	5.6	4.04	0.99	4.66	4.66	N	N	
7/21B	Boron	7	9	78	1.55	22	6.26	6.33	10.18	10.18	Y	Y	
7/21B	Barium	9	9	100	54	480	181.2	165.6	283.9	283.9	Y	Y	
7/21B	Beryllium	0	9	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
7/21B	Cadmium	9	9	100	0.16	14	2.15	4.51	4.95	4.95	Y	Y	
7/21B	Cobalt	9	9	100	2.1	6.3	3.77	1.49	4.69	4.69	Y	Y	
7/21B	Chromium	9	9	100	6.3	63	20.37	17.03	30.92	30.92	Y	Y	
7/21B	Copper	9	9	100	8.4	210	48.91	64.99	89.20	89.20	Y	Y	
7/21B	Iron	9	9	100	7600	17000	11056	3049	12946	12946	N	N	
7/21B	Mercury	0	9	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
7/21B	Manganese	9	9	100	100	270	206.67	57.66	242.42	242.42	N	N	
7/21B	Molybdenum	3	9	33.3	0.2	2.4	0.58	0.74	1.03	1.03	Y	Y	
7/21B	Nickel	9	9	100	4	11	6.69	2.33	8.13	8.13	Y	Y	
7/21B	Lead	9	9	100	19	1100	258.9	358.8	481.3	481.3	Y	Y	
7/21B	Antimony	ND[(f)]	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	
7/21B	Selenium	0	9	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
7/21B	Tin	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	
7/21B	Thallium	9	9	100	0.66	2.1	1.20	0.39	1.44	1.44	Y	Y	
7/21B	Vanadium	9	9	100	7.2	24	16.02	5.23	19.26	19.26	Y	Y	
7/21B	Zinc	9	9	100	21	170	56.11	49.05	86.52	86.52	Y	Y	

Note:

Calcium, magnesium, sodium and potassium were not included in risk assessment as they are macronutrients.

Footnotes:

(a) Upper 95 percent confidence limit

(b) Exposure point concentration, micrograms per gram, equivalent to parts per million.

(c) Contaminant of potential concern.

(d) Not calculated. Not a COPC.

(e) Not applicable or not evaluated.

(f) No data.

TABLE 10.7-8

Summary of Contaminants of Potential Concern Exposure Point Concentrations by Medium
IM Confirmation Sampling Data
Site 7/21B
Jefferson Proving Ground
Madison, Indiana

	Measured Concentrations in Abiotic Media				Estimated Concentrations in Biotic Media							
Analyte Name	Filtered Surface Water (µg/L) [a]	Sediment (mg/kg) [b]	Unfiltered Surface Water (mg/L) [c]	Soil (mg/kg)	Plant (mg/kg)	Invertebrate (mg/kg)	Mouse (mg/kg)	Swift (mg/kg)	Aquatic Plants (mg/kg)	Benthic Invertebrate (mg/kg)	Fish (mg/kg)	Frogs (mg/kg)
Barium				283.9	4.17E+01	1.02E+01	5.07E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Boron				10.18	4.07E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium				4.95	1.98E+00	1.84E+01	2.47E-02	3.79E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium				30.92	3.71E-01	8.04E-01	6.03E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt				4.69	8.45E-02	1.64E-01	2.18E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper				89.20	8.83E+00	7.85E+01	6.82E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead				481.3	6.26E+01	3.37E+01	4.62E-02	2.51E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Molybdenum				1.03	2.58E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel				8.13	3.58E-01	4.07E-01	1.63E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium				1.44	5.75E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Vanadium				19.26	5.78E-02	1.73E-01	2.40E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc				86.52	4.76E+01	5.71E+01	3.52E+00	6.61E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Footnotes:
(a) Micrograms per liter, equivalent to parts per billion.
(b) Milligrams per kilogram, equivalent to parts per million.
(c) Milligrams per liter, equivalent to parts per million.

TABLE 10.7-9

Summary of DERA RME Risk Drivers (Phase I)
Site 7 - Red Lead Disposal Area
Jefferson Proving Ground
Madison, Indiana

7	NOAEL-Based HQs Due to Soil Ingestion or Direct Contact - RME			NOAEL-Based HQs Due to Dietary Ingestion - RME	Total NOAEL-Based HQs Summed Across Pathways - RME		
Parameter	**White-footed Mouse**	**Plants**	**Soil Fauna**	**White-footed Mouse**	**White-footed Mouse**	**Plants**	**Soil Fauna**
Aluminum	3.44	324.00	6.48	1.26	4.70	324.00	6.48
Arsenic				3.20	4.17		
Chromium		3.88	48.50			3.88	48.50
Iron	1.26		17.40		1.39		17.40
Lead	13.00	40.03	11.82	63.68	76.68	40.03	11.82
Vanadium	11.45	13.15	1.32	3.37	14.81	13.15	1.32
HI_NOAEL	**29.14**	**381.06**	**85.52**	**71.51**	**101.75**	**381.06**	**85.52**

7	LOAEL-Based HQs Due to Soil Ingestion - RME			LOAEL-Based HQs Due to Dietary Ingestion - RME	Total LOAEL-Based HQs Summed Across Pathways - RME		
Parameter	**White-footed Mouse**	**Plants**	**Soil Fauna**	**White-footed Mouse**	**White-footed Mouse**	**Plants**	**Soil Fauna**
Aluminum	1.74	22.19	5.79		2.38	22.19	5.79
Lead		14.51		1.50	1.80	14.51	
Vanadium	3.82			1.12	4.94		
HI_LOAEL	**5.56**	**36.70**	**5.79**	**2.62**	**9.12**	**36.70**	**5.79**

Notes:
1. DERA = Detailed Ecological Risk Assessment
2. RME = Reasonable Maximum Exposure
3. HI = Hazard Index
4. HQ = Hazard Quotient
5. NOAEL = No Observed Adverse Effect Level
6. LOAEL = Lowest Observed Adverse Effect Level

TABLE 10.7-10

Summary of DERA CT Risk Drivers (Phase I)
Site 7 - Red Lead Disposal Area
Jefferson Proving Ground
Madison, Indiana

7	NOAEL-Based HQs Due to Soil Ingestion - CT	NOAEL-Based HQs Due to Dietary Ingestion - CT	Total NOAEL-Based HQs Summed Across Pathways - CT
Parameter	**White-footed Mouse**	**White-footed Mouse**	**White-footed Mouse**
Lead	**1.34**	**6.57**	**7.91**
Vanadium	**1.18**		**1.53**
HI_NOAEL	**2.52**	**6.57**	**9.44**

7	
Parameter	**NONE**
HI_LOAEL	**NONE**

Notes:
1. DERA = Detailed Ecological Risk Assessment
2. CT = Central Tendency
3. HI = Hazard Index
4. HQ = Hazard Quotient
5. NOAEL = No Observed Adverse Effect Level
6. LOAEL = Lowest Observed Adverse Effect Level

TABLE 10.7-11

Summary of DERA RME Risk Drivers (Phase I)
Site 21B - Temporary Storage Area At Building 211
Jefferson Proving Ground
Madison, Indiana

21B	NOAEL-Based HQs Due to Soil Ingestion or Direct Contact - RME			NOAEL-Based HQs Due to Dietary Ingestion - RME				Total NOAEL-Based HQs Summed Across Pathways - RME					
Parameter	White-footed Mouse	Plants	Soil Fauna	Chimney Swift	White-footed Mouse	Eastern Cottontail	Little Brown Myotis	Chimney Swift	White-footed Mouse	Eastern Cottontail	Little Brown Myotis	Plants	Soil Fauna
Aluminum	11.09	292.00	5.84		4.08				15.17			292.00	5.84
Arsenic	3.76				12.34				16.10				
Barium	2.92	1.60			13.09				16.01			1.60	
Cadmium	8.11	52.00	17.33	2.34	818.20	1.07	1.75	2.41	826.30	1.25	1.76	52.00	17.33
Chromium		6.32	79.00									6.32	79.00
Cobalt					1.16				2.06				
Copper		2.15	2.57		10.31				10.74			2.15	2.57
Dieldrin	1.05				111.05				112.10				
Endrin					9.32				9.41				
Iron	4.96		19.10						5.45				19.10
Lead	3.25	2.79			15.91				19.16			2.79	
Manganese		1.20										1.20	
Vanadium	43.02	13.80	1.38		12.65				55.67			13.80	1.38
Zinc		2.70	1.35		1.83				1.90			2.70	1.35
HI_NOAEL	78.16	374.6	126.6	2.34	1010	1.07	1.75	2.41	1090	1.25	1.76	374.6	126.6

21B	LOAEL-Based HQs Due to Soil Ingestion - RME			LOAEL-Based HQs Due to Dietary Ingestion - RME	Total LOAEL-Based HQs Summed Across Pathways - RME		
Parameter	White-footed Mouse	Plants	Soil Fauna	White-footed Mouse	White-footed Mouse	Plants	Soil Fauna
Aluminum	5.62	20.00	5.21	2.07	7.69	20.00	5.21
Arsenic					1.27		
Cadmium		1.56	7.80			1.56	7.80
Dieldrin				31.05	31.34		
Endrin				5.59	5.64		
Iron	2.48				2.72		
Lead		1.01				1.01	
Vanadium	14.34			4.22	18.56		
HI_LOAEL	22.45	22.57	13.01	42.92	67.22	22.57	13.01

Notes:

1. DERA = Detailed Ecological Risk Assessment
2. RME = Reasonable Maximum Exposure
3. HI = Hazard Index
4. HQ = Hazard Quotient
5. NOAEL = No Observed Adverse Effect Level
6. LOAEL = Lowest Observed Adverse Effect Level

TABLE 10.7-12

Summary of DERA CT Risk Drivers (Phase I)
Site 21B - Temporary Storage Area At Building 211
Jefferson Proving Ground
Madison, Indiana

21B	NOAEL-Based HQs Due to Soil Ingestion - CT	NOAEL-Based HQs Due to Dietary Ingestion - CT				Total NOAEL-Based HQs Summed Across Pathways - CT			
Parameter	**White-footed Mouse**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Little Brown Myotis**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Little Brown Myotis**
Aluminum	3.70			1.36				5.07	
Arsenic	1.26			4.12				5.38	
Barium				4.37				5.35	
Cadmium	2.71	1.97	1.16	273.26	1.65	2.03	1.18	275.97	1.66
Copper				3.44				3.59	
Dieldrin				37.09				37.44	
Endrin				3.11				3.14	
Iron	1.66							1.82	
Lead	1.08			5.31				6.40	
Vanadium	14.37			4.22				18.59	
HI_NOAEL	**24.78**	**1.97**	**1.16**	**336.29**	**1.65**	**2.03**	**1.18**	**362.73**	**1.66**

21B	LOAEL-Based HQs Due to Soil Ingestion - CT	LOAEL-Based HQs Due to Dietary Ingestion - CT	Total LOAEL-Based HQs Summed Across Pathways - CT
Parameter	**White-footed Mouse**	**White-footed Mouse**	**White-footed Mouse**
Aluminum	1.88		2.57
Dieldrin		10.37	10.47
Endrin		1.87	1.88
Vanadium	4.79	1.41	6.20
HI_LOAEL	**6.67**	**13.64**	**21.12**

Notes:

1. DERA = Detailed Ecological Risk Assessment
2. CT = Central Tendency
3. HI = Hazard Index
4. HQ = Hazard Quotient
5. NOAEL = No Observed Adverse Effect Level
6. LOAEL = Lowest Observed Adverse Effect Level

TABLE 10.7-13

Summary of DERA RME Risk Drivers
Interim Measures Confirmation Sampling
Site 7/21B
Jefferson Proving Ground
Madison, Indiana

7/21B	NOAEL-Based HQs Due to Soil Ingestion or Direct Contact - RME			NOAEL-Based HQs Due to Dietary Ingestion - RME	Total NOAEL-Based HQs Summed Across Pathways - RME		
Parameter	White-footed Mouse	Plants	Soil Fauna	White-footed Mouse	White-footed Mouse	Plants	Soil Fauna
Barium	1.04			4.64	5.68		
Boron				6.10	6.16		
Cadmium		1.65		25.96	26.22	1.65	
Chromium		6.18	77.31			6.18	77.31
Cobalt					1.63		
Copper			1.06	4.28	4.45		1.06
Lead	3.13	2.69		15.32	18.44	2.69	
Vanadium	30.03	9.63		8.83	38.85	9.63	
Zinc		1.73		1.18	1.22	1.73	
HI_NOAEL	**34.19**	**21.89**	**78.37**	**66.30**	**102.7**	**21.89**	**78.37**

7/21B	LOAEL-Based HQs Due to Soil Ingestion - RME	LOAEL-Based HQs Due to Dietary Ingestion - RME	Total LOAEL-Based HQs Summed Across Pathways - RME
Parameter	White-footed Mouse	White-footed Mouse	White-footed Mouse
Boron		3.05	3.08
Vanadium	10.01	2.94	12.95
HI_LOAEL	**10.01**	**5.99**	**16.03**

Notes:
1. DERA = Detailed Ecological Risk Assessment
2. RME = Reasonable Maximum Exposure
3. HI = Hazard Index
4. HQ = Hazard Quotient
5. NOAEL = No Observed Adverse Effect Level
6. LOAEL = Lowest Observed Adverse Effect Level

TABLE 10.7-14

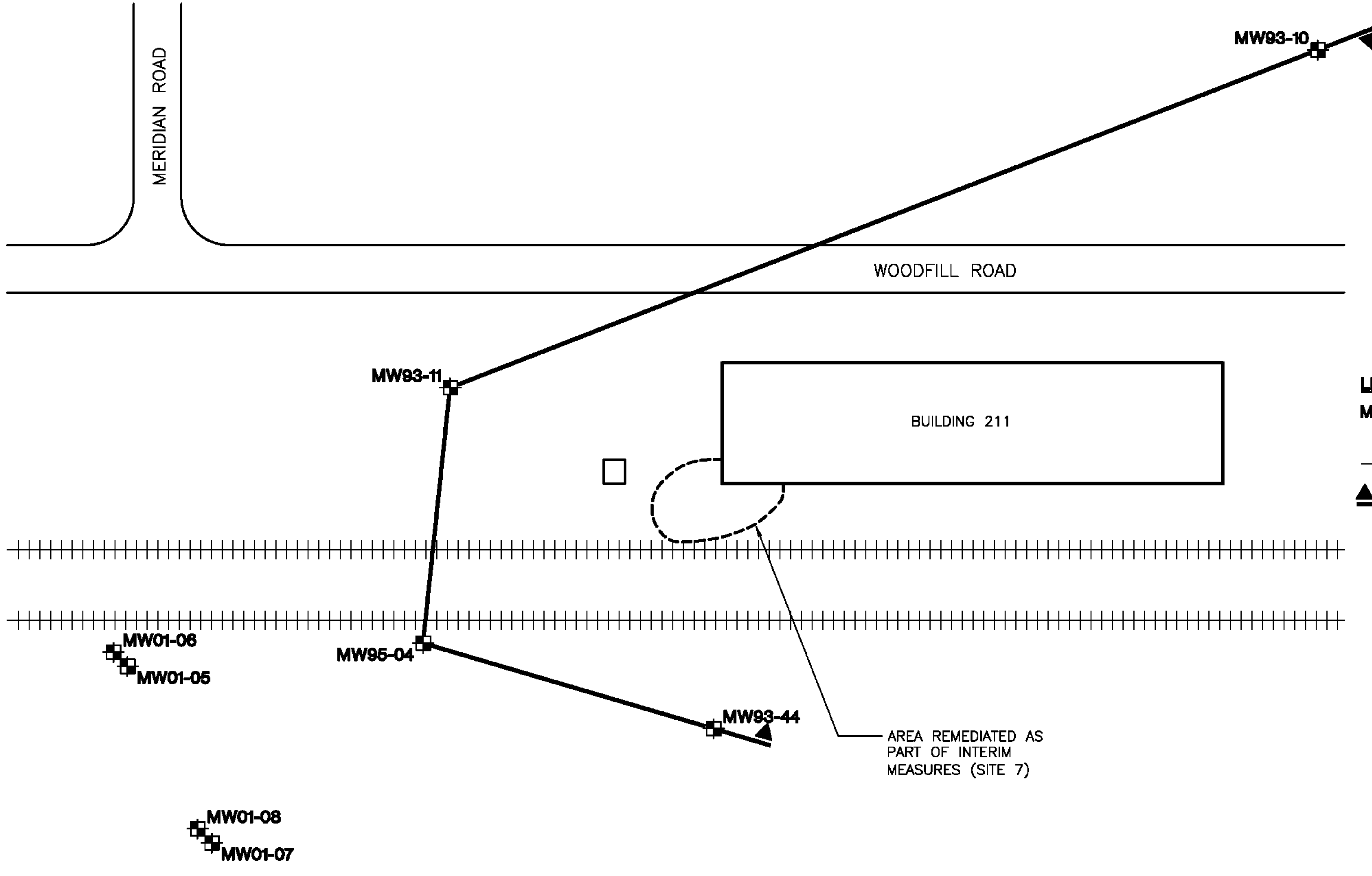
Summary of DERA CT Risk Drivers
Interim Measures Confirmation Sampling
Site 7/21B
Jefferson Proving Ground
Madison, Indiana

7/21B	NOAEL-Based HQs Due to Soil Ingestion - CT	NOAEL-Based HQs Due to Dietary Ingestion - CT	Total NOAEL-Based HQs Summed Across Pathways - CT
Parameter	**White-footed Mouse**	**White-footed Mouse**	**White-footed Mouse**
Barium		2.87	3.52
Boron		3.77	3.81
Cadmium		16.07	16.23
Cobalt			1.01
Copper		2.65	2.76
Lead	1.93	9.48	11.42
Vanadium	18.58	5.46	24.05
HI_NOAEL	**20.52**	**40.31**	**62.79**

7/21B	LOAEL-Based HQs Due to Soil Ingestion - CT	LOAEL-Based HQs Due to Dietary Ingestion - CT	Total LOAEL-Based HQs Summed Across Pathways - CT
Parameter	**White-footed Mouse**	**White-footed Mouse**	**White-footed Mouse**
Boron		1.89	1.91
Vanadium	6.19	1.82	8.02
HI_LOAEL	**6.19**	**3.71**	**9.92**

Notes:
1. DERA = Detailed Ecological Risk Assessment
2. CT = Central Tendency
3. HI = Hazard Index
4. HQ = Hazard Quotient
5. NOAEL = No Observed Adverse Effect Level
6. LOAEL = Lowest Observed Adverse Effect Level

FIGURES



LEGEND

MW93-10 — MONITORING WELL LOCATION AND NUMBER

RAILROAD TRACKS

LINE OF CROSS SECTION

NOTES

1. BASE MAP DEVELOPED FROM FIGURE 10–1 FROM A REPORT BY RUST ENVIRONMENT & INFRASTRUCTURE, DATED: 3–25–98.
2. CROSS SECTION SHOWN ON FIGURE 10–2, MONITORING WELL CROSS SECTION OF RED LEAD DISPOSAL AREA (SITE 7), PREPARED BY EARTHTECH.

north

0 50 100

SCALE IN FEET

SITE FEATURES MAP - RED LEAD DISPOSAL AREA (SITE 7) AND TEMPORARY STORAGE AREA (SITE 21B)

SOUTH OF THE FIRING LINE
JEFFERSON PROVING GROUND
MADISON, INDIANA

Developed By TAPB
Drawn By DLF
Approved By
Date
Reference 2440025.040201–B4
Revisions

Drawing Number 2440025 010102 **B5**

MWH MONTGOMERY WATSON HARZA

FIGURE 10-1

QUALITY CONTROL
Graphic Standards DLF 2–22–02
Lead Professional TAPB 2–22–02
Technical Review LAB
Project Manager 3–18–02
Management Review
Other

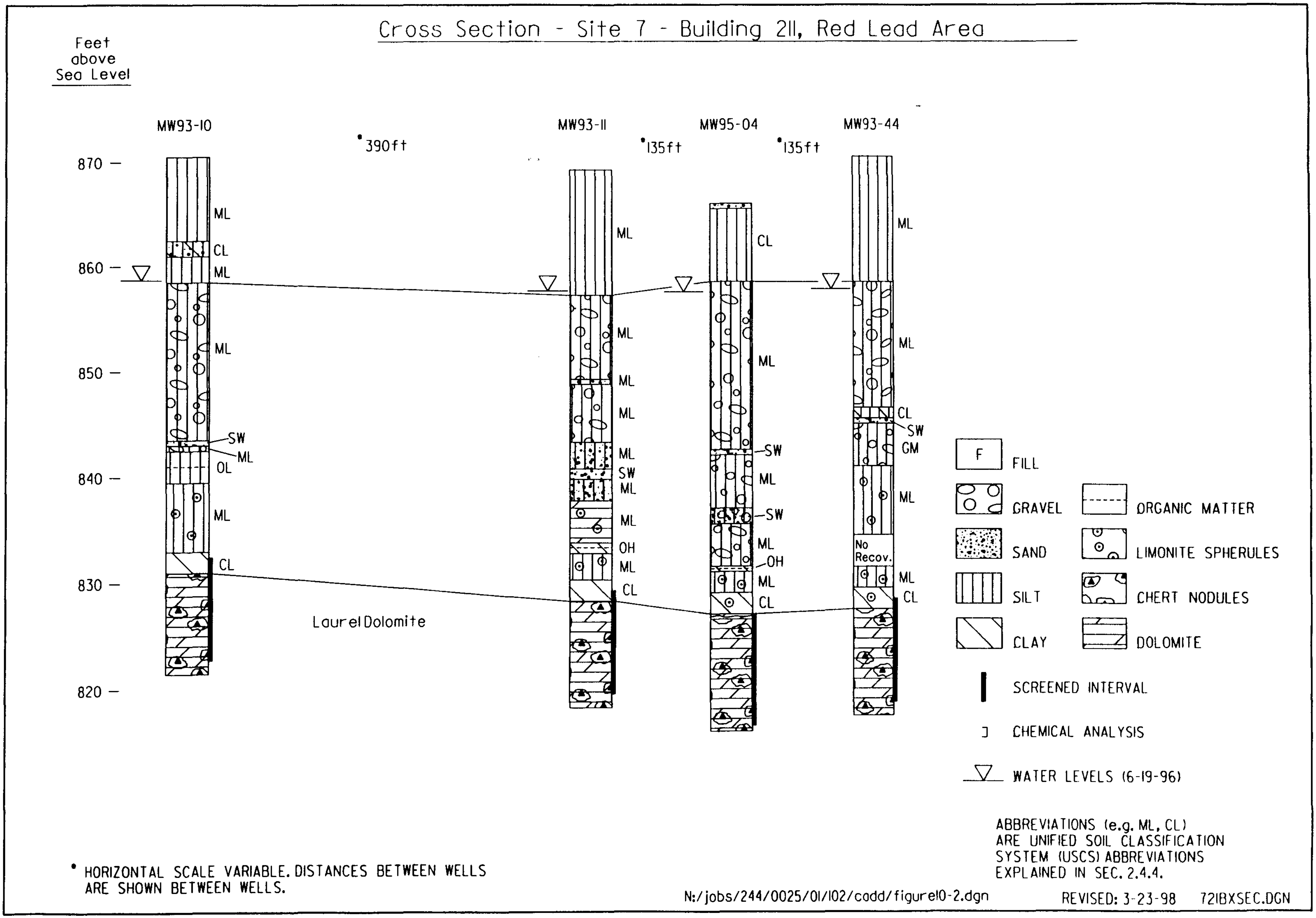
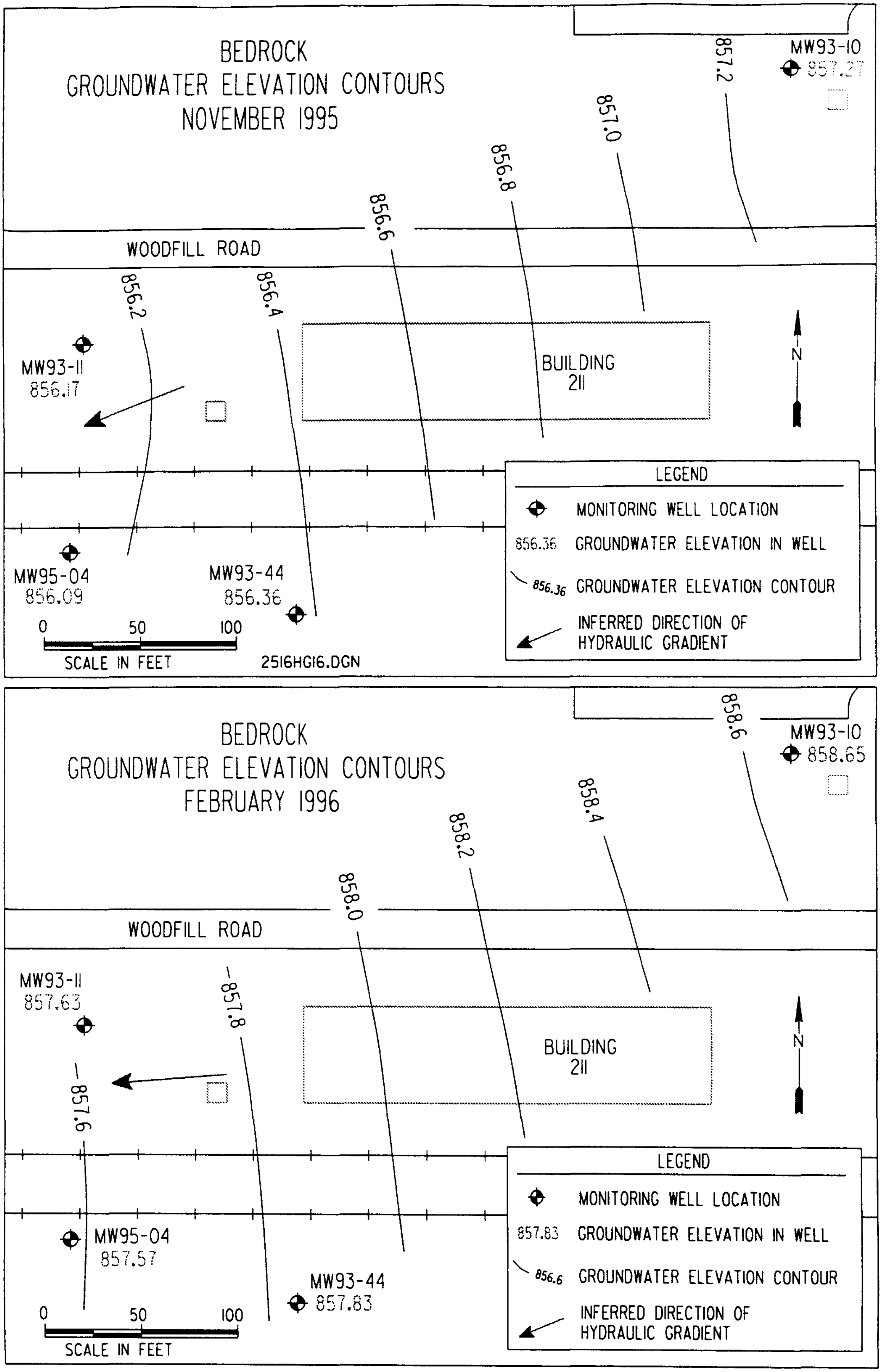


Figure 10-2. Monitoring Well Cross Section of Red Lead Disposal Area (Site 7)



N:/jobs/244/0025/01/102/cadd/figure10-3.dgn REVISED: 3-12-99 721CONNF.DGN

Figure 10-3. Bedrock Potentiometric Contour Map, November 1995 and February 1996, Red Lead Disposal Area (Site 7)

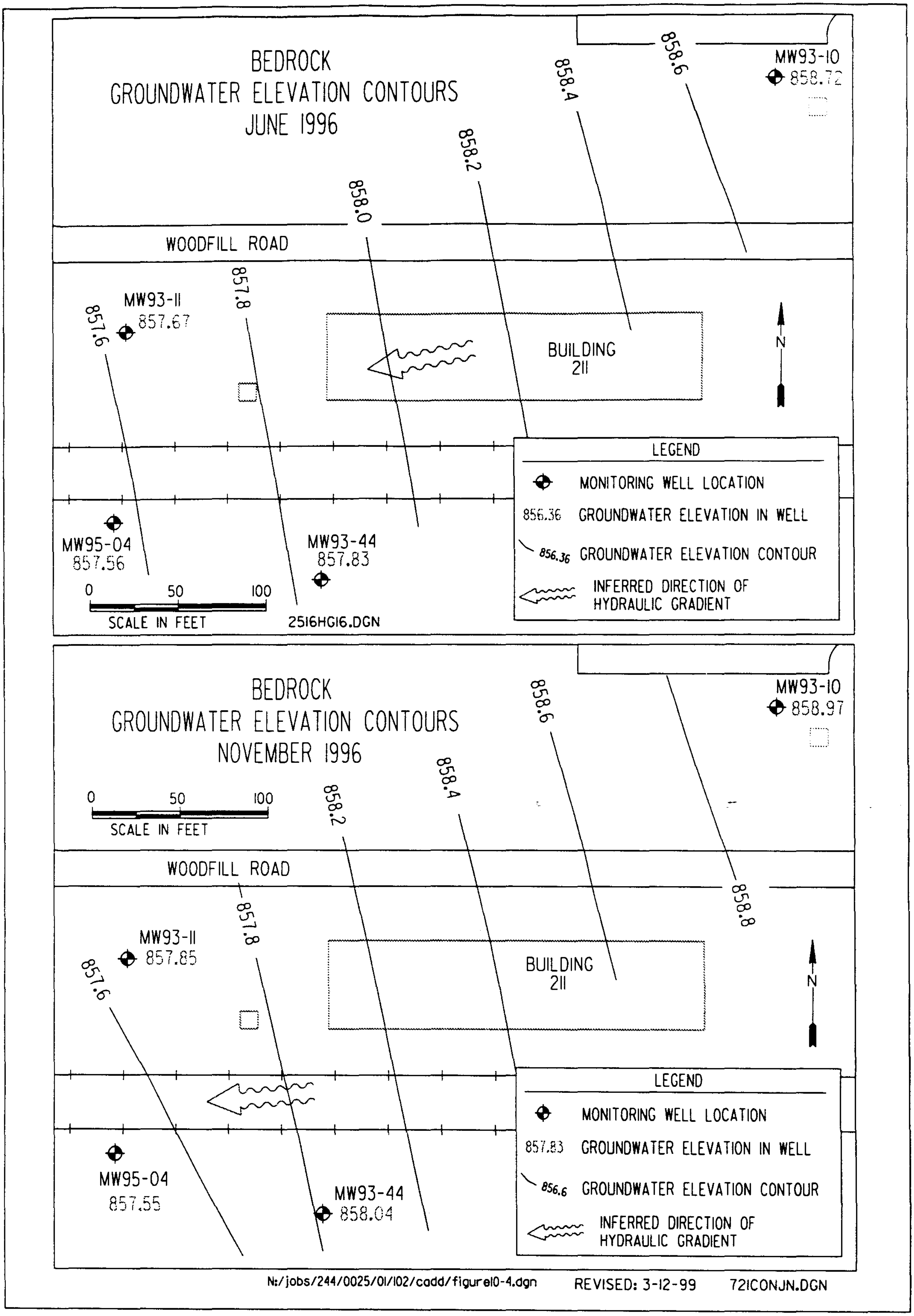
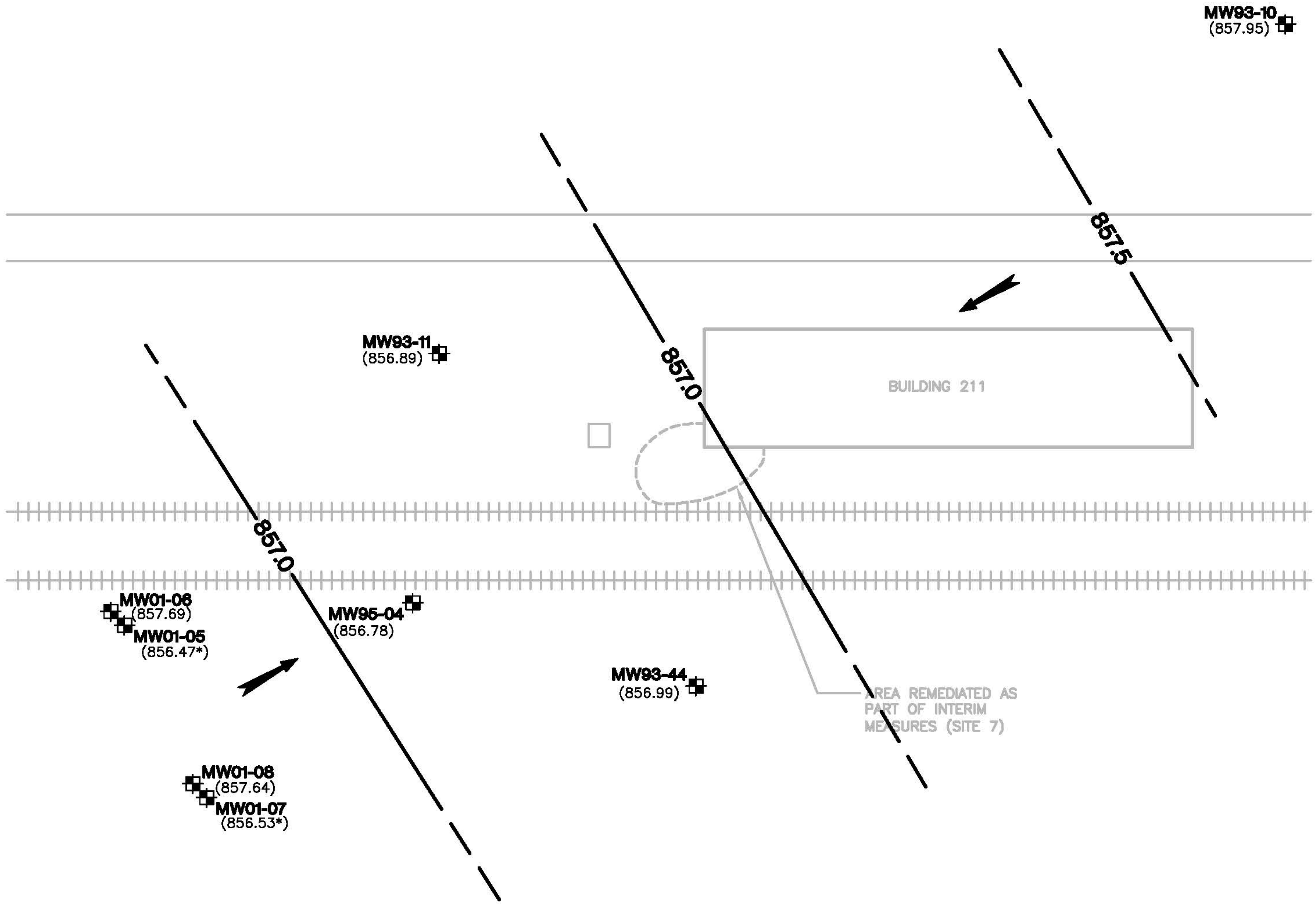


Figure 10-4. Bedrock Potentiometric Contour Map, June 1996 and November 1996, Red Lead Disposal Area (Site 7)



LEGEND

MW93-10 (857.95) — MONITORING WELL LOCATION, NUMBER, AND GROUNDWATER POTENTIOMETRIC SURFACE ELEVATION, IN FEET ABOVE MEAN SEA LEVEL

—857.0— POTENTIOMETRIC SURFACE CONTOUR (CONTOUR INTERVAL: 0.5 FT)

ESTIMATED GROUNDWATER FLOW DIRECTION

RAILROAD TRACKS

NOTES

1. BASE MAP DEVELOPED FROM FIGURE 10–1 FROM A REPORT BY RUST ENVIRONMENT & INFRASTRUCTURE, DATED: 3–25–98.
2. GROUNDWATER ELEVATIONS DENOTED BY AN "*" ARE NOT INCLUDED IN THE INTERPRETATION OF THE CONTOURED SURFACE.

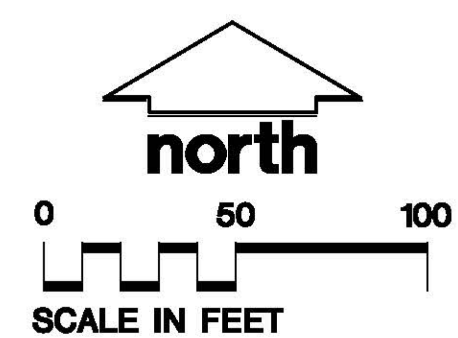


FIGURE 10-4a

POTENTIOMETRIC SURFACE MAP (JUNE 5, 2001) - RED LEAD DISPOSAL AREA (SITE 7) AND TEMPORARY STORAGE AREA (SITE 21B)

SOUTH OF THE FIRING LINE
JEFFERSON PROVING GROUND
MADISON, INDIANA

Developed By	TAPB
Drawn By	DLF
Approved By	
Date	
Reference	2440025.040201–B4
Revisions	

Drawing Number 2440025 010102 **B6**

MWH MONTGOMERY WATSON HARZA

QUALITY CONTROL		
Graphic Standards	DLF	2–19–02
Lead Professional	TAPB	2–22–02
Technical Review		
Project Manager	LAB	3–18–02
Management Review		
Other		

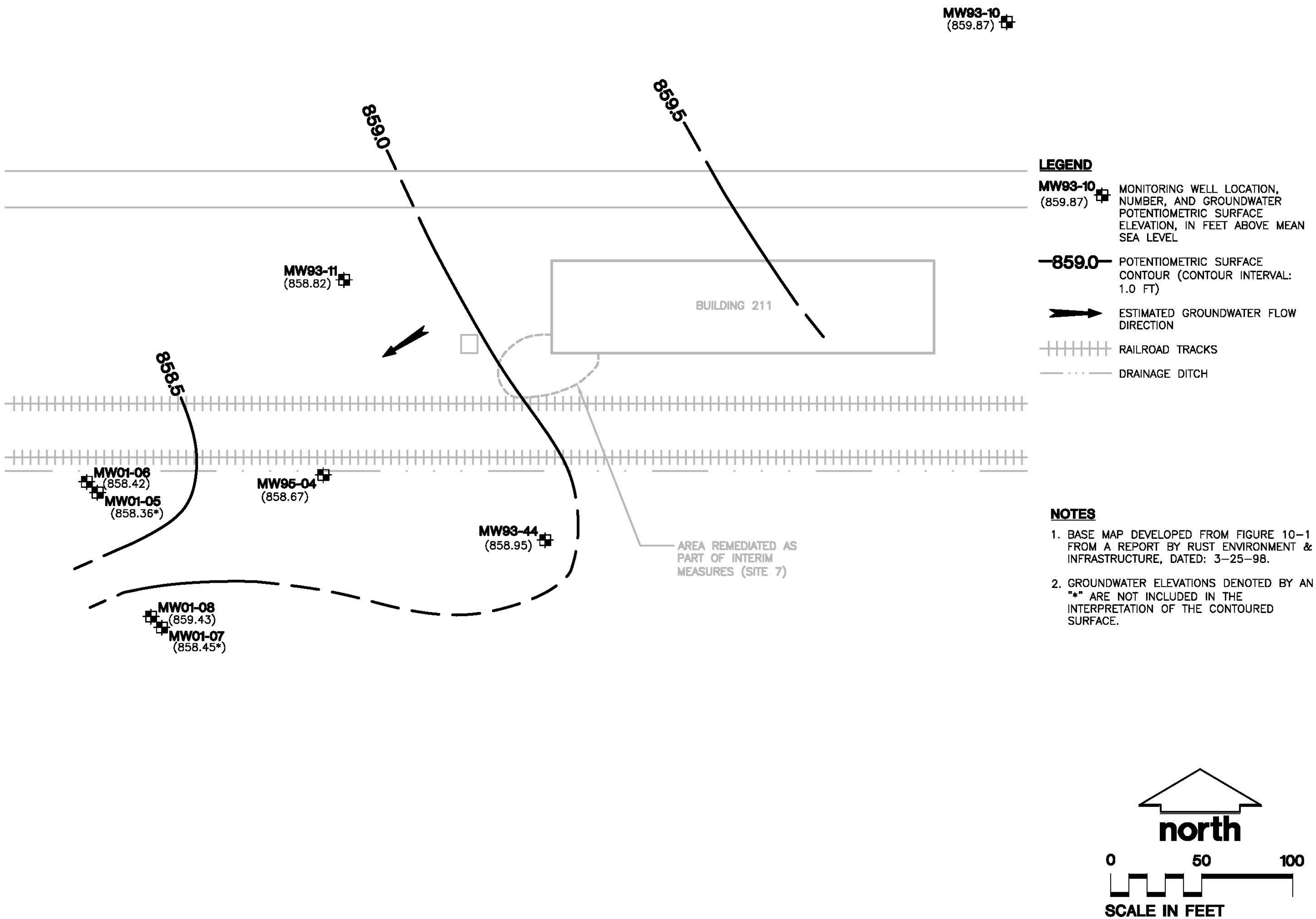


FIGURE 10-4b

POTENTIOMETRIC SURFACE MAP (NOVEMBER 30, 2001) - RED LEAD DISPOSAL AREA (SITE 7) AND TEMPORARY STORAGE AREA (SITE 21B)

SOUTH OF THE FIRING LINE
JEFFERSON PROVING GROUND
MADISON, INDIANA

Developed By TAPB | Drawn By DLF
Approved By | Date
Reference 2440025.040201-B4
Revisions

Drawing Number 2440025 010102 B7

MWH MONTGOMERY WATSON HARZA

QUALITY CONTROL | Graphic Standards DLF 2-19-02 | Technical Review LAB | Management Review
Lead Professional TAPB 2-22-02 | Project Manager 3-18-02 | Other

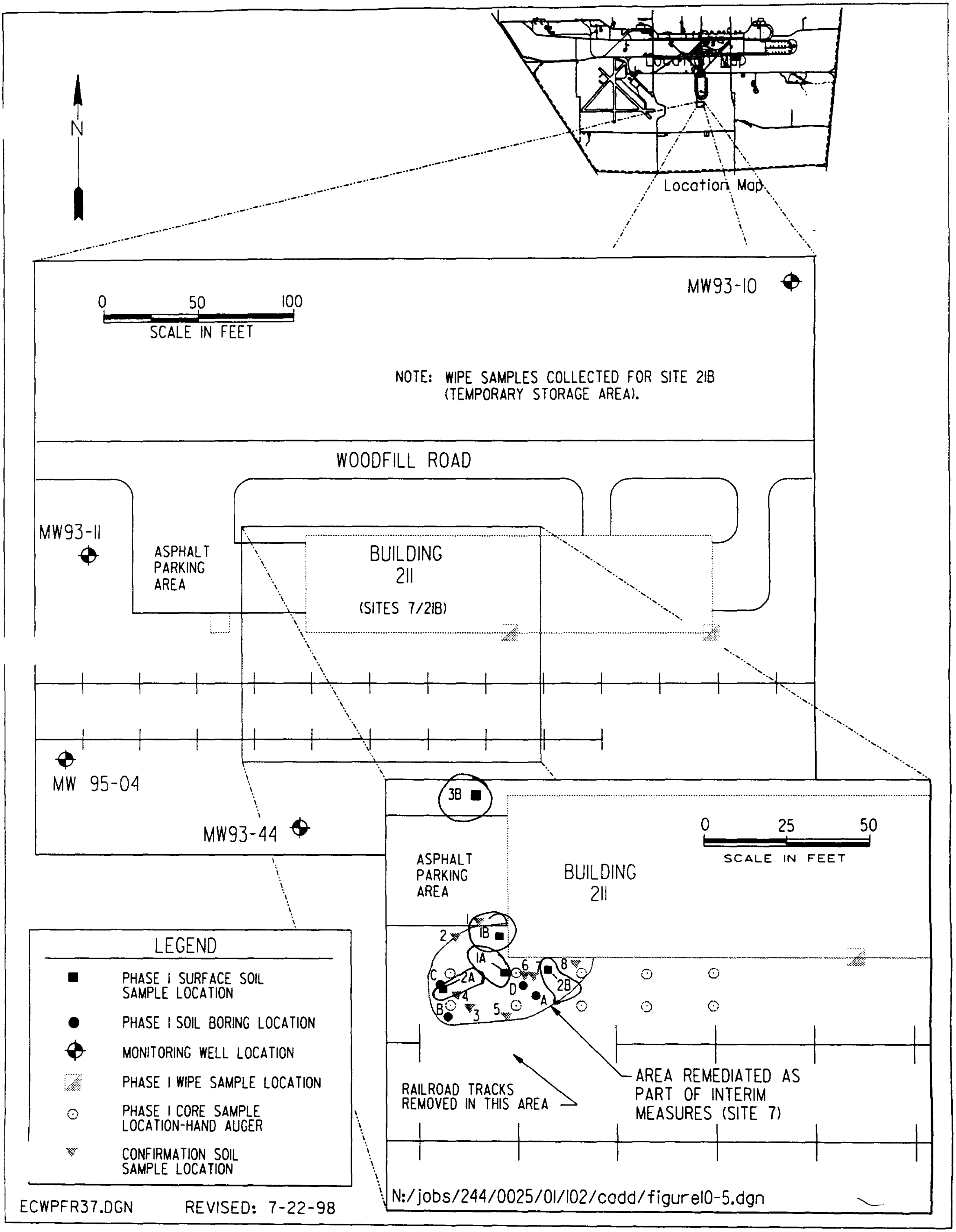
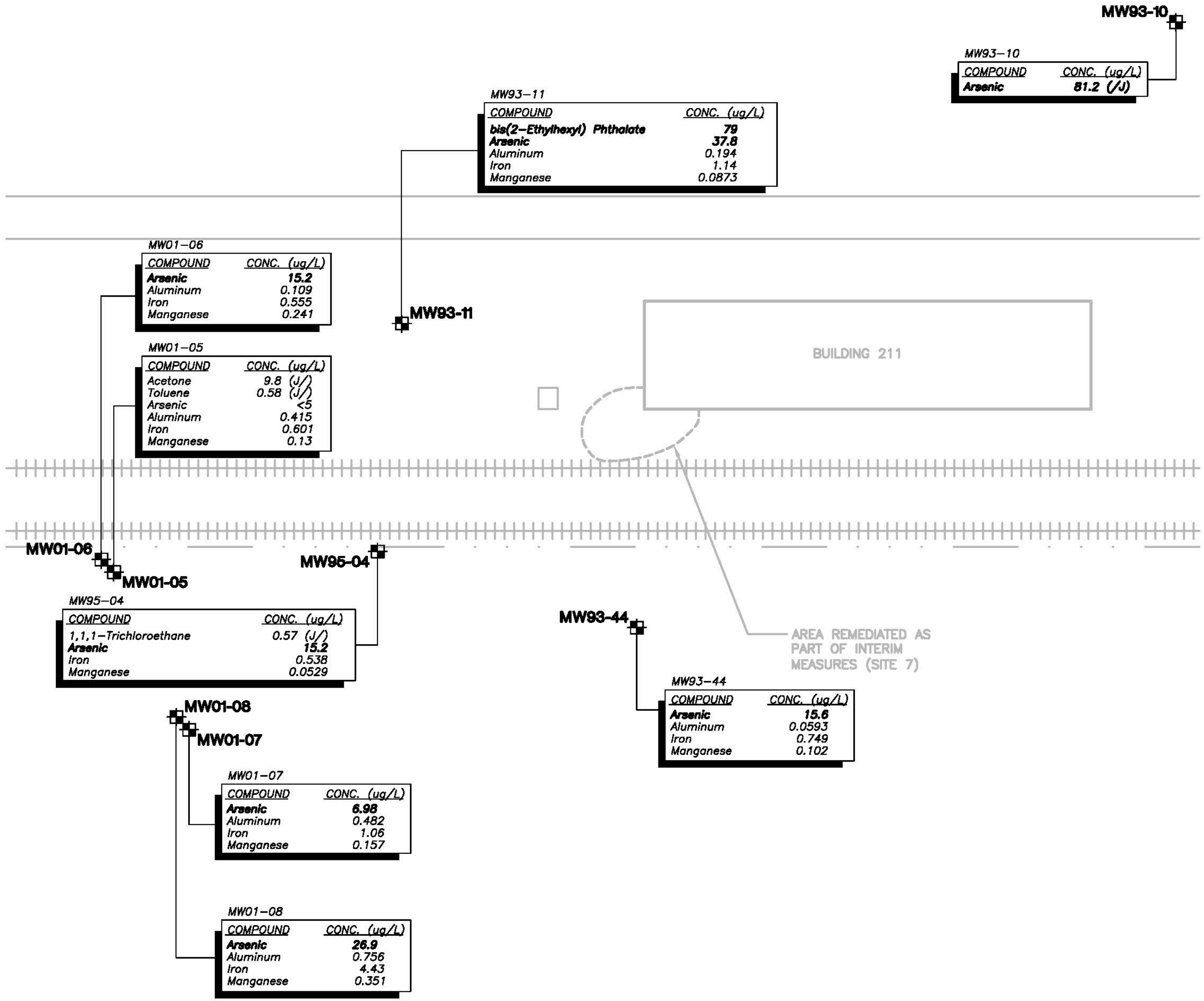


Figure 10-5. Interim Measures Confirmation and Sampling Locations for Soils Red Lead Disposal Area (Site 7) and the Temporary Storage Area at Building 211 (Site 21B)



LEGEND

MW93-10 MONITORING WELL LOCATION AND NUMBER

RAILROAD TRACKS

DRAINAGE DITCH

NOTES

1. BASE MAP DEVELOPED FROM FIGURE 10-1 FROM A REPORT BY RUST ENVIRONMENT & INFRASTRUCTURE, DATED: 3-25-98.
2. MW01 SERIES MONITORING WELLS WERE INSTALLED DURING 2001 UNDER THE SUPERVISION OF MWH.
3. MW93-10 GROUNDWATER SAMPLE WAS COLLECTED ON NOVEMBER 29, 2001.
4. ONLY ORGANIC COMPOUNDS WHICH WERE DETECTED ARE SHOWN ON THE MAP. SEE ANALYTICAL LABORATORY REPORT FOR PARAMETER LIST, DETECTION LIMITS, AND EXPLANATION OF LABORATORY NOTES.
5. RESULTS IN BOLD FONT INDICATES THAT CONCENTRATION EXCEEDS THE USEPA REGION 9 TAP WATER PRG (2000) FOR THAT COMPOUND.

north

0 50 100

SCALE IN FEET

FIGURE 10-5a

VOC, SVOC, AND ARSENIC CONCENTRATIONS IN GROUNDWATER (JUNE 2001) - RED LEAD DISPOSAL AREA (SITE 7) AND TEMPORARY STORAGE AREA (SITE 21B)

SOUTH OF THE FIRING LINE
JEFFERSON PROVING GROUND
MADISON, INDIANA

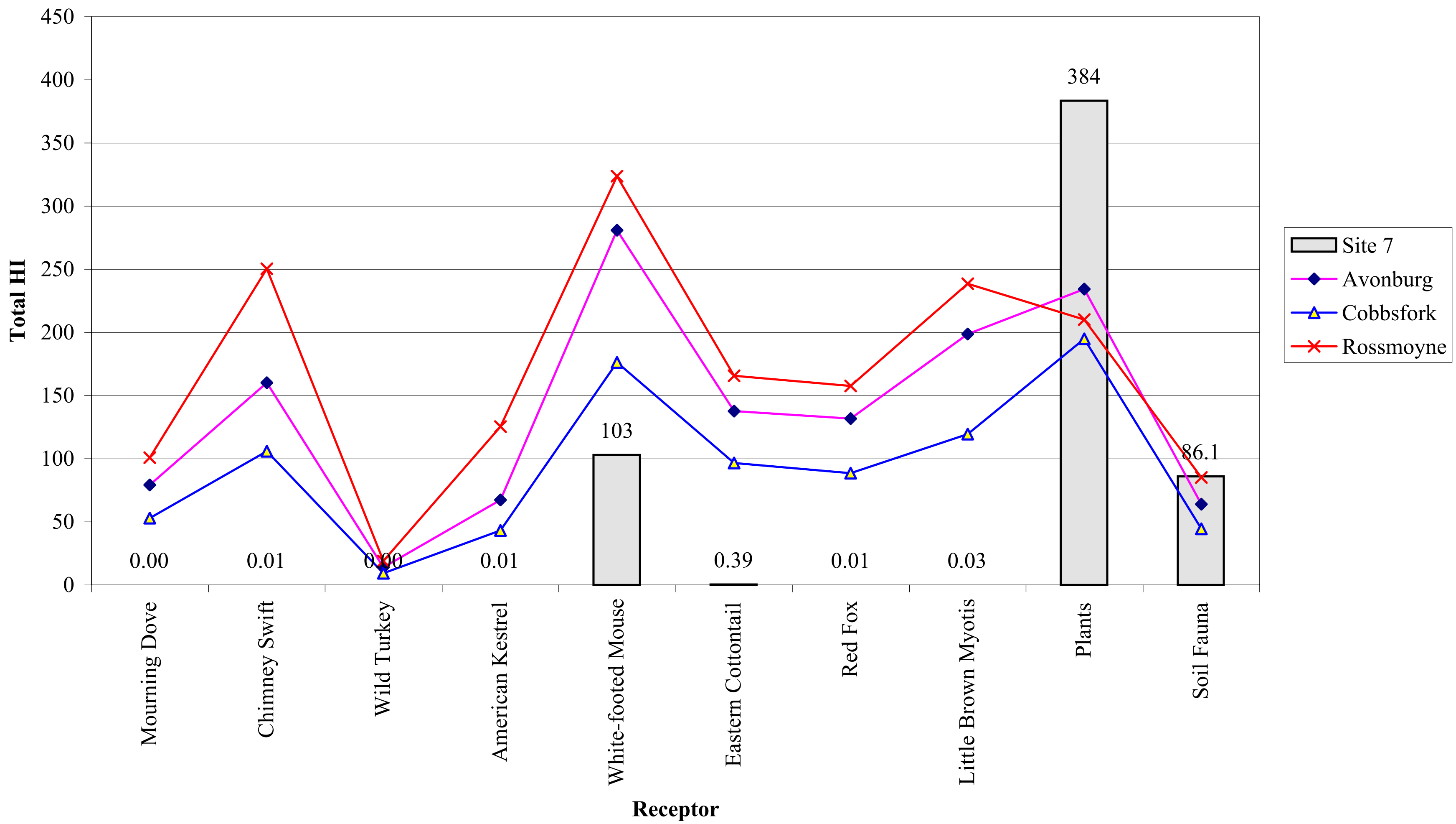
Developed By TAPB
Drawn By DLF
Approved By
Date
Reference 2440025.040201-B4
Revisions

Drawing Number
2440025
010102 B8

MWH MONTGOMERY WATSON HARZA

QUALITY CONTROL
Graphic Standards DLF 2-19-02
Lead Professional TAPB 2-22-02
Technical Review
Project Manager
Management Review
Other

Figure 10.7-1 Total HIs - RME Risks Summed for All Pathways Based on NOAELs at Site 7 - Red Lead Disposal Area - Phase I



N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase 1\Risk2\P1era_7MWH.xls Figure 10.7-1

Receptor & Exposure Data

Primary Source	Primary Release	Primary Transport	Exposure Medium	Plants	Soil Fauna[1]	Mourning Dove	Chimney Swift	Wild Turkey	Great Blue Heron	American Kestrel	White-Footed Mouse	Eastern Cottontail	Little Brown Myotis	Raccoon	Red Fox	Pickerel Frog	Creek Chub	Benthic Invertebrates[1]
Spills, Leaks; Surface or Buried Wastes, Burning	Volatilization; Fugitive Dust	Air Movement	Air	NA	NA	INH	INH	INH	INH	INH	INH	INH	INH	INH	INH	INH	NA	NA
Contaminated Surface Soil	Leaching	Infiltration	Ground Water	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Contaminated Surface Soil	Surface Runoff	Water movement	Surface Water	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Contaminated Surface Soil	Surface Runoff	Deposition	Sediments	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Contaminated Surface Soil	Tracking		Soil	DC	DC	ING	ING	ING	ING	ING	ING	ING	ING	ING	ING	DC	NA	NA
Contaminated Surface Soil	Biotic Uptake[a]	Biota[a]	Biota[a]	NA	ING	ING	ING	ING	NA	ING	ING	ING	ING	NA	ING	NA	NA	NA

(dotted box) Pathway may be significant; not evaluated because toxicity criteria lacking

(hatched box) Insignificant pathway; not quantitatively evaluated

NA Not Applicable

ING Ingestion

INH Inhalation

DC Direct Contact

1 Includes the terrestrial or aquatic crayfish

a Refer to JPG Food Web (Figure 5.3-5)

Figure 10.7-1a
JPG Conceptual Site Model
Site 7

N:Jobs\244\0025\01\102\cadd\figure10.7-1a.ppt

Receptor & Exposure Data

Primary Source	Primary Release	Primary Transport	Exposure Medium	Plants	Soil Fauna[1]	Mourning Dove	Chimney Swift	Wild Turkey	Great Blue Heron	American Kestrel	White-Footed Mouse	Eastern Cotton-tail	Little Brown Myotis	Raccoon	Red Fox	Pickerel Frog	Creek Chub	Benthic Inver-tebrates[1]
Spills, Leaks; Surface or Buried Wastes, Burning	Volatilization; Fugitive Dust	Air Movement	Air	NA	NA	INH	INH	INH	INH	INH	INH	INH	INH	INH	INH	INH	NA	NA
Contaminated Surface Soil	Leaching	Infiltration	Ground Water	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Contaminated Surface Soil	Surface Runoff	Water movement	Surface Water	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Contaminated Surface Soil	Surface Runoff	Deposition	Sediments	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Contaminated Surface Soil	Tracking		Soil	DC	DC	ING	ING	ING	ING	ING	ING	ING	ING	ING	ING	DC	NA	NA
Contaminated Surface Soil	Biotic Uptake[a]	Biota[a]	Biota[a]	NA	ING	ING	ING	ING	NA	ING	ING	ING	ING	NA	ING	NA	NA	NA

Pathway may be significant; not evaluated because toxicity criteria lacking

Insignificant pathway; not quantitatively evaluated

NA Not Applicable

ING Ingestion

INH Inhalation

DC Direct Contact

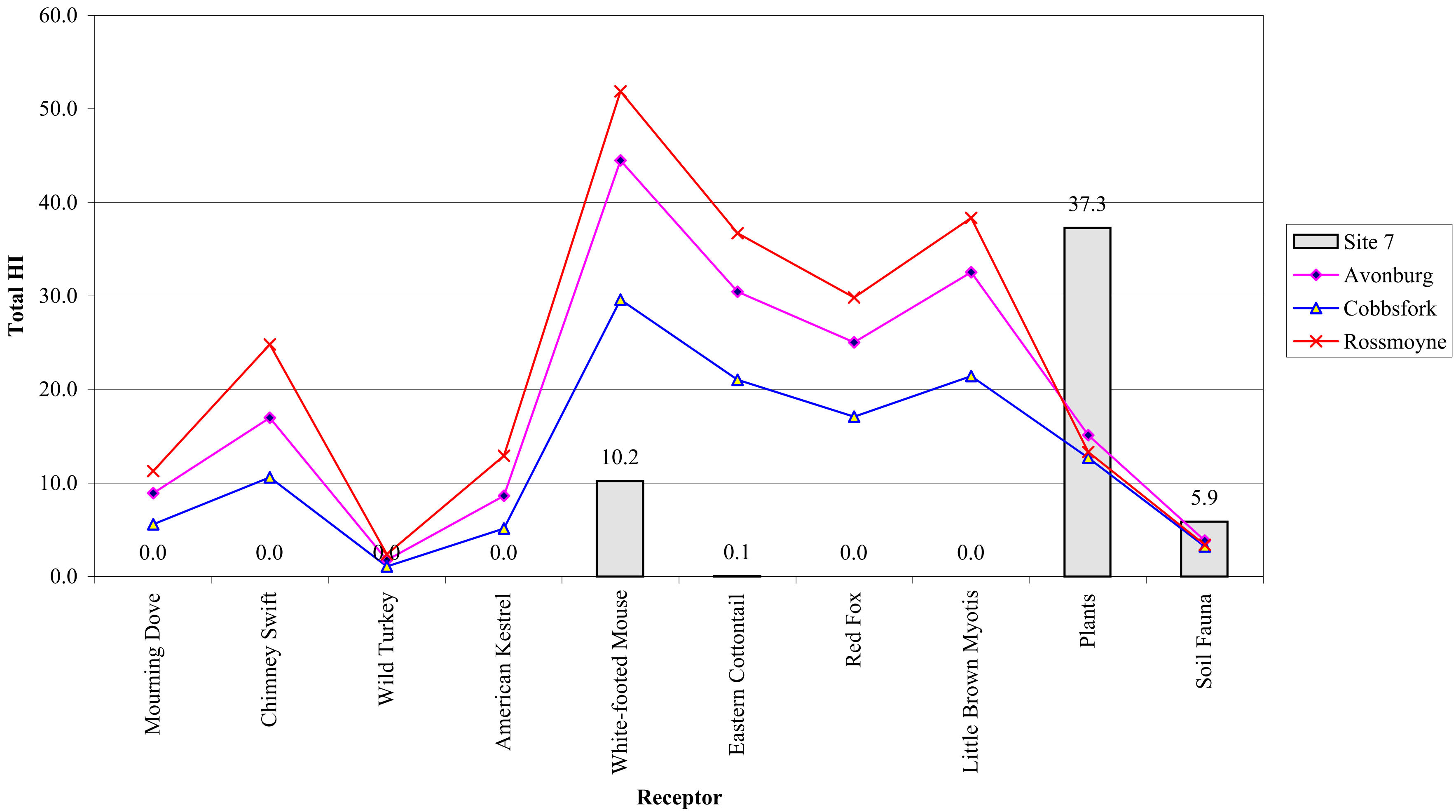
1 Includes the terrestrial or aquatic crayfish

a Refer to JPG Food Web (Figure 5.3-5)

Figure 10.7-1b
JPG Conceptual Site Model
Site 21B

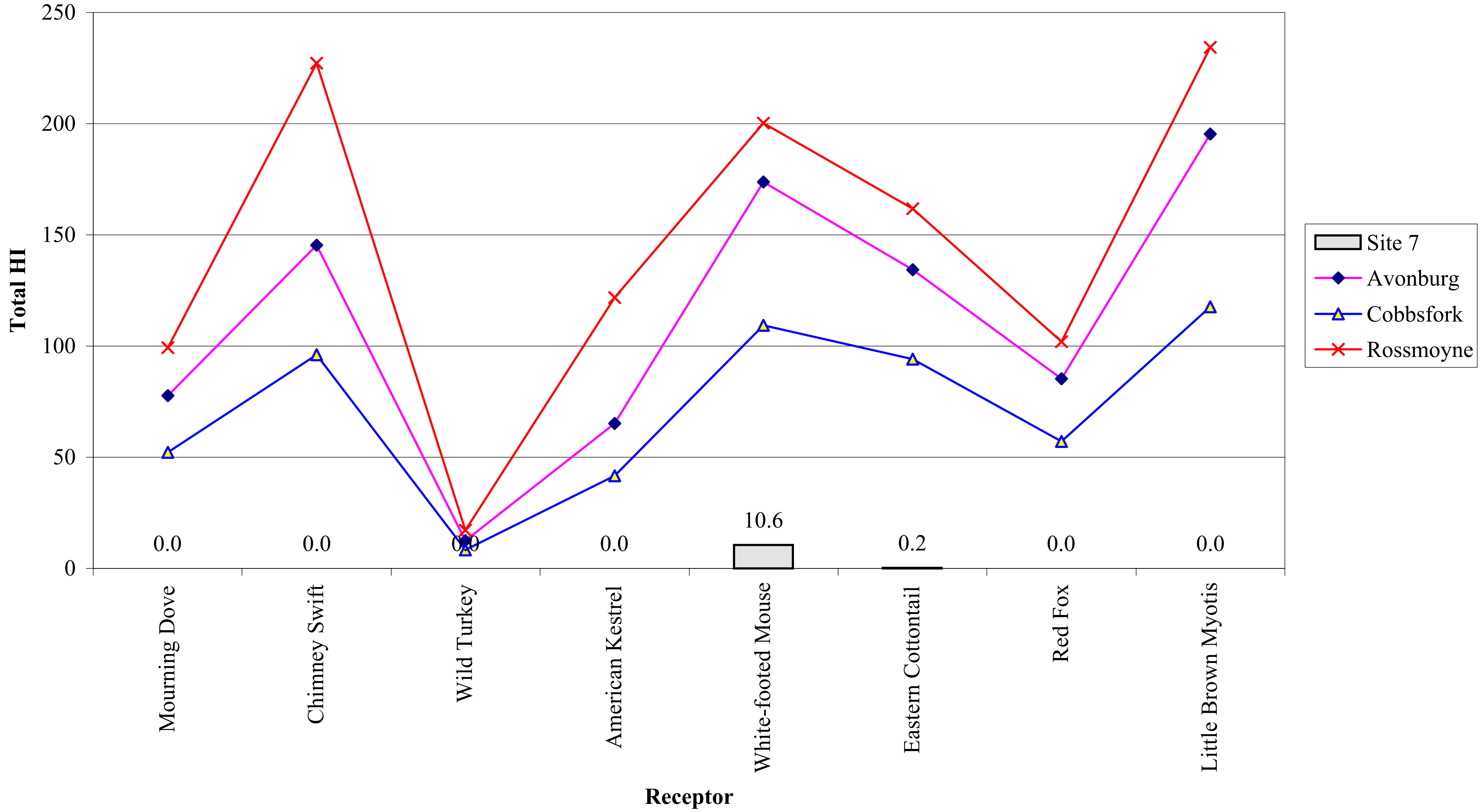
N:Jobs\244\0025\01\102\cadd\figure10.7-1b.ppt

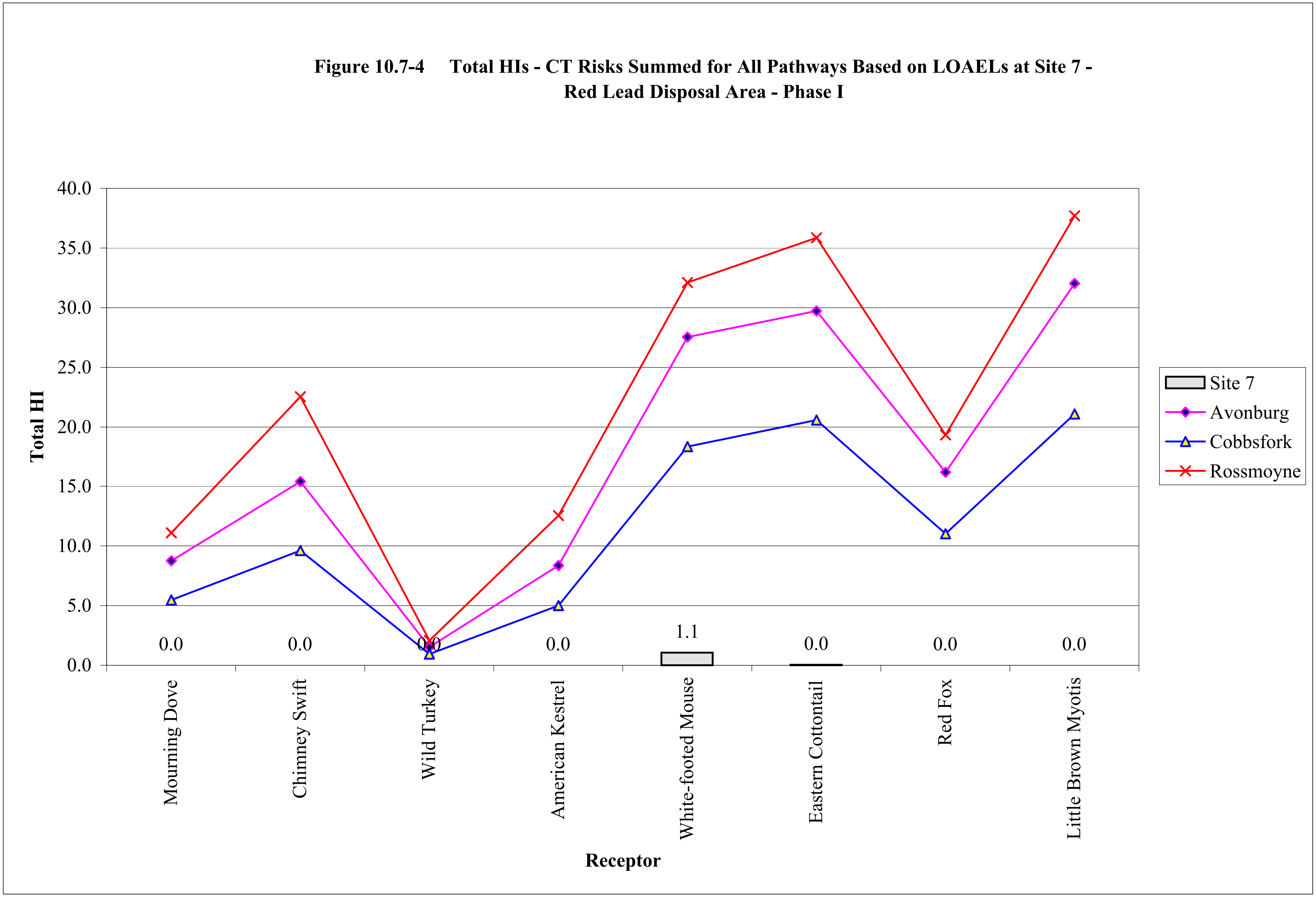
Figure 10.7-2 Total HIs - RME Risks Summed for All Pathways Based on LOAELs at Site 7 - Red Lead Disposal Area - Phase I



N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase 1\Risk2\P1era_7MWH.xls Figure 10.7-2

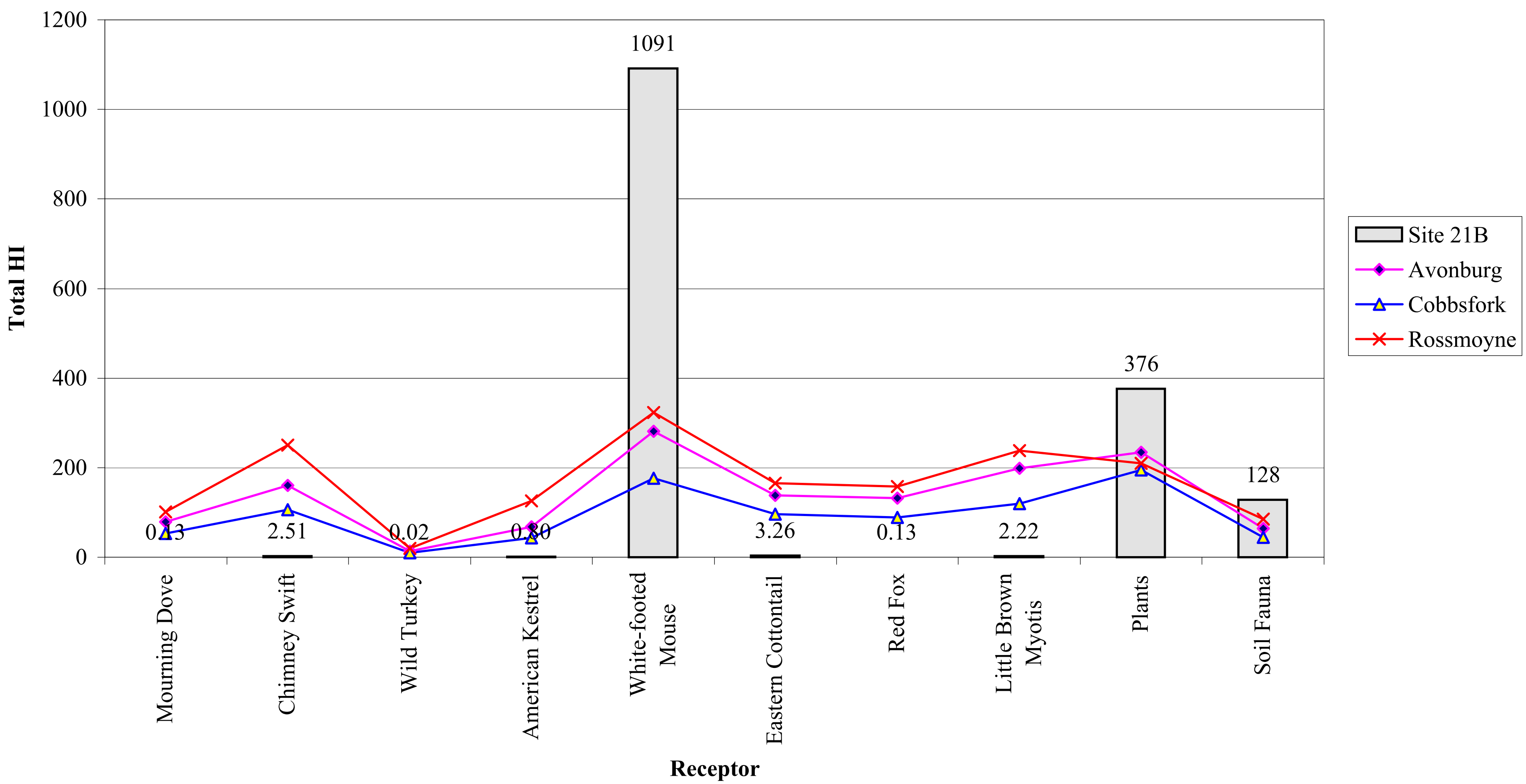
Figure 10.7-3 Total HIs - CT Risks Summed for All Pathways Based on NOAELs at Site 7 - Red Lead Disposal Area - Phase I





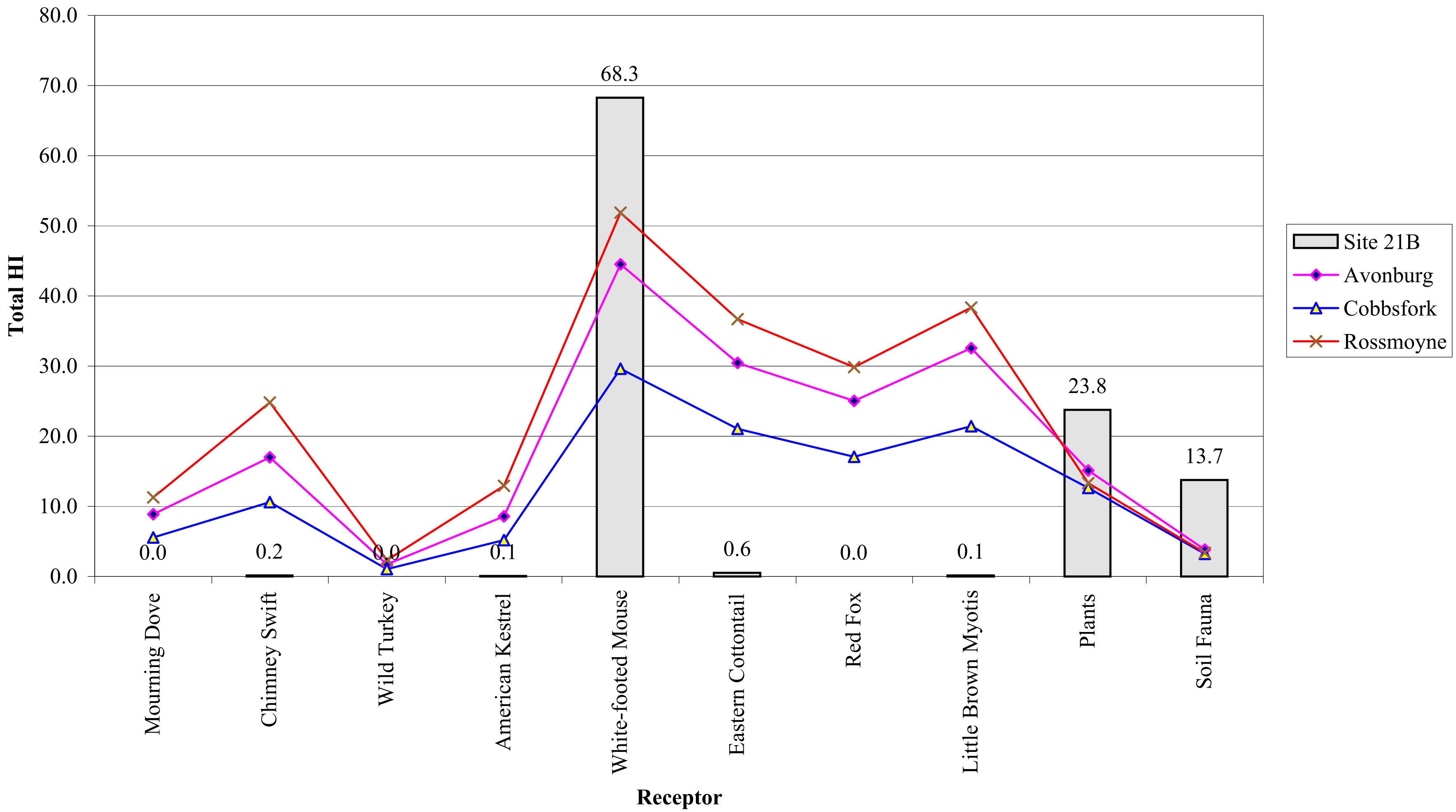
N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase 1\Risk2\P1era_7MWH.xls Figure 10.7-4

Figure 10.7-5 Total HIs - RME Risks Summed for All Pathways Based on NOAELs at Site 21B - Temporary Storage Area at Building 211 - Phase I



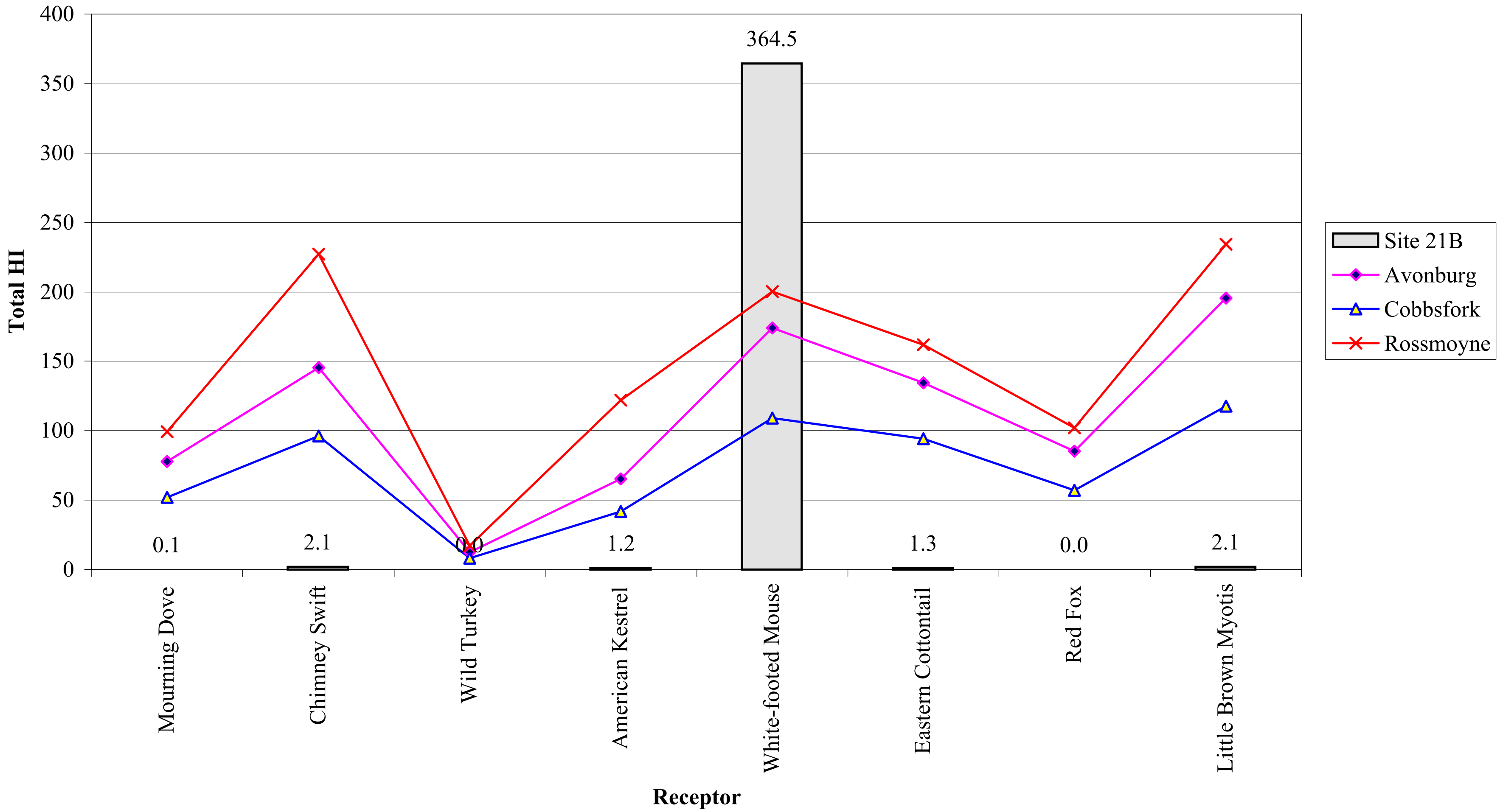
N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase 1\Risk2\P1era_21MWH.xls Figure 10.7-5

Figure 10.7-6 Total HIs - RME Risks Summed for All Pathways Based on LOAELs at Site 21B - Temporary Storage Area at Building 211 - Phase I



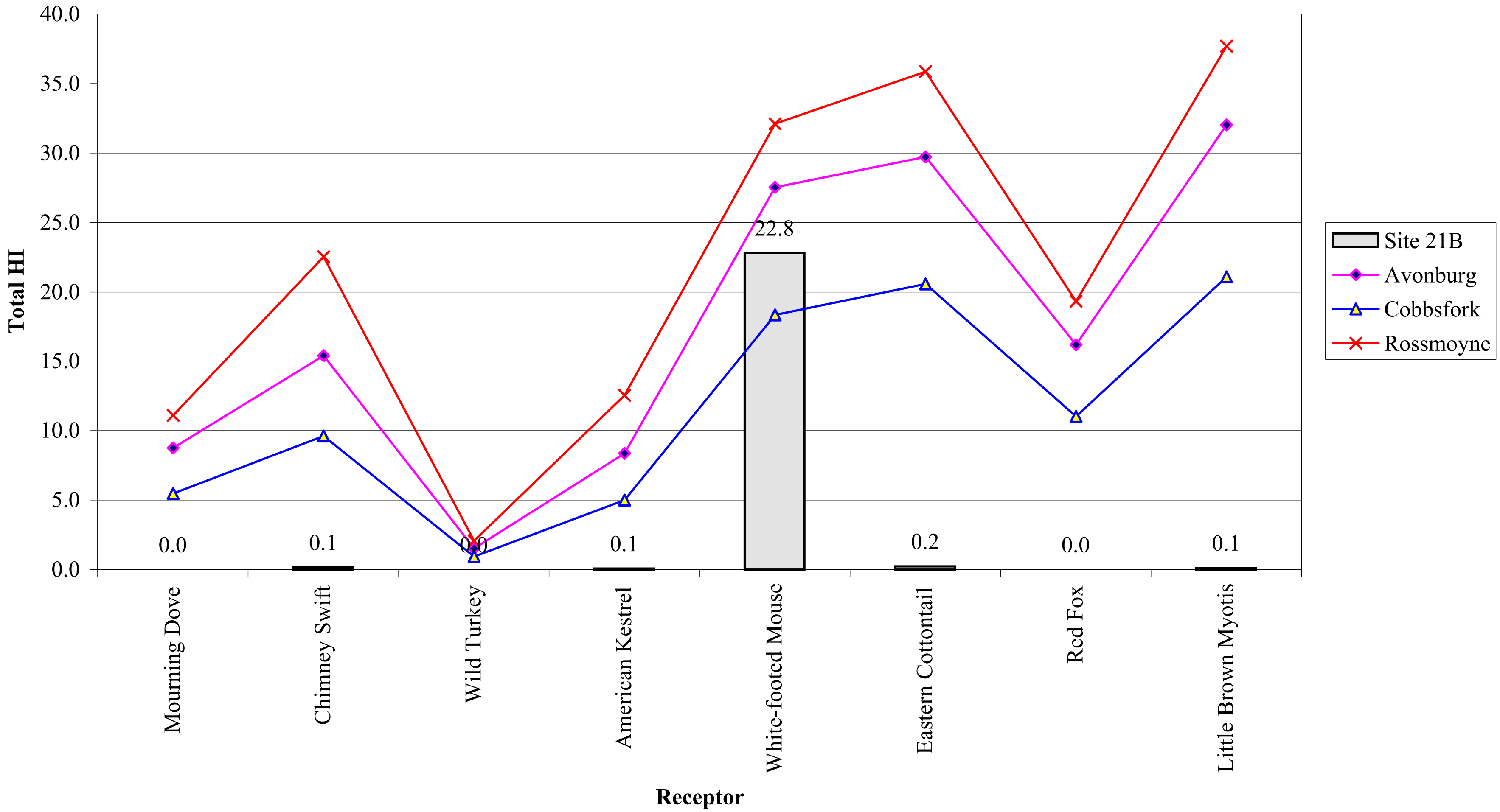
N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase 1\Risk2\P1era_21MWH.xls Figure 10.7-6

Figure 10.7-7 Total HIs - CT Risks Summed for All Pathways Based on NOAELs at Site 21B - Temporary Storage Area at Building 211 - Phase I



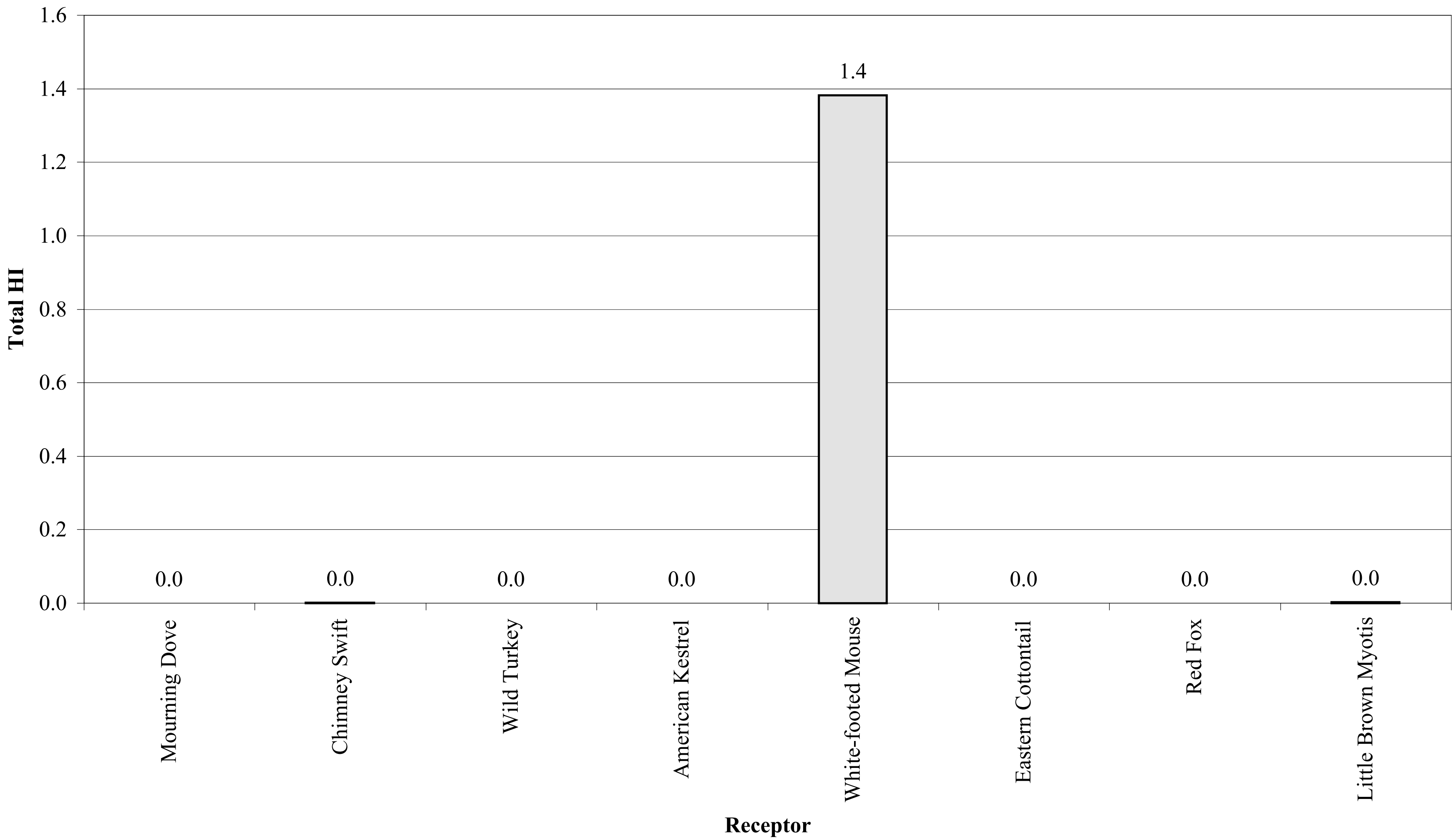
N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase 1\Risk2\P1era_21MWH.xls Figure 10.7-7

Figure 10.7-8 Total HIs - CT Risks Summed for All Pathways Based on LOAELs at Site 21B - Temporary Storage Area at Building 211 - Phase I



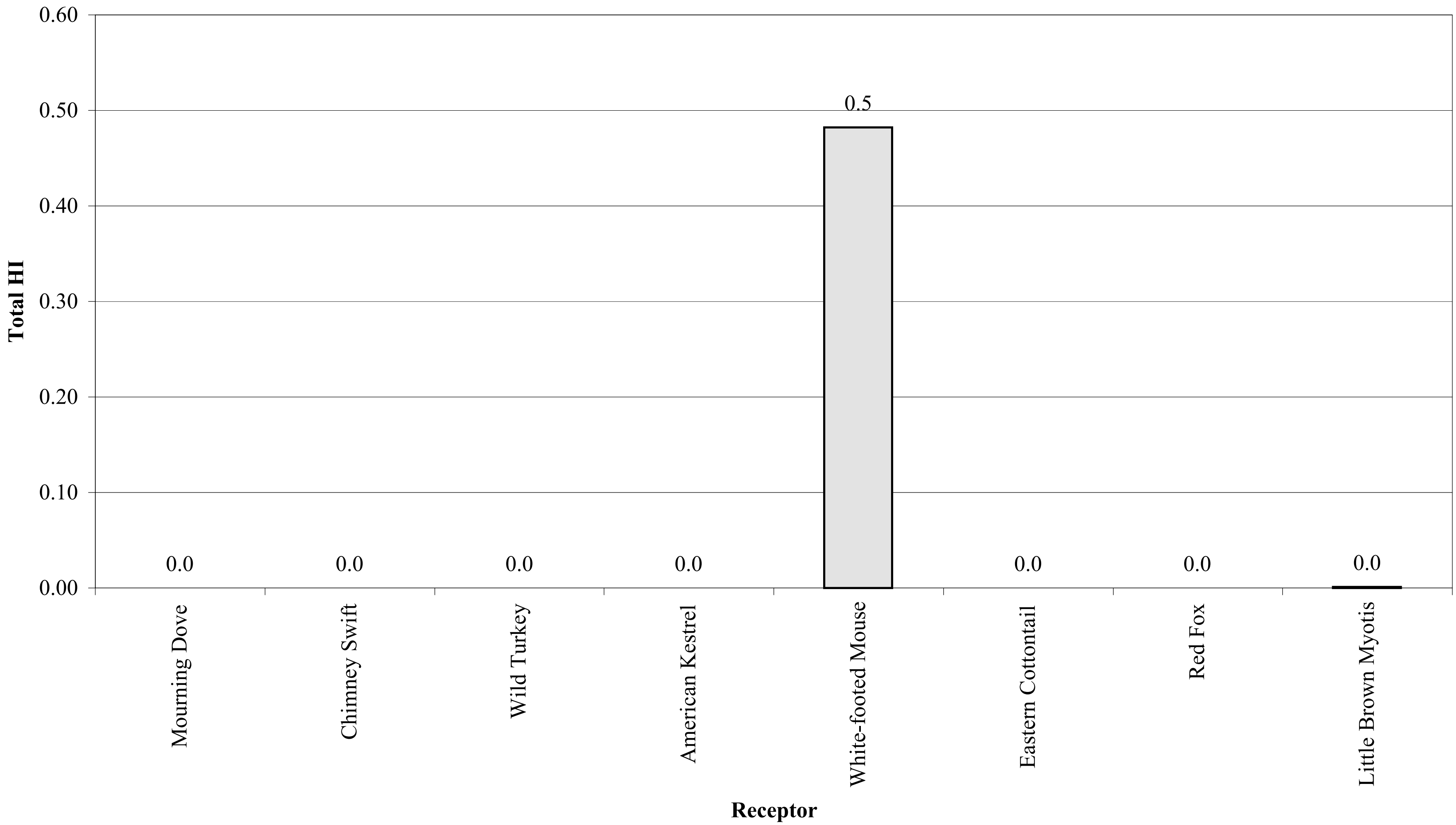
N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase 1\Risk2\P1era_21MWH.xls Figure 10.7-8

Figure 10.7-9 Total HIs - RME Risks Summed for All Pathways Based on NOAELs at Site 21B - Temporary Storage Area at Building 211 - Phase II



N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase 2\Risk2\P2era_21MWH.xls Figure 10.7-9

Figure 10.7-10 Total HIs - RME Risks Summed for All Pathways Based on LOAELs at Site 21B - Temporary Storage Area at Building 211 - Phase II



N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase 2\Risk2\P2era_21MWH.xls Figure 10.7-10

Figure 10.7-11 Total HIs - CT Risks Summed for All Pathways Based on NOAELs at Site 21B - Temporary Storage Area at Building 211 - Phase II

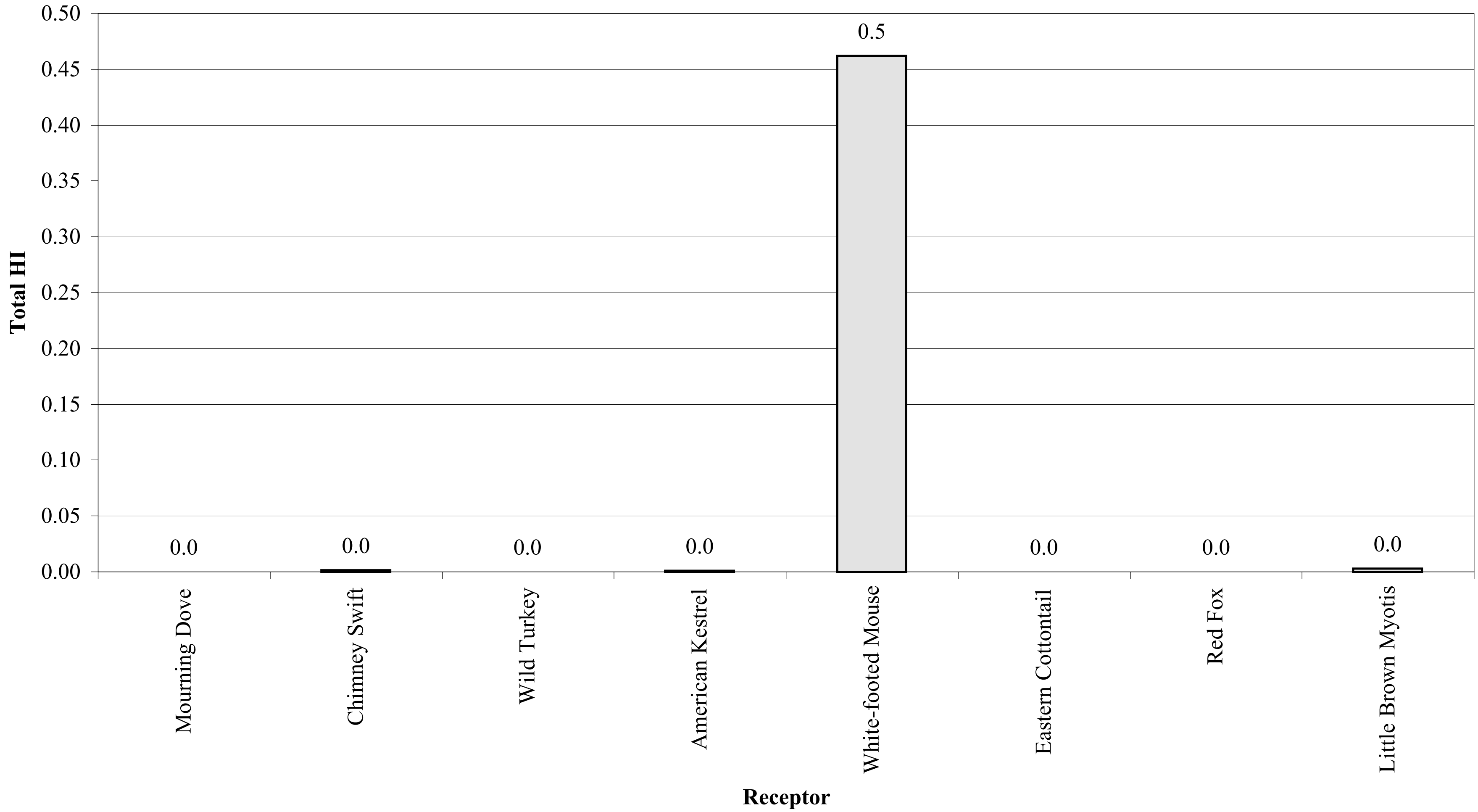
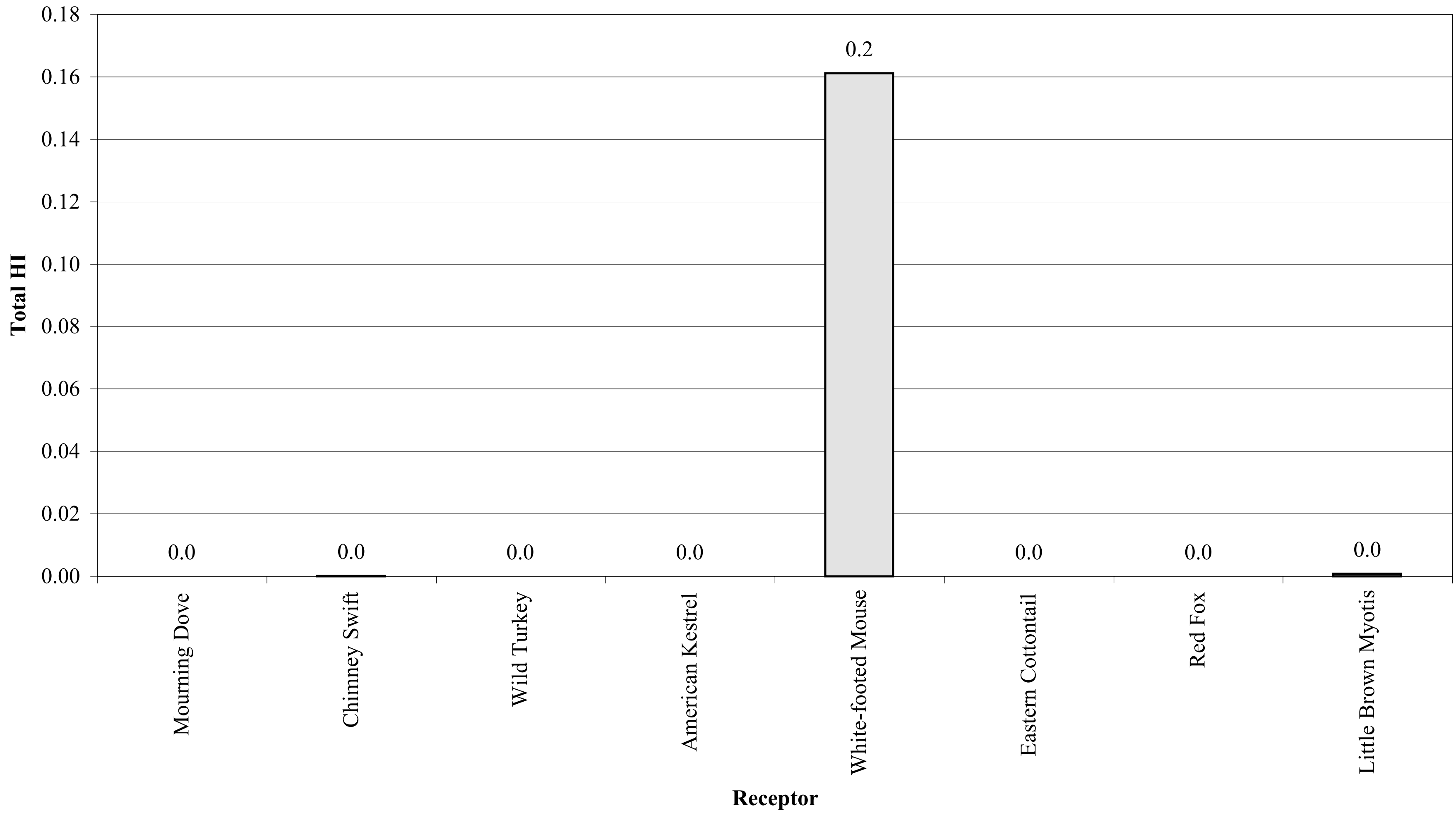
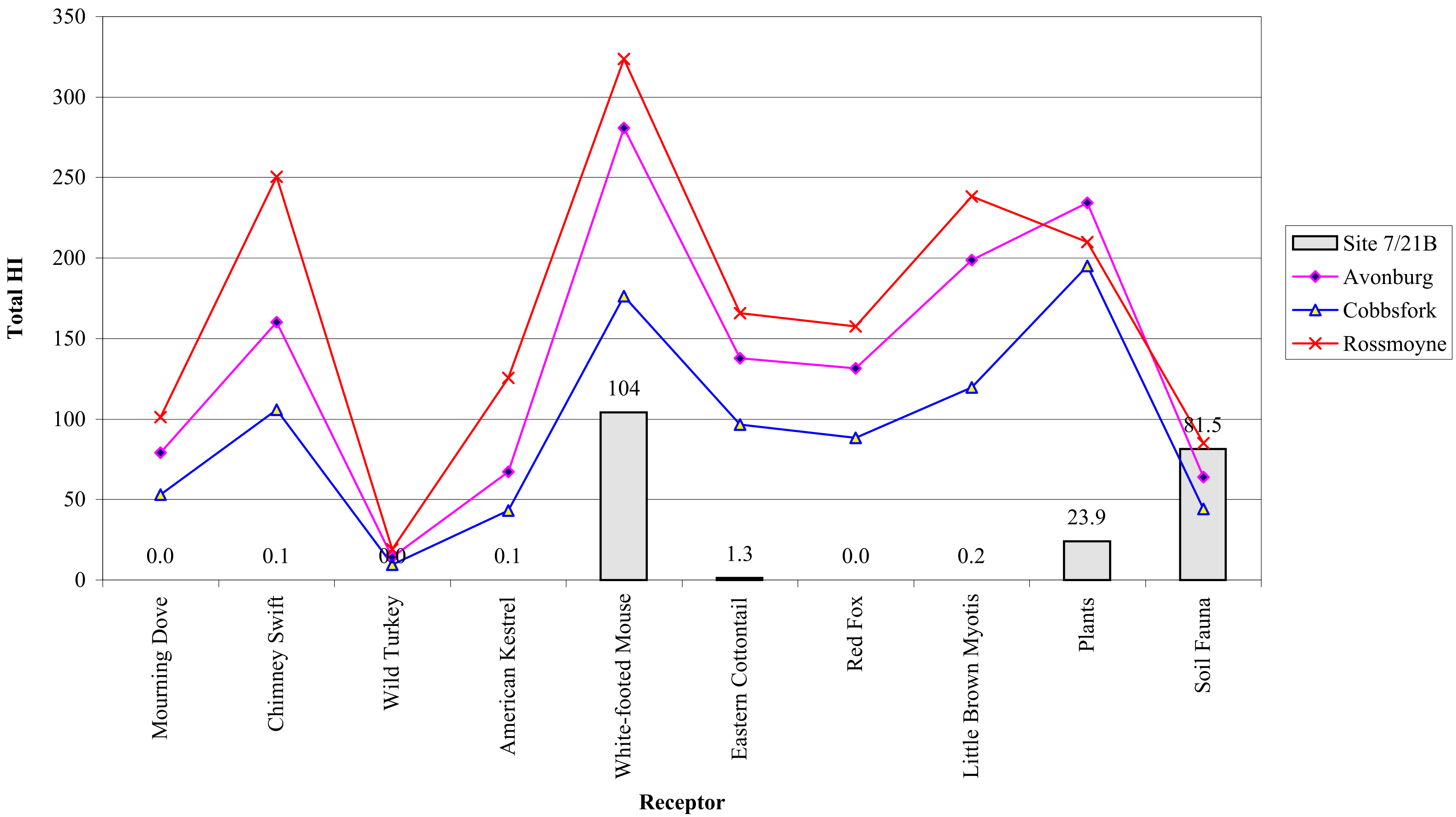


Figure 10.7-12 Total HIs - CT Risks Summed for All Pathways Based on LOAELs at Site 21B - Temporary Storage Area at Building 211 - Phase II



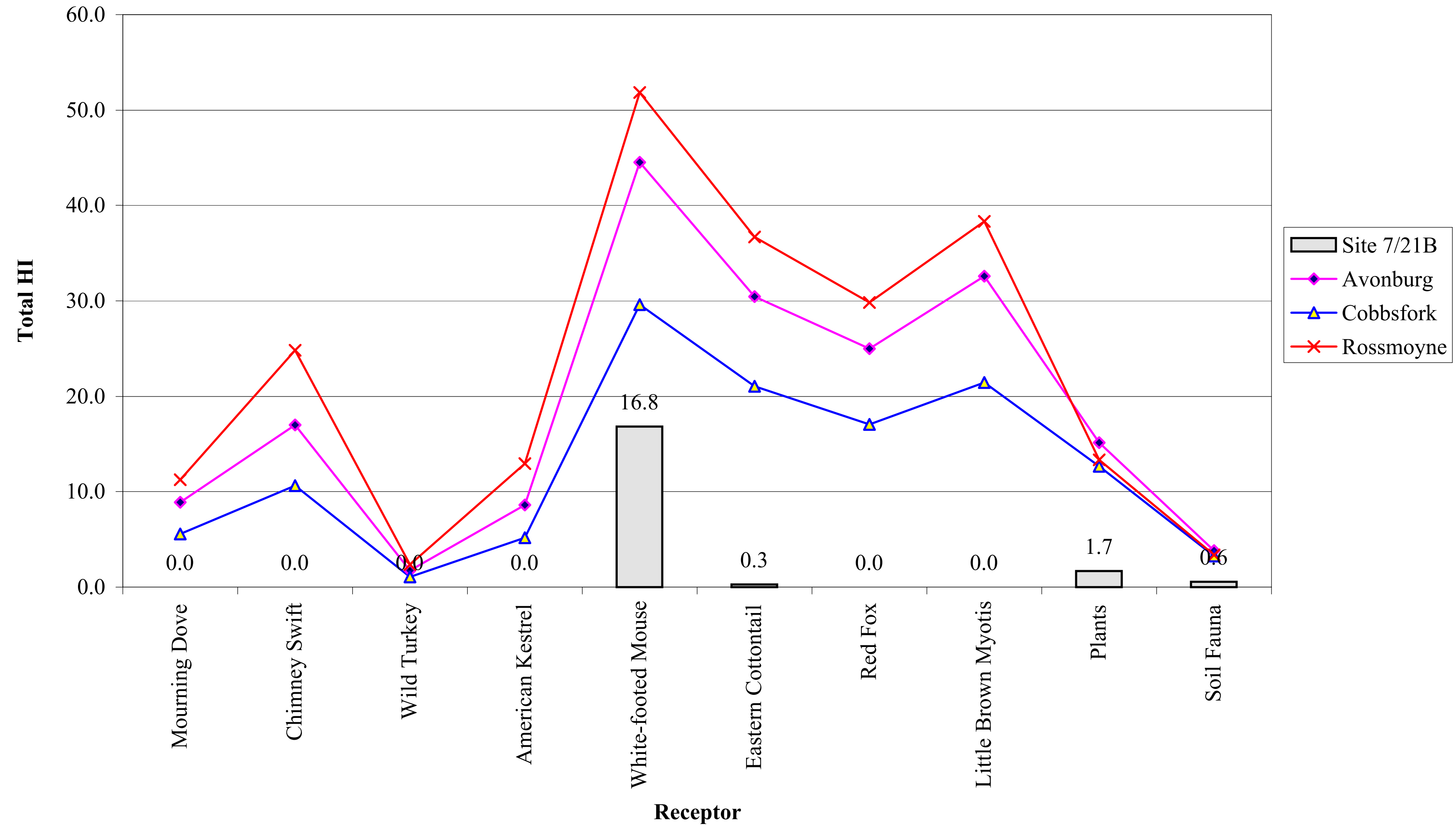
N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase 2\Risk2\P2era_21MWH.xls Figure 10.7-12

Figure 10.7-13 Total HIs - RME Risks Summed for All Pathways Based on NOAELs at Site 7/21B - Red Lead Disposal Area/Temporary Storage Area at Bldg. 211 - IM Confirmation Sampling



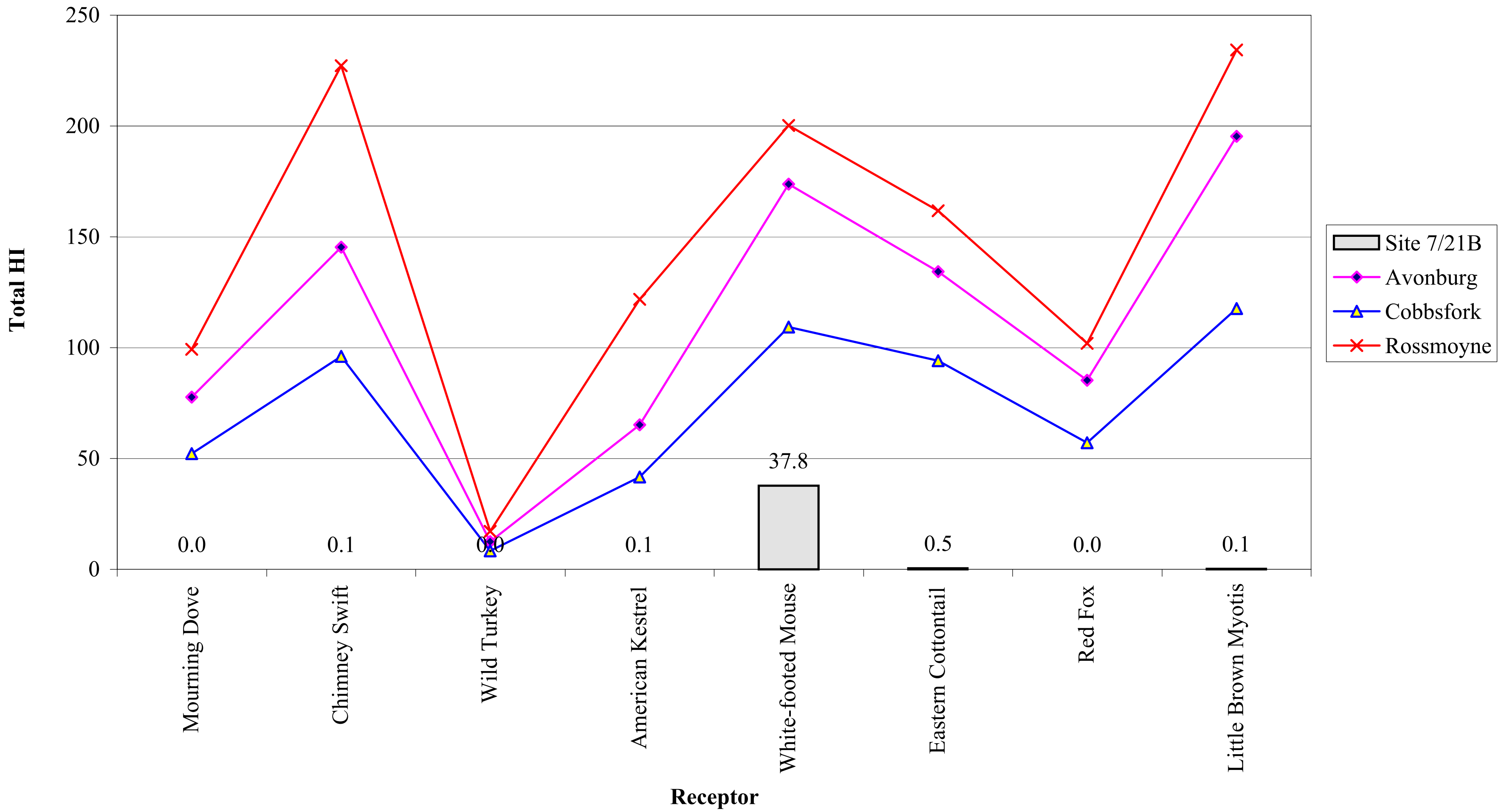
N:\jobs\244\0025\01\ET ECO Files\Jpg\Im\Risk2\Eraim721MWH.xls Figure 10.7-13

Figure 10.7-14 Total HIs - RME Risks Summed for All Pathways Based on LOAELs at Site 7/21B - Red Lead Disposal Area/Temporary Storage Area at Bldg. 211 - IM Confirmation Sampling



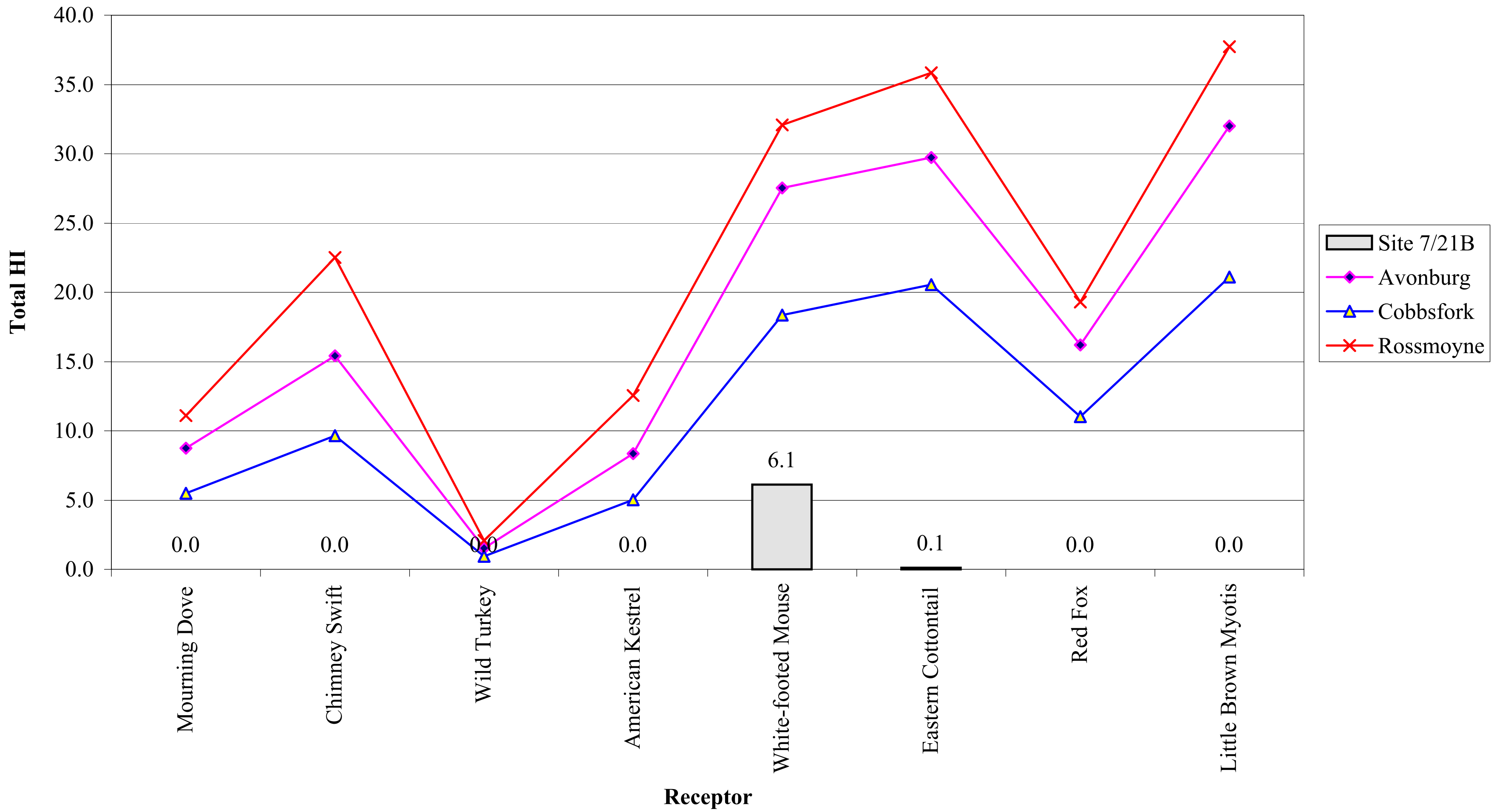
N:\jobs\244\0025\01\ET ECO Files\Jpg\Im\Risk2\Eraim721MWH.xls Figure 10.7-14

Figure 10.7-15 Total HIs - CT Risks Summed for All Pathways Based on NOAELs at Site 7/21B - Red Lead Disposal Area/Temporary Storage Area at Bldg. 211 - IM Confirmation Sampling



N:\jobs\244\0025\01\ET ECO Files\Jpg\Im\Risk2\Eraim721MWH.xls Figure 10.7-15

Figure 10.7-16 Total HIs - CT Risks Summed for All Pathways Based on LOAELs at Site 7/21B - Red Lead Disposal Area/Temporary Storage Area at Bldg. 211 - IM Confirmation Sampling



N:\jobs\244\0025\01\ET ECO Files\Jpg\Im\Risk2\Eraim721MWH.xls Figure 10.7-16

11.0 BUILDING 295 SMALL ARMS FIRING RANGE (SITE 8)

11.1 SITE CHARACTERISTICS

The Building 295 Small Arms Firing Range is located just south of firing position J along Firing Line Road (Figure 11-1). The building is several hundred feet long and contains four firing lanes and several other rooms. One firing lane was operational at the time of the Phase I RI, while the other three did not appear to be in use. One of the former firing lanes was being used primarily for storage. Past use at the indoor range was primarily limited to small arms testing and training. The range was closed several years ago to regular use because of concerns of lead-dust contamination derived from lead bullets used in the range. At the time of the RI, the firing range use was limited to occasional target practice by installation security personnel and local Madison law enforcement personnel. Following base closure in 1995, the building is no longer in use. In addition to the potential lead contamination, one lane was found to contain a test facility used for testing trip flares (on the basis of procedures found in the control room during a site visit by Rust E&I personnel in October 1991). In June 1997, interim action was initiated at Site 8 that consisted of (1) cleaning concrete and steel surfaces with detergent and water, (2) rinsing with water, and (3) removing the contaminated soil floor. This effort was completed in September 1997. However, additional work is on-going, which includes the spraying of the The walls were sprayed with an epoxy sealant to encapsulate any potential residual lead dust contaminants. Confirmation results from this effort are pending sampling was performed to ensure residuals are below USEPA Region 9 PRGs. (EPA174).

The area around the building is flat with no apparent slope. Surface water drainage is toward the northwest, and runoff eventually enters Middle Fork Creek (Figure 2-1). The area around Building 295 is overgrown with grass and weeds. The area is not regularly mowed and was not included in the open burning program during the RI.

The site is located in an area that has soils belonging to the Cobbsfork soil series. The depth to bedrock is unknown, but geologic cross sections indicate it is probably between 20 and 40 feet. According to geologic mapping of the subsurface bedrock, the glacial till is underlain by the Geneva Dolomite of Devonian age. No wells were installed in this area because groundwater was not considered a transport pathway of concern for this site.

Activities at the Small Arms Firing Range at the time of the RI were limited to use of one firing lane by installation security personnel and local Madison law enforcement personnel, who occasionally accessed the building for target practice. Otherwise, the building remained locked and inaccessible. Following interim remedial action activities in the summer of 1997, there are currently no activities being conducted at Building 295.

11.2 PREVIOUS INVESTIGATIONS

Prior to the RI, this site was included in both the *Enhanced PA Report* (Ebasco 1990a) and the *Master Environmental Plan* (Ebasco 1990b). This site, which is listed in the *Enhanced PA*

Report as SWMU 12, was inspected, records were checked, and interviews were conducted to characterize it. The *Master Environmental Plan* recommended further action, including the collection of wipe samples of the interior surfaces. It was also suggested that several surface-soil samples from around the building be collected and tested for lead. No environmental samples were collected prior to the present RI.

11.3 STUDY AREA INVESTIGATIONS

11.3.1 Phase I RI Field Activities

Lead contamination was the original environmental concern at the Small Arms Firing Range; however, potential asbestos contamination in wall tiles and an unknown white powder in a test facility were also identified as potential contamination/problems/areas of concern. Samples of each type of suspected contamination were collected to determine if there was a risk to human health or the environment.

As part of the installation-wide asbestos survey and inspection, samples of wall tile and white powder were removed and sent to a laboratory for analysis of asbestos. Conclusions and recommendations concerning asbestos-containing materials (ACM) are addressed separately in the *Jefferson Proving Ground, South of the Firing Line, Final Asbestos Survey Report* (Rust E&I 1993a; see also Section 19.0). A total of 345 buildings were inspected by a State of Indiana Asbestos Hazard Emergency Response Act (AHERA)-accredited inspector and a technician. Materials suspected of being ACM were identified, collected, and sent for analysis to DataChem Laboratories. The general condition of ACM in Building 295 was observed to be fair to good. Pipe insulations were observed to be friable, while other ACMs were nonfriable. (EPA38)

During the Phase I RI field investigation, a total of 20 wipe samples were collected at the Small Arms Firing Range. Five wipe samples from the walls of each of the four firing lanes were analyzed for metals.

Because airborne particulates may have been discharged to the exterior through the ventilation system, four surface-soil samples were collected during the Phase I RI near roof drain downspouts where contamination could have been concentrated. These samples were analyzed for metals.

11.3.2 Phase II RI Field Activities

No additional samples were collected during Phase II activities.

11.3.3 Interim Measures Activities

In June 1997, removal actions were conducted on the surface and pore spaces of ~~all~~ interior surfaces of the building by Ferguson Harbour Incorporated (FHI), Hendersonville, Tennessee (FHI 1998). The contaminated soils of the building floor and soils in the bullet trap were

removed. Following soil removal, the walls, ceilings, and appurtenances were cleaned with detergent and water and then rinsed with water. The water was containerized and samples were collected to allow proper disposal. The walls were subsequently sprayed with an epoxy sealant to encapsulate ~~any~~ potential residual contaminants.

Confirmation soil samples were collected from the floor and bullet trap areas to ~~ensure~~ verify that the removal action was complete.

11.3.3.1 Sand and Soil Removal. The sand and soil from Building 295 firing lines 3 (rear) and 4 were removed by using a dry vacuum (King Vac) with a modified exhaust system to return vapors into the building. The sand and soil from Building 295 firing line 3 (front) were removed by hand and by using a small skid steer front-end loader. In the firing lines, which required soil removal of the upper 1 inch, FHI scraped the surface with a loader and transported the soil to the rear of the building. Soil was removed from the building using a larger front-end loader and transported to a roll-off box container.

11.3.3.2 Floor Covering. After the lead-contaminated sand and soil were removed, the floor was covered with double-layered 6-mil plastic sheeting to prevent the contaminated wash and rinse water from contacting the clean soils during the lead-dust removal.

11.3.3.3 Lead-Dust Removal. Lead-dust removal involved a five-phase approach: (1) removing loose dust particles using a Hepa-vacuum; (2) spraying walls with an airless sprayer using 1 gallon of a non-phosphatic soap and water mixture over an 80-square-foot area; (3) scrubbing the mixture into the surface with a brush; (4) rinsing the wall by spraying it with water; and (5) removing excess water from the wall with a squeegee.

11.3.3.4 Encapsulation. After the lead dust was removed and the surface areas had dried, concrete walls and floors were sprayed at an approximately 4-to-6-millimeter thickness with Lead Barrier Compound (L-B-C®), an encapsulation epoxy. Asbestos Binding Compound (A-B-C®) was used on the dirt floors.

11.3.3.5 Transportation and Disposal of Waste. Contaminated sand and soil removed from the building was placed in roll-off box containers and staged in a storage area adjacent to the rear of the building. During the winter months, some of the containers had to be stored at the front of Building 295 in order to keep the containers from sinking or freezing on wet, cold ground. Each container was sealed at the door and lined with a plastic liner prior to the loading of ~~any~~ contaminated materials. ~~All c~~Containers were covered at the end of each day. Contaminated wash and rinse water was dumped into the hazardous waste containers in order to reduce waste. ~~All s~~Storage areas and containers were inspected on a daily basis.

11.3.3.6 Unexploded Ordnance Removal and Avoidance. During site activities, FHI personnel discovered the presence of UXO in Building 295, firing line 3. The USACE and FHI took appropriate action in evacuating personnel from the area and suspending ~~all~~ work activities in Building 295 until it could be cleared of ~~all~~ UXO (EPA11).

11.3.3.7 Confirmation Sampling and Analysis.

11.3.3.7.1 Wipe Samples. FHI obtained wipe samples from various locations throughout the building to confirm that levels of less than 2,000 ppm had been achieved. The wipe samples were analyzed for lead using method SW846 6010. The laboratory analyses were performed by GP Environmental Services, Inc. out of Gathersburg, MD. GP Environmental is certified by the USACE and the USEPA. Sampling locations are shown in Figure 11-2.

11.3.3.7.2 Water Samples. FHI obtained water samples (Figure 11-2) as requested by the USEPA in order to provide QA/QC samples in order to qualify results of wipe samples. The water samples were representative of the final rinse phase of the concrete floor and wall decontamination activity.

11.3.3.7.3 Soil Samples. Soil samples were collected from locations at Building 295 lane 4 and Building 281 lanes 1 and 2 as shown in Figure 11-2. These samples were analyzed for lead and used as confirmation of meeting the prescribed cleanup levels. (EPA174)

11.4 DATA EVALUATION

11.4.1 Data Validation Results

~~All~~ Phase I metals results for Site 8 were determined to be acceptable for use with the exception of antimony. Antimony results (non-detects) were rejected because of poor recoveries. Arsenic, manganese, vanadium, and selenium results are qualified but usable. Arsenic and selenium results are potentially biased high; manganese results may be imprecise based on the matrix spike RPD, and vanadium results may be biased low.

11.4.2 Data Quality Summary

On the basis of the Phase I results, it was determined that additional sampling during Phase II was not required. Since no risk assessment was required for this site, no additional data screening was required.

11.4.3 Background Screening

TCLP metals data for wipe samples cannot be screened against background. The data for the four surface soil samples were screened against background, and it was determined that aluminum, arsenic, barium, cobalt, chromium, copper, manganese, nickel, lead, selenium, and zinc exceeded background in at least one of the four samples.

11.4.4 Summary of Analytical Results

Table 11-1 presents the analytical results for Phase I wipe samples. Table 11-2 presents the analytical results for metals in surface soils outside of Building 295. Confirmation data ~~were not available for this report~~ verifying the success of the removal action are contained in the *Technical Memorandum, No Further Remedial Action is Planned At Site 8,* dated April 2000. (EPA174)

11.5 NATURE AND EXTENT OF CONTAMINATION

Wipe samples were collected from the interior walls to determine if contamination by lead and/or other metals derived from bullets was present (Table 11-1). The results of the 20 wipe samples collected from the 4 firing lanes show lead was detected in samples 5, 7, 8, 9, 11, 12, and 20. Other metals of potential concern include silver (samples 2, 5, 6, 8, and 10), cadmium (sample 15), chromium (samples 2, 6, 7, 8, 9, 15, 19, and 20), and nickel (samples 6, 7, and 20). Although there are no risk criteria for wipe sample data, they indicate that the building materials are contaminated.

Air ducts that vent to the roof of the building may constitute a pathway for contaminants to migrate outside the building. Therefore, four soil samples were collected. The four samples contained lead above the background soil criterion. The maximum lead concentration measured in soils at the site, 71.0 µg/g, is less than the USEPA lead cleanup level of 400 µg/g. Other metals that exceeded their screening criteria were arsenic (one sample), barium (one sample), chromium (two samples), cobalt (four samples), copper (four samples), manganese (two samples), nickel (four samples), selenium (three samples), silver (four samples), and zinc (four samples). Arsenic was the only metal that exceeded the USEPA Region 9 criteria for carcinogenic risk. However, the highest arsenic detection at this site (12.0 µg/g) is only slightly higher than the background concentration of 9.26 µg/g. Also, the IDEM Tier II cleanup goal for arsenic in surface soils is 81 µg/g, and the IDEM maximum background stream and lake sediment concentration for arsenic is 29 µg/g (IDEM 305b Report 1989).

In summary, lead was thought to be the primary COPC at this site. The maximum lead concentration measured, 71.0 µg/g, exceeded the background soil screening value, but was much less than the USEPA lead cleanup level of 400 µg/g. Only one arsenic detection at this site exceeded the background value. This detection (12.0 µg/g) is only slightly above the arsenic background of 9.26 µg/g and is significantly less than the IDEM Tier II cleanup goals for this metal (81 µg/g). Furthermore, arsenic is not a suspected contaminant at this site. For these reasons, no risk assessment was performed for this site.

Although contaminant levels were believed to be at acceptable levels, the removal of contaminated soils and washing of the building interior allows the building to be subject to reuse without additional restrictions.

11.6 HUMAN HEALTH RISK ASSESSMENT

Due to the interim measures conducted at Site 8, it was determined that a human health risk assessment was not required.

11.7 ECOLOGICAL RISK ASSESSMENT

Results of the preliminary ecological risk assessment (Rust E&I 1997g) indicated that there was little likelihood of adverse impacts to flora and fauna at Site 8. As a result, no further ecological investigations were required.

11.8 CONCLUSIONS AND RECOMMENDATIONS

The suspected contaminants for the Building 295 Small Firing Range (Site 8) were metals with the primary suspected contaminant being lead. The Phase I soil sample and building wipe sampling confirmed that metals contamination was present. However, in soils, the maximum lead concentration was 71 µg/g, which is well below the USEPA cleanup goal of 400µg/g. There is no criteria for wipe sample data, but the results did indicate that the interior surfaces of the building were contaminated with metals. Results of a preliminary ecological risk assessment at Site 8 indicated that impacts to flora and fauna were unlikely and that no further investigation was required.

In the summer of 1997, interim remedial action was conducted at Site 8, consisting of cleaning of the concrete and steel surfaces with water and detergent and final rinsing with water, and removing the contaminated soil for off-site disposal. These actions were followed by the spraying of an epoxy sealant on the walls of the building to encapsulate ~~any~~ the potential residual contamination.

As a result of these interim measures, no human health risk assessment was conducted. ~~Receipt of the~~ The confirmation sampling results indicated that the removal action was successful, residual soils met PRGs (EPA174). ~~is pending.~~ ~~*Add these results (EPA 174).*~~

~~It is recommended that a~~ A No Further Action Technical Memorandum ~~be~~ was prepared for this site (April 2000). ~~and that the~~ The site will be removed from the RI/FS process. ~~The closure report prepared by USACE will provide the basis for the technical memorandum.~~

TABLES

TABLE 11-1

Analytical Results for Wipe Samples
Site 8 - Small Arms Firing Range
Jefferson Proving Ground
Madison, Indiana

Sample ID Analyte	SAF08WP001 (µg/C^2)[a]	SAF08WP002 (µg/C^2)	SAF08WP003 (µg/C^2)	SAF08WP004 (µg/C^2)	SAF08WP005 (µg/C^2)	SAF08WP006 (µg/C^2)	SAF08WP007 (µg/C^2)	SAF08WP008 (µg/C^2)
Aluminum	2.40	2.20	1.30	0.74	1.60	0.36	0.74	7.20
Arsenic	LT[b] 0.16	LT 0.16	LT 0.16	LT 0.16	LT 0.16	LT 0.16	LT 0.16	LT 0.16
Barium	LT 0.033	LT 0.033	LT 0.033	LT 0.033	LT 0.033	LT 0.033	LT 0.033	2.40
Beryllium	LT 0.0043	LT 0.0043	LT 0.0043	LT 0.0043	LT 0.0043	LT 0.0043	LT 0.0043	LT 0.0043
Boron	0.072	0.088	LT 0.066	LT 0.066	0.081	0.068	0.120	0.130
Cadmium	LT 0.012	LT 0.012	LT 0.012	LT 0.012	LT 0.012	LT 0.012	LT 0.012	LT 0.012
Calcium	10.0	14.8	8.10	11.0	16.0	3.00	6.90	81.0
Cobalt	LT 0.025	LT 0.025	LT 0.025	LT 0.025	LT 0.025	LT 0.025	LT 0.025	LT 0.025
Chromium	LT 0.010	0.011	LT 0.010	LT 0.010	LT 0.010	0.012	0.240	0.027
Copper	0.075	0.250	0.033	LT 0.028	0.052	LT 0.028	0.061	0.072
Iron	3.50	2.80	1.80	1.30	2.50	1.50	33.0	8.20
Lead	LT 0.074	LT 0.074	LT 0.074	LT 0.074	0.19	LT 0.074	0.12	0.90
Magnesium	1.10	1.10	0.74	0.44	0.59	0.24	0.72	2.10
Manganese	LT 0.099	LT 0.099	LT 0.099	LT 0.099	LT 0.099	LT 0.099	0.17	0.24
Molybdenum	LT 0.014	LT 0.014	LT 0.014	LT 0.014	LT 0.014	LT 0.014	LT 0.014	LT 0.014
Nickel	LT 0.027	LT 0.027	LT 0.027	LT 0.027	LT 0.027	0.031	0.390	LT 0.027
Selenium	LT 0.21	LT 0.21	LT 0.21	LT 0.21	LT 0.21	LT 0.21	LT 0.21	LT 0.21
Silver	LT 0.000080	0.00066	LT 0.000080	LT 0.000080	0.0013	0.000085	LT 0.000080	0.000160
Sodium	0.59	0.44	LT 0.39	0.40	LT 0.39	LT 0.39	0.40	0.87
Tin	LT 0.074	LT 0.074	LT 0.074	LT 0.074	LT 0.074	LT 0.074	0.150	LT 0.074
Thallium	LT 0.34	LT 0.34	LT 0.34	LT 0.34	LT 0.34	LT 0.34	LT 0.34	LT 0.34
Vanadium	LT 0.014	LT 0.014	LT 0.014	LT 0.014	LT 0.014	LT 0.014	LT 0.014	LT 0.014
Zinc	0.074	0.130	0.044	0.026	0.180	0.028	0.075	1.60

TABLE 11-1
Analytical Results for Wipe Samples
Site 8 - Small Arms Firing Range
Jefferson Proving Ground
Madison, Indiana

Sample ID Analyte	SAF08WP009 (µg/C^2)	SAF08WP010 (µg/C^2)	SAF08WP011 (µg/C^2)	SAF08WP012 (µg/C^2)	SAF08WP013 (µg/C^2)	SAF08WP014 (µg/C^2)	SAF08WP015 (µg/C^2)	SAF08WP016 (µg/C^2)
Aluminum	2.10	1.20	0.66	0.38	0.41	0.31	3.60	2.00
Arsenic	LT 0.16	LT 0.16	LT 0.16	LT 0.16	LT 0.16	LT 0.16	LT 0.16	LT 0.16
Barium	LT 0.033	LT 0.033	LT 0.033	LT 0.033	LT 0.033	LT 0.033	LT 0.033	LT 0.033
Beryllium	LT 0.0043	LT 0.0043	LT 0.0043	LT 0.0043	LT 0.0043	LT 0.0043	LT 0.0043	LT 0.0043
Boron	0.099	0.081	0.074	0.075	0.083	0.074	LT 0.066	LT 0.066
Cadmium	LT 0.012	LT 0.012	LT 0.012	LT 0.012	LT 0.012	LT 0.012	0.052	LT 0.012
Calcium	19.0	9.40	3.10	1.40	1.3.0	1.20	18.0	28.0
Cobalt	LT 0.025	LT 0.025	LT 0.025	LT 0.025	LT 0.025	LT 0.025	LT 0.025	LT 0.025
Chromium	0.011	LT 0.010	LT 0.010	LT 0.010	LT 0.010	LT 0.010	0.018	LT 0.010
Copper	0.038	0.94	0.011	LT 0.028	LT 0.028	LT 0.028	6.00	LT 0.028
Iron	3.10	2.50	0.38	0.096	LT 0.067	LT 0.067	4.30	2.40
Lead	0.098	LT 0.074	1.80	0.21	LT 0.074	LT 0.074	LT 0.074	LT 0.074
Magnesium	1.00	1.20	0.38	LT 0.100	LT 0.100	LT 0.100	1.10	0.65
Manganese	LT 0.099	LT 0.099	LT 0.099	LT 0.099	LT 0.099	LT 0.099	LT 0.099	LT 0.099
Molybdenum	LT 0.014	LT 0.014	LT 0.014	LT 0.014	LT 0.014	LT 0.014	LT 0.014	LT 0.014
Nickel	LT 0.027	LT 0.027	LT 0.027	LT 0.027	LT 0.027	LT 0.027	LT 0.027	LT 0.027
Selenium	LT 0.21	LT 0.21	LT 0.21	LT 0.21	LT 0.21	LT 0.21	LT 0.21	LT 0.21
Silver	LT 0.000080	0.0029	LT 0.00080	LT 0.00080	LT 0.00080	LT 0.00080	LT 0.00080	LT 0.00080
Sodium	LT 0.39	LT 0.39	LT 0.39	LT 0.39	LT 0.39	LT 0.39	0.46	LT 0.39
Tin	LT 0.074	LT 0.074	LT 0.074	LT 0.074	LT 0.074	LT 0.074	LT 0.074	LT 0.074
Thallium	LT 0.34	LT 0.34	LT 0.34	LT 0.34	LT 0.34	LT 0.34	LT 0.34	LT 0.34
Vanadium	LT 0.014	LT 0.014	LT 0.014	LT 0.014	LT 0.014	LT 0.014	LT 0.014	LT 0.014
Zinc	0.061	0.34	LT 0.023	LT 0.023	LT 0.023	LT 0.023	0.073	0.035

TABLE 11-1
Analytical Results for Wipe Samples
Site 8 - Small Arms Firing Range
Jefferson Proving Ground
Madison, Indiana

Sample ID Analyte	**SAF08WP017 (µg/C²)**	**SAF08WP018 (µg/C²)**	**SAF08WP019 (µg/C²)**	**SAF08WP020 (µg/C²)**
Aluminum	1.20	5.20	0.88	2.90
Arsenic	LT 0.16	LT 0.16	LT 0.16	LT 0.16
Barium	LT 0.033	0.040	0.034	0.390
Beryllium	LT 0.0043	LT 0.0043	LT 0.0043	LT 0.0043
Boron	0.088	0.110	0.100	0.110
Cadmium	LT 0.012	LT 0.012	LT 0.012	LT 0.012
Calcium	14.0	120	9.30	16.0
Cobalt	LT 0.025	LT 0.025	LT 0.025	LT 0.025
Chromium	LT 0.010	LT 0.010	0.014	0.064
Copper	LT 0.028	LT 0.028	LT 0.028	2.00
Iron	1.90	5.20	5.10	3.00
Lead	LT 0.074	LT 0.074	LT 0.074	0.16
Magnesium	0.31	0.93	0.54	1.00
Manganese	LT 0.099	LT 0.099	LT 0.099	LT 0.099
Molybdenum	LT 0.014	LT 0.014	LT 0.014	LT 0.014
Nickel	LT 0.027	LT 0.027	LT 0.027	0.091
Selenium	LT 0.21	LT 0.21	LT 0.21	LT 0.21
Silver	LT 0.00080	0.0029	LT 0.00080	LT 0.00080
Sodium	LT 0.39	0.50	LT 0.39	0.61
Tin	LT 0.074	LT 0.074	LT 0.074	LT 0.074
Thallium	LT 0.34	LT 0.34	LT 0.34	LT 0.34
Vanadium	LT 0.014	0.018	LT 0.014	LT 0.014
Zinc	0.047	0.040	0.110	0.330

Note:

Sample date for all wipe samples was 11/22/92. (EPA 18)
Table revised to include cadmium. (EPA 172)

Footnotes:

(a) Micrograms per square centimeter.
(b) Less than the reporting limit.

TABLE 11-2

Analytical Results for Surface Soil Samples
Site 8 - Small Arms Firing Range
Jefferson Proving Ground
Madison, Indiana

Sample ID Analyte	SAF08SF001 (µg/g)[a]	SAF08SF002 (µg/g)	SAF08SF003 (µg/g)	SAF08SF004 (µg/g)	Background (µg/g)
Metals					
Aluminum	14,600	13,300	12,900	9,560	11,000
Arsenic	6.79	5.39	4.19	12.0	9.26
Barium	75.0	178	58.9	52.1	84.5
Beryllium	LT[b] 0.427	LT 0.427	LT 0.427	LT 0.427	0.52
Boron	LT 6.64	LT 6.64	LT 6.64	LT 6.64	ND[c]
Calcium	12,300	2,930	3,090	4,340	750
Chromium	15.2	16.2	14.3	17.5	15.1
Cobalt	6.08	10.2	4.58	3.99	3.5
Copper	11.1	15.7	14.2	18.4	5.64
Iron	17,400	20,700	16,000	16,600	14,800
Lead	22.0	37.0	36.0	71.0	14.9
Magnesium	6,630	1,650	1,490	1,650	700
Manganese	321	892	217	243	302
Mercury	LT 0.05	LT 0.05	LT 0.05	LT 0.05	ND
Nickel	10.6	16.2	7.47	21.8	2.23
Potassium	677	636	691	599	681
Selenium	7.80	LT 4.5	7.70	6.90	0.74
Silver	0.029	0.025	0.034	0.039	ND
Sodium	LT 38.7	LT 38.7	LT 38.7	LT 38.7	50.5
Vanadium	22.6	19.4	25.0	25.9	27.0
Zinc	37.3	48.0	63.3	79.7	19.5

Note:

Sampling date for surface soil samples was 11/19/92; depth was 0 feet for all four samples. (EPA 18)
Table was revised to include selenium (EPA 173)

Footnotes:

(a) Micrograms per gram.
(b) Less than the reporting limit.
(c) Not detected.

FIGURES

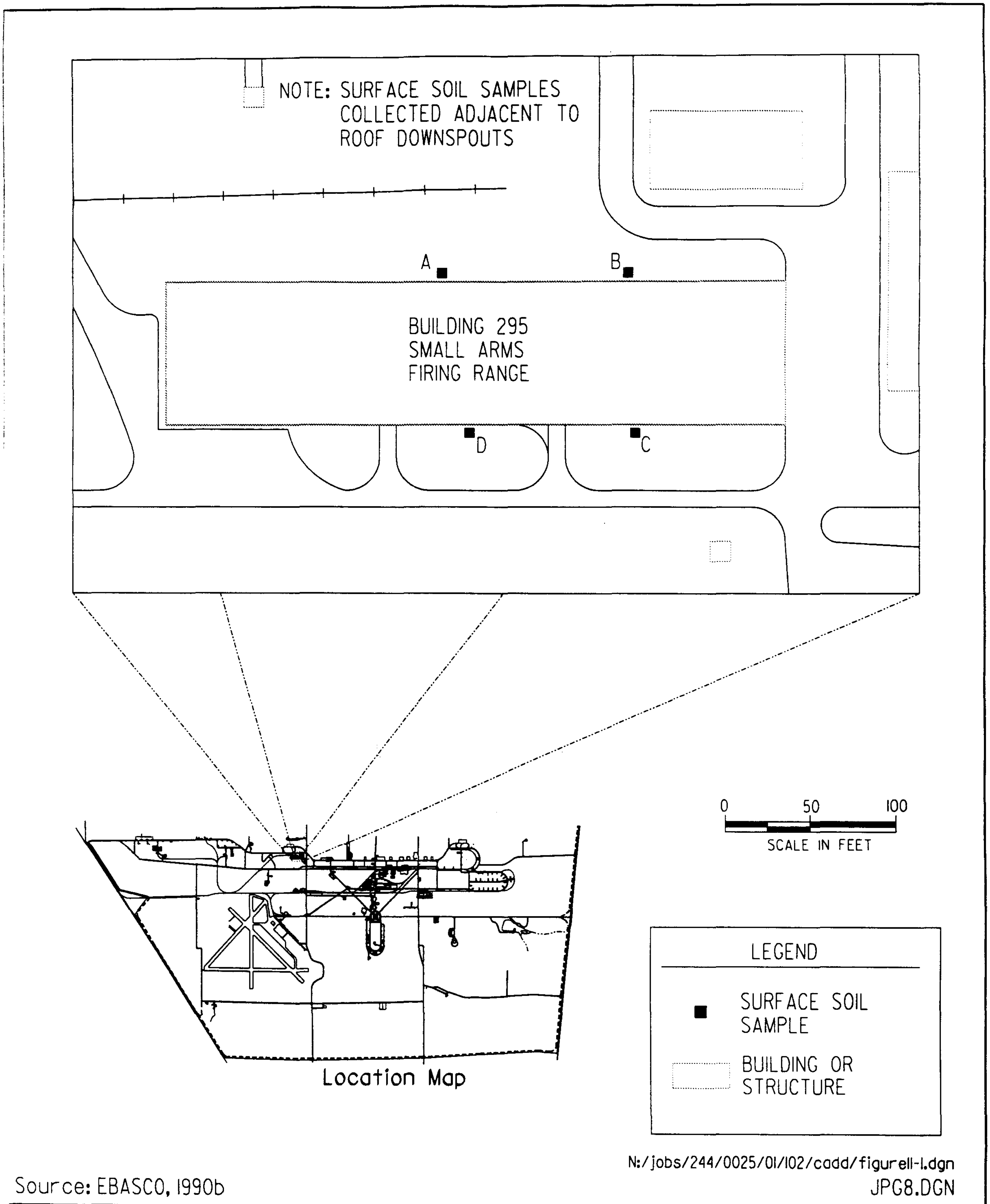


Figure II-1. Sampling Locations at the Small Arms Firing Range (Site 8)

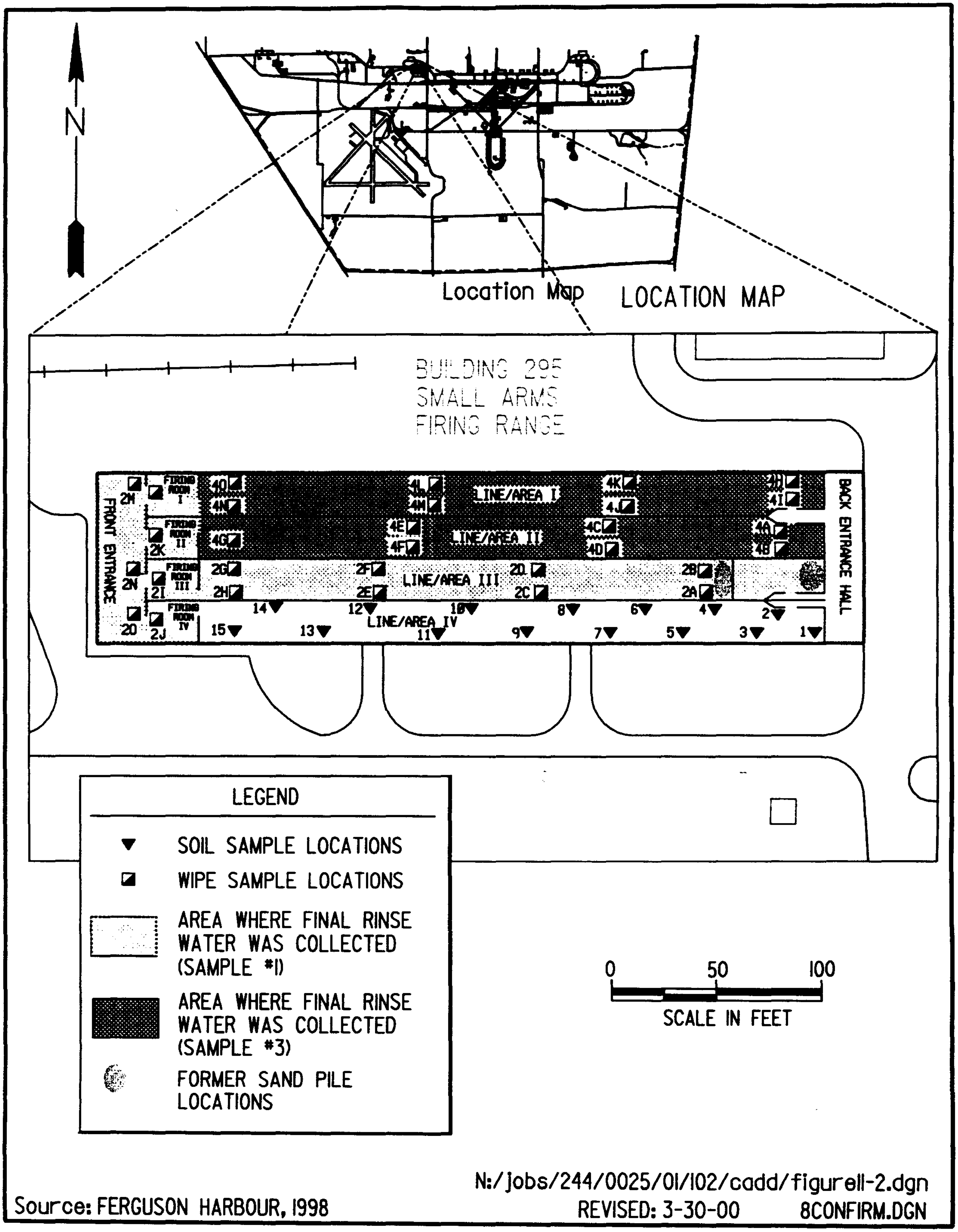


Figure II-2. Confirmation Sampling Locations at the Small Arms Firing Range (Site 8)

12.0 BURNING GROUND SOUTH OF GATE 19 LANDFILL (SITE 9) AND THE GATE 19 LANDFILL (SITE 10)

12.1 SITE CHARACTERISTICS

The Gate 19 Landfill and the associated former burning ground are located at the far west end of the Firing Line north of the intersection of Firing Line Road and West Perimeter Road (Figure 12-12-1). The Gate 19 Landfill is a 12-acre landfill that includes an asbestos-disposal area and a waste pile of construction debris. The landfill was in use from 1960 to 1994. Waste disposal at the landfill was restricted at the time of the Phase I RI, and landfill closure had begun at the time of the Phase II RI was beginning in 1995. Closure at the landfill included placement of a synthetic membrane and clean soil cover. Prior to landfill closure, disposal of asbestos occurred in the northwestern corner of the landfill and along the west side away from the construction debris. Asbestos was double bagged and buried, which significantly reduced risk of exposure to asbestos prior to the placement of the final landfill cover. Construction debris reportedly consisted mainly of concrete block, metal, wire, and a minor amount of wood debris, which was deposited on the ground surface over as much as 10 acres of the 12-acre area. The construction debris is inert and has minimal potential as a source of hazardous contaminants. Other trash and debris were reportedly disposed of in shallow trenches. The trenches historically received ash from the Building 185 new incinerator (Site 33) and other non-combustible trash. No information is available to document the depth of fill materials at the Gate 19 Landfill. (EPA20) At one time, the landfill reportedly received red lead paint and methylene chloride/polyurethane residues from inert loading activities. Between 1960 and 1980, the site also reportedly received 1,000 to 10,000 gallons of TCE and paint. COCs are primarily solvents and metals. IDEM reported that they had also issued special waste permits for this site. The types of special waste permitted by IDEM included chemicals, chemical warfare suits, test kits, and other items. (IN18)

The Burning Ground, a ½-acre area used for the open burning of construction debris and waste propellants, was reportedly located in the southern part of the Gate 19 Landfill (Figure 12-1). The burning area, which was used between the 1950s and 1970s, reportedly also received trichloroethene and paint waste. Aerial photographs of the site show possible puddles or trenches and mounded material present. The puddles are not necessarily related to site activities as it was noted during the RI that water often ponds in low spots around the site after rainfall. The area lies just south of the landfill cover and is currently overgrown with vegetation, making the burning area not readily discernable. COCs are solvents and metals.

Human activities at the site are currently limited to occasional access by investigation and maintenance personnel.

The area is flat to gently rolling, and most surface-water runoff appears to flow toward a small pond at the southwestern corner of the area. Refer to Figure 2-1 for a topographic map showing surface water drainage paths. (EPA204) This pond also receives runoff from a ditch that flows west along Firing Line Road from as far away as Building 602 (Site 12A).

Installation personnel reported that the pond is an abandoned rock quarry that predates JPG. The pond discharges to the west via a small drainage, and the water runs through open farmland until it enters Middle Fork Creek about a quarter of a mile west of the installation boundary (Figure 2-1). The landfill is currently covered by an engineered cover that includes revegetation with grass. The area is surrounded on the north, east, and south sides by dense woods, and is bounded on the west side by West Perimeter Road.

The soils at the site belong to the Cobbsfork and Avonburg soil series. The depth to bedrock ranges from 3.5 to 14 feet deep. The first bedrock encountered beneath the site is the North Vernon Limestone of Devonian age. The monitoring well cross section shows the soil types, bedrock formations, screened intervals, and water levels (Figure 12-2).

Prior to a preliminary assessment by ESE in 1989, seven monitoring wells had been constructed at the site, and the groundwater had been analyzed periodically since 1982 (ESE 1989). No well records are available for those wells. Those wells designated as Old MW-1, Old MW-2, Old MW-3, and Old MW-4 were renamed by ESE in 1989 as 81-1, 81-2, 81-3, and 81-4, respectively. Those wells, installed in October 1981, were installed to the top of bedrock and usually contained no water. Monitor wells designated as New MW-1, New MW-2, and New MW-3 were renamed 83-1, 83-2, and 83-3, respectively. Those wells were installed into bedrock by the Monsanto Research Center in December 1983. In 1988, ESE installed 17 monitoring wells (MW88-01 through MW88-17). Monitor wells MW88-06 and MW88-08 were subsequently abandoned and filled with grout because they contained no water. Table 12-1 contains a summary of the ESE well information. Appendix H contains the well logs for the ESE wells. (EPA13d, EPA39)

Although some 20 groundwater-monitoring wells had already been installed in this area prior to the Phase I RI work, there was still insufficient hydrogeologic data available for the southern region of the landfill. Thus, ~~; thus, in 1993,~~ 5 additional groundwater-monitoring wells (MW93-15, MW93-16, MW93-17, MW93-18, and MW93-19) were installed in the southern portion of the landfill. The average total depth of these wells was approximately 16 feet bgs. According to the boring logs from the ~~1993~~ MW93 series wells, the glacial till in this area of the landfill averages about 8 feet in thickness. The screened interval for each well began at the top of and extended 10 feet into the North Vernon Limestone, the shallowest bedrock formation (Figure 12-2). During the drilling of MW93-17, a large void was intercepted. Voids were not encountered during the drilling ~~of any~~ of the other MW93 Gate 19 Landfill wells.

Based on slug test data, the hydraulic conductivity ranges from 9.22 x 10^{-4} cm/sec in well MW93-18 to 4.82 x 10^{-3} cm/sec in well MW93-15. Despite the large void, the hydraulic conductivity calculated at MW93-17 was not much higher than the values for the other wells.

Unlike the other sites, bedrock groundwater underlying the Gate 19 Landfill appears to be unconfined. ~~in four of the five 1993 wells. This may be the result of the rather thin glacial till (only 8 feet) overlying the bedrock. Only in MW93-15 does the bedrock groundwater appear to be semi-confined.~~ Depth to groundwater ranges from 7 to 10 feet bgs in MW93-16,

MW93-17, MW93-18, and MW93-19, while depth to groundwater in MW93-15 is approximately 4 feet bgs.

Figures 12-3, 12-4, and 12-5 are groundwater contour maps generated using water-level data collected from the ~~1993~~ MW93 series wells in November 1995, and June and November 1996, respectively. As shown in the figures, bedrock groundwater tends to flow to the west-northwest, with a calculated average hydraulic gradient of 0.0057 foot/foot.

Water-level data were also collected from the previously installed wells to determine bedrock groundwater flow direction and gradient in the other areas of the landfill. MW88-5, MW88-7, MW88-9, MW88-10, MW88-11, MW88-12, MW88-13, MW88-17, 83-2, and 83-3 are ~~all~~ screened in the bedrock from approximately 25 to 35 feet bgs. Data from these wells could not be combined with data from the ~~1993~~ MW93 series wells because of the difference ~~of~~in the screened interval depths.

Groundwater contained in the bedrock 25 to 35 feet bgs (possibly Jeffersonville Limestone) also tends to flow toward the west-northwest. The calculated hydraulic gradient, based on the water levels, averages 0.014 foot/foot. According to water-level data collected from MW88-1, MW88-2, MW88-3, MW88-4, and 83-1 (all of which are screened in the bedrock approximately 40 to 50 feet bgs), deep bedrock (possibly Geneva Dolomite) groundwater flows west-northwest with an average hydraulic gradient of 0.012 foot/foot.

MW88-4 and MW88-9 were installed as a well pair, as were MW88-1 and MW88-11. Vertical gradients were calculated for these two well pairs using water-level data collected in August and September 1993. At the MW88-4/MW88-9 pair, the average vertical gradient was 0.096 foot/foot in the upwards direction. According to the data associated to the MW88-1/MW8811 pair, the gradient direction changed from August (downward, 0.064 foot/foot) to September (upward, 0.044 foot/foot). It appears the changing of gradient direction may be suspect. From August to September, the groundwater elevation in ~~all~~ the previously installed wells at the site increased approximately 1 foot, with the exception of the groundwater elevation in MW88-11, which appeared to decrease 1 foot.

~~It should be noted that, as~~ As a result of placement of the landfill cover, 10 of the previously existing wells were abandoned. These wells include wells 81-1, 81-2, 81-3, 83-2, MW88-3, MW88-4, MW88-10, MW88-12, MW88-13, and MW88-17.

12.2 PREVIOUS INVESTIGATIONS

An RI/FS was previously conducted at the Gate 19 Landfill site by Environmental Science and Engineering (ESE 1989). During this investigation, ~~12~~ 17 groundwater-monitoring wells were installed to monitor ~~any~~ potential migration of contaminants from the landfill. Prior to the ESE investigation, ~~eight~~ seven groundwater-monitoring wells had been installed at the site by other investigators. Analytical results from the ESE RI/FS indicated that groundwater contamination may not exist; however, because infiltration of precipitation presents an

ongoing potential for leachate generation and contaminant migration to the groundwater system, additional sampling of Gate 19 monitoring wells was conducted during the site-specific sampling and analysis in January 1992 (SEC Donahue 1992). Mercury, which had been previously undetected at the Gate 19 Landfill, exceeded federal drinking water criteria in the January 1992 sampling of wells MW88-2, MW88-4, and MW88-7. Because of mercury detected in associated QC samples, it was recommended that these wells be resampled to confirm the presence of mercury in the groundwater.

A soil-gas investigation had also been conducted by ESE (1988), and five small localized areas with low concentrations of VOCs were detected (Figure 12-5a). ESE concluded that VOCs detected during the soil gas investigation were related to small, localized spills or discharges that had not migrated from the soil to the groundwater.

Groundwater-monitoring data have not consistently detected VOCs in the groundwater. Prior to the ESE RI/FS, contaminants reportedly identified in groundwater from some of the seven initial wells included trichloroethene, trichloroethane, benzene, toluene, methylene chloride, and trichlorofluoromethane. Sampling of the ESE wells performed during the previous RI/FS resulted in detection of only acetone at a concentration of 27 µg/L in MW88-05 from one round of sampling in October 1988, although it had not been detected in MW88-05 during the previous round of sampling in June 1988. No QA/QC information was presented in the ESE RI Report to allow a determination of whether the acetone detected was actual site contamination or laboratory contamination since acetone is a common laboratory contaminant. In the subsequent five rounds of sampling conducted by Rust E&I, no acetone detections were identified for MW88-05. The inconsistency of previous results and ESE results for other VOCs may be partially due to the fact that most of the previous wells were screened at inconsistent depths in the bedrock below the water table, which could result in an inability to detect LNAPLs or solvents that may be slowly leaching from the soil into the shallow glacial till groundwater.

Near-surface contaminants may be present but were undetected since because the first water-producing zone in the bedrock reported in the ESE RI/FS was 25 feet below the surface in the bedrock. Wells installed at the landfill by Rust E&I during the current Phase I study were all completed at the glacial till/bedrock contact, which was considered the most likely horizon for contaminant detection.

An evaluation of previous well completions versus the water table indicates that the bedrock aquifer is under some artesian head. This artesian condition indicates that bedrock groundwater will most likely discharge into local surface streams along fractures and bedding planes. Several paired wells were installed by ESE to evaluate vertical gradients in the bedrock aquifer, but the results were not discussed. Data presented in a table of groundwater elevations for July 1988 indicate that the vertical gradient in the vicinity of MW88-01 and MW88-11 (northwestern corner of the landfill) favored downward groundwater movement and in the vicinity of MW88-04 and MW88-09 (southeastern corner of the landfill) favored upward groundwater movement. Thus, the inconsistent vertical gradients across the site and the inconsistent completion depths for the ESE wells make analysis of horizontal hydraulic

gradients and mapping of the potentiometric surface using the data from the previous wells suspect.

Both the burning area and the landfill were included in previous investigations by Ebasco Environmental. In March 1990, visual site inspections, files searches, and JPG personnel interviews for both of these sites were included in the *Enhanced PA Report* (Ebasco 1990a). These sites are listed in the *Enhanced PA Report* as SWMUs 14 and 15. The existing conditions and proposed sampling activities for these sites were summarized in the *Master Environmental Plan* (Ebasco 1990b).

12.3 STUDY AREA INVESTIGATIONS

12.3.1 Phase I RI Field Activities

The investigative approach for the landfill and the burning ground involved the use of geophysics to locate former disposal trenches, surface soil sampling to delineate the burning area, soil borings to investigate the shallow glacial till around the trenches, surface water and sediment samples from the pond to evaluate the surface water pathway, and groundwater wells to evaluate contamination in the bedrock groundwater.

12.3.1.1 Geophysical Surveys. Geophysical surveys using magnetometry and EM conductivity were performed over both sites to help define the location of six former landfill trenches observed in aerial photographs from the 1950s to the 1970s. The surveys also identified buried metallic debris, which have included drums or paint containers. Anomalies The six former trenches were identified on a map of the Gate 19 Landfill and were used to guide the other sampling investigations (Figure 12-6). Appendix C presents a detailed discussion of methods and results for the geophysical survey. (EPA25)

12.3.1.2 Surface Soils. Surface burning areas were identified on aerial photographs during Phase I of the RI, and 16 surface soil samples (SF01 to SF16) were collected from a gridded area in order to identify possible surface soil contamination (Figure 12-812-6). These samples were analyzed for VOCs, SVOCs, metals, and explosives. Because the Phase I SVOC results were suspect due to problems detecting method calibration standards, five additional surface soil samples (SF17 to SF21) were collected during Phase II field activities for SVOC analysis. Explosives compounds were not detected in the Phase I soil samples. However, regulatory agencies expressed concern that explosives breakdown products not analyzed for in the Phase I samples may be present at this site. Therefore, four of the five Phase II surface samples were also analyzed for an expanded list of explosives.

During Phase I of the RI, a possible trench was identified in the burning area and six soil borings (BGG-A to BGG-F) were drilled around the perimeter of the trench to a depth of 10 feet (Figure 12-812-6). One sample from each borehole was collected near the surface and analyzed for VOCs, SVOCs, metals, and explosives.

Ten other soil borings (GLF-A to GLF-I; 2 borings for each of 5 former trenches) were drilled around the perimeter of possible trenches identified by geophysics in the landfill. One surface sample was collected per boring and analyzed for VOCs, SVOCs, explosives, and metals.

12.3.1.3 Subsurface Soils. The six Phase I soil borings (BGG-A to BGG-F) drilled around the perimeter of the possible trench in the burning area had subsurface soil samples collected at two depths (5 and 10 feet) ~~from each of the six borings~~ (Figure ~~12-8~~12-6). In boreholes in which bedrock was encountered at less than 10 feet, the last sample was collected ~~near~~ at the bottom. These samples were analyzed for VOCs, SVOCs, metals, and explosives. Drilling within the trenches or pits was avoided because of the potential for UXO or other safety hazards (EPA11).

Ten soil borings (GLF-A to GLF-I) were drilled around the perimeter of possible landfill trenches identified by geophysics in the landfill during Phase I. Two subsurface samples (at depths of 5 and 10 feet) were collected from each of these borings and analyzed for VOCs, SVOCs, explosives, and metals.

12.3.1.4 Surface Water and Sediments. During Phase I of the RI, the pond adjacent to the burning ground was sampled in three locations (Figure ~~12-8~~12-6). Both surface water samples and sediment samples were collected and analyzed for VOCs, SVOCs, ~~TCLP~~ metals, and explosives. Middle Fork Creek was inspected for obvious seeps and springs as evidence of groundwater discharge to surface water. This inspection showed that groundwater discharges into the stream along horizontal bedding planes and vertical fractures wherever outcrops were observed. No high volume springs were found along the ½-mile reach of the stream north of the landfill~~.~~**; however, Middle Fork Creek was sampled at the request of USEPA for sediment and surface water at six locations (SW01 to SW06) in April 2001 (Figure 12-6a). (EPA205)**

12.3.1.5 Monitoring Wells. Five additional wells were installed during Phase I (MW93-15, MW93-~~15~~16, MW93-~~16~~17, MW93-~~17~~18, and MW93-~~18~~19) ~~to intercept~~ investigate possible contaminants at or near the water table ~~at this Site~~ (Figure ~~12-8~~12-6). The wells were located around the south perimeter of the disposal areas identified through the geophysical survey and the aerial photo study. Soil samples were collected from the surface and depths of 5 feet and 10 feet from these monitoring well borings in order to perform on-site soil screening for VOCs. Groundwater samples collected from each of the Phase I wells were analyzed for metals, VOCs, and SVOCs. In addition, three existing wells (MW88-2, MW88-4, and MW88-7) were resampled to confirm the presence of mercury contamination in the groundwater.

12.3.2 Phase II RI Field Activities

12.3.2.1 Surface Soils. The Phase I RI results for SVOCs in soils at the Gate 19 Landfill were considered to be suspect due to problems with detecting method calibration standards by the laboratory. As a result during Phase II, five additional surface samples ~~(depth of less than 2 feet) from two soil borings~~ (SF17 to SF21) were collected and analyzed for SVOCs and explosives (only 4 of 5 samples).

12.3.2.2 Subsurface Soils. To verify the absence of SVOCs in Phase I subsurface soil samples, Phase II field activities included drilling two soil borings (GLF-K and GLF-L) and collecting subsurface soil samples from depths of 1 foot and 5 feet. These samples were analyzed for SVOCs only.

12.3.2.3 Surface Water and Sediments. One ~~set of Phase II~~additional surface water ~~and sediment~~ sample~~s~~ (Sample #4) was collected from the pond adjacent to the burning ground and analyzed for explosives. At the request of USEPA, six sediment and surface water locations (SW01 to SW06) along Middle Fork Creek were sampled in April 2001 and analyzed for VOCs, PAHs, and metals. Sampling locations were selected in the field by USEPA with concurrence from USACE and IDEM (Figure 12-6a). Surface water and sediment samples were analyzed for VOCs, PAHs, and target analyte list (TAL) metals. (EPA205)

12.3.2.4 Groundwater. During Phase II, four additional rounds of groundwater sampling were conducted. A total of 11 monitoring wells (1 for Site 9 and 10 for Site 10) were included in these sampling events and each well was analyzed for metals (total and dissolved), VOCs, SVOCs, and explosive compounds. Specifically, well MW93-19 was sampled at Site 9 and wells MW83-1, MW88-2, MW88-3, MW88-5, MW88-7, MW88-11, MW93-15, MW93-16, MW93-17, and MW93-18 were sampled at Site 10 (EPA13e).

12.4 DATA EVALUATION

12.4.1 Data Validation Results

Surface and subsurface soil samples, surface water and sediment samples, and groundwater samples from Sites 9 and 10 were collected/analyzed for VOCs, SVOCs, explosives, and metals during Phases I and II. Surface water and sediment samples were collected from Middle Fork Creek and analyzed for VOCs, PAHs, and TAL metals.

12.4.1.1 Blank Assessment. When blank contamination exists, the investigative results must exceed the blank result by a factor of 5 (all compounds) or 10 (common laboratory contaminants such as acetone) to be considered positive. Several VOCs, SVOCs, and metals were detected in blanks associated with Site 9 and 10 samples. Based on comparisons to blanks, select positive results were changed to nondetects ("U"). The associated sample quantitation limit became either the concentration detected in the sample, if the detected value was above the quantitation limit, or the quantitation limit, if detected results were less than the quantitation limit. Samples qualified nondetected were not listed in the validation report during Phase I. Phase II samples were listed in the validation report and in the database. Several samples qualified nondetected were listed in the database but not in the EcoChem validation report.

During Phase I, the following results were qualified nondetected:

- Surface Water
  - Zinc - BGG09SW001, -002, -003
  - 1,3,5-Trinitrobenzene - BGG09SW003, -003D

- Sediment
  - Beryllium - BGG09SD003
  - Boron - BGG09SD001, -002
  - Sodium - BGG09SD002, -003, -003D

- Surface Soil
  - Boron - BGG09BHD01

During Phase II the following results were qualified nondetected:

- Groundwater
  - Aluminum - GLF10GWB02, -B04, -C04, -D04
  - Arsenic - GLF10MW2E, -5D
  - Antimony - GLF10GWC05; GLF10MW3D, -11D
  - Beryllium - GLF10GWB04, -B05, -C04, -C05
  - Boron - GLF10GWA04, -C04; GLF10MW1C, -2D, -3C, -5C
  - Cadmium - GLF10GWC02; GLF10MW3A, -5A, -7C, -11A, -11B
  - Chromium - BGG09GWA05,D, -B05; GLF10GWB05, -C05, -D05; GLF10MW3D
  - Cobalt - BGG09GWA05; GLF10MW1D, -3D, -11D
  - Copper - GLF10GWB02; GLF10MW1A, -2B, -5A, -7B, -11A
  - Iron - GLF10MW2B
  - Lead - BGG09GWA05,D; GLF10MW1D, -5C, -7E
  - Manganese - GLF10MW2B
  - Mercury - BGG09GWA02; GLF10GWB02; GLF10MW1A, -2B.
  - Molybdenum - BGG09GWA05,D, -B05; GLF10GWB03, -D05; GLF10MW1B, -1D, -2C, -2E, -7C, -7E, -11B
  - Nickel - GLF10MW2D, -7D
  - Potassium - BGG09GWA05, -A05,D, -B05; GLF10GWB05, -C05, -D04, -D05, GLF10MW1D, -2D, -3C, -3D, -5C, -5D, -7D, -7E, -11C, -11D
  - Sodium - GLF10GWA03, -A04
  - Tin - GLF10GWB04, -C04, -D04; GLF10MW2D, -3C
  - Vanadium - BGG09GWA03, -A03,D, -A05,D, -B02, -B03, -B05; GLF10GWD05; GLF10MW1B, -1D, -2E, -3B, -5A, -5B, -5D, -7C, -7E, -11B
  - Zinc - BGG09GWA03, -A03,D, -B03; GLF10GWA03, -A04, -C03; GLF10MW1B, -2C, -2E, -3B, -3C, 5B, -5C, -7C, -11C
  - Di-n-butyl phthalate - BGG09GWA04, -A05, -B05; GLF10GWA04, -A05, -B04, -B05, -C04, -C05, D04, -D05; GLF10MW1C, -1D, -2D, -2E, -3C, -3D, -5C, -5D, -7D, -7E, -11C, -11D
  - Dimethyl phthalate - GLF10GWA02,R
  - Diethylphthalate - BGG09GWB05; GLF10GWD05; GLF10MW1D

  - 1,1-Dichloroethane - GLF10GWA02
  - Methylene chloride - BGG09GWA04

- Soil
  - Di-n-butyl phthalate - BGG09SF017, -018, -019; GLF10BHK01, -K02, -L01, -L02

- **Supplemental Middle Fork Creek Sampling**
  - No surface water or sediment samples were qualified based on blank contamination.

12.4.1.2 Rejected Results. Results for antimony and several SVOCs were rejected during Phase I. Antimony soil results were rejected due to poor MS/MSD recoveries. Several parameters included in the SVOC list were rejected because of calibration problems. Due to these problems, all SVOC analyses were subjected to the Tier 2 validation. The Phase I SVOC results were not used for the risk assessment other than for qualitative information. In general, the following concerns were noted:

- All results for PCB compounds and toxaphene were rejected because they were not included in the calibration standard.

- 4-Nitrophenol and indeno(1,2,3-cd)pyrene were rejected in several samples because of poor response during calibration.

- Other low responses were noted, particularly for pesticides. Qualifiers were not assigned unless other calibration information was also unacceptable.

- Several PAHs had an elevated CRL because of calibration problems.

For the Phase II groundwater data, the results for two VOCs (MEK and vinyl acetate) and one SVOC (kepone) were rejected due to low response in the calibration in one or more analytical batch. The results for MEK (also known as, 2-butanone) were estimated due to calibration outliers (EPA84). Non-target (unknown) VOC and SVOC compounds were rejected in several analyses due to blank contamination. Analytes associated with rejected data were not included in the database used for the risk assessment.

For supplemental Middle Fork Creek data, one VOC (vinyl acetate) was rejected (qualified unusable "R") for sediment samples, due to a low relative response factor (RRF) (<0.05). For surface water samples several VOCs were rejected (qualified unusable) due to low RRFs (<0.05).

During the November 1995 event (Phase II), two sets of results were reported for the VOC analysis for sample BGG09GWA02. One data set was rejected because of laboratory contamination; it was also removed to delete duplicated results from the database. Additionally, two sets of results were reported for the SVOC analysis for sample

GLF10GWA02. The original results were rejected due to low surrogate recoveries and to delete duplicate results from the database. As a full set of usable results was available for both samples, percent completeness was not affected. The following list identifies rejected sample results. Results are not listed below if a reanalysis provided acceptable data for the same sample.

- Groundwater

Phase I

- Methyl ethyl ketone - GLF10GWD01
- 2-Chloroethylvinyl ether - GLF10GWD01
- Chloromethane - GLF10MW2
- 4-Chloroaniline - GLF10MW2, -MW4, -MW7
- Atrazine - GLF10GWA01; GLF10MW2, -MW4, -MW7
- 4-Nitrophenol - BGG09GWA01; GLF10GWA01, -B01, -C01
- Methoxychlor - BGG09GWA01; GLF10GWA01, -B01, -C01; GLF10MW2, -MW4, -MW7
- PCBs (1016, 1221, 1232, 1242, 1248, 1254, and 1260) - BGG09GWA01; GLF10GWA01, -B01, -C01; GLF10MW2, -MW4, -MW7
- Toxaphene - BGG09GWA01; GLF10GWA01, -B01, -C01; GLF10MW2, -MW4, -MW7

Phase II

- 1,1,1-Trichloroethane - BGG09GWA02
- 1,1-Dichloroethene - BGG09GWA02
- 1,1-Dichloroethane - BGG09GWA02 (EPA84)
- Acetone - BGG09GWA02
- Methyl ethyl ketone - BGG09GWA02, -A03, -A04, -A05, -B03, -B05; GLF10GWA04, A05, -B03, -B04, -B05, -C04, -C05, -D04, -D05; GLF10MW1B, -1C,
- 1D, -2C,-2D, -2E, -3B, -3C, -3D, -5B, -5C, -5D, -7C, -7D, -7E, -11B, -11C, -11D
- Vinyl acetate - BGG09GWA02, GLF10GWA02, -B02, -C02, -D02; GLF10MW1A, -2B, -3A, -5A, -7B, -11A
- Kepone - BGG09GWA02, -A03, -A04, -A05, -B03, -B05; GLF10GWA02, -A03, -A04, -A05, -B02, -B03, -B04, -B05, -C02, -C03, -C04, -C05, -D02, -D03, -D04, -D05; GLF10MW1A, -1B, -1C, -1D, -2B, -2C, -2D, -2E, -3A, -3B, -3C, -3D, -5A, -5B, -5C, -5D, -7B, -7C, -7D, -7E, -11A, -11B, -11C, -11D
- Unknown (UNK)538 - GLF10GWA02
- UNK543 - GLF10GWA02, -B02; GLF10MW1B, -2B, -3A, -3B, -5A
- UNK571 - GLF10GWA03, -B03, -C03, -D03
- UNK579 - GLF10GWB03
- UNK585 - GLF10GWA04, -B04, -C04, -D04

- Soil

Phase I

- 2,4-Dinitrophenol - BGG09BHA01, -A02, -B03, -C03

- 4-Chloroaniline - BGG09BHB01, -B02, -C01, -E01, -E02, -F01, -F02; BGG09SF007, -008, -009, -010, -011, -015, -016; GLF10BHA01, -A02, -A03, -B01, -B02, -B03, -C01, -C02, -C03, -D01, -D02, -D03,- E01, -E02, -E03, -F01, -F02, -F03, -G01, -G02, -G03, -H01, -H02, -H03, -I01, -I02, -J01
- 4-Methylphenol - BGG09BHE01, -E02, -F01, -F02; GLF10BHA01, -A02, -A03, -B01, -B02, -B03, -C01, -C02, -C03, -D01, -D02, -D03,- E01, -E02, -E03, -F01, -F02, -F03, -G01, -G02, -G03, -H01, -H02, -H03, -I01, -I02, -J01
- Atrazine - BGG09BHC02, -D01, -D02, -E01, -E02, -F01, -F02; BGG09SF003, -005, -006; GLF10BHA01, -A02, -A03, -B01, -B02, -B03, -C01, -C02, -C03, -D01, -D02, -D03, E01, -E02, -E03, -F01, -F02, -F03, -G01, -G02, -G03, -H01, -H02, -H03, -I01, -I02, -J01, -J02
- beta-Endosulfan - BGG09BHA01, -A02, -B01, -B02, -B03, -C01, -C02, -C03, -D01, -D02, -E01, -E02, -F01; BGG09SF003, -005, -006, -007, -008, -009, -010, -011, -015, -016; GLF10BHA01, -D01, -D02, -D03, -E01E02, -E03, -F01, -F02, -F03, -G01, -G02, -G03, -H01, -H02, -H03, -I01, -I02, -J01, -J02
- Indeno(1,2,3-cd)pyrene - BGG09BHA01, -A02, -B03, -C03, -D01, -D02, -E01, -F01; GLF10BHA02, -A03, -B01, -B02, -B03, -C01, -C02, -C03, -J02
- Benzo(a)anthracene - BGG09BHE01, -F01, -F02; GLF10BHD02, -D03, -E01, -E02, -E03, -F01, -F02, I01, -I02, -J01
- Benzo(k)fluoranthene—BGG09BHA01, -A01, -B01, -B02, -B03, -C01, -C02, -C03
- bis(2-Chloroethyl)ether - GLF10BHJ02
- 3,5-Dinitroaniline - BGG09BHB01, -B02, -C01, -C02
- 4-Nitroaniline—BGG09SF001, -002, -003, -004, -007, -008, -009, -010, -011, -012, -013, -014, -015, -016
- Phenol - BGG09SF002, -003, -004, -007, -008, -009, -010, -011, -012, -013, -014, -015, -016
- PCBs (1016, 1221, 1232, 1242, 1248, 1254, 1260, and 1262 - BGG09BHA01, -A02, -B01, -B02, -B03, -C01, -C02, -C03, -D01, -D02, -E01, -E02, -F01, -F02; BGG09SF001, -002, -003, -004, -005, -006, -007, -008, -009, -010, -011, -012, -013, -014, -015, -016; GLF10BHA01, -A02, -A03, -B01, -B02, -B03, -C01, -C02, -C03, -D01, -D02, -D03, -E01, -E02, -E03, -F01, -F02, -F03, -G01, -G02, -G03, -H01, -H02, -H03, -I01, -I02, -J01, -J02
- Toxaphene - BGG09BHA01, -A02, -B01, -B02, -B03, -C01, -C02, -C03, -D01, -D02, -E01, -E02, -F01, -F02; BGG09SF001, -002, -003, -004, -005, -006, -007, -008, -009, -010, -011, -012, -013, -014, -015, -016; GLF10BHA01, -A02, -A03, -B01, -B02, -B03, -C01, -C02, -C03, -D01, -D02, -D03,--E01, -E02, -E03, -F01, -F02, -F03, -G01, -G02, -G03, -H01, -H02, -H03, -I01, -I02, -J01, -J02
- UNK603 - BGG09BHD01
- Antimony - BGG09BHD01, -D02, -E01, -E02, -F01, -F02; BGG09SF001, -002, -003, -004, -005, -006, -007, -008, -009, -010, -011, -012, -013, -014, -015, -016; GLF10BHA01, -A02, -A03, -B01, -B02, -B03, -C01, -C02, -C03, -D01, -D02, -D03, -E01, -E02, -E03, -F01, -F02, -F03

Phase II

- Kepone - BGG09SF017, -SF018, -SF019, -SF020, -SF021, -BHK01, -BHK02, BHL01, -BHL02
- UNK536 - BGG09SF017, -SF018, -SF019, -SF020, -SF021, -BHK01, -BHK02, -BHL01, -BHL02

- Surface Water (Phase I Only)
  - 4-Chloroaniline - BGG09SW003
  - PCBs (1016, 1221, 1232, 1242, 1248, 1254, and 1260) - BGG09SW001, -002, -003
  - Toxaphene - BGG09SW001, -002, -003

- Sediment (Phase I Only)
  - PCBs (1016, 1221, 1232, 1242, 1248, 1254, 1260, and 1262 - BGG09SD001, -002, -003
  - Antimony - BGG09SD001, -002, -003

Supplemental Middle Fork Creek Sampling

- Sediment
  - Vinyl acetate - S9/10 SD01, S9/10 SD02, S9/10 SD03, S9/10 SD04, S9/10 SD05, S9/10 SD06, S9/10 SD105

- Surface Water
  - Bromoform - S9/10 SW01, S9/10 SW105, S9/10 SW02, S9/10 SW03, S9/10 SW04, S9/10 SW05, and S9/10 SW06
  - Carbon tetrachloride - S9/10 SW01, S9/10 SW105, S9/10 SW02, S9/10 SW03, S9/10 SW04, S9/10 SW05, and S9/10 SW06
  - cis-1,3-dichloropropene – S9/10 SW01, S9/10 SW105, S9/10 SW02, S9/10 SW03, S9/10 SW04, S9/10 SW05, and S9/10 SW06
  - Dibromochloromethane – S9/10 SW01, S9/10 SW105, S9/10 SW02, S9/10 SW03, S9/10 SW04, S9/10 SW05, and S9/10 SW06
  - o-xylene – S9/10 SW01, S9/10 SW03, S9/10 SW04, S9/10 SW05, and S9/10 SW06
  - Toluene – S9/10 SW01, S9/10 SW105, S9/10 SW02, S9/10 SW03, S9/10 SW04, S9/10 SW05, and S9/10 SW06
  - trans-1,3-dichloropropene – S9/10 SW01, S9/10 SW105, S9/10 SW02, S9/10 SW03, S9/10 SW04, S9/10 SW05, and S9/10 SW06.
  - 1,1,1-Trichloroethane – S9/10 SW105, S9/10 SW02
  - 1,1,2,2-Tetrachloroethane – S9/10 SW05, S9/10 SW02, S9/10 SW03
  - 1,1,2-Trichloroethane – S9/10 SW105, S9/10 SW02, S9/10 SW03
  - 1,1-Dichloroethane – S9/10 SW105, S9/10 SW02, and S9/10 SW03
  - 1,2-Dichloroethane – S9/10 SW105, S9/10 SW02, and S9/10 SW03
  - 1,2-Dichloropropane – S9/10 SW105, S9/10 SW02, and S9/10 SW03
  - 2-hexanone – S9/10 SW105, S9/10 SW02, S9/10 SW03

- Acetone – S9/10 SW105, S9/10 SW02, S9/10 SW03
- Benzene – S9/10 SW105, S9/10 SW02, S9/10 SW03
- Bromodichloromethane – S9/10 SW105, S9/10 SW02, S9/10 SW03
- Bromomethane – S9/10 SW105, S9/10 SW02, S9/10 SW03
- Chlorobenzene – S9/10 SW105, S9/10 SW02, S9/10 SW03
- Chloroethane – S9/10 SW105, S9/10 SW02, S9/10 SW03
- Chloroform – S9/10 SW105, S9/10 SW02, S9/10 SW03
- Chloromethane – S9/10 SW105, S9/10 SW02, S9/10 SW03
- cis 1,2-Dichloroethene – S9/10 SW105, S9/10 SW02, S9/10 SW03
- Dibromomethane – S9/10 SW105, S9/10 SW02, S9/10 SW03
- Ethylbenzene – S9/10 SW105, S9/10 SW02, S9/10 SW03
- 2-butanone – S9/10 SW105, S9/10 SW02, S9/10 SW03
- 4-methyl-2-pentanone – S9/10 SW105, S9/10 SW02, S9/10 SW03
- Methylene chloride - S9/10 SW105, S9/10 SW02, S9/10 SW03
- trans 1,3-dichloropropene - S9/10 SW105, S9/10 SW02, S9/10 SW03
- Vinyl acetate - S9/10 SW105, S9/10 SW02, S9/10 SW03
- Vinyl chloride - S9/10 SW105, S9/10 SW02, S9/10 SW03

12.4.1.3 Evaluation of Non-Detected Values. A comparison was made between the USEPA Region 5 DQLs and the project CRLs for chemicals that were analyzed for but not detected in environmental media at this site. No exceedances for SVOCs or explosives were found. Exceedances for antimony and thallium were noted for surface water samples.

Several groundwater VOCs had reported non-detected values from one to three orders of magnitude greater than the DQLs for at least one event and one location. However, these were limited to less than half the sampling events; acceptable CRLs were achieved at the other site wells for the same VOCs during the same events. Therefore, none of the VOCs warranted identification as having exceeded the DQLs.

Method reporting limits for surface water and sediment VOC, PAHs, and metals are sufficiently low to meet action levels in the Supplemental Groundwater Monitoring QAPP.

12.4.2 Data Quality Summary

Positive results were changed to nondetects ("U") for a number of metals analyzed in groundwater during Phase II. In particular, chromium, molybdenum, vanadium, and zinc results were affected by blank contamination. Most of the detections in the affected samples, however, were below quantitation limits. All of the Phase I surface and subsurface soil antimony results were rejected, and no Phase II soil samples were analyzed for this metal. As a result, potential antimony contamination has not been characterized in soil. The potential impact of the lack of antimony data is discussed in the uncertainty section of the human risk assessment (EPA84, EPA99). Analysis of Phase II soil samples confirmed the presence of low amounts of PAHs in surface soil. Therefore, with the exception of antimony, rejected data do not substantially affect the risk assessment conclusions.

Although several VOCs were rejected for surface water samples collected and analyzed during supplemental monitoring, the remaining usable data is sufficient for interpretation of the data. One of the samples with rejected compounds (SW105) is a field duplicate of location SW05, thus there is acceptable data for that location. In addition manyost of the compounds rejected were not compounds of concern.

In summary, the number of samples, the comprehensiveness of the parameter list, and the quality of the data (with the exception of antimony in soil) is adequate to characterize the nature and magnitude of soil, groundwater, sediment, and surface water contamination at Sites 9 and 10.

12.4.3 Background Screening

12.4.3.1 Surface Soil. For the purposes of the background comparison, samples were divided into those from the Gate 19 Landfill (Site 9) and those from the Burning Ground at the Gate 19 Landfill (Site 10).

The background screening protocol is described in Section 5.1.4.5.2. The site samples were compared to the background for the Cobbsfork soil series. The results of the background screening for Sites 9 and 10 are presented in Tables 12-1A and 12-1B. Since not all surface samples were analyzed for metals, the number of samples within each area of concern in the background evaluation does not equal the total number of samples collected. There were sufficient samples analyzed for inorganic constituents (12) at the Burning Ground to perform the t-test or Mann-Whitney test where appropriate. There were only two samples from the Gate 19 Landfill. Therefore, the maximum detected concentration of each inorganic chemical detected in surface soil at this site was compared to its background screening threshold.

Metals exceeding background in surface soil at the Burning Ground include aluminum, barium, beryllium, boron, chromium, cobalt, copper, lead, manganese, nickel, silver, vanadium, and zinc. The following metals exceeded background in surface soil at Gate 19 Landfill: aluminum, barium, beryllium, chromium, cobalt, copper, lead, manganese, nickel, silver, vanadium, and zinc.

12.4.3.2 Subsurface Soil. Only two subsurface samples each were collected at the Burning Ground and Gate 19 Landfill from borings outside of the cap. As shown in Table 12-1B, all inorganic constituents detected in subsurface soil at these two sites are above background and are therefore carried through the COPC selection process.

12.4.3.3 ~~Pond~~ Sediment Sampling. Only two inorganic constituents (arsenic and mercury) were detected in both background sediment and sediment in the pond adjacent to the Burning Ground. Because there were only three pond sediment samples, the maximum detected concentrations of arsenic and mercury were compared to the sediment background screening values (Table 12-2). As shown in the table, mercury was above background in the pond sediment. Mercury is therefore carried through the COPC selection process, along with the

other inorganics detected in pond sediment: aluminum, barium, beryllium, boron, chromium, cobalt, copper, lead, manganese, mercury, nickel, silver, vanadium, and zinc.

Six sediment samples were collected from the Middle Fork Creek in April 2001. The samples were analyzed for metals, PAHs, and VOCs. Table 12-2 shows the background screening results. Arsenic was detected at one sampling location at a concentration slightly above background. **(EPA206)**

12.4.3.4 ~~Pond~~ Surface Water Sampling. Only one inorganic constituent (mercury) was detected in both background surface water and water in the pond adjacent to the Burning Ground. Because there were only three pond surface water samples, the maximum detected concentration of mercury was compared to its surface water background screening value (Table 12-3). As shown in the table, mercury was less than background in the pond surface water. Mercury is therefore eliminated as a preliminary COPC. The other inorganic constituents detected in pond surface water are carried through the COPC selection process: aluminum, barium, beryllium, boron, chromium, cobalt, copper, lead, manganese, nickel, silver, vanadium, and zinc.

Six surface water samples were collected from the Middle Fork Creek in April 2001. The samples were analyzed for TAL metals, PAHs, and VOCs. Table 12-3 shows the background screening results. Arsenic and mercury did not exceed background. **(EPA206)**

12.4.3.5 Groundwater. The groundwater background screening protocol is described in Section 5.1.4.5.2. ~~Since~~ Because there were 10 ~~site samples~~monitoring well locations, there were sufficient ~~samples analyzed~~locations sampled for inorganic constituents to perform the t-test or Mann-Whitney test where appropriate. Table 12-4 documents the groundwater background screening at Sites 9 and 10. As shown in the table, aluminum, antimony, barium, beryllium, chromium, cobalt, copper, mercury, molybdenum, nickel, selenium, vanadium, and zinc are above background; therefore, these inorganic constituents are carried through the groundwater COPC selection process. The four sample rounds (Phase II data only) from each of the wells were averaged to derive a single data point for each chemical.

12.4.4 Summary of Analytical Results

Table 12-5 summarizes the analytical results for metals in soil samples at Sites 9 and 10; Table 12-6 for organic contaminants in soil samples; Table 12-7 for surface water and sediment samples collected from the pond; Tables 12-7a and 12-7b for surface water and sediment samples collected from Middle Fork Creek; Table 12-8 for metals in groundwater; and Table 12-9 for organic contaminants in groundwater. A complete listing of all analytical results, including nondetected and below reporting limit analytes, is presented in Appendix N.

12.5 NATURE AND EXTENT OF CONTAMINATION

12.5.1 Geophysical Surveys

Performance of EM-31 and magnetometer surveys across the sites revealed the locations of several suspected trenches and pits. The geophysical survey results are summarized in Appendix C. (EPA25)

12.5.2 Surface Soils

Phase I data for VOCs and SVOCs are not presented in Table 12-6, however these analytical results are contained in Appendix N. Phase I analyses of the surface soil samples collected from the burning ground revealed solvent- and fuel-related compounds at sample locations 3, 4, 5, and 6 (see Table 12-6). A total of 11 SVOCs were detected in surface soil sample 5. Bis(2-ethylhexyl)phthalate was detected in all surface soil samples; however, concentrations detected in Phase I samples are similar to those detected in the corresponding method blank samples and are, therefore, qualified as laboratory contaminants. Phase II surface samples, however, were found to contain valid detections of a variety of SVOCs (Table 12-6). These SVOCs includeing benzo[a]anthracene (three samples), benzo[a]pyrene (three samples), benzo[b]fluoranthene (three samples), benzo[g,h,i]perylene (one sample), benzo[k]fluoranthene (three samples), chrysene (three samples), fluoranthene (three samples), indeno[1,2,3-c,d]pyrene (one sample), n-nitroso diphenylamine (one sample), phenanthrene (three samples), and pyrene (three samples). None of the detected SVOCs, however, were found to exceed USEPA Region 9 criteria.

No explosive residues were detected during Phase I sampling. One sample (SF19) collected during Phase II contained the explosive compound 2,4-dinitrotoluene (2,4-DNT) at a low concentration that is well below the USEPA Region 9 criteriaPRG (Table 12-6).

The following metals exceeded their respective background values in surface soils: barium (7 samples), beryllium (15 samples), boron (9 samples), chromium (7 samples), cobalt (14 samples), copper (14 samples), lead (15 samples), manganese (12 samples), nickel (16 samples), selenium (2 samples), silver (16 samples),vanadium (9 samples), and zinc (16 samples). Cobalt was detected at 20.9 µg/g, which is two times its background criterion, and the lead concentrations ranged from 19.4 to 41.0 µg/g, which is well below the USEPA cleanup criteriaPRG of 400 µg/g. The only metals that were detected at concentrations greater than the USEPA Region 9 criteria PRGs are aluminum, beryllium, and manganese for surface soils (Figure 12-7).

12.5.3 Subsurface Soils

There Ten were 10 boreholes were drilled and sampled for the Gate 19 Landfill (designated as A through J in Figure 12-6), and 6 boreholes drilled and sampled for the burning ground (designated as A through F on Figure 12-6). All of the bBorehole locations were selected based on interpretation of geophysical surveys, and the boreholes were placed near suspected buried trenches.

Analyses of the soil samples collected from the landfill boreholes revealed no detectable explosives compounds. Also, ~~no UXO was located by EODT personnel who used magnetometry to detect potential downhole~~EODT personnel, who used magnetometry to detect potential downhole UXO, located no UXO (EPA11). Soil samples from the Gate 19 Landfill boreholes were also analyzed for VOCs and SVOCs and revealed detectable concentrations of some compounds in borehole C near the surface, in borehole H at about 5 feet deep, and in borehole G near the surface ~~(Table 12-6)~~. The compounds detected in borehole H, located in the southeastern corner of the landfill, were mostly solvent-related, such as 1,1-dichloroethylene and trichloroethene, and fuel-related compounds, such as benzene and toluene. These results imply that the pit detected by geophysical methods in the vicinity of borehole H was used to dispose of and possibly burn a number of waste products. All of the compounds detected in borehole C were PAHs, indicating that open burning may also have been conducted in the central part of the landfill. All of these SVOCs and VOCs were detected at concentrations that were less than the USEPA Region 9 action level criteria.

Analyses for metals in the soil samples collected from the landfill boreholes revealed the following metals with concentrations above their background screening levels: arsenic (11 samples), barium (14 samples), beryllium (17 samples), boron (6 samples), cadmium (1 sample), chromium (21 samples), cobalt (23 samples), copper (24 samples), lead (18 samples), manganese (18 samples), mercury (1 sample), nickel (31 samples), silver (28 samples), vanadium (18 samples), and zinc (29 samples). The only metals that were detected above the USEPA Region 9 criteria are arsenic (all 31 samples), barium (1 sample), beryllium (18 samples), and manganese (6 samples).

Analyses of the soil samples collected from the burning ground boreholes revealed detectable concentrations of PAHs in boreholes A (1 to 1.5 feet), B (1 to 1.5, 5.5 to 6, and 7.5 to 8 feet), C (1 to 1.5 and 5.5 to 6 feet), D (1 to 1.5 feet), E (1 to 1.5 feet), and F (1 to 1.5 feet). Detections of PAHs (eight or more detections) are clustered in the near surface (1 to 1.5 feet) and middle (5.5 to 6 feet) sample location of boreholes B and C. The middle location in borehole B has the most PAH detections with five: benzo[a]anthracene, benzo[a]pyrene, 3,4-benzofluroanthene, benzo[k]fluoranthene, and 1,2,5,6-dibenzoanthracene, all exceeding the USEPA Region 9 criteria. In the other three boreholes with anomalous detections, 3,4-benzofluoranthene also exceeds the USEPA Region 9 action level criteria. Other SVOCs were detected in the top sample of borehole A (1 detection); borehole B has 3 and 4 detections at the top and middle samples; and borehole C has two detections in both the top and middle sample locations. Both of the samples in borehole D have SVOC detections (two detections in the upper sample and one detection in the deeper sample), and one detection was found in the top samples of boreholes E and F. Most of the detections are polyaromatic hydrocarbons (PAHs) and are most likely related to incomplete combustion of fuel products.

Analyses for metals in the soil samples collected from the burning ground boreholes revealed the following metals concentrations that exceeded their background criteria: arsenic (5 samples), barium (8 samples), beryllium (7 samples), chromium (8 samples), cobalt (10 samples), copper (13 samples), lead (11 samples), manganese (8 samples), nickel (14 samples), silver (15 samples), vanadium (9 samples), and zinc (15 samples). Aluminum, arsenic,

barium, beryllium, manganese, and vanadium were the only metals found to exceed USEPA Region 9 criteria (Figure ~~12-10~~12-7). It should be noted that arsenic and beryllium in background soils of JPG also exceed their respective USEPA Region 9 criteria.

12.5.4 Sediment

Analyses of Phase I sediment samples collected from the landfill pond revealed no detectable explosives or VOCs (see Table 12-7). Bis(2-ethylhexyl)phthalate was detected in all three sediment samples in concentrations below the USEPA Region 9 criteria. Bis(2-ethylhexyl)-phthalate is recognized by USEPA as a common laboratory contaminant. Concentrations detected in the sediment samples are similar to those detected in the corresponding method blank samples and are, therefore, qualified as a laboratory contaminant. Metals detected above their background values for soils include arsenic (one sample), barium (three samples), beryllium (two samples), boron (one sample), chromium (one sample), cobalt (three samples), lead (two samples), manganese (two samples), mercury (three samples), nickel (three samples), silver (one sample), vanadium (two samples), and zinc (two samples). Only aluminum, beryllium, and manganese exceeded the USEPA Region 9 criteria in the sediment samples (Figure ~~12-11~~12-8).

Six sediment samples were collected from the Middle Fork Creek in April 2001. The samples were analyzed for metals, PAHs, and VOCs. Table 12-7b shows the sample results. Figure 12-6a shows the sample locations. VOCs and PAHs were not detected in the sediment samples. Arsenic was detected at sampling location SD02 (15.1 mg/Kg) at a concentration slightly above the JPG background of 13.7 mg/Kg. Iron was detected above the PRG at two locations.

12.5.5 Surface Water

Analyses of surface-water samples collected from the landfill pond revealed the presence of detectable concentrations of 1,3,5-trinitrobenzene, an explosive compound, in two out of three samples (see Table 12-7). This explosive was not detected in either soil or groundwater samples collected from the burning ground or landfill. During the Phase II, an additional surface water sample (BGG09SW004) was analyzed for explosives, and the results indicated that no explosive compounds were detectable. ~~It is likely that the explosive residue was transported to the pond by surface-water runoff from the nearest firing position located about 2,000 feet east of the pond. Metals analysis of the surface water revealed that none of the metals exceeded MCLs.~~ During Phase I, manganese and 1,3,5-trinitrobenzene were found to exceed USEPA Region 9 PRGs (Figure 12-~~11~~8). No VOCs or SVOCs were detected in the surface-water samples.

Six surface water samples were collected from the Middle Fork Creek in April 2001. The samples were analyzed for metals, PAHs, and VOCs. Table 12-7a shows the sample results. Figure 12-6a shows the sample locations. Sample results were compared to the U.S. EPA Region 9 PRGs for tap water. VOCs and PAHs were not detected in the six surface water samples. Metals, where detected, did not exceed the Region 9 PRG.

12.5.6 Groundwater

Groundwater samples collected from the five new wells and the three old wells were analyzed for explosives, metals, VOCs, and SVOCs during Phase I sampling. The results indicate detectable quantities of 1,1,1-trichloroethane in MW93-16 (see Table 12-9) (EPA13e). Also, 1,3-dimethylbenzene was detected in MW88-7. This result is suspect because the MW88-7 sample was in the same lot that had data reported as "greater than" for the MW88-15 sample. Review of the laboratory raw data showed that cross contamination had occurred in this lot. The VOC detections in MW93-16 and MW88-7 were both less than the USEPA Region 9 criteria. No explosives, anomalous metals, or SVOCs were detected in any of these wells. The non-detection of mercury in MW88-2, MW88-4, and MW88-7 indicates that the previous suspect detections in these wells (see Section 12.2) were likely in error.

During Phase II, MW93-15 was found to contain several SVOCs including benzo[a]anthracene, diethyl phthalate, di-n-octyl phthalate, fluoranthene, and pyrene, ~~and several tentatively identified compounds. A~~also detected were ~~the VOCs~~ 1,1,1-trichloroethane (round 3) and 1,1-dichloroethene (rounds 3 and 4). MW93-17 was found to contain ~~the SVOCs~~ 2-chlorophenol, 4-chloro-3-cresol, and acenaphthene~~, and two tentatively identified compounds~~. This well also contained ~~the VOC~~ 1,1,1-trichloroethane (rounds 3 and 4)~~ and two tentatively identified VOC compounds~~. MW93-18 was found to contain diethyl phthalate and ~~several tentatively identified SVOC compounds and the VOC~~ 1,1,1-trichloroethane. MW88-1 contained diethyl phthalate, dimethyl phthalate, pyrene, and the explosive compound 1,3,5-trinitrobenzene. MW88-2 contained detections of dimethyl phthalate, butylbenzyl phthalate, di-n-butyl phthalate, and 1,1,1-trichloroethane. MW88-3 contained one detection of dimethyl phthalate. MW88-5 contained dimethyl phthalate, di-n-butyl phthalate, and pyrene. MW88-7 contained 2-chlorophenol, butylbenzyl phthalate, and di-n-butyl phthalate. These results indicate that there is fairly widespread low level solvent-related contamination~~.~~ near the Burning Ground area (Figure 12-9). SVOCs, particularly phthalates, appear to be widely distributed but at low concentrations in the Gate 19 Landfill and Burning Ground areas. (EPA40)

Metals exceeding their respective background criteria were aluminum, antimony, arsenic, beryllium, cobalt, lead, manganese, molybdenum, nickel, selenium, vanadium, and zinc. Of these metals, arsenic (eight ~~sample~~locations), beryllium (one ~~sample~~location), cobalt (four ~~sample~~locations), lead (four ~~sample~~locations), and manganese (two ~~sample~~locations) exceeded USEPA Region 9 criteria (see Table 12-8).

12.6 HUMAN HEALTH RISK ASSESSMENT

12.6.1 Selection of the Contaminants of Potential Concern at Sites 9 and 10

12.6.1.1 Surface Soil

12.6.1.1.1 Data Grouping. For the purposes of the risk assessment, analytical data for samples collected at the Burning Ground were separated from those collected at Gate 19 Landfill. The samples used in the human health risk assessment are identified in the data evaluation discussion of this Section (12.4). All acceptable analytical data were used in the risk assessment. (EPA17)

12.6.1.1.2 Frequency of Detection. Evaluation of frequency of detection was not undertaken at these sites because of too few samples.

12.6.1.1.3 Nutrient Screening. The maximum value of each of the nutrients detected in surface soil at both Site 9 and Site 10 was less than the corresponding nutrient screening value:

- Site 9
  - Calcium - maximum 115,000 µg/g; screening value 1,000,000 µg/g
  - Iron - maximum 32,600 µg/g; screening value 70,000 µg/g
  - Magnesium - maximum 39,250 µg/g; screening value 1,000,000 µg/g
  - Potassium - maximum 1,250 µg/g; screening value 150,000 µg/g
  - Sodium - maximum 189 µg/g; screening value 1,000,000 µg/g

Therefore, all nutrients were eliminated as COPCs in surface soil at the Burning Ground South of Gate 19 Landfill.

- Site 10
  - Calcium - maximum 2,170 µg/g; screening value 1,000,000 µg/g
  - Iron - maximum 48,500 µg/g; screening value 70,000 µg/g
  - Magnesium - maximum 1,700 µg/g; screening value 1,000,000 µg/g
  - Potassium - maximum 685 µg/g; screening value 150,000 µg/g

Therefore, all nutrients were eliminated as COPCs in surface soil at Gate 19 Landfill.

12.6.1.1.4 Summary of Preliminary COPCs. Table 12-10 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95 percent UCL of the mean, and the exposure point concentration for each preliminary COPC in surface soil at Sites 9 and 10. Preliminary surface soil COPCs are those chemicals detected above background (or nutrient screening values) in more than 5 percent of surface soil samples.

12.6.1.1.5 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for each preliminary soil COPC was compared to the chemical-specific Region 9 residential soil PRG (Table 12-11). One-tenth of the PRG was used for noncarcinogens, with the exception of lead and organic chemicals with a PRG based on saturation limits; for these chemicals the full PRG was used. As a result of the screening, aluminum, beryllium, manganese, and benzo(a)pyrene are ***retained*** as COPCs in surface soil at Site 9. At Site 10, aluminum, beryllium, manganese, and vanadium are ***retained*** as COPCs in surface soil.

12.6.1.2 Surface/Subsurface Soil Combined.

12.6.1.2.1 Data Grouping. Surface/subsurface data were grouped in a manner consistent with the surface soil grouping; analytical data for the Burning Ground were evaluated separately from analytical data for Gate 19 Landfill.

12.6.1.2.2 Frequency of Detection. Evaluation of frequency of detection was not undertaken at these sites because of too few samples.

12.6.1.2.3 Nutrient Screening. With the exception of iron, the maximum value of each of the nutrients detected in surface/subsurface soil at Site 9 was less than the corresponding nutrient screening value:

- Calcium—maximum 115,000 µg/g; screening value 1,000,000 µg/g
- Iron—maximum 150,000 µg/g; screening value 70,000 µg/g
- Magnesium—maximum 39,250 µg/g; screening value 1,000,000 µg/g
- Potassium—maximum 1,250 µg/g; screening value 150,000 µg/g
- Sodium—89 µg/g; screening value 1,000,000 µg/g

Iron is, therefore, the only nutrient retained as a preliminary COPC in surface/subsurface soil at Site 9. The maximum value of each of the nutrients detected in surface/subsurface soil at Site 10 was less than the corresponding nutrient screening value:

- Calcium—maximum 5,600 µg/g; screening value 1,000,000 µg/g
- Iron—maximum 61,200 µg/g; screening value 70,000 µg/g
- Magnesium—maximum 1,860 µg/g; screening value 1,000,000 µg/g
- Potassium—maximum 685 µg/g; screening value 150,000 µg/g
- Sodium—maximum 116 µg/g, screening value 1,000,000 µg/g

Therefore, all nutrients were eliminated as COPCs in surface/subsurface soil combined at Gate 19 Landfill.

12.6.1.2.4 Summary of Preliminary COPCs. Table 12-10 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95 percent UCL of the mean, and the exposure point concentration for each preliminary COPC in surface/subsurface soil at Sites 9 and 10. Preliminary surface/subsurface soil COPCs are those chemicals detected above background (or nutrient screening values) in more than 5 percent of surface/subsurface soil samples.

12.6.1.2.5 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for each preliminary soil COPC was compared to the chemical-specific Region 9 residential soil PRG (see Table 12-11). One-tenth of the PRG was used for noncarcinogens, with the exception of lead and organic chemicals with a PRG based on saturation limits. For these chemicals, the full PRG was used. As a result of the screening, aluminum, arsenic, barium, beryllium, manganese, and benzo(a)pyrene are ***retained*** as COPCs in surface/subsurface soil combined at Site 9. The following chemicals are retained as COPCs at Site 10: aluminum, arsenic, barium, beryllium, manganese, and vanadium.

12.6.1.3 Air.

12.6.1.3.1 Summary of Preliminary COPCs. Ambient air concentrations to which future receptors at this site might be exposed were estimated using air emission/dispersion modeling, as described in Appendix R. In the site-specific conceptual model, discussed below in Section 12.6.2.1, Sites 9 and 10 are evaluated under two future site-specific scenarios: as residential sites and as industrial sites.

In the future industrial land use scenario for the facility, all sites were assumed to be industrial, except for the five sites designated agricultural sites. Each site with particulate-bound COPCs in surface soil (metals, SVOCs, and dioxins/furans) and/or volatile COPCs in surface/subsurface soil combined was assumed to contribute to the air concentrations at all of the sites. In the future residential scenario for the facility, all sites were assumed to be residential except for the five sites designated agricultural. It was assumed that particulate and VOC emissions from the strictly residential sites would be negligible because the home sites would be covered with dense vegetation (lawns) and pavement. Therefore, under the residential scenario, only the five agricultural sites contribute to the air concentrations at all of the sites. The list of preliminary air COPCs is therefore the same for every site for a given scenario, but the concentrations of the COPCs vary. Tables R-4 and R-6 in Appendix R present the estimated ambient air concentrations at Sites 9 and 10 under the future industrial and residential scenarios, respectively.

12.6.1.3.2 Region 9 Preliminary Remediation Goal Screening. The exposure point concentrations for each preliminary air COPC at Sites 9 and 10 in the future residential scenario and the future industrial scenario were compared to chemical-specific Region 9 air PRGs (Table 12-12). One-tenth of the PRG was used for noncarcinogens. The exception was lead, for which the full PRG was used. As a result of the screening, aluminum, silver, thallium, vanadium, and zinc are retained as COPCs in air for future on-site residents. For future on-site workers, aluminum, manganese, silver, thallium, vanadium, and zinc were retained.

12.6.1.4 Pond Sediment.

12.6.1.4.1 Frequency of Detection. Evaluation of frequency of detection was not undertaken at these sites because of too few sediment samples.

12.6.1.4.2 Nutrient Screening. The maximum value of each of the nutrients detected in sediment in the pond adjacent to the burning ground was less than the corresponding nutrient screening value:

- Calcium—maximum 47,900 µg/g; screening value 1,000,000 µg/g
- Iron—maximum 30,850 µg/g; screening value 70,000 µg/g
- Magnesium—maximum 8,020 µg/g; screening value 1,000,000 µg/g
- Potassium—maximum 1,028 µg/g; screening value 150,000 µg/g
- Sodium—109 µg/g; screening value 1,000,000 µg/g

All nutrients are therefore eliminated as preliminary COPCs in pond sediment.

12.6.1.4.3 Summary of Preliminary COPCs. Table 12-13 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95 percent UCL of the mean, and the exposure point concentration for each preliminary COPC in pond sediment. Preliminary sediment COPCs are those chemicals detected above background (or nutrient screening values) in more than 5 percent of sediment samples **(aka, one sample)**.

12.6.1.4.4 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for each preliminary sediment COPC was compared to the chemical-specific Region 9 residential soil PRG (Table ~~12-9~~**12-14**). One-tenth of the PRG was used for noncarcinogens, with the exception of lead, for which the full PRG was used. As a result of the screening, aluminum, beryllium, and manganese are retained as COPCs in pond sediment.

12.6.1.5 Pond Surface Water.

12.6.1.5.1 Frequency of Detection. Evaluation of frequency of detection was not undertaken at these sites because of too few surface water samples.

12.6.1.5.2 Nutrient Screening. The maximum value of each of the nutrients detected in surface water in the pond adjacent to the burning ground was less than the corresponding nutrient screening value:

- Calcium - maximum 42,300 µg/L; screening value 510,000 µg/L
- Iron - maximum 1,000 µg/L; screening value 9,400 µg/L
- Magnesium - maximum 13,400 µg/L; screening value 200,000 µg/L
- Potassium - maximum 3,500 µg/L; screening value 20,000 µg/L

- Sodium - 8,560 µg/L; screening value 730,000 µg/L

All nutrients are therefore eliminated as preliminary COPCs in pond surface water.

12.6.1.5.3 Summary of Preliminary COPCs. Table 12-13 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95 percent UCL of the mean, and the exposure point concentration for each preliminary COPC in pond surface water. Preliminary surface water COPCs are those chemicals detected above background (or nutrient screening values) in more than 5 percent of surface water samples **(aka, one sample)**.

12.6.1.5.4 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for each preliminary surface water COPC was compared to the chemical-specific Region 9 tap water PRG (Table 12-14). One-tenth of the PRG was used for noncarcinogens. As a result of the screening, manganese and 1,3,5-trinitrobenzene are retained as COPCs in pond surface water.

12.6.1.6 Groundwater.

12.6.1.6.1 Frequency of Detection. Evaluation of frequency of detection was not undertaken at these sites because of too few groundwater samples.

12.6.1.6.2 Nutrient Screening. With the exception of iron, the maximum well-specific value of each of the nutrients detected in groundwater at Sites 9 and 10 was less than the corresponding nutrient screening value:

- Calcium - maximum 122,000 µg/L; screening value 510,000 µg/L
- Iron - maximum 11,710 µg/L; screening value 9,400 µg/L
- Magnesium - maximum 66,787 µg/L; screening value 200,000 µg/L
- Potassium - maximum 2,950 µg/L; screening value 20,000 µg/L
- Sodium - 90,200 µg/L; screening value 730,000 µg/L

Iron is therefore the only nutrient retained as a preliminary COPC in groundwater.

12.6.1.6.3 Summary of Preliminary COPCs. Table 12-15 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95 percent UCL of the mean, and the exposure point concentration for each preliminary COPC in groundwater. Preliminary groundwater COPCs are those chemicals detected above background (or nutrient screening values) in more than 5 percent of groundwater samples **(aka, one sample)**.

12.6.1.6.4 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for each preliminary groundwater COPC was compared to the chemical-specific Region 9 tap water PRG (Table 12-16). One-tenth of the PRG was used for noncarcinogens. As a result of the screening, aluminum, antimony, barium, beryllium, chromium, manganese, molybdenum, 4-chloro-3-cresol, and benzo(a)anthracene are ***retained*** as COPCs in groundwater at Sites 9 and 10.

12.6.2 Exposure Assessment

12.6.2.1 Site Conceptual Model. **As described in Section 5.1.4.6,** no people specifically work at or frequent Sites 9 and 10. There are, however, several types of individuals who could potentially be affected by the existing contamination at the facility. These are current trespassers to JPG, off-facility (nearby) rural residents, and future hunters. In each case, these individuals would most likely be impacted simultaneously by multiple sites rather than by single units. Because of this, these current and future receptor populations are addressed on a facility-wide, cumulative basis rather than by specific sites (see Sections 28 and 29).

Therefore, this site-specific exposure scenario only addresses future land use development. Sites 9 and 10 have two potential future land uses forwarded for evaluation:

- Residential
- Industrial

Residential Use. Under the future residential land use scenario, these sites are assumed to be developed for residential purposes, with the supposition that a family would build a house directly on or within these areas of potential concern.

With respect to a risk assessment analysis, resident populations are assumed to consist of both adults and toddlers. Each individual would be expected to come in contact with site contaminants in the following pathways at Sites 9 and 10:

- Inhalation of VOCs and fugitive particulates from soils
- Dermal contact with soil (surface only and surface/subsurface combined) while gardening/playing outdoors
- Incidental ingestion of soil (surface only and surface/subsurface combined) while gardening/playing outdoors
- Ingestion of fresh homegrown fruits and vegetables (grown in surface soil only or surface/subsurface combined)
- Ingestion/dermal contact with groundwater

- Inhalation of VOCs while showering/bathing
- Ingestion/dermal contact with surface water in the pond adjacent to the landfill
- Ingestion/dermal contact with sediment in the pond adjacent to the landfill

On-site Worker. Industrial land use is considered to be a plausible future option for these sites at JPG. On-site industrial workers ~~(adult males and females)~~ are assumed to be individuals who could be exposed directly to contaminated media through the following pathways:

- Inhalation of VOCs and fugitive particulates from soils
- Incidental ingestion/dermal contact with soil
- Ingestion of groundwater

12.6.2.2 Exposure Point Concentrations.

12.6.2.2.1 Air. The estimated ambient air concentrations of COPCs at these sites for the future on-site residents and the future on-site workers are presented in Table 12-12.

12.6.2.2.2 Soil. The concentrations of COPCs in surface soil and surface/subsurface soil combined at these sites are presented in Table 12-11. Sites 9 and 10 were evaluated separately in this assessment for future on-site residents. However, it was assumed that future workers would have access to both sites. Therefore, for the purpose of estimating worker exposure to surface soil contaminants, site-wide average concentrations of soil COPCs at Sites 9 and 10 were calculated. A site-wide area-weighted concentration for each surface soil COPC was calculated by multiplying the concentration of the COPC in soil at the site (sub-area) of concern by a modifying factor. The modifying factor was calculated as the area of the site of potential concern divided by the area of Sites 9 and 10 combined. The modified concentrations were then summed to derive a site-wide concentration for each surface soil COPC. These site-wide area-weighted concentrations are presented in Table 12-17.

12.6.2.2.3 Fruits and Vegetables. COPC concentrations in homegrown fruits and vegetables were estimated using the methods described in Section 5.1.5.2.8. Appendix U, Table U-6, documents the calculation of contaminant concentrations in fruits and vegetables at Sites 9 and 10.

12.6.2.2.4 Groundwater. The concentrations of COPCs in groundwater at Sites 9 and 10 are presented in Table 12-16.

12.6.2.2.5 Shower Air. There are no VOC COPCs in groundwater at these sites. Therefore, this exposure pathway is incomplete.

12.6.2.2.6 Surface Water and Sediment. The concentrations of COPCs in sediment and surface water in the pond adjacent to the Gate 19 Landfill are presented in Table 12-14.

12.6.2.3 Human Exposure Doses.

12.6.2.3.1 Inhalation of Contaminated Air. Inhalation of airborne contaminants (VOCs and particulates) is a potential route of exposure for future on-site residents (adults and children) and workers at Sites 9 and 10. The equation used for calculating human exposure doses of contaminants of potential concern due to inhalation of volatile and dust-bound contaminants is provided in Section 5.1.5.3.1, Table 5-**11**~~12~~. Table V-6, Appendix V, documents the calculation of human exposure doses due to inhalation of contaminated air at these sites.

12.6.2.3.2 Incidental Ingestion of Contaminated On-site Soil. Mouthing behavior (toddlers) and incidental ingestion of soil with recreational or work-related activities may expose human receptors to contaminated soil at a site via the oral route of exposure. The equation used to calculate the human exposure dose due to incidental ingestion of contaminated soil is presented in Section 5.1.5.3.2, Table 5-**12**~~13~~. This pathway was assumed to be complete at Sites 9 and 10 for future on-site residents (adults and children) and future workers. Table V-6, Appendix V, documents the calculation of human exposure doses due to incidental ingestion of soil at Sites 9 and 10.

12.6.2.3.3 Dermal Contact with Contaminated On-site Soil. The chemicals in contaminated soil also may be absorbed into a receptor's body through dermal contact. The equation used to calculate chemical doses due to dermal contact with contaminated soil is presented in Section 5.1.5.3.3, Table 5-**13**~~14~~. This pathway is relevant for future on-site residents (adults and children) and future workers at Sites 9 and 10. Table V-6, Appendix V, documents the calculation of human exposure doses due to dermal contact with soil at these sites.

12.6.2.3.4 Ingestion of Contaminated Fruits and Vegetables. Consumption of contaminated homegrown fruits and vegetables may be a source of chemical exposure for future on-site residents (adults and children) at Sites 9 and 10. The equation used to calculate human exposure doses due to ingestion of contaminated fruits and vegetables is provided in Section 5.1.5.3.11, Table 5-**22**~~23~~. Table V-6, Appendix V, documents the calculation of human exposure doses due to ingestion of contaminated fruits and vegetables grown in soil at these sites.

12.6.2.3.5 Incidental Ingestion of Surface Water in the Pond Adjacent to Gate 19 Landfill. Water ingested while wading in the pond may be a source of exposure for future on-site resident adults and children. The equation to calculate human exposure doses due to incidental ingestion of contaminated surface water is provided in Section 5.1.5.3.7, Table 5-18~~19~~. Table V-6, Appendix V, documents the calculation of human exposure doses due to incidental ingestion of contaminated surface water while wading.

12.6.2.3.6 Dermal Contact with Surface Water in the Pond Adjacent to Gate 19 Landfill. Receptors may also absorb chemicals through the skin while wading in the pond. The equation used to calculate human exposure doses due to dermal contact with contaminated surface water is provided in Section 5.1.5.3.8, Table 5-**19**~~20~~. Table V-6, Appendix V, documents the calculation of human exposure doses due to dermal contact with surface water while wading.

12.6.2.3.7 Incidental Ingestion of Sediment in the Pond Adjacent to Gate 19 Landfill. Receptors may be exposed to contaminated sediments while wading in the pond. The equation to calculate human exposure doses due to incidental ingestion of contaminated sediments is provided in Section 5.1.5.3.9, Table 5-**20**~~21~~. Table V-6, Appendix V, documents the calculation of human exposure doses due to incidental ingestion of contaminated sediment while wading. This pathway is complete for future on-site residents at Sites 9 and 10.

12.6.2.3.8 Dermal Contact with Sediment in the Pond Adjacent to Gate 19 Landfill. Future on-site residents wading in the pond may also come into dermal contact with sediment-bound contaminants. The equation to calculate human exposure doses due to dermal contact with contaminated sediments is provided in Section 5.1.5.3.10, Table 5-21~~22~~. Table V-6, Appendix V, documents the calculation of human exposure doses due to dermal contact with contaminated sediment while wading.

12.6.3 Risk Characterization

12.6.3.1 Chronic Health Hazards. The noncancer daily exposure doses calculated in the exposure assessment were used to calculate HQs for each of the COPCs possessing RfDs. Pathway-specific and overall HIs were then calculated for each receptor. The calculations of HQs and HIs are described in Section 5.1.7.1. If an overall HI is calculated to be greater than 1.0 for a particular receptor, then the exposure pathway(s) primarily responsible for the result is identified as a "critical pathway(s)." For each critical pathway, those chemical contaminants responsible for the majority of the HI are listed as COCs. Table W-6, Appendix W, documents the calculation of the pathway- and chemical-specific HQs for the human receptors at Sites 9 and 10. The pathway-specific and overall HIs are summarized in Table 12-18, 12-19, and 12-20.

12.6.3.1.1 Future On-Site Residents - Site 9 - Burning Ground at Gate 19 Landfill. If future receptors build a home at Site 9 and are exposed to COPCs in surface soil only, the overall HIs for the future on-site adult and toddler residents are calculated to be **1.2**~~1.7~~ and **2.3** ~~4.5~~, respectively. These HIs exceed the USEPA's risk management criterion of 1.0. No single exposure pathway or chemical-specific multipathway HI exceeds 1.0 for the adult. For the child, ingestion of ~~homegrown fruits and vegetables~~**groundwater** is the critical exposure pathway~~, and manganese is the noncarcinogenic COC~~.

If subsurface soil is assumed to be mixed and dispersed with surface soil across the ground surface at the home-site at Site 9, the overall HIs for the future on-site adult and toddler residents are calculated to be 3.3 and 9.4, respectively. These HIs exceed the

USEPA's risk management criterion of 1.0. Ingestion of homegrown fruits and vegetables is a critical exposure pathway for both receptors, and manganese is the noncarcinogenic COC. For the child, incidental ingestion of soil and ingestion of groundwater are also critical exposure pathways and manganese is the noncarcinogenic COC in both pathways.

12.6.3.1.1a Future On-Site Residents - Site 10 - Gate 19 Landfill. If future receptors build a home at Site 10 and are exposed to COPCs in surface soil only, the overall HIs for the future on-site adult and toddler residents are calculated to be 1.2 and 3.1, respectively. These HIs exceed the USEPA's risk management criterion of 1.0. No single exposure pathway or chemical-specific multipathway HI exceeds 1.0 for the adult. For the child, ingestion of groundwater is the critical exposure pathway.

If subsurface soil is assumed to be mixed and dispersed with surface soil across the ground surface at the home-site at Site 10, the overall HIs for the future on-site adult and toddler are calculated to be 8~~15~~ and 23~~42~~, respectively. Ingestion of homegrown fruits and vegetables is a critical exposure pathway for both receptors, and manganese is the noncarcinogenic COC. For the child, incidental ingestion of soil is also a critical exposure pathway and manganese is the noncarcinogenic COC.

12.6.3.1.2 Future On-Site Workers. The overall HI for the future on-site worker at Sites 9 and 10 is calculated to be 2.1~~1.7~~. This value exceeds the USEPA's risk management criterion of 1.0. The critical exposure pathway is inhalation of fugitive dusts, and manganese is the noncarcinogenic COC for this pathway.

Manganese is naturally occurring in soils at the JPG facility. The relative contributions of background soil concentrations of manganese to the hazards at this site were estimated by comparing the average soil background concentration of manganese (in Cobbsfork soils) to the average concentration in site soils. At Site 9, background manganese accounts for approximately 10 percent of the total manganese concentration in surface soils and approximately 5 percent of the total manganese concentration in surface/subsurface soils combined. At Site 10, background manganese accounts for approximately 8 percent of the total manganese concentration in surface soils and less than 1 percent of the total manganese concentration in surface/subsurface soils combined.

At Site 9, background manganese would contribute approximately 10 percent to the hazard associated with exposure to surface soil and approximately 5 percent to the hazard associated with exposure to combined surface/subsurface soil. At Site 10, manganese would contribute approximately 7 percent to the hazard associated with exposure to surface soil and less than 1 percent to the hazard associated with exposure to surface/subsurface soil combined.

12.6.3.2 Excess Lifetime Cancer Risks. The cancer risks for each receptor were determined from the pathway-specific exposure doses and the route-specific SFs, as described in Section 5.1.7.2. To assess the simultaneous exposure of a receptor population to multiple carcinogens from multiple exposure routes, all of the cancer risks calculated for a receptor

population were summed. Each overall receptor cancer risk was then compared to USEPA's target risk range (1.0E-06 to 1.0E-04). If the total cancer risk for a receptor from all exposure pathways is less than 1.0E-04, then it is concluded that the site(s) does not pose a significant risk to that receptor. If the overall cancer risk exceeds the target risk range, any chemical individually associated with a risk level greater than 1.0E-05 is identified as a COC. COCs represent the primary contributors to the potential cancer risk for the receptor-specific exposure pathway under evaluation. Table W-6, Appendix W, documents the calculation of the pathway- and chemical-specific cancer risks for the human receptors at Sites 9 and 10. The pathway-specific and overall cancer risks are summarized in Tables 12-18, 12-19, and 12-20.

12.6.3.2.1 Future On-Site Residents—Site 9 - Burning Ground at Gate 19 Landfill. If future receptors build a home at Site 9 and are exposed to COPCs in surface soil only, the overall cancer risks for the future on-site adult and toddler residents are calculated to be **6.4E-06**~~4.8E-05~~ and **4.0E-06**~~2.5E-05~~, respectively. These cancer risks are within the USEPA's target risk range of 1.0E-06 to 1.0E-04. Therefore, no critical exposure pathways or carcinogenic COCs are identified for these receptors.

If subsurface soil is assumed to be mixed and dispersed with surface soil across the ground surface at the home-site at Site 9, the overall cancer risks for the future on-site adult and toddler residents are calculated to be **5.3**~~9.7~~E-05 and **5.0**~~7.5~~E-05, respectively. These cancer risks are within the USEPA's target risk range of 1.0E-06 to 1.0E-04. Therefore, no critical exposure pathways or carcinogenic COCs are identified for these receptors in the excavation scenario.

12.6.3.2.1.a Future On-Site Residents - Site 10 - Gate 19 Landfill. If future receptors build a home at Site 10 and are exposed to COPCs in surface soil only, the overall cancer risks for the future on-site adult and toddler residents are calculated to be **2.9E-06**~~4.4E-05~~ and **1.4E-06**~~2.2E-05~~, respectively. These cancer risks are within the USEPA's target risk range of 1.0E-06 to 1.0E-04. Therefore, no critical exposure pathways or carcinogenic COCs are identified for these receptors.

If subsurface soil is assumed to be mixed and dispersed with surface soil across the ground surface at the home-site at Site 10, the overall cancer risks for the future on-site adult and toddler residents are calculated to be **4.2E-05**~~2.2E-05~~ and **4.0E-05**~~8.4E-05~~, respectively. These cancer risks are within the USEPA's target risk range of 1.0E-06 to 1.0E-04. Therefore, no critical exposure pathways or carcinogenic COCs are identified for these receptors in the excavation scenario.

12.6.3.2.2 Future On-Site Workers. The overall cancer risk for the future on-site worker at Sites 9 and 10 is **8.34E-07**~~1.2E-05~~. Since this cancer risk is **below**~~within~~ the USEPA's target risk range of 1.0E-06 to 1.0E-04, no critical exposure pathways or carcinogenic COCs are identified for this receptor at these sites.

12.6.3.3 Uncertainty/Sensitivity Analysis. The numerical risks/hazards that are calculated for Sites 9 and 10 represent *conditional* estimates of risk based on various simplifying assumptions concerning contaminant exposure and toxicity. These estimates of risk/hazard are derived using a series of conservative procedures that address contaminant concentrations at the site, their fate in the environment, how someone currently or in the future might be exposed to these contaminants, and the toxicity of each chemical toward humans. The purpose of the uncertainty analysis is therefore to specify, when appropriate, the critical assumptions made for the site so that the site-specific results can be interpreted by risk managers in a proper context.

To assist the risk managers in this project, a qualitative uncertainty analysis has been performed. The primary goals of a qualitative uncertainty analysis are (1) to itemize the major areas of uncertainty in the site-specific risk assessment and (2) to demonstrate that the assessment overall has been conservatively performed (i.e., that the potential risks/hazards at the site have not likely been underestimated, but may have been significantly overestimated).

The qualitative uncertainty analysis for this site is presented in Table 12-21. Based on this analysis, it can be concluded that this risk assessment is conservative. Some of the major uncertainties in this study that are most influential to the risks/hazards that were calculated include:

- Assumed receptors' foodstuff ingestion rates (95th percentile of U.S. population)
- Receptors' exposure time (24 hours/day)
- Food-chain concentrations were modeled, not measured

There are a number of uncertainties associated with the fruit and vegetable ingestion pathway. A major source of uncertainty is attributable to uncertainty in soil-to-plant transfer factors. Many site-specific factors can affect the extent of uptake of chemicals into plants. Some of these factors include pH, the organic carbon content of the soil, and the presence of other chemicals. Site conditions may vary from those in studies used to derive the uptake factors used in the assessment. Some of the equations used to estimate plant uptake from soil utilize chemical-specific properties such as K_d and K_{ow}. For each chemical there may be a range of values for these parameters reported in the literature. Professional judgment was used to select the values used in the assessment. Another source of uncertainty for this pathway is the assumption that the intake rates for fruits and vegetables, which are based on data collected during a nationwide survey by Pao *et al*. (1982), would be representative of actual exposure conditions at this site. The percent of fruit and vegetable intake, which is homegrown produce, also cannot be known for a future population, and conservative estimates were used in the assessment based on national surveys. Because of these uncertainties, the HIs and cancer risks calculated for receptors ingesting fruits and vegetables grown at this site may be over- or underestimated by an order of magnitude.

In addition, Phase I antimony results obtained by USATHAMA-certified methods were acceptable under USATHAMA QA/QC guidelines, but were later rejected in accordance with EPA CLP functional guidelines for data review. The rejected data were not used quantitatively in this risk assessment. The absence of antimony analytical data may underestimate risk to human health and ecological receptors. (EPA99)

12.7 ECOLOGICAL RISK ASSESSMENT

12.7.1 Ecological Site Description

Site 9 is located in a remote area consisting primarily of unmowed grasses and forbs and surrounded by flatwoods in varying degrees of succession. At the time of the 1993 Phase I RI investigation, a hill was located in the center of the area, and demolition debris was present in the southeastern section of the site. Disturbed areas were located in the northern portion of the site. There was an open trench with water standing near the western border. In 1995/1996, the landfill was capped and sealed with a clay liner and the entire area was secured behind a locked gate. Since the exposure pathways to the landfill are now considered incomplete, Site 10 was removed from further consideration in the DERA.

Vegetation is extremely variable in species richness and density. Vegetation ranged from grasses and forbs to brambles and briars, to young and mature flatwood forests. In the area of the landfill, there was no tree canopy cover. Vegetation observed included clover, common milkweed, goldenrod, aster, blackberry, raspberry, grape, poison ivy, multiflora rose, mullein, cattail, dandelion, beggar-ticks, plantain, dogbane, pepper grass, hop-clover, bindweed, ragwort, steeplebush, knotweed, honeysuckle, aster, and dock. Tree seedlings of red maple, sycamore, sassafras, sweetgum, white ash, and persimmon were also observed. Refer to Figure 5.3-13 for a map of habitat types at JPG. (EPA184) Wildlife observed included bluebirds, crows, and various species of frogs. In addition, there was evidence of crayfish and deer**. Refer to Table 12.7-a1 for a summary of Site 9 ecological habitat characteristics identified during site visits. (EPA184)**

12.7.2 Site 9 Investigations

Ecological risk assessment sampling locations from the ~~Fall 1997 Phase III~~ Phase I and II investigations are shown in Figure 12.7-1. For convenience to the reader, summary statistics, EPCs, risk driver HQs, total RME and CT HIs are provided in this section. All intakes and ~~other non risk-driving~~ HQs are located in Appendix AA**. The COPCs for each medium which were evaluated in the DERA are presented on the EPC tables in this section. Refer to Appendix AA for details pertaining to the specific data sets (e.g., sample numbers, depths, dates, etc.) used in the risk assessment for Sites 9 and 10. (EPA179)**

12.7.2.1 Phase I Activities. The Phase I summary statistics for Site 9 are provided in Table 12.7-1 and include data for sediment, surface water, and soil. Table 12.7-2 provides the EPCs for Site 9.

12.7.2.2 Phase II Activities. Phase II soil data for SVOCs were collected at Site 9. Table 12.7-3 reports the summary statistics available for the Phase II sampling; Table 12.7-4 presents the EPCs.

12.7.2.3 Phase III Activities. Phase III soil data for metals were collected at Site 9. Table 12.7-5 reports the summary statistics available for the Phase III sampling; Table 12.7-6 presents the EPCs.

12.7.2.4 Additional Middle Fork Creek Sampling Activities. Additional sediment and surface water sampling in Middle Fork Creek was conducted in April 2001 at the request of USEPA. VOCs and PAHs were not detected in the sediment or surface water samples. Arsenic was detected slightly above background at one sediment sampling location. Neither arsenic nor mercury exceeded background in surface water. Refer to Sections 12.4.3.3 and 12.5.4 for summaries of the sediment sampling. Refer to Sections 12.4.3.4 and 12.5.5 for summaries of the surface water sampling. Due the lack of background exceedances and the lack of detections of VOCs and PAHs, the results from the additional Middle Fork Creek sampling activities were not carried through the rest of the ecological risk assessment for Site 9. **(EPA205, EPA206 EPA207b)**

12.7.3 Exposure and Ecological Effects Profile

Fish, amphibians, reptiles, aquatic invertebrates, aquatic macrophytes, birds, and mammals may all be exposed to COPCs at Site 9 (Phase I data only), either by direct contact with or ingestion of the surface water and/or sediments and soil. To determine the estimated intakes of the COPCs, various key receptor species were selected to evaluate the impacts to area wildlife. Birds and mammals may be exposed to COPCs in soil at Site 9; key terrestrial receptors evaluated at Site 9 included mourning dove, chimney swift, American kestrel, wild turkey white-footed mouse, eastern cottontail, red fox, little brown myotis, plants, and soil fauna. The key aquatic receptors evaluated for Site 9 (Phase I) included creek chub, Pickerel frog, crayfish, great blue heron, and raccoon.

The conceptual site model (CSM) for Site 9 provides an overview of the ecological receptors and exposure pathways evaluated in the ecological risk assessment. Refer to Figure 12.7-1a for a schematic of the CSM. Multiple lines of evidence were evaluated for the ecological assessment conducted at Site 9. For Site 9 both terrestrial and aquatic lines of evidence were evaluated. The lines of evidence were primarily hazard quotient (HQ) calculations for a number of different receptors, but for the terrestrial ecosystem toxicity testing was also conducted. Refer to Table 7.7-11a for a summary of the terrestrial and aquatic ecosystem lines of evidence. (EPA180a,b, EPA204)

The exposure pathways and receptors evaluated at this site are as follows:

- Aquatic Ecosystem (Phase I data only)

- Great blue heron - surface water and sediment ingestion, and dietary ingestion of fish, crayfish, and aquatic plants
- Raccoon - surface water and sediment ingestion, and dietary ingestion of fish, crayfish, and aquatic plants
- Creek chub, pickerel frog, crayfish - direct contact with surface water and sediment
- Aquatic invertebrates - direct contact with surface water and sediment

- Terrestrial Ecosystem (Phase I, II, and III) (all receptors except raccoon, great blue heron, creek chub, pickerel frog, crayfish)
  - All wildlife receptors - –soil ingestion
  - All wildlife receptors - surface water ingestion
  - All wildlife receptors - dietary ingestion
  - Plants - direct contact with soil
  - Soil fauna - direct contact with soil

Note: TRVs for aquatic plants were unavailable from the literature; it was assumed that risks to other aquatic life would be representative of aquatic plants.

12.7.3.1 Selection of COPCs. Inorganic analytes from soil data collected during Phases I, II, and III were compared to the JPG Phase II background data set (Section 5.3.2.1). Analytes which were not statistically elevated relative to background were removed from consideration as COPCs. No comparisons to background were made for sediment or surface water~~ at the time of this report~~ due to the limited amount of data available for these media. The COPCs for Site 9 in the various media are presented in Tables 12.7-1 through 12.7-6**. Pesticides and SVOCs were not detected in surface water at Site 9, nor were explosives or SVOCs detected in sediment in the Phase I data. SVOCs were detected in soil in the Phase I data. The compound 1,3,5-trinitrobenzene was detected in 2 out of 3 surface water samples, and no explosives ~~or SVOCs~~ were detected in surface soil in the Phase I data. All antimony in sediment results were rejected in the Phase I data. (EPA205)**

Only arsenic was eliminated as a COPC at Site 9 for the Phase I data since it was not statistically elevated above background.

Phase II data collected at Site 9 were restricted to organic analytes; as such, no organic analytes were removed as COPCs.

Selenium was not detected in soil at the ecological study Site 9 (Phase III) and so was not considered a COPC. Both arsenic and nickel were removed as COPCs since they were not statistically elevated above background.

12.7.3.2 Comparison of Site Data to Reference Area Concentrations. Aluminum was significantly different by site (p=0.0004) in the Phase III data. Site 9 had significantly higher aluminum concentrations than at any of the three reference areas. Beryllium was different by location (p=0.006); Site 9 had higher concentrations of beryllium than other areas or the

reference areas. Cobalt was significantly different by location (p=0.0039); Site 9 had significantly higher concentrations of cobalt than at any of the three reference areas.

Manganese was significantly different by location (p < 0.0000). Site 9 had significantly higher manganese concentrations than at any of the three reference areas or other JPG sites.

Zinc was significantly different by location (p=0.0003). However, concentrations at most of the JPG sites overlapped or were lower than those at the reference areas, except Site 9, which had higher concentrations than at the reference areas.

Cadmium, chromium, copper, mercury, molybdenum, antimony, and thallium did not differ significantly by location for the Phase III data.

TOC of reference area soils ranged from 1920 to 11,500 mg/kg. TOC of Site 9 soils ranged from 5930 to 8820 mg/kg. Thus, the TOC concentrations of Site 9 soils are within the range of the TOC concentrations of reference site soils. (EPA192)

The pH of reference area soils ranged from 4.93 to 6.16. The pH of Site 9 soils ranged from 5.43 to 8.92. Thus, the pH of Site 9 soils is higher than the pH of reference site soils. In general, as pH increases, bioavailability of some micronutrients and heavy metals decreases. Therefore, it is possible that some micronutrients and heavy metals are less bioavailable in Site 9 soils than in reference soils, which would reduce their toxicity. (EPA192)

12.7.3.3 Earthworm Toxicity Test. Earthworm mortality at Site 9 ranged from 5 to 20 percent. **Refer to Table 8.7-12a for results of the earthworm toxicity testing. (EPA191)** The null hypothesis is "the number of dead earthworms is similar among all locations". The χ^2 test statistic was 49.25 with a degree of freedom of 40, which resulted in a p value of 0.1498. Since this p-value exceeds 0.1, site location may bear no relation to earthworm mortality when this test is used. ANOVA on the arcsine-transformed data provides a different interpretation. The p-value for ANOVA is 0.0016, indicating a significant difference between the mean mortality from one location to another at the 95 percent confidence level. A 95 percent LSD indicated that mortality was significantly higher at Site 9 than at Avonburg or Cobbsfork reference areas, but that mortality at Site 9 overlapped (was not significantly higher) that observed at the Rossmoyne reference area. The statistical analysis therefore indicates that earthworm mortality at Site 9 is not likely to be significantly affected by existing site conditions at Site 9, but is the result of inherent variability.

12.7.3.4 Phytotoxicity Test. The phytotoxicity early seedling growth test resulted in data for percent germination and biomass. The results are summarized in Appendix Z. The germination data were neither normal or log-normal. The biomass data on a wet-weight basis were lognormal. Percent germination ranged from 90 to 95 percent at Site 9.

ANOVA of the germination data resulted in a p-value of 0.1480, which is greater than 0.05, indicating that location does not have a statistically significant effect on germination at the 95

percent confidence level. ANOVA of the biomass data resulted in a p-value of 0.0037, indicating site location has a significant effect on wet weight biomass at the 95 percent confidence level. The lowest biomass observed in the study was the biomass for the Cobbsfork reference area. An LSD multiple range test revealed that Avonburg and Cobbsfork reference areas had significantly lower biomass than the Rossmoyne reference area or Site 9.

The biomass data indicate that existing site conditions at Site 9 will not significantly decrease plant growth or reproduction relative to effects observed in controls. Instead, the site appears more productive than the reference areas.

12.7.3.5 Soil Fauna Community Structure. The number of individuals per sample (density) was log-normal. The number of species was neither normal or log-normal. Diversity ranged from 0 to 97 percent at the reference areas, indicating that this parameter is so inherently variable at JPG that it may not be possible to use diversity to identify contaminant-related effects. The number of individuals was not significantly different by location when the log transformed data were analyzed by ANOVA. The number of invertebrate species was not statistically significantly different at the 95 percent confidence level when analyzed by the Kruskal-Wallis test. There does not appear to be any affect of site location on soil invertebrates, although community similarity may be examined in a later version of this report.

12.7.4 Risk Characterization

12.7.4.1 Risk Estimation. The HIs are summarized for each sampling event and receptor below. The HIs have been grouped by order of magnitude for discussion purposes. HIs based on RME and CT exposure parameters are presented. In addition, a conservative NOAEL-based TRV and a dose at which population-level effects may occur (LOAEL-based TRV) were used to establish the lower and upper bounds on toxicity, respectively. These values define the risk boundaries. There are thus four sets of HI values for each location and sampling event (NOAEL-RME, NOAEL-CT, LOAEL-RME, and LOAEL-CT). The exposure intakes, HQs, and HIs are presented in Appendix AA. Figures 12.7-2 through 12.7-13 show the total NOAEL and LOAEL-based HI risks for both the RME and CT exposure scenarios by receptor. The reference area ~~RME-NOAEL~~ HIs were ~~presented graphically only on the RME-NOAEL site graphs due to the low risks generally observed~~ overlayed on those figures where an HI was greater than 1 for one or more receptors.

Site 9

Phase I RME NOAEL HIs
(See Figure 12.7-2)
Key Receptors with HI range 0-1: Wild Turkey
HI Range 1.1-10: Mourning Dove, Chimney Swift, American Kestrel, Red Fox, Raccoon, Benthic Invertebrates, Creek Chub, Pickerel Frog
HI Range 10.1-100: Great Blue Heron, Little Brown Myotis, Soil Fauna
HI Range 100.1-1000: White-footed Mouse, Eastern Cottontail, Plants
HI > 1000: None

Phase I RME LOAEL HIs
(See Figure 12.7-3)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, Red Fox, American Kestrel
HI Range 1.1-10: Little Brown Myotis, Great Blue Heron, Raccoon, Benthic Invertebrates, Creek Chub, Pickerel Frog, Soil Fauna
HI Range 10.1-100: White-footed Mouse, Eastern Cottontail, Plants
HI Range 100.1-1000: None

Phase I CT NOAEL HIs
(See Figure 12.7-4)
Key Receptors with HI range 0-1: Raccoon, Wild Turkey, Red Fox
HI Range 1.1-10: Mourning Dove, Chimney Swift, American Kestrel, Benthic Invertebrates, Creek Chub, Pickerel Frog
HI Range 10.1-100: Great Blue Heron, Eastern Cottontail, Little Brown Myotis
HI Range 100.1-1000: White-footed Mouse

Phase I CT LOAEL HIs
(See Figure 12.7-5)
Key Receptors with HI range 0-1: Raccoon, Wild Turkey, Red Fox, American Kestrel, Mourning Dove, Chimney Swift
HI Range 1.1-10: Great Blue Heron, Little Brown Myotis, Benthic Invertebrates, Creek Chub, Pickerel Frog
HI Range 10.1-100: White-footed Mouse, Eastern Cottontail
HI Range 100.1-1000: None

Site 9

Phase II RME NOAEL HIs
(See Figure 12.7-6)
Key Receptors with HI range 0-1: Mourning Dove, Wild Turkey, Red Fox, Chimney Swift, American Kestrel, Little Brown Myotis, White-footed Mouse, Eastern Cottontail, Plants, Soil Fauna
HI Range 1.1-10: None
HI Range 10.1-100: None
HI Range 100.1-1000: None

Phase II RME LOAEL HIs
(See Figure 12.7-7)
Key Receptors with HI range 0-1: Mourning Dove, Wild Turkey, Red Fox, Chimney Swift, American Kestrel, Little Brown Myotis, Soil Fauna, White-footed Mouse, Eastern Cottontail, Plants, Soil Fauna
HI Range 1.1-10: None
HI Range 10.1-100: None
HI Range 100.1-1000: None

Phase II CT NOAEL HIs
(See Figure 12.7-8)
Key Receptors with HI range 0-1: Wild Turkey, Red Fox, American Kestrel, Mourning Dove, Chimney Swift, Little Brown Myotis, Eastern Cottontail, White-footed Mouse
HI Range 1.1-10: None
HI Range 10.1-100: None
HI Range 100.1-1000: None

Phase II CT LOAEL HIs
(See Figure 12.7-9)
Key Receptors with HI range 0-1: Wild Turkey, Red Fox, American Kestrel, Mourning Dove, Chimney Swift, Little Brown Myotis, Eastern Cottontail, White-footed Mouse
HI Range 1.1-10: None
HI Range 10.1-100: None
HI Range 100.1-1000: None

Site 9

Phase III RME NOAEL HIs
(See Figure 12.7-10)
Key Receptors with HI range 0-1: Wild Turkey
HI Range 1.1-10: Mourning Dove, Chimney Swift, Red Fox
HI Range 10.1-100: American Kestrel, Little Brown Myotis
HI Range 100.1-1000: White-footed Mouse, Eastern Cottontail, Plants, Soil Fauna

Phase III RME LOAEL HIs
(See Figure 12.7-11)
Key Receptors with HI range 0-1: Mourning Dove, Wild Turkey, Red Fox, Chimney Swift
HI Range 1.1-10: American Kestrel, Little Brown Myotis, Soil Fauna
HI Range 10.1-100: White-footed Mouse, Eastern Cottontail, Plants
HI Range 100.1-1000: None

Phase III CT NOAEL HIs
(See Figure 12.7-12)
Key Receptors with HI range 0-1: Wild Turkey, Red Fox
HI Range 1.1-10: American Kestrel, Mourning Dove, Chimney Swift
HI Range 10.1-100: Little Brown Myotis, Eastern Cottontail
HI Range 100.1-1000: White-footed Mouse

Phase III CT LOAEL HIs
(See Figure 12.7-13)
Key Receptors with HI range 0-1: Wild Turkey, Red Fox, American Kestrel, Mourning Dove, Chimney Swift
HI Range 1.1-10: Little Brown Myotis
HI Range 10.1-100: White-footed Mouse, Eastern Cottontail
HI Range 100.1-1000: None

12.7.4.2 Risk Description. Very few Phase III analytes were statistically elevated at Site 9 relative to the reference areas. Aluminum, beryllium, cobalt, manganese, and zinc are statistically elevated at Site 9 relative to the soil concentrations observed in the reference areas. All other COPCs at Site 9 appeared to be within the expected ambient concentrations predicted by the data from the reference areas.

The soils at Site 9 did not produce elevated levels of mortality in earthworms relative to that observed at the reference areas, nor was the soil fauna diversity obviously affected. Plant germination and biomass were not significantly different at Site 9 than at the reference areas.

Phase I RME NOAEL-based HIs at Site 9 exceed those at the reference areas for plants and soil fauna. Lower risks for aquatic receptors were observed; however, no comparison to the reference areas could be made (Figure 12.7-2). The HIs for each reference area and the inherent JPG Phase II background risks can be found in Section 32.

Wetland receptors were evaluated at Site 9 because of the presence of a small pond near the site and the availability of surface water and sediment data from the Phase I sampling event. Phase I RME NOAEL-based HIs and RME LOAEL-based HIs exceeded 1 for aquatic life, great blue heron, and raccoon. However, ~~at this time~~ no comparison to reference area conditions can be made since the Phase III reference area samples were all from terrestrial habitat. ~~Data from other RIs and sources will be used to obtain background data, if possible, to evaluate relative risk to aquatic life, great blue heron, and raccoon for exposure to sediments and surface water in the next version of this report.~~

The Phase II data indicated no risk to any ecological receptor for exposure to SVOCs in soil (Figure 12.7-6). The Phase III RME NOAEL-based HIs are within the same order of magnitude as those at the reference areas, with the exception of the RME NOAEL-based HI for plants (Figure 12.7-10). The soil fauna HI at Site 9 slightly exceeds those at the reference areas based on Phase III data.

The Phase I RME LOAEL-based HIs for Site 9 were higher than the order of magnitude range expected based on evaluation of the reference area data only for plants and soil fauna, indicating a potential for population-level effects only for these receptors. The HI results are therefore in direct conflict with the results of the biometric studies, which measured a lack of population and individual level effects in earthworms, other soil invertebrates, and plants at Site 9. The Phase III RME LOAEL-based HIs for Site 9 were within the order of magnitude predicted from the reference area data for all receptors except plants, indicating no increased risk of population level effects relative to the reference areas.

The results suggest that the TRVs are overly conservative for this site, since ambient levels of inorganics in the reference areas produce high risk estimates. Given that few analytes statistically exceed those at reference areas, that HIs for receptors other than plants and soil fauna are not significantly higher than HIs at the reference areas, and that the biometric data failed to detect adverse effects in plants and soil fauna in direct contact with soils from Site 9, it appears that contamination at Site 9 is not a likely threat to ecological health at JPG.

12.7.4.2.1 Risk Drivers/Summary of Lines of Evidence. Risk drivers associated with Site 9 are summarized in Tables 12.7-7 through 12.7-10. A COPC was categorized as a risk driver if it produced an HQ greater than or equal to 1 for any exposure pathway. There were no risk drivers associated with the Phase II Site 9 data.

In addition, to provide an overall summary of the multiple lines of evidence that were evaluated for the Site, a summary table was developed. The lines of evidence were primarily hazard quotient (HQ) calculations for a number of different receptors, but for the terrestrial ecosystem, toxicity testing was also conducted. Refer to Table 7.7-11a for a summary of the terrestrial and aquatic ecosystem lines of evidence. A number of measurement endpoints were assessed for both aquatic and terrestrial ecosystems as summarized in Table 7.7-11a. An evaluation was made of which measurement endpoints were most sensitive in determining the potential for an ecological concern by terrestrial or aquatic ecosystem. (EPA180a,b)

Terrestrial Ecosystem

The most sensitive of the terrestrial measurement endpoints are plants, soil fauna, and white-footed mice HQs. The reasonable maximum exposure (RME) no observed adverse effect level (NOAEL)-based hazard indices (HIs) for each of these receptors are as follows: 393 (plants), 221 (white-footed mice), and 108 (soil fauna). The primary contributors of risk to plants are aluminum (RME NOAEL HQ of 350) and vanadium (RME NOAEL HQ of 32) from direct contact with soil. These HQs were derived using Phase III data. The primary contributors of risk to soil fauna are chromium (RME NOAEL HQ of 67) and iron (RME NOAEL HQ of 30) from direct contact with soil. These HQs were derived using Phase III data. The primary contributors of risk to white-footed mice are selenium (RME NOAEL HQ of 110) through dietary ingestion and vanadium (RME NOAEL HQ of 56) through ingestion of soil. These HQs were derived using Phase I data.

Of the metals listed as primary contributors to ecological risk, only aluminum is present at concentrations that exceed reference area concentrations. Thus, chromium, iron, selenium, and vanadium would not be expected to contribute to ecological risk exceeding that in the reference areas. Based on Figure 12-7, there do not appear to be well-defined areas of high aluminum concentrations within Site 9.

Although HIs for plants and soil fauna exceeded 1, they were similar to HIs calculated for reference areas. In addition, no adverse effects significantly above background were observed in the field earthworm and plant toxicity tests conducted at Site 9. (EPA180a,b)

Aquatic Ecosystem

The most sensitive of the aquatic measurement endpoints is the great blue heron HI. The maximum RME NOAEL HI for this receptor is 37. The primary contributor of risk to great blue heron is vanadium (RME NOAEL HQ of 34) through ingestion of sediment. This HQ was derived using Phase I data. (EPA180a,b)

12.7.4.3 Uncertainty Analysis. The analytical soil data for Site 9 are from Phase I, II and III; however, the soil samples collected during Phase II were analyzed only for SVOCs. The

aquatic data were collected only during Phase I. Since the analytes and media for all three sampling events were not the same, risk estimates at Site 9 are more uncertain. Phase III reference area data are not strictly comparable to Phase I and Phase II; however, no other basis of comparison was available. Since there are inherent levels of risk, it is important to compare site risks to reference areas as a reality check on the risk assessment.

The biological data provide site-specific evidence of a lack of adverse effects in lower trophic level species. These data decrease uncertainty at this site.

Uncertainty in the exposure estimates is due primarily to:

- Variability in the exposure parameters, which produce a natural distribution of the variables in the intake equations for each of the receptors;
- Exposure parameters derived from literature and not measured on site;
- Uncertainty in the dietary ingestion pathway, which utilized BAFs to predict dietary concentrations;
- Variation in the concentrations of COPCs in the environment;
- Uncertainty as to whether the most conservative pathways have been addressed and evaluated.

The predicted effect of each of these sources of uncertainty on the risk assessment is as follows:

Variability in the exposure parameters—Because both the average and RME scenarios were quantitatively addressed, this source of uncertainty is expected to have no overall effect on the risk assessment results.

Exposure parameters derived from literature—Because so many ecological receptors were quantitatively considered in the ecological risk assessment, this source of uncertainty is expected to have no overall effect on the risk assessment.

Uncertainty in the dietary ingestion pathway—The use of literature-based BAFs or BCFs is expected to overestimate as opposed to underestimate concentrations in the dietary pathway. This is because under laboratory conditions, animals are chronically exposed on a daily basis and supposedly reach steady state. In the wild, as animals move in and out of contaminated areas, metabolism and excretion are expected to reduce the body burden. Use of field-based BAFs from TEAD is not expected to overestimate or underestimate risk for these analytes, since these data were measured in conjunction with co-located soil samples.

Variation in the concentrations of COPCs in the environment—This uncertainty is not expected to bias the risk assessment towards underestimation of risk since maximum or UCL95 concentrations were used in all exposure scenarios to estimate the EPCs.

Uncertainty whether the most conservative pathways have been addressed—The receptors were considered carefully by the DSG, and typically have high exposure rates due to their life-histories (i.e., ground-feeding or burrowing). Therefore, this source of uncertainty is not expected to impact the risk assessment.

Uncertainty in the ecological analysis is less than the uncertainty in the exposure estimates because these data were gathered as part of a site-specific, controlled field study. There were sufficient samples collected at each site (n=5) to identify within and between site variability. The data identify the potential for adverse effects to species that form the basis of the JPG food web, that is, the plants and soil fauna.

12.7.5 Ecological Risk Assessment Summary

The conceptual site model (CSM) for Site 9 provides an overview of the ecological receptors and exposure pathways evaluated in the ecological risk assessment. Refer to Figure 12.7-1a for a schematic of the CSM. Site 9 will likely become part of a wildlife refuge in the future. This future land use will not likely affect the CSM.

Multiple lines of evidence were evaluated for the ecological assessment conducted at Site 9 for both the aquatic and terrestrial ecosystems. For Site 9 both terrestrial and aquatic lines of evidence were evaluated. The lines of evidence were primarily hazard quotient (HQ) calculations for a number of different receptors, but for the terrestrial ecosystem, toxicity testing was also conducted. Refer to Table 7.7-11a for a summary of the terrestrial and aquatic ecosystem lines of evidence. (EPA180a,b)

The following **is an overall** summary **of the key results of the ecological assessment for Site 9.** ~~is based on an initial review of the data. A full evaluation of whether or not the data meet all DQOs, and further statistical examination, will be made prior to finalizing these results for the next version of this report.~~

Terrestrial Ecosystem

~~Based on the ecological effects data, there are no adverse ecological effects at this site.~~

- Based on the analytical data, there are few COPCs statistically elevated above those at the reference areas. Aluminum, beryllium, cobalt, manganese, and zinc are the only analytes that are statistically elevated at Site 9 relative to the reference areas. ~~These analytes are nearly the same as those elevated at Site 3/4.~~ It should be noted that an on-site soil survey indicated that the JPG sites were predominantly fill instead of native soil. This may explain the trend in soil concentrations observed for these inorganics.

- Phase I HIs are within the same order of magnitude, or lower than, those observed at the reference areas for all receptors except plants and soil fauna. HIs indicated the potential for adverse population-level effects on these **two** groups of receptors. Other lines of evidence refute the HI results, however. Effects on plant reproduction and growth were not observed. Effects on earthworm mortality were also not observed.

- Phase III HIs are within the same order of magnitude as those observed at the reference areas for all receptors.

- There is no significant ecological risk at this location based on evaluation of the different terrestrial ecosystem lines of evidence.

Aquatic Ecosystem

- Based on the Phase I analytical results, HIs were greater than 1 for each aquatic receptor evaluated. The great blue heron was the most sensitive aquatic receptor.

- Based on the HIs being greater than 1, there is some potential for aquatic ecological risks at this site. However, since no comparison to reference area sediment were made, these risks may not be above the background conditions at the site. (EPA207a)

12.8 CONCLUSIONS AND RECOMMENDATIONS

Following the Phase I RI, the Gate 19 Landfill was capped as part of USACE's Interim Measures program at JPG. As a result, only the groundwater contamination and the contaminated burn area south of the landfill (Site 10) were evaluated during the Phase II RI. The Phase II RI results for surface and subsurface soil samples beyond the landfill cap indicate that soil in the area south of the landfill is contaminated with a variety of low concentrations of SVOCs, elevated metals, and one detection of the explosive compound 2,4-dinitrotoluene. Data for sediments and surface water from the pond south of the landfill indicate the presence of elevated metals ~~and one explosive compound (1,3,5-trinitrobenzene)~~ in surface water and elevated metals in sediments. Middle Fork Creek sediment and surface water samples did not have detectable concentrations of VOCs or PAHs and in general metals were below background concentrations.

Groundwater data from Phase I and Phase II indicate that there are low concentrations of ~~solvent-related~~ VOCs, ~~several~~ SVOCs, and metals ~~as contaminants~~ at the Gate 19 Landfill. Of these contaminants, aluminum, antimony, barium, beryllium, chromium, manganese, molybdenum, 4-chloro-3-cresol, and benzo(a)anthracene were retained as ~~COPS~~ **COPCs** due to the fact that their concentrations exceeded the USEPA Region 9 tap water PRGs.

Results of the human health risk assessment show that chronic health hazard estimates for the future on-site resident at the Gate 19 Landfill exceed the USEPA goal of a HI of 1.0. The cancer risks, however, are within the USEPA target range of 1E-04 to 1E-06. The hazards associated with the future resident at the Gate 19 Landfill are primarily due to the potential ingestion of manganese in homegrown produce at Site 10.

For the future on-site residents at Site 9, the chronic health hazard estimates also exceed the USEPA HI goal of 1.0. As with Site 10, the cancer risks associated with Site 9 are within the USEPA target ranges of 1E-04 to 1E-06.

The future on-site worker has estimated total chronic health hazards that exceed the USEPA HI goal of 1.0. As with the future residents, the cancer risks are within the USEPA target range of 1E-04 to 1E-06.

Ecological risk was assessed for the burn area south of the landfill (Site 9) in September 1997. The results of this assessment indicate that there are no adverse ecological effects resulting from the contamination at this site. Some metals were found to be elevated when compared against the concentrations determined for the reference areas. The HIs estimated on the basis of Phase I data are within the same order of magnitude or lower as those estimated for the reference areas except for plants. With the addition of the September 1997 data (referred to as Phase III), the HIs are still consistent with those estimated for the reference areas. Conclusions from the ecological risk assessment are that there are no significant ecological risks at Site 9.

Due to the chronic health hazard estimates that exceed USEPA risk management criteria, it is recommended that Site 9 be carried forward to the FS process. It appears that sufficient data have been collected to characterize the nature and extent of contamination at Site 9 and 10 and that no further investigation is warranted under the RI/FS. The interim measures at the Gate 19 Landfill have significantly reduced the risks to human health and the environment. However, there appear to be risks under the hypothetical future residential scenario for contaminants outside of the landfill cap. As a result, an FS will be conducted for Site 9.

TABLES

TABLE 12-1

Groundwater Monitoring Well Information Summary
Site 10 - Gate 19 Landfill
Jefferson Proving Ground
South of the Firing Line
Madison, Indiana

Site	Borehole ID	Date Installed	Borehole Depth (ft)	Depth to Top of Rock (ft)	Well Depth (ft)	Well Diameter (in)	Screen Length (ft)	Screen Interval (ft)	Screened Unit	Notes
Gate 19 Landfill	MW88-01	20-Jun-88	56.0	10.0	55.5	NR	1.0	54.5-55.5	North Vernon Ls.	
	MW88-02	18-Jun-88	55.0	14.0	54.5	NR	10.0	44.5-55.5	North Vernon Ls.	
	MW88-03	21-Jun-88	55.0	14.5	54.5	NR	10.0	44.5-55.5	North Vernon Ls.	
	MW88-04	17-Jun-88	55.0	NR	54.5	NR	10.0	44.0-54.0	North Vernon Ls.	See log of borings MW8 and MW9
	MW88-05	12-Apr-88	35.0	10.5	NR	NR	NR	NR	North Vernon Ls.	
	MW88-06	13-Apr-88	101.3	12.5	100.0	NR	NR	NR	Laurel Dm.	Well MW6 abandoned 6/4/88
	MW88-07	3-Jun-88	36.0	12.5	35.0	NR	10.0	25-35	North Vernon Ls.	See log of boring MW6
	MW88-08	1-Jun-88	110.0	7.0	NR	NR	20.0	NR	Laurel Dm.	Well MW8 abandoned 6/5/88
	MW88-09	5-Jun-88	36.0	8.0	35.0	NR	10.0	25-35	North Vernon Ls.	
	MW88-10	27-Jun-88	36.0	12.0	35.0	NR	10.0	25-35	North Vernon Ls.	
	MW88-11	4-Jun-88	36.0	9.5	35.0	NR	10.0	25-35	North Vernon Ls.	
	MW88-12	28-Jun-88	26.0	11.0	34.5	NR	10.0	24.5-34.5	North Vernon Ls.	
	MW88-13	7-Jun-88	35.0	9.5	34.5	NR	10.0	24-34	North Vernon Ls.	
	MW93-15	27-Apr-93	17.0	6.0	17.0	4.0	10.5	6.5-17	North Vernon Ls.	
	MW93-16	28-Apr-93	14.0	3.5	14.0	4.0	10.3	3.7-14	North Vernon Ls.	
	MW93-17	28-Apr-93	17.0	6.0	16.3	4.0	10.3	6-16.3	North Vernon Ls.	
	MW93-18	28-Apr-93	17.0	6.0	16.5	4.0	10.5	6-16.5	North Vernon Ls.	
	MW93-19	28-Apr-93	16.5	5.5	16.0	4.0	10.5	5.5-16	North Vernon Ls.	

General Notes:
1. Information summarized in this table for wells MW88-01 through MW88-13 was taken from boring logs supplied by Environmental Science and Engineering, Inc. (ESE)
2. NR = Information not reported on the ESE boring logs.

TABLE 12-1a

Background Screening of Inorganic Chemicals Detected in Surface Soil
Site 9 - Burning Ground South of Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Chemical	Location	Frequency of Detection[a]	Maximum Detected Value (µg/g)	Avg. Conc. (µg/g)	Median Conc. (µg/g)	Background Threshold[b] (µg/g)	Data Distribution	Test Performed	p value	Site > Bkgd?
Surface Soil										
Aluminum	Burning Ground[b]	12/12	23,600	14,397	12,450		Lognormal	t test	<0.001	**YES**
	Background	**10/10**	**10,900**	**7,673**	**7,845**	**11,000**	**Lognormal**			
Arsenic	Burning Ground	9/12	7.42	4.7	5.4		Normal	Mann-Whitney	0.35	No
	Background	**10/10**	**9.46**	**4.8**	**3.9**	**9.26**	**Neither**			
Barium	Burning Ground	12/12	589	142	84.6		Neither	Mann-Whitney	0.003	**YES**
	Background	**10/10**	**74.1**	**49.8**	**45.7**	**84.5**	**Lognormal**			
Beryllium	Burning Ground	11/12	0.895	0.644	0.629		Normal	t test	<0.001	**YES**
	Background	**10/10**	**0.45**	**0.32**	**0.32**	**0.52**	**Normal**			
Boron	Burning Ground	6/12	24.6	7.0	5.4		Neither	---	---	**YES**
	Background	**0/10**	---[c]	**---**	**---**	**---**	**---**			
Chromium (total)	Burning Ground	12/12	24.3	15.3	13.8		Lognormal	t test	<0.001	**YES**
	Background	**10/10**	**15.5**	**9.7**	**9.9**	**15.1**	**Lognormal**			
Cobalt	Burning Ground	12/12	20.9	6.6	4.9		Lognormal	t test	<0.001	**YES**
	Background	**10/10**	**3.6**	**1.9**	**1.9**	**3.5**	**Lognormal**			
Copper	Burning Ground	12/12	15.9	10.1	10.5		Normal	t test	0.001	**YES**
	Background	**7/10**	**4.96**	**3.5**	**4.1**	**5.64**	**Normal**			
Lead	Burning Ground	12/12	32.5	19.9	20.0		Lognormal	Mann-Whitney	<0.001	**YES**
	Background	**10/10**	**14.6**	**13.6**	**13.6**	**14.9**	**Normal**			

TABLE 12-1a

Background Screening of Inorganic Chemicals Detected in Surface Soil
Site 9 - Burning Ground South of Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Chemical	Location	Frequency of Detection[(a)]	Maximum Detected Value (µg/g)	Avg. Conc. (µg/g)	Median Conc. (µg/g)	Background Threshold[(b)] (µg/g)	Data Distribution	Test Performed	p value	Site > Bkgd?
Manganese	Burning Ground	12/12	4,800	996	588		Lognormal	t test	<0.001	**YES**
	Background	**10/10**	**344**	**115**	**85.9**	**302**	**Lognormal**			
Nickel	Burning Ground	12/12	21.5	10.0	8.8		Neither	Extreme value	---	**YES**
	Background	**1/10**	**2.30**	**2.0**	**2.0**	**2.23**	**Neither**			
Selenium	Burning Ground	1/12	0.583	0.25	0.23		Neither	Extreme value	---	No
	Background	**5/10**	**0.66**	**0.40**	**0.30**	**0.74**	**Neither**			
Silver	Burning Ground	12/12	0.081	0.042	0.042		Lognormal	---	---	**YES**
	Background	**0/10**	**---**	**---**	**---**	**---**	**---**			
Vanadium	Burning Ground	12/12	51.0	28.9	27.0		Lognormal	t test	0.004	**YES**
	Background	**10/10**	**27.6**	**19.8**	**19.2**	**27.0**	**Lognormal**			
Zinc	Burning Ground	12/12	41.6	35.9	37.4		Normal	t test	<0.001	**YES**
	Background	**10/10**	**18.5**	**14.7**	**14.7**	**19.5**	**Normal**			

Note:
Concentrations are in micrograms per gram, µg/g.

Footnotes:
(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) See Section 5.1.4.5.2 for an explanation of how the soil background screening values were calculated.
(c) Not applicable.

TABLE 12-1b

Background Screening of Inorganic Chemicals Detected in Soil
Site 9 - Burning Ground South of Gate 19 Landfill and Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Maximum Detected Value (µg/g)[b]	Soil Series Background Screening Value[c] (µg/g)	Exceeds Soil Series Background?
Subsurface Soil - Burning Ground at Gate 19 Landfill				
Aluminum	2/2	21,900	11,000	**YES**
Arsenic	1/2	70	9.26	**YES**
Barium	2/2	6,000	84.5	**YES**
Beryllium	2/2	3.91	0.52	**YES**
Cadmium	1/2	2.0	NA[d]	**YES**
Chromium	2/2	23	15.1	**YES**
Cobalt	2/2	121	3.5	**YES**
Copper	2/2	32.6	5.64	**YES**
Lead	2/2	19.6	14.9	**YES**
Manganese	2/2	50,000	302	**YES**
Nickel	2/2	157	2.2	**YES**
Silver	2/2	0.038	NA	**YES**
Vanadium	2/2	31.3	27.0	**YES**
Zinc	2/2	75.7	19.5	**YES**
Surface Soil - Gate 19 Landfill				
Aluminum	2/2	18,900	11,000	**YES**
Arsenic	2/2	6.96	9.26	No
Barium	2/2	345	84.5	**YES**
Beryllium	1/2	0.631	0.52	**YES**
Chromium	2/2	26.9	15.1	**YES**
Cobalt	2/2	18.3	3.5	**YES**
Copper	2/2	15.3	5.64	**YES**
Lead	2/2	23.1	14.9	**YES**
Manganese	2/2	2,500	302	**YES**
Nickel	2/2	13.7	2.2	**YES**

TABLE 12-1b

Background Screening of Inorganic Chemicals Detected in Soil
Site 9 - Burning Ground South of Gate 19 Landfill and Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Maximum Detected Value (µg/g)[b]	Soil Series Background Screening Value[c] (µg/g)	Exceeds Soil Series Background?
Surface Soil - Gate 19 Landfill (Continued)				
Silver	2/2	0.037	ND	**YES**
Vanadium	2/2	62.1	27.0	**YES**
Zinc	2/2	42.9	19.5	**YES**
Subsurface Soil - Gate 19 Landfill				
Aluminum	2/2	18,700	11,000	**YES**
Arsenic	1/2	16.0	9.26	**YES**
Barium	2/2	1,800	84.5	**YES**
Beryllium	2/2	1.08	0.52	**YES**
Chromium	2/2	17.0	15.1	**YES**
Cobalt	2/2	56.9	3.5	**YES**
Copper	2/2	7.93	5.64	**YES**
Lead	2/2	23.2	14.9	**YES**
Manganese	2/2	42,000	302	**YES**
Nickel	2/2	42.8	2.2	**YES**
Silver	2/2	0.059	ND[e]	**YES**
Vanadium	2/2	32.4	27.0	**YES**
Zinc	2/2	40.2	19.5	**YES**

Footnotes:

(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Micrograms per gram.
(c) See Section 5.1.4.5.2 for an explanation of how the soil-series-specific background screening values were calculated.
(d) No screening value available.
(e) Not detected.

TABLE 12-2

Background Screening of Inorganic Chemicals
Site 9 - Sediment Pond Adjacent to the Burning Ground at Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[(a)]	Maximum Detected Value (µg/g)[(b)]	Sediment Background Screening Value[(c)] (µg/g)	Exceeds Sediment Background?
Arsenic	3/3	10.8	13.7	No
Mercury	3/3	0.639	0.057	**YES**

Notes:
Background values for arsenic and mercury only. Other chemicals detected are not considered.

Footnotes:
(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Micrograms per gram.
(c) See Section 5.1.2.5.2 for an explanation of how the sediment background screening values were calculated.

TABLE 12-3

Background Screening of Inorganic Chemicals
Site 9 - Surface Water Pond Adjacent to the Burning Ground at Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[(a)]	Maximum Detected Value (µg/L)[(b)]	Surface Water Background Screening Value[(c)] (µg/L)	Exceeds Surface Water Background?
Mercury	1/3	0.208	0.27	No

Notes:
Background values for arsenic and mercury only. Other chemicals detected are not considered.

Footnotes:
(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Micrograms per liter.
(c) See Section 5.1.4.5.2 for an explanation of how the surface water background screening values were calculated.

TABLE 12-4

Background Screening of Inorganic Chemicals Detected in Groundwater
Site 9 - Burning Ground South of Gate 19 Landfill and Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Chemical	Location	Frequency of Detection[a]	Maximum Detected Value (µg/L)	Average Conc. (µg/L)	Median Conc. (µg/L)	Background Threshold[b] (µg/L)	Data Distribution	Test Performed	p value	Site > Bkgd?
Aluminum	Site	9/10	8,074	2,143	1,553		Lognormal	t test	0.014	**YES**
	Background[b]	**4/4**	**443**	**166.7**	**102**	**553**	**Lognormal**			
Antimony	Site	2/10	2.75	4.5	5.0		Neither	NA[c]	NA	**YES**
	Background	**0/4**	**NA**	**NA**	**NA**	**NA**	**NA**			
Arsenic	Site	4/10	12.8	3.8	2.5		Neither	NA[d]	NA	No
	Background	**1/4**	**2.57**	**2.5**	**2.5**	**2.6**	**Neither**			
Barium	Site	10/10	379	205	183		Lognormal	t test	0.011	**YES**
	Background	**4/4**	**411**	**127**	**41.7**	**509.3**	**Lognormal**			
Beryllium	Site	1/10	0.66	2.3	2.5		Neither	Extreme value	NA	**YES**
	Background	**1/4[d]**	**0.33**	**NA**	**NA**	**0.33**	**Normal**			
Born	Site	8/10	78.5	42.7	42.2		Normal	NA[d]	NA	No
	Background	**2/4**	**113.9**	**57**	**50**	**140**	**Lognormal**			
Cadmium	Site	3/10	2.2	2.2	2.5		Neither	NA[d]	NA	No
	Background	**1/4**	**2.7**	**2.6**	**2.5**	**2.75**	**Neither**			
Chromium (total)	Site	8/10	55.8	15.7	10.5		Lognormal	t test	0.01	**YES**
	Background	**2/4**	**5.95**	**5.34**	**5.2**	**6.24**	**Lognormal**			
Cobalt	Site	3/10	16.2	21.4	25		Neither	NA	NA	**YES**
	Background	**0/4**	**NA**	**NA**	**NA**	**NA**	**NA**			
Copper	Site	4/10	11.6	8.2	10		Neither	NA	NA	**YES**
	Background	**0/4**	**NA**	**NA**	**NA**	**NA**	**NA**			

TABLE 12-4

Background Screening of Inorganic Chemicals Detected in Groundwater
Site 9 - Burning Ground South of Gate 19 Landfill and Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Chemical	Location	Frequency of Detection[a]	Maximum Detected Value (µg/L)	Average Conc. (µg/L)	Median Conc. (µg/L)	Background Threshold[b] (µg/L)	Data Distribution	Test Performed	p value	Site > Bkgd?
Lead	Site	6/10	4.83	2	1.6		Neither	Mann-Whitney	0.11	No
	Background	**1/4**	**1.66**	**1.54**	**1.5**	**1.71**	**Neither**			
Manganese	Site	10/10	1,998	453	285		Lognormal	Mann-Whitney	0.13	No
	Background	**4/4**	**208.3**	**134.6**	**152**	**290**	**Normal**			
Mercury	Site	1/10	0.079	0.098	0.1		Neither	Extreme value	NA	**YES**
	Background	**1/4** [b]	**0.056**	**NA**	**NA**	**0.056**	**NA**			
Molybdenum	Site	9/10	28.3	18.9	18.3		Lognormal	Extreme value	NA	**YES**
	Background	**2/4** [b]	**8.1**	**7.24**	**7.24**	**9.67**	**NA**			
Nickel	Site	7/10	54.7	22.7	20		Lognormal	NA	NA	**YES**
	Background	**0/4**	**NA**	**NA**	**NA**	**NA**	NA			
Selenium	Site	2/10	3.37	2.6	2.5		Neither	NA	NA	**YES**
	Background	**0/4**	**NA**	**NA**	**NA**	NA	**NA**			
Tin	Site	2/10	51.7	49	50		Neither	NA[d]	NA	No
	Background	**4/4**	**51.3**	**48.9**	**50.2**	**55.7**	**Lognormal**			
Vanadium	Site	6/10	24.4	16.3	22.4		Neither	Extreme value	NA	**YES**
	Background	**1/4**[e]	**2.89**	**NA**	**NA**	**2.89**	**NA**			
Zinc	Site	7/10	45.4	17.2	10		Neither	NA	NA	**YES**
	Background	**0/4**	**NA**	**NA**	**NA**	**NA**	**NA**			

Note:
Concentrations are in micrograms per liter (µg/L).

Footnotes:
(a) Number of locations in which the analyte was detected/total number of locations sampled.
(b) See Section 5.1.4.5.2 for an explanation of how the groundwater background screening values were calculated.
(c) Not applicable.
(d) The Mann-Whitney test was not performed because the median site concentration is less than or equal to the median background concentration.
(e) Since all nondetections (½ the detection limit) exceeded the single detected value, the detected value is the background threshold value.

TABLE 12-5

Analytical Results for Metals in Soil Samples – Phase I
Site 9 - Burning Ground South of Gate 19 Landfill and Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Sample ID Sample Date Depth (feet) Analyte	BGG09SF001 11/20/92 0.0	BGG09F002 11/20/92 0.0	BGG09SF003 11/20/92 0.0	BGG09SF004 11/20/92 0.0	BGG09SF005 11/20/92 0.0	BGG09SF006 11/20/92 0.0	BGG09SF007 11/20/92 0.0	BGG09SF008 11/20/92 0.0	Background (µg/g)[a]
Aluminum	11,100	12,000	8,770	9,130	12,100	16,200	15,600	13,500	16,600
Antimony	LT[b] 19.6 R[c]	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	0.44
Arsenic	3.97	7.12	3.95	4.08	3.72	8.09	8.27	4.69	6.30
Barium	65.5	322	70.5	80.1	57.5	82.6	80.9	105	95.0
Beryllium	0.596	0.636	LT 0.427	0.591	0.498	0.678	0.824	0.874	0.48
Boron	7.39	8.38	LT 6.64	8.73	8.28	8.88	7.58	9.33	0
Cadmium	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	0
Calcium	985	94,000	68,000	5,350	7,310	1,800	3,490	598	588
Chromium	10.7	12.9	11.1	22.1	14.8	16.9	18.5	14.0	18.0
Cobalt	4.09	7.41	2.75	2.78	3.47	5.16	7.36	5.53	5.60
Copper	6.34	8.88	39.3	131	8.30	8.42	9.78	5.52	5.71
Iron	11,100	23,100	10,200	21,800	14,400	18,800	25,100	13,800	11,800
Lead	17.5	19.4	20.8	22.7	20.0	16.7	41.0	18.9	16.2
Magnesium	825	31,200	13,000	8,780	2,730	1,380	1,790	913	1,000
Manganese	529	2,100	359	136	184	496	653	780	718
Mercury	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	0
Molybdenum	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	0
Nickel	7.65	10.9	5.96	6.66	14.0	16.0	11.6	10.3	6.31
Potassium	579	511	567	428	728	817	953	682	2,360
Selenium	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	0.613	1.21
Silver	0.0381	0.0459	0.068	0.069	0.039	0.054	0.181	0.040	0
Sodium	LT 38.7	149	77.2	50.4	56.5	LT 38.7	LT 38.7	LT 38.7	377
Thallium	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	0
Tin	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	0
Vanadium	19.5	21.0	17.3	48.8	24.7	31.8	69.0	26.2	31.7
Zinc	38.2	35.1	32.6	25.4	28.7	33.1	35.6	28.7	23.9

TABLE 12-5

Analytical Results for Metals in Soil Samples – Phase I
Site 9 - Burning Ground South of Gate 19 Landfill and Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Sample ID Sample Date Depth (feet) Analyte	BGG09SF009 11/20/92 0.0	BGG09SF010 11/20/92 0.0	BGG09SF011 11/20/92 0.0	BGG09SF012 11/20/92 0.0	BGG09SF013 11/20/92 0.0	BGG09SF014 11/20/92 0.0	BGG09SF015 11/20/92 0.0	BGG09SF016 11/20/92 0.0	BGG09BHA01 11/24/92 0.4	Background (µg/g)
Aluminum	21,900	11,400	13,600	23,600	14,300	21,900	12,000	12,900	9640	16,600
Antimony	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6	0.44
Arsenic	7.26	5.37	LT 2.50	5.44	7.42	6.87	LT 2.50	5.57	4.36	6.30
Barium	89.7	193	54.2	589	135	57.3	114	79.6	67.9	95.0
Beryllium	0.579	0.621	0.528	0.892	0.589	0.682	0.895	0.780	LT 0.427	0.48
Boron	LT 6.64	LT 6.64	LT 6.64	LT 6.64	8.21	7.80	LT 6.64	LT 6.64	LT 6.64	0
Cadmium	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	0
Calcium	1,420	1,720	3,410	895	1,600	1,710	2,520	1,540	19,100	588
Chromium	22.3	16.4	14.3	24.3	14.6	19.0	11.4	13.2	10.4	18.0
Cobalt	4.93	6.11	3.34	20.9	4.71	8.92	4.86	8.74	4.89	5.60
Copper	10.6	8.52	12.5	15.9	5.60	11.6	8.18	10.4	10.4	5.71
Iron	26,800	28,500	12,900	32,600	15,000	21,000	12,200	23,900	13,300	11,800
Lead	12.8	16.9	23.0	16.0	22.1	22.6	21.0	20.7	15.0	16.2
Magnesium	1,780	990	1,820	1,770	1,080	1,660	933	1,010	5440	1,000
Manganese	246	1,200	153	4,800	647	387	998	816	234	718
Mercury	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	0
Molybdenum	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	0
Nickel	10.7	7.58	7.73	21.5	9.13	11.2	8.56	10.5	6.26	6.31
Potassium	1,110	587	746	1,250	772	1,150	812	792	471	2,360
Selenium	0.583	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	1.21
Silver	0.0260	0.0326	0.0478	0.0248	0.0576	0.0197	0.0546	0.0491	0.118	0
Sodium	LT 38.7	LT 38.7	45.4	LT 38.7	LT 38.7	LT 38.7	LT 38.7	LT 38.7	69.9	377
Thallium	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	0
Tin	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	0
Vanadium	41.7	33.5	23.6	51.0	30.3	35.7	22.0	30.7	18.8	31.7
Zinc	37.5	32.4	26.7	41.6	33.1	34.0	39.8	37.5	29.7	23.9

TABLE 12-5

Analytical Results for Metals in Soil Samples – Phase I
Site 9 - Burning Ground South of Gate 19 Landfill and Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Sample ID	BGG09BHA02	BGG09BHB01	BGG09BHB02	BGG09BHB03	BGG09BHC01	BGG09BHC02	BGG09BHC03	BGG09BHD01	Background
Sample Date	11/24/92	11/24/92	11/24/92	11/24/92	11/24/92	11/24/92	11/24/92	11/25/92	(µg/g)
Depth (feet)	4.5	0.4	4.9	6.9	0.3	4.7	9.7	0.7	
Analyte									
Aluminum	17,100	16,200	11,000	22,500	16,400	12,300	40,800	14,500	16,600
Antimony	LT 19.6	LT 19.6	LT 19.6	LT 19.6	LT 19.6	LT 19.6	LT 19.6	LT 19.6 R	0.44
Arsenic	12.2	3.94	2.50	43.2	4.10	4.90	6.06	2.50	6.30
Barium	199	56.5	585	407	94.2	561	154	103	95.0
Beryllium	LT 0.427	LT 0.427	LT 0.427	1.83	LT 0.427	0.731	2.45	LT 0.427	0.48
Boron	LT 6.64	11.0	LT 6.64	LT 6.64	LT 6.64	LT 6.64	LT 6.64	11.7	0
Cadmium	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	0
Calcium	1,280	4,400	96,000	50,800	3,510	16,100	24,100	19,800	588
Chromium	44.4	16.3	13.3	21.4	15.6	17.8	35.3	21.4	18.0
Cobalt	8.99	4.14	3.30	14.7	8.78	14.5	15.9	4.12	5.60
Copper	17.8	14.8	24.8	31.5	8.83	29.8	25.8	116	5.71
Iron	95,000	14,200	11,600	57,600	19,100	36,800	60,000	17,900	11,800
Lead	29.0	66.0	9.41	52.0	16.1	38.0	39.0	16.0	16.2
Magnesium	872	1,630	34,600	13,800	1,580	4,020	3,030	7,040	1,000
Manganese	2,700	120	437	21,000	258	12,000	13,000	189	718
Mercury	LT 0.05	1.70	0.0729	LT 0.05	LT 0.05	LT 0.05	0.101	LT 0.05	0
Molybdenum	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	0
Nickel	20.2	6.73	6.56	60.2	5.58	12.5	61.1	9.42	6.31
Potassium	577	1,110	793	2,340	802	585	2,080	641	2,360
Selenium	2.20	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	1.21
Silver	0.0192	0.0490	0.0174	0.186	0.0458	0.0711	0.148	0.162	0
Sodium	LT 38.7	56.1	111	176	LT 38.7	LT 38.7	253	83.3	377
Thallium	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	0
Tin	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	0
Vanadium	104	28.5	19.4	41.2	26.5	27.9	58.5	33.1	31.7
Zinc	59.2	36.9	37.9	218	32.5	38.9	193	45.4	23.9

TABLE 12-5

Analytical Results for Metals in Soil Samples – Phase I
Site 9 - Burning Ground South of Gate 19 Landfill and Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Sample ID Sample Date Depth (feet) Analyte	BGG09BHD02 11/25/92 4.6	BGG09BHE01 12/01/92 0.5	BGG09BHE02 12/01/92 4.0	BGG09BHF01 12/01/92 0.3	BGG09BHF02 12/01/92 4.1	GLF10BHA01 12/01/92 0.7	GLF10BHA02 12/01/92 5.0	GLF10BHA03 12/01/92 7.1	Background (µg/g)
Aluminum	24,500	9,520	19,800	5,790	21,900	21,800	13,300	24,300	16,600
Antimony	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	0.44
Arsenic	9.41	2.50	70.0	4.27	LT 2.50	7.16	8.29	5.70	6.30
Barium	427	54.8	6,000	40.3	71.1	67.1	41.4	501	95.0
Beryllium	0.780	LT 0.427	3.91	LT 0.427	2.14	LT 0.427	0.631	0.737	0.48
Boron	LT 6.64	10.6	LT 6.64	12.2	LT 6.64	12.0	LT 6.64	LT 6.64	0
Cadmium	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	0
Calcium	1,530	68,000	4,450	110,000	3,130	2,510	1,800	3,540	588
Chromium	21.6	12.9	19.4	12.3	12.8	23.0	13.6	25.4	18.0
Cobalt	8.07	3.56	121	3.60	4.97	15.5	7.75	8.00	5.60
Copper	10.1	11.1	9.50	11.9	32.6	12.5	4.74	17.8	5.71
Iron	30,800	12,500	150,000	9,260	23,500	32,600	41,800	12,500	11,800
Lead	39.0	14.8	19.6	35.0	10.1	15.3	7.83	18.4	16.2
Magnesium	1,900	19,600	1,640	41,300	1,760	1,550	1,050	1,900	1,000
Manganese	2,600	299	50,000	319	169	592	199	2,400	718
Mercury	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	0
Molybdenum	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	0
Nickel	12.6	8.03	157	6.22	18.7	11.4	12.5	18.4	6.31
Potassium	691	453	545	223	505	994	709	865	2,360
Selenium	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	1.21
Silver	0.0364	0.0275	0.0383	0.121	0.0253	0.0246	0.0197	0.0178	0
Sodium	61.0	119	97.0	149	77.8	57.0	38.7	82.2	377
Thallium	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.4	LT 34.4	LT 34.4	0
Tin	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	0
Vanadium	28.5	19.0	31.3	13.6	29.7	41.8	18.4	36.1	31.7
Zinc	40.2	37.7	75.7	32.9	45.2	37.9	20.5	58.0	23.9

TABLE 12-5

Analytical Results for Metals in Soil Samples – Phase I
Site 9 - Burning Ground South of Gate 19 Landfill and Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Sample ID Sample Date Depth (feet) Analyte	GLF10BHB01 12/01/92 0.9	GLF10BHB02 12/01/92 4.8	GLF10BHB03 12/01/92 6.3	GLF10BHC01 12/01/92 0.6	GLF10BHC02 12/01/92 4.9	GLF10BHC03 12/01/92 7.1	GLF10BHD01 12/02/92 1.4	GLF10BHD02 12/02/92 5.0	GLF10BHD03 12/02/92 8.0	GLF10BHE01 12/02/92 1.0	Background (µg/g)
Aluminum	23,000	23,000	18,700	8,920	25,700	15,500	5,540	21,400	13,800	14,900	16,600
Antimony	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	0.44
Arsenic	5.33	5.09	19.8	3.07	26.2	4.82	4.45	11.0	31.8	4.64	6.30
Barium	81.9	53.6	2,400	79.2	5,600	605	101	44.2	107	56.2	95.0
Beryllium	LT 0.427	LT 0.427	1.03	LT 0.427	1.30	1.55	LT 0.427	0.921	2.08	LT 0.427	0.48
Boron	LT 6.64	LT 6.64	10.1	11.1	LT 6.64	LT 6.64	LT 6.64	LT 6.64	LT 6.64	LT 6.64	0
Cadmium	LT 1.20	LT 1.20	2.21	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	0
Calcium	727	1,810	11,200	80,000	1,860	3,460	150,000	978	3,600	706	588
Chromium	24.9	24.5	24.5	11.9	21.6	21.7	9.32	22.3	16.6	23.8	18.0
Cobalt	16.2	LT 2.50	38.7	3.24	134	28.6	3.75	13.3	4.88	4.32	5.60
Copper	17.6	14.5	19.9	12.0	10.6	28.7	11.7	7.20	27.5	16.0	5.71
Iron	30,700	35,500	110,000	10,400	78,000	33,700	8,240	90,000	24,700	38,000	11,800
Lead	20.3	16.8	20.7	76.0	34.0	20.9	100	8.89	15.6	11.6	16.2
Magnesium	1,780	1,190	1,730	24,200	1,100	1,400	64,000	921	1,000	960	1,000
Manganese	1,400	149	41,000	369	28,000	14,000	1,700	352	812	135	718
Mercury	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	0
Molybdenum	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	0
Nickel	15.5	15.5	78.7	8.88	37.4	76.9	8.36	13.3	26.7	8.87	6.31
Potassium	914	404	728	336	649	919	220	385	396	521	2,360
Selenium	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	1.21
Silver	0.0207	0.0252	0.0554	0.0388	0.0340	0.0280	1.10	0.0124	LT 0.0184	0.0202	0
Sodium	60.6	LT 38.7	128	125	80.0	54.5	354	64.4	55.6	LT 38.7	377
Thallium	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	0
Tin	LT 7.30	LT 7.30	LT 7.30	LT 7.30	LT 7.30	LT 7.30	LT 7.30	LT 7.30	LT 7.30	LT 7.30	0
Vanadium	42.4	46.4	46.6	19.1	37.4	32.9	12.2	38.9	24.0	60.7	31.7
Zinc	46.8	35.1	363	39.4	39.9	128	44.0	29.2	80.3	33.5	23.9

TABLE 12-5

Analytical Results for Metals in Soil Samples – Phase I
Site 9 - Burning Ground South of Gate 19 Landfill and Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Sample ID Sample Date Depth (feet) Analyte	GLF10BHE02 12/02/92 4.9	GLF10BHE03 12/02/92 9.0	GLF10BHF01 12/02/92 1.0	GLF10BHF02 12/02/92 5.0	GLF10BHF03 12/02/92 9.2	GLF10BHG01 12/02/92 0.9	GLF10BHG02 12/02/92 4.9	GLF10BHG03 12/02/92 9.4	GLF10BHH01 12/02/92 0.9	GLF10BHH02 12/02/92 4.9	Background (µg/g)
Aluminum	18,700	21,600	11,800	11,400	12,500	14,400	13,300	15,700	10,400	12,800	16,600
Antimony	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6	LT 19.6	LT 19.6	LT 19.6	LT 19.6	0.44
Arsenic	10.1	12.7	6.48	5.01	15.7	6.95	6.46	6.85	7.52	8.47	6.30
Barium	62.7	118	95.7	135	74.7	61.0	119	72.6	77.2	88.7	95.0
Beryllium	0.686	1.09	0.710	LT 0.427	0.991	LT 0.427	LT 0.427	0.958	LT 0.427	0.756	0.48
Boron	LT 6.64	LT 6.64	LT 6.64	LT 6.64	9.36	9.24	LT 6.64	LT 6.64	LT 6.64	LT 6.64	0
Cadmium	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	0
Calcium	848	3,300	1,780	848	2,000	9,640	1,120	2,670	447	1,750	588
Chromium	20.5	25.8	12.6	11.5	15.3	17.1	12.0	21.1	9.93	14.7	18.0
Cobalt	6.28	5.57	6.56	29.8	8.2	5.12	LT 2.50	9.28	3.87	4.93	5.60
Copper	16.6	31.6	8.27	13.0	19.9	10.6	5.88	34.3	3.70	10.7	5.71
Iron	37,300	28,400	15,000	14,300	78,000	16,200	7,720	26,200	12,000	14,500	11,800
Lead	11.0	11.6	15.3	18.3	11.8	17.6	7.49	9.86	48.0	27.0	16.2
Magnesium	1,500	2,030	1,150	885	1,010	3,390	746	1,180	623	1,230	1,000
Manganese	195	114	398	1,300	231	237	25.8	210	320	196	718
Mercury	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	0
Molybdenum	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	0
Nickel	11.7	30.0	9.28	15.8	28.6	6.40	2.74	20.8	4.17	8.02	6.31
Potassium	775	1,080	270	340	280	477	239	569	199	303	2,360
Selenium	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	1.21
Silver	0.0155	LT 0.0124	0.0393	0.0229	LT 0.0124	0.0323	0.0259	0.0187	0.296	0.0324	0
Sodium	58.6	82.8	LT 38.7	LT 38.7	52.8	LT 38.7	LT 38.7	58.3	LT 38.7	53.9	377
Thallium	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	0
Tin	LT 7.30	LT 7.30	LT 7.30	LT 7.30	LT 7.30	LT 7.30	LT 7.30	LT 7.30	LT 7.30	LT 7.30	0
Vanadium	50.8	38.0	26.7	25.8	44.2	25.7	9.95	48.5	21.4	29.6	31.7
Zinc	37.2	69.9	27.1	24.2	54.1	29.6	21.2	66.1	21.5	24.6	23.9

TABLE 12-5

Analytical Results for Metals in Soil Samples – Phase I
Site 9 - Burning Ground South of Gate 19 Landfill and Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Sample ID Sample Date Depth (feet) Analyte	GLF10BHH03 12/02/92 8.9	GLF10BHI 01 12/02/92 0.9	GLF10BHI 02 12/02/92 5.4	GLF10BHJ 01 12/02/92 0.9	GLF10BHJ 02 12/02/92 4.9	Background (µg/g)
Aluminum	38,200	17,000	16,300	18,900	18,700	16,600
Antimony	LT 19.6	LT 19.6	LT 19.6	LT 19.6	LT 19.6	0.44
Arsenic	3.55	5.49	16.0	6.96	LT 2.50	7.34
Barium	630	130	1,800	345	214	66.0
Beryllium	3.61	LT 0.427	1.08	0.631	0.712	0.43
Boron	LT 6.64	LT 6.64	LT 6.64	LT 6.64	LT 6.64	0
Cadmium	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	0
Calcium	10,100	1,720	5,600	2,170	4070	588
Chromium	39.6	23.2	15.2	26.9	17.0	18.0
Cobalt	32.0	7.39	56.9	18.3	10.1	5.60
Copper	55.4	8.44	3.76	15.3	7.93	5.71
Iron	20,900	32,100	61,200	48,500	29,500	11,800
Lead	30.0	12.0	23.2	23.1	12.5	16.2
Magnesium	2,820	1,350	1,860	1,700	1,820	1,000
Manganese	7,300	523	42,000	2,500	9,116	718
Mercury	0.0819	LT 0.05	LT 0.05	LT 0.05	LT 0.05	0
Molybdenum	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	0
Nickel	119	8.08	42.8	13.7	10.4	6.31
Potassium	675	645	561	685	458	2,360
Selenium	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	1.21
Silver	0.0629	0.0372	0.0589	0.0327	0.0349	0
Sodium	148	LT 38.7	116	LT 38.7	84.1	377
Thallium	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	0
Tin	LT 7.30	LT 7.30	LT 7.30	LT 7.30	LT 7.30	0
Vanadium	62.5	44.8	32.4	62.1	18.5	27.2
Zinc	74.8	32.7	40.2	42.9	29.5	20.5

Footnotes:
(a) Micrograms per gram; all results are in µg/g.
(b) Less than the reporting limit.
(c) Rejected. Value is unusable.

TABLE 12-6

Phase II - Analytical Results for Organic Contaminants Detected in Soil Samples
Sites 9 – Burning Ground South of Gate 19 Landfill and 10 – Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Sample ID	Contaminant	Concentration (µg/g)[a]	Sample Date	Depth (feet)
BGG09SF019	2,4-Dinitrotoluene	0.124	5/12/96	0.0
	4-Methylphenol	0.0564		
	Benzo[a]anthracene	0.0371		
	Benzo[a]pyrene	0.0272		
	Benzo[b]fluoranthene	0.0556		
	Benzo[k]fluoranthene	0.0136		
	Chrysene	0.0334		
	Fluoranthene	0.0556		
	N-Nitroso diphenylamine	0.0556		
	Phenanthrene	0.0260		
	Pyrene	0.0610		
BGG09SF020	Benzo[a]anthracene	0.1360	5/12/96	0.0
	Benzo[a]pyrene	0.1360		
	Benzo[b]fluoranthene	0.2970		
	Benzo[b,h,i]perylene	0.0756		
	Benzo[k]fluoranthene	0.0768		
	Chrysene	0.1160		
	Fluoranthene	0.1240		
	Indeno[1,2,3-c,d]pyrene	0.0818		
	Phenanthrene	0.0260		
	Pyrene	0.1800		
BGG09SF022	4-Methylphenol	0.0564	5/13/96	0.0
	Benzo[a]anthracene	0.0433		
	Benzo[a]pyrene	0.0262		
	Benzo[b]fluoranthene	0.0538		
	Benzo[k]fluoranthene	0.0223		
	Chrysene	0.0341		
	Fluoranthene	0.0525		
	Phenanthrene	0.0223		
	Pyrene	0.0530		
GLF10BHL01	Bis(2-ethylhexyl)phthalate	0.1140	5/11/96	1.0

Footnote:
(a) Micrograms per gram.

TABLE 12-7

Summary of Analytical Results for Surface Water and Sediment Samples
Site 9 - Burning Ground South of Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Analyte / Site ID	Surface Water			Sediment		
	BGG09SW001 (µg/L)[a]	BGG09SW002 (µg/L)	BGG09SW003 (µg/L)	BGG09SD001 (µg/g)[d]	BGG09SD002 (µg/g)	BGG09SD003 (µg/g)
Aluminum	484	950	596	12,700	7,440	23,600
Antimony	LT[b] 60.0	LT 60.0	LT 60.0	LT 19.6 R[c]	LT 19.6 R	LT 19.6 R
Arsenic	LT 2.35	LT 2.35	LT 2.35	5.16	10.8	LT 2.50
Barium	59.3	61.7	70.4	198	241	256
Beryllium	LT 1.12	LT 1.12	LT 1.12	1.13	1.00	LT 0.427
Boron	LT 230	LT 230	LT 230	LT 6.64	LT 6.64	23.6
Cadmium	LT 6.78	LT 6.78	LT 6.78	LT 1.20	LT 1.20	LT 1.20
Calcium	42,100	42,300	40,800	47,900	2,440	5,930
Chromium	LT 16.8	LT 16.8	LT 16.8	17.8	12.3	22.1
Cobalt	LT 25.0	LT 25.0	LT 25.0	11.7	13.9	11.4
Copper	LT 18.8	LT 18.8	LT 18.8	16.4	9.57	21.1
Iron	554	1,000	668	29,200	28,400	18,300
Magnesium	13,400	13,200	12,400	8,020	716	2,410
Manganese	108	59.1	336	1,900	4,800	754
Mercury	LT 0.10	LT 0.10	0.208	0.157	0.639	0.213
Molybdenum	LT 52.7	LT 52.7	LT 52.7	LT 14.3	LT 14.3	LT 14.3
Nickel	LT 32.1	LT 32.1	LT 32.1	22.3	152	20.8
Potassium	2,540	3,500	3,500	611	250	1,270
Selenium	LT 2.53	LT 2.53	LT 2.53	LT 0.449	LT 0.449	LT 0.449
Silver	LT 0.333	LT 0.333	LT 0.333	0.0580	0.0485	0.0808
Thallium	LT 125	LT 125	LT 125	LT 34.3	LT 34.3	LT 34.3
Tin	LT 59.9	LT 59.9	LT 59.9	LT 7.43	LT 7.43	LT 7.43

TABLE 12-7

Summary of Analytical Results for Surface Water and Sediment Samples
Site 9 - Burning Ground South of Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Analyte / Site ID	Surface Water			Sediment		
	BGG09SW001 (µg/L)[(a)]	BGG09SW002 (µg/L)	BGG09SW003 (µg/L)	BGG09SD001 (µg/g)	BGG09SD002 (µg/g)	BGG09SD003 (µg/g)
Vanadium	LT 27.6	LT 27.6	LT 27.6	38.3	48.5	40.3
Zinc	LT 18.0	LT 18.0	LT 18.0	99.2	47.3	95.8
Bis(2-ethylhexyl)phthalate	LT 19.9	LT 19.9	LT 19.9	2.60	3.10	5.20
1,3,5-Trinitrobenzene	0.283	0.472	LT 0.21	LT 2.11	LT 2.11	LT 2.11

General Note:

1. Samples were collected on 11/21/92 (EPA 18 and 42).

Footnotes:

(a) Micrograms per liter.
(b) Value is less than the reporting limit.
(c) Value is rejected. Value is unusable.
(d) Micrograms per gram.

TABLE 12-8

Analytical Results for Metals in Groundwater
Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Analyte	Well ID Sample ID Sample No.*	MW93-15 GLF10GWA- (µg/L)[(a)]	MW93-16 GLF10GWB- (µg/L)	MW93-17 GLF10GWC- (µg/L)	MW93-18 GLF10GWD- (µg/L)	MW83-1 GLF10MW1- (µg/L)
Aluminum	-1	124	LT[(b)] 112	LT 112	LT 112	NA[(c)]
	-2	11,200	LT 200	LT 200	LT 200	2,780
	-3	36.3	73.9	489	370	1,450
	-4	2,230	LT 200	LT 200	LT200	1,530
	-5	39.4	LT 200	114	76.5	3,430
Arsenic	-1	LT 2.35	LT 2.35	LT 2.35	LT 2.35	NA
	-2	LT 5.00	LT 5.00	LT 5.00	LT 5.00	LT 5.00
	-3	ND[(d)] 5.00	ND 5.00	ND 5.00	ND 5.00	ND 5.00
	-4	LT 5.56	4.52	LT 5.56	LT 5.56	LT 5.56
	-5	LT 5.00	LT 5.00	LT 5.00	LT 5.00	LT 5.00
Antimony	-1	LT 60.0	LT 60.0	LT 60.0	LT 60.0	NA
	-2	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0
	-3	ND 10.0	ND 10.0	ND 10.0	ND 10.0	ND 10.0
	-4	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0
	-5	LT 10.0	LT 10.0	10.0	LT 10.0	LT 10.0
Barium	-1	118	57.6	101	47.3	NA
	-2	234	52.7	130	54.6	384
	-3	126	161	188	47.5	364
	-4	124	127	255	46.4	374
	-5	129	86.4	233	51.2	391
Beryllium	-1	LT 1.12	LT 1.12	LT 1.12	LT 1.12	NA
	-2	LT 5.00	LT 5.00	LT 5.00	LT 5.00	LT 5.00
	-3	LT 5.00	LT 5.00	ND 5.00	ND 5.00	LT 5.00
	-4	LT 5.00	5.00	5.00	LT 5.00	LT 5.00
	-5	LT 5.00	5.00	5.00	LT 5.00	LT 5.00
Boron	-1	LT 230	LT 230	LT 230	LT 230	NA
	-2	54.0	43.0	42.0	LT 100	111
	-3	LT 100	38.5	ND 100	ND 100	78.8
	-4	LT 100	LT 100	LT 100	LT 100	106
	-5	47.9	36.0	33.6	LT 100	72.6
Cadmium	-1	LT 6.78	LT 6.78	LT 6.78	LT 6.78	NA
	-2	LT 5.00	LT 5.00	LT 5.00	LT 5.00	LT 5.00
	-3	LT 5.00	LT 5.00	ND 5.00	1.85	LT 5.00
	-4	LT 5.00	LT 5.00	LT 5.00	LT 5.00	LT 5.00
	-5	LT 5.00	LT 5.00	LT 5.00	LT 5.00	LT 5.00
Calcium	-1	80,900	71,800	77,700	119,000	NA
	-2	111,000	48,400	72,700	110,000	142,000
	-3	75,400	97,200	77,200	108,000	101,000
	-4	76,300	96,200	88,200	109,000	92,300
	-5	81,000	92,500	88,300	112,000	153,00
Chromium	-1	LT 16.8	LT 16.8	LT 16.8	LT 16.8	NA
	-2	9.90	LT 10.0	LT 10.0	LT 10.0	106
	-3	LT 10.0	LT 10.0	4.27	ND 10.0	16.2
	-4	LT 10.0	LT 10.0	LT 10.0	LT 10.0	15.1
	-5	7.41	10.0	10.0	10.0	87.1

TABLE 12-8

Analytical Results for Metals in Groundwater
Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Analyte	Well ID Sample ID Sample No.*	MW93-15 GLF10GWA- (µg/L)[a]	MW93-16 GLF10GWB- (µg/L)	MW93-17 GLF10GWC- (µg/L)	MW93-18 GLF10GWD- (µg/L)	MW83-1 GLF10MW1- (µg/L)
Cobalt	-1	LT 25.0	LT 25.0	LT 25.0	LT 25.0	NA
	-2	LT 50.0	LT 50.0	LT 50.0	LT 50.0	22.0
	-3	LT 50.0	LT 50.0	ND 50.0	ND 50.0	10.3
	-4	LT 50.0	LT 50.0	LT 50.0	LT 50.0	LT 50.0
	-5	LT 50.0	LT 50.0	50.0	LT 50.0	50.0
Copper	-1	LT 18.8	LT 18.8	LT 18.8	LT 18.8	NA
	-2	4.10	20.0	LT 20.0	LT 20.0	20.0
	-3	LT 20.0	LT 20.0	ND 20.0	ND 20.0	LT 20.0
	-4	LT 20.0	LT 20.0	LT 20.0	LT 20.0	LT 20.0
	-5	LT 20.0	LT 20.0	LT 20.0	LT 20.0	LT 20.0
Iron	-1	106	302	330	771	NA
	-2	5,660	336	628	838	3,550
	-3	25.4	242	397	1,590	1,280
	-4	1,100	311	149	1,010	1,460
	-5	32.5	330	301	1,990	3,500
Lead	-1	LT 4.47	LT 4.47	LT 4.47	LT 4.47	NA
	-2	3.07	LT 3.00	LT 3.00	LT 3.00	3.21
	-3	ND 3.00	ND 3.00	ND 3.00	ND 3.00	ND 3.00
	-4	LT 3.33	LT 3.33	LT 3.33	LT 3.33	LT 3.33
	-5	LT 3.00	LT 3.00	LT 3.00	LT 3.00	4.21
Magnesium	-1	14,000	24,600	24,500	59,700	NA
	-2	20,800	14,200	24,500	55,800	79,600
	-3	14,900	34,100	30,500	53,000	54,800
	-4	14,000	31,500	31,900	53,700	65,500
	-5	14,700	31,900	35,400	55,600	67,00
Manganese	-1	1,269	768	700	271	NA
	-2	1,690	664	1,150	225	476
	-3	1,790	644	461	248	241
	-4	1,510	419	553	237	253
	-5	3,000	357	510	247	441
Mercury	-1	LT 0.10	LT 0.10	LT 0.10	LT 0.10	NA
	-2	0.079	LT 0.20	LT 0.20	LT 0.20	LT 0.20
	-3	ND 0.20	ND 0.20	ND 0.20	ND 0.20	LT 0.20
	-4	LT 0.20	LT 0.20	LT 0.20	LT 0.20	LT 0.20
	-5	LT 0.20	LT.020	LT 0.20	LT 0.20	LT 0.20
Molybdenum	-1	LT 52.7	LT 52.7	LT 52.7	LT 52.7	NA
	-2	LT 100	LT 100	LT 100	LT 100	30.0
	-3	LT 100	100	ND 100	ND 100	100
	-4	6.14	10.7	7.47	LT 100	LT 100
	-5	LT 100	LT 100	LT 100	LT 100	100
Nickel	-1	LT 32.1	LT 32.1	LT 32.1	LT 32.1	NA
	-2	LT 40.0	LT 40.0	LT 40.0	LT 40.0	121
	-3	LT 40.0	LT 40.0	ND 40.0	ND 40.0	LT 40.0
	-4	LT 40.0	LT 40.0	LT 40.0	LT 40.0	30.1
	-5	LT 40.0	LT 40.0	7.90	LT 40.0	56.5

TABLE 12-8

Analytical Results for Metals in Groundwater
Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Analyte	Well ID Sample ID Sample No.*	MW93-15 GLF10GWA- (µg/L)[a]	MW93-16 GLF10GWB- (µg/L)	MW93-17 GLF10GWC- (µg/L)	MW93-18 GLF10GWD- (µg/L)	MW83-1 GLF10MW1- (µg/L)
Potassium	-1	LT 1,240	LT 1,240	LT 1,240	LT 1,240	NA
	-2	2,900	1,300	1,200	LT 3,000	3,510
	-3	3,930	776	1,070	556	3,040
	-4	2,610	435	743	3,000	3,470
	-5	2,360	LT 3,000	LT 3,000	LT 3,000	3,000
Selenium	-1	LT 2.53	LT 2.53	LT 2.53	LT 2.53	NA
	-2	4.20	LT 5.00	LT 5.00	LT 5.00	LT 5.00
	-3	ND 5.00	ND 5.00	ND 5.00	ND 5.00	ND 5.00
	-4	LT 5.56	LT 5.56	LT 5.56	LT 5.56	LT 5.56
	-5	LT 5.00	LT 5.00	LT 5.00	LT 5.00	LT 5.00
Silver	-1	LT 0.333	LT 0.333	LT 0.333	LT 0.333	NA
	-2	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0
	-3	LT 10.0	LT 10.0	ND 10.0	ND 10.0	LT 10.0
	-4	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0
	-5	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0
Sodium	-1	6,780	24,300	26,200	95,000	NA
	-2	6,130	10,200	25,800	93,400	39,700
	-3	LT 3,670	37,400	33,200	87,000	36,000
	-4	LT 3,860	29,500	31,200	86,400	36,500
	-5	3,860	37,500	40,400	94,000	30,900
Thallium	-1	LT 125	LT 125	LT 125	LT 125	NA
	-2	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0
	-3	ND 10.0	ND 10.0	ND 10.0	ND 10.0	ND 10.0
	-4	LT 11.1	LT 11.1	LT 11.1	LT 11.1	LT 11.1
	-5	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0
Tin	-1	NA	NA	NA	NA	NA
	-2	LT 100	LT 100	LT 100	LT 100	LT 100
	-3	LT 100	LT 100	ND 100	ND 100	LT 100
	-4	38.2	LT 100	LT 100	LT 100	LT 100
	-5	LT 100	LT 100	LT 100	LT 100	LT 100
Vanadium	-1	LT 27.6	LT 27.6	LT 27.6	LT 27.6	NA
	-2	14.0	3.60	LT 50.0	LT 50.0	6.00
	-3	LT 50.0	LT 50.0	ND 50.0	ND 50.0	50.0
	-4	2.20	LT 50.0	LT 50.0	LT 50.0	LT 50.0
	-5	LT 50.0	LT 50.0	LT 50.0	LT 50.0	50.0
Zinc	-1	LT 18.0	LT 18.0	LT 18.0	LT 18.0	NA
	-2	49.0	LT 20.0	LT 20.0	LT 20.0	10.0
	-3	LT 20.0	LT 20.0	LT 20.0	ND 20.0	20.0
	-4	LT 20.0	LT 20.0	LT 20.0	LT 20.0	LT 20.0
	-5	LT 20.0	LT 20.0	LT 20.0	LT 20.0	13.7

TABLE 12-8

Analytical Results for Metals in Groundwater
Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Analyte	Well ID Sample ID Sample No.	MW88-2 GLF10MW2- (µg/L)	MW88-3 GLF10MW3- (µg/L)	MW88-5 GLF10MW5- (µg/L)	MW88-7 GLF10MW7- (µg/L)	MW88-11 GLF10MW11- (µg/L)	MW93-19 BGG09GWA- (µg/L)
Aluminum	-1	LT 112	NA	NA	1,080	NA	2910
	-2	LT 200	LT 200	928	2,800	494	1,960
	-3	1,450	LT 200	1,520	1,020	499	1,210
	-4	1,130	LT 200	11,200	1,060	514	967
	-5	3,050	LT 200	1,200	1,810	447	36,200
Arsenic	-1	LT 2.35	NA	NA	LT 2.35	NA	LT 2.35
	-2	LT 5.00	LT 5.00	LT 5.00	LT 5.00	LT 5.00	LT 5.00
	-3	ND 5.00	ND 5.00	3.25	ND 5.00	2.81	ND 5.00
	-4	LT 5.56	LT 5.56	42.8	LT 5.56	3.36	LT 5.56
	-5	5.00	LT 5.00	5.00	LT 5.00	5.38	4.64
Antimony	-1	LT 60.0	NA	NA	LT 60.0	NA	NA
	-2	LT 10.0	2.40	LT 10.0	LT 10.0	LT 10.0	LT 10.0
	-3	ND 10.0	ND 10.0	2.75	ND 10.0	ND 10.0	ND 10.0
	-4	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0
	-5	LT 10.0	10.0	LT 10.0	LT 10.0	10.0	LT 10.0
Barium	-1	229	NA	NA	223	NA	201
	-2	198	137	275	220	213	143
	-3	234	117	265	202	148	141
	-4	236	116	466	203	137	135
	-5	286	145	254	203	151	260
Beryllium	-1	LT 1.12	NA	NA	LT 1.12	NA	LT 1.12
	-2	LT 5.00	LT 5.00	LT 5.00	LT 5.00	LT 5.00	LT 5.00
	-3	LT 5.00	LT 5.00	LT 5.00	LT 5.00	LT 5.00	LT 5.00
	-4	LT 5.00	LT 5.00	LT 5.00	LT 5.00	LT 5.00	LT 5.00
	-5	LT 5.00	LT 5.00	LT 5.00	LT 5.00	LT 5.00	1.08
Boron	-1	LT 230	NA	NA	LT 230	NA	LT 230
	-2	LT 100	LT 100	37.0	LT 100	LT 100	LT 100
	-3	48.2	LT 100	LT 100	LT 100	LT 100	LT 100
	-4	100	100	100	LT 100	LT 100	LT 100
	-5	61.0	LT 100	36.0	17.3	LT 100	24.5
Cadmium	-1	LT 6.78	NA	NA	LT 6.78	NA	LT 6.78
	-2	LT 5.00	LT 5.00	LT 5.00	LT 5.00	LT 5.00	LT 5.00
	-3	LT 5.00	LT 5.00	LT 5.00	LT 5.00	LT 5.00	LT 5.00
	-4	LT 5.00	LT 5.00	LT 5.00	LT 5.00	LT 5.00	LT 5.00
	-5	LT 5.00	LT 5.00	LT 5.00	LT 5.00	LT 5.00	LT 5.00
Calcium	-1	82,800	NA	NA	99,300	NA	94,500
	-2	84,700	91,600	82,700	88,800	86,200	85,700
	-3	105,000	86,600	79,100	88,400	77,500	91,000
	-4	105,000	88,100	126,00	91,400	72,700	89,700
	-5	158,000	89,400	78,500	90,900	78,100	149,000
Chromium	-1	LT 16.8	NA	NA	LT 16.8	NA	LT 16.8
	-2	LT 10.0	LT 10.0	8.20	6.30	12.0	4.20
	-3	18.5	LT 10.0	4.27	8.24	LT 10.0	LT 10.0
	-4	LT 10.0	LT 10.0	63.6	14.8	3.32	LT 10.0
	-5	55.1	10.0	12.4	25.0	22.3	30.8

TABLE 12-8

Analytical Results for Metals in Groundwater
Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Analyte	Well ID Sample ID Sample No.	MW88-2 GLF10MW2- (µg/L)	MW88-3 GLF10MW3- (µg/L)	MW88-5 GLF10MW5- (µg/L)	MW88-7 GLF10MW7- (µg/L)	MW88-11 GLF10MW11- (µg/L)	MW93-19 BGG09GWA- (µg/L)
Cobalt	-1	LT 25.0	NA	NA	LT 25.0	NA	LT 25.0
	-2	LT 50.0	LT 50.0	LT 50.0	LT 50.0	LT 50.0	LT 50.0
	-3	10.3	LT 50.0	LT 50.0	LT 50.0	LT 50.0	LT 50.0
	-4	LT 50.0	LT 50.0	LT 50.0	LT 50.0	LT 50.0	LT 50.0
	-5	LT 50.0	50.0	LT 50.0	LT 50.0	50.0	50.0
Copper	-1	LT 18.8	NA	NA	LT 18.8	NA	LT 18.8
	-2	20.0	LT 20.0	20.0	20.0	20.0	LT 20.0
	-3	LT 20.0	LT 20.0	LT 20.0	LT 20.0	LT 20.0	LT 20.0
	-4	LT 20.0	LT 20.0	Lt 20.0	LT 20.0	LT 20.0	LT 20.0
	-5	LT 20.0	LT 20.0	LT 20.0	LT 20.0	LT 20.0	16.2
Iron	-1	118	NA	NA	2,100	NA	2,010
	-2	50.0	196	1,700	1,540	555	681
	-3	1,220	255	3,330	581	382	534
	-4	1,100	446	40,100	695	447	367
	-5	2,760	419	1,710	930	530	16,400
Lead	-1	LT 4.47	NA	NA	LT 4.47	NA	LT 4.47
	-2	LT 3.00	LT 3.00	LT 3.00	4.12	LT 3.00	LT 3.00
	-3	2.02	ND 3.00	ND 3.00	ND 3.00	ND 3.00	ND 3.00
	-4	LT 3.33	LT 3.33	6.96	LT 3.33	LT 3.33	LT 3.33
	-5	LT 3.00	LT 3.00	1.71	3.00	LT 3.00	3.00
Magnesium	-1	40,700	NA	NA	36,700	NA	32,400
	-2	33,000	29,800	37,000	33,900	30,200	28,500
	-3	45,900	27,900	36,000	33,100	25,500	30,100
	-4	46,100	28,400	43,000	34,300	24,300	29,700
	-5	67,500	30,700	36,100	33,700	26,500	39,800
Manganese	-1	47.7	NA	NA	92.0	NA	631
	-2	10.0	45.5	226	53.0	240	479
	-3	83.3	45.2	148	33.4	49.6	473
	-4	65.3	37.3	643	33.8	43.9	471
	-5	182	51.3	88.3	36.6	27.8	718
Mercury	-1	LT 0.10	NA	NA	LT 0.10	NA	LT 0.10
	-2	0.20	LT 0.20	LT 0.20	LT 0.20	LT 0.20	0.20
	-3	LT 0.20	LT 0.20	LT 0.20	LT 0.20	LT 0.20	LT 0.20
	-4	LT 0.20	LT 0.20	LT 0.20	LT 0.20	LT 0.20	LT 0.20
	-5	LT 0.20	LT 0.20	LT 0.20	LT 0.20	LT 0.20	LT 0.20
Molybdenum	-1	LT 52.7	NA	NA	LT 52.7	NA	LT 52.7
	-2	19.0	LT 100	LT 100	18.0	LT 100	LT 100
	-3	100	LT 100	LT 100	100	100	LT 100
	-4	LT 100	LT 100	19.3	LT 100	LT 100	LT 100
	-5	100	LT 100	LT 100	100	25.4	LT 100
Nickel	-1	LT 32.1	NA	NA	LT 32.1	NA	LT 32.1
	-2	LT 40.0	LT 40.0	LT 40.0	13.0	19.0	LT 40.0
	-3	LT 40.0	LT 40.0	LT 40.0	LT 40.0	LT 40.0	LT 40.0
	-4	40.0	LT 40.0	66.9	40.0	9.95	LT 40.0
	-5	30.6	LT 40.0	LT 40.0	18.1	15.9	LT 40.0

TABLE 12-8

Analytical Results for Metals in Groundwater
Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Analyte	Well ID Sample ID Sample No.	MW88-2 GLF10MW2- (µg/L)	MW88-3 GLF10MW3- (µg/L)	MW88-5 GLF10MW5- (µg/L)	MW88-7 GLF10MW7- (µg/L)	MW88-11 GLF10MW11- (µg/L)	MW93-19 BGG09GWA- (µg/L)
Potassium	-1	LT 1,240	NA	NA	LT 1,240	NA	1,640
	-2	560	LT 3,000	480	1,100	560	500
	-3	1,130	1,160	1,140	1,530	1,350	975
	-4	3,000	3,000	3,000	3,000	3,000	488
	-5	1,910	3,000	3,000	3,000	3,000	3,000
Selenium	-1	LT 2.53	NA	NA	LT 2.53	NA	LT 2.53
	-2	LT 5.00	LT 5.00	LT 5.00	LT 5.00	LT 5.00	LT 5.00
	-3	ND 5.00	ND 5.00	ND 5.00	ND 5.00	ND 5.00	ND 5.00
	-4	LT 5.56	LT 5.56	LT 5.56	LT 5.56	LT 5.56	LT 5.56
	-5	LT 5.00	LT 5.00	LT 5.00	LT 5.00	LT 5.00	7.43
Silver	-1	LT 0.333	NA	NA	LT 0.333	NA	LT 0.333
	-2	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0
	-3	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0
	-4	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0
	-5	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0
Sodium	-1	34,900	NA	NA	19,700	NA	28,500
	-2	19,000	19,800	24,500	18,900	18,300	25,200
	-3	32,400	17,900	23,400	18,800	13,900	26,400
	-4	32,000	18,200	23,900	19,700	13,000	24,900
	-5	31,400	20,000	22,600	19,100	14,500	28,100
Thallium	-1	LT 125	NA	NA	LT 125	NA	LT 125
	-2	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0
	-3	ND 10.0	ND 10.0	ND 10.0	ND 10.0	ND 10.0	ND 10.0
	-4	LT 11.1	LT 11.1	LT 11.1	LT 11.1	LT 11.1	LT 11.1
	-5	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0	LT 10.0
Tin	-1	LT 59.9	NA	NA	LT 59.9	NA	LT 59.9
	-2	LT 100	LT 100	LT 100	LT 100	LT 100	LT 100
	-3	LT 100	LT 100	LT 100	LT 100	LT 100	LT 100
	-4	100	100	LT 100	LT 100	LT 100	67.7
	-5	LT 100	LT 100	LT 100	LT 100	LT 100	LT 100
Vanadium	-1	LT 27.6	NA	NA	LT 27.6	NA	LT 27.6
	-2	LT 50.0	LT 50.0	50.0	2.60	50.0	4.40
	-3	LT 50.0	50.0	50.0	50.0	LT 50.0	50.0
	-4	LT 50.0	LT 50.0	20.5	LT 50.0	50.0	LT 50.0
	-5	50.0	LT 50.0	50.0	50.0	LT 50.0	43.2
Zinc	-1	LT 18.0	NA	NA	20.3	NA	LT 18.0
	-2	4.80	11.0	LT 20.0	12.0	14.0	LT 20.0
	-3	20.0	20.0	20.0	20.0	106	20.0
	-4	LT 20.0	20.0	36.5	LT 20.0	56.0	7.97
	-5	20.0	LT 20.0	LT 20.0	8.62	33.5	16.6

Footnotes:
(a) Micrograms per liter.
(b) Less than the reporting limit.
(c) Not analyzed.
(d) Not detected. Detection limits for analyte follow ND.
(*) Sample number corresponds to round number. Sampling dates were as follows:
Round 1: 06/16/93 Round 2: 11/06-07/95 Round 3: 02/19-20/96 Round 4: 04/27-05/01/96 Round 5: 06/20-26/96. EPA 13e

TABLE 12-9

Summary of Organic Contaminants Detected in Groundwater Samples
Site 9 - Burning Ground South of Gate 19 Landfill and Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Well No.	Sample ID	Contaminant	Concentration (µg/L)[a]	Date Sampled[e]
MW93-15	GLF10GWA02	Benzo[a]anthracene Diethyl phthalate Di-*n*-octyl phthalate Fluoranthene Pyrene 1,1-Dichloroethane	0.34 0.81 0.27 0.25 0.43 LT 1.00	11/07/95
	GLF10GWA04	1,1,1-Trichloroethane 1,1-Dichloroethane	1.40 0.43	04/27/96
	GLF10GWA05	1,1-Dichloroethane	0.62	06/26/96
MW93-16	GLF10GWB01	1,1,1-Trichloroethane	3.00	06/18/93
MW93-17	GLF10GWC02	2-Chlorophenol 4-Chloro-3-cresol Acenaphthene	1.00 1.50 0.56	11/05/95
	GLF10GWC04	1,1,1-Trichloroethane	0.33	04/28/96
	GLF10GWC05	1,1,1-Trichloroethane	0.32	06/27/96
MW93-18	GLF10GWD05	Diethyl phthalate 1,1,1-Trichloroethane	LT 10.0 0.43	06/26/96
MW88-1	GLF10MW1A	Diethyl phthalate Dimethyl phthalate	0.76 16.0	11/05/95
	GLF10MW1B	Pyrene	0.40	02/17/96
	GLF10MW1C	1,3,5-Trinitrobenzene	0.08	04/29/96
	GLF10MW1D	Diethyl phthalate	LT 10.0	06/26/96
MW88-2	GLF10MW2C	Dimethyl phthalate	0.59	02/17/96
	GLF10MW2D	Butylbenzyl phthalate Di-n-butyl phthalate	0.68 10.0	04/30/96
	GLF10MW2E	1,1,1-Trichloroethane	0.35	06/26/96
MW83-3	GLF10MW3A	Dimethyl phthalate	1.30	11/05/95
MW88-5	GLF10MW5A	Dimethyl phthalate	2.40	11/05/95
	GLF10MW5C	Di-n-butyl phthalate	LT 10.0	04/30/96
	GLF10MW5D	Pyrene	0.26	06/25/96
MW88-7	GLF10MW7A	1,3-Dimethylbenzene	1.30	06/21/93
	GLF10MW7B	2-Chlorophenol	0.97	11/04/95
	GLF10MW7D	Butylbenzyl phthalate Di-n-butyl phthalate	0.75 10.0 U[b]	04/30/96

TABLE 12-9

Summary of Organic Contaminants Detected in Groundwater Samples
Site 9 - Burning Ground South of Gate 19 Landfill and Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Well No.	Sample ID	Contaminant	Concentration (µg/L)[(a)]	Date Sampled[(e)]
MW93-19	BGG09GWA02	Dimethyl phthalate 1,1,1-Trichloroethane 1,1-Dichloroethene 1,1-Dichloroethane	0.53 2.00 R[(c)] 0.67 XR[(d)] 0.32 XR	11/06/95

Footnotes:
(a) Micrograms per liter.
(b) Not detected following external data validation.
(c) Rejected. Value unusable.
(d) Rejected and result less than reporting limit
(e) Response to EPA comment 13e.

TABLE 12-10

Soil Exposure Point Concentrations of Contaminants of Potential Concern
Site 9 - Burning Ground South of Gate 19 Landfill and Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/g)[b]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[c] (µg/g)
Surface Soil - Burning Ground at Gate 19 Landfill						
Aluminum	12/12	8,345 - 23,600	NA[d]	14,397	17,686	17,686
Barium	12/12	54.2 - 589	NA	142	265	265
Beryllium	11/12	0.528 - 0.895	0.427	0.644	0.738	0.738
Boron	6/12	7.39 - 24.6	6.64	7.0	11.5	11.5
Chromium	12/12	10.7 - 24.3	NA	15.3	17.9	17.9
Cobalt	12/12	3.34 - 20.9	NA	6.6	9.6	9.6
Copper	12/12	5.6 - 15.9	NA	10.1	11.6	11.6
Lead	12/12	12.8 - 32.5	NA	19.9	23.0	23.0
Manganese	12/12	153 - 4,800	NA	997	2,415	2,415
Nickel	12/12	7.58 - 21.5	NA	9.9	11.9	11.9
Silver	12/12	0.0197 - 0.0812	NA	0.042	0.056	0.056
Vanadium	12/12	18.3 - 51.0	NA	28.9	35.6	35.6
Zinc	12/12	26.7 - 41.6	NA	35.9	38.0	38.0
2,4-Dinitrotoluene	1/17	0.198	0.10 - 2.5	1.29	4.93	0.198
4-Methylphenol	1/5	0.0451	0.670	0.304	2.5	0.0451
Benzo(a)anthracene	3/5	0.0371 - 0.136	0.670	0.187	2.35	0.136
Benzo(a)pyrene	3/5	0.027 - 0.136	0.670	0.18	6.2	0.136

TABLE 12-10

Soil Exposure Point Concentrations of Contaminants of Potential Concern
Site 9 - Burning Ground South of Gate 19 Landfill and Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[(a)]	Range of Detected Values (µg/g)[(b)]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[(c)] (µg/g)
Surface Soil - Burning Ground at Gate 19 Landfill (cont'd)						
Benzo(b)fluoranthene	3/5	0.056 - 0.297	0.670	0.23	1.72	0.297
Benzo(g,h,i)perylene	1/5	0.0756	0.670	0.30	1.1	0.0756
Benzo(k)fluoranthene	3/5	0.0136 - 0.0768	0.670	0.169	37.1	0.0768
Chrysene	3/5	0.0334 - 0.116	0.670	0.178	3.3	0.116
Fluoranthene	3/5	0.0556 - 0.124	0.670	0.18	1.5	0.124
Indeno(1,2,3-c,d)pyrene	1/5	0.082	0.670	0.29	1.0	0.082
N-Nitrosodiphenylamine	1/5	0.0556	0.670	0.30	1.7	0.0556
Phenanthrene	3/5	0.023 - 0.026	0.670	0.15	3.1	0.026
Pyrene	3/5	0.061 - 0.18	0.670	0.20	1.4	0.18
Surface Soil - Gate 19 Landfill						
Aluminum	2/2	17,000 - 18,900	NA	17,950	NC[(e)]	18,900
Barium	2/2	130 - 345	NA	238	NC	345
Beryllium	1/2	0.631	0.427	0.422	NC	0.631
Chromium	2/2	23.2 - 26.9	NA	25.0	NC	26.9
Cobalt	2/2	7.39 - 18.3	NA	12.8	NC	18.3
Copper	2/2	8.44 - 15.3	NA	11.9	NC	15.3
Lead	2/2	12.0 - 23.1	NA	17.6	NC	23.1
Manganese	2/2	523 - 2,500	NA	1,511	NC	2,500
Nickel	2/2	8.08 - 13.7	NA	10.9	NC	13.7

TABLE 12-10

Soil Exposure Point Concentrations of Contaminants of Potential Concern
Site 9 - Burning Ground South of Gate 19 Landfill and Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/g)[b]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[c] (µg/g)
Surface Soil - Gate 19 Landfill (cont'd)						
Silver	2/2	0.0327 - 0.037	NA	0.035	NC	0.037
Vanadium	2/2	44.8 - 62.1	NA	53.5	NC	62.1
Zinc	2/2	32.7 - 42.9	NA	37.8	NC	42.9
Bis(2-ethylhexyl)phthalate	1/2	0.114	0.670	0.22	NC	0.114
Surface/Subsurface Soil Combined - Burning Ground at Gate 19 Landfill						
Aluminum	14/14	8,345 - 23,600	NA	15,307	18,578	18,578
Arsenic	10/14	3.65 - 70.0	2.5	7.42	19.0	19.0
Barium	14/14	54.2 - 6,000	NA	295	1,075	1,075
Beryllium	13/14	0.528 - 3.91	0.427	0.94	1.48	1.48
Boron	6/14	7.39 - 24.6	6.64	6.41	9.86	9.86
Cadmium	1/14	2.0	1.2	0.68	0.87	0.87
Chromium	14/14	10.7 - 24.3	NA	16.2	18.7	18.7
Cobalt	14/14	3.34 - 121	NA	10.7	23.3	23.3
Copper	14/14	5.6 - 32.6	NA	11.5	14.8	14.8
Iron	14/14	11,000 - 150,000	NA	26,913	41,896	41,896
Lead	14/14	10.1 - 32.5	NA	19.2	22.4	22.4
Manganese	14/14	153 - 50,000	NA	2,227	13,278	13,278
Nickel	14/14	7.58 - 157	NA	16.5	29.5	29.5

TABLE 12-10

Soil Exposure Point Concentrations of Contaminants of Potential Concern
Site 9 - Burning Ground South of Gate 19 Landfill and Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/g)[b]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[c] (µg/g)
Surface/Subsurface Soil Combined - Burning Ground at Gate 19 Landfill (cont'd)						
Silver	14/14	0.0197 - 0.0812	NA	0.041	0.051	0.051
Vanadium	14/14	18.3 - 51.0	NA	29.1	34.6	34.6
Zinc	14/14	26.7 - 75.7	NA	39.4	44.5	44.5
2,4-Dinitrotoluene	1/19	0.198	0.10 - 2.5	1.3	4.1	0.198
4-Methylphenol	1/5	0.0451	0.670	0.304	2.5	0.0451
Benzo(a)anthracene	3/5	0.0371 - 0.136	0.670	0.187	2.35	0.136
Benzo(a)pyrene	3/5	0.027 - 0.136	0.670	0.18	6.2	0.136
Benzo(b)fluoranthene	3/5	0.056 - 0.297	0.670	0.23	1.72	0.297
Benzo(g,h,i)perylene	1/5	0.0756	0.670	0.30	1.1	0.0756
Benzo(k)fluoranthene	3/5	0.0136 - 0.0768	0.670	0.169	37.1	0.0768
Chrysene	3/5	0.0334 - 0.116	0.670	0.178	3.3	0.116
Fluoranthene	3/5	0.0556 - 0.124	0.670	0.18	1.5	0.124
Indeno(1,2,3-cd)pyrene	1/5	0.082	0.670	0.29	1.0	0.082
N-Nitrosodiphenylamine	1/5	0.0556	0.670	0.30	1.7	0.0556
Phenanthrene	3/5	0.023 - 0.026	0.670	0.15	31	0.026
Pyrene	3/5	0.061 - 0.18	0.670	0.20	1.4	0.18
Toluene	1/14	0.130	0.10	0.055	0.063	0.063
Aluminum	4/4	16,300 - 18,900	NA	17,725	19,463	18,900
Arsenic	3/4	5.49 - 16.0	2.50	7.43	784	16.0

TABLE 12-10

Soil Exposure Point Concentrations of Contaminants of Potential Concern
Site 9 - Burning Ground South of Gate 19 Landfill and Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/g)[b]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[c] (µg/g)
Surface/Subsurface Soil Combined - Burning Ground at Gate 19 Landfill (cont'd)						
Barium	4/4	130 - 1,800	NA	622	1.3E+5	1,800
Beryllium	3/4	0.631 - 1.08	0.427	0.659	1.08	1.08
Chromium	4/4	15.2 - 26.9	NA	20.6	31.8	26.9
Surface/Subsurface Soil Combined - Gate 19 Landfill						
Cobalt	4/4	7.39 - 56.9	NA	23.2	576	56.9
Copper	4/4	3.76 - 15.3	NA	8.9	37.6	15.3
Lead	4/4	12.0 - 23.2	NA	17.7	35.4	23.2
Manganese	4/4	523 - 42,000	NA	13,535	1.6E+10	42,000
Nickel	4/4	8.08 - 42.8	NA	18.7	195	42.8
Silver	4/4	0.033 - 0.059	NA	0.04	0.063	0.059
Vanadium	4/4	18.1 - 62.1	NA	39.5	61.3	61.3
Zinc	4/4	29.5 - 42.9	NA	36.3	46.7	42.9
Bis(2-ethylhexyl)phthalate	3/4	0.114 - 0.355	0.670	0.268	0.396	0.355

Footnotes:

(a) Micrograms per gram.
(b) Number of samples in which the analyte was detected/total number of samples analyzed.
(c) The 95% UCL (upper confidence limit of the mean) or the maximum detected value, whichever is lower (USEPA 1989b).
(d) Not applicable.
(e) Not calculated due to insufficient data.

TABLE 12-11

Selection of Contaminants of Potential Concern (COPC) in Soil Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 9 - Burning Ground at Gate 19 Landfill and Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Residential PRG (µg/g)[(a)]**	**Exposure Point Conc. (µg/g)**	**Retained as Soil COPC?**
Surface Soil - Burning Ground at Gate 19 Landfill			
Aluminum	7,667	17,686	**YES**
Barium	527	265	No
Beryllium	0.143	0.738	**YES**
Boron	586	11.5	No
Chromium	30.1[(b)]	17.9	No
Cobalt	456	9.6	No
Copper	285	11.6	No
Lead	400[(c)]	23.0	No
Manganese	318	2,415	**YES**
Nickel	153	11.9	No
Silver	38.3	0.056	No
Vanadium	53.7	35.6	No
Zinc	2,300	38.0	No
2,4-Dinitrotoluene	0.65	0.198	No
4-Methylphenol	32.6	0.0451	No
Benzo(a)anthracene	0.61	0.136	No
Benzo(a)pyrene	0.06	0.136	**YES**
Benzo(b)fluoranthene	0.61	0.297	No
Benzo(g,h,i)perylene	100[(d, e)]	0.0756	No
Benzo(k)fluoranthene	6.1	0.0768	No
Chrysene	7.2[(e)]	0.116	No

TABLE 12-11

Selection of Contaminants of Potential Concern (COPC) in Soil Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Goals (PRGs)
Site 9 - Burning Ground at Gate 19 Landfill and Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	Residential PRG (µg/g)[(a)]	Exposure Point Conc. (µg/g)	Retained as Soil COPC?
Surface Soil - Burning Ground at Gate 19 Landfill (cont'd)			
Fluoranthene	261	0.124	No
Indeno(1,2,3-cd)pyrene	0.61	0.082	No
N-Nitrosodiphenylamine	90.7	0.0556	No
Phenanthrene	100[(d, e)]	0.026	No
Pyrene	100[(e)]	0.18	No
Surface Soil - Gate 19 Landfill			
Aluminum	7,667	18,900	**YES**
Barium	527	345	No
Beryllium	0.143	0.631	**YES**
Chromium	30.1[(b)]	26.9	No
Cobalt	456	18.3	No
Copper	285	15.3	No
Lead	400[(c)]	23.1	No
Manganese	318	2,500	**YES**
Nickel	153	13.7	No
Silver	38.3	0.037	No
Vanadium	53.7	62.1	**YES**
Zinc	2,300	42.9	No
Bis(2-ethylhexyl)phthalate	31.7	0.114	No
Surface/Subsurface Soil Combined - Burning Ground at Gate 19 Landfill			
Aluminum	7,667	18,578	**YES**
Arsenic	0.38	19.0	**YES**
Barium	527	1,075	**YES**

TABLE 12-11

**Selection of Contaminants of Potential Concern (COPC) in Soil Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Goals (PRGs)
Site 9 - Burning Ground at Gate 19 Landfill and Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana**

	USEPA Region 9 PRG Screen		
Chemical	**Residential PRG (µg/g)[(a)]**	**Exposure Point Conc. (µg/g)**	**Retained as Soil COPC?**
Surface/Subsurface Soil Combined - Burning Ground at Gate 19 Landfill (cont'd)			
Beryllium	0.143	1.48	**YES**
Boron	586	9.86	No
Cadmium	3.8	0.87	No
Chromium	30.1[(b)]	18.7	No
Cobalt	456	23.3	No
Copper	285	14.8	No
Iron	70,000[(f)]	41,896	No
Lead	400[(c)]	22.4	No
Manganese	318	13,278	**YES**
Nickel	153	29.5	No
Silver	38.3	0.051	No
Vanadium	53.7	34.6	No
Zinc	2,300	44.5	No
2,4-Dinitrotoluene	0.65	0.198	No
4-Methylphenol	32.6	0.0451	No
Benzo(a)anthracene	0.61	0.136	No
Benzo(a)pyrene	0.06	0.136	**YES**
Benzo(b)fluoranthene	0.61	0.297	No
Benzo(g,h,i)perylene	100[(d, e)]	0.0756	No
Benzo(k)fluoranthene	6.1	0.0768	No
Chrysene	7.2[(e)]	0.116	No
Fluoranthene	261	0.124	No
Indeno(1,2,3-cd)pyrene	0.61	0.082	No
N-Nitrosodiphenylamine	90.7	0.0556	No

TABLE 12-11

Selection of Contaminants of Potential Concern (COPC) in Soil Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Goals (PRGs)
Site 9 - Burning Ground at Gate 19 Landfill and Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Residential PRG (µg/g)[a]**	**Exposure Point Conc. (µg/g)**	**Retained as Soil COPC?**
Surface/Subsurface Soil Combined - Burning Ground at Gate 19 Landfill (cont'd)			
Phenanthrene	100[d, e]	0.026	No
Pyrene	100[e]	0.18	No
Toluene	79.3	0.063	No
Surface/Subsurface Soil Combined - Gate 19 Landfill			
Aluminum	7,667	18,900	**YES**
Arsenic	0.38	16.0	**YES**
Barium	527	1,800	**YES**
Beryllium	0.143	1.08	**YES**
Chromium	30.1[b]	26.9	No
Cobalt	456	56.9	No
Copper	285	15.3	No
Lead	400[c]	23.2	No
Manganese	318	42,000	**YES**
Nickel	153	42.8	No
Silver	38.3	0.059	No
Vanadium	53.7	61.3	**YES**
Zinc	2,300	42.9	No
Bis(2-ethylhexyl)phthalate	31.7	0.355	No

Note:

PRGs were taken directly from the Region 9 PRG Table (USEPA 1998). Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:

(a) Micrograms per gram.
(b) Value for chromium VI.
(c) Value for lead is full PRG.
(d) Value for pyrene.
(e) Value is full PRG based on saturation limits.
(d) Nutrient screening value for iron.

TABLE 12-12

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 9 - Burning Ground at Gate 19 Landfill and Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Chemical	USEPA Region 9 PRG Screen		
	Ambient Air PRG (µg/m^3)[a]	Exposure Point Conc. (µg/m^3)	Retained as Air COPC?
Residential Scenario			
Aluminum	NA[b]	3.66E-03	**YES**
Arsenic	4.5E-04	1.83E-06	No
Barium	5.2E-02	5.58E-06	No
Beryllium	8.0E-04	1.43E-07	No
Cadmium	1.1E-03	1.09E-08	No
Chromium	2.3E-05	5.14E-06	No
Lead	1.5E+00[c]	8.05E-07	No
Manganese	5.1E-03	2.66E-04	No
Silver	NA	1.01E-05	**YES**
Thallium	NA	7.42E-07	**YES**
Vanadium	NA	9.13E-07	**YES**
Zinc	NA	5.55E-07	**YES**
Dioxins/Furans	4.5E-08	4.70E-14	No
Benzo(a)anthracene	9.2E-03	9.99E-10	No
Benzo(a)pyrene	9.2E-04	2.63E-09	No
Benzo(b)fluoranthene	9.2E-03	5.04E-09	No
DDE	2.0E-02	5.88E-10	No
Dibenz(a,h)anthracene	9.2E-04	1.18E-10	No
Dieldrin	4.2E-04	NA	No
Indeno(1,2,3-cd)pyrene	9.2E-03	5.90E-10	No
1,1-Dichloroethylene	3.8E-02	1.88E-09	No
Chlorobenzene	2.1E+00	1.10E-06	No

TABLE 12-12

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs) Site 9 - Burning Ground at Gate 19 Landfill and Site 10 - Gate 19 Landfill Jefferson Proving Ground Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Ambient Air PRG (µg/m³)(a)**	**Exposure Point Conc. (µg/m³)**	**Retained as Air COPC?**
Industrial Scenario			
Aluminum	NA	2.88E+00	**YES**
Arsenic	4.5E-04	2.56E-06	No
Barium	5.2E-02	5.73E-06	No
Beryllium	8.0E-04	1.15E-04	No
Cadmium	1.1E-03	4.18E-08	No
Chromium	2.3E-05	9.54E-06	No
Lead	1.5E+00(c)	8.05E-07	No
Manganese	5.1E-03	3.90E-01	**YES**
Silver	NA	1.01E-05	**YES**
Thallium	NA	7.42E-07	**YES**
Vanadium	NA	1.55E-06	**YES**
Zinc	NA	3.42E-05	**YES**
Dioxins/Furans	4.5E-08	1.03E-12	No
Benzo(a)anthracene	9.2E-03	9.99E-10	No
Benzo(a)pyrene	9.2E-04	2.65E-09	No
Benzo(b)fluoranthene	9.2E-03	5.04E-09	No
DDE	2.0E-02	5.88E-10	No
Dibenz(a,h)anthracene	9.2E-04	1.18E-10	No
Dieldrin	4.2E-04	9.16E-10	No
Indeno(1,2,3-cd)pyrene	9.2E-03	5.88E-10	No
1,1-Dichloroethylene	3.8E-02	1.88E-09	No
Chlorobenzene	2.1E+00	1.10E-06	No

Note:
PRGs were taken directly from the Region 9 PRG Table (USEPA 1998). Values for noncarcinogens are 1/10 of the Region 9 PRG.
EPCs are calculated and presented in Table R-4 and R-6 in Appendix R.

Footnotes:
(a) Micrograms per cubic meter.
(b) Not applicable.
(c) Federal ambient air quality criterion for lead.

TABLE 12-13

Sediment/Surface Water Exposure Point Concentrations of Preliminary Contaminants of Potential Concern
Site 9 - Pond Adjacent to the Burning Ground at Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[(a)]	Range of Detected Values (µg/g)[(b)]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[(c)] (µg/g)
Sediment						
Aluminum	3/3	7,440 - 19,550	NA[(d)]	13,230	127,356	19,550
Barium	3/3	198 - 241	NA	227	295	241
Beryllium	3/3	1.0 - 1.39	NA	1.17	1.74	1.39
Boron	1/3	23.6	6.64	9.4	3.3E+06	23.6
Chromium	3/3	12.3 - 22.1	NA	17.4	41.8	22.1
Cobalt	3/3	11.7 - 13.5	NA	12.3	14.4	13.5
Copper	3/3	9.57 - 21.9	NA	16.0	113	21.9
Lead	3/3	18.0 - 30.3	NA	22.7	51.1	30.3
Manganese	3/3	840 - 4,800	NA	2,503	4.0E+06	4,800
Mercury	3/3	0.157 - 0.639	NA	0.32	97.8	0.639
Nickel	3/3	20.8 - 152	NA	60.9	2.0E+07	152
Silver	3/3	0.0485 - 0.0804	NA	0.062	0.132	0.0804
Vanadium	3/3	38.3 - 48.5	NA	42.4	56.7	48.5
Zinc	3/3	47.3 - 99.2	NA	80.1	549	9.2

TABLE 12-13

Sediment and Surface Water Exposure Point Concentrations of Preliminary Contaminants of Potential Concern
Site 9 - Pond Adjacent to the Burning Ground at Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/L)[d]	Range of Reporting Limits (µg/L)	Arithmetic Mean Concentration (µg/L)	95% UCL Concentration (µg/L)	Exposure Point Concentration[c] (µg/L)
Surface Water						
Aluminum, Total	3/3	456.5 - 950	NA	626	4,192	950
Barium, Total	3/3	59.3 - 64.9	NA	62	67.7	64.9
Manganese, Total	3/3	59.1 - 259	NA	141	37,350	259
Zinc, Total	1/3	18.7	18.0	12.2	87.3	18.7
1,3,5-Trinitrobenzene	2/4	0.283 - 0.472	0.13 - 0.21	0.23	8.5	0.472

Footnotes:

(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Micrograms per gram.
(c) The 95% UCL (upper confidence limit of the mean) or the maximum detected value, whichever is lower (USEPA 1989b).
(d) Not applicable.
(e) Micrograms per liter.

TABLE 12-14

Selection of Contaminants of Potential Concern (COPC) in Sediment and Surface Water Based on USEPA Region 9 Preliminary Remediation Goals (PRG's) Pond Adjacent to the Burning Ground at Gate 19 Landfill (Site 9) Jefferson Proving Ground Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Residential PRG (µg/g)[(a)]**	**Exposure Point Conc. (µg/g)**	**Retained as Sediment COPC?**
Sediment – Soil PRG			
Aluminum	7,667	19,550	**YES**
Barium	527	241	No
Beryllium	0.143	1.39	**YES**
Boron	586	23.6	No
Chromium	30.1[(b)]	22.1	No
Cobalt	456	13.5	No
Copper	285	21.9	No
Lead	400[(c)]	30.3	No
Manganese	318	4,800	**YES**
Nickel	153	152	No
Silver	38.3	0.0804	No
Vanadium	53.7	48.5	No
Zinc	2,300	99.2	No
Surface Water - Tap Water PRG	**(ug/L)[(d)]**	**(ug/L)[(d)]**	
Aluminum, Total	3,650	950	No
Barium, Total	256	64.9	No
Manganese, Total	170	259	**YES**
Zinc, Total	1,095	18.7	No
1,3,5-Trinitrobenzene	0.18	0.472	**YES**

Note:

PRGs were taken directly from the Region 9 PRG Table (USEPA 1998). Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:

(a) Micrograms per gram.
(b) Value for chromium VI.
(c) Value for lead is full PRG.
(d) Microgram per liter.

TABLE 12-15

Groundwater Exposure Point Concentrations of Preliminary Contaminants of Potential Concern
Site 9 –Burning Ground South of Gate 19 Landfill and Site 19 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[(a)]	Range of Detected Values (µg/L)[(b)]	Range of Reporting Limits (µg/L)	Arithmetic Mean Concentration (µg/L)	95% UCL Concentration (µg/L)	Exposure Point Concentration[(c)] (µg/L)
Aluminum	9/10	73.9 - 8,074	200	2,143	42,987	8,074
Antimony	2/10	2.4 - 2.75	10	4.5	5.5	2.75
Barium	10/10	106.8 - 378.5	NA[(d)]	204	270	270
Beryllium	1/10	0.658	5	2.3	3.2	0.658
Chromium	8/10	4.27 - 55.83	10	15.7	35.5	35.5
Cobalt	3/10	10.3 - 16.2	50	21.4	27.4	16.2
Copper	4/10	2.9 - 11.6	20	8.2	10.1	10.1
Iron	10/10	304.8 - 11,710	NA	1,749	7,272	7,272
Manganese	10/10	39.2 - 1,998	NA	454	2,621	1,998
Mercury	1/10	0.079	0.20	0.098	0.10	0.079
Molybdenum	9/10	4.8 - 28.3	100	18.9	38.4	28.3
Nickel	7/10	7.9 - 54.7	40	22.7	33.2	33.2
Selenium	2/10	2.99 - 3.37	5	2.7	2.8	2.8
Vanadium	6/10	2.6 - 24.4	50	16.3	49.5	24.4
Zinc	7/10	4.8 - 45.4	20	17.2	30.9	30.9
1,1-Dichloroethane	1/10	0.513	1.0	0.5	0.50	0.50
1,1,1-Trichloroethane	3/10	0.325 - 0.725	1.0	0.49	0.568	0.568
1,3,5-Trichlorobenzene	1/10	0.069	0.13	0.065	0.066	0.066

TABLE 12-15

Groundwater Exposure Point Concentrations of Preliminary Contaminants of Potential Concern
Site 9 –Burning Ground South of Gate 19 Landfill and Site 19 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[(a)]	Range of Detected Values (µg/L)[(b)]	Range of Reporting Limits (µg/L)	Arithmetic Mean Concentration (µg/L)	95% UCL Concentration (µg/L)	Exposure Point Concentration[(c)] (µg/L)
2-Chlorophenol	2/10	0.97 - 1.0	10	4.2	8.14	1.0
4-Chloro-3-cresol	1/10	1.5	20	9.2	15.9	1.5
Acenaphthene	1/10	0.56	10	4.6	9.2	0.56
Benzo(a)anthracene	1/10	0.34	10	4.5	12.5	0.34
Bis(2-ethylhexyl)phthalate	6/10	1.0 - 3.7	10	3.0	5.7	3.7
Butylbenzyl phthalate	2/10	0.68 - 0.75	10	4.1	10.5	0.75
Diethylphthalate	2/10	0.76 - 0.81	10	4.2	9.5	0.81
Dimethylphthalate	5/10	0.53 - 7.8	10	3.8	5.2	5.2
Di-n-butyl phthalate	2/10	0.57 - 3.8	10	4.4	5.3	3.8
Di-n-octylphthalate	1/10	0.27	10	4.5	14.9	0.27
Fluoranthene	1/10	0.25	10	4.5	15.5	0.25
Pyrene	3/10	0.26 - 0.43	10	3.6	25.7	0.43

Footnotes:

(a) Number of locations in which the analyte was detected/total number of locations sampled. Data from the ten monitoring wells were used in the calculations.
(b) Micrograms per liter.
(c) The 95% UCL (upper confidence limit of the mean) or the maximum detected value, whichever is lower (USEPA 1989b).
(d) Not applicable.

TABLE 12-16

Selection of Contaminants of Potential Concern (COPC) in Groundwater Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 9 - Burning Ground South of Gate 19 Landfill Site 10 -Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	Tap Water PRG (µg/L)[a]	Exposure Point Conc. (µg/L)	Retained as GW COPC?
Aluminum	3,650	8,074	**YES**
Antimony	1.46	2.75	**YES**
Barium	255.5	270	**YES**
Beryllium	0.016	0.658	**YES**
Chromium	18.25	35.5	**YES**
Cobalt	219	16.2	No
Copper	135.6	10.1	No
Iron	9,400[b]	7,272	No
Manganese	170.3	1,998	**YES**
Mercury	1.1	0.079	No
Molybdenum	18.25	28.3	**YES**
Nickel	73	33.2	No
Selenium	18.25	2.8	No
Vanadium	25.55	24.4	No
Zinc	1,095	30.9	No
1,1-Dichloroethane	81.1	0.5	No
1,1,1-Trichloroethane	79.2	0.568	No
1,3,5-Trinitrobenzene	0.18	0.066	No
2-Chlorophenol	3.84	1.0	No
4-Chloro-3-cresol	---[c]	1.5	**YES**
Acenaphthene	36.5	0.56	No
Benzo(a)anthracene	0.092	0.34	**YES**
Bis(2-ethylhexyl)phthalate	4.8	3.7	No
Butylbenzyl phthalate	730	0.75	No
Diethylphthalate	2,920	0.81	No
Dimethylphthalate	36,500	5.2	No
Di-n-butyl phthalate	365	3.8	No
Di-n-octylphthalate	73	0.27	No
Fluoranthene	146	0.25	No
Pyrene	18.25	0.43	No

Note:

PRGs were taken directly from the Region 9 PRG Table (USEPA 1998) except as noted in the footnotes. Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:

(a) Micrograms per liter.
(b) Nutrient screening value for iron.
(c) Not applicable; no screening PRG available.

TABLE 12-17

Site-Wide Area-Weighted Concentrations of Contaminants of Potential Concern (COPCs) in Surface Soil
Site 9 –Burning Ground at Gate 19 Landfill and Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Chemical of Potential Concern	Soil Concentration[a] (µg/g)		Area-Weighted Concentration in Sub-Area of Concern (µg/g)[b]		Site-Wide Area-Weighted Concentration (µg/g)
	Burning Ground	Gate 19 Landfill	Burning Ground (MF = 0.8)[c]	Gate 19 Landfill (MF = 0.2)	
Aluminum	17,686	18,900	14,149	3,780	17,929
Beryllium	0.738	0.631	0.59	0.13	0.72
Manganese	2,415	2,500	1,932	500	2,432
Benzo(a)pyrene	0.136	NA[d]	0.11	NA	0.11
Vanadium	NA	62.1	NA	12.4	12.4

Footnotes:
- (a) The maximum concentration or the 95% UCL on the mean, whichever is lower in micrograms per gram (µg/g).
- (b) The soil concentration times the modifying factor.
- (c) MF = modifying factor.
- (d) Not applicable; chemical not a COPC in sub-area of concern.

TABLE 12-18

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 9 - Burning Ground South of Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
		Future On-site Resident Adult (surface soil only)		
Incidental ingestion of soil	5.83E-07		0.0241	
Dermal contact with soil	NA		0.0020	
Ingestion of homegrown fruits/vegetables	2.92E-06		0.3673	
Ingestion of groundwater	2.91E-06		0.7823	
Dermal contact with groundwater	NA		0.0014	
Incidental ingestion of surface water in the pond adjacent to Gate 19 Landfill	NA[a]		0.0004	
Dermal contact with surface water in the pond adjacent to Gate 19 Landfill	NA		0.0001	
Incidental ingestion of sediment in the pond adjacent to Gate 19 Landfill	NA		0.0025	
Dermal contact with sediment in the pond adjacent to Gate 19 Landfill	NA		0.0035	
Inhalation of VOCs[b] and fugitive dusts	NA		NA	
Total	6.41E-06		1.1836	

TABLE 12-18

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 9 - Burning Ground South of Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
	Future On-site Resident Child (surface soil only)			
Incidental ingestion of soil	1.09E-06		0.2253	
Dermal contact with soil	NA		0.0058	
Ingestion of homegrown fruits/vegetables	1.60E-06		0.8623	
Ingestion of groundwater	1.36E-06		1.8254	
Dermal contact with groundwater	NA		0.0014	
Incidental ingestion of surface water in the pond adjacent to Gate 19 Landfill	NA		0.0019	
Dermal contact with surface water in the pond adjacent to Gate 19 Landfill	NA		0.0001	
Incidental ingestion of sediment in the pond adjacent to Gate 19 Landfill	NA		0.0230	
Dermal contact with sediment in the pond adjacent to Gate 19 Landfill	NA		0.0082	
Inhalation of VOCs and fugitive dusts	NA		NA	
Total	4.05E-06		2.9534	

TABLE 12-18

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 9 - Burning Ground South of Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
Future On-site Resident Adult (surface/subsurface soil combined)				
Incidental ingestion of soil	1.73E-05		0.2387	
Dermal contact with soil	4.19E-06		0.0344	
Ingestion of homegrown fruits/vegetables	2.81E-05		2.2423	Manganese (90%)
Ingestion of groundwater	2.91E-06		0.7823	
Dermal contact with groundwater	NA		0.0014	
Incidental ingestion of surface water in the pond adjacent to Gate 19 Landfill	NA		0.0004	
Dermal contact with surface water in the pond adjacent to Gate 19 Landfill	NA		0.0001	
Incidental ingestion of sediment in the pond adjacent to Gate 19 Landfill	NA		0.0025	
Dermal contact with sediment in the pond adjacent to Gate 19 Landfill	NA		0.0035	
Inhalation of VOCs and fugitive dusts	NA		NA	
Total	5.25E-05		3.3056	

TABLE 12-18

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 9 - Burning Ground South of Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
Future On-site Resident Child (surface/subsurface soil combined)				
Incidental ingestion of soil	3.23E-05		2.2282	Manganese (54%)
Dermal contact with soil	2.42E-06		0.0992	
Ingestion of homegrown fruits/vegetables	1.38E-05		5.2748	Manganese (90%)
Ingestion of groundwater	1.36E-06		1.8254	
Dermal contact with groundwater	NA		0.0014	
Incidental ingestion of surface water in the pond adjacent to Gate 19 Landfill	NA		0.0019	
Dermal contact with surface water in the pond adjacent to Gate 19 Landfill	NA		0.0001	
Incidental ingestion of sediment in the pond adjacent to Gate 19 Landfill	NA		0.0230	
Dermal contact with sediment in the pond adjacent to Gate 19 Landfill	NA		0.0082	
Inhalation of VOCs and fugitive dusts	NA		NA	
Total	4.99E-05		9.4622	

Footnotes:
(a) Not applicable.
(b) Volatile organic compounds.

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TABLE 12-19

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
		Future On-site Resident Adult (surface soil only)		
Incidental ingestion of soil	NA		0.0370	
Dermal contact with soil	NA		0.0031	
Ingestion of homegrown fruits/vegetables	NA		0.3870	
Ingestion of groundwater	2.91E-06		0.7823	
Dermal contact with groundwater	NA		0.0014	
Incidental ingestion of surface water in the pond adjacent to Gate 19 Landfill	NA[a]		0.0004	
Dermal contact with surface water in the pond adjacent to Gate 19 Landfill	NA		0.0001	
Incidental ingestion of sediment in the pond adjacent to Gate 19 Landfill	NA		0.0025	
Dermal contact with sediment in the pond adjacent to Gate 19 Landfill	NA		0.0035	
Inhalation of VOCs[b] and fugitive dusts	NA		NA	
Total	2.91E-06		1.2173	

TABLE 12-19

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
		Future On-site Resident Child (surface soil only)		
Incidental ingestion of soil	NA		0.3458	
Dermal contact with soil	NA		0.0089	
Ingestion of homegrown fruits/vegetables	NA		0.9098	
Ingestion of groundwater	1.36E-06		1.8254	
Dermal contact with groundwater	NA		0.0014	
Incidental ingestion of surface water in the pond adjacent to Gate 19 Landfill	NA		0.0019	
Dermal contact with surface water in the pond adjacent to Gate 19 Landfill	NA		0.0001	
Incidental ingestion of sediment in the pond adjacent to Gate 19 Landfill	NA		0.0230	
Dermal contact with sediment in the pond adjacent to Gate 19 Landfill	NA		0.0082	
Inhalation of VOCs and fugitive dusts	NA		NA	
Total	1.36E-06		3.1245	

TABLE 12-19

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
	Future On-site Resident Adult (surface/subsurface soil combined)			
Incidental ingestion of soil	1.41E-05	Arsenic (100%)	0.5320	
Dermal contact with soil	3.53E-06		0.0566	
Ingestion of homegrown fruits/vegetables	2.12E-05	Arsenic (100%)	6.6570	Manganese (96%)
Ingestion of groundwater	2.91E-06		0.7823	
Dermal contact with groundwater	NA		0.0014	
Incidental ingestion of surface water in the pond adjacent to Gate 19 Landfill	NA		0.0004	
Dermal contact with surface water in the pond adjacent to Gate 19 Landfill	NA		0.0001	
Incidental ingestion of sediment in the pond adjacent to Gate 19 Landfill	NA		0.0025	
Dermal contact with sediment in the pond adjacent to Gate 19 Landfill	NA		0.0035	
Inhalation of VOCs and fugitive dusts	NA		NA	
Total	4.17E-05		8.0358	

TABLE 12-19

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
Future On-site Resident Child (surface/subsurface soil combined)				
Incidental ingestion of soil	2.63E-05	Arsenic (100%)	4.9651	Manganese (77%)
Dermal contact with soil	2.03E-06		0.1631	
Ingestion of homegrown fruits/vegetables	1.03E-05		15.6396	Manganese (96%)
Ingestion of groundwater	1.36E-06		1.8254	
Dermal contact with groundwater	NA		0.0014	
Incidental ingestion of surface water in the pond adjacent to Gate 19 Landfill	NA		0.0019	
Dermal contact with surface water in the pond adjacent to Gate 19 Landfill	NA		0.0001	
Incidental ingestion of sediment in the pond adjacent to Gate 19 Landfill	NA		0.0230	
Dermal contact with sediment in the pond adjacent to Gate 19 Landfill	NA		0.0082	
Inhalation of VOCs and fugitive dusts	NA		NA	
Total	4.00E-05		22.6278	

Footnotes:

(a) Not applicable.

(b) Volatile organic compounds.

TABLE 12-20

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 9 - Burning Ground South of Gate 19 Landfill and Site 10 - Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
		Future On-site Worker		
Incidental ingestion of soil	1.40E-07		0.0095	
Dermal contact with soil	NA		0.0010	
Ingestion of groundwater	8.67E-07		0.2794	
Inhalation of VOCs[(a)] and fugitive dusts	NA[(b)]		1.7719	Manganese (100%)
Total	1.07E-06		2.0618	

Footnotes:
(a) Volatile organic compounds.
(b) Not applicable.

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TABLE 12-21

Qualitative Uncertainty Analysis
Site 9 - Burning Ground South of Gate 19 Landfill and Site 10 -Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Overestimation	Comments
A. Human Behavior				
Future receptors' exposure duration	30 years	Medium	Medium	National upper-bound time (90th percentile) at one residence
Future receptors' exposure frequency	350 days/year	Medium	Medium	High-end value
Future receptors' exposure time	24 hours/day	Low	High	Maximum possible value
Future receptors' foodchain ingestion rates	NA[(a)]	Low	High	Nearly impossible for an average weight receptor to ingest daily the 95th percentile U.S. population consumption amounts
Exclusion of certain exposure pathways in the quantitative analysis	NA	Low	Low	Pathways eliminated are those that have low possibility of contributing risk to these receptors
B. Chemical Fate/Transport in the Environment				
Calculation of exposure point concentration of COC[(b)]/foodchain modeling	NA	Low	High	Conservative assumptions and input parameters
Use of air dispersion modeling to predict air concentrations	NA	Low	High	Conservative assumptions and input parameters

TABLE 12-21

Qualitative Uncertainty Analysis
Site 9 - Burning Ground South of Gate 19 Landfill and Site 10 -Gate 19 Landfill
Jefferson Proving Ground
Madison, Indiana

		Potential for:		
Key Assumption/ Input Parameter	**Selected Value**	**Underestimation**	**Overestimation**	**Comments**
C. Chemical Toxicity				
Assumption that USEPA[c] reference doses truly represent toxicological thresholds	Mn[d] inhalation RfD[e] (1.4E-05 mg/kg-d)[f]	Low	Medium	IRIS[g] value; high degree of conservativeness utilized by USEPA in deriving RfDs from toxicological literature
Assumption that USEPA carcinogenic slope factors truly represent dose-response phenomena	NA	Low-moderate	Moderate-high	Use of linearized, multi-stage mathematical model to predict cancer incidence at low exposure levels is USEPA policy; not currently supported by scientific data
Assumption of risk/hazard additivity	NA	Moderate	Moderate	Summation of chemical-specific risks/hazards may over- or under-predict risks/hazards to receptors
Screening out of certain contaminants based on USEPA criteria	NA	Low	Low	Chemicals present in concentrations less than USEPA criteria eliminated

Footnotes:

(a) Not applicable.
(b) Contaminant of concern.
(c) United States Environmental Protection Agency.
(d) Mn = manganese
(e) Reference dose.
(f) mg/kg = milligram per kilogram
(g) Integrated Risk Information System.

TABLE 12.7-a1

Site 9/10 Habitat Summary

Site 9/10 - Gate 19 Landfill - Burning Ground Near Gate 19 Landfill
Date of Site Visit: 4/19/93; 6/10/93; 6/29/93; 7/1/93
Acreage: 5
Soils mapping unit: NA
Vegetation mapping unit: Infrequently mowed grassland; unmowed grasses and forbs surrounded by flatwoods

General site conditions: "Natural' but in varying stages of disturbance; earthern hill in north center and pile of demolition debris to southeasat
Slope: 0-15 degree; concrete hill in center
Aspect: North facing
Drainages: Near pond is a stream; south end drains to pond and southwest; north end drains to Middle Fork Creek
Surface water/wetlands: Pond
Evidence of flood/fire: Standing water in places
Description of surrounding area: Remote area with no buildings; however there is surface disturbance on the site; area is surrounded by flatwoods in varying stages of succession.

<u>Soils</u>
Surface layer texture: Typical
Surface color: Typical

<u>Vegetation</u>
Ground cover description: Infrequently mowed grass
Species: Typical though variable across site
Canopy cover: Flatwoods
Species: Typical
Successional status: Primarily weedy, bare ground, intermediate and mature flatwoods
Vegetation condition: Bare to poor to excellent

<u>Wildlife</u>
Habitat type: Open grassland surrounded by flatwoods
Species observations: Bluebirds, crow, vultures, frogs
Sign Observations: Crayfish holes, deer tracks

Remarks: This site is quite variable ecologically; recently scalped areas are at north end of site; disturbed grassy areas; areas where understory brush was cleared; young bramble/briar scrub; young flatwoods; mature flatwoods; infrequently mowed grassland; no obvious areas of ecological contamination; no obvious pathways; need to check subsurface water and pond as well as soil contaminants; possible pathways there.

TABLE 12.7-1

Summary Statistics for Contaminants of Potential Concern (COPC)
Site 9 - Phase I
Jefferson Proving Ground
Madison, Indiana

Site	Medium	Analyte	Number of Detects	Number of Samples	% Detects	Minimum (ug/g)	Maximum (ug/g)	Average (ug/g)	Standard Deviation	UCL95 [(a)]	Exposure Point Concentration (µg/g) [(b)]	Exceed Background (Bkg)?	Retain as COPC[(c)]?	Comment
09	CSO[(d)]	Silver	22	22	100	0.02	0.18	0.06	0.04	0.08	0.08	Yes (Y)	Y	Not detected in Bkg.
09	CSO	Aluminum	22	22	100	8345	23600	13864	4262	15431	15431	Y	Y	
09	CSO	Arsenic	18	22	82	1.25	8.27	4.69	2.21	5.50	5.50	No (N)	N	
09	CSO	Boron	12	22	55	3.32	24.60	7.11	4.78	8.87	8.87	Y	Y	Not detected in Bkg.
09	CSO	Barium	22	22	100	54.20	589.0	119.5	120.5	163.8	163.8	Y	Y	
09	CSO	Beryllium	16	22	73	0.21	0.90	0.55	0.24	0.63	0.63	Y	Y	
09	CSO	Cadmium	0	22	0	NC[(e)]	NC	NC	NC	NC	NC	NA[(f)]	N	Not a COPC.
09	CSO	Cobalt	22	22	100	2.00	20.90	5.91	3.87	7.34	7.34	Y	Y	
09	CSO	Chromium	22	22	100	10.40	24.30	15.72	4.03	17.20	17.20	Y	Y	
09	CSO	Copper	22	22	100	5.52	131.0	21.12	33.59	33.48	33.48	Y	Y	
09	CSO	Iron	22	22	100	11100	32600	18656	6161	20922	20922	Y	Y	
09	CSO	Mercury	1	22	4.5	0.025	1.7	NC	NC	NC	NC	N	N	< 5% detection frequency
09	CSO	Manganese	22	22	100	120.0	4800	727.0	1018	1101	1101	Y	Y	
09	CSO	Molybdenum	0	22	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC.
09	CSO	Nickel	22	22	100	5.58	21.50	9.71	3.70	11.08	11.08	Y	Y	
09	CSO	Lead	22	22	100	12.80	66.00	22.36	11.54	26.61	26.61	Y	Y	
09	CSO	Antimony	0	3	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC.
09	CSO	Selenium	2	22	9	0.22	1.10	0.30	0.21	0.38	0.38	Y	Y	
09	CSO	Tin	0	22	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC.
09	CSO	Tellurium	0	22	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC.
09	CSO	Thallium	0	22	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC.
09	CSO	Vanadium	21	21	100	18.30	69.00	31.20	12.67	35.97	35.97	Y	Y	
09	CSO	Zinc	22	22	100	25.40	45.40	34.45	4.94	36.27	36.27	Y	Y	
09	CSO	2-Methylnaphthalene	1	23	4	0.02	0.10	0.02	0.02	0.03	0.03	NA	Y	
09	CSO	Acenaphthene	4	22	18	0.02	0.31	0.06	0.10	0.10	0.10	NA	Y	
09	CSO	Acenaphthylene	2	22	9	0.02	0.24	0.03	0.06	0.05	0.05	NA	Y	
09	CSO	Bis(2-ethylhexyl) phthalate	1	22	5	0.24	2.20	1.13	0.66	1.37	1.37	NA	Y	
09	CSO	Benzo[a]anthracene	9	22	41	0.02	0.82	0.18	0.26	0.27	0.27	NA	Y	
09	CSO	Benzo[b]fluoranthene	7	22	32	0.16	2.60	0.63	0.85	0.94	0.94	NA	Y	
09	CSO	Benzo[ghi]perylene	6	22	27	0.09	1.80	0.37	0.52	0.56	0.56	NA	Y	
09	CSO	Benzo[k]fluoranthene	5	19	26	0.07	1.70	0.29	0.45	0.47	0.47	NA	Y	
09	CSO	Chrysene	12	22	55	0.02	1.60	0.34	0.50	0.53	0.53	NA	Y	
09	CSO	Di-n-butyl phthalate	2	22	9	0.65	13.59	1.44	2.81	2.47	2.47	NA	Y	
09	CSO	Fluoranthene	12	22	55	0.02	3.90	0.70	1.16	1.12	1.12	NA	Y	
09	CSO	Fluorene	3	22	14	0.03	0.38	0.07	0.10	0.11	0.11	NA	Y	
09	CSO	Phenanthrene	11	22	50	0.02	4.70	0.74	1.35	1.24	1.24	NA	Y	
09	CSO	Phenol	1	9	11	0.03	3.50	0.57	1.11	1.26	1.26	NA	Y	
09	CSO	Pyrene	12	22	55	0.04	3.40	0.72	1.07	1.11	1.11	NA	Y	
Sediment						**(µg/g)**	**(µg/g)**	**(µg/g)**			**(µg/g)**			
09	CSE [(g)]	Silver	3	3	100	0.05	0.08	0.06	0.02	0.09	0.08	NA	Y	
09	CSE	Aluminum	3	3	100	7440	19550	13230	6072	23467	19550	NA	Y	

TABLE 12.7-1

Summary Statistics for Contaminants of Potential Concern (COPC)
Site 9 - Phase I
Jefferson Proving Ground
Madison, Indiana

Site	Medium	Analyte	Number of Detects	Number of Samples	% Detects	Minimum (ug/g)	Maximum (ug/g)	Average (ug/g)	Standard Deviation	UCL95 [(a)]	Exposure Point Concentration (µg/g) [(b)]	Exceed Background (Bkg)?	Retain as COPC[(c)]?	Comment
09	CSE	Arsenic	3	3	100	3.15	10.80	6.37	3.97	13.06	10.80	NA	Y	
09	CSE	Boron	1	3	33	3.32	23.60	10.08	11.71	29.82	23.60	NA	Y	
09	CSE	Barium	3	3	100	198.0	241.0	226.5	24.68	268.1	241.0	NA	Y	
09	CSE	Beryllium	3	3	100	0.80	1.13	0.98	0.17	1.26	1.13	NA	Y	
09	CSE	Cobalt	3	3	100	11.70	13.50	12.32	1.03	14.04	13.50	NA	Y	
09	CSE	Copper	3	3	100	9.57	21.85	15.94	6.15	26.31	21.85	NA	Y	
09	CSE	Iron	3	3	100	28400	30850	29483	1249	31590	30850	NA	Y	
09	CSE	Mercury	3	3	100	0.16	0.64	0.33	0.27	0.78	0.64	NA	Y	
09	CSE	Manganese	3	3	100	840.0	4800	2513	2050	5969	4800	NA	Y	
09	CSE	Nickel	3	3	100	20.80	152.0	65.03	75.32	192.0	152.0	NA	Y	
09	CSE	Lead	3	3	100	18.00	30.25	22.75	6.57	33.83	30.25	NA	Y	
09	CSE	Vanadium	3	3	100	38.30	48.50	42.37	5.40	51.48	48.50	NA	Y	
09	CSE	Zinc	3	3	100	47.30	99.20	80.05	28.50	128.1	99.20	NA	Y	
Unfiltered Surface Water						**(ug/L)**	**(ug/L)**	**(ug/L)**			**(µg/L) [(h)]**			
09	CSW [(i)]	1,3,5-Trinitrobenzene	2	3	100	0.28	0.47	0.35	0.11	0.53	0.47	NA	Y	
09	CSW	Aluminum	3	3	100	456.50	950.0	630.2	277.3	1098	950.0	NA	Y	
09	CSW	Barium	3	3	100	59.30	64.90	61.97	2.81	66.70	64.90	NA	Y	
09	CSW	Iron	3	3	100	554.0	1000	714.2	248.14	1132	1000	NA	Y	
09	CSW	Mercury	1	3	33	0.05	0.13	0.08	0.05	0.15	0.13	NA	Y	
09	CSW	Manganese	3	3	100	59.10	259.0	142.0	104.2	317.7	259.0	NA	Y	
09	CSW	Zinc	1	3	33	9.00	13.85	10.62	2.80	15.34	13.85	NA	Y	

Note:

1. Calcium, magnesium, sodium and potassium were not included in risk assessment as they are macronutrients.

Analytes included above if detected in one or more samples or > 5% DF (inorganics only)

Footnotes:

(a) Upper 95% confidence limit.

(b) Exposure point concentration, micrograms per gram, equivalent to parts per million.

(c) Contaminant of potential concern.

(d) Surface soil.

(e) Not calculated. Not a COPC.

(f) Not applicable or not evaluated.

(g) Sediment

(h) Micrograms per liter, equivalent to parts per billion.

(i) Surface water.

TABLE 12.7-2

Summary of Contaminants of Potential Concern Exposure Point Concentrations by Medium
Site 9 - Phase I
Jefferson Proving Ground
Madison, Indiana

	Measured Concentrations in Abiotic Media				Estimated Concentrations in Biotic Media							
Analyte Name	Filtered Surface Water (µg/L) [(a)]	Sediment (mg/kg) [(b)]	Unfiltered Surface Water (mg/L) [(c)]	Soil (mg/kg)	Plant (mg/kg)	Invertebrate (mg/kg)	Mouse (mg/kg)	Swift (mg/kg)	Aquatic Plants (mg/kg)	Benthic Invertebrate (mg/kg)	Fish (mg/kg)	Frogs (mg/kg)
Acenaphthene				0.10	1.30E-03	0.00E+00	4.13E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Acenaphthylene				0.05	6.50E-04	0.00E+00	2.06E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Aluminum		19550	0.95	15431	6.17E+01	1.70E+02	4.24E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic		10.80			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Barium		241.0	0.06	163.8	2.41E+01	5.90E+00	2.92E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beryllium		1.13		0.63	2.52E-03	6.93E-03	1.73E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Bis(2-ethylhexyl) phthalate				1.37	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Boron		23.60		8.87	3.55E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium				17.20	2.06E-01	4.47E-01	3.35E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chrysene				0.53	6.89E-03	0.00E+00	2.19E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt		13.50		7.34	1.32E-01	2.57E-01	3.41E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper		21.85		33.48	3.31E+00	2.95E+01	2.56E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Di-n-butyl phthalate				2.47	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fluoranthene				1.12	1.46E-02	0.00E+00	4.62E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fluorene				0.11	1.43E-03	0.00E+00	4.54E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Iron		30850	1.00	20922	8.37E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead		30.25		26.61	3.46E+00	1.86E+00	2.55E-03	1.39E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Manganese		4800	0.26	1101	4.08E+01	4.19E+01	1.27E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury		0.64	0.0001		0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.33E-02	1.25E-02	2.13E-02	2.13E-02
Nickel		152.0		11.08	4.88E-01	5.54E-01	2.23E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Phenanthrene				1.24	1.61E-02	0.00E+00	5.12E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Phenol				1.26	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pyrene				1.11	1.44E-02	0.00E+00	4.58E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Selenium				0.38	3.60E+00	2.98E+00	6.89E-01	3.92E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Silver		0.08		0.08	3.84E-03	9.60E-03	6.91E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,3,5-Trinitrobenzene			0.0005		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Vanadium		48.50		35.97	1.08E-01	3.24E-01	4.49E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc		99.20	0.01	36.27	1.99E+01	2.39E+01	1.47E+00	2.77E-02	4.69E+01	2.63E+01	3.91E+00	3.91E+00
2-Methylnaphthalene				0.03	3.90E-04	0.00E+00	1.24E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo[a]anthracene				0.27	3.51E-03	0.00E+00	1.11E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo[b]fluoranthene				0.94	1.22E-02	0.00E+00	3.88E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo[ghi]perylene				0.56	7.28E-03	0.00E+00	2.31E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo[k]fluoranthene				0.47	6.11E-03	0.00E+00	1.94E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Footnootes:

(a) Micrograms per liter, equivalent to parts per billion.

(b) Milligrams per kilogram, equivalent to parts per million.

(c) Milligrams per liter, equivalent to parts per million.

TABLE 12.7-3

Summary Statistics for Contaminants of Potential Concern (COPC)-Semivolatile Organic Compounds in Surface Soil
Site 9 - Phase II
Jefferson Proving Ground
Madison, Indiana

Site	Analyte	Number of Detects	Number of Samples	% Detects	Minimum (ug/g)[b]	Maximum (ug/g)	Average (ug/g)	Standard Deviation	UCL95 [a]	EPC (µg/g)
09	2,4-Dinitrotoluene	1	5	20	0.20	0.34	0.31	0.06	0.37	0.34
09	p-Cresol	1	5	20	0.05	0.34	0.28	0.13	0.40	0.34
09	Benzo[a]anthracene	3	5	60	0.04	0.34	0.18	0.14	0.32	0.32
09	Benzo[a]pyrene	3	5	60	0.03	0.34	0.18	0.15	0.32	0.32
09	Benzo[b]fluoranthene	3	5	60	0.06	0.34	0.22	0.14	0.35	0.34
09	Benzo[ghi]perylene	1	5	20	0.08	0.34	0.28	0.12	0.39	0.34
09	Benzo[k]fluoranthene	3	5	60	0.01	0.34	0.16	0.16	0.31	0.31
09	Chrysene	3	5	60	0.03	0.34	0.17	0.15	0.32	0.32
09	Fluoranthene	3	5	60	0.06	0.34	0.18	0.14	0.32	0.32
09	Indeno[1,2,3-cd]pyrene	1	5	20	0.08	0.34	0.28	0.11	0.39	0.34
09	N-Nitrosodiphenylamine	1	5	20	0.06	0.34	0.28	0.12	0.40	0.34
09	Phenanthrene	3	5	60	0.02	0.34	0.15	0.17	0.31	0.31
09	Pyrene	3	5	60	0.06	0.34	0.20	0.14	0.33	0.33

Note:

Analytes included above if detected in one or more samples or > 5% DF (inorganics only)

Footnotes:

(a) Upper 95% confidence limit.

(b) Exposure point concentration, micrograms per gram, equivalent to parts per million.

TABLE 12.7-4

Summary of Contaminant of Potential Concern (COPC) Exposure Point Concentrations by Medium
Site 9 - Phase II
Jefferson Proving Ground
Madison, Indiana

	Measured Concentrations in Abiotic Media				Estimated Concentrations in Biotic Media							
Analyte Name	Filtered Surface Water (µg/L) [a]	Sediment (mg/kg) [b]	Unfiltered Surface Water (mg/L) [c]	Soil (mg/kg)	Plant (mg/kg)	Invertebrate (mg/kg)	Mouse (mg/kg)	Swift (mg/kg)	Aquatic Plants (mg/kg)	Benthic Invertebrate (mg/kg)	Fish (mg/kg)	Frogs (mg/kg)
2,4-Dinitrotoluene				0.34	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo[a]anthracene				0.32	4.15E-03	0.00E+00	1.32E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo[b]fluoranthene				0.34	4.35E-03	0.00E+00	1.38E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo(a)pyrene				0.32	4.16E-03	0.00E+00	1.32E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo[g,h,i]perylene				0.34	4.35E-03	0.00E+00	1.38E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo[k]fluoranthene				0.31	4.08E-03	0.00E+00	1.29E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chrysene				0.32	4.12E-03	0.00E+00	1.31E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fluoranthene				0.32	4.13E-03	0.00E+00	1.31E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo[g,h,i]perylene				0.34	4.35E-03	0.00E+00	1.38E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo[k]fluoranthene				0.34	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
p-Cresol				0.34	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Phenanthrene				0.31	4.04E-03	0.00E+00	1.28E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pyrene				0.33	4.22E-03	0.00E+00	1.34E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Footnotes:
(a) Micrograms per liter, equivalent to parts per billion.
(b) Milligrams per kilogram, equivalent to parts per million.
(c) Milligrams per liter, equivalent to parts per million.

TABLE 12.7-5

Summary Statistics for Contaminants of Potential Concern (COPC) Metals in Surface Soil
Eco Site 9 - Phase III
Jefferson Proving Ground
Madison, Indiana

Site	Analyte	Number of Detects	Number of Samples	% Detects	Minimum (ug/g)[b]	Maximum (ug/g)	Average (ug/g)	Standard Deviation	UCL95 [a]	Exposure Point Concentration (µg/g)	Exceed Background (Bkg)?	Retain as COPC[c]?	Comment
09	Silver	0	5	0	NC[d]	NC	NC	NC	NC	NC	NA[e]	N	Not a COPC
09	Aluminum	5	5	100	8930	19000	13926	3766	17517	17517	Yes (Y)	Y	
09	Boron	0	5	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
09	Barium	5	5	100	65.05	106.0	88.05	15.09	102.4	102.4	Y	Y	
09	Beryllium	5	5	100	0.42	1.18	0.78	0.27	1.03	1.03	Y	Y	
09	Cadmium	5	5	100	0.12	0.39	0.22	0.11	0.33	0.33	Y	Y	
09	Cobalt	3	5	60	1.83	10.70	5.86	3.74	9.43	9.43	Y	Y	
09	Chromium	5	5	100	10.44	27.20	19.89	7.14	26.70	26.70	Y	Y	
09	Copper	5	5	100	6.85	16.10	11.71	3.93	15.46	15.46	Y	Y	
09	Cyanide	0	5	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
09	Iron	5	5	100	10055	34700	19741	10593	29841	29841	Y	Y	
09	Mercury	3	5	60	0.05	0.08	0.06	0.01	0.07	0.07	Y	Y	Not detected in Bkg.
09	Manganese	5	5	100	476.0	1610	888.5	441.1	1309	1309	Y	Y	
09	Molybdenum	3	5	60	1.53	5.0	3.94	1.44	5.31	5.00	Y	Y	
09	Nickel	5	5	100	5.0	16.20	10.28	4.34	14.41	14.41	Y	Y	
09	Lead	5	5	100	16.80	29.10	21.67	5.28	26.70	26.70	Y	Y	
09	Antimony	2	5	40	0.25	0.38	0.29	0.06	0.34	0.34	Y	Y	
09	Selenium	0	5	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
09	Tin	0	5	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
09	Thallium	1	5	20	0.50	0.97	0.59	0.21	0.79	0.79	Y	Y	
09	Vanadium	5	5	100	18.15	77.70	41.28	23.57	63.75	63.75	Y	Y	
09	Zinc	5	5	100	25.95	51.70	38.39	9.77	47.70	47.70	Y	Y	

Note:

Calcium, magnesium, sodium and potassium were not included in risk assessment as they are macronutrients.

Footnotes:

(a) Upper 95% confidence limit.

(b) Micrograms per gram, equivalent to parts per million.

(c) Contaminant of potential concern.

(d) Not calculated. Not a COPC.

(e) Not applicable or not evaluated.

TABLE 12.7-6

Summary of Contaminants of Potential Concern (COPC) Exposure Point Concentrations by Medium
Site 9 - Phase III
Jefferson Proving Ground
Madison, Indiana

	Measured Concentrations in Abiotic Media				Estimated Concentrations in Biotic Media							
Analyte Name	Filtered Surface Water (µg/L) [(a)]	Sediment (mg/kg) [(b)]	Unfiltered Surface Water (mg/L) [(c)]	Soil (mg/kg)	Plant (mg/kg)	Invertebrate (mg/kg)	Mouse (mg/kg)	Swift (mg/kg)	Aquatic Plants (mg/kg)	Benthic Invertebrate (mg/kg)	Fish (mg/kg)	Frogs (mg/kg)
Aluminum				17517	7.01E+01	1.93E+02	4.82E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Antimony				0.34	8.94E-02	6.49E-02	7.81E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Barium				102.4	1.51E+01	3.69E+00	1.83E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beryllium				1.03	4.12E-03	1.13E-02	2.83E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium				0.33	1.32E-01	1.23E+00	1.65E-03	2.52E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium				26.70	3.20E-01	6.94E-01	5.21E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt				9.43	1.70E-01	3.30E-01	4.38E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper				15.46	1.53E+00	1.36E+01	1.18E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Iron				29841	1.19E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead				26.70	3.47E+00	1.87E+00	2.56E-03	1.39E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Manganese				1309	4.84E+01	4.97E+01	1.51E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury				0.07	1.40E-04	1.01E-01	6.43E-02	1.31E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Molybdenum				5.00	1.25E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel				14.41	6.34E-01	7.21E-01	2.90E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium				0.79	3.16E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Vanadium				63.75	1.91E-01	5.74E-01	7.96E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc				47.70	2.62E+01	3.15E+01	1.94E+00	3.64E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Footnotes:

(a) Micrograms per liter, equivalent to parts per billion.

(b) Milligrams per kilogram, equivalent to parts per million.

(c) Milligrams per liter, equivalent to parts per million.

TABLE 12.7-7

Summary of Detailed Ecological Risk Assessment (DERA) Reasonable Maximum Exposure (RME) Risk Drivers
Site 9 - Phase 1
Jefferson Proving Ground
Madison, Indiana

9	NOAEL [(a)]-Based HQs [(b)] Due to Soil Ingestion or Direct Contact - RME								NOAEL-Based HQs Due to Sediment Ingestion or Direct Contact - RME					NOAEL-Based HQs Due to Dietary Ingestion - RME		
Parameter	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**Plants**	**Soil Fauna**	**Great Blue Heron**	**Raccoon**	**Benthic Invertebrate**	**Creek Chub**	**Pickerel Frog**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**
Aluminum				11.72	12.08		308.62	6.17						4.31		
Arsenic											1.32	1.32	1.32			
Barium														2.68	1.35	
Boron														5.31	3.32	
Chromium							3.44	43.00								
Chrysene																
Cobalt				1.11	1.15									1.44		
Copper														1.60		
Fluorene																
Iron				5.44	5.60			20.92	1.78							
Lead																
Manganese							2.20									
Mercury											4.27	4.27	4.27			
Selenium														110.18	37.71	6.81
Vanadium	1.34	3.99	6.84	56.07	57.79	3.83	17.99	1.80	33.75	3.53				16.48	2.58	1.69
HI_NOAEL	**1.34**	**3.99**	**6.84**	**74.34**	**76.61**	**3.83**	**332.2**	**71.89**	**35.53**	**3.53**	**5.58**	**5.58**	**5.58**	**142.0**	**44.96**	**8.50**

9	Total NOAEL-Based HQs Summed Across Pathways - RME												
Parameter	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**Great Blue Heron**	**Raccoon**	**Benthic Invertebrate**	**Creek Chub**	**Pickerel Frog**	**Plants**	**Soil Fauna**
Aluminum				16.05	12.81	1.25						308.62	6.17
Arsenic									1.32	1.32	1.32		
Barium				3.28	1.97								
Boron				5.37	3.38								
Chromium												3.44	43.00
Chrysene													
Cobalt				2.56	1.45								
Copper				1.67									
Fluorene													
Iron				5.97	5.94		1.78						20.92
Lead				1.02									
Manganese												2.20	
Mercury									4.27	4.27	4.27		
Selenium				110.44	37.98	6.83							
Vanadium	1.37	4.30	6.91	72.55	60.36	5.51	33.75	3.53				17.99	1.80

TABLE 12.7-7

Summary of Detailed Ecological Risk Assessment (DERA) Reasonable Maximum Exposure (RME) Risk Drivers
Site 9 - Phase 1
Jefferson Proving Ground
Madison, Indiana

HI_NOAEL	1.37	4.30	6.91	218.9	123.9	13.59	35.53	3.53	5.58	5.58	5.58	332.2	71.89

9	LOAEL [c]-Based HQs Due to Soil Ingestion - RME					LOAEL-Based HQs Due to Sediment Ingestion or Direct Contact - RME					LOAEL-Based HQs Due to Dietary Ingestion - RME	
Parameter	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**Plants**	**Soil Fauna**	**Great Blue Heron**	**Raccoon**	**Benthic Invertebrate**	**Creek Chub**	**Pickerel Frog**	**White-footed Mouse**	**Eastern Cottontail**
Aluminum	5.94	6.13		21.14	5.51						2.18	
Boron											2.66	1.66
Iron	2.72	2.80										
Manganese								1.08	1.08	1.08		
Nickel								3.53	3.53	3.53		
Selenium											7.35	2.51
Vanadium	18.69	19.26	1.28			2.25	1.18				5.49	
HI_LOAEL	**27.35**	**28.19**	**1.28**	**21.14**	**5.51**	**2.25**	**1.18**	**4.61**	**4.61**	**4.61**	**17.68**	**4.18**

9	Total LOAEL-Based HQs Summed Across Pathways - RME									
Parameter	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**Great Blue Heron**	**Raccoon**	**Benthic Invertebrate**	**Creek Chub**	**Pickerel Frog**	**Plants**	**Soil Fauna**
Aluminum	8.14	6.50							21.14	5.51
Boron	2.68	1.69								
Iron	2.99	2.97								
Manganese						1.08	1.08	1.08		
Nickel						3.53	3.53	3.53		
Selenium	7.36	2.53								
Vanadium	24.18	20.12	1.84	2.25	1.18					
HI [d]_LOAEL	**45.35**	**33.81**	**1.84**	**2.25**	**1.18**	**4.61**	**4.61**	**4.61**	**21.14**	**5.51**

Footnotes:

(a) NOAEL = No Observed Adverse Effect Level

(b) HQ = Hazard Quotient

(c) LOAEL = Lowest Observed Adverse Effect Level

(d) HI = Hazard Index

TABLE 12.7-8

Summary of Detailed Ecological Risk Assessment (DERA) Central Tendency (CT) Risk Drivers
Site 9 - Phase 1
Jefferson Proving Ground
Madison, Indiana

9	NOAEL[a]-Based HQs[b] Due to Soil Ingestion - CT					NOAEL-Based HQs Due to Sediment Ingestion or Direct Contact - CT				NOAEL-Based HQs Due to Dietary Ingestion - CT		
Parameter	**Mourning Dove**	**Chimney Swift**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**Great Blue Heron**	**Benthic Invertebrate**	**Creek Chub**	**Pickerel Frog**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**
Aluminum			7.26	6.08						2.67		
Arsenic							1.32	1.32	1.32			
Barium										1.66		
Boron										3.29	1.67	
Cobalt												
Copper												
Iron			3.36	2.82								
Mercury							4.27	4.27	4.27			
Selenium										68.19	18.99	6.42
Vanadium	1.31	3.37	34.70	29.10	3.61	13.96				10.20	1.30	1.59
HI_NOAEL	**1.31**	**3.37**	**45.32**	**38.00**	**3.61**	**13.96**	**5.58**	**5.58**	**5.58**	**86.01**	**21.96**	**8.01**

9	Total NOAEL-Based HQs Summed Across Pathways - CT								
Parameter	**Mourning Dove**	**Chimney Swift**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**Great Blue Heron**	**Benthic Invertebrate**	**Creek Chub**	**Pickerel Frog**
Aluminum			9.94	6.46	1.18				
Arsenic							1.32	1.32	1.32
Barium			2.03						
Boron			3.32	1.70					
Cobalt			1.58						
Copper			1.03						
Iron			3.70	2.99					
Mercury							4.27	4.27	4.27
Selenium			68.36	19.12	6.44				
Vanadium	1.34	3.63	44.91	30.40	5.20	13.96			
HI_NOAEL	**1.34**	**3.63**	**134.87**	**60.68**	**12.82**	**13.96**	**5.58**	**5.58**	**5.58**

9	LOAEL[c]-Based HQs Due to Soil Ingestion - CT			LOAEL-Based HQs Due to Sediment Ingestion or Direct Contact - CT			LOAEL-Based HQs Due to Dietary Ingestion - CT		Total LOAEL-Based HQs Summed Across Pathways - CT					
Parameter	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**Benthic Invertebrate**	**Creek Chub**	**Pickerel Frog**	**White-footed Mouse**	**Eastern Cottontail**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**Benthic Invertebrate**	**Creek Chub**	**Pickerel Frog**
Aluminum	3.68	3.08					1.35		5.04	3.27				
Boron							1.64		1.66					
Iron	1.68	1.41							1.85	1.50				
Manganese				1.08	1.08	1.08						1.08	1.08	1.08
Nickel				3.53	3.53	3.53						3.53	3.53	3.53
Selenium							4.55	1.27	4.56	1.27				
Vanadium	11.57	9.70	1.20				3.40		14.97	10.13	1.73			
HI[d]_LOAEL	**16.93**	**14.19**	**1.20**	**4.61**	**4.61**	**4.61**	**10.94**	**1.27**	**28.08**	**16.18**	**1.73**	**4.61**	**4.61**	**4.61**

Footnotes:

(a) NOAEL = No Observed Adverse Effect Level

(b) HQ = Hazard Quotient

(c) LOAEL = Lowest Observed Adverse Effect Level

(d) HI = Hazard Index

TABLE 12.7-9

Summary of Detailed Ecological Risk Assessment (DERA) Reasonable Maximum Exposure (RME) Risk Drivers
Site 9 - Phase III
Jeffferson Proving Ground
Madison, Indiana

9	NOAEL[a]-Based HQs[b] Due to Soil Ingestion or Direct Contact - RME									NOAEL-Based HQs Due to Dietary Ingestion - RME		
Parameter	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**	**Plants**	**Soil Fauna**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**
Aluminum				13.31	13.71			350.33	7.01	4.89		
Barium										1.68		
Cadmium										1.73		
Chromium								5.34	66.75			
Cobalt				1.43	1.47					1.86		
Iron				7.75	7.99				29.84			
Lead												
Manganese								2.62				
Molybdenum										2.65		
Vanadium	2.37	7.08	12.12	99.37	102.41	1.39	6.78	31.88	3.19	29.22	4.57	2.99
HI_NOAEL	**2.37**	**7.08**	**12.12**	**121.9**	**125.6**	**1.39**	**6.78**	**390.2**	**106.8**	**42.02**	**4.57**	**2.99**

9	Total NOAEL-Based HQs Summed Across Pathways - RME								
Parameter	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**	**Plants**	**Soil Fauna**
Aluminum				18.20	14.53		1.40	350.33	7.01
Barium				2.05	1.23				
Cadmium				1.75					
Chromium								5.34	66.75
Cobalt				3.28	1.87				
Iron				8.51	8.47				29.84
Lead				1.02					
Manganese								2.62	
Molybdenum				3.09	1.26				
Vanadium	2.44	7.62	12.25	128.59	106.98	1.58	9.77	31.88	3.19
HI_NOAEL	**2.44**	**7.62**	**12.25**	**166.5**	**134.3**	**1.58**	**11.17**	**390.2**	**106.8**

9	LOAEL[c]-Based HQs Due to Soil Ingestion - RME					LOAEL-Based HQs Due to Dietary Ingestion - RME		Total LOAEL-Based HQs Summed Across Pathways - RME				
Parameter	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**Plants**	**Soil Fauna**	**White-footed Mouse**	**Eastern Cottontail**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**Plants**	**Soil Fauna**
Aluminum	6.75	6.95		24.00	6.26	2.48		9.23	7.37		24.00	6.26
Iron	3.88	3.99						4.26	4.23			
Vanadium	33.12	34.14	2.26			9.74	1.52	42.86	35.66	3.26		
HI[d]_LOAEL	**43.75**	**45.09**	**2.26**	**24.00**	**6.26**	**12.22**	**1.52**	**56.35**	**47.26**	**3.26**	**24.00**	**6.26**

Footnotes:

(a) NOAEL = No Observed Adverse Effect Level

(b) HQ = Hazard Quotient

(c) LOAEL = Lowest Observed Adverse Effect Level

(d) HI = Hazard Index

N:/jobs/244/0025/01/wp/tbl/Table 12.7-9.xls

TABLE 12.7-10

Summary of Detailed Ecological Risk Assessment (DERA) Reasonable Maximum Exposure (RME) Risk Drivers
Eco Site 9 - Phase III
Jefferson Proving Ground
Madison, Indiana

9	NOAEL[a]-Based HQs[b] Due to Soil Ingestion - CT						NOAEL-Based HQs Due to Dietary Ingestion - CT			Total NOAEL-Based HQs Summed Across Pathways - CT					
Parameter	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**
Aluminum				8.24	6.91		3.03						11.26	7.32	1.32
Barium							1.04						1.27		
Cadmium							1.07						1.08		
Cobalt							1.15						2.03		
Iron				4.80	4.02								5.27	4.26	
Molybdenum							1.64						1.91		
Vanadium	2.32	5.97	1.45	61.51	51.57	6.39	18.08	2.30	2.82	2.38	6.43	1.72	79.59	53.87	9.21
HI_NOAEL	**2.32**	**5.97**	**1.45**	**74.54**	**62.50**	**6.39**	**26.01**	**2.30**	**2.82**	**2.38**	**6.43**	**1.72**	**102.4**	**65.45**	**10.53**

9	LOAEL[c]-Based HQs Due to Soil Ingestion - CT			LOAEL-Based HQs Due to Dietary Ingestion - CT	Total LOAEL-Based HQs Summed Across Pathways - CT		
Parameter	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**White-footed Mouse**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**
Aluminum	4.18	3.50		1.53	5.71	3.71	
Iron	2.40	2.01			2.63	2.13	
Vanadium	20.50	17.19	2.13	6.03	26.53	17.96	3.07
HI[d]_LOAEL	**27.08**	**22.70**	**2.13**	**7.56**	**34.87**	**23.80**	**3.07**

Footnotes:
(a) NOAEL = No Observed Adverse Effect Level
(b) HQ = Hazard Quotient
(c) LOAEL = Lowest Observed Adverse Effect Level
(d) HI = Hazard Index

FIGURES

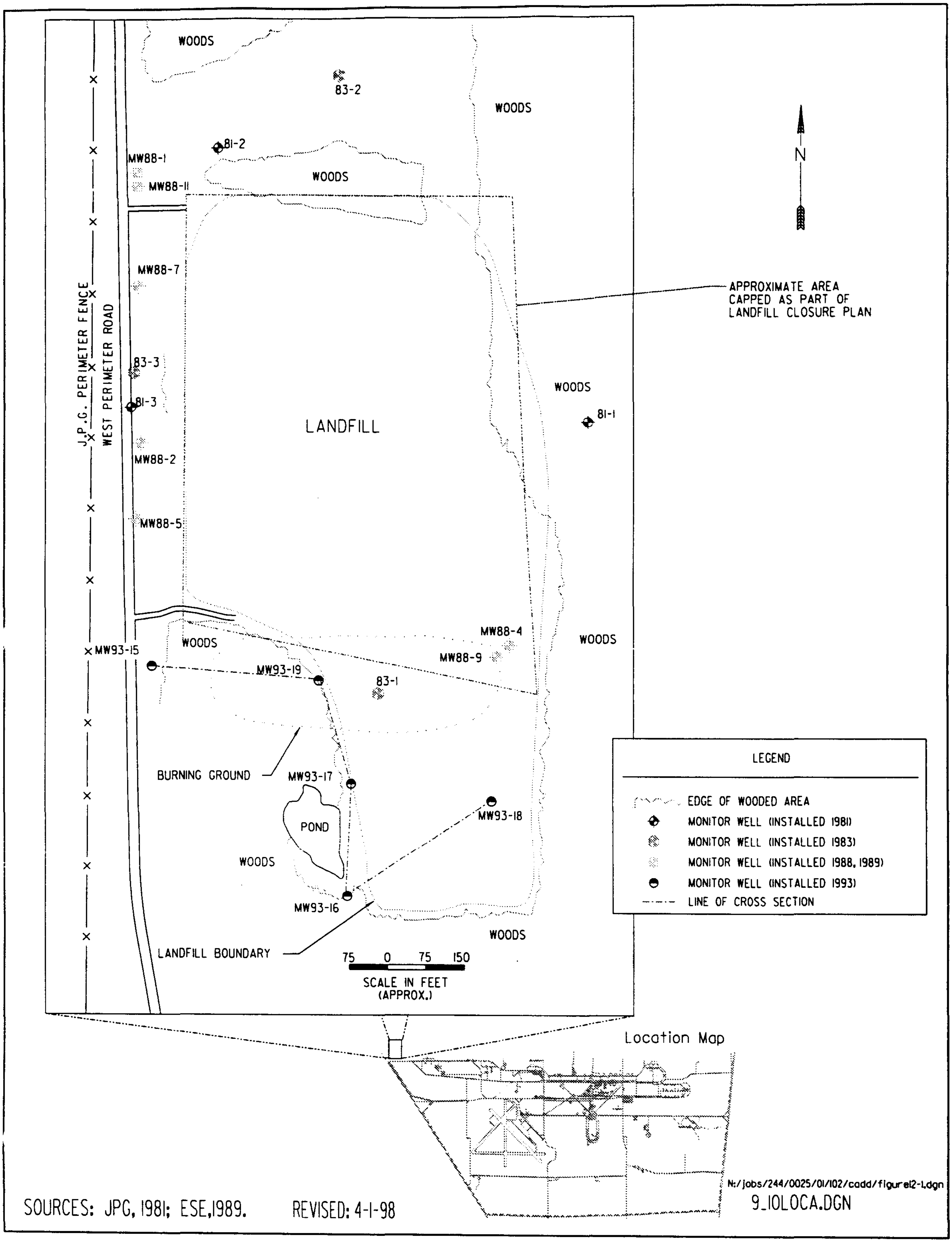


Figure 12-1. Sampling Locations at the Burning Ground South of Gate 19 Landfill (Site 9) and Gate 19 Landfill (Site 10)

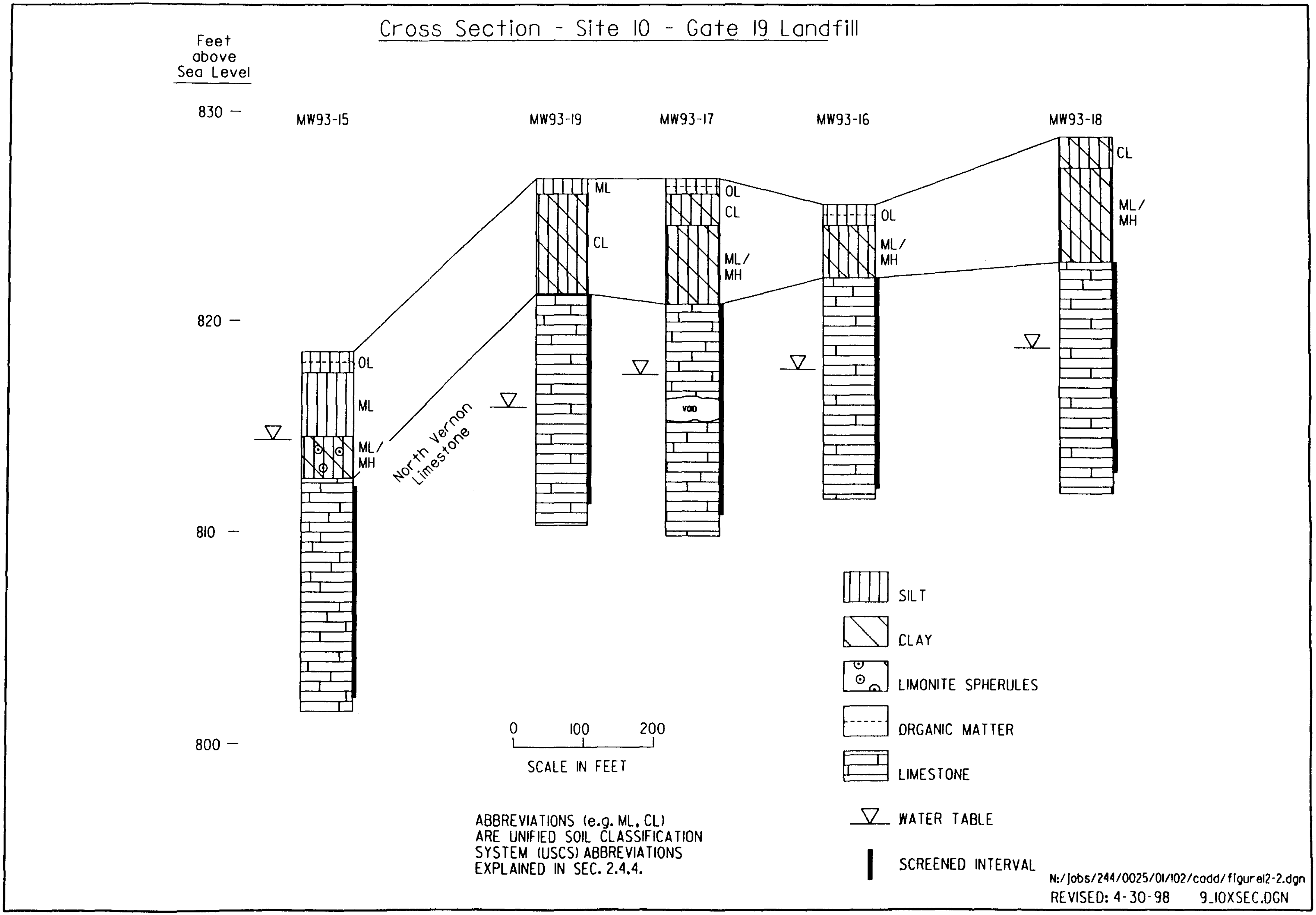


Figure 12-2. Cross Section Using Monitoring Well Data, Burning Ground South of Gate 19 Landfill (Site 9) and the Gate 19 Landfill (Site 10)

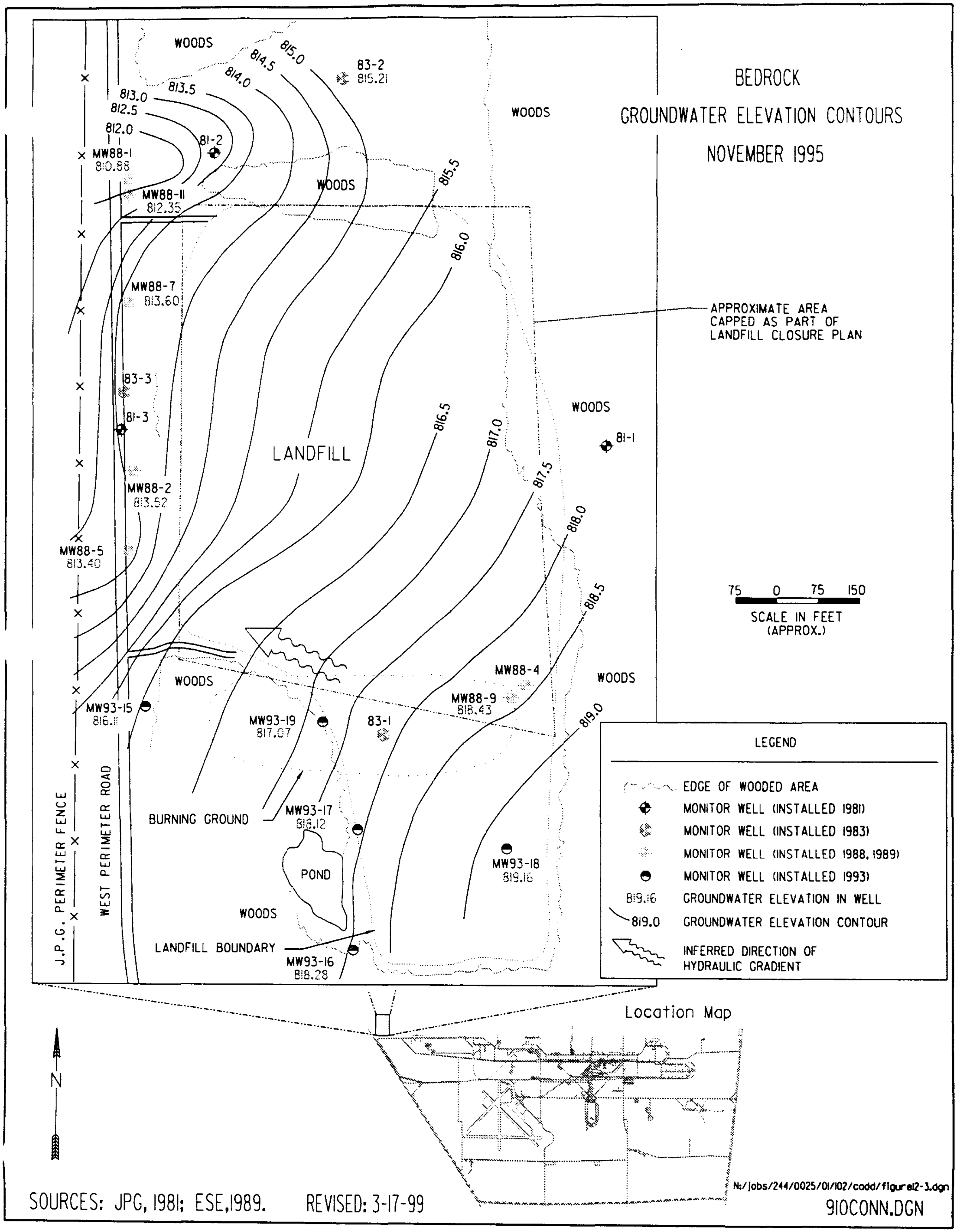


Figure 12-3. Bedrock Potentiometric Contour Map - November 1995
Gate 19 Landfill (Site 10)

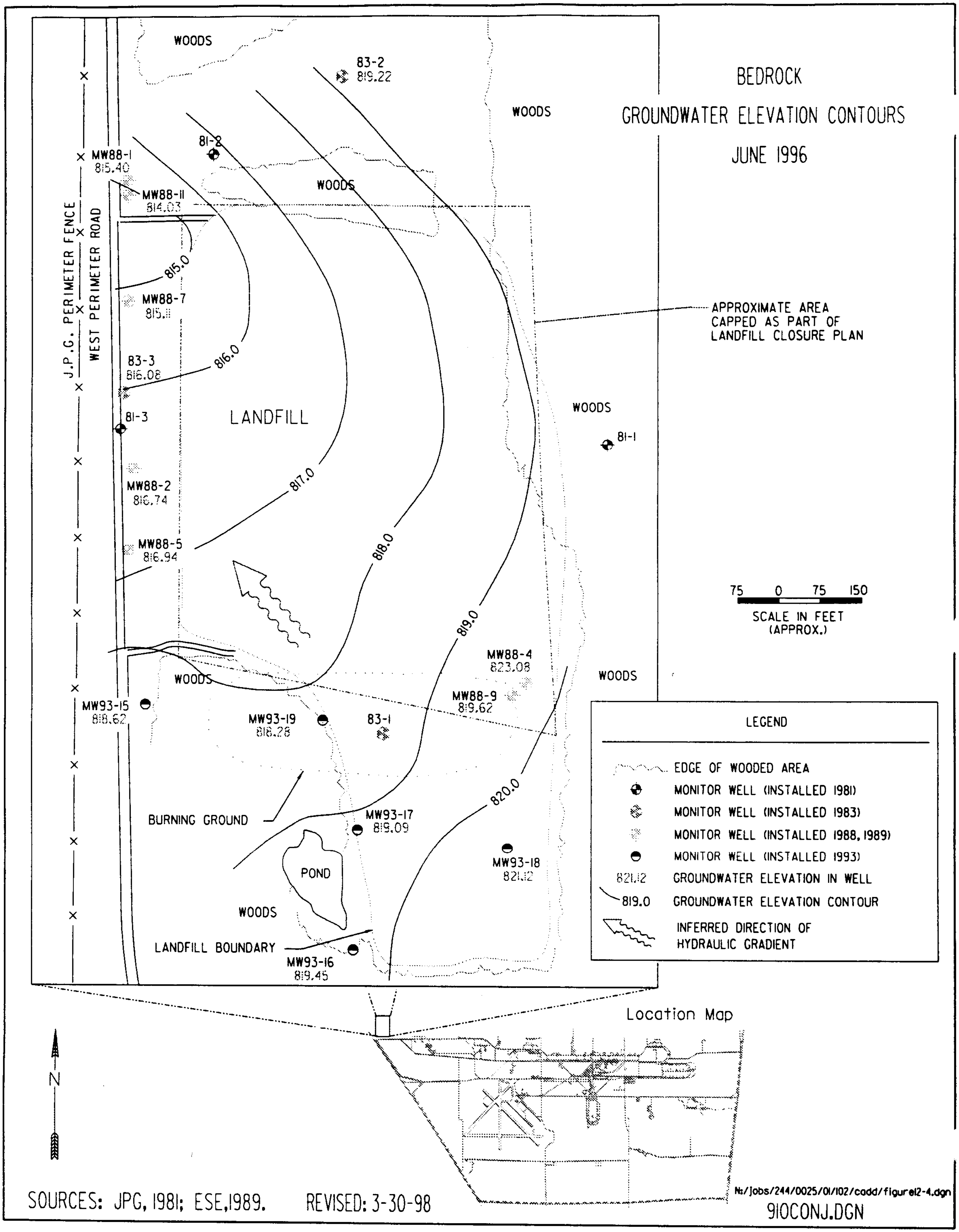


Figure 12-4. Bedrock Potentiometric Contour Map - June 1996
Gate 19 Landfill (Site 10)

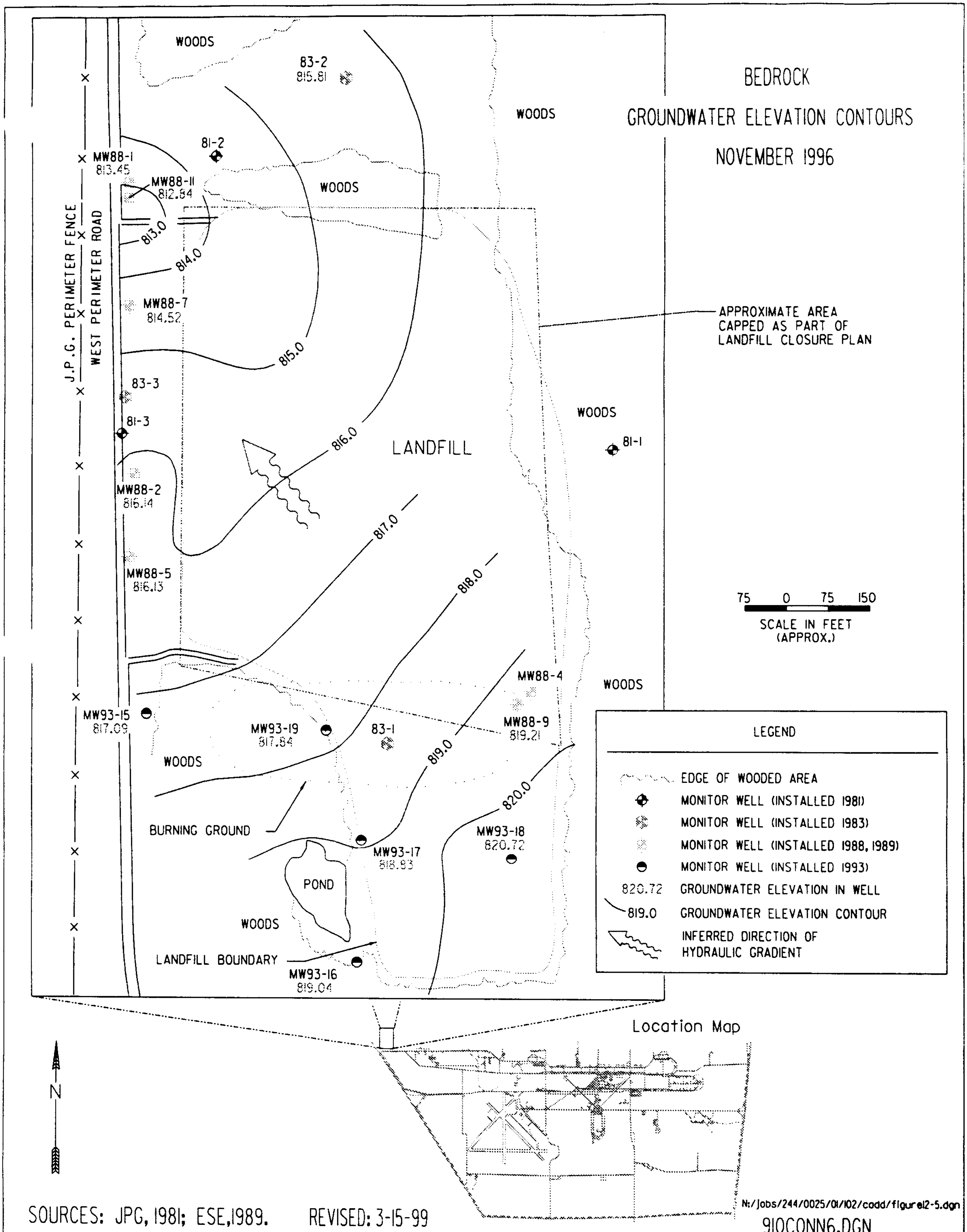
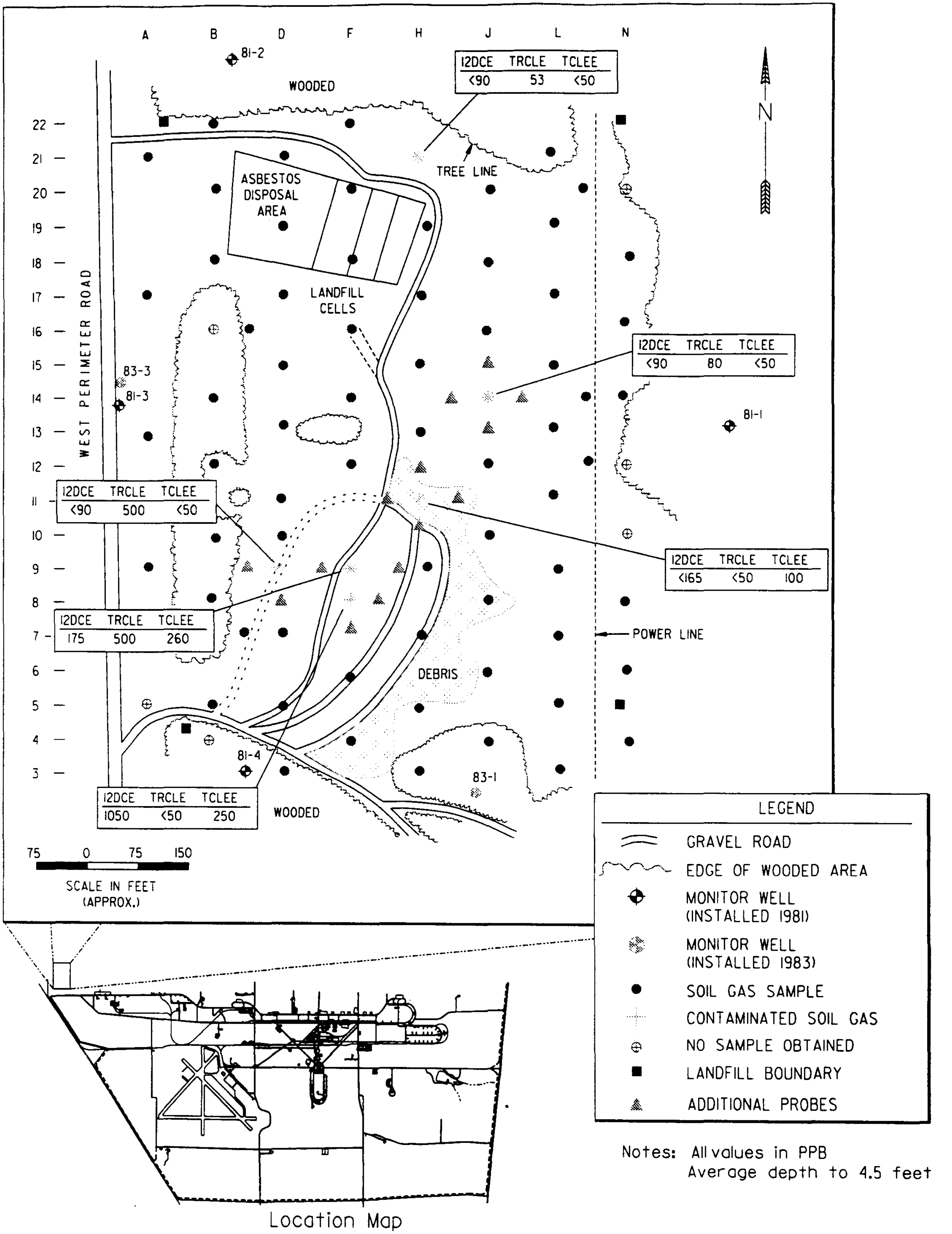


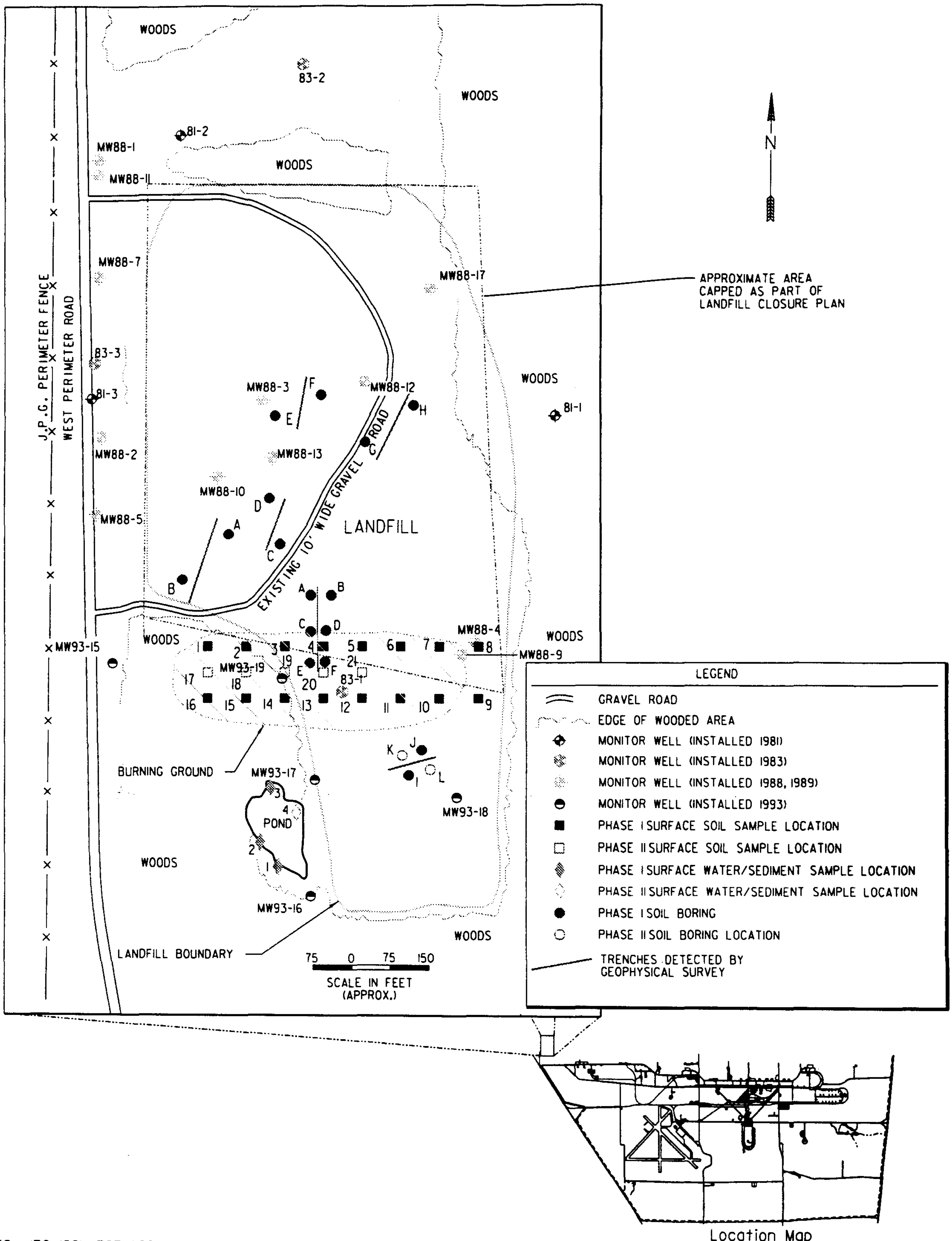
Figure 12-5. Bedrock Potentiometric Contour Map - November 1996
Gate 19 Landfill (Site 10)



SOURCES: JPG, 1981; ESE, 1989.

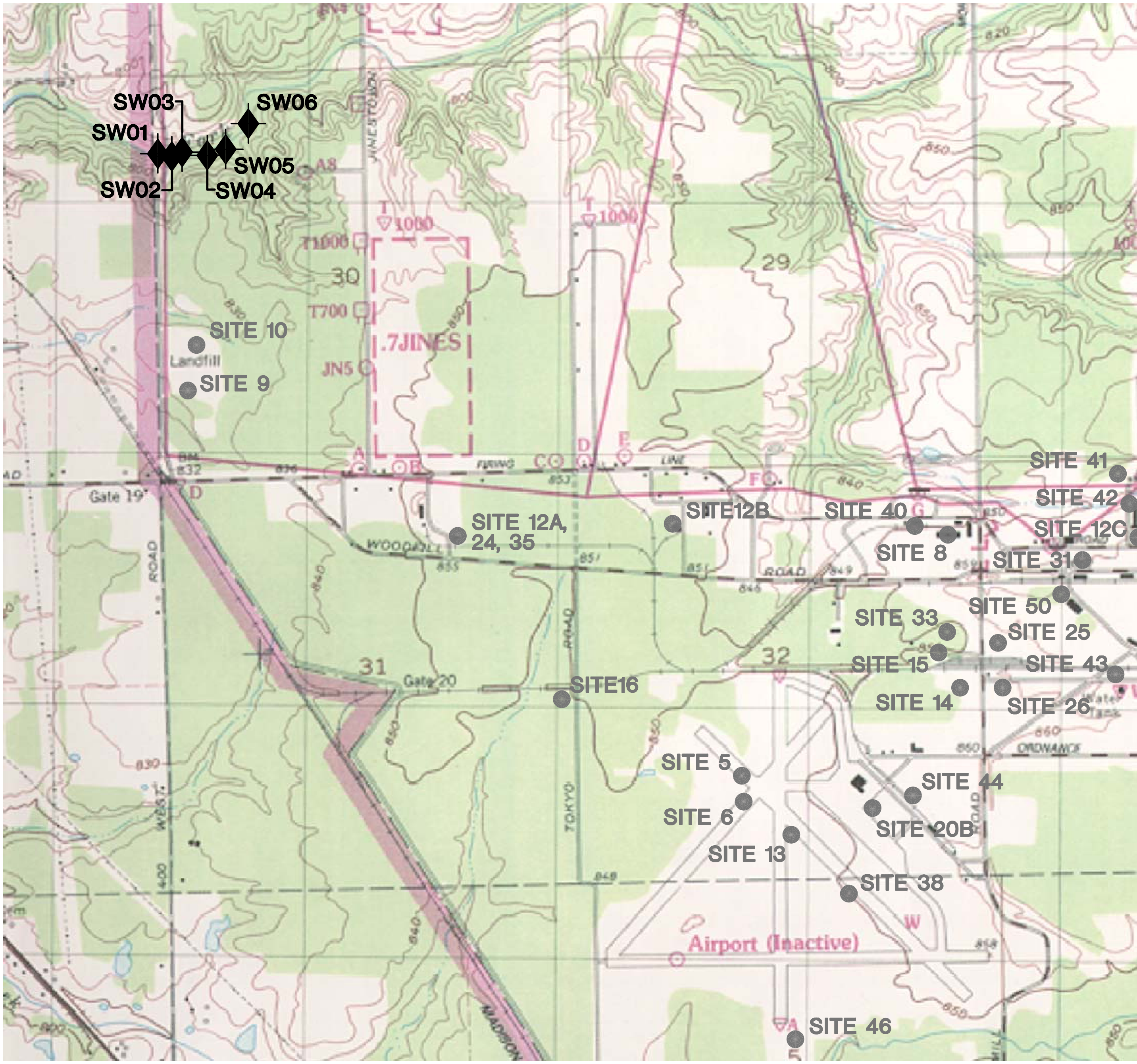
N:/jobs/244/0025/01/102/cadd/figure12-5a.dgn
REVISED: 7-13-99 SOILGAS.DGN

Figure 12-5a. ESE Soil Gas Sampling Locations and Results for Gate 19 Landfill (Site 10)



SOURCES: JPG, 1981; ESE, 1989. N:/jobs/244/0025/01/102/cadd/figure12-6.dgn REVISED: 4-6-98 910SAMPL.DGN

Figure 12-6. Phase I and Phase II Sampling Locations at the Burning Ground South of Gate 19 Landfill (Site 9) and Gate 19 Landfill (Site 10)



LEGEND

SITE 9 — SITE LOCATION AND NUMBER

SW06 — SURFACE WATER/SEDIMENT SAMPLE LOCATION AND NUMBER

NOTE

BASE MAP DEVELOPED FROM A U.S.G.S. TOPOGRAPHIC QUADRANGLE MAP PREPARED FOR UNITED STATES ARMY: JEFFERSON PROVING GROUND, INDIANA, DATED 1986.

north

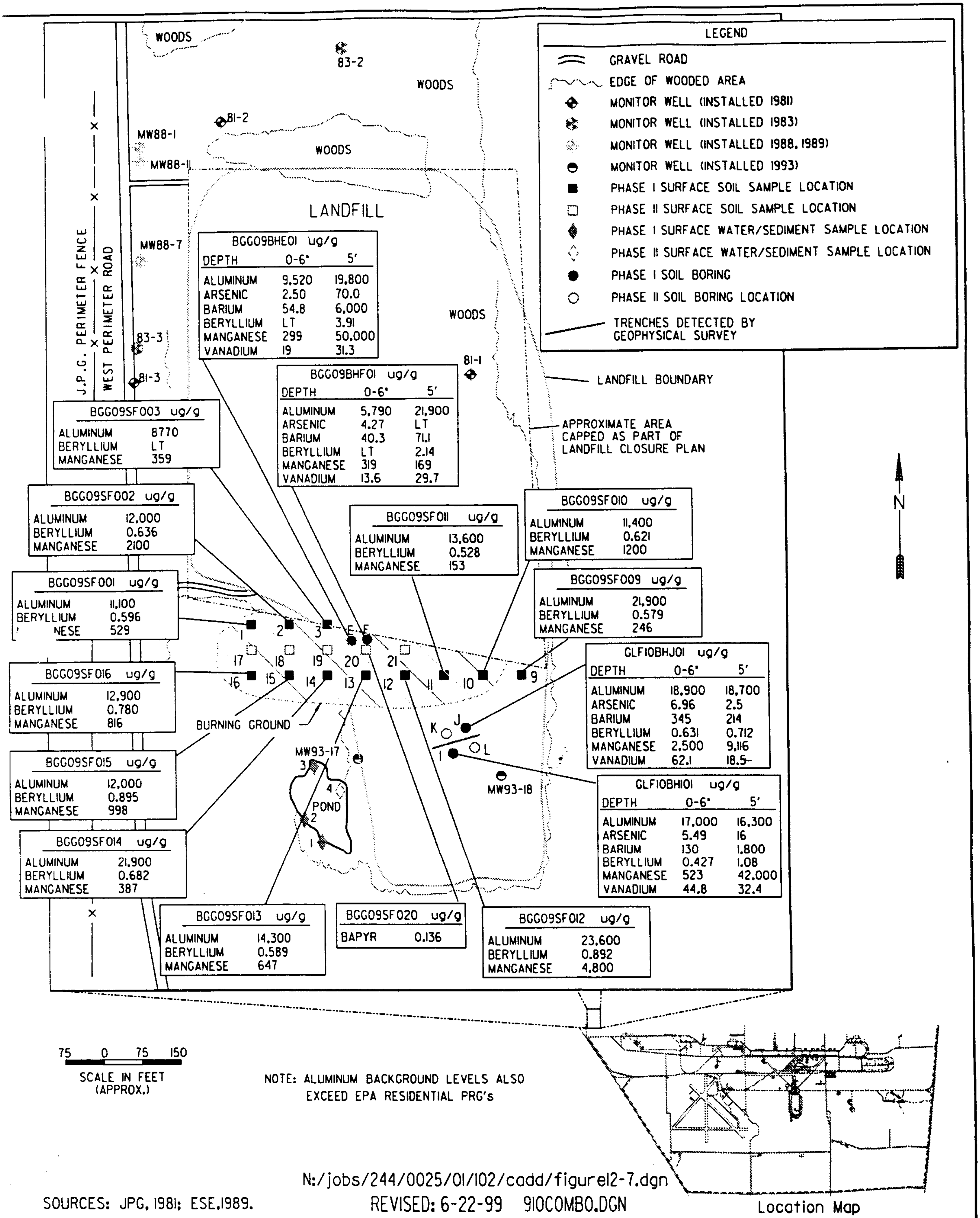
0 2000 4000

SCALE IN FEET

FIGURE 12-6a

Developed By TAPB	Drawn By DLF	MIDDLE FORK CREEK SURFACE WATER/ SEDIMENT SAMPLE LOCATION MAP (4-25-01)	Drawing Number 2440025 010102 A1
Approved By	Date	SOUTH OF THE FIRING LINE JEFFERSON PROVING GROUND MADISON, INDIANA	MWH MONTGOMERY WATSON HARZA
Reference			
Revisions			

QUALITY CONTROL
Graphic Standards DLF 2-19-02
Lead Professional TEM 2-19-02
Technical Review LAB 3-19-02
Project Manager
Management Review
Other



igure 12-7. Summary of Contaminants Exceeding Background and Regulatory Risk-Based Concentrations - Phase I and Phase II Surface Soils and Phase I Soil Borings Burning Ground South of Gate 19 Landfill (Site 9) and Gate 19 Landfill (Site 10)

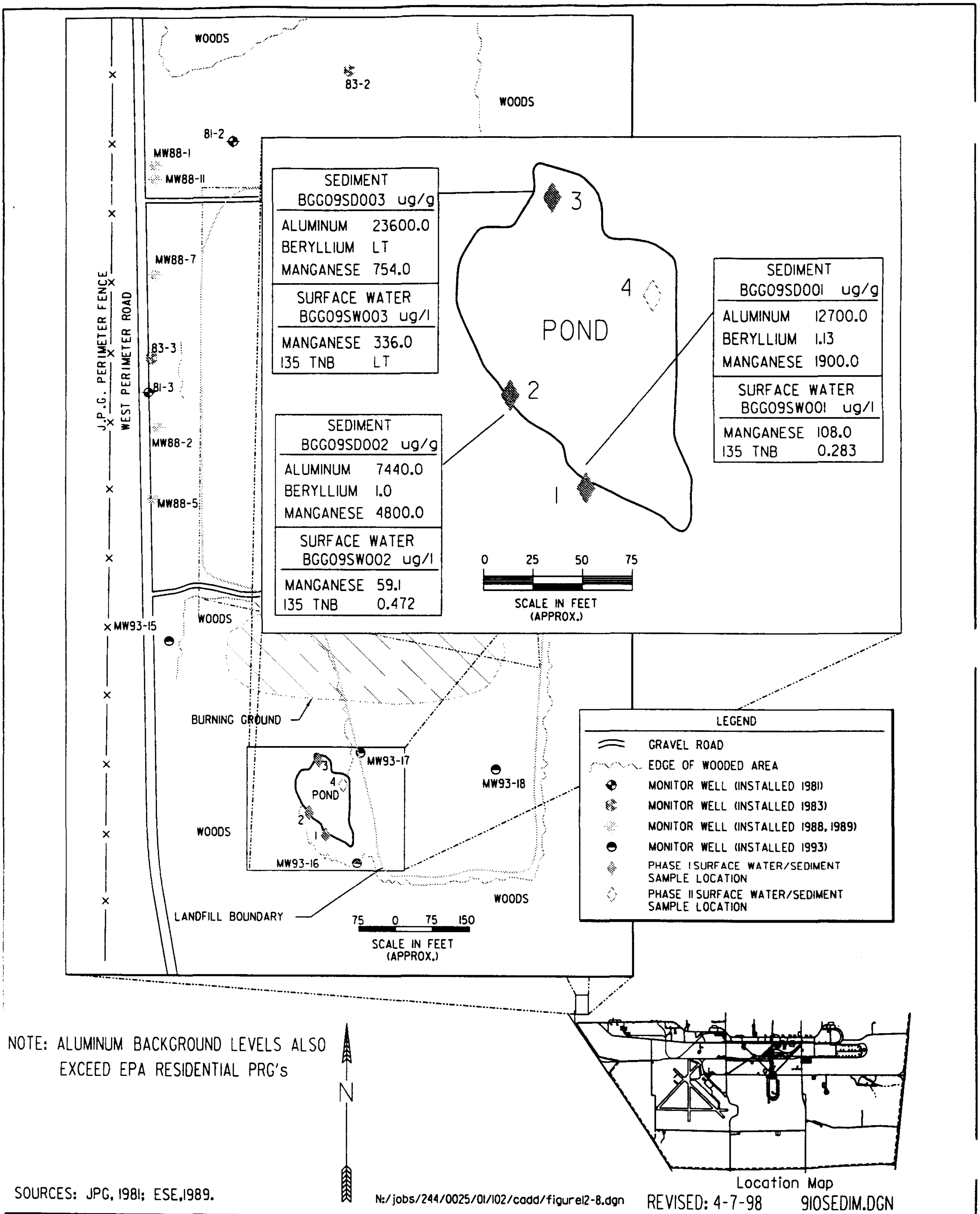
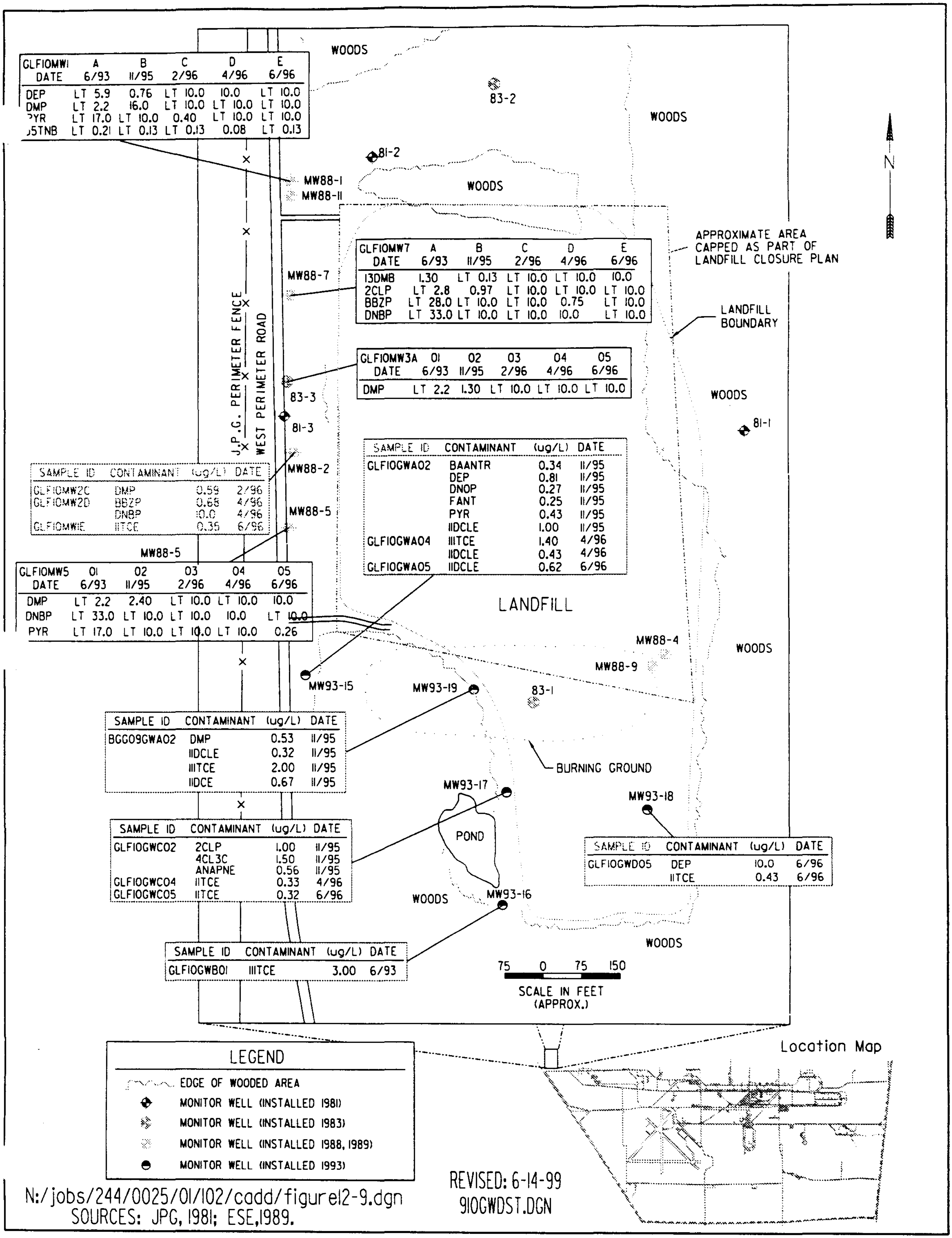


Figure 12-8. Summary of Contaminants in Sediment and Surface Water Exceeding Background and Regulatory Risk-Based Concentrations, Pond Adjacent to the Burning Ground (Site 9)



GLFIOMW1	A	B	C	D	E
DATE	6/93	11/95	2/96	4/96	6/96
DEP	LT 5.9	0.76	LT 10.0	10.0	LT 10.0
DMP	LT 2.2	16.0	LT 10.0	LT 10.0	LT 10.0
PYR	LT 17.0	LT 10.0	0.40	LT 10.0	LT 10.0
35TNB	LT 0.21	LT 0.13	LT 0.13	0.08	LT 0.13

GLFIOMW7	A	B	C	D	E
DATE	6/93	11/95	2/96	4/96	6/96
13DMB	1.30	LT 0.13	LT 10.0	LT 10.0	10.0
2CLP	LT 2.8	0.97	LT 10.0	LT 10.0	LT 10.0
BBZP	LT 28.0	LT 10.0	LT 10.0	0.75	LT 10.0
DNBP	LT 33.0	LT 10.0	LT 10.0	10.0	LT 10.0

GLFIOMW3A	01	02	03	04	05
DATE	6/93	11/95	2/96	4/96	6/96
DMP	LT 2.2	1.30	LT 10.0	LT 10.0	LT 10.0

SAMPLE ID	CONTAMINANT	(ug/L)	DATE
GLFIOGWA02	BAANTR	0.34	11/95
	DEP	0.81	11/95
	DNOP	0.27	11/95
	FANT	0.25	11/95
	PYR	0.43	11/95
	11DCLE	1.00	11/95
GLFIOGWA04	111TCE	1.40	4/96
	11DCLE	0.43	4/96
GLFIOGWA05	11DCLE	0.62	6/96

SAMPLE ID	CONTAMINANT	(ug/L)	DATE
GLFIOMW2C	DMP	0.59	2/96
GLFIOMW2D	BBZP	0.68	4/96
	DNBP	10.0	4/96
GLFIOMW1E	11TCE	0.35	6/96

GLFIOMW5	01	02	03	04	05
DATE	6/93	11/95	2/96	4/96	6/96
DMP	LT 2.2	2.40	LT 10.0	LT 10.0	10.0
DNBP	LT 33.0	LT 10.0	LT 10.0	10.0	LT 10.0
PYR	LT 17.0	LT 10.0	LT 10.0	LT 10.0	0.26

SAMPLE ID	CONTAMINANT	(ug/L)	DATE
BGG09GWA02	DMP	0.53	11/95
	11DCLE	0.32	11/95
	111TCE	2.00	11/95
	11DCE	0.67	11/95

SAMPLE ID	CONTAMINANT	(ug/L)	DATE
GLFIOGWC02	2CLP	1.00	11/95
	4CL3C	1.50	11/95
	ANAPNE	0.56	11/95
GLFIOGWC04	11TCE	0.33	4/96
GLFIOGWC05	11TCE	0.32	6/96

SAMPLE ID	CONTAMINANT	(ug/L)	DATE
GLFIOGWD05	DEP	10.0	6/96
	11TCE	0.43	6/96

SAMPLE ID	CONTAMINANT	(ug/L)	DATE
GLFIOGWB01	111TCE	3.00	6/93

Figure 12-9. Groundwater Results Exceeding Regulatory Risk-Based Concentrations, Burning Ground South of Gate 19 Landfill (Site 9) and Gate 19 Landfill (Site 10)

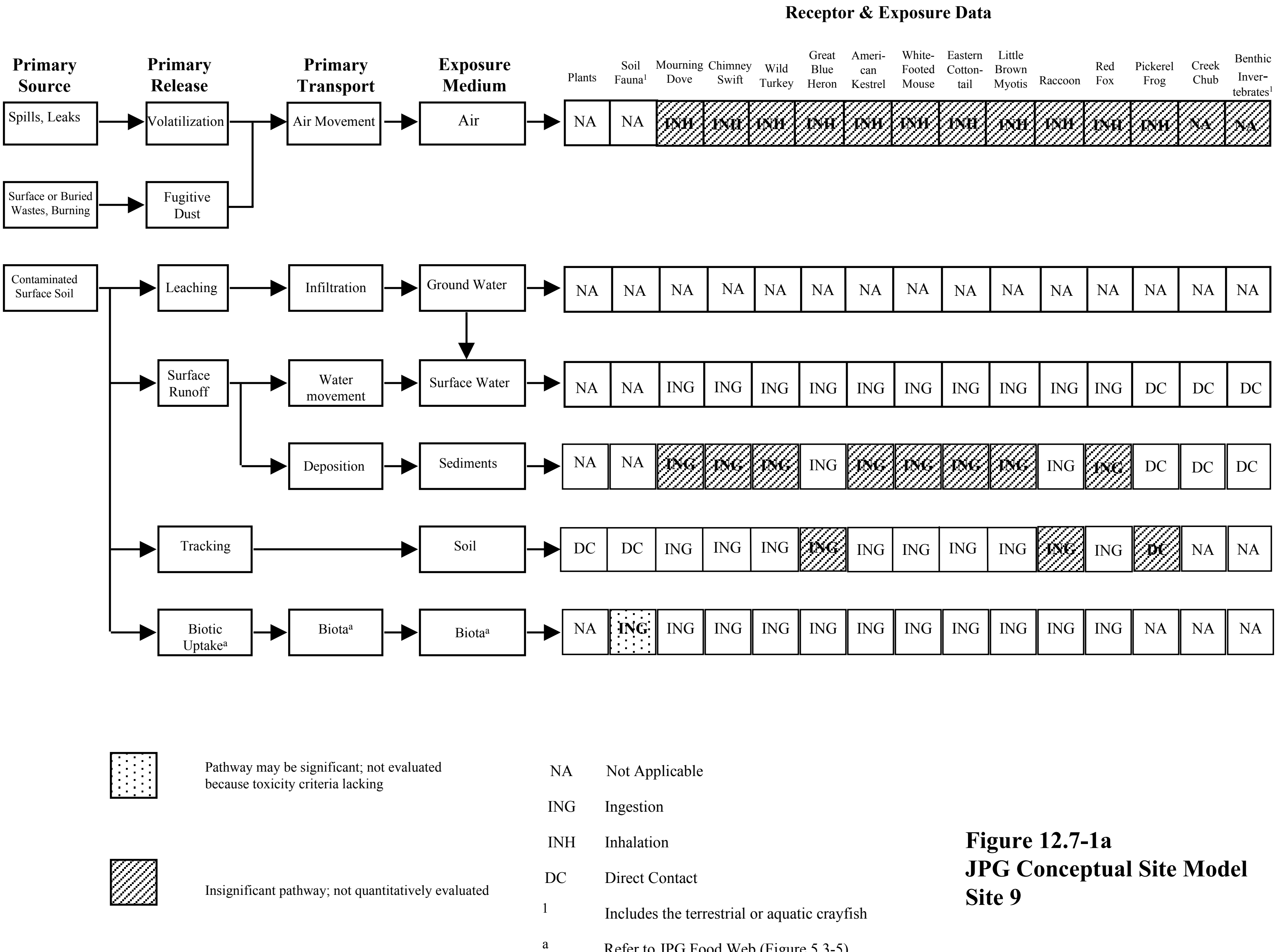
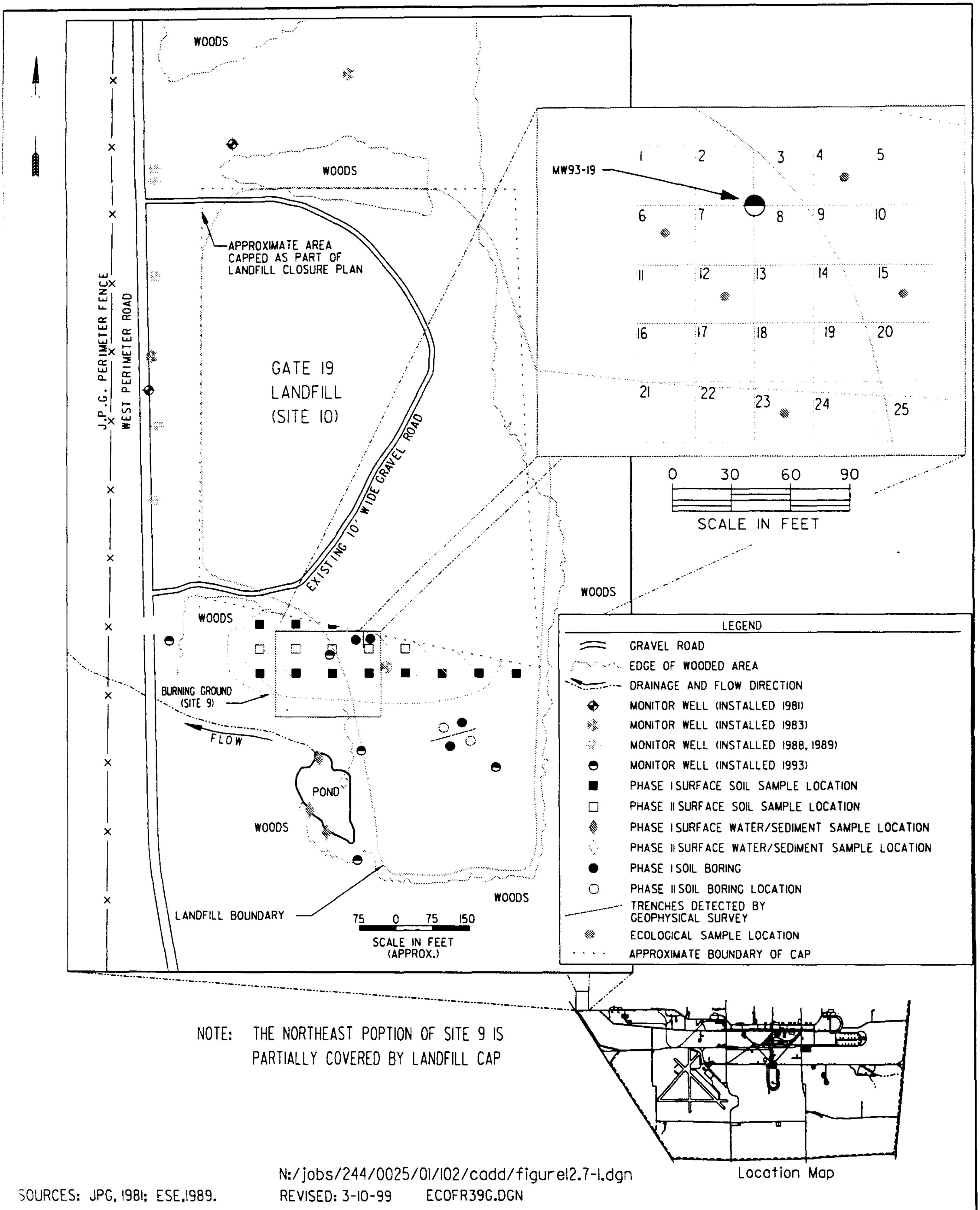


Figure 12.7-1a
JPG Conceptual Site Model
Site 9

N:Jobs\244\0025\01\102\cadd\figure12.7-1a.ppt



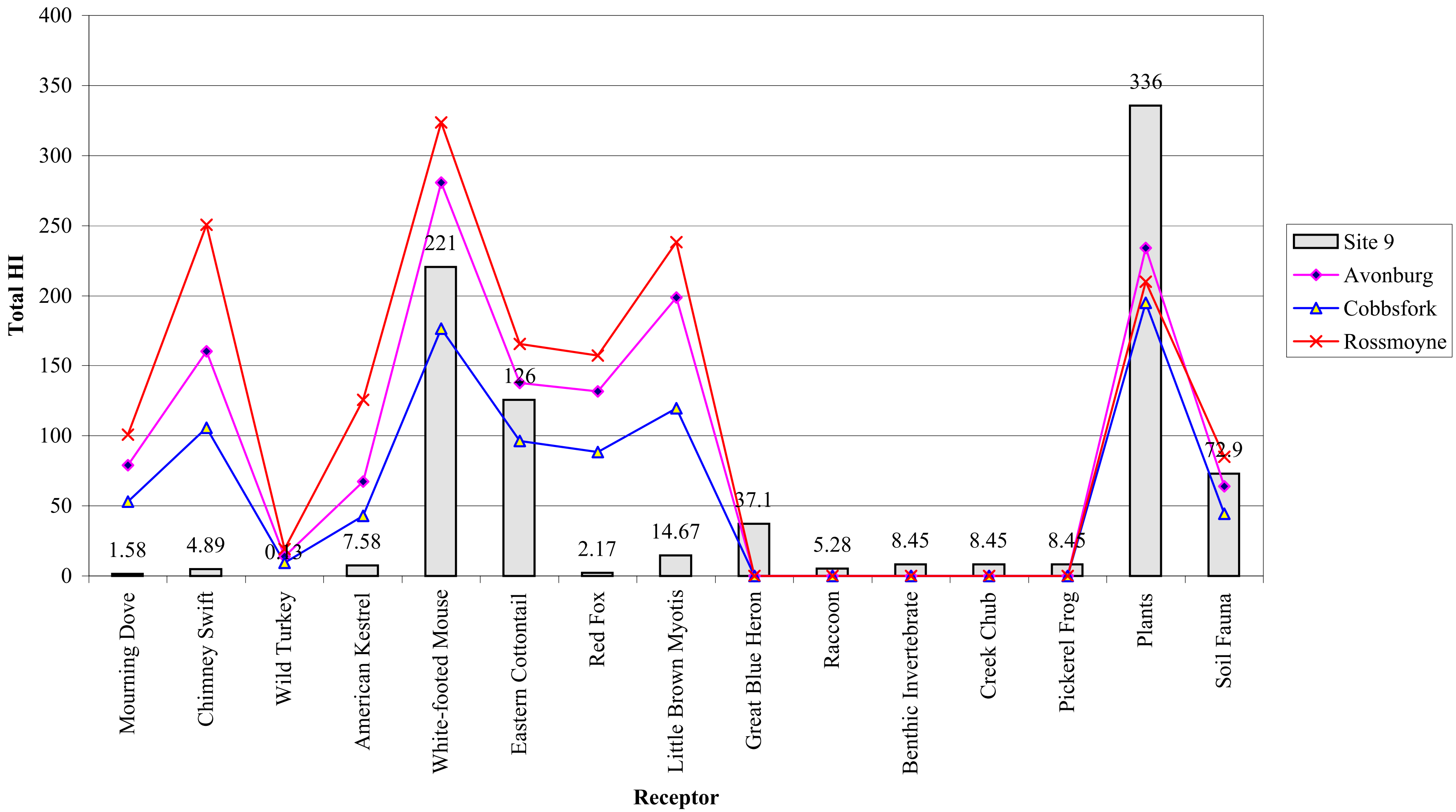
NOTE: THE NORTHEAST POPTION OF SITE 9 IS PARTIALLY COVERED BY LANDFILL CAP

N:/jobs/244/0025/01/102/cadd/figure12.7-1.dgn

SOURCES: JPG, 1981; ESE, 1989. REVISED: 3-10-99 ECOFR39G.DGN

Figure 12.7-1. Burning Ground South of Gate 19 Landfill (Site 9)

Figure 12.7-2 Total HIs - RME Risks Summed for All Pathways Based on NOAELs at Site 9 - Burning Ground South of Gate 19 Landfill - Phase I



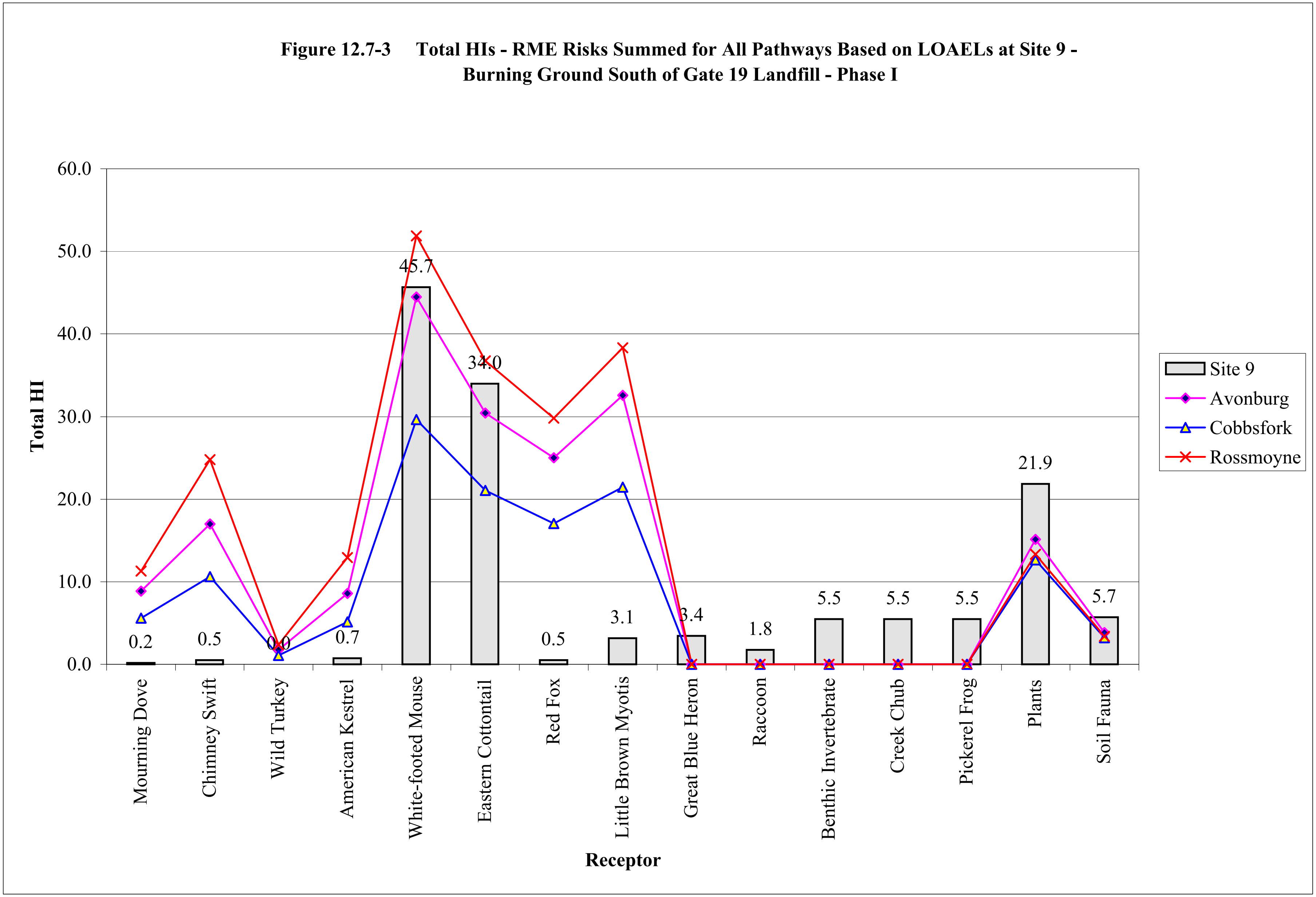


Figure 12.7-3 Total HIs - RME Risks Summed for All Pathways Based on LOAELs at Site 9 - Burning Ground South of Gate 19 Landfill - Phase I
Total HI
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0.2
0.5
0.0
0.7
45.7
34.0
0.5
3.1
3.4
1.8
5.5
5.5
5.5
21.9
5.7
Mourning Dove
Chimney Swift
Wild Turkey
American Kestrel
White-footed Mouse
Eastern Cottontail
Red Fox
Little Brown Myotis
Great Blue Heron
Raccoon
Benthic Invertebrate
Creek Chub
Pickerel Frog
Plants
Soil Fauna
Receptor
Site 9
Avonburg
Cobbsfork
Rossmoyne

Figure 12.7-4 Total HIs - CT Risks Summed for All Pathways Based on NOAELs at Site 9 - Burning Ground South of Gate 19 Landfill - Phase I

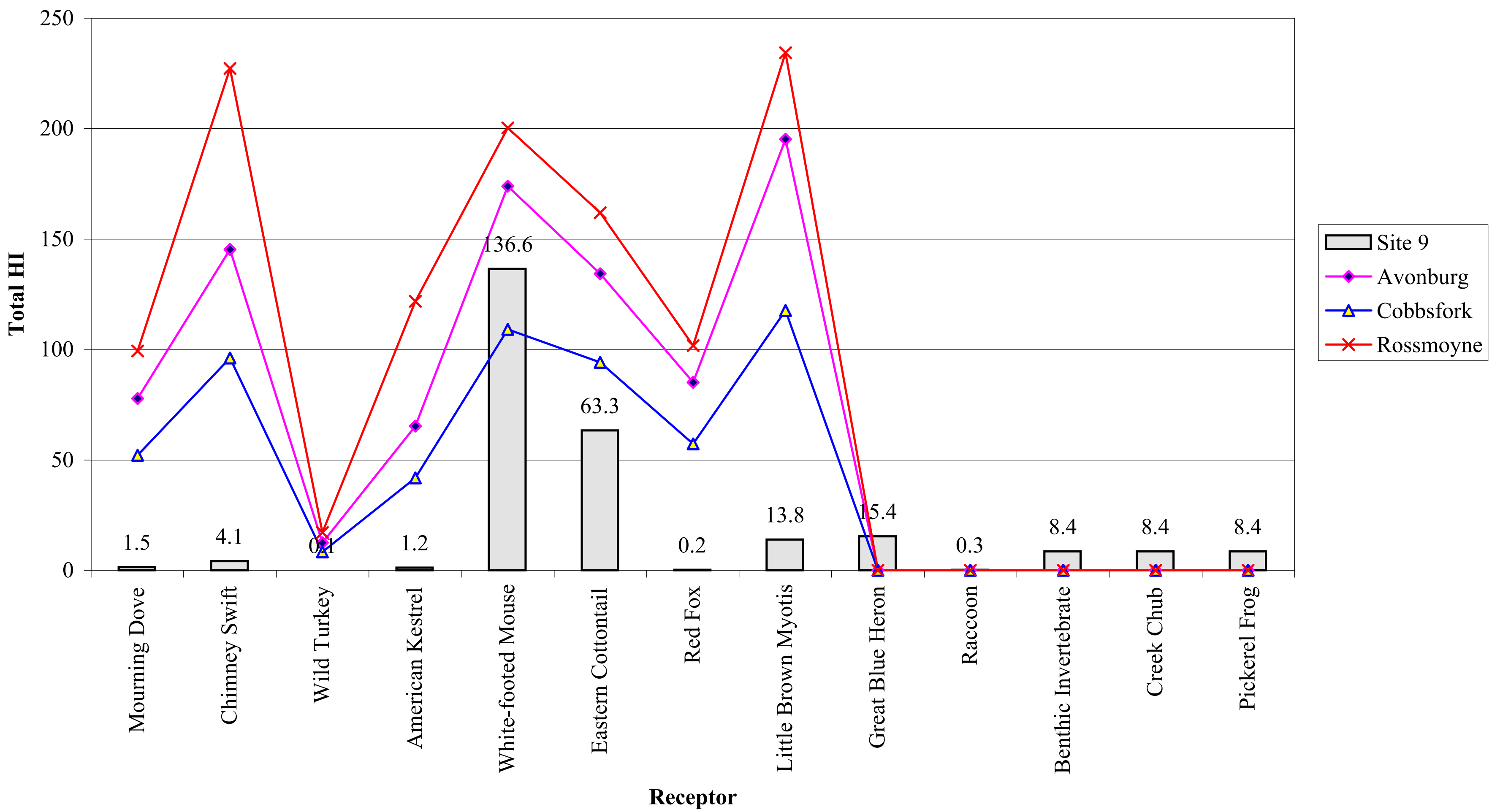


Figure 12.7-5 Total HIs - CT Risks Summed for All Pathways Based on LOAELs at Site 9 - Burning Ground South of Gate 19 Landfill - Phase I

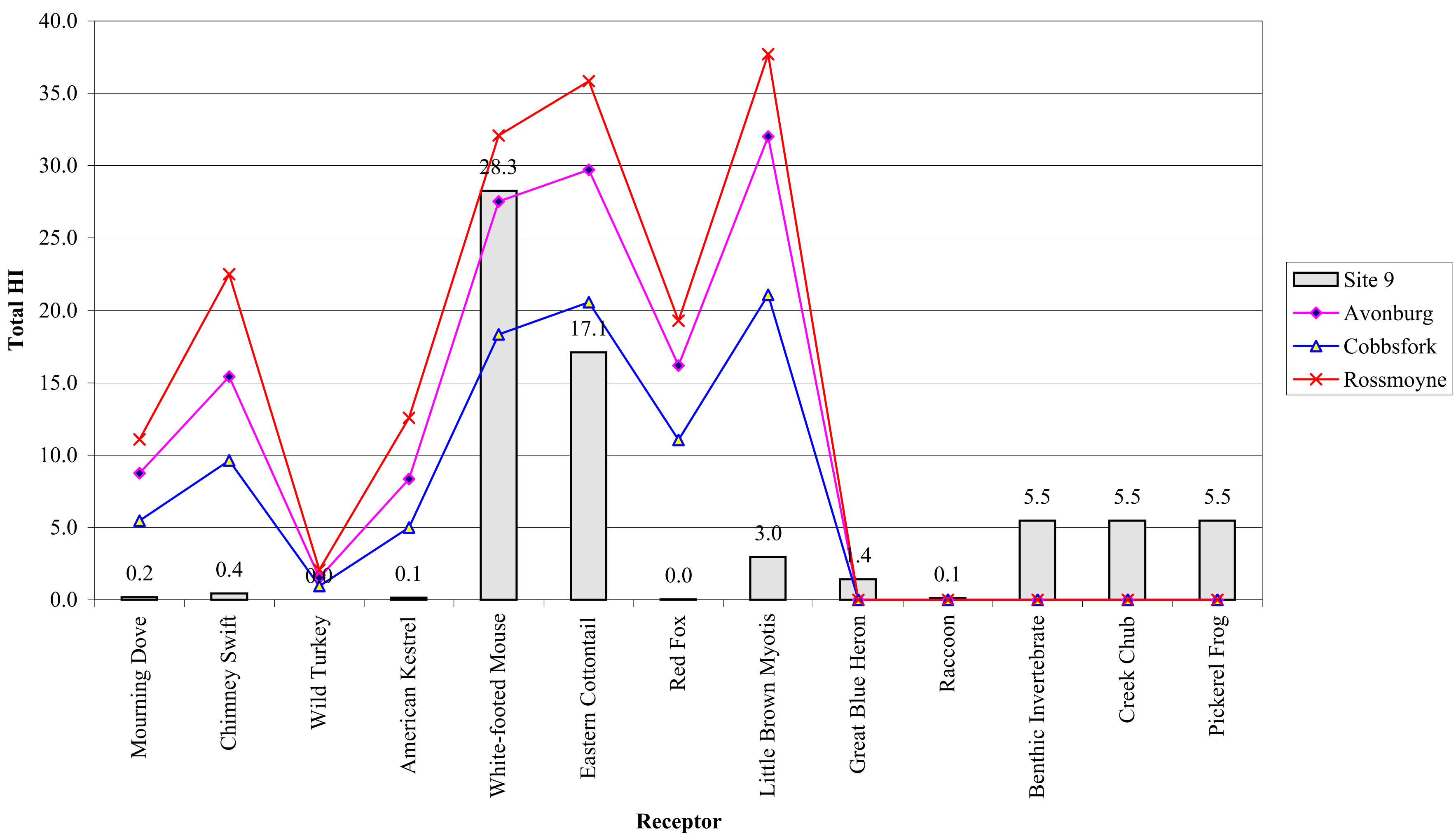


Figure 12.7-6 Total HIs - RME Risks Summed for All Pathways Based on NOAELs at Site 9 - Burning Ground South of Gate 19 Landfill - Phase II

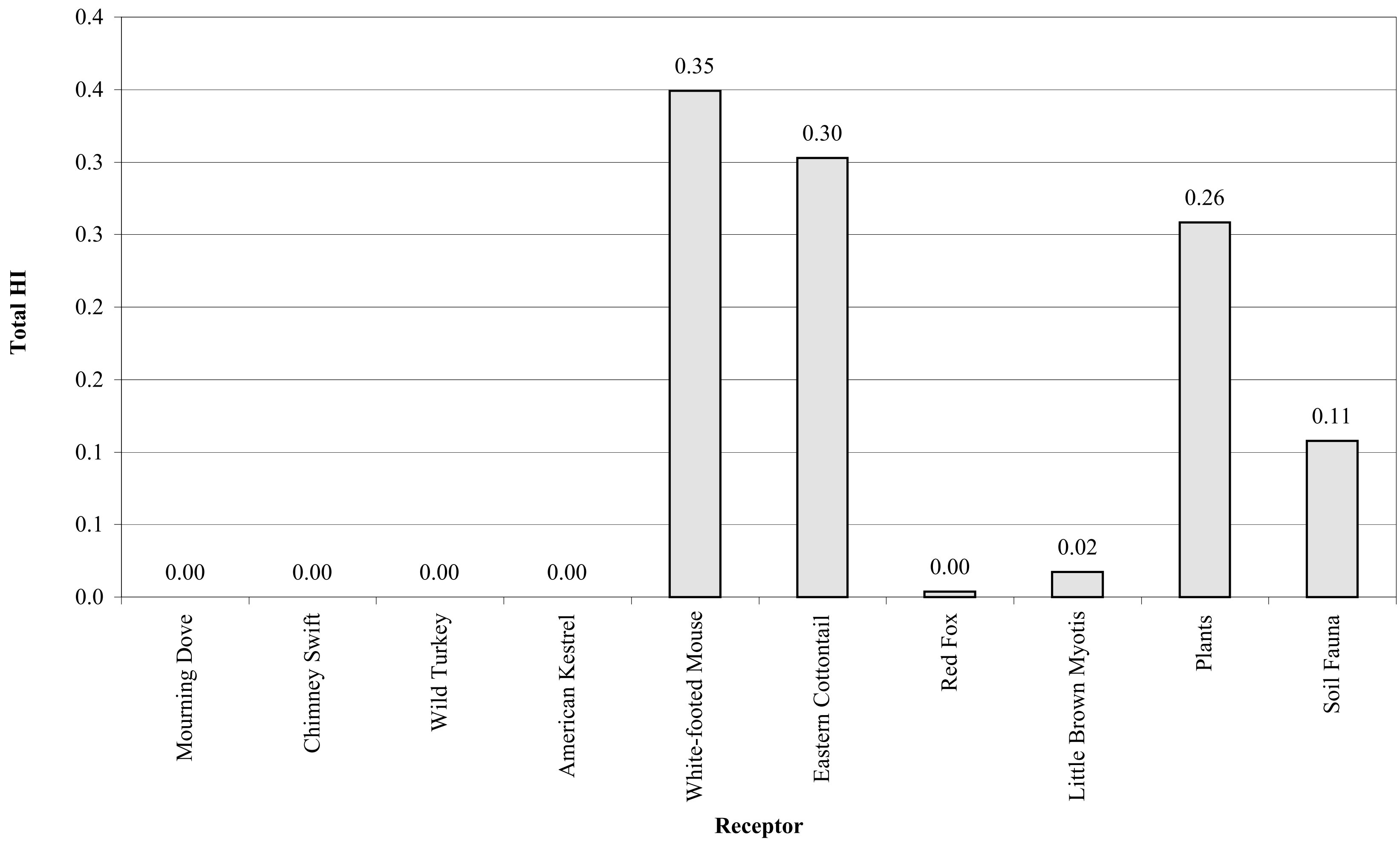
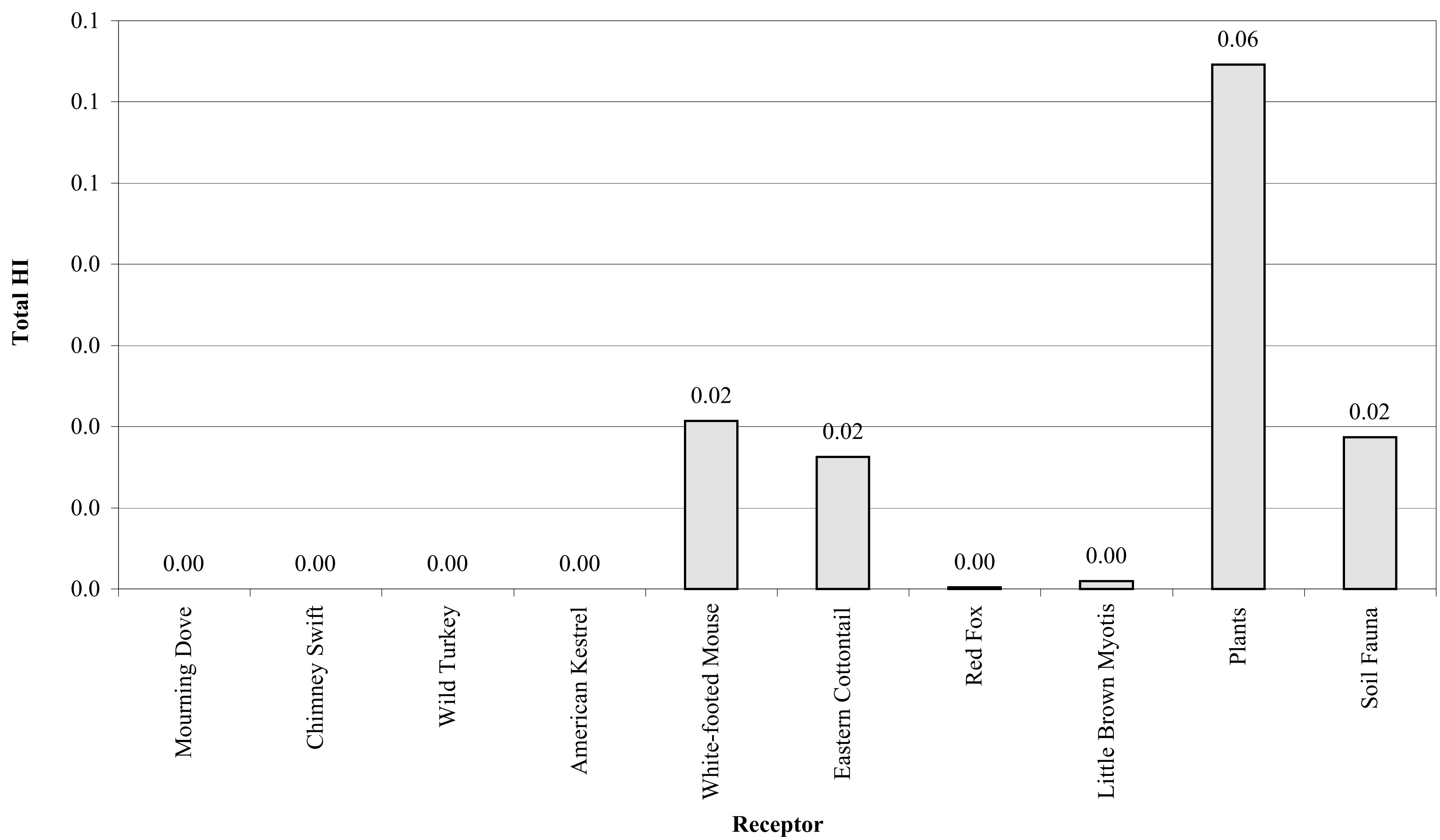
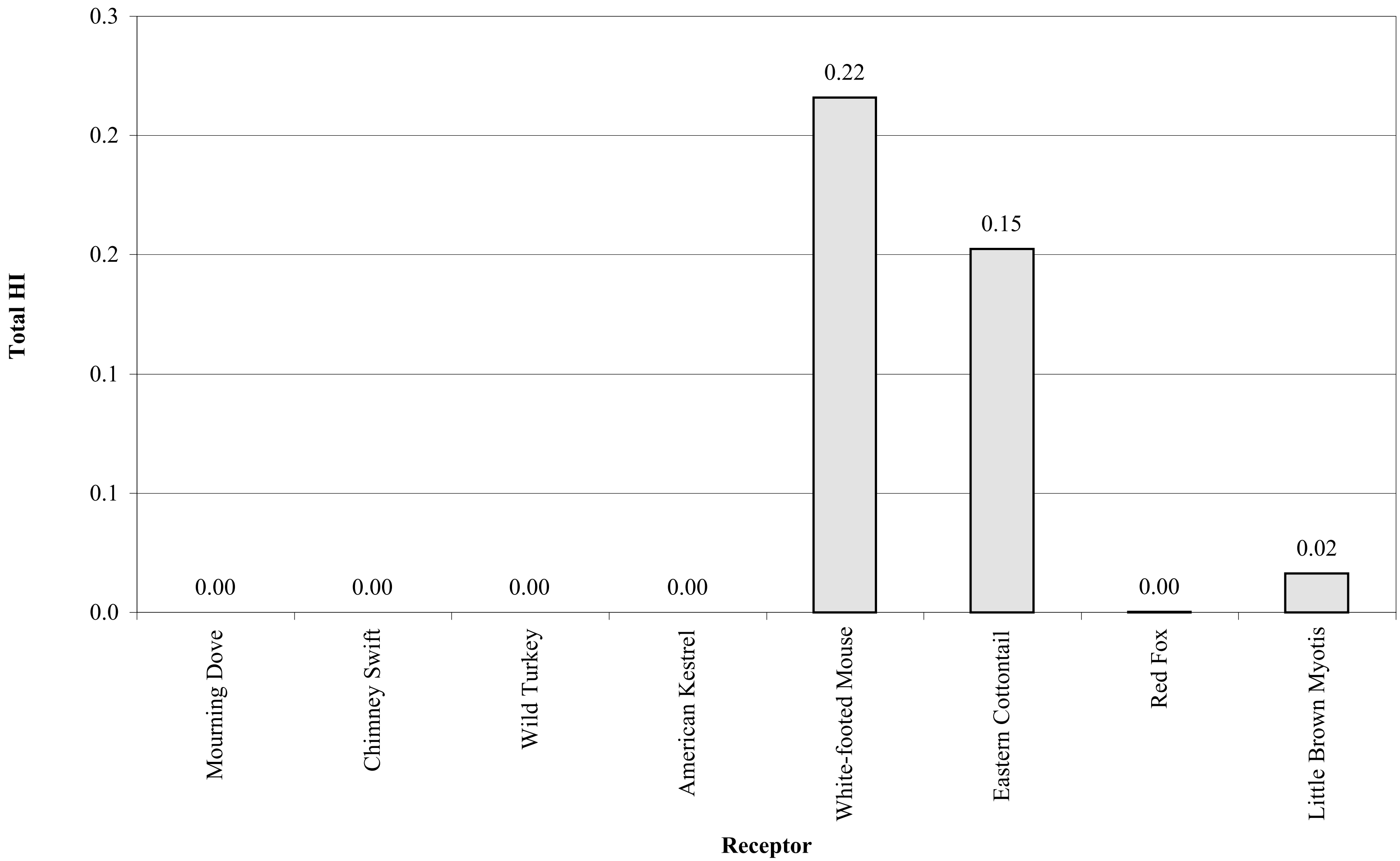


Figure 12.7-7 Total HIs - RME Risks Summed for All Pathways Based on LOAELs at Site 9 - Burning Ground South of Gate 19 Landfill - Phase II



N:\jobs\244\0025\01\ET ECO FILES\Jpg\Phase2\Risk2\P2era_9MWH.xls Figure 12.7-7

Figure 12.7-8 Total HIs - CT Risks Summed for All Pathways Based on NOAELs at Site 9 - Burning Ground South of Gate 19 Landfill - Phase II



N:\jobs\244\0025\01\ET ECO FILES\Jpg\Phase2\Risk2\P2era_9MWH.xls Figure 12.7-8

Figure 12.7-9 Total HIs - CT Risks Summed for All Pathways Based on LOAELs at Site 9 - Burning Ground South of Gate 19 Landfill - Phase II

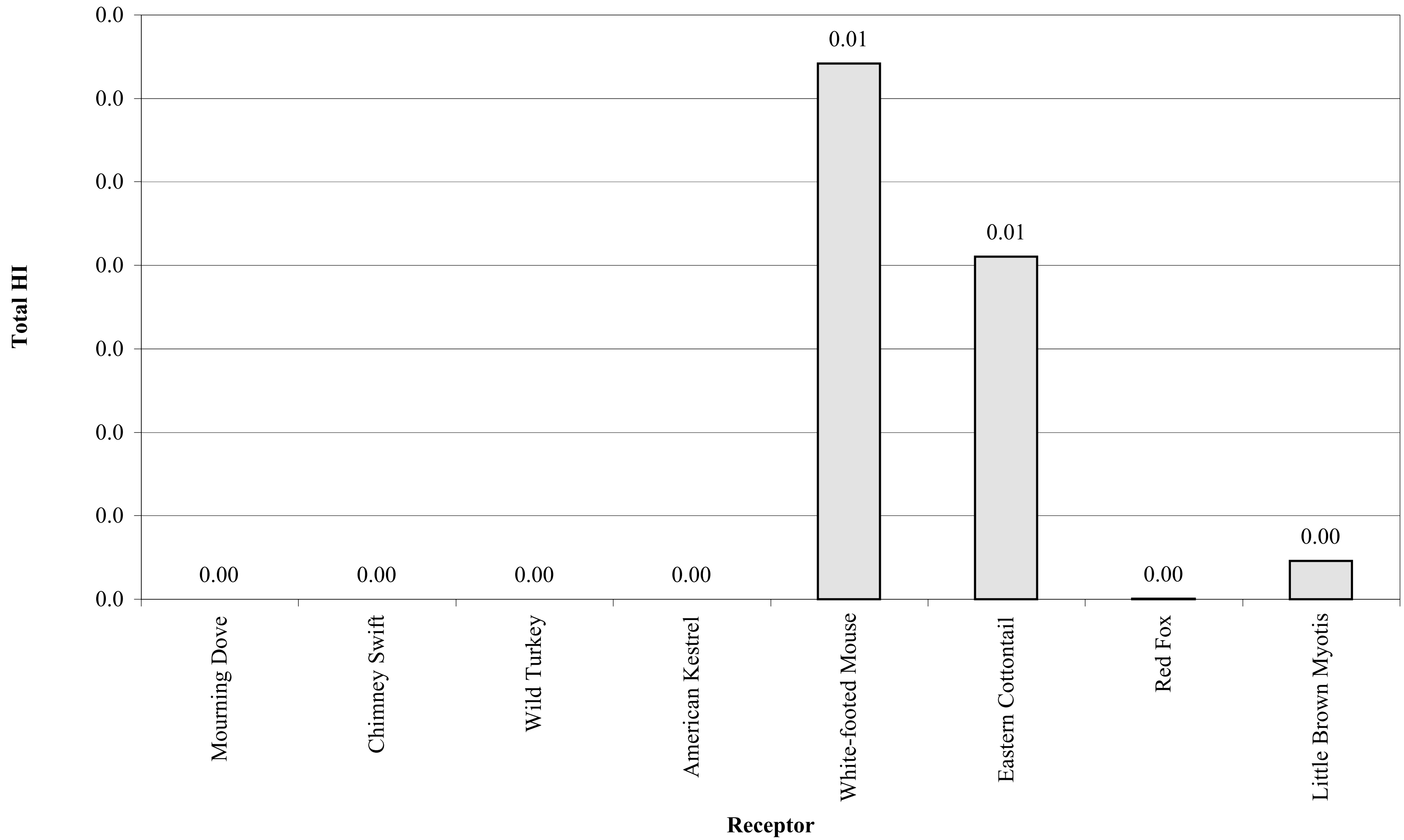
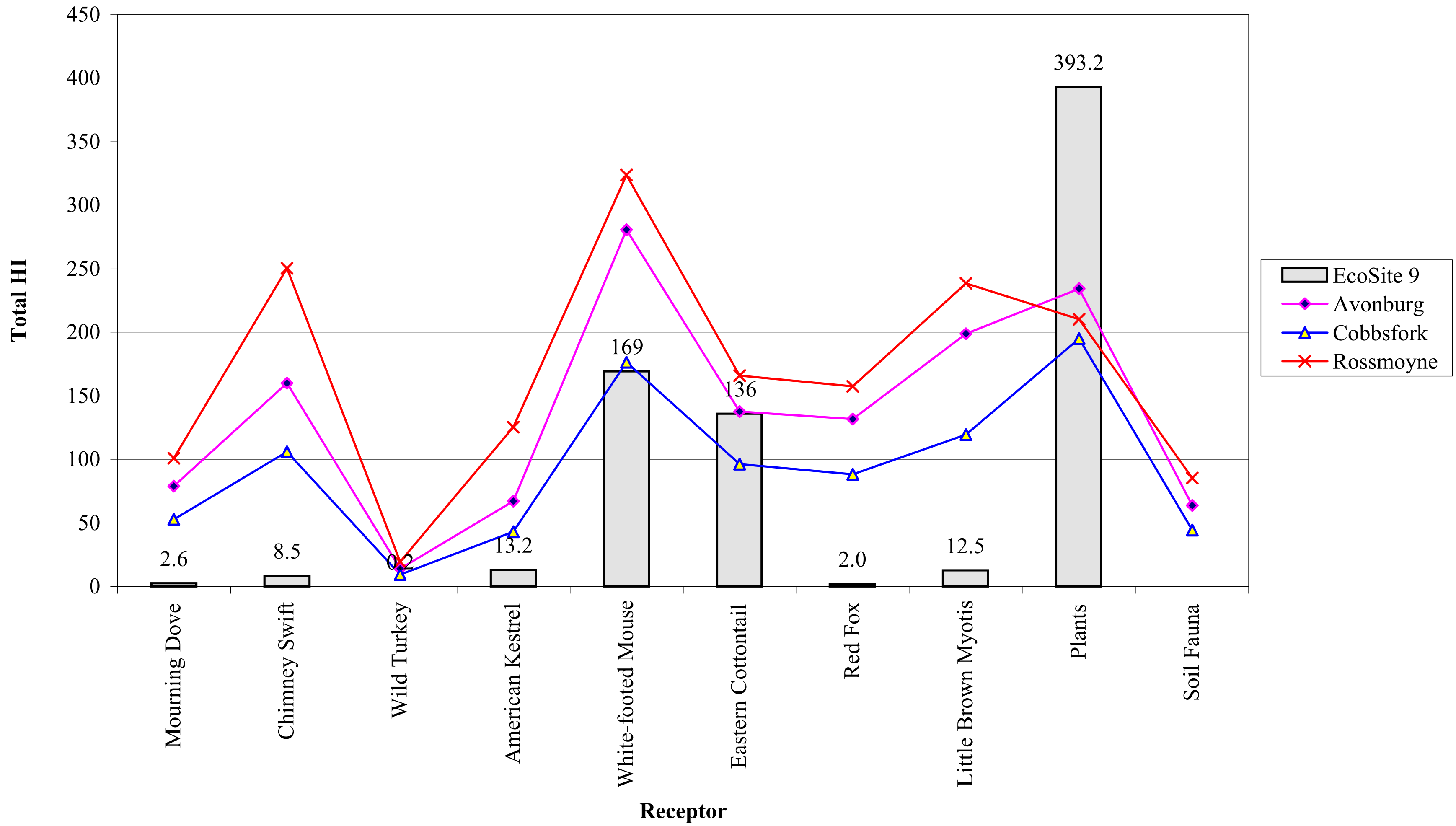
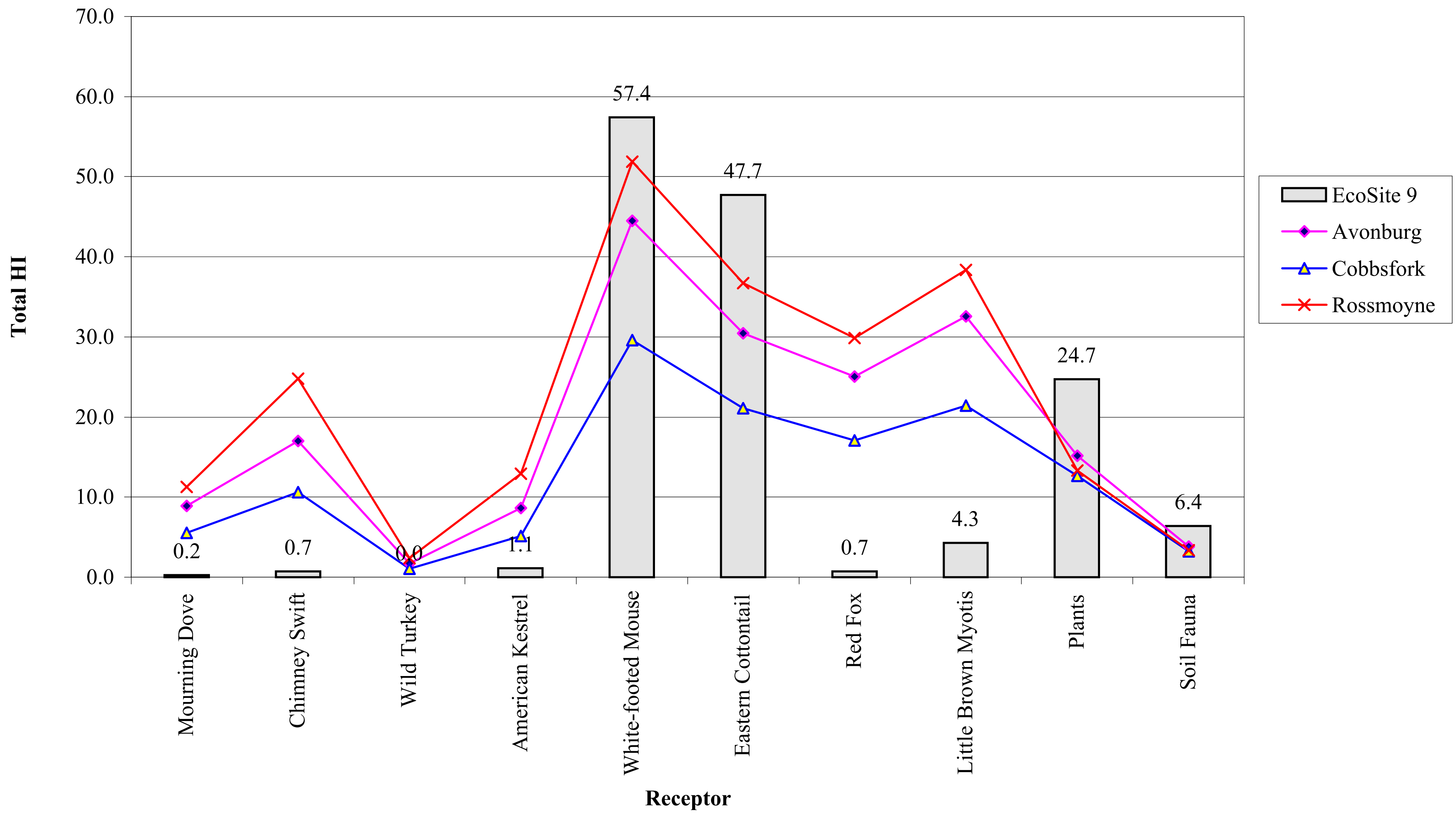


Figure 12.7-10 Total HIs-RME Risks Summed for All Pathways Based on NOAELs at Eco Site 9 - Phase III

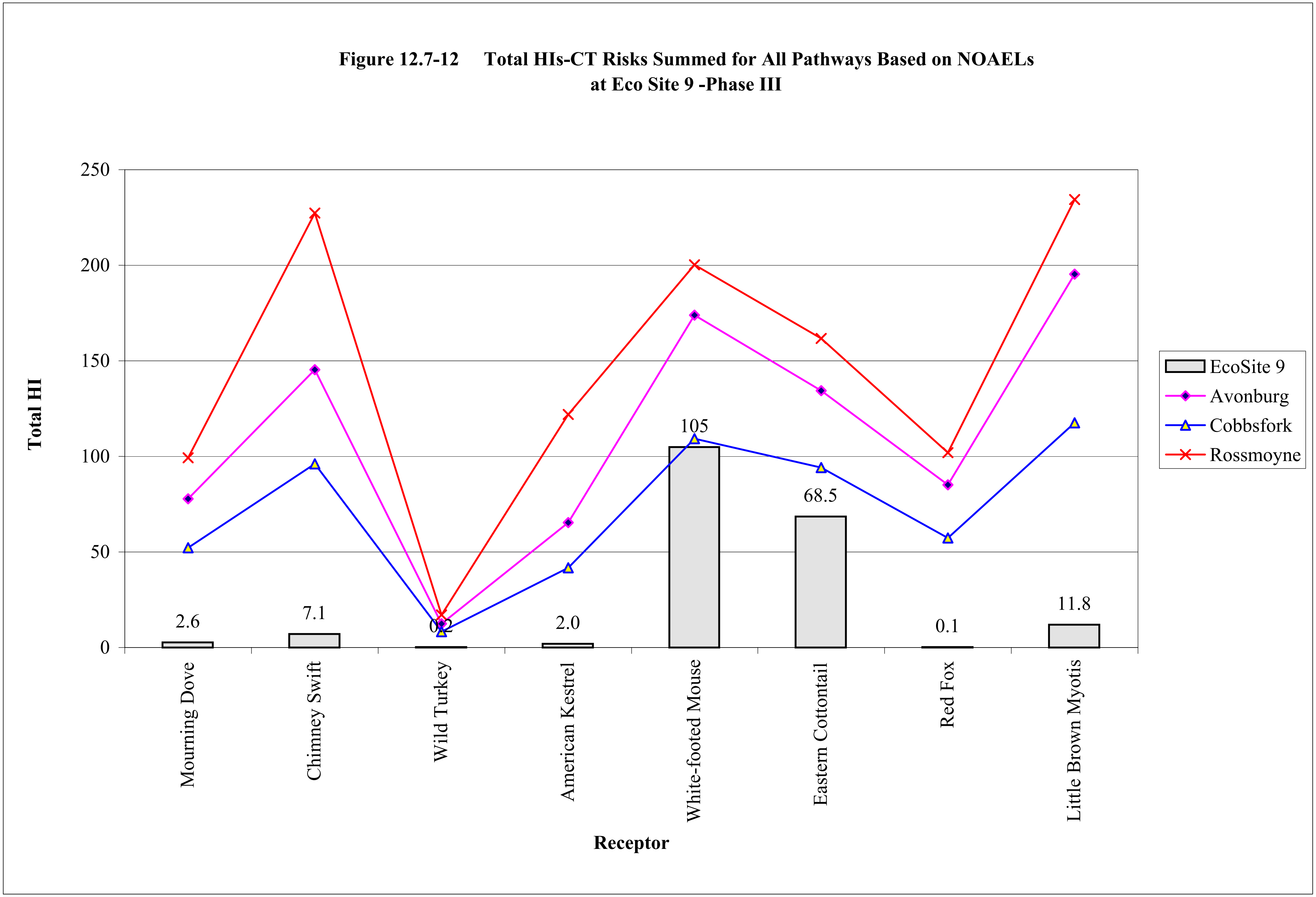


N:\jobs\244\0025\01\ET ECO FILES\Jpg\Phase3\Risk2\P3era_9MWH.xls Figure 12.7-10

Figure 12.7-11 Total HIs-RME Risks Summed for All Pathways Based on LOAELs at Eco Site 9 - Phase III

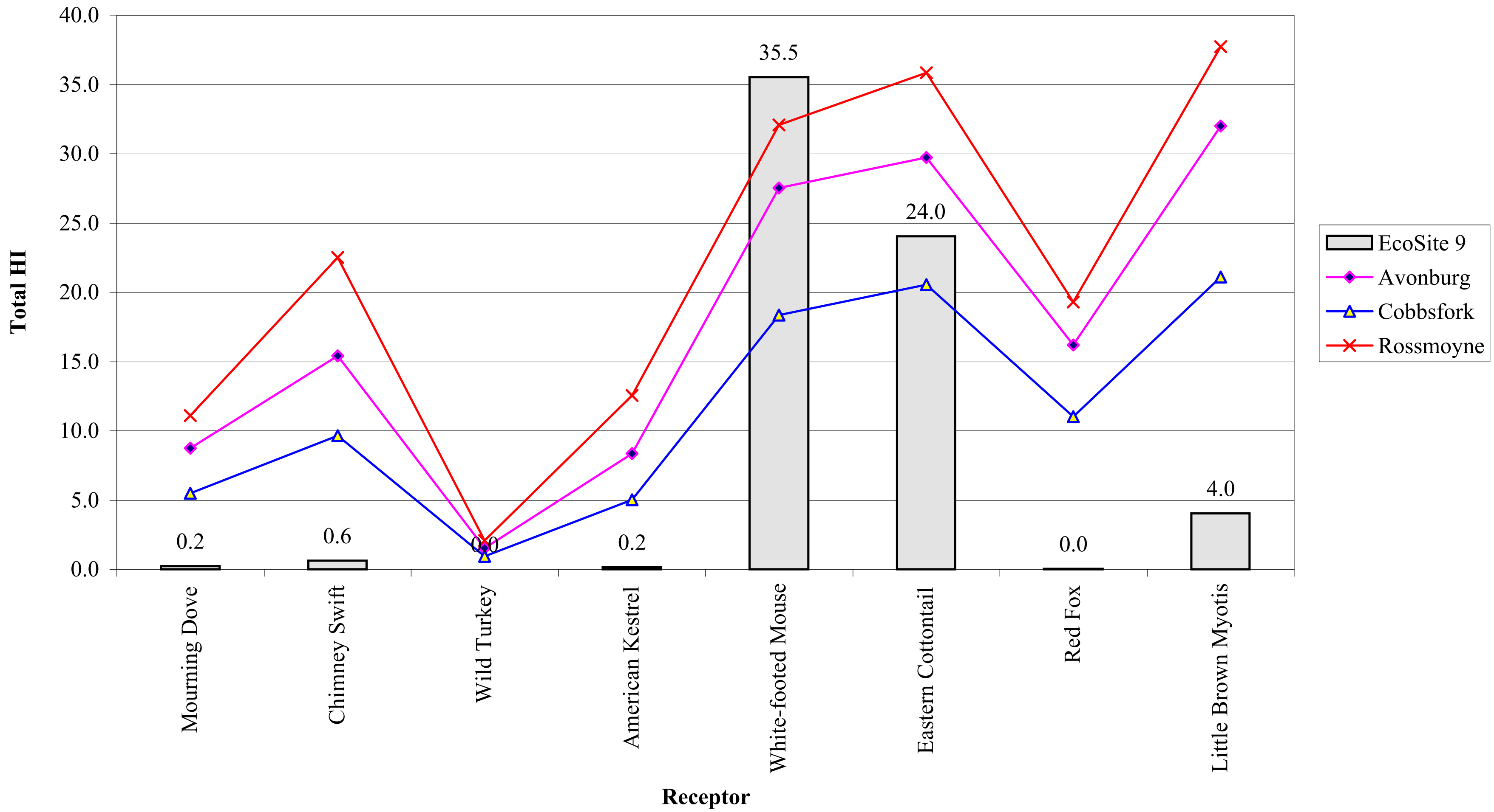


N:\jobs\244\0025\01\ET ECO FILES\Jpg\Phase3\Risk2\P3era_9MWH.xls Figure 12.7-11



N:\jobs\244\0025\01\ET ECO FILES\Jpg\Phase3\Risk2\P3era_9MWH.xls Figure 12.7.12

Figure 12.7-13 Total HIs-CT Risks Summed for All Pathways Based on LOAELs at Eco Site 9 - Phase III



N:\jobs\244\0025\01\ET ECO FILES\Jpg\Phase3\Risk2\P3era_9MWH.xls Figure 12.7.13

13.0 BUILDING 602 SOLVENT PIT (SITE 12A)

13.1 SITE CHARACTERISTICS

Building 602 is located just north of Woodfill Road about one-third of a mile west of Tokyo Road (Figure 2-1 ~~13-1~~). Building 602, a former ammunition-assembly plant, was being used as an employee break area and a boiler plant at the time of the Phase I RI. Since facility closure in 1995, the building has no longer been in use.

Building 602 was previously the site of a 25,000 gallon leaking underground storage tank (UST) that was used to store No. 2 diesel fuel (Site 35). ~~-~~In 1988, the 25,000 gallon tank was removed and the associated contaminated soils were excavated and stockpiled in the parking area east of the building prior to off-site disposal (Site 24). It was suspected that surface runoff from the stockpiled soils may have resulted in contamination of the small drainage swale adjacent to the stockpile. A second 1,000 gallon UST was also located in this vicinity but had been removed before the beginning of the Phase I investigation. The 1,000 gallon UST also contained No. 2 fuel oil. (EPA21) The Phase I RI resulted in the determination that the residual contamination associated with Sites 24 and 35 posed no unacceptable risks to human health and the environment. The solvent pit (Site 12A), however, was found to contain contaminants in concentrations that may pose a possible future threat to human health. As a result, additional Phase II investigations were completed for Site 12A.

The solvent disposal pit, located immediately adjacent to Building 602 (Figure 13-1), consist~~s~~ed of a pit, approximately 3 feet in diameter and 3 feet deep, filled with gravel. It was used from 1970 to 1978 to dispose of waste solvents/degreasers, including 1,1,1-trichloroethane (TCA) used during routine maintenance and sonic cleaning of gauges. An estimated maximum of 500 gallons of ~~trichloroethane~~ TCA was disposed ~~of~~ in this pit~~. Other unknown solvents and degreasers were also likely disposed of in the pits~~. This disposal practice resulted in VOC contamination of the surrounding soils.

The area around Building 602 is relatively flat and surrounded by a combination of open grassy areas and pavement. Woods encroach on the south and east sides of Building 602. Surface water~~s~~ drains into a ditch along the railroad tracks south of the building and then flows to the west toward the landfill pond, eventually discharging into Middle Fork Creek (Figure 2-1). The soils surrounding the site belong to the Cobbsfork soil series. The glacial till is about 30 feet thick at this site and is underlain by the Jeffersonville Limestone of Devonian age. The Phase I monitoring well cross section shows the ~~bedrock~~ unconsolidated formations, screened intervals, and water levels (Figure 13-2). The Phase II cross section shows the unconsolidated (glacial till) and bedrock formations and the screened intervals for temporary and permanent monitoring wells (Figure 13-3)

The VOC contaminated soils in the vicinity of the solvent pit were excavated and disposed of during the solvent pit removal activities conducted from July 19 through September 21, 2000. Approximately 140 tons of soils were excavated. Confirmation sampling was performed to

assess the remedial action. Minor residual contamination was detected in the confirmation samples. However, additional excavation was not performed due to the proximity of building structures and the potential for undermining those structures. Following receipt of analytical results, contaminated soils were transported for disposal at an off-site regulated disposal facility. The excavation site was backfilled with clean fill material that was compacted, and 10-10-10 fertilizer was added to the backfill to promote biological activity in the soils. A perforated PVC pipe was also added along the footprint of building 602 so that additional fertilizer could be added to the soil if needed. A detailed description of the construction activities and sample results is contained in the *Draft-Final Construction Completion Report, Remedial Removal Actions, Sites 12A, 12B, 12C, and 33* (Montgomery Watson, February 2002).

13.1.1 Groundwater

At Building 602, groundwater ~~exists in two distinct zones. Groundwater~~ is encountered in the bedrock aquifer system and in the ~~perched zone on top of the Illinoian~~ glacial till. A total of ~~nine~~ 12 groundwater monitoring wells have been installed in the bedrock ~~to depths of 69 feet below ground surface~~ or at the till/bedrock interface (Figures 13-1 and 13-3). ~~Eight~~ Nine of these wells are screened in the upper 9 feet of the Jeffersonville Limestone and approximately 1 foot in the overlying ~~Illinoian~~ glacial till (approximate depth of 35 ft). The ~~last~~ three remaining wells (MW96-01, MW01-10, and MW01-11) ~~was~~ were screened ~~almost entirely~~ in the Louisville Limestone, which overlies the Waldron Shale (approximate depth of 65 ft). The Waldron Shale is an impermeable unit and is considered the lower boundary of the first encountered bedrock ~~groundwater~~aquifer. A summary of monitoring well information is shown in Table 13-1a.

The bedrock ~~groundwater~~ aquifer underlying this site is semi-confined, with the depth to the potentiometric surface ranging from 9 to 11 bgs. Water-level data collected from the four existing wells in June, August, and September 1993 were inconclusive in terms of defining groundwater flow direction. The horizontal groundwater gradient, ~~on the basis of~~based on water level measurements performed since ~~the~~ August 1993, is ~~water level data was~~ essentially flat. Minor apparent flow deviations occurred in each round of water level measurement, but did not yield a definitive or consistent groundwater flow direction. ~~, while the data collected in September 1993 suggested groundwater flow to be toward the northwest with a gradient of 0.0022 foot/foot.~~ Additional monitoring wells installed during Phase II and in 2001were intended ~~designed~~ to provide the information needed to define groundwater flow characteristics and to characterize the nature and extent of contamination.

Groundwater elevation data were measured at Building 602 on 11 occasions over 3 years (see Table 13-1b). Figures 13-4 through 13-7 show water level data collected in November 1995 and February, April, June, October, November, and December 1996. With the installation of the additional wells in 2001, subsequent water-level measurements suggest that the groundwater flow direction is primarily to the south (Figures 13-7a & 13-7b). (EPA77)

As discussed in Section 13.5.1, the head measured in the aquifer across Site 12A is relatively uniform. Accordingly, assumptions regarding groundwater flow direction were based on observed contaminant distribution relative to the known solvent pit source area.

~~However, from t~~The monitoring well chemical data~~,~~ shows that the solvent plume ~~appears to have~~has spread from the source area, represented by groundwater quality results from well MW93-47, to wells MW93-46 and MW95-10, suggesting a local groundwater flow direction to the southeast. (EPA14d, 79d)~~ and northeast, respectively. As shown in Figures 13-4 through 13-7, groundwater flow direction at this site is variable.~~

13.1.1.1 ~~Perched~~ Shallow Groundwater. Small diameter well points were installed ~~on top of and, in some instances,~~ within the ~~Illinoian~~ glacial till during the field screening work performed during April 1996. The well points were designed to assess aquifer hydraulics and groundwater flow near the water table surface, and ~~. These well points were used to~~ to evaluate ~~the~~ groundwater quality~~characteristics of~~in the ~~perched zone~~ glacial till at the solvent pit sites. Water-level measurements were collected from the well points in April, June, October, and November 1996 (Table 13-1c).

The elevation of groundwater in the ~~perched zone~~ glacial till was ~~is typically~~ 3 to 5 feet higher than the apparent potentiometric surface ~~of groundwater~~ in the bedrock ~~system~~ aquifer. The till at Site 12A is comprised primarily of silt and clay with some sand and gravel. Groundwater recharge through such material can give the appearance of high potentiometric head during wet periods versus low potentiometric head during dry periods. This occurs because of the susceptibility of the aquifer material to high tension head following precipitation events. High tension head further slows the potential for recharge through the till. The area in the aquifer where this occurs is also known as a tension-saturated zone (Freeze and Cherry, 1979).~~, as shown in Figure 13-3.~~

The ground-surface elevation at Building 602 has minor changes in surface elevation and varies only 3 to 4 feet. ~~The vertical potential gradient in the perched groundwater at Building 602 is down with a value between 0.12 and 0.2 ft/ft. Groundwater elevations increase and decrease as a direct result of the changing seasons.~~ Groundwater elevations ~~appear~~ at Site 12A are observed to be highest in typically wet months (February and April) and lowest in typically dry months (October and November).

~~There appears to be a~~An inverse relationship between precipitation and groundwater gradient has been observed at the site and has been attributed to the existence of a tension-saturated zone in the glacial till. The ~~perched~~ groundwater gradient measured in the till apparently decreases during times when precipitation increases. This typically occurs when the pore spaces fill with water. As the moisture content in the soil increases, the pressure head and hydraulic head increase while the downward hydraulic gradient decreases. This decrease in downward hydraulic gradient is balanced by an increase in hydraulic conductivity values under the influence of rising pressure head. Thus, infiltration continues to decrease until a time when the gradients and conductivities can no longer accept all of the infiltration due to

the high tension head that has been developed. When that occurs, ponding, interflow, and overland flow can occur (Freeze and Cherry, 1979).

Groundwater ~~perched on top of~~in the ~~Illinoian~~ glacial till at Building 602 occurs at depths between 4 and 8 feet below ground surface. The apparent horizontal hydraulic gradient of the ~~perched~~ shallow groundwater was calculated to be between 0.03 (April 1996) and 0.067 ft/ft (October 1996), with an average of 0.043 ft/ft. The ~~perched~~ groundwater flow direction is inferred from the contour maps to be consistently to the southeast (Figures 13-8, 13-9, and 13-10).

~~The perched~~ The shallow groundwater in the glacial till is in communication with the bedrock aquifer as demonstrated by the pumping test results (Section 13.1.1.3). Drawdown associated with the pumping test performed on well MW93- 46 installed in the bedrock was recorded in five of the well points screened in ~~or on top of~~ the ~~Illinoian~~ glacial till. The drawdown results are plotted in Appendix B (Figure B-2). Groundwater levels in the ~~perched zone~~ glacial till did not ~~never~~ recover~~ed~~ to pre-test levels after the test was complete, as shown by the recovery data in Appendix B (Figure B-2). In three of the well points (WP-19, WP-23, and WP-24), ~~perched~~ shallow groundwater continued to decline even after the pump was shut off. The decline in head observed after the pump test is a characteristic response to a reduction in tension head in the till (Freeze and Cherry, 1979). The rate of decline during the pumping test, compared to the decline following it, indicates that ~~most~~ the glacial till is hydraulically connected to the bedrock aquifer, and the~~of the~~ drawdown observed in the till was in direct response to the pumping test in the bedrock aquifer.

Shallow groundwater ~~perched on top of~~in the glacial till appears to recharge the bedrock aquifer as flow through porous media and through vertical fractures in the till. The relationship between the ~~perched~~ till and bedrock groundwater systems are illustrated by the conceptual model presented in Figure 13-11.

Field experiments by McKay et al. (1993a and 1993b) yield values of hydraulic conductivity for till similar to those measured at the JPG. Relatively large test volumes, similar in size to the volumes sampled by slug tests, yield K values of about 10^{-5} cm/sec. Smaller scale *in situ* and laboratory tests reveal that the till matrix is typically about 10^{-8} cm/sec. Fractures in the till, however, can cause bulk permeabilities as high as 10^{-4} cm/sec.

McKay and others (1993a and 1993b) found till matrix porosities to be about 0.40. This relatively high porosity likely leads to significant diffusion of solutes into the till matrix. The strong tendency for matrix diffusion can complicate active remediation efforts in the till because solutes stored in the till matrix are readily attenuated and may be difficult to extract. Fracture porosity is much lower, on the order of 10^{-5} to 10^{-3}.

Thus, although the fractures may provide important pathways for solute transport, they will hold only relatively small volumes of solute. As a consequence, only small spills are required to cause contamination of large areas of the subsurface. Small fracture porosities could also contribute to the relatively large vertical variations in water levels. Seasonal or storm-based

changes in groundwater recharge can rapidly fill the low porosity fracture network, causing a rapid rise in water levels in piezometers connected to the fracture system, and promoting tension-saturated zones, as discussed above.

Insight into the process of vertical transport of solutes through fractured till is provided by has been examined in numerical simulations (Harrison et al. 1992). Small hydraulically active fractures that are very difficult to detect or identify within clayey deposits may cause rapid and large-scale contamination of the underlying groundwater. Significant transport can occur through fractures with aperture on the order of 10 to 50 μm or greater. Small, deep, widely spaced fractures can be significant yet difficult to detect.

13.1.1.2 Bedrock Groundwater Elevation and Hydraulic Gradients. The bedrock aquifer discussed in this section pertains to that groundwater encountered above the Waldron Shale and focuses on the upper 10 feet of the Jeffersonville Limestone. Groundwater in the bedrock equilibrates at depths between 3 and 14 feet bgs, depending on well location and the time of year (Figures 13-4 through 13-7). The potentiometric surface of the bedrock groundwater system aquifer occurs below the surface of the perched groundwaterwithin the glacial till at Site 12A. The hydraulic gradientregional groundwater flow within of the bedrock flow system is generally toward the southwest (Figures 2-16 and 2-17). However, contamination observed in wells located to the southeast of the solvent source area suggest a local groundwater flow component is present causing groundwater to flow toward the southeast, suggesting a flow in the same directionbased on observed contaminant distribution. However, the actual flow path may be controlled more by fractures in the bedrock than the hydraulic gradientHowever, heads are relatively uniform in the bedrock underlying Site 12A, and corresponding horizontal hydraulic gradients are quite flat. (EPA81)

The series of bedrock groundwater contour maps presented as Figures 13-4 through 13-7 attempted to illustrate the potentiometric surface of the groundwater in the upper 9 feet of bedrock from June, August, and September 1993, and from November 1995 to December 1996. The water level data collected in 1995 and 1996 were done so at a frequency that would potentially record the changes in groundwater elevations in response to changing seasons.

The potentiometric surface of the bedrock groundwater varied over the period it was monitored. Generally, groundwater elevation is highest near Building 602 and decreases to the southwest and the north-northeast. The apparent groundwater high near the building forms a ridge that may have allowed groundwater to flow to the southwest and north-northeast from the former solvent pit.

The contour maps produced for November 1995, and February and April 1996 indicate a the apparent horizontal hydraulic gradient to the southwest with values of 0.0035 ft/ft, 0.001 ft/ft, and 0.0007 ft/ft, respectively (Figures 13-4 and 13-5). However, there is also a slight), and a small apparent horizontal hydraulic gradient to the north-northeast during these three months. -With the addition of wells MW96-6 and MW96-7 in April 1996, interpretation of the groundwater potentiometric surface becomes became more complex (Figures 13-5 through 13-7). The groundwater ridge high near Building 602 is still evident, but groundwater at well

MW96-6 is higher compared to the remainder of the site. A steeper apparent horizontal hydraulic gradient of approximately 0.006 ft/ft existed from well MW96-6 to the northwest toward MW93-46. In June 1996 (Figure 13-5), the apparent horizontal hydraulic gradient on the east half of the site from well MW96-6 to MW93-46 was still toward the northwest; however, the apparent horizontal hydraulic gradient on the west half of the site from well MW93-38 to MW93-46 appeared to be reversed and was toward the northeast. October, November, and December 1996 groundwater contour maps show a very similar potentiometric surface. During these months, an apparent groundwater ~~ridge~~ high was present near the building, and the apparent horizontal hydraulic gradient directions from the former solvent pit were to the southwest and the northeast.

Groundwater flow in the bedrock aquifer at Building 602 may be controlled ~~more~~ by fracture orientation rather than hydraulic gradient. This statement is based on the distribution of the contaminants in the groundwater. Groundwater monitoring wells located southwest of the former solvent pit either contain very low or no detected concentrations of ~~dissolved solvent~~ VOC compounds. Whereas, well MW93-46 located southeast of the former solvent pit is the second most contaminated well at ~~Building 602~~Site 12A. The site-scale permeability structure of the bedrock due to heterogeneities caused by fractures, solution-enhanced permeability, and bedding-plane fractures may provide an environment where the ~~actual~~ groundwater flow path can vary ~~significantly~~ from the apparent hydraulic gradient, and can cause local influences in groundwater flow that may be different from the observed regional groundwater flow. Fracture orientation may then control the direction and distribution of contaminant migration away from the source area. Fractures at Site 12A may play a role in the observed contaminant distribution and localized changes in groundwater flow direction. (EPA80) ~~However, the ultimate flow path of the groundwater system in the bedrock is controlled by the JPG-scale head distribution.~~

Vertical ~~potential~~ hydraulic gradients were examined using the groundwater elevation data from wells MW96-1 and MW93-47 located near the former solvent pit. Well MW93-47 is screened from 29 to 39 feet bgs, and well MW96-1 is screened from 58 to 68 feet bgs. The vertical potential gradient between these two wells has always been down and ranges from a low of 0.01 ft/ft to a high of 0.053 ft/ft, with an average of 0.028 ft/ft. Similarly, the vertical hydraulic gradients were calculated for two new well nests in 2001. Table 13-1d presents the results and indicates that vertical hydraulic gradients are relatively small ranging from 0.002 to 0.022 ft/ft and that direction is generally downward.

13.1.1.3 Pumping Test Results. A pumping test was performed at Building 602 to determine the hydraulic conductivity of the bedrock aquifer, and to evaluate the hydraulic connection between the till and underlying bedrock. The pumping test was also performed to determine the effective radius of the pumping well in the event extraction of contaminated groundwater ~~is~~ became a viable option for the feasibility study. The pumping test was conducted before the installation of the three 2001 monitoring wells occurred. Appendix B contains detailed information on the pumping test. (EPA19)

Well MW93-46 was pumped at a constant rate of 2 gallons-per-minute (gpm) for 17 hours, producing 7.64 feet of drawdown (in the pumping well). Drawdown was recorded in all of each of the wells at the site except for MW93-48 (see Appendix B) (IN19). Drawdown amounts ranged from a low of 1.8 feet in well MW96-1 (deep well), to a high of over 6 feet in wells MW93-45, MW93-47, and MW95-10. Drawdown was measured at 2.04 feet in well MW96-6, located furthest from the pumping well at a distance of approximately 280 feet.

The results of the pumping test at Building 602 are presented in Table 13-2. A more detailed discussion of the methods used and corresponding results are provided in Appendix B. As shown in Table 13-2, the average K value for each well was determined from K values computed using different analytical methods. The results indicate that K is not very sensitive to the method applied. The averaged K values for each well using all various methods ranged from a low of 2.85 x 10^{-4} cm/sec to a high of 8.33 x 10^{-4} cm/sec. The site average K value computed from the pumping test was 5.54.34 x 10^{-4} cm/secsec. The drawdown results were also reduced using the distance drawdown method. The distance drawdown method yielded two slopes, A and B (see Appendix B). The computed K value for Slope A was 5.2 x 10^{-4} cm/sec, and the computed K value for Slope B was 1.4 x 10^{-4} cm/sec. The average of the two was 3.3 x 10^{4} cm/sec, which is comparable to the results obtained using analytical methods.

Review of the data sets suggests one interpretation that is consistent with the geological structure. Two major, vertical fracture sets might provide the maximum values of K indicated in northwest-southeast, north-northeast, and south-southwest directions (see Figure 2-8). The lower K values indicated at other orientations might reflect the impact of a set of horizontal fractures that exhibit internal anisotropy within the horizontal fracture plane(s), combined with the influence of anisotropy found within subhorizontal and bedding-controlled fractures and regions of solution-enhanced permeability.

As mentioned previously, groundwater in the perched zone glacial till responded to pumping of in the bedrock aquifer. Since the drawdown in the perched zonetill was in response to pumping in the bedrock aquifer, below, the results may be more representative of vertical hydraulic conductivity valuesconfirm that the bedrock and till are hydraulically connected. The results of the hydraulic conductivity values calculated from the drawdown produced in the perched zonetill are shown in Table 13-3. Hydraulic conductivity values ranged fromranged from a low of 8.0 x 10^{-4} at temporary well point WP-21 to a high of 9.1 x 10^{-3} cm/sec at temporary well point WP-22. Both of these temporary well points were are located approximately 15 feet from the pumping well. Well point WP-21 was installed within the Illinoian till, while well point WP-22 was installed on top of the till (Table 13-4).Table 13-4 presents the distance-drawdown information for the temporary well points. The uncharacteristically high hydraulic conductivities and the variations in the drawdown observed at comparable distances from the pumping well may indicate that the calculated hydraulic conductivities may be a combination of horizontal flow at the bedrock/till interface and vertical flow through microfractures in the glacial till.

13.1.1.4 Seepage Velocity Determination. The range of seepage velocities are presented in Table 13-5. In Table 13-5, the highest, lowest, and average K value derived from the pumping

test were used with a range of hydraulic ~~conductivity~~ gradients and effective porosity values to determine the range of seepage velocities for the bedrock groundwater. The effective porosity of fractured bedrock reportedly can range from 1 to 30 percent (Fetter 1988). As evident by the range in values in Table 13-5, the seepage velocity is very sensitive to hydraulic gradient and the effective porosity. The data presented in Table 13-5 suggest that the groundwater at Building 602 could flow as little as 1 foot per year, or as much as 301 feet per year. Both of these end member values seem unreasonable given the location of wells that ~~solvent~~ VOC contamination has been detected.

For instance, during the Field Screening work in April 1996, temporary well point WP96-7 was installed on top of the bedrock within the ~~Illinoian~~ glacial till, 210 feet south of the former solvent pit. Groundwater samples collected from this well point contained 4.9 and 3.0 parts-per-billion 1,1-DCA and 1,1-DCE, respectively. These ~~solvent~~ VOC detections in temporary well point WP96-7 ~~are~~ were some of the furthest removed from the former solvent pit. Assuming the former solvent pit was discontinued as a disposal receptacle in 1978, and that in 1978 solvents had impacted the groundwater beneath the former solvent pit, a travel time of approximately 11 feet per year (220 feet/20 years = 11 ft/year) is calculated. The combination of parameters that best fit this seepage rate is an average K value of 5.5×10^{-4} cm/sec, a hydraulic gradient of 0.0035 ft/ft, and an effective porosity of 0.15.

13.1.1.5 Downhole Flow Meter Results. A flow meter was used to further characterize groundwater flow direction(s) at Building 602. The flow meter consisted of a heat pulse surrounded by 10 thermal sensors that was lowered down the well to the screen interval. The groundwater was allowed to equilibrate for approximately 5 to 15 minutes before measurements began. The instrument operates by producing heat pulses and simultaneously measuring the temperature differential between thermal sensors. Sensors that are in line to groundwater flow are cooled more quickly causing the temperature differential. Plotting the measured temperature differential in vector form determines the groundwater flow direction.

The flow meter was used in wells MW93-45, MW93-46, and MW93-48 with flow measurements collected at three different vertical positions within the screen interval of each well. Testing three sections of the screen interval was more likely to encounter a fluid transmitting fracture(s).

The flow meter results showing groundwater flow direction and velocity for wells MW93-45, MW93-46, and MW93-48 are presented in Appendix B (Figure B-3). Generally, the flow meter results agree with the flow direction inferred from the groundwater contour maps (Figures 13-4 through 13-8) generated for Building 602. Based on the flow meter, groundwater in well MW93-45 flows to the north ~~at a velocity of 1.6 ft/d~~.

From the flow meter measurements performed in well MW93-46, groundwater may flow to the northeast or south. A flow direction to the south is supported by the November 1995 (Figure 13-4), and February and April 1996 (Figures 13-4 and 13-5) groundwater contour maps. Groundwater flow to the northeast is supported by the June 1996 groundwater contour map (Figure 13-5). Groundwater in the vicinity of well MW93-46 could flow to the northeast

or the southwest as interpreted from the October 1996 (Figure 13-6) groundwater contour map. The different flow directions may be attributed to the local bedrock fracture orientation or the occasional localized ~~a possible localized~~ groundwater high in the vicinity of Building 602. ~~;~~ ~~t~~This apparent groundwater high ~~may~~ experiences seasonal fluctuations ~~in position which may account for changing hydraulic gradient directions.~~corresponding to changes in precipitation and attendant groundwater recharge.

The results from the flow meter measurements indicate a southern component of groundwater flow in well MW93-48. Generally, this is in agreement with ~~all~~ the groundwater contour maps except for the June 1996 map (Figure 13-5).

13.2 PREVIOUS INVESTIGATIONS

Some information was available from previous site investigations; however, the sites had not been completely characterized, so additional site characterization was required during the current RI. A previous RI was conducted at this site by Environmental Science and Engineering (1989). The investigation consisted of soil-gas surveys and soil sampling. Although ~~no~~ VOC contamination was not detected during the soil-gas investigation, soil samples collected immediately adjacent to the ~~disposal~~ former solvent pit (within 2 to 3 feet laterally) contained the following contaminants:

- Acetone
- 1,1,1-Trichloroethane
- 1,1,2-Trichloroethane
- 1,1-Dichloroethane
- 1,2-Dichloroethane
- Toluene
- Trichloroethane

The analytical data acquired from the two soil samples collected near Building 602 during the previous RI indicated that solvents were present in the soils adjacent to the former solvent disposal ~~area~~ pit. The lateral and vertical extent of soil contamination was not characterized during this 1988 RI investigation. The RI report (ESE 1989) recommended that the soil in and around the solvent pit be removed or remediated. Installation of groundwater-monitoring wells was also recommended to determine the horizontal and vertical extent of groundwater contamination, ~~strength~~ magnitude of the contaminant sources, and groundwater flow characteristics.

The Building 602 Solvent Disposal Pit was included in two previous investigations by Ebasco, reported in the *Enhanced PA Report* (1990a) and the *Master Environmental Plan* (1990b). This site is listed in the Enhanced PA as SWMU 27.

13.3 STUDY AREA INVESTIGATIONS

13.3.1 Phase I RI Field Activities

13.3.1.1 Surface Soils. During Phase I, four surface soil samples (A to D) were collected from soil borings located adjacent to the solvent pit at Building 602 to confirm the results of the previous RI (Figure 13-12). Soil core/cuttings were scanned for VOCs using a PID. Potentially contaminated intervals identified with the PID were sampled as well as predetermined soil depths. ~~All~~The samples were analyzed for VOCs. (EPA13f).

13.3.1.2 Subsurface Soils. During Phase I, eight subsurface-soil samples were collected from the four soil borings (A to D) installed near the solvent pit and analyzed for VOCs. Analytical results from these samples indicated that solvent-related contamination was present in soils.

The detection of VOCs in the subsurface soils resulted in the recommendation for a field-screening survey to be conducted. A field-screening survey using direct push probeholes was conducted during Phase I of the RI to provide additional information on the nature and extent of solvent contamination in the subsurface soil and shallow groundwater. A total of 18 probeholes (PH01 to PH18) were completed and sampled for VOC analysis (Figure 13-12). (EPA13f).

13.3.1.3 **Groundwater.** Since the effectiveness of the previous soil-gas surveys for detecting contaminants potentially present in the groundwater was considered questionable, groundwater samples were collected during the Phase I RI at Building 602. Well locations were selected based on the results of soil boring samples and the field-screening survey. Four wells (MW93-45 through MW95-48) were installed at the site and analyzed for VOCs (Figures 13-1 & 13-2). (EPA13f).

13.3.2 Phase II RI Field Activities

13.3.2.1 Surface Soils. ~~No a~~Additional surface soil samples were not collected during Phase II.

13.3.2.2 Subsurface Soils. ~~No a~~Additional subsurface soil samples were not collected during Phase II.

13.3.2.3 Groundwater. Phase II ~~field work~~fieldwork was designed to permit better understanding of groundwater flow direction and the distribution of ~~solvent~~ VOC contamination in groundwater. Eight temporary well points (WP96-19 through WP96-26) were installed as part of a second field screening program designed to better define ~~solvent~~ VOC

contaminant distribution and groundwater flow direction in both the glacial till and bedrock. Four additional top of bedrock wells (MW95-10, MW95-11, MW96-6, and MW96-7) were installed during Phase II.

Four rounds of sampling were conducted for two wells (MW95-10 and MW95-11), and two rounds were conducted for the other two (MW96-06 and MW96-07) because these wells were installed after the first two rounds of sampling were completed. In addition, a deep bedrock monitoring well (MW96-01) was installed and sampled to determine the vertical extent of contamination.

In June 2001, the eight monitoring wells at the site were sampled to collect more recent groundwater quality data and to evaluate the potential for natural attenuation. Water samples were analyzed for VOCs and the natural attenuation parameters: total iron, total manganese, total organic carbon, dissolved gases (ethene, ethane, methane, and carbon dioxide), sulfate, sulfide, nitrate, total kjeldahl nitrogen, chloride, and alkalinity. In addition, field indicators for natural attenuation were also measured including dissolved oxygen (DO), oxidation-reduction potential (ORP), pH, conductivity, and temperature.

Based on the June 2001 monitoring results, three additional monitoring wells (MW01-09, MW01-10, and MW01-11) were installed at Site 12A in November 2001 to augment the existing site monitoring well network (Figure 13-1). (EPA81) Wells MW01-09 and MW01-10 were installed as bedrock wells in the Louisville Limestone, and well MW01-11 was installed at the bedrock/till interface. Well MW01-09 was installed near well MW93-46 to form a well nest to the southeast of the former solvent pit, while well MW01-10 was installed near well MW93-48 to form a well nest to the southwest of the former solvent pit. Well MW01-11 was installed to the southeast of well MW01-09, between wells MW01-09 and well MW96-06. Groundwater samples were collected in November 2001 from the three new wells. Water samples were analyzed for VOCs and natural attenuation parameters. Field indicators for natural attenuation were also measured.

13.3.3 Interim Measures Removal Action

The VOC contaminated soils in the vicinity of the solvent pit were excavated and disposed of during the solvent pit removal activities conducted from July 19 through September 21, 2000. Approximately 140 tons of soils were excavated. Confirmation sampling was performed to assess the remedial action. Minor residual contamination was detected in the confirmation samples. However, additional excavation was not performed due to the proximity of building structures and the potential for undermining those structures. Following receipt of analytical results, contaminated soils were transported for off-site disposed at a regulated disposal facility. The excavation site was backfilled with clean fill material that was compacted, and 10-10-10 fertilizer was added to the backfill to promote biological activity in the soils. A perforated PVC pipe was also added along the footprint of building 602 so that additional fertilizer could be added to the soil if needed. A detailed description of the construction activities and sample results is contained in the *Draft-Final Construction Completion Report,*

Remedial Removal Actions, Sites 12A, 12B, 12C, and 33 (Montgomery Watson, February 2002).

13.4 DATA EVALUATION

13.4.1 Data Validation Results

During Phase I, one VOC (chloromethane) had a low calibration response, and ~~all~~ the results were rejected. The CRLs were elevated for six VOCs; the elevated CRL for MEK exceeded the Region 5 DQL. The Phase I VOC groundwater results were not used for the risk assessment other than for qualitative information. None of the soil sample data were rejected. The following two groundwater sample results were rejected during Phase I:

- Chloromethane in SVA12GWB01 and -C01

For Phase II data (four rounds), the results for one VOC (vinyl acetate) were rejected due to insufficient calibration or low response in the calibration in several analytical batches. The results for MEK (also known as 2-butanone) were either estimated or rejected due to calibration outliers. Analytes associated with the rejected data were not included in the database used for the human health risk assessment. The following groundwater sample results were rejected during Phase II:

- February 1996
  - MEK in samples SVA12GWA03, -D03, -F02

- Spring 1996
  - MEK in samples SVA12GWA04, -B04, -C04, -D04, -E03, -F03, -G01, -H01, and -I01

- Summer 1996
  - MEK in samples SVA12GWA05, -B05, -C05, -D05, -E04, -F04, -G02, -H02, -I02, and -I02D

- January 1997
  - Acetone in sample SVA12GWE01
  - Vinyl acetate in samples SVA12GWA02, -B02, C02,-D02, -E01, and -F01
  - MEK in samples SVA12GWE01 and -F01

For supplemental groundwater sampling, acetone and 2-butanone were rejected when not detected due to low relative response factors. In addition 1,1,2-trichloroethane, carbon tetrachloride, and trans 1,3-dichloropropene were rejected when not detected due to low method reporting limit, (MRL) continuing calibration verification results. The following groundwater samples were qualified.

- 1,1,2-trichloroethane - S12AMW01-50, S12AMW93-48, S12AMW95-10, S12AMW95-11, S12AMW96-01

- acetone - S12AMW01-50, S12AMW93-45, S12AMW93-46, S12AMW93-47, S12AMW93-48, S12AMW95-10, S12AMW95-11, S12AMW96-01, S12AMW96-06, S12AMW96-07

- carbon tetrachloride - S12AMW01-50, S12AMW93-46, S12AMW93-47, S12AMW93-48, S12AMW95-10, S12AMW95-11, S12AMW96-01

- 2-butanone - S12AMW01-50, S12AMW93-45, S12AMW93-46, S12AMW93-47, S12AMW93-48, S12AMW95-10, S12AMW95-11, S12AMW96-01, S12AMW96-06

Compounds which were qualified unusable were not compounds of concern at the site and will not negatively impact the use of the data.

13.4.1.1 Evaluation of Non-Detected Values. A comparison was made between the USEPA Region 5 DQLs and the project CRLs for chemicals that were analyzed for but not detected in environmental media at this site. No exceedances were identified for soils. Several VOCs had reported non-detected values from one to three orders of magnitude greater than the DQLs for at least one event and one location. However, these were limited to less than half the sampling events; acceptable CRLs were achieved at the other site wells for the same VOCs during the same events. Therefore, none of the VOCs warranted identification as having exceeded the DQLs. No exceedances for SVOCs were found.

MRL's for supplemental groundwater monitoring were reviewed and are sufficiently low to meet MRL's as stated in the Supplemental Groundwater Monitoring QAPP.

13.4.2 Data Quality Summary

13.4.2.1 Blank Assessment. When blank contamination exists, the investigative results must exceed the blank result by a factor of 5 (all compounds) or 10 (common laboratory contaminants such as phthalates) in order to be considered positive. Positive results were changed to nondetects ("U") if their concentrations were less than the above 5 times or 10 times limits. In these cases, the associated sample quantitation limit became either the concentration detected in the sample, if the detected value was above the quantitation limit, or the quantitation limit, if detected results were less than the quantitation limit. One VOC was detected in blanks; it was associated with the following soil samples which were qualified as nondetected during Phase I:

- 1,1,1-trichloroethylene in samples SVA12BHA01 and -D01

Three VOCs were detected in the lab blank associated with the following groundwater samples which were qualified as nondetected during Phase II:

- February 1996
  - Methylene chloride in sample SVA12GWC03

- Spring 1996
  - Methylene chloride in sample SVA12GWI01

- Summer 1996
  - Methylene chloride in sample SVA12GWF04
  - Chloroform in sample SVA12GWF04

- January 1997
  - 1,1,1-TCE in SVA12GWA02

No analytes were qualified not detected due to blank contamination during supplemental groundwater monitoring.

13.4.3 Background Screening

No samples were analyzed for ~~inorganic constituents~~ TAL metals or dioxins at this site. Therefore, ~~no~~ background screening was not required.

13.4.4 Summary of Analytical Results

Table 13-6 summarizes the analytical results for groundwater samples collected at Site ~~20A~~12A. The~~se~~ table~~s~~ includes only contaminants that were detected in at least one sample. ~~for a specific media.~~ Table 13-6a presents the field and laboratory results for natural attenuation parameters. A compr~~ehensive~~~~lete~~ listing ~~on all~~of the analytical results, including nondetected and below reporting limit analytes, is presented in Appendix N.

13.5 NATURE AND EXTENT OF CONTAMINATION

13.5.1 Soil

During Phase I, four boreholes (A to D) were drilled around the solvent pit, including one borehole that was hand-augured inside the building (Figures 13-12). Three samples were collected per boring and analyzed for VOCs. The results of the soil sampling indicated that the near surface sample collected in borehole C contained 0.78 µg/g of 1,1,1 trichloroethane, a concentration below the USEPA Region 9 ~~criteria~~ PRG. ~~No~~ VOCs were not detected in ~~any of~~ the other borehole samples.

13.5.1.1 Geoprobe Field-Screening Survey. The Geoprobe field-screening survey for the Phase I investigation was conducted at Building 602 in April 1993. A total of 18 probeholes (SVA-PH01 through SVA-PH04, and B602-PH01 through B602-PH14) were completed (Figure 13-12) (IN20, EPA45). The initial probehole, SVA-PH-01, was located adjacent to

the solvent pit, which was considered the source area for the contamination. PH-02, PH-03, and PH-04 were arranged as offsets to the solvent disposal pit. PH-01 was pushed to refusal at 27 feet deep, which was assumed to be the top of bedrock in the area. The soil in PH-01 was contaminated from the surface to at least 22 feet deep with the most contaminated zone lying from 5 to 7 feet bgs. The predominant contaminant at this depth was identified as 1,1,1-trichloroethane at 295 ppm. The contaminant concentrations appear to fall gradually in the deeper zones until at 25 to 27 feet there were no detectable VOCs. The shallow groundwater sample from PH-01 taken at 11 feet bgs contained 11 ppm 1,1,1-trichloroethane, but the groundwater sample taken from below 15 feet contained only 1 to 2 ppm of 1,1,1-trichloroethane, indicating that the groundwater contamination also decreases with depth. Offsets to PH-01 (PH-02, PH-03, and PH-04) revealed no detectable VOC contamination in either soil or groundwater. This was taken as evidence that the solvent contamination was contained within the vicinity of the solvent pit. The distribution of 1,1,1-trichloroethane contamination is illustrated in Figure 13-13. (EPA41)

The investigation proceeded ~~around~~ to the south side of Building 602 near the two former USTs (EPA21). Because the contaminants of interest here were expected to be BTEX compounds related to the fuel oil, the investigation was conducted using only the BTEX calibration for the field GC. The first probehole for the USTs, B602-PH01, was located in the backfilled excavation adjacent to the former 25,000-gallon fuel oil tank. The sampler was pushed to refusal at 13.5 feet bgs, which is the estimated depth of the former tank anchor concrete pad. The bottom sample had a detectable hydrocarbon odor but had no detectable VOCs. However, the chromatogram from the water sample showed some late peaks related to SVOC compounds, which eluted from the column later than ~~any of~~ the calibrated compounds and were not included in the total VOC calculation. It is likely that the odor detected was also related to SVOC compounds contained in fuel oil. Fuel oil reportedly has a very low percentage of VOCs, which are also the most likely chemicals to dissipate through volatilization or to biodegrade in the subsurface. This would account for the lack of detectable VOCs in the sample. The next probehole, PH-02, was located east of the former UST, but still within the former tank removal excavation pit. Neither the soil nor groundwater in this probehole contained detectable VOCs. The samples did, however, have strong hydrocarbon odors and strong peaks on the chromatograms in the SVOC range. Because of the odors and peaks, another probehole, PH-03, was located 20 feet east of PH-02. It had no detectable odors, VOCs, or SVOCs. Probeholes PH-04 and PH-06 were located on the south and west sides of the former 25,000-gallon UST, respectively. Both revealed total VOCs from 100 to over 1,000 ppb; however, none of the contaminants were identified as BTEX compounds. The chromatograms revealed VOCs in the same ranges as the chlorinated ~~solvent~~ VOC compounds detected adjacent to the solvent disposal pit. These VOCs ~~are assumed to~~may be related to contamination spreading south from the solvent pit. This assumption was supported by the results of samples collected from probeholes PH-08, PH-09, PH-11, PH-12, PH-13, and PH-14. The solvent plume was detected as far south as the railroad tracks in PH-13; however, ~~no~~ additional offsets were not performed because of the access being blocked by the forest and the railroad tracks. The contaminant concentrations appeared to be dropping with distance from the USTs and the solvent pit. ~~, but it was impossible to determine the southerly extent of contamination from the available data.~~

The results of probehole PH-05, which was located in the former tank excavation pit for the small tank, show a combination of the SVOC contamination similar to PH-02 and the chlorinated compound contamination noted in the aforementioned probeholes. The deepest soil sample from PH-05 was collected from 23 to 25 feet bgs and was essentially clean and odor free, indicating that the contamination has not penetrated to this depth. PH-07 and PH-08, offsets to PH-05, both revealed contamination, with the PH-07 groundwater sample showing just less than 2 ppm total VOCs. Examination of the chromatograms revealed that contamination in PH-07 is a combination of SVOCs from fuel oil and chlorinated from the solvent pit, whereas those in PH-08 are chlorinated VOC compounds.(EPA43) Contamination in PH-07 is probably a combination of SVOCs from fuel oil and chlorinated solvents from the solvent pit. Based on Phase I data, the contamination appeared to be confined to the vicinity of the former USTs and solvent pit area; however, the extent of contamination was not determined during Phase I in the southerly portion of the area. There was abundant groundwater in the former excavation sites and in the shallow subsurface (approximately 10 to 20 feet deep). ~~The soil is relatively dry below the perched zone until around 30 feet deep where another water zone was encountered. Only very low concentrations of contaminants were detected in the water samples from this zone.~~

13.5.2 Groundwater

Based on the results of the borehole soil-sample results and the field-screening survey conducted at Building 602 during Phase I, it was recommended that four groundwater-monitoring wells be installed around the site instead of the three recommended in the work plans. The four wells (MW93-45 to MW93-48), consisting of one upgradient and three downgradient monitoring wells, were sampled and analyzed for VOCs. A sample from the upgradient well was also analyzed for anions and metals.

The results of the Phase I groundwater sampling indicate that two wells, MW93-46 and MW93-47, contained VOC contamination (Table 13-6) (EPA44). The VOCs are ~~all~~ solvent related, and there does not appear to be ~~any~~ bedrock groundwater contamination related to the former USTs. Two contaminants (1,1,1-trichloroethane and 1,1-dichloroethane) were detected in both MW93-46 and MW93-47 at concentrations below the USEPA Region 9 action level. The compound 1,1-dichloroethylene was found in MW93-46 at a concentration exceeding the MCL and USEPA Region 9 criteria for groundwater. Additionally, 1,1,1-trichloroethane exceeds the MCL in both wells. The distribution of 1,1,1-trichloroethane in groundwater ~~contamination~~ during the Phase I is shown in Figure 13-13~~12~~.

During Phase II, eight temporary wells were installed and had groundwater analyzed for VOCs to provide information to locate the Phase II monitoring wells. Figure 13-14 presents the results and locations of the temporary well survey. Based on those results, the Phase II monitoring wells were installed and sampled. ~~m~~Maximum concentrations of 1,1,1-trichloroethane were ~~also~~ detected in MW93-46 (940 µg/L) and MW93-47 (115,000 µg/L) with concentrations in both wells exceeding the USEPA Region 9 criteria ~~of 790 µg/L~~. Detections of 1,1-dichloroethylene in MW93-46 (up to 960 µg/L), MW93-47 (up to 4,000

μg/L), and MW95-10 (up to 55 μg/L) also exceeded USEPA Region 9 criteria. Other contaminants present in concentrations exceeding their respective USEPA Region 9 criteria were 1,1,2-trichloroethane, 1,1-dichloroethylene, 1,2-dichloroethylene, chloroform, trichloroethylene, and vinyl chloride.

In addition to contamination identified in wells MW93-46 and -47, well MW95-10 installed to the northeast of the solvent pit during Phase II was also found to contain solvent-related contamination with 1,1-dichloroethylene, 1,1-dichloroethane, and 1,1,1-trichloroethane being the primary contaminants. However, only 1,1-dichloroethylene was present at concentrations exceeding USEPA Region 9 criteria. Minor detections of 1,1,1-trichloroethane were also found in wells MW93-45 (north) and MW95-11 (west)., indicating some lateral movement of contaminants. However, the primary solvent plume is confined to the immediate area surrounding the solvent pit. Contaminants were not detected in MW96-07 during the Phase II RI (EPA13g). The overall distribution of 1,1-DCE at Site 12A based on the June 1996 sampling event is presented on Figure 13-15.

The supplemental groundwater monitoring performed in 2001 indicated that VOCs were detected in five (MW93-46, MW93-47, MW95-10, MW96-01, and MW01-11) of the twelve wells at this site (Table 13-6). 1,1-DCE was detected above the EPA Region 9 PRG for tap water at the five monitoring wells. 1,1,1-TCA and 1,1-DCA were also detected above their PRGs at well MW93-47. Minor concentrations of these compounds were also detected in monitoring wells MW93-46, MW93-47, MW95-10, MW96-01, and MW01-11. The remaining seven monitoring wells did not have any VOC detects (Figure 13-15a).

13.5.3 Summary of Contamination

An overall picture of solvent-pit-related contamination can be constructed from a combination of the borehole, field screening, and monitoring well data. The lack of detection of any significant contamination in the boreholes or probeholes surrounding the solvent pit indicate that the lateral extent of the contamination is very limited in the glacial till. above the water table. The probehole that was located within the former solvent pit detected contamination from the surface to a depth of about 22 feet (EPA14b), with the most contaminated zone occurring from 5 to 7 feet bgs. Other nearby boreholes and probeholes showed no detection or only slight detection of solvents VOCs in the top 10 to 12 feet of soil. Shallow perched groundwater samples also revealed no detections of solvent VOC contamination except in probehole 1. Probehole 1 was located very near the current location of well MW93-47, as seen in (Figure 13-12. (EPA45) However, the existence occurrence of chlorinated compounds in the deeper glacial till groundwater samples from the top of bedrock collected south of the solvent pit, indicates that a DNAPL chlorinated solvents have migrated plume has formed in the glacial till groundwater above the bedrock laterally along the till/bedrockinterface. This, coupled with In addition, the 1,1,1-trichloroethane detected in MW93-47 and in MW93-46 (located over approximately 100 feet away apart), indicates a bedrock VOC groundwater plume of limited size. The high concentrations of 1,1,1-trichloroethane in MW93-47 indicate DNAPLs are in or on top the bedrock beneath the former solvent pit. The occurrence of downward vertical groundwater gradients at the site also suggests that chlorinated VOC

contaminated groundwater may migrate downward through the glacial till to the top of the bedrock. (EPA14c) The additional Phase II monitoring wells helped to define the lateral extent of the contaminant plume that exceeds regulatory criteria. ~~The contaminant that appears to have the highest mobility is 1,1,-dichloroethylene.~~

As observed ~~From~~ in the 2001 rounds of groundwater sampling, VOC contamination ~~this contaminant~~ has migrated ~~the greatest distance~~ to the southeast from the former solvent pit to well MW01-11. This observation is consistent with previous observations (Figure 13-15a). This observation and assessment of the extent of contamination is discussed further in the next section below.(EPA14b)

The solvent pit was removed in 2000. Contaminated soils were excavated to the extent that was practical and disposed off-site at a regulated disposal facility. A detailed description of the construction activities and sample results are contained in the *Draft-Final Construction Completion Report, Remedial Removal Actions, Sites 12A, 12B, 12C, and 33 (Montgomery Watson, February 2002).*

13.5.4 Assessment Of Site 12A For Natural Attenuation

Site 12A was assessed as a candidate for natural attenuation using the U.S. EPA screening criteria contained within the BIOCHLOR model (USEPA, 2000). Suitability of a candidate site is based on a list of criteria contained in Table 13-6b. Numerical scores are given for each criterion. If a candidate site scores 0 to 5 points there is inadequate evidence to support a natural attenuation by reductive dechlorination decision at the site. A score of 6 to 14 means that there is limited evidence for natural attenuation by reductive dechlorination at the site. A score of 15 to 20 indicates that adequate evidence exists that natural attenuation by reductive dechlorination may be supported at the site. Scores over 20 strongly support natural attenuation by reductive dechlorination at a site.

These scoring criteria can be used as general guidance for determining the site's initial suitability for natural attenuation by reductive dechlorination. Accordingly, these criteria were applied to Site 12A (Table 13-6b), and were used in combination with field and laboratory data (Table 13-6a) to evaluate Site 12A.

Using the field and fixed laboratory results for DO, nitrogen, ferrous iron, sulfate, methane, ORP, pH, TOC, temperature, alkalinity, sulfate, chloride, ethane, methane, and ethene present at locations where chlorinated VOCs were detected, Site 12A scored 21 points. Therefore, based on this assessment, Site 12A is a strong candidate site for natural attenuation by reductive dechlorination.

The field and laboratory data from well MW93-47 strongly supports this assessment. Well MW93-47 is located immediately adjacent to the contaminant source area. Strong concentrations of 1,1,1-TCA and associated daughter products including 1,1-DCA were detected at well MW93-47 in June 2001. Chloroethane and chloroform, also daughter products, were detected in relatively minor amounts. This is expected near the contaminant

source area, as first order kinetics would support rapid reductive dechlorination of the parent compound and successively lesser reduction of sequential daughter products to lower order daughter products (such as chloroethane) at the expense of the first order reduction.

Examining the remaining indicator parameter, field, metals, and gas data also shows that reductive dechlorination is progressing at the site. For example, the highest detected concentrations of ferrous and total iron, carbon dioxide, manganese, methane, and chloride at Site 12A in June 2001 were observed in the sample collected from well MW93-47, indicating that strong bacterial activity is occurring at this location. Anaerobic processes including methanogenesis, and iron and manganese reduction, are supported by the low ORP observed at well MW93-47. However, the presence of DO in excess of 1.0 mg/L combined with the production of carbon dioxide during respiration by aerobic bacteria suggests that cometabolic processes may also be working to degrade some contaminants. In summary, Site 12A groundwater seems to be amenable to natural attenuation.

13.6 HUMAN HEALTH RISK ASSESSMENT

Since the Draft RI was submitted, a Remedial Removal Action was performed at Site 12A. The soils in the vicinity of the solvent pit were excavated and disposed during construction activities. The excavation at this particular location was 15 ft by 15 ft and approximately 12 feet deep. Confirmation sampling was performed to assess the remedial action. Minor residual contamination (i.e., slightly above IX soil PRGs) was detected in the confirmation samples. However, additional excavation was not performed due to the proximity of building structures and the potential of undermining those structures. Because soil remediation has already been performed at Site 12A to a depth of 12 ft , the soil risk estimates for Site 12A provided in the Draft RI have not been updated. Rather the original draft risk calculations are provided for informational purposes to document, in part, why soil removal was considered warranted at this site. Rather, for purposes of the human health risk assessment, a new exposure pathway was assessed which considered if vapor from subsurface soil contamination (post-remediation) and groundwater contamination could pose a health concern if the buildings were used as commercial/industrial facilities. Soil vapor intrusion modeling was performed to estimate the potential for exposure. It should be noted that the original risk assessment contained in this section was performed under the assumption that the area would be residential in the future. Currently, it is planned that this site will continue to be used as commercial property, and so the indoor air modeling was based on a commercial land use scenario.

13.6.1 Selection of the Contaminants of Potential Concern for Site 12A

13.6.1.1 Surface Soil.

13.6.1.1.1 Frequency of Detection. Evaluation of frequency of detection was not undertaken at this site because of too few surface soil samples.

13.6.1.1.2 Nutrient Screening. Surface soil samples collected at this site were not analyzed for inorganic constituents. Therefore, nutrient screening was not performed.

13.6.1.1.3 Summary of Preliminary COPCs. Table 13-7 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95% UCL of the mean, and the exposure point concentration for the preliminary COPC in soil at Site 12A.

13.6.1.1.4 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for 1,1,1-trichloroethane was compared to the chemical-specific Region 9 residential soil PRG (Table 13-8). One-tenth of the PRG was used. As a result of the screening, 1,1,1-trichloroethane is eliminated as a COPC in surface soil at this site.

13.6.1.2 Surface/Subsurface Soil Combined.

13.6.1.2.1 Frequency of Detection. Evaluation of frequency of detection was not undertaken at this site because of too few soil samples.

13.6.1.2.2 Nutrient Screening. Soil samples collected at this site were not analyzed for inorganic constituents. Therefore, nutrient screening was not performed.

13.6.1.2.3 Summary of Preliminary COPCs. Table 13-7 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95% UCL of the mean, and the exposure point concentration for the preliminary COPCs in surface/ subsurface soil at Site 12A.

13.6.1.2.4 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for 1,1,1-trichloroethane was compared to the chemical-specific Region 9 residential soil PRG (Table 13-8). One-tenth of the PRG was used. As a result of the screening, 1,1,1-trichloroethane is eliminated as a COPC in surface/subsurface soil at this site.

13.6.1.3 Air.

13.6.1.3.1 Summary of Preliminary COPCs. Ambient air concentrations to which future receptors at this site might be exposed were estimated using air emission/dispersion modeling, as described in Appendix R. In the site-specific conceptual model, discussed below in Section 13.6.2.1, Site 12a is evaluated under two future site-specific scenarios: as a residential site and as an industrial site.

In the future industrial land use scenario for the facility, ~~all~~ **the** sites were assumed to be industrial, except for the five sites designated agricultural sites. Each site with particulate-bound COPCs in surface soil (metals, SVOCs, and dioxins/furans) and/or volatile COPCs in surface/subsurface soil combined was assumed to contribute to the air concentrations at ~~all of~~ the sites. In the future residential scenario for the facility, ~~all~~ **the** sites were assumed to be residential except for the five sites designated agricultural. It was assumed that particulate and

VOC emissions from the strictly residential sites would be negligible because the home sites would be covered with dense vegetation (lawns) and pavement. Therefore, under the residential scenario only the five agricultural sites contribute to the air concentrations at ~~all of~~ the sites. The list of preliminary air COPCs is therefore the same for every site for a given scenario, but the concentrations of the COPCs vary. Tables R-4 and R-6 in Appendix R present the estimated ambient air concentrations at Site 12A under the future industrial and residential scenarios, respectively.

13.6.1.3.2 Region 9 Preliminary Remediation Goal Screening. The exposure point concentrations for each preliminary air COPC at Site 12A in the future residential scenario and the future industrial scenario were compared to chemical-specific Region 9 air PRGs (Table 13-9). One-tenth of the PRG was used for noncarcinogens. The exception was lead, for which the full PRG was used. As a result of the screening, aluminum, silver, thallium, vanadium, and zinc are retained as COPCs in air for future on-site residents. For future on-site workers, aluminum, silver, thallium, vanadium, and zinc were retained.

13.6.1.4 Groundwater.

13.6.1.4.1 Frequency of Detection. Evaluation of frequency of detection was not undertaken at this site because of too few groundwater samples.

13.6.1.4.2 Nutrient Screening. Groundwater samples collected at this site were not analyzed for inorganic constituents. Therefore, nutrient screening was not performed.

13.6.1.4.3 Summary of Preliminary COPCs. Table 13-10 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95% UCL of the mean, and the exposure point concentration for the preliminary COPC in groundwater at Site 12A. Prior to this statistical analysis, the sampling round data from each well were averaged to obtain a single data point for representation of each well.

13.6.1.4.4 ***Region 9 Preliminary Remediation Goal Screening***. The exposure point concentrations for the preliminary groundwater COPCs were compared to the chemical-specific Region 9 residential soil PRG (Table 13-11). One-tenth of the PRG was used for noncarcinogens. As a result of the screening, 1,1-dichloroethane, 1,1-dichloroethylene, 1,1,1-trichloroethane, 1,1,2-trichloroethane, 1,2-dichloroethane, 1,2-dichloroethylene, acetone, chloroform, toluene, trichloroethylene, and vinyl chloride are retained as COPCs in groundwater at Site 21A.

13.6.2 Exposure Assessment

13.6.2.1 Site Conceptual Model. **As discussed in Section 5.1.4.6,** ~~N~~no people **are known to** specifically work at or frequent Site 12A. There are, however, several types of individuals who could potentially be affected by the existing contamination at the facility. These are current trespassers to JPG, off-facility (nearby) rural residents, and future hunters. In each case, these individuals would most likely be impacted simultaneously by multiple sites rather

than by single units. Because of this, these current and future receptor populations are addressed on a facility-wide, cumulative basis rather than by specific sites (see Sections 28 and 29).

Therefore, this site-specific exposure scenario only addresses future land use development. Site 12A has two potential future land uses forwarded for evaluation:

- Residential
- Industrial

Residential Use. Under the future residential land use scenario, this site is assumed to be developed for residential purposes, with the supposition that a family would build a house directly on or within this area of potential concern.

With respect to a risk assessment analysis, resident populations are assumed to consist of both adults and toddlers. Each individual would be expected to come in contact with site contaminants in the following pathways at Site 12A:

- Inhalation of VOCs and fugitive particulates from soils
- Dermal contact with soil while gardening/playing outdoors
- Incidental ingestion of soil while gardening/playing outdoors
- Ingestion of fresh homegrown fruits and vegetables
- Ingestion/dermal contact with groundwater
- Inhalation of VOCs while showering/bathing

On-site Worker. Industrial land use is considered to be a plausible future option for this site at JPG. On-site industrial workers (adult males and females) are assumed to be individuals who could be exposed directly to contaminated media through the following pathways:

- Inhalation of VOCs and fugitive particulates from soils **and vapors**
- Incidental ingestion/dermal contact with soil
- Ingestion of groundwater

13.6.2.2 Exposure Point Concentrations.

13.6.2.2.1 Air. The estimated ambient air concentrations of COPCs at this site for the future on-site residents and the future on-site workers are presented in Table 13-9.

13.6.2.2.2 Soil. ~~No s~~Soil COPCs were not selected at this site.

13.6.2.2.3 Fruits and Vegetables. Fruit and vegetable concentrations were not calculated because there are no soil COPCs at this site.

13.6.2.2.4 Groundwater. The concentrations of COPCs in groundwater at Site 12A are presented in Table 13-11.

13.6.2.2.5 Shower Air. COPC concentrations in shower air were estimated using the methods described in Appendix T. Table 13-12 summarizes the shower air concentrations for Site 12A.

13.6.2.3 Human Exposure Doses.

13.6.2.3.1 Inhalation of Contaminated Air. Inhalation of airborne contaminants (VOCs and particulates) is a potential route of exposure for future on-site residents (adults and children) and future on-site workers at this site. The equation used for calculating human exposure doses of COPCs due to inhalation of volatile and dust-bound contaminants is provided in Section 5.1.5.3.1, Table 5-12. Table V-7, Appendix V, documents the calculation of human exposure doses at Site 12A due to inhalation of contaminated air.

As discussed in Section 5.1.5.3.1, the potential for VOCs at Site 12A to migrate from soil or groundwater into indoor air was evaluated as part of this risk assessment. Indoor air risk estimates were made using the Johnson and Ettinger model (1991, revised) for subsurface vapor intrusions into buildings, using U.S. Environmental Protection Agency (EPA) software (U.S. EPA, 2000a). Doses were estimated by modeling maximum detected concentrations of VOCs in groundwater and soil at this location. Cancer risk and hazard estimates were prepared for an industrial worker scenario, because this is the current and most likely future land use at this location. The details of this evaluation are provided in an addendum to Appendix R. (EPA120d)

13.6.2.3.2 Ingestion of Contaminated Groundwater. Contaminated drinking water may be a source of chemical exposure for future on-site residents (adults and children) and future workers. The equation used to calculate human exposure doses due to ingestion of contaminated drinking water is provided in Section 5.1.5.3.4, Table 5-15. Table V-7, Appendix V, documents the calculation of human exposure doses at Site 12A due to ingestion of contaminated groundwater.

13.6.2.3.3 Dermal Contact with Contaminated Groundwater. Exposure via dermal contact with chemicals in groundwater may occur when receptors (future residents) shower or bathe. The equation used to calculate daily chemical doses due to dermal contact with contaminated groundwater is provided in Section 5.1.5.3.5, Table 5-16. Table V-7, Appendix V, documents the calculation of human exposure doses at Site 12A due to dermal contact with contaminated groundwater.

13.6.2.3.4 Inhalation of Volatile Organic Chemicals While Showering/Bathing. Inhalation of VOCs while showering/bathing is a potential route of exposure when these contaminants are present in residential water systems. The equation that was used to calculate human exposure dose due to inhalation of VOCs while showering/bathing is provided in Section 5.1.5.3.6, Table 5-18. Table V-7, Appendix V, documents the calculation of human exposure doses at Site 12A due to inhalation of VOCs while showering.

13.6.3 Risk Characterization

13.6.3.1 Chronic Health Hazards. The noncancer daily exposure doses calculated in the exposure assessment were used to calculate HQs for each of the COPCs possessing RfDs. Pathway-specific and overall HIs were then calculated for each receptor. The calculations of HQs and HIs are described in Section 5.1.7.1. If an overall HI is calculated to be greater than 1.0 for a particular receptor, then the exposure pathway(s) primarily responsible for the result is identified as a "critical pathway(s)." For each critical pathway, those chemical contaminants responsible for the majority of the HI are listed as COCs. Table W-7, Appendix W, documents the calculation of the pathway- and chemical-specific HQs for the human receptors at Site 12A. The pathway-specific and overall HIs are summarized in Table 13-**13**~~10~~.

13.6.3.1.1 Future On-Site Residents. The overall HIs for the future on-site adult and toddler residents at Site 12A are calculated to be 109 and 243, respectively. Both of these HIs exceed USEPA's risk management criterion of 1.0. The critical pathways are ingestion of and dermal contact with groundwater and inhalation of shower VOCs. The chemical responsible for most of the hazard for ~~all~~ **these** pathways is 1,1,1-trichloroethane. Other noncarcinogenic COCs for the ingestion of groundwater pathway are 1,1-dichloroethane and 1,1-dichloroethylene.

13.6.3.1.2 Future On-Site Workers. The overall HI for the future on-site worker at Site 12A is calculated to be 36. This value exceeds the USEPA's risk management criterion of 1.0. The critical exposure pathway is ingestion of groundwater. The compound 1,1,1-trichloroethane is responsible for most of the hazard; 1,1-dichloroethylene is also a noncarcinogenic COC for this receptor.

13.6.3.2 Excess Lifetime Cancer Risks. The cancer risks for each receptor were determined from the pathway-specific exposure doses and the route-specific SFs, as described in Section 5.1.7.2. To assess the simultaneous exposure of a receptor population to multiple carcinogens from multiple exposure routes, ~~all of~~ the cancer risks calculated for a receptor population were summed. Each overall receptor cancer risk was then compared to USEPA's target risk range (1.0E-06 to 1.0E-04). If the total cancer risk for a receptor from ~~all~~ **the** exposure pathways is less than 1.0E-04, then it is concluded that the site(s) does not pose a significant risk to that receptor. If the overall cancer risk exceeds the target risk range, ~~any~~**a** chemical that individually is associated with a risk level greater than 1.0E-05 is identified as a COC. COCs represent the primary contributors to the potential cancer risk for the receptor-specific exposure pathway under evaluation. Table W-7, Appendix W, documents the

calculation of the pathway- and chemical-specific cancer risks for the human receptors at Site 12A. The pathway-specific and overall cancer risks are summarized in Table 13-13.

13.6.3.2.1 Future On-Site Residents. The overall cancer risks calculated for the future adults and toddlers living at Site 12A are 1.7E-02 and 7.4E-03, respectively. Both of these cancer risks exceed the USEPA's target risk range of 1.0E-06 to 1.0E-04. The critical pathways are ingestion of and dermal contact with groundwater and inhalation of shower VOCs. Most of the cancer risk is due to exposure to 1,1-dichloroethylene. Other carcinogenic COCs for both receptors are 1,2-dichloroethane and vinyl chloride. The compound 1,1,2-trichloroethane is also a carcinogenic COC for the future adult resident.

13.6.3.2.2 Future On-Site Workers. The overall cancer risk calculated for the future workers at Site 12A is 4.3E-03, which exceeds the USEPA's target risk range of 1.0E-06 to 1.0E-04. The critical exposure pathway is ingestion of groundwater. The primary carcinogenic COC for this receptor is 1,1-dichloroethylene. Other COCs are 1,2-dichloroethane and vinyl chloride.

For Site 12A, the estimated cancer risk attributable to indoor air is 4 x 10^{-4} for groundwater and 7 x 10^{-7} for soil. This cancer risk is derived almost entirely from 1,1-DCE in groundwater. With a value greater than 1 x 10^{-4}, this cancer risk is in the range that may require remediation. Note that these risk estimates apply to future conditions; the building at Site 12A is currently unoccupied. The hazard index was 0.04 for groundwater and 0.02 for soil. These values are much less than 1, and there is no expectation of adverse non-cancer type health effects. (EPA120d)

13.6.3.3 Uncertainty/Sensitivity Analysis. The numerical risks/hazards that are calculated for Site 12A represent *conditional* estimates of risk based on various simplifying assumptions concerning contaminant exposure and toxicity. These estimates of risk/hazard are derived using a series of conservative procedures that address contaminant concentrations at the site, their fate in the environment, how someone currently or in the future might be exposed to these contaminants, and the toxicity of each chemical toward humans. The uncertainty analysis specifies, when appropriate, the critical assumptions made for the site so that the site-specific results can be interpreted by risk managers in a proper context.

To assist the risk managers in this project, a qualitative uncertainty analysis has been performed. The primary goals of a qualitative uncertainty analysis are (1) to itemize the major areas of uncertainty in the site-specific risk assessment and (2) to demonstrate that the assessment overall has been conservatively performed (i.e., that the potential risks/hazards at the site have not likely been underestimated, but may have been significantly overestimated).

The qualitative uncertainty analysis for this site is presented in Table 13-14. Based on this analysis, it can be concluded that this risk assessment is conservative. Some of the major uncertainties in this study that are most influential to the risks/hazards that were calculated include:

- Maximum detected groundwater concentrations used
- Use of modeling to predict shower air concentrations
- Use of modeling to predict indoor air concentrations.
- Mass-balance considerations suggest insufficient chemical mass is present at site to maintain exposure concentrations throughout 30-year exposure period
- Receptors' groundwater ingestion rate (2 L/day)
- Receptors' exposure frequency (350 days/year)

13.7 ECOLOGICAL RISK ASSESSMENT

Based on protocols established in the PERA (Rust E&I 1997g), there were no potential ecological risks determined for Site 12A. Primary solvent-related contamination at Site 12A is located in the subsurface soils and groundwater (generally, at depths greater than 4 feet). The primary pathways for ecological receptors would be direct contact, ingestion, and inhalation of soil particles. At Site 12A these pathways are incomplete for ecological receptors. As a result, no further ecological risk analysis has **not** been undertaken.

13.8 CONCLUSIONS AND RECOMMENDATIONS

Extensive studies of groundwater contamination and groundwater flow were conducted at the Building 602 Solvent Pit (Site 12A). Solvent-related groundwater contamination has migrated approximately 300 feet primarily in a southerly and southeasterly direction. The chlorinated solvent compounds 1,1,1-trichloroethaneTCA, 1,1-dichloroethyleneDCE, and 1,1-dichloroethaneDCA are the dominant contaminants in groundwater. The highest concentrations remain in the vicinity immediately downgradient of the former solvent pit. These concentrations decrease dramatically (IN2) with distance away from the former solvent pit.

Of the borehole and probehole soil samples, no significant contamination was not detected. Only one sample contained low concentrations of 1,1,1-trichloroethaneTCA. The lack of soil contamination indicates that the lateral extent of the contamination is very limited in the glacial till above the water table. As a result, the primary emphasis at Site 12A is the groundwater contamination at the till/bedrock interface. The solvent pit was removed in 2000. Contaminated soils were excavated to the extent practical and disposed off-site at a regulated disposal facility.

Site 12A was assessed to evaluate whether natural attenuation was occurring at the site. Reductive dechlorination of TCA to daughter products is occurring near the source of

contamination. Field measurements, coupled with indicator parameter results, also suggest that natural attenuation of VOCs is occurring. Accordingly, natural attenuation appears to be a viable remedial alternative for treatment of groundwater below Site 12A.

The results of the human health risk assessment indicated that risks to potential future residents and industrial workers exceed USEPA risk-based criteria for both carcinogenic and chronic hazard exposure scenarios. These risks are related to potential exposure to contaminated groundwater through the ingestion, dermal contact, and inhalation pathways. In addition, vapor intrusion from groundwater into indoor air was predicted to exceed the USEPA risk-based cancer criteria for the industrial worker exposure.

Due to the elevated risks associated with the ~~solvent~~VOC-contaminated groundwater, it is recommended that this site be carried through the FS. Sufficient data were collected during the Phase I and Phase II RI and the installation of new wells in 2001 to evaluate potential ~~cleanup technologies~~ remedial alternatives. Therefore, no further remedial investigation activities are ~~warranted~~necessary at this time, but may be needed during future remedial design activities (IN21).

TABLES

TABLE 13-1a

Groundwater Monitoring Well Information Summary
Site 12A - Building 602 Solvent Pit
Jefferson Proving Ground
South of the Firing Line
Madison, Indiana

Site	Well ID	Date Installed	Location (ft)		Elevation (ft)		Well Depth (ft)	Depth to Top of Rock (ft)	Well Diameter (In)	Screen Length (ft)	Screen Interval (ft)	Screened Unit	Gradient Relation
			Northing	Easting	TOC	Ground							
Site 12A	MW93-45	06/03/93	487159.30	561906.13	857.98	856.02	39.0	30.0	4.0	10.6	28.4-39	Till/Bedrock	Up
	MW93-46	06/04/93	487012.87	561995.35	857.99	856.16	38.0	28.7	4.0	10.3	27.7-38	Till/Bedrock	Down
	MW93-47	06/05/93	487109.36	561899.87	855.46	855.84	39.0	30.0	4.0	10.5	28.5-39	Till/Bedrock	Down
	MW93-48	06/06/93	486922.43	561776.36	857.62	855.47	39.0	29.5	4.0	10.3	28.7-39	Till/Bedrock	Down
	MW95-10	11/11/95	487105.05	562001.57	858.40	856.06	38.0	29.0	4.0	10.0	28-38	Till/Bedrock	Down
	MW95-11	11/14/95	487084.47	561794.86	857.13	854.89	38.2	30.0	4.0	10.0	28.2-38.2	Till/Bedrock	Down
	MW96-01	04/11/96	487110.69	561905.16	855.32	855.87	69.0	30.0	4.0	10.0	59-60	Louisville Lm.	Down
	MW96-06	04/30/96	486786.76	562155.23	854.79	852.70	34.2	25.0	4.0	10.2	24-34.2	Till/Bedrock	Down
	MW96-07	05/01/96	486807.42	561935.99	855.25	852.98	36.2	27.0	4.0	10.2	26-36.2	Till/Bedrock	Down
	MW01-09	10/31/01	487011.29	561983.31	857.84	854.88	67.4	28.0	3.0	5.0	62.4-67.4	Louisville Lm.	Down
	MW01-10	11/01/01	486912.45	561780.86	857.31	854.54	69.4	28.5	3.0	5.0	64.4-69.4	Louisville Lm.	Down
	MW01-11	11/02/01	486909.00	562066.80	857.74	854.67	32.6	27.5	3.0	10.0	22.6-32.6	Till/Bedrock	Down

Notes:
1. Information summarized in this table was taken from the Draft Phase II Remedial Investigation (RI) by Rust Environmental and Infrastructure dated August 1998.
2. Horizontal coordinates relative to Indiana State Coordinates - East Zone, 1983. Vertical coordinate tied to JPG monuments relative to NAD1929.
3. NR = Information not reported in the Draft Phase II RI.
4. Well location and elevation data for sites 12A and 12B are from a December 2001 survey performed by Classickle Inc.

TABLE 13-1b

Summary of Monitoring Well Survey Data and Groundwater Elevations
Site 12A - Building 602 Solvent Pit
Jefferson Proving Ground
Madison, Indiana

	MW93-45	MW93-46	MW93-47	MW93-48	MW95-10	MW95-11	MW96-01	MW96-06	MW96-07	MW01-09	MW01-10	MW01-11
Elevations												
Top of Casing	857.98	857.99	855.46	857.62	858.40	857.13	855.32	854.79	855.25	857.84	857.31	857.74
Land Surface	856.02	856.16	855.84	855.47	856.06	854.89	855.87	852.70	852.98	854.88	854.54	854.67
Top of Screen	827.62	828.46	827.34	826.77	828.06	826.69	796.87	828.70	826.98	792.48	790.14	832.07
Well Bottom	817.02	818.16	816.84	816.47	818.06	816.69	786.87	818.50	816.78	787.48	785.14	822.07
Top of Rock	826.02	827.46	825.84	825.97	827.06	824.89	825.87	827.70	825.98	826.88	826.04	827.17
Well Depth	39.0	38.0	39.0	39.0	38.0	38.2	69.0	34.2	36.2	67.4	69.4	32.6
Screen Length	10.6	10.3	10.5	10.3	10.0	10.0	10.0	10.2	10.2	5.0	5.0	10.0
Top of Rock (ft)	30.0	28.7	30.0	29.5	29.0	30.0	30.0	25.0	27.0	28.0	28.5	27.5

Date	Depth to Groundwater Below Top of Casing, In Feet											
06/29/93	11.38	11.38	8.90	20.21								
08/13/93	13.83	13.84	11.32	13.51								
09/13/93	11.82	11.46	9.56	11.34								
11/19/95	16.03	16.04	13.55	16.25	10.48	13.12						
02/02/96	9.83	9.82	7.33	9.62	4.48	22.48						
04/24/96	9.04	9.03	6.54	8.78	10.33	5.02						
06/19/96	9.53	9.55	7.05	8.9	22.48	15.36	0.28	23.16	18.14			
09/11/96	15.46	15.46	11.81	15.01	21.07	13.12	2.38	10.04	17.16			
10/03/96	13.93	13.95	11.45	14.07	8.38	23.16	12.00	10.04	1.40			
11/25/96	12.76	12.76	Under water	12.69	5.02	22.19	7.12	12.14	23.31			
12/25/96	9.86	9.82	7.31	9.79	7.26	23.02	18.43	14.38	22.04			
06/05/01	9.53	9.63	7.10	8.21	10.02	8.75	7.15	6.12	6.70			
09/21/01	10.58	10.58	8.11	10.13	10.98	9.67	8.09	7.11	7.65			
11/26/01	9.56	9.54	7.32	9.07	9.93	8.59	6.93	5.91	6.60	9.33	9.39	22.55
01/25/02	8.48	8.52	5.95	8.24	8.89	7.65	6.11	5.22	5.72	8.53	8.67	7.60

Date	Groundwater Elevation, in Feet above MSL											
06/29/93	846.60	846.61	846.56	837.41								
08/13/93	844.15	844.15	844.14	844.11								
09/13/93	846.16	846.53	845.90	846.28								
11/19/95	841.95	841.95	841.91	841.37	847.92	844.01						
02/02/96	848.15	848.17	848.13	848.00	853.92	834.65						
04/24/96	848.94	848.96	848.92	848.84	848.07	852.11						
06/19/96	848.45	848.44	848.41	848.72	835.92	841.77	855.04	831.63	837.11			
09/11/96	842.52	842.53	843.65	842.61	837.33	844.01	852.94	844.75	838.09			
10/03/96	844.05	844.04	844.01	843.55	850.02	833.97	843.32	844.75	853.85			
11/25/96	845.22	845.23		844.93	853.38	834.94	848.20	842.65	831.94			
12/25/96	848.12	848.17	848.15	847.83	851.14	834.11	836.89	840.41	833.21			
06/05/01	848.45	848.36	848.36	849.41	848.38	848.38	848.17	848.67	848.55			
09/21/01	847.40	847.41	847.35	847.49	847.42	847.46	847.23	847.68	847.60			
11/26/01	848.42	848.45	848.14	848.55	848.47	848.54	848.39	848.88	848.65	848.51	847.92	835.19
01/25/02	849.50	849.47	849.51	849.38	849.51	849.48	849.21	849.57	849.53	849.31	848.64	850.14

Notes:
1. All elevations recorded in Mean Sea Level (MSL) datum.
2. All depth measurements in feet.

TABLE 13-1c

Summary of Temporary Well Survey Data and Groundwater Elevations
Site 12A -Building 602 Solvent Pit
Jefferson Proving Ground
Madison, Indiana

	WP96-07	WP96-08	WP96-19	WP96-21	WP96-22	WP96-23	WP96-24	WP96-25	WP96-26
Elevations									
Top of Casing	856.97	858.32	857.34	858.04	856.75	856.17	857.82	857.72	857.67
Land Surface									
Top of Screen									
Well Bottom									
Top of Rock									
Well Depth									
Screen Length									
Top of Rock (ft)									

Date	Depth to Groundwater Below Top of Casing, In Feet								
04/24/96	20.56	23.52	3.16	6.03	4.81	3.36	3.53	5.20	6.60
06/19/96	13.43	18.21	3.68	6.85	5.56	4.42	3.90	3.58	6.66
09/11/96	11.36	14.15	4.03	11.92	10.21	8.38	6.34	6.41	11.01
10/03/96	11.18	14.78	5.91	9.03	10.62	7.70	5.39	5.09	9.36
11/25/96	10.45	12.61	5.41	9.71	8.13	3.85	5.11	4.94	8.67
12/25/96	9.87	11.91	3.99	7.06	5.91	4.92	4.27	3.96	6.92

Date	Groundwater Elevation, in Feet above MSL								
04/24/96	836.41	834.80	854.18	852.01	851.94	852.81	854.29	852.52	851.07
06/19/96	843.54	840.11	853.66	851.19	851.19	851.75	853.92	854.14	851.01
09/11/96	845.61	844.17	853.31	846.12	846.54	847.79	851.48	851.31	846.66
10/03/96	845.79	843.54	851.43	849.01	846.13	848.47	852.43	852.63	848.31
11/25/96	846.52	845.71	851.93	848.33	848.62	852.32	852.71	852.78	849.00
12/25/96	847.10	846.41	853.35	850.98	850.84	851.25	853.55	853.76	850.75

Notes:

1. All elevations recorded in Mean Sea Level (MSL) datum.
2. All depth measurements in feet.

TABLE 13-1d

Vertical Hydraulic Gradients at Well Nests
Site 12A - Building 602 Solvent Pit
Jefferson Proving Ground
Madison, Indiana

Site	Well Nest (shallow)	Deep)	Gradient 5-Jun-01	Gradient 21-Sep-01	Gradient 26-Nov-01	Gradient 25-Jan-02
12A	MW93-46	MW01-09	NA	NA	0.002	-0.005
	MW93-47	MW96-01	-0.006	-0.004	0.008	-0.010
	MW93-48	MW01-10	NA	NA	-0.019	-0.022

Notes:
1. A negative sign (-) indicates a downgradient gradient.
2. NA = Water level data not available for this date.

TABLE 13-2

Pumping Test Results Hydraulic Conductivity Values
Site 12 - Building 602 Solvent Pit
Jefferson Proving Grounds
Madison, Indiana

	OBSERVATION WELLS									
INPUT	MW93-45	MW93-46	MW93-47	MW93-48	MW95-10	MW95-11	MW96-01	MW96-06	MW96-07	Site Average
Confined Solutions (cm/sec)[c]										
Theis	$8.13\ 10^{-4}$	PW[a]	$7.87\ 10^{-4}$	NA[b]	$4.72\ 10^{-4}$	$3.0\ 10^{-4}$	$2.3\ 10^{-4}$	$8.59\ 10^{-4}$	$1.12\ 10^{-3}$	$5.72\ 10^{-4}$
Cooper-Jacob	$8.13\ 10^{-4}$	PW	$8.13\ 10^{-4}$	NA	$5.08\ 10^{-4}$	$3.28\ 10^{-4}$	$4.6\ 10^{-3}$	$1.22\ 10^{-3}$	$1.27\ 10^{-3}$	$9.66\ 10^{-4}$
Papadopulos Cooper	$8.13\ 10^{-4}$	PW	$8.13\ 10^{-4}$	NA	$4.78\ 10^{-4}$	$2.9\ 10^{-4}$	$2.2\ 10^{-4}$	$8.53\ 10^{-4}$	$1.12\ 10^{-3}$	$5.69\ 10^{-4}$
Leaky Solutions (cm/sec)										
Hantush	$8.33\ 10^{-4}$	PW	$7.11\ 10^{-4}$	NA	$3.4\ 10^{-4}$	$3.04\ 10^{-4}$	$2.3\ 10^{-4}$	$7.62\ 10^{-5}$	$3.2\ 10^{-4}$	$3.19\ 10^{-4}$
Moench	$8.38\ 10^{-4}$	PW	$6.9\ 10^{-4}$	NA	$3.4\ 10^{-4}$	$2.98\ 10^{-4}$	$2.3\ 10^{-4}$	$7.62\ 10^{-5}$	$3.15\ 10^{-4}$	$3.17\ 10^{-4}$
Fractured Solutions (cm/sec)										
Moench	$6.4\ 10^{-4}$	PW	$8.13\ 10^{-4}$	NA	$1.83\ 10^{-4}$	$2.49\ 10^{-4}$	$3.4\ 10^{-4}$	$1.12\ 10^{-4}$	$8.64\ 10^{-4}$	$3.60\ 10^{-4}$
Hydraulic Conductivity (cm/sec)										
K-max (method)	$8.38\ 10^{-4}$	PW	$8.13\ 10^{-4}$ (Confined) (Fractured)	NA	$5.08\ 10^{-4}$ (Confined)	$3.28\ 10^{-4}$ (Confined)	$4.6\ 10^{-4}$ (Confined)	$1.22\ 10^{-3}$ (Confined)	$1.27\ 10^{-3}$ (Confined)	$6.98\ 10^{-4}$
K-min (method)	$6.4\ 10^{-4}$	PW	$6.9\ 10^{-4}$ (Fractured)	NA	$1.83\ 10^{-4}$ (Fractured)	$2.49\ 10^{-4}$ (Fractured)	$2.2\ 10^{-4}$ (Confined)	$7.62\ 10^{-5}$ (Leaky)	$3.2\ 10^{-4}$ (Leaky)	$2.71\ 10^{-4}$
Average K	$7.32\ 10^{-4}$	PW	$7.49\ 10^{-4}$	NA	$3.04\ 10^{-4}$	$2.85\ 10^{-4}$	$3.18\ 10^{-4}$	$3.04\ 10^{-4}$	$6.37\ 10^{-4}$	$4.34\ 10^{-4}$

TABLE 13-2

Pumping Test Results Hydraulic Conductivity Values
Site 12A - Building 602 Solvent Pit
Jefferson Proving Grounds
Madison, Indiana

	OBSERVATION WELLS									
INPUT	MW93-45	MW93-46	MW93-47	MW93-48	MW95-10	MW95-11	MW96-01	MW96-06	MW96-07	Site Average
Pumping Test Drawdown (feet)										
Total Drawdown	6.58	7.40	6.28	NA	6.52	4.67	1.80	2.04	4.29	4.9
Observation Well Location (feet)										
Distance from Pumping Well	170	0	135	NA	90	213	133	280	223	177
Bedrock Formation										
Rock Type & Name	Jeffersonville Limestone	Jeffersonville Limestone	Jeffersonville Limestone	NA	Jeffersonville Limestone	Jeffersonville Limestone	Louisville Limestone	Jeffersonville Limestone	Jeffersonville Limestone	

Footnotes:

(a) Pumping Well.
(b) Well was not influenced during pumping test.
(c) cm/sec = centimeters per second.

TABLE 13-3

Hydraulic Conductivity Values from Drawdown in the Glacial Till
Site 12A - Building 602 Solvent Pit
Jefferson Proving Grounds
Madison, Indiana

Method	WP-19 (cm/sec) [(a)]	WP-21 (cm/sec)	WP-22 (cm/sec)	WP-23 (cm/sec)	WP-24 (cm/sec)	Site Average (cm/sec)
Theis	$2.6E^{-3}$	$8.0E^{-4}$	$6.6E^{-3}$	$5.1E^{-3}$	NA[(b)]	$2.9E^{-3}$
Cooper-Jacob	$5.6E^{-3}$	$1.3E^{-3}$	$9.1E^{-3}$	$7.1E^{-3}$	NA	$4.7E^{-3}$
Neuman	$2.6E^{-3}$	$8.0E^{-4}$	$5.6E^{-3}$	$3.8E^{-3}$	NA	$2.6E^{-3}$
Average	$3.4E^{-3}$	$9.4E^{-4}$	$7.0E^{-3}$	$5.2E^{-3}$	NA	$3.3E^{-3}$

Footnotes:

(a) cm/sec = centimeters per second
(b) Not applicable.

TABLE 13-4

Well Point Drawdown Results Top of Glacial Till
Site 12A - Building 602 Solvent Pit
Jefferson Proving Grounds
Madison, Indiana

Well Point	Drawdown Feet (ft)	Distance (ft)	Till
WP-19	0.30	92	Top
WP-21	1.55	11	In
WP-22	1.64	14	Top
WP-23	0.35	145	Top
WP-24	0.13	110	

TABLE 13-5

Groundwater Seepage Velocities Sensitivity Analysis
Site 12A - Building 602 Solvent Pit
Jefferson Proving Grounds
Madison, Indiana

Hydraulic Conductivity	Hydraulic Gradient	Effective Porosity	Seepage Velocity (feet/day)	Seepage Velocity (feet/year)
$8.33\ 10^{-4}$ cm/sec[a] Average Maximum	0.0007	.01	0.16	60
		.15	0.011	4
		.30	0.006	2
	.0035	.01	0.826	301
		.15	0.055	20
		.30	0.028	10
$2.95\ 10^{-4}$ cm/sec Average Minimum	0.0007	.01	0.059	21
		.15	0.004	1.42
		.30	0.002	0.7
	.0035	.01	0.293	107
		.15	0.020	7
		.30	0.010	3.6
$5.5\ 10^{-4}$ cm/sec Average	0.0007	.01	0.109	40
		.15	0.007	2.7
		.30	0.004	1.33
	.0035	.01	0.546	199
		.15	0.036	13
		.30	0.018	6.6

Footnotes:
(a) cm/sec = centimeter per second

TABLE 13-6

Summary of Organic Contaminants Detected in Groundwater Samples
Site 12A - Building 602 Solvent Pit
Jefferson Proving Ground
Madison, Indiana

Sample Identification	Sample Location	Sample Date	Sample Type	VOCs (ug/L)															
				1,1,1-Trichloroethane	**1,1,2-Trichloroethane**	**1,1-Dichloroethane**	**1,1-Dichloroethene**	**1,2-Dichloroethane**	**Acetone**	**Carbon Disulfide**	**Chloroform**	**Chloromethane**	**cis-1,2-Dichloroethylene**	**m,p-Xylene (Sum of Isomers)**	**Methyl Ethyl Ketone (2-butanone)**	**Toluene**	**Trichloroethylene (TCE)**	**Vinyl Chloride**
JPG-S12AMW93-45	**MW93-45**	11/6/1995	N	LT 1.0	LT 1.0	0.62	LT 1.0	LT 1.0	LT 5.0	LT 1.0	LT 1.0	NA	LT 1.0	LT 1.0	LT 5.0 R	LT 1.0	LT 1.0	LT 1.0
		2/19/1996	N	0.62	LT 1.0	LT 1.0	LT 1.0	LT 1.0	LT 5.0	LT 1.0	LT 1.0	NA	LT 1.0	LT 1.0	LT 5.0	LT 1.0	LT 1.0	LT 1.0
		4/27/1996	N	0.93	LT 1.0	LT 1.0	LT 1.0	LT 1.0	LT 5.0	LT 1.0	LT 1.0	NA	LT 1.0	LT 1.0	LT 5.0 R	LT 1.0	LT 1.0	LT 1.0
		6/20/1996	N	0.50U(d)	LT 1.0	LT 1.0	LT 1.0	LT 1.0	LT 5.0	LT 1.0	LT 1.0	NA	LT 1.0	LT 1.0	LT 5.0	LT 1.0	LT 1.0	LT 1.0
		6/7/2001	N	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	10(U / R)	1(U / UJ)	1(U /)	1(U / UJ)	1(U /)	1(U / UJ)	10(U / R)	1(U /)	1(U /)	1(U /)
JPG-S12AMW93-46	**MW93-46**	11/6/1995	N	**940**	**5.70**	84.0	**960.0**	**12.0**	LT 5.0	LT 1.0	LT 1.0	NA	8.50	LT 1.0	LT 5.0	LT 1.0	**9.20**	**0.35**
		2/19/1996	N	520	**2.40**	54.0	**440.0**	**4.4**	LT 5.0	LT 1.0	LT 1.0	NA	3.90	LT 1.0	LT 5.0 R	LT 1.0	**4.40**	**0.28**
		4/27/1996	N	485	LT 1.0	74.0	**460.0**	LT 1.0	LT 5.0	LT 1.0	LT 1.0	NA	LT 1.0	LT 1.0	LT 5.0 R	LT 1.0	**5.90**	LT 1.0
		6/20/1996	N	365	**2.40**	55.0	**335.0**	**5.0**	LT 5.0	LT 1.0	LT 1.0	NA	2.55	LT 1.0	LT 5.0	LT 1.0	**4.30**	LT 1.0
		6/7/2001	N	200	**1.2(/ J)**	56(/ J)	**280(/ J)**	**2.9**	10(U / R)	1(U / UJ)	1(U /)	1(U /)	1.6	1(U /)	10(U / R)	1(U /)	**2.40**	1(U /)
JPG-S12AMW93-47	**MW93-47**	11/6/1995	N	**95,000**	LT 1.0	**8,000**	**2,100**	LT 1.0	LT 5.0	LT 1.0	LT 1.0	NA	LT 1.0	LT 1.0	LT 5.0	LT 1.0	LT 1.0	LT 1.0
		2/19/1996	N	**45,000**	**25.0**	**4,750**	**1,550**	**57.0**	99.0	0.3	**9.1**	NA	38.0	LT 1.0	200.0	200.0	**91.0**	**4.4**
		4/27/1996	N	**115,000**	LT 1.0	**11,000**	**4,000**	LT 1.0	LT 5.0	LT 1.0	LT 1.0	NA	LT 1.0	LT 1.0	LT 5.0	550.0	LT 1.0	LT 1.0
		6/20/1996	N	**10,500**	LT 1.0	**2,000**	**550**	LT 1.0	LT 5.0	LT 1.0	LT 1.0	NA	LT 1.0	LT 1.0	LT 5.0	56.0	**27**	LT 1.0
		6/7/2001	N	**75000(/ J)**	**5,000(/ J)**	**15000(/ J)**	**18000(/ J)**	5,000(U /)	10(U / R)	1(U / UJ)	**21**	**3.4**	5,000(U /)	1(U /)	10(U / R)	5,000(U /)	5,000(U /)	5,000(U /)
JPG-S12AMW93-48	**MW93-48**	11/6/1995	N	LT 1.0	LT 1.0	LT 1.0	LT 1.0	LT 1.0	LT 5.0	LT 1.0	LT 1.0	NA	LT 1.0	LT 1.0	LT 5.0 R	LT 1.0	LT 1.0	LT 1.0
		2/19/1996	N	LT 1.0	LT 1.0	LT 1.0	LT 1.0	LT 1.0	LT 5.0	LT 1.0	LT 1.0	NA	LT 1.0	LT 1.0	LT 5.0 R	LT 1.0	LT 1.0	LT 1.0
		4/27/1996	N	1.3	LT 1.0	LT 1.0	LT 1.0	LT 1.0	LT 5.0	LT 1.0	LT 1.0	NA	LT 1.0	LT 1.0	LT 5.0 R	LT 1.0	LT 1.0	LT 1.0
		6/20/1996	N	LT 1.0	LT 1.0	LT 1.0	LT 1.0	LT 1.0	LT 5.0	LT 1.0	LT 1.0	NA	LT 1.0	LT 1.0	LT 5.0	LT 1.0	LT 1.0	LT 1.0
		6/7/2001	N	1(U /)	1(U / R')	1(U /)	1(U /)	1(U /)	10(U / R)	1(U / UJ)	1(U /)	1(U /)	1(U /)	1(U /)	10(U / R)	1(U /)	1(U /)	1(U /)
JPG-S12AMW95-10	**MW95-10**	11/6/1995	N	93.0	LT 1.0	13.0	**44.0**	LT 1.0	LT 5.0	LT 1.0	LT 1.0	NA	0.47	0.18	LT 5.0	0.33	LT 1.0	LT 1.0
		2/19/1996	N	44.0	LT 1.0	16.0	**32.0**	LT 1.0	LT 5.0	LT 1.0	LT 1.0	NA	LT 1.0	LT 1.0	LT 5.0 R	LT 1.0	LT 1.0	LT 1.0
		4/27/1996	N	115.0	LT 1.0	26.0	**55.0**	**1.40**	LT 5.0	LT 1.0	LT 1.0	NA	LT 1.0	LT 1.0	LT 5.0 R	0.14	0.34	LT 1.0
		6/20/1996	N	75.0	LT 1.0	19.0	**38.8**	**1.10**	LT 5.0 R(e)	LT 1.0	LT 1.0	NA	LT 1.0	LT 1.0	LT 5.0	LT 1.0	LT 1.0	LT 1.0
		6/7/2001	N	7.7	1(U / R')	4.0	**6.0**	1(U /)	10(U / R)	1(U / UJ)	1(U /)	1(U /)	1(U /)	1(U /)	10(U / R)	1(U /)	1(U /)	1(U /)
JPG-S12AMW95-11	**MW95-11**	11/6/1995	N	LT 1.0	LT 1.0	LT 1.0	LT 1.0	LT 1.0	40.0	0.24	LT 1.0	NA	LT 1.0	LT 1.0	LT 5.0 R	0.20	LT 1.0	LT 1.0
		2/19/1996	N	0.89	LT 1.0	LT 1.0	LT 1.0	LT 1.0	LT5.0	LT 1.0	LT 1.0	NA	LT 1.0	LT 1.0	LT 5.0 R	LT 1.0	LT 1.0	LT 1.0
		4/27/1996	N	1.30	LT 1.0	LT 1.0	LT 1.0	LT 1.0	LT5.0	LT 1.0	LT 1.0	NA	LT 1.0	LT 1.0	LT 5.0 R	LT 1.0	LT 1.0	LT 1.0
		6/20/1996	N	LT 1.0	LT 1.0	LT 1.0	LT 1.0	LT 1.0	LT5.0	LT 1.0	LT 1.0	NA	LT 1.0	0.14	LT 5.0	LT 1.0	LT 1.0	LT 1.0 R
		6/7/2001	N	1(U /)	1(U / R')	1(U /)	1(U /)	1(U /)	10(U / R)	1(U / UJ)	1(U /)	1(U /)	1(U /)	1(U /)	10(U / R)	1(U /)	1(U /)	1(U /)
JPG-S12AMW96-01	**MW96-01**	4/27/1996	N	11	LT 1.0	0.76	LT 1.0	LT 1.0	LT 5.0	LT 1.0	**3.70**	NA	LT 1.0	LT 1.0	LT 5.0 R	0.39	LT 1.0	LT 1.0
		6/20/1996	N	5.2	LT1.0	0.92	LT 1.0	LT 1.0	LT 5.0	0.96	**3.50**	NA	LT 1.0	LT 1.0	LT 5.0	0.23	LT 1.0	LT1.0
		6/7/2001	N	2.8	1(U / R')	0.77 (J /)	**0.54 (J /)**	1(U /)	10(U / R)	1(U / UJ)	1(U /)	1(U /)	1(U /)	1(U /)	10(U / R)	1(U /)	1(U /)	1(U /)
JPG-S12AMW01-50	**MW96-01**	6/7/2001	FD	3.8	1(U / R')	0.79 (J /)	**0.69 (J /)**	1(U /)	10(U / R)	1(U / UJ)	1(U /)	1(U /)	1(U /)	1(U /)	10(U / R)	1(U /)	1(U /)	1(U /)
JPG-S12AMW96-06	**MW96-06**	5/9/1996	N	LT 1.0	LT 1.0	LT 1.0	LT 1.0	LT 1.0	LT 5.0	LT 1.0	**0.43**	NA	LT 1.0	LT 1.0	LT 5.0	LT 1.0	LT 1.0	LT 1.0
		6/20/1996	N	LT 1.0	LT 1.0	LT 1.0	LT 1.0	LT 1.0	LT 5.0	0.49	**1.9**	NA	LT 1.0	LT 1.0	LT 5.0	LT 1.0	LT 1.0	LT 1.0
		6/6/2001	N	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	10(U / R)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	10(U / R)	1(U /)	1(U /)	1(U /)
JPG-S12AMW96-07	**MW96-07**	5/9/1996	N	LT 1.0	LT 1.0	LT 1.0	LT 1.0	LT 1.0	LT 5.0	LT 1.0	LT 1.0	NA	LT 1.0	LT 1.0	LT 5.0	LT 1.0	LT 1.0	LT 1.0
		6/20/1996	N	LT 1.0	LT 1.0	LT 1.0	LT 1.0	LT 1.0	LT 5.0	LT 1.0	LT 1.0	NA	LT 1.0	LT 1.0	LT 5.0	LT 1.0	LT 1.0	LT 1.0
		6/6/2001	N	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	10(U / R)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	10(U / R)	1(U /)	1(U /)	1(U /)

TABLE 13-6

Summary of Organic Contaminants Detected in Groundwater Samples
Site 12A - Building 602 Solvent Pit
Jefferson Proving Ground
Madison, Indiana

Sample Identification	Sample Location	Sample Date	Sample Type	VOCs (ug/L) 1,1,1-Trichloroethane	1,1,2-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichloroethane	Acetone	Carbon Disulfide	Chloroform	Chloromethane	cis-1,2-Dichloroethylene	m,p-Xylene (Sum of Isomers)	Methyl Ethyl Ketone (2-butanone)	Toluene	Trichloroethylene (TCE)	Vinyl Chloride
JPG-S12AMW01-09	**MW01-09**	11/29/2001	N	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	10(U /UJ)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	10(U /)	1(U /)	1(U /)	1(U /)
JPG-S12AMW01-71	**MW01-09**	11/29/2001	FD	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	10(U / UJ)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	10(U /)	1(U /)	1(U /)	1(U /)
JPG-S12AMW01-10	**MW01-10**	11/29/2001	N	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	10(U / UJ)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	10(U /)	1(U /)	1(U /)	1(U /)
JPG-S12AMW01-11	**MW01-11**	11/28/2001	N	15	1(U /)	4.7	**8.2**	1(U /)	10(U / UJ)	1.2	1(U /)	1(U /)	1(U /)	1(U /)	10(U /)	1(U /)	1(U /)	1(U /)
			PRGs (1)	540	0.2	810	0.046	0.12	610	1000	0.16	1.5	61	1400(3)	1900	720	1.6	0.041

General Notes:
1. (LF / VF) = Lab Flag / Validation Flag
2. Only detected compounds are listed in this table
3. ug/L = Micrograms per liter
4. VOCs = Volatile organic compounds
5. Sample Types:
   "N" = Normal field Sample
   "FD" = Field Duplicate
6. LT = Less than the reporting limit
7. ND = Not detected
8. NA = Not analyzed
9. PRGs = Preliminary Remediation Goals
10. NS = No standard established
11. U = Compound was not detected
12. J = Estimated value. The result is less than the reporting limit, but greater than the maximum detection limit.
13. Bolded results indicate a PRG exceedance
14. NSE = No standard established

Footnotes:
(1) PRGs = Preliminary Remediation Goals from US EPA Region 9 for Tap Water
(2) Proir to 2001, results for 1, 2-dichloroethylene (1, 2-DCE) were reported as the total of cis- and trans- isomers with the total result reported in the column for cis-1, 2-DCE
(3) The PRG is for total Xylenes (o- and m,p-xylenes combined)

TABLE 13-6a

Summary of Inorganic and Indicator Parameters Detected in Groundwater Samples
Site 12A - Building 602 Solvent Pit
Jefferson Proving Ground
Madison, Indiana

				Metals				General Chem							Gas				Field NA						
Field Identification	**Location Identification**	**Sample Date**	**Sample Type**	IRON	DISSOLVED IRON	MANGANESE	DISSOLVED MANGANESE	ALKALINITY, TOTAL (AS CaCO3)	CHLORIDE (AS CL)	NITROGEN, KJELDAHL, TOTAL	NITROGEN, NITRATE (AS N)	SULFATE (AS SO4)	SULFIDE	TOTAL ORGANIC CARBON	CARBON DIOXIDE	ETHANE	ETHENE	METHANE	DISSOLVED OXYGEN	FERROUS IRON	OXIDATION-REDUCTION POTENTIAL	pH	SPECIFIC CONDUCTANCE	TEMPERATURE	TURBIDITY
				ug/L	ug/L	ug/L	ug/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	ug/L	ug/L	mg/L	mg/L	mV	S.U.	umhos/cm	Deg C	NTU
JPG-S12AMW93-45	**MW93-45**	6/7/2001	N	116	NA	53.2	NA	436.0	21.7(/ J)	0.1(U /)	0.1(U /)	27.8	0.1(U /)	5(U /)	59800	1.3(U / UJ)	1.2(U / UJ)	4.4(/ J)	0.71	0	74.0	7.01	823	16.79	8.4
JPG-S12AMW93-46	**MW93-46**	6/7/2001	N	875	NA	149	NA	431.0	25.4(/ J)	0.14	0.1(U /)	57.2	0.1(U /)	5(U /)	55700	1.3(U / UJ)	1.2(U / UJ)	16(/ J)	6.22	0.2	-22.0	7.21	989	15.3	4
JPG-S12AMW93-47	**MW93-47**	6/7/2001	N	8760	NA	1070	NA	500.0	366(/ J)	0.302	0.1(U /)	22.4	0.1(U /)	49.1	182000	9(/ J)	5.8(/ J)	1400(/ J)	2.19	10	-153.0	6.63	2270	18.25	12
JPG-S12AMW93-48	**MW93-48**	6/7/2001	N	5270	NA	181	NA	364.0	9.75(/ J)	0.223	0.1(U /)	47.6	0.1(U /)	5(U /)	57600	1.3(U / UJ)	1.2(U / UJ)	0.91(J / 1UJ)	5.78	0	238.0	7.32	705	16.27	6.4
JPG-S12AMW95-10	**MW95-10**	6/7/2001	N	2990	NA	223	NA	599.0	21(/ J)	0.314	0.1(U /)	185.0	0.1(U /)	5(U /)	69400	1.3(U / UJ)	1.2(U / UJ)	0.61(J / 1UJ)	7.48	0.2	61.0	7.16	1420	15.4	69.9
JPG-S12AMW95-11	**MW95-11**	6/7/2001	N	1680	NA	218	NA	423.0	10.1(/ J)	0.133	0.1(U /)	34.8	0.1(U /)	5(U /)	28300	1.3(U / UJ)	1.2(U / UJ)	0.75(J / 1UJ)	7.12	0	22.0	7.25	892	16.7	115
JPG-S12AMW96-01	**MW96-01**	6/7/2001	N	728	NA	31.6	NA	128.0	2.59(/ J)	0.278	0.1(U /)	44.3	0.1(U /)	5(U /)	43700	1.3(U / UJ)	2 (/ J)	3900(/ J)	2.17	0	-107.0	7.69	261	19.39	29.8
JPG-S12AMW01-05	**MW96-01**	6/7/2001	FD	545	NA	26.3	NA	144.0	2.74(/ J)	0.1(U /)	0.1(U /)	46.6	0.1(U /)	5(U /)	39900	1.3(U / UJ)	1.2(U / UJ)	5300(/ J)	NA	NA	NA	NA	NA	NA	NA
JPG-S12AMW96-06	**MW96-06**	6/6/2001	N	2610	NA	360	NA	410.0	14.0	0.326	0.1(U /)	20.3	0.1(U /)	7.2	43700	1.3(U /)	1.2(U /)	2500	0	1.5	-201.0	7.15	746	18.51	0.9
JPG-S12AMW96-07	**MW96-07**	6/6/2001	N	4700	NA	202	NA	482.0	28.0	0.344	0.1(U /)	30.7	0.1(U /)	10.4	53800	1.3(U /)	1.2(U /)	2100	7.75	2.5	-139.0	7.12	1000	15.3	20.7
JPG-S12AMW01-09	**MW01-09**	11/29/2001	N	421(/ J)	226(/ J)	321(/ J)	369(/ J)	436.0	10.8	0.271	0.1(U /)	11.2	0.1(U /)	5(U /)	1900	1.3(U /)	1.2(U /)	4.1	0	0.2	-74.0	7.4	1660	14.64	1.8
JPG-S12AMW01-71	**MW01-09**	11/29/2001	FD	339(/ J)	217(/ J)	353(/ J)	635(/ J)	420.0	10.7	0.491	0.1(U /)	10.9	0.1(U /)	5(U /)	4400	1.3(U /)	1.2(U /)	4.2	NA	NA	NA	NA	NA	NA	NA
JPG-S12AMW01-10	**MW01-10**	11/29/2001	N	407(/ J)	355(/ J)	1400(/ J)	1610(/ J)	453.0	14.1	0.355	0.1(U /)	13.0	0.1(U /)	5(U /)	2200	1.3(U /)	1.2(U /)	4.7	0	0.2	-96.0	7.49	1780	15.14	1.4
JPG-S12AMW01-11	**MW01-11**	11/28/2001	N	184(/ J)	100(U /)	142	143	436.0	34.4	0.432	0.047(J / U)	97.9	0.1(U /)	2.74	3100	1.3(U /)	1.2(U /)	6.2	0	0.1	28.0	7.00	1100	14.98	0.0

General Notes:
1. (LF / VF) = Lab Flag / Validation Flag
2. ug/L = Micrograms per liter.
3. mg/L = Milligrams per liter
4. Sample Types:
   "N" = Normal field Sample
   "FD" = Field Duplicate
5. NA = Sample not analyzed for this analyte
6. R = Result rejected
7. S.U. = Standard Units
8. NTU = Nephelometric Turbidity Units
9. R = Analytical data was rejected
10. U = Compound was not detected
11. J = Estimated value. The result is less than the reporting limit, but greater than the maximum detection limit.

TABLE 13-6b

Reductive Dechlorination Scoring
Site 12A - Building 602 Solvent Pit
Jefferson Proving Ground
Madison, Indiana

Natural Attenuation Screening Protocol	Interpretation	Score	
The following is taken from the USEPA protocol (USEPA, 1998). The results of this scoring process have no regulatory significance.	Inadequate evidence for anaerobic biodegradation* of chlorinated organics	0 to 5	**Score: 21**
	Limited evidence for anaerobic biodegradation* of chlorinated organics	6 to 14	
	Adequate evidence for anaerobic biodegradation* of chlorinated organics	15 to 20	
	Strong evidence for anaerobic biodegradation* of chlorinated organics	>20	Scroll to End of Table

*reductive dechlorination

Analysis	Concentration in Most Contam. Zone	Interpretation	Yes	No	Points Awarded
Oxygen*	<0.5 mg/L	Tolerated, suppresses the reductive pathway at higher concentrations			0
	>5 mg/L	Not tolerated; however, VC may be oxidized aerobically		●	0
Nitrate*	<1 mg/L	At higher concentrations may compete with reductive pathway	●		2
Iron II*	>1 mg/L	Reductive pathway possible; VC may be oxidized under Fe(III)-reducing conditions		●	0
Sulfate*	<20 mg/L	At higher concentrations may compete with reductive pathway	●		2
Sulfide*	>1 mg/L	Reductive pathway possible		●	0
Methane*	<0.5 mg/L	VC oxidizes			0
	>0.5 mg/L	Ultimate reductive daughter product, VC Accumulates	●		3
Oxidation Reduction Potential* (ORP)	<50 millivolts (mV)	Reductive pathway possible	●		1
	<-100 mV	Reductive pathway likely			0
pH*	5 < pH < 9	Optimal range for reductive pathway	●		0
	5 > pH > 9	Outside optimal range for reductive pathway			0
TOC	>20 mg/L	Carbon and energy source; drives dechlorination; can be natural or anthropogenic			0
Temperature*	>20°C	At T > 20°C biochemical process is accelerated	●		1
Carbon Dioxide	>2x background	Ultimate oxidative daughter product	●		1
Alkalinity	>2x background	Results from interaction of carbon dioxide with aquifer minerals	●		1
Chloride*	>2x background	Daughter product or organic chlorine	●		2
Hydrogen	>1 nM	Reductive pathway possible, VC may accumulate			0
	<1 nM	VC oxidized			0
Volatile Fatty Acids	>0.1 mg/L	Intermediates resulting from biodegradation of aromatic compounds; carbon and energy source			0
BTEX*	>0.1 mg/L	Carbon and energy source; drives dechlorination	●		2
PCE*		Material released			0
TCE*		Material released	●		0
		Daughter product of PCE[(a)]			0
DCE*		Material released			0
		Daughter product of TCE. If cis is greater than 80% of total DCE, it is likely a daughter product of TCE[(a)], 1,1-DCE can be a chem. reaction product of TCA	●		2
VC*		Material released			0
		Daughter product of DCE[(a)]	●		2
1,1,1-Trichloroethane*		Material released	●		0
DCA		Daughter product of TCA under reducing conditions	●		2
Carbon Tetrachloride		Material released			0
Chloroethane*		Daughter product of DCA or VC under reducing conditions	●		0
Ethene/Ethane	>0.01 mg/L	Daughter product of VC/ethene		●	0
	>0.1 mg/L	Daughter product of VC/ethene		●	0
Chloroform		Material released			0
		Daughter product of Carbon Tetrachloride			0
Dichloromethane		Material released			0
		Daughter product of Chloroform			0

*required analysis.
(a) points awarded only if it can be shown that the compound is a daughter product (i.e., not a constituent of the source NAPL).

SCORE Reset

End of Form

TABLE 13-7

Soil Exposure Point Concentrations of Preliminary Contaminants of Potential Concern (COPC)
Site 12A - Building 602 Solvent Pit
Jefferson Proving Grounds
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/g)[b]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[c] (µg/g)
Surface Soil						
1,1,1-Trichloroethane	1/4	0.780	0.20	0.27	20	0.78
Surface/Subsurface Soil						
1,1,1-Trichloroethane	1/12	0.780	0.20	0.16	0.21	0.21

Footnotes:

(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Micrograms per gram.
(c) The 95% UCL (upper confidence limit of the mean) or the maximum detected value, whichever is lower (USEPA 1989b).

TABLE 13-8

Selection of Contaminants of Potential Concern (COPC) in Soil Based on USEPA Region 9 Preliminary Remediation Goals (PRGs) Site 12A - Building 602 Solvent Pit Jefferson Proving Grounds Madison, Indiana

	USEPA Region 9 PRG Screening Data		
Chemical	**Residential PRG (µg/g)[a]**	**Exposure Point Conc. (µg/g)**	**Retained as Soil COPC?**
Surface Soil			
1,1,1-Trichloroethane	122	0.78	No
Surface/Subsurface Soil			
1,1,1-Trichloroethane	122	0.21	No

Note:
PRGs were taken directly from the Region 9 PRG Table (USEPA 1998).

Footnotes:
(a) Micrograms per gram.

TABLE 13-9

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 12A - Building 602 Solvent Pit
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Ambient Air PRG (µg/m^3)[(a)]**	**Exposure Point Conc. (µg/m^3)**	**Retained as Air COPC?**
Residential Scenario			
Aluminum	NA[(b)]	6.08E-03	**YES**
Arsenic	4.5E-04	3.07E-06	No
Barium	5.2E-02	8.53E-06	No
Beryllium	8.0E-04	2.39E-07	No
Cadmium	1.1E-03	1.66E-08	No
Chromium	2.3E-05	8.65E-06	No
Lead	1.5E+00[(c)]	1.23E-06	No
Manganese	5.1E-03	4.40E-04	No
Silver	NA	1.69E-05	**YES**
Thallium	NA	1.26E-06	**YES**
Vanadium	NA	1.53E-06	**YES**
Zinc	NA	8.49E-07	**YES**
Dioxins/Furans	4.5E-08	6.77E-14	No
Benzo(a)anthracene	9.2E-03	1.53E-09	No
Benzo(a)pyrene	9.2E-04	4.42E-09	No
Benzo(b)fluoranthene	9.2E-03	8.62E-09	No
DDE	2.0E-02	8.98E-10	No
Dibenz(a,h)anthracene	9.2E-04	1.80E-10	No
Dieldrin	4.2E-04	NA	No
Indeno(1,2,3-cd)pyrene	9.2E-03	9.00E-10	No
1,1-Dichloroethylene	3.8E-02	5.74E-09	No
Chlorobenzene	2.1E+00	2.34E-06	No

TABLE 13-9

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 12A - Building 602 Solvent Pit
Jefferson Proving Ground
Madison, Indiana

Chemical	USEPA Region 9 PRG Screen Ambient Air PRG (µg/m³)(a)	Exposure Point Conc. (µg/m³)	Retained as Air COPC?
Industrial Scenario			
Aluminum	NA	1.03E-02	**YES**
Arsenic	4.5E-04	3.99E-06	No
Barium	5.2E-02	8.81E-06	No
Beryllium	8.0E-04	4.71E-07	No
Cadmium	1.1E-03	8.25E-08	No
Chromium	2.3E-05	1.46E-05	No
Lead	1.5E+00	1.23E-06	No
Manganese	5.1E-03	8.93E-04	No
Silver	NA	1.69E-05	**YES**
Thallium	NA	1.26E-06	**YES**
Vanadium	NA	2.88E-06	**YES**
Zinc	NA	7.24E-05	**YES**
Dioxins/Furans	4.5E-08	2.28E-12	No
Benzo(a)anthracene	9.2E-03	1.53E-09	No
Benzo(a)pyrene	9.2E-04	4.46E-09	No
Benzo(b)fluoranthene	9.2E-03	8.62E-09	No
DDE	2.0E-02	8.98E-10	No
Dibenz(a,h)anthracene	9.2E-04	1.80E-10	No
Dieldrin	4.2E-04	1.60E-09	No
Indeno(1,2,3-cd)pyrene	9.2E-03	8.98E-10	No
1,1-Dichloroethylene	3.8E-02	5.74E-09	No
Chlorobenzene	2.1E+00	2.34E-06	No

Note:
PRGs were taken directly from the Region 9 PRG Table (USEPA 1998). Values for noncarcinogens are 1/10 of the Region 9 PRG.
EPCs are calculated and presented in Table R-4 and R-6 in Appendix R.

Footnotes:
(a) Micrograms per cubic meter.
(b) Not applicable or not available.
(c) Federal ambient air quality criterion for lead.

TABLE 13-10

Groundwater Exposure Point Concentrations of Preliminary Contaminants of Potential Concern (COPC)
Site 12A - Building 602 Solvent Pit
Jefferson Proving Grounds
Madison, Indiana

Chemical	Frequency of Detection[(a)]	Range of Detected Values (μg/L)[(b)]	Range of Reporting Limits (μg/L)	Arithmetic Mean Concentration (μg/L)	95% UCL Concentration (μg/L)	Exposure Point Concentration[(c)] (μg/L)
1,1-Dichloroethane	5/8	0.62 - 6,437	1.0	815	1.8E+09	6,437
1,1-Dichloroethylene	3/8	42.5 - 2,050	1.0	330	3.2E+10	2,050
1,1,1-Trichloroethane	7/8	0.68 - 66,375	1.0	8,380	2.8E+14	66,375
1,1,2-Trichloroethane	2/8	3.88 - 25.0	1.0	3.98	42.7	25.0
1,2-Dichloroethane	3/8	0.875 - 57.0	1.0	8.37	251	57.0
1,2-Dichloroethylene (mixed isomers)	3/8	0.47 - 38.0	1.0	5.74	113	38.0
Acetone	2/8	11.8 - 99.0	5.0	15.7	113	99.0
Benzene	1/8	0.38	1.0	0.49	0.52	0.38
Carbon disulfide	3/8	0.24 - 0.73	1.0	0.47	0.57	0.57
Chloroethane	1/8	1.2	1.0 - 10.0	1.2	2.8	1.2
Chloroform	2/8	3.6 - 9.1	1.0	1.9	9.9	9.1
Methyl ethyl ketone	1/5[(d)]	110	5.0	24	19,815	110
Toluene	5/8	0.20 - 269	1.0	33.9	8,827	269
Trichloroethylene	3/8	0.34 - 59.0	1.0	8.5	334	59.0

TABLE 13-10

Groundwater Exposure Point Concentrations of Preliminary COPCs
Site 12A - Building 602 Solvent Pit
Jefferson Proving Grounds
Madison, Indiana

Chemical	Frequency of Detection[(a)]	Range of Detected Values (µg/L)[(b)]	Range of Reporting Limits (µg/L)	Arithmetic Mean Concentration (µg/L)	95% UCL Concentration (µg/L)	Exposure Point Concentration[(c)] (µg/L)
Vinyl chloride	2/8	0.32 - 4.4	1.0	0.96	2.3	2.3
Xylene	2/8	0.14 - 0.18	1.0 - 100	6.6	190	0.18

Footnote:
(a) Number of locations in which the analyte was detected/total number of locations sampled. Data from the eight downgradient wells (MW93-45, MW93-46, MW93-47, MW93-48, MW95-10, MW95-11, MW96-1, and MW96-7) were used in the calculations.
(b) Micrograms per liter.
(c) The 95% UCL (upper confidence limit of the mean) or the maximum detected value, whichever is lower (USEPA 1989b).
(d) Three of 5 wells had methyl ethyl ketone data rejected.

TABLE 13-11

Selection of Contaminants of Potential Concern (COPC) in Groundwater Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 12A - Building 602 Solvent Pit
Jefferson Proving Grounds
Madison, Indiana

	USEPA Region 9 PRG Screening Data		
Chemical	**Tap Water PRG (µg/L)[a]**	**Exposure Point Conc. (µg/L)**	**Retained as GW COPC?**
1,1-Dichloroethane	81	6,437	**YES**
1,1-Dichloroethylene	0.046	2,050	**YES**
1,1,1-Trichloroethane	79	66,375	**YES**
1,1,2-Trichloroethane	0.20	25	**YES**
1,2-Dichloroethane	0.123	57	**YES**
1,2-Dichloroethylene (mixed isomers)	5.48	38	**YES**
Acetone	60.8	99	**YES**
Benzene	0.386	0.38	No
Carbon disulfide	2.1	0.57	No
Chloroethane (ethyl chloride)	70.5	1.2	No
Chloroform	0.165	9.1	**YES**
Methyl ethyl ketone	190	110	No
Toluene	72.3	269	**YES**
Trichloroethylene	1.64	59	**YES**
Vinyl chloride	0.02	2.3	**YES**
Xylene	143[b]	0.18	No

Note:

PRGs were taken directly from the Region 9 PRG Table (USEPA 1998c). Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:

(a) Micrograms per liter.
(b) Value for mixed xylenes.

TABLE 13-12

Shower Air Concentrations of Volatile Organic Compounds
Site 12A - Building 602 Solvent Pit
Jefferson Proving Ground
Madison, Indiana

Volatile Chemical	Exposure Point Concentration in Groundwater (µg/L[a] = mg/m^3)	Exposure Point Concentration in Shower Air (mg/m^3)[b]
1,1-Dichloroethane	6,437	2.14E+01
1,1-Dichloroethylene	2,050	7.11E+00
1,1,1-Trichloroethane	66,375	1.95E+02
1,1,2-Trichloroethane	25	5.85E-02
1,2-Dichloroethane	57	1.55E-01
1,2-Dichloroethylene	38	1.29E-01
Acetone	99	6.05E-02
Chloroform	9.1	2.65E-02
Toluene	269	9.33E-01
Trichloroethylene	59	1.73E-01
Vinyl chloride	2.3	7.84E-04

General Notes:
EPCs for shower air are estimated using methods described in Appendix T.

Footnotes:

(a) Micrograms per liter.
(b) Milligrams per cubic meter.

TABLE 13-13

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 12A - Building 602 Solvent Pit
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
		Future On-site Resident Adult		
Inhalation of VOCs[b] and fugitive dusts	NA[a]		0.0009	
Ingestion of groundwater	1.45E-02	1,1-DCE (99%); 1,1,2-TCA (<1%); 1,2-DCA (<1%); vinyl chloride (<1%)	99.5739	1,1-DCA (2%); 1,1-DCE (6%); 1,1,1-TCA (91%)
Dermal contact with groundwater	7.01E-04	1,1-DCE (99.7%)	6.7093	1,1,1-TCA (99%)
Inhalation of shower VOCs	1.27E-03	1,1-DCE (98%); 1,2-DCA (1%)	2.3760	1,1,1-TCA (67%)
Total	1.65E-02		108.6601	
		Future On-site Resident Child		
Inhalation of VOCs and fugitive dusts	NA		0.0032	
Ingestion of groundwater	6.78E-03	1,1-DCE (99%); 1,2-DCA (<1%); vinyl chloride (<1%)	232.3392	1,1-DCA (2%); 1,1-DCE (6%); 1,1,1-TCA (91%);
Dermal contact with groundwater	1.34E-04	1,1-DCE (98%)	6.3877	1,1,1-TCA (99%)
Inhalation of shower VOCs	4.91E-04	1,1-DCE (98%)	4.6031	1,1,1-TCA (67%)
Total	7.41E-03		243.3332	

TABLE 13-13

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 12A - Building 602 Solvent Pit
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
		Future On-site Worker		
Inhalation of VOCs and fugitive dusts	NA		0.0003	
Ingestion of groundwater	4.33E-03	1,1-DCE (99%); 1,2-DCA (<1%); vinyl chloride (<1%)	35.5621	1,1-DCE (6%); 1,1,1-TCA (91%)
Total	4.33E-03		35.5624	

Note:
1,1-DCE = 1,1-Dichloroethylene; 1,1,2-TCA = 1,1,2-Trichloroethane; 1,2-DCA = 1,2-Dichloroethane; 1,1-DCA = 1,1-Dichloroethane; 1,1,1-TCA = 1,1,1-Trichloroethane.

Footnotes:
(a) Not applicable or not available.
(b) Volatile organic compounds.

TABLE 13-14

Qualitative Uncertainty Analysis
Site 12A - Building 602 Solvent Pit
Jefferson Proving Grounds
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
A. Human Behavior				
Future receptors' exposure duration	30 years	Medium	Medium	National upper-bound time (90th percentile) at one residence
Future receptors' exposure frequency	350 days/year	Medium	Medium	High-end value
Future receptors' water ingestion rate	2 L/day	Low	High	Water consumption rates are high-end values obtained from published distribution data
Exclusion of certain exposure pathways in the quantitative analysis	NA[a]	Low	Low	Pathways eliminated are those that have low possibility of contributing risk to these receptors
B. Chemical Fate/Transport in the Environment				
Groundwater exposure point concentration of COC[b]	Maximum detected value	Low	High	Site average would be lower
Mass balance	NA	Low	High	Insufficient mass of chemicals likely present in groundwater to maintain exposure throughout 30-year exposure duration due to highly limited contaminated area
Use of modeling to predict shower air concentrations	NA	Low	High	Conservative assumptions and input parameters

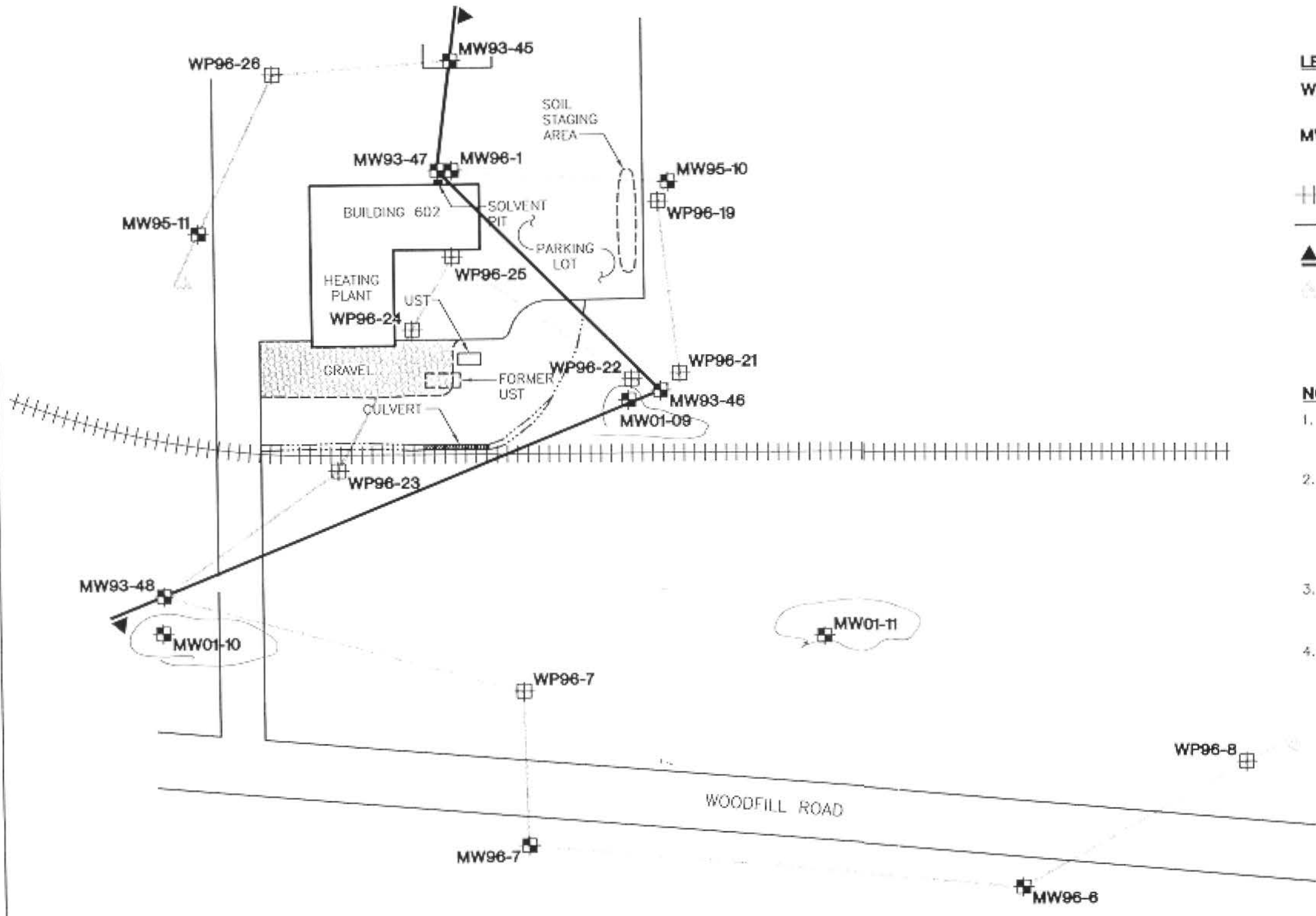
TABLE 13-14

Qualitative Uncertainty Analysis
Site 12A - Building 602 Solvent Pit
Jefferson Proving Grounds
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
C. Chemical Toxicity				
Assumption that USEPA[c] reference doses truly represent toxicological thresholds	NA	Low	High	High degree of conservativeness utilized by USEPA in deriving RfDs[d] from toxicological literature
Assumption that USEPA carcinogenic slope factors truly represent dose-response phenomena	NA	Low-moderate	Moderate-high	Use of linearized, multi-stage mathematical model to predict cancer incidence at low exposure levels is USEPA policy; not currently supported by scientific data
Assumption of risk/hazard additivity	NA	Moderate	Moderate	Summation of chemical-specific risks/hazards may over- or under-predict risks/hazards to receptors
Screening out of certain contaminants based on USEPA criteria	NA	Low	Low	Chemicals present in concentrations less than USEPA criteria eliminated

Footnotes:
(a) Not applicable or not available.
(b) Contaminant of concern.
(c) United States Environmental Protection Agency.
(d) Reference doses.

FIGURES



LEGEND

WP96-26 TEMPORARY WELL LOCATION AND NUMBER

MW93-45 MONITORING WELL LOCATION AND NUMBER

RAILROAD TRACKS

SURFACE WATER DRAINAGE

PHASE I LINE OF CROSS SECTION

PHASE II LINE OF CROSS SECTION

NOTES

1. BASE MAP DEVELOPED FROM FIGURE 13-7 FROM A REPORT BY RUST ENVIRONMENT & INFRASTRUCTURE, DATED: 3-18-98.
2. MONITORING WELLS AND TEMPORARY WELLS TAKEN FROM FIGURE 13-12, VOLATILE ORANANIC COMPOUNDS IN GROUNDWATER AT BUILDING 602 SOLVENT PIT (SITE 12A), PREPARED BY RUST E&I, DATED 8-6-98.
3. MW01 SERIES WELLS WERE INSTALLED DURING 2001 UNDER THE SUPERVISION OF MWH.
4. PHASE I CROSS SECTION SHOWN ON FIGURE 13-2. PHASE II CROSS SECTION SHOWN ON FIGURE 13-3. BOTH PREPARED BY EARTHTECH.

north

0 50 100

SCALE IN FEET

FIGURE 13-1

QUALITY CONTROL | Graphic Standards DLF | Lead Professional TAPB | 2-22-02 | 2-22-02 | Technical Review LBL | Project Manager LAB | 3-13-02 | 3-14-02 | Management Review | Other

This document has been developed for a specific application and may not be used without the written approval of Montgomery Watson.

Developed By TAPB | Drawn By DLF

Approved By [signature] | Date 3-19-02

Reference 2440025.040201-B5

Revisions

MONITORING WELL LOCATION MAP
BUILDING 602 SOLVENT PIT (SITE 12A)
SOUTH OF THE FIRING LINE
JEFFERSON PROVING GROUND
MADISON, INDIANA

Drawing Number 2440025 010102 B9

MWH

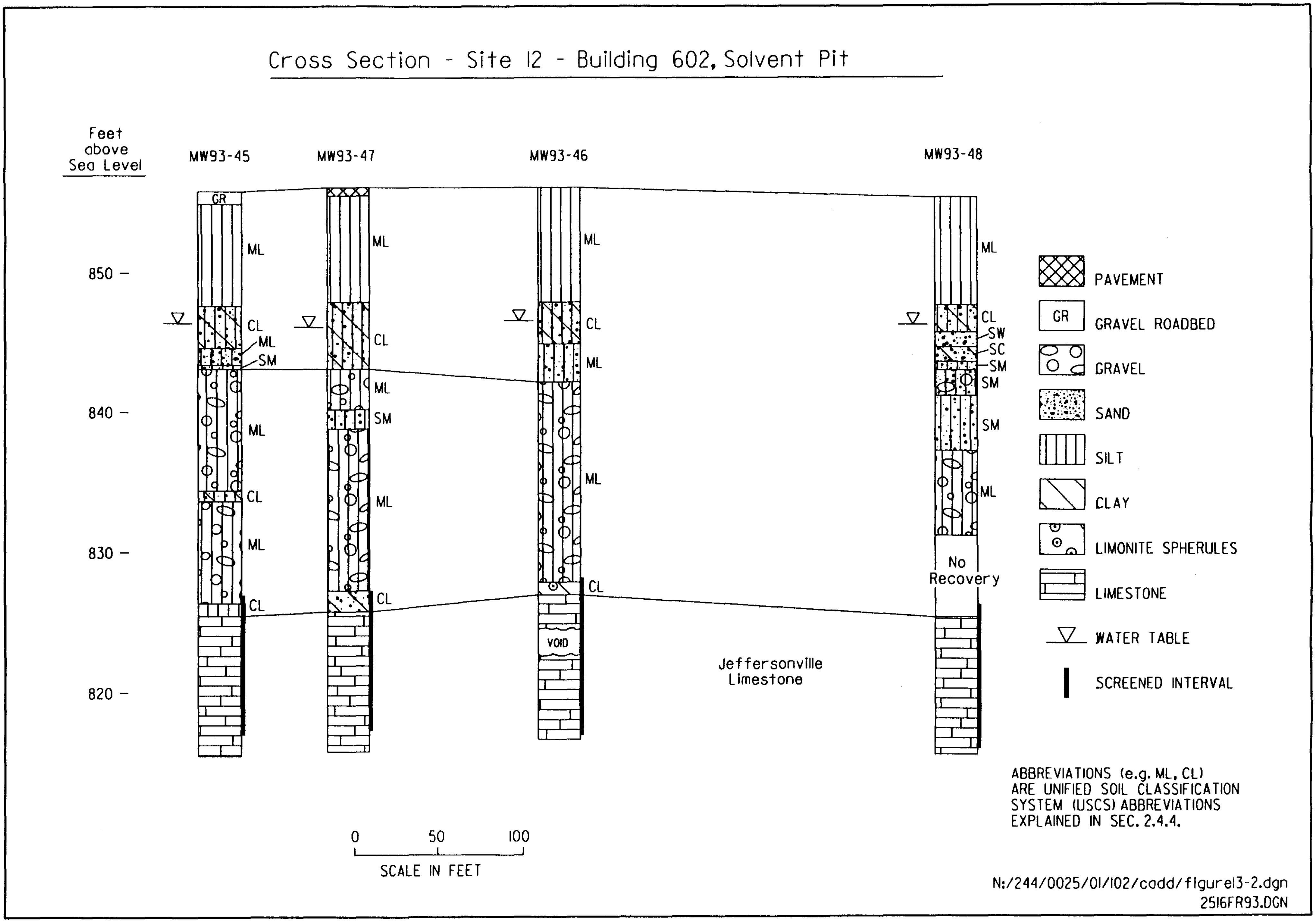


Figure 13-2. Phase I Cross Section of Building 602 Solvent Pit (Site 12A)

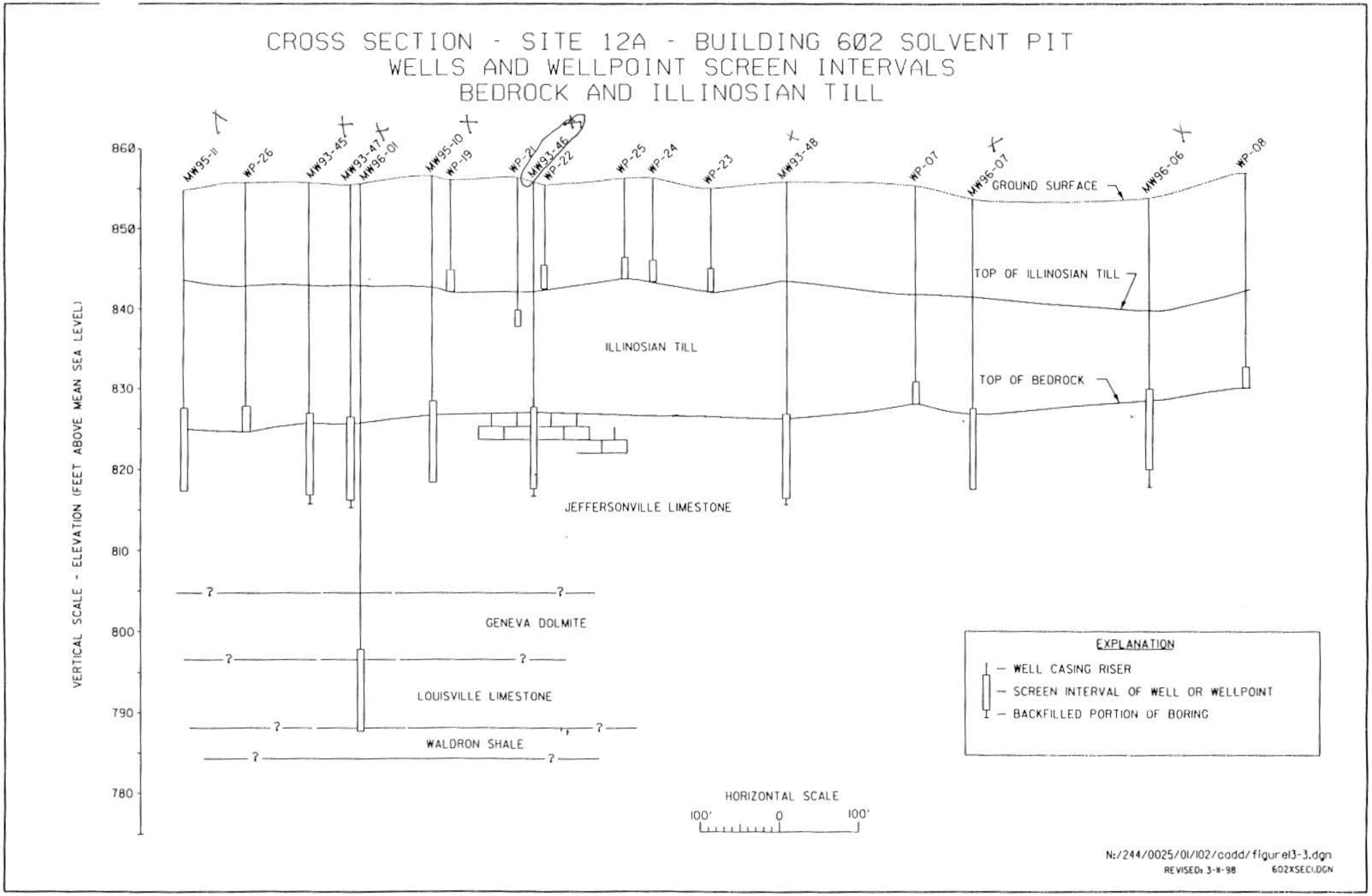
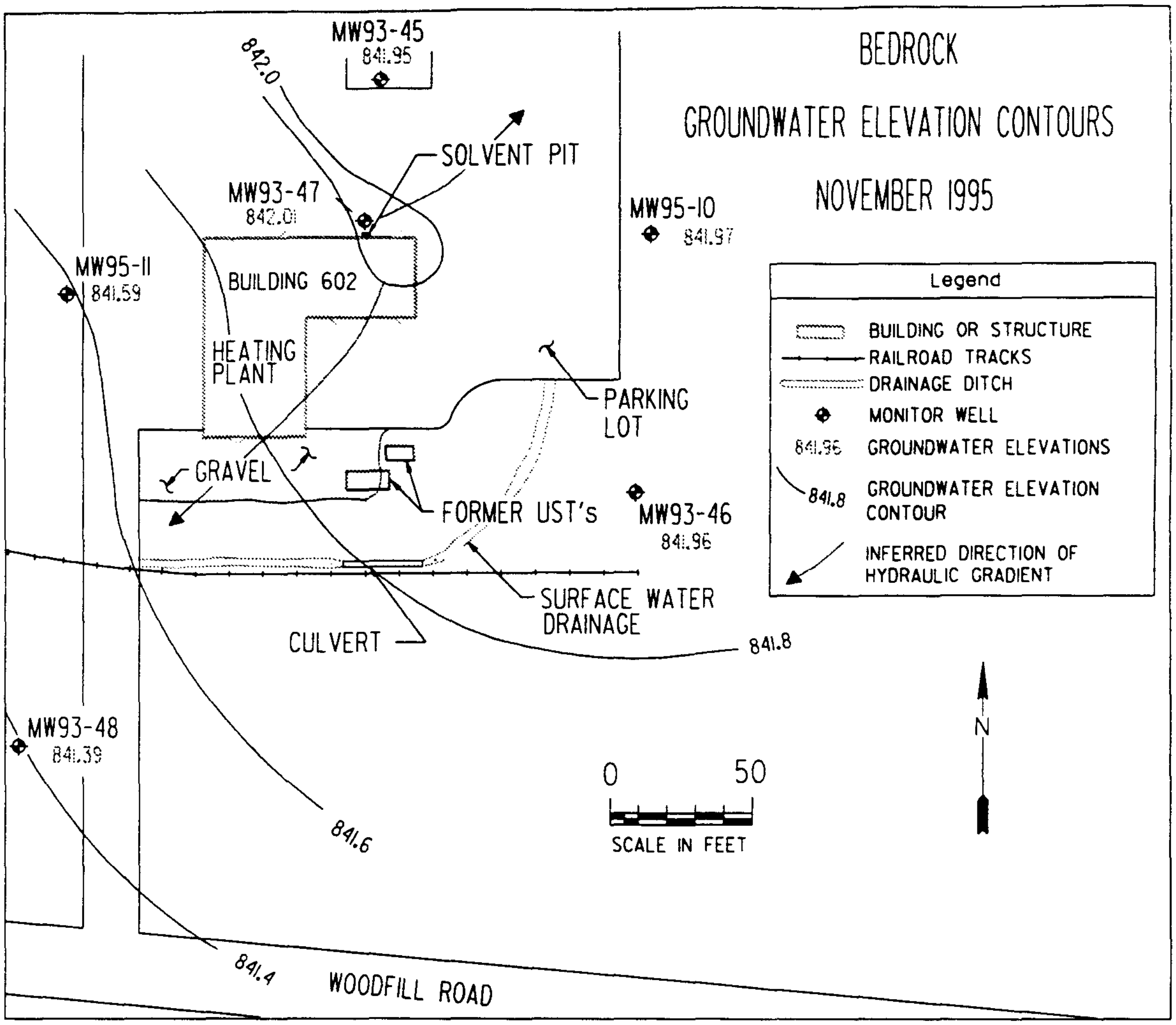
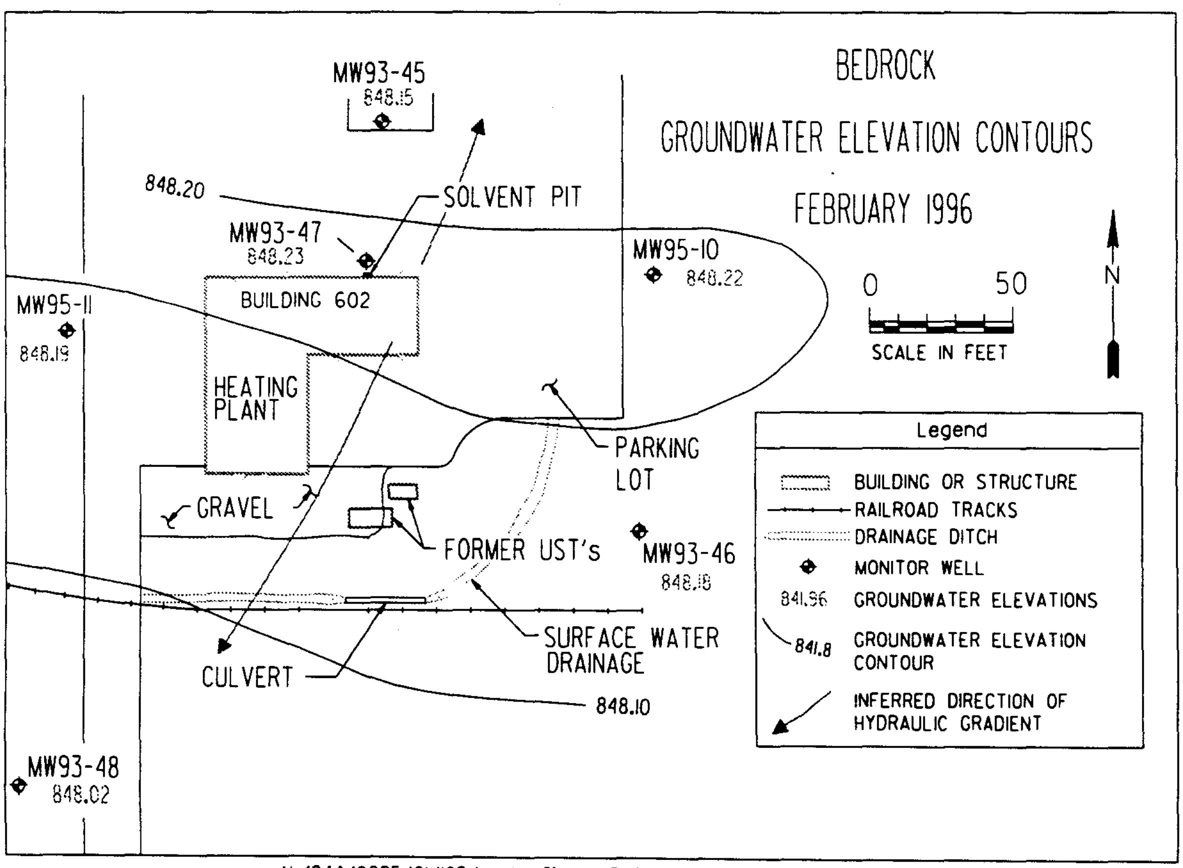


Figure 13-3. Phase II Cross Section of Building 602 Solvent Pit (Site 12A) Using Soil Boring Data





N:/244/0025/01/102/cadd/figure13-4.dgn REVISED: 3-15-99 SVABDN_F.DGN

Figure 13-4. Bedrock Potentiometric Contour Map - November 1995 and February 1996 Building 602 Solvent Pit (Site 12A)

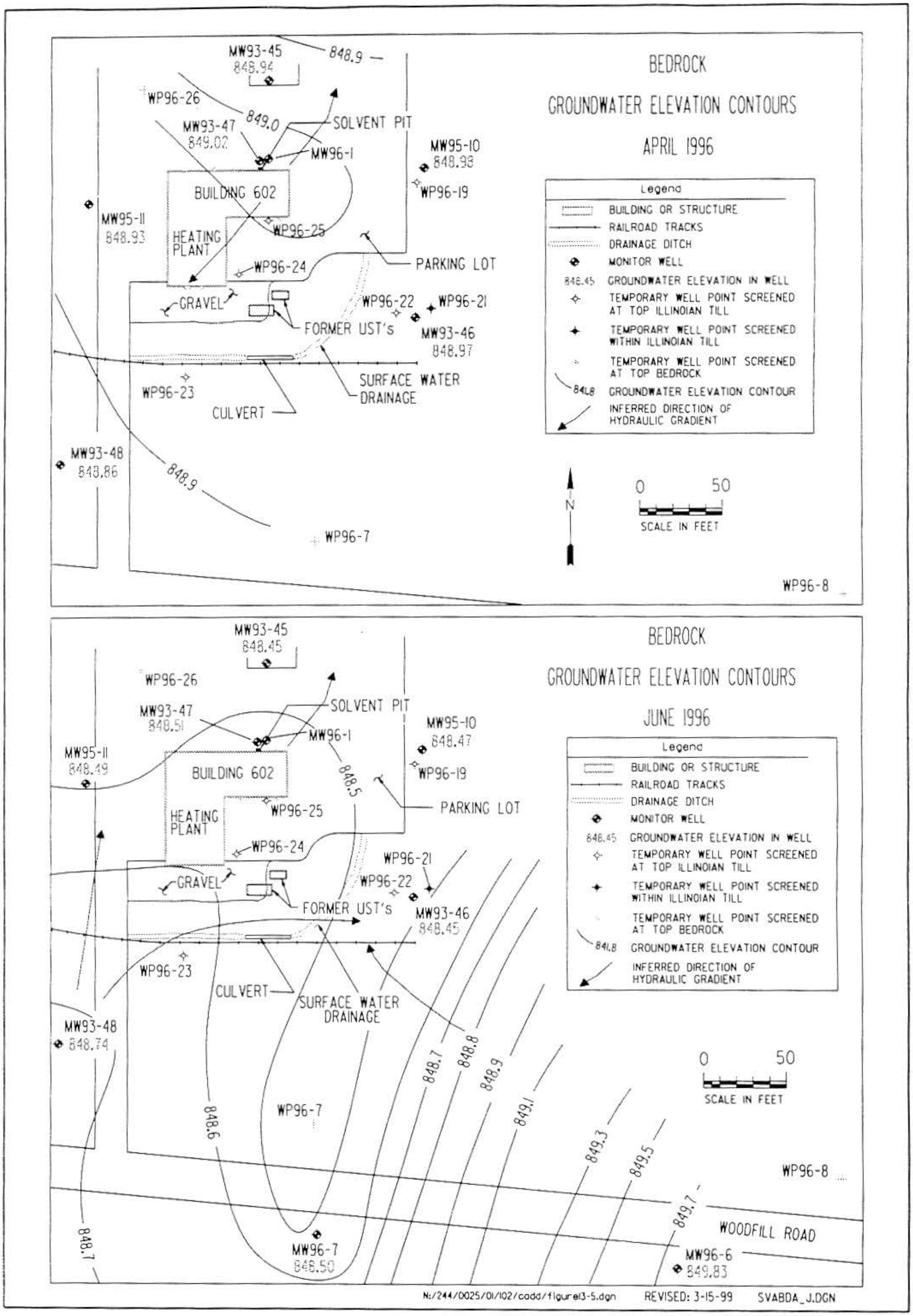


Figure 13-5. Bedrock Potentiometric Contour Maps - April and June 1996
Building 602 Solvent Pit (Site 12A)

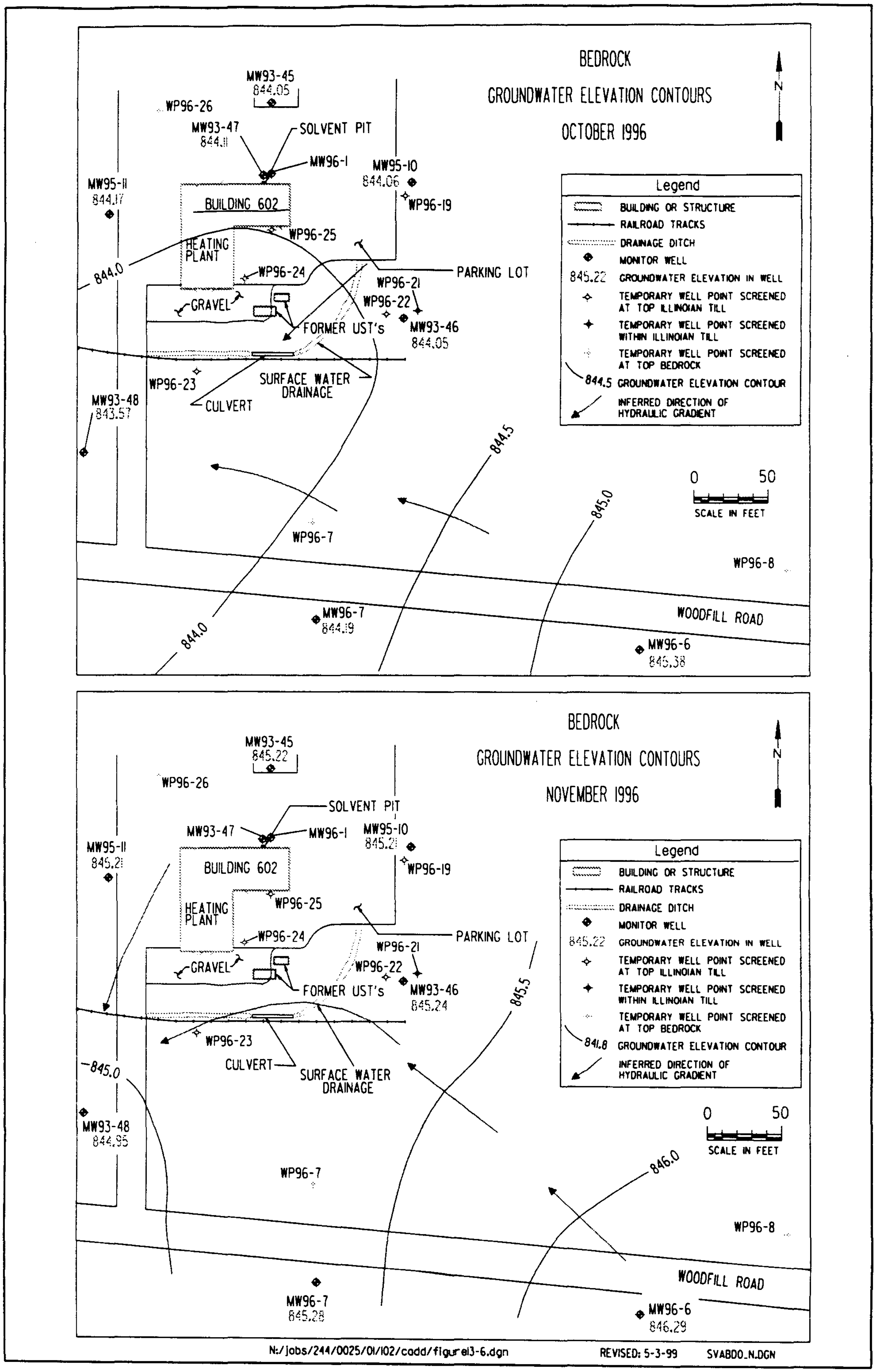


Figure 13-6. Bedrock Potentiometric Contour Map - October and November 1996
Building 602 Solvent Pit (Site 12A)

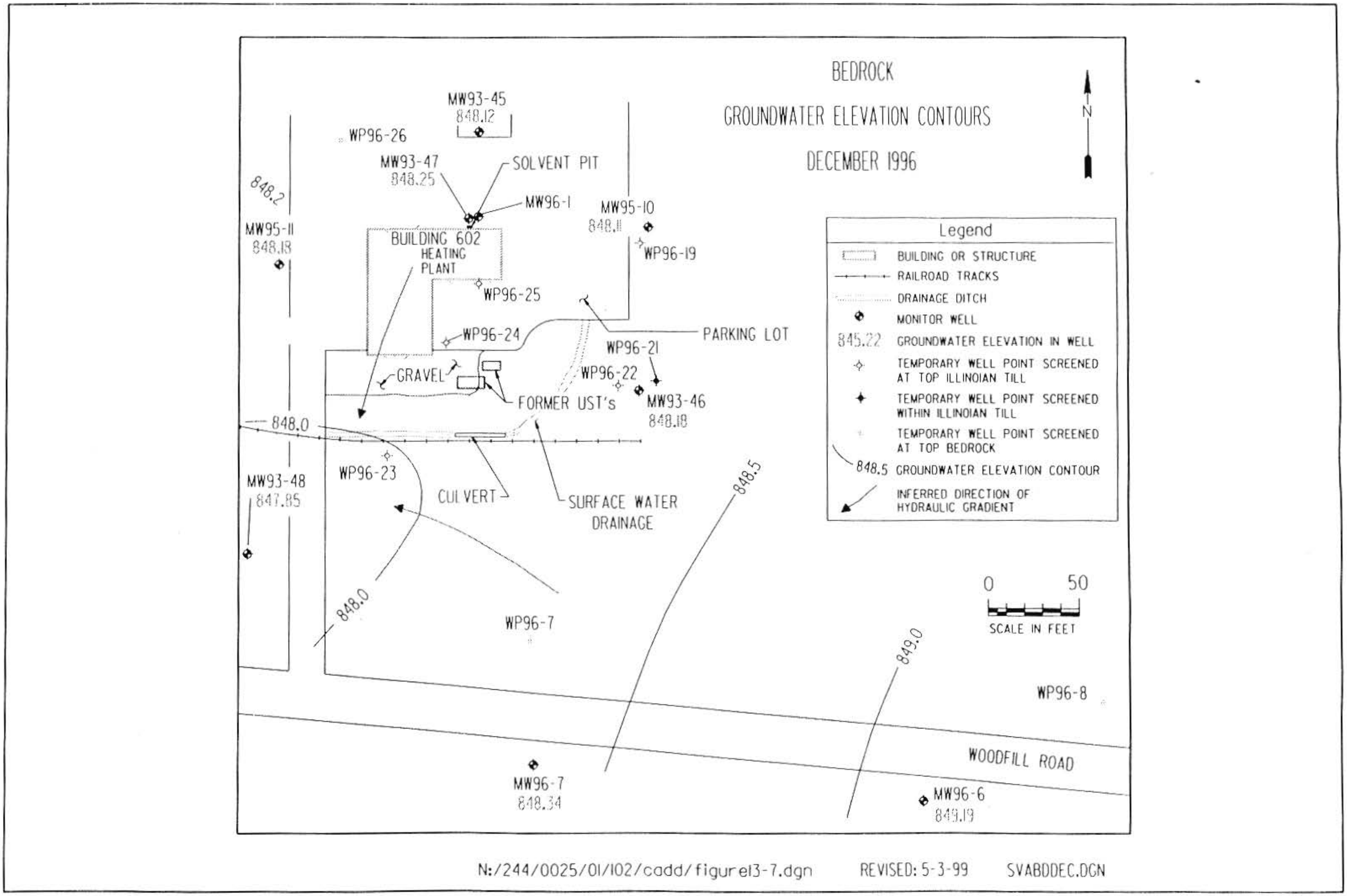
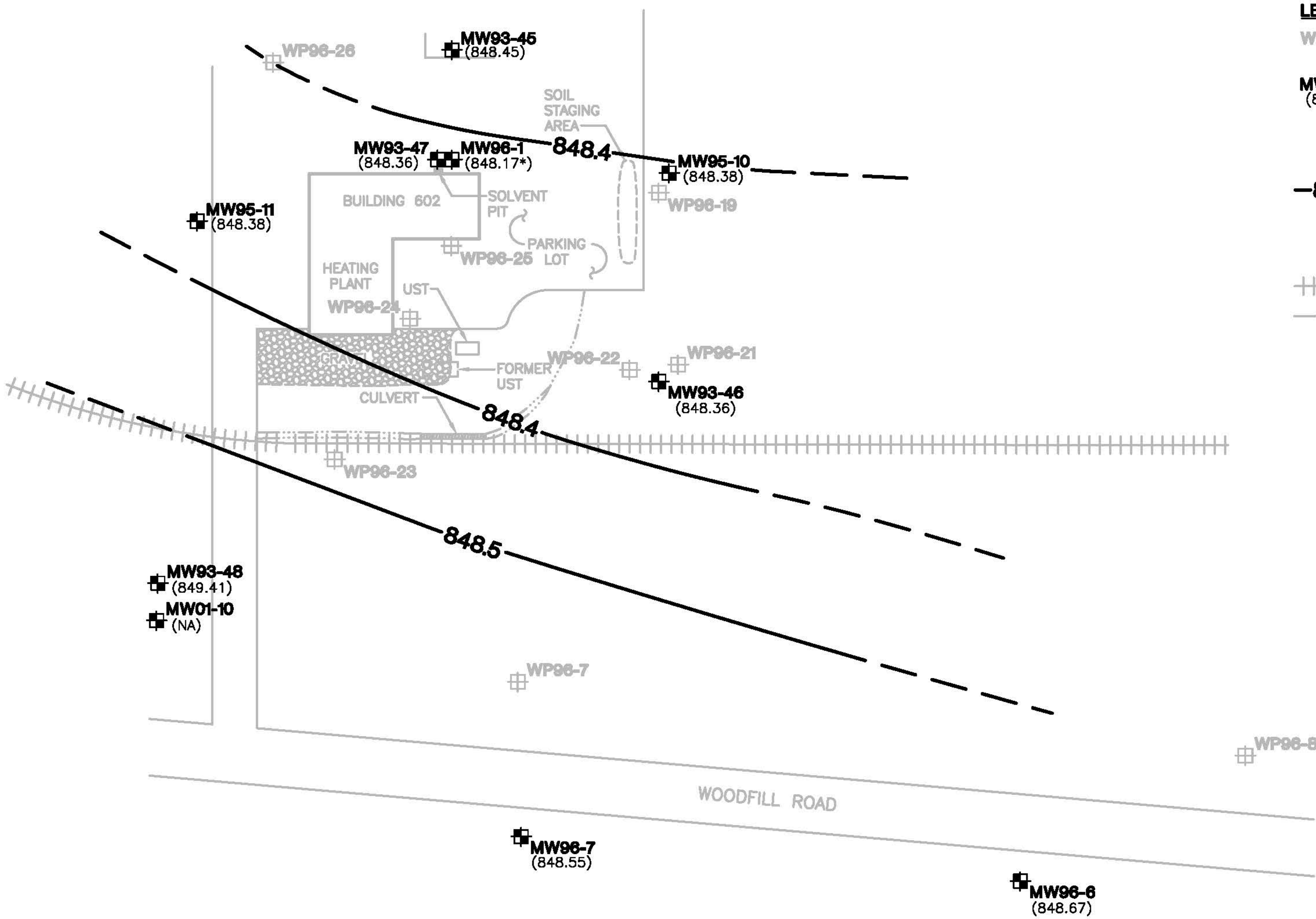


Figure 13-7. Bedrock Potentiometric Contour Map - December 1996
Building 602 Solvent Pit (Site 12A)



LEGEND

WP96-26 — TEMPORARY WELL LOCATION AND NUMBER

MW93-45 (848.45) — MONITORING WELL LOCATION, NUMBER, AND GROUNDWATER POTENTIOMETRIC SURFACE ELEVATION, IN FEET ABOVE MEAN SEA LEVEL

—848.5— POTENTIOMETRIC SURFACE CONTOUR (CONTOUR INTERVAL: 0.1 FT)

(NA) NOT AVAILABLE

RAILROAD TRACKS

SURFACE WATER DRAINAGE

NOTES

1. BASE MAP DEVELOPED FROM FIGURE 13–7 FROM A REPORT BY RUST ENVIRONMENT & INFRASTRUCTURE, DATED: 3–18–98.
2. MONITORING WELLS AND TEMPORARY WELLS TAKEN FROM FIGURE 13–12, VOLATILE ORANANIC COMPOUNDS IN GROUNDWATER AT BUILDING 602 SOLVENT PIT (SITE 12A), PREPARED BY RUST E&I, DATED 8–6–98.
3. GROUNDWATER ELEVATIONS DENOTED BY AN "*" ARE NOT INCLUDED IN THE INTERPRETATION OF THE CONTOURED SURFACE.

north

0 50 100

SCALE IN FEET

FIGURE 13-7a

POTENTIOMETRIC SURFACE MAP (JUNE 5, 2001)
BUILDING 602 SOLVENT PIT (SITE 12A)

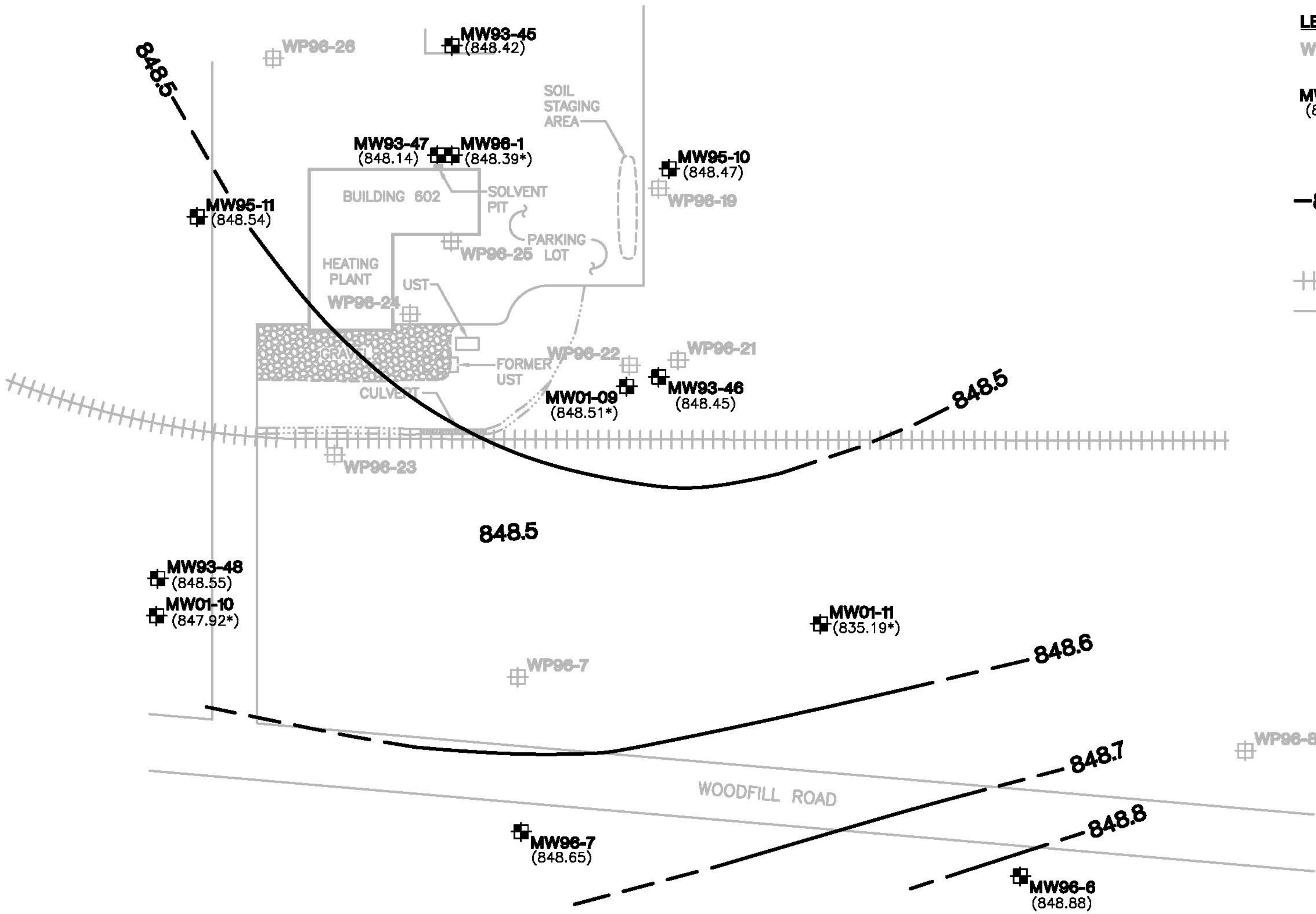
SOUTH OF THE FIRING LINE
JEFFERSON PROVING GROUND
MADISON, INDIANA

Developed By TAPB
Drawn By DLF
Approved By
Date
Reference 2440025.040201–B5
Revisions

Drawing Number
2440025
010102
B10

MWH
MONTGOMERY WATSON HARZA

QUALITY CONTROL
Graphic Standards DLF 2–19–02
Lead Professional TAPB 2–22–02
Technical Review LBL 3–13–02
Project Manager LAB 3–14–02
Management Review
Other



LEGEND

WP96-26	TEMPORARY WELL LOCATION AND NUMBER
MW93-45 (848.42)	MONITORING WELL LOCATION, NUMBER, AND GROUNDWATER POTENTIOMETRIC SURFACE ELEVATION, IN FEET ABOVE MEAN SEA LEVEL
—848.5—	POTENTIOMETRIC SURFACE CONTOUR (CONTOUR INTERVAL: 0.1 FT, DASHED WHERE INFERRED)
	RAILROAD TRACKS
	SURFACE WATER DRAINAGE

NOTES

1. BASE MAP DEVELOPED FROM FIGURE 13-7 FROM A REPORT BY RUST ENVIRONMENT & INFRASTRUCTURE, DATED: 3-18-98.
2. MONITORING WELLS AND TEMPORARY WELLS TAKEN FROM FIGURE 13-12, VOLATILE ORANANIC COMPOUNDS IN GROUNDWATER AT BUILDING 602 SOLVENT PIT (SITE 12A), PREPARED BY RUST E&I, DATED 8-6-98.
3. GROUNDWATER ELEVATIONS DENOTED BY AN "*" ARE NOT INCLUDED IN THE INTERPRETATION OF THE CONTOURED SURFACE.

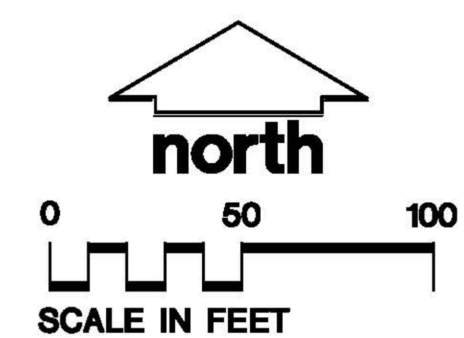


FIGURE 13-7b

POTENTIOMETRIC SURFACE MAP (NOVEMBER 26, 2001)
BUILDING 602 SOLVENT PIT (SITE 12A)

SOUTH OF THE FIRING LINE
JEFFERSON PROVING GROUND
MADISON, INDIANA

Developed By TAPB
Drawn By DLF
Approved By
Date
Reference 2440025.040201-B5
Revisions

Drawing Number 2440025 010102 B11

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Graphic Standards	DLF	2-19-02	Technical Review	LBL	3-13-02	Management Review
Lead Professional	TAPB	2-22-02	Project Manager	LAB	3-14-02	Other

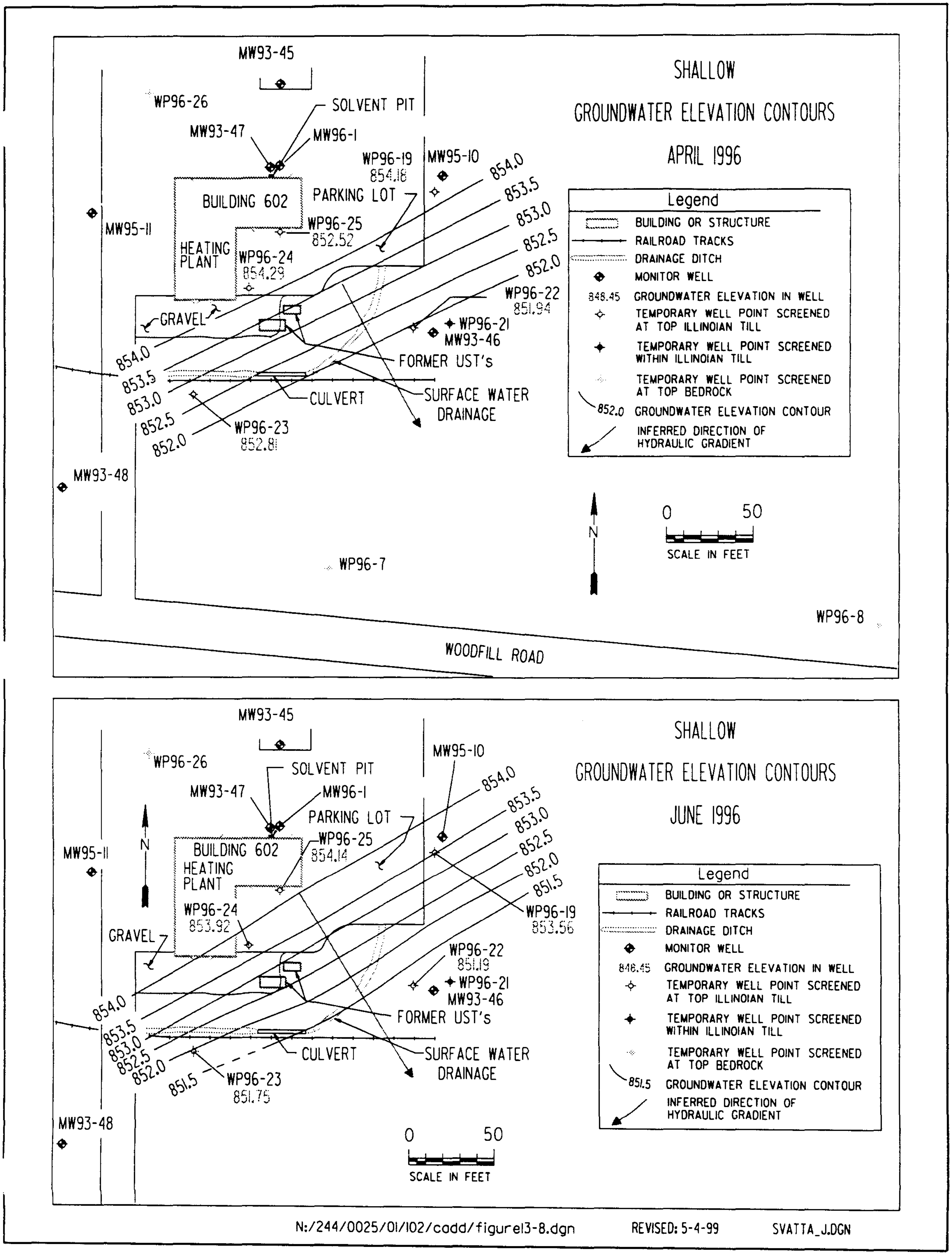


Figure 13-8. Glacial Till Potentiometric Contour Map - April and June 1996
Building 602 Solvent Pit (Site 12A)

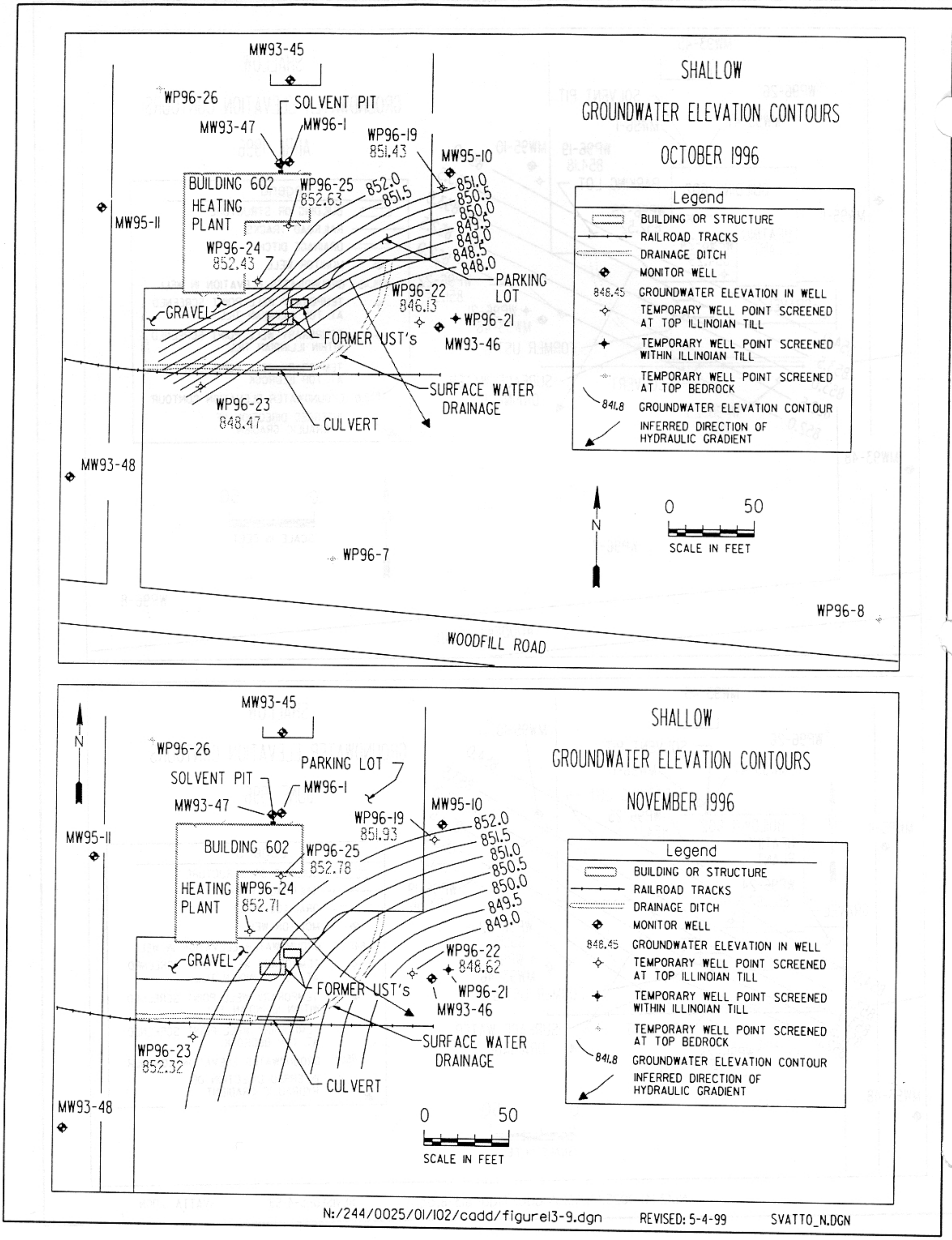
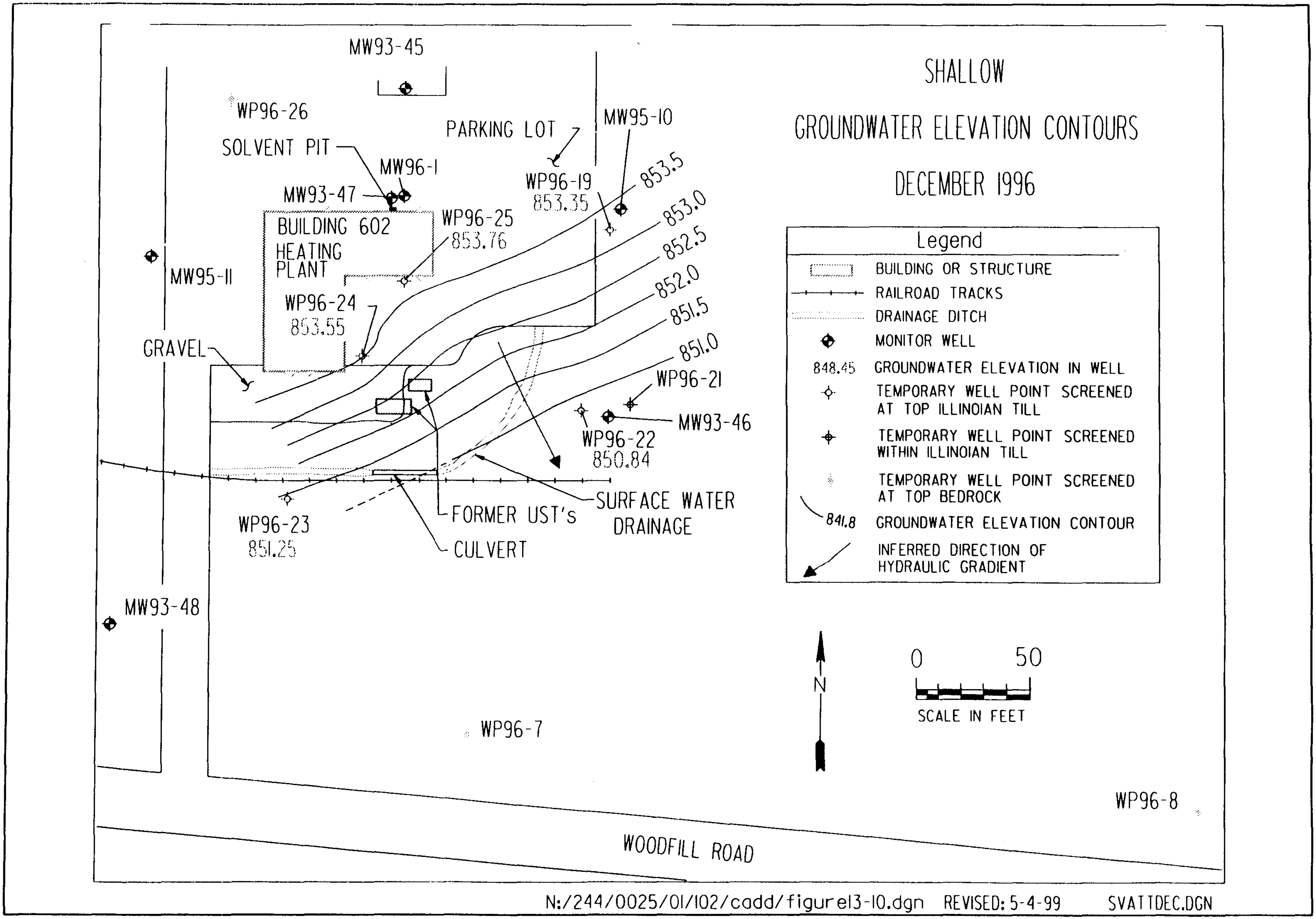


Figure 13-9. Glacial Till Potentiometric Contour Map - October and November 1996
Building 602 Solvent Pit (Site 12A)



N:/244/0025/01/102/cadd/figure13-10.dgn REVISED: 5-4-99 SVATTDEC.DGN

Figure 13-10. Glacial Till Potentiometric Contour Map - December 1996
Building 602 Solvent Pit (Site 12A)

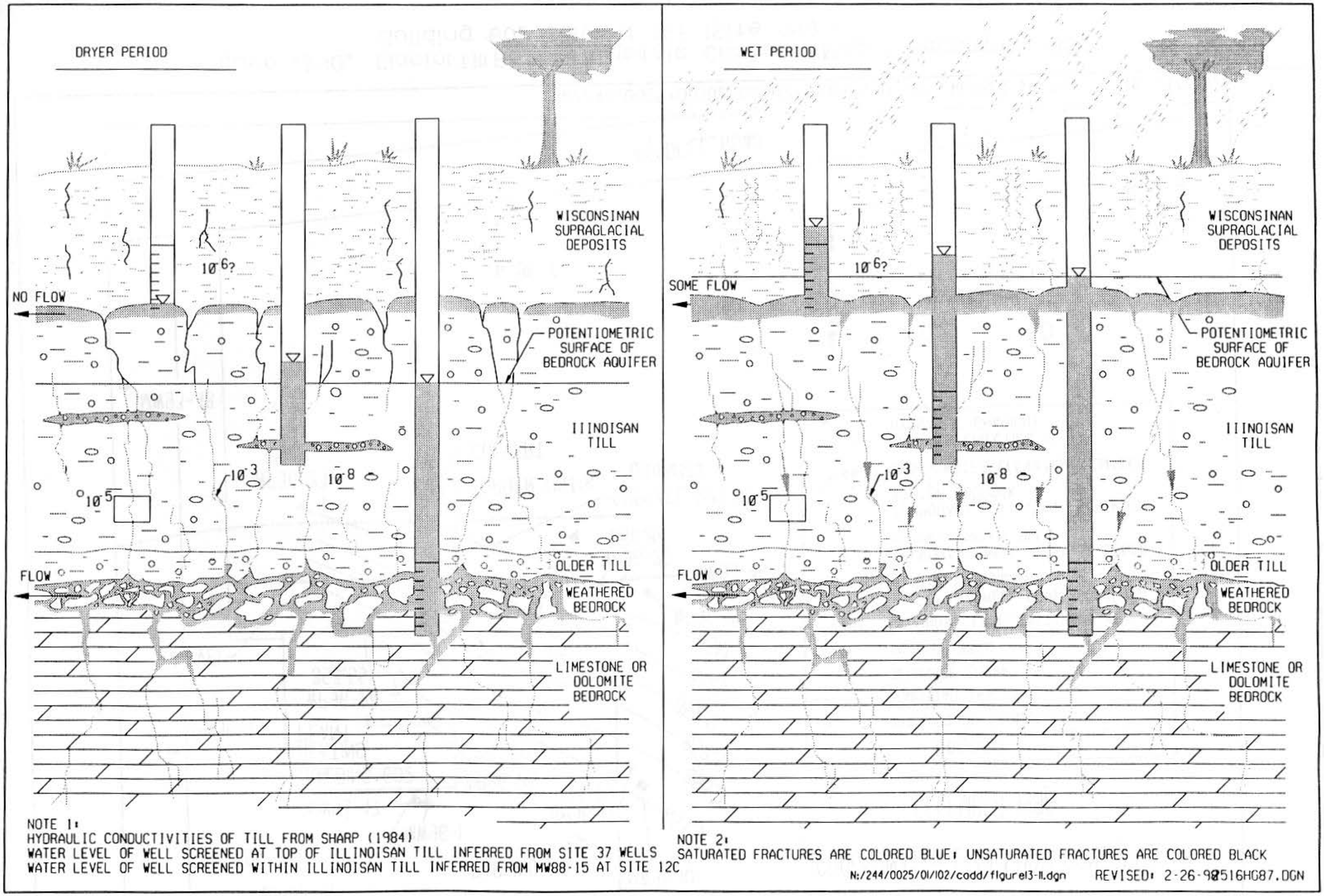


Figure 13-11. Schematic Cross Section Summarizing Hydrogeologic Model

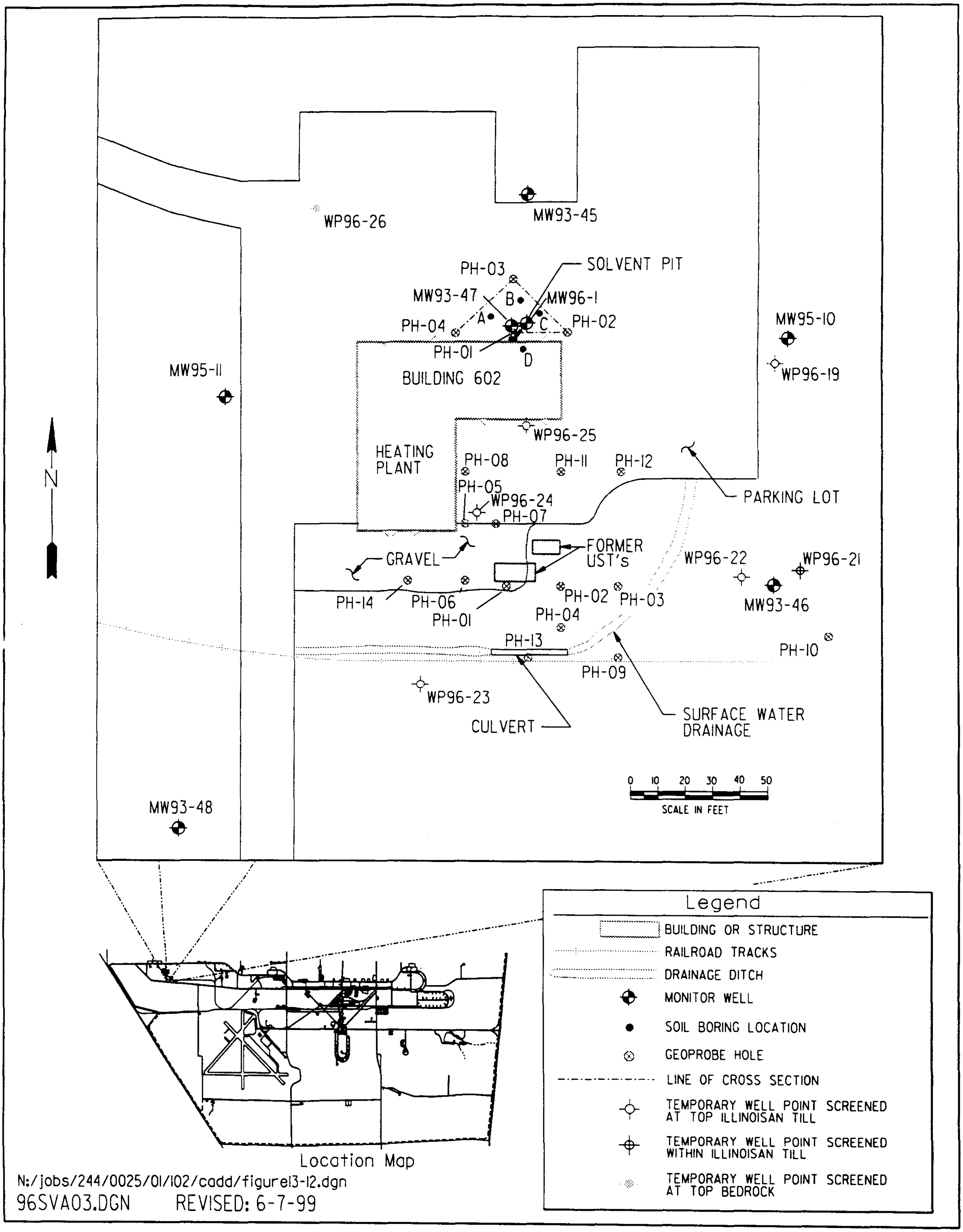


Figure 13-12. Probehole Location Map for Field Screening Survey
Building 602 Solvent Pit (Site 12A)

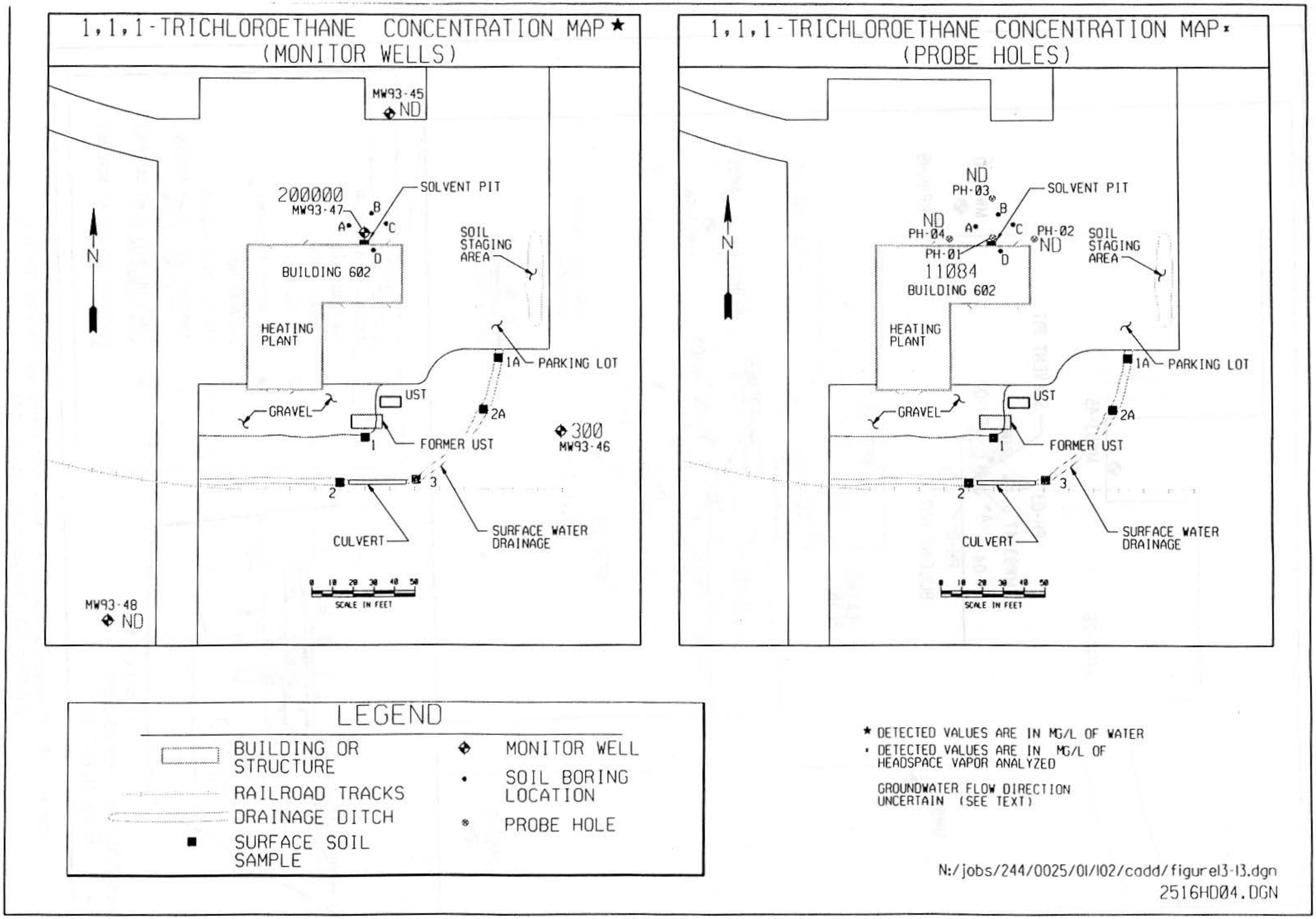


Figure 13-13. Distribution of 1,1,1-Trichloroethane Contamination in Monitoring Well and Probehole Groundwater Samples at Building 602 Solvent Pit (Site 12A) During Phase I

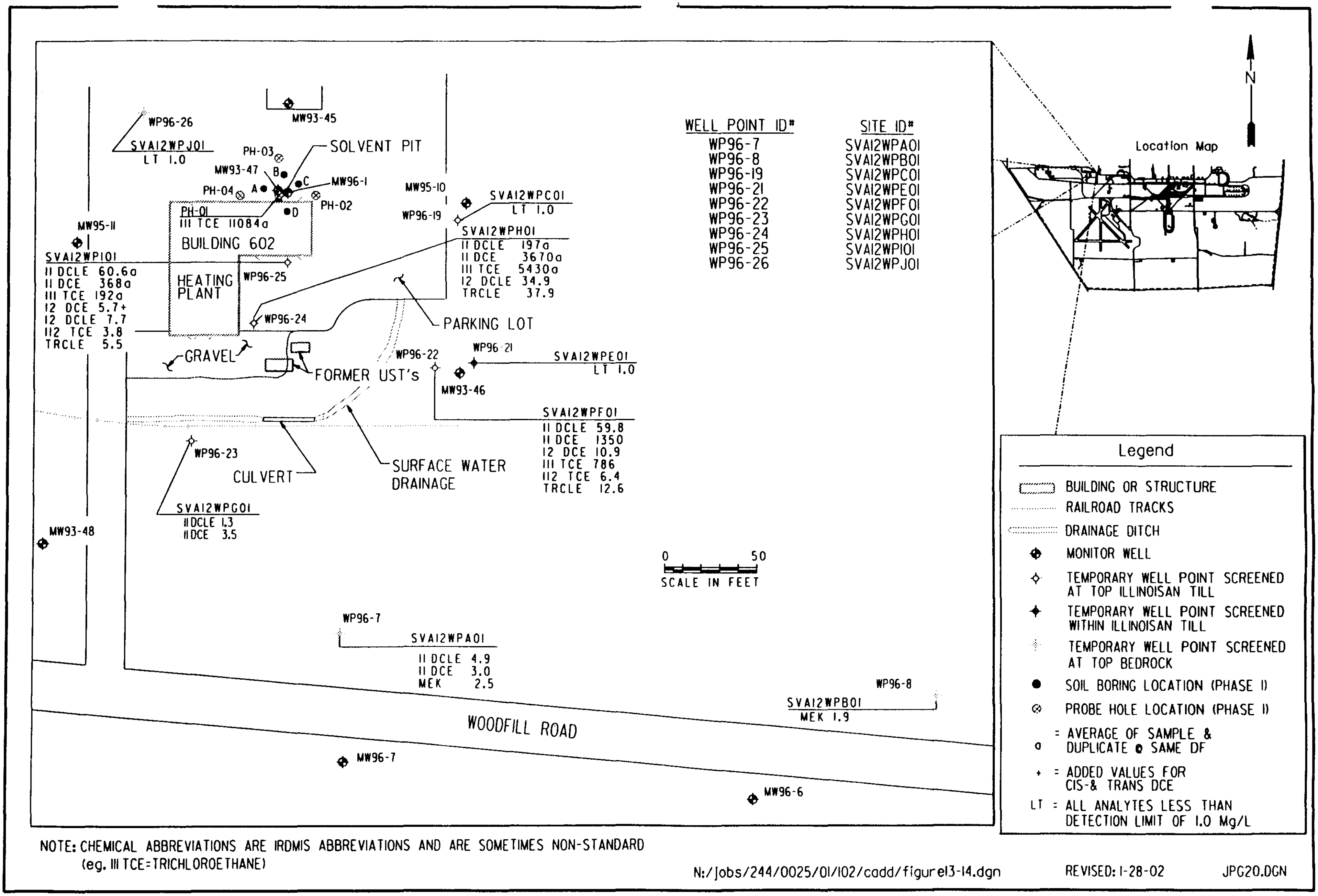


Figure 13-14. Volatile Organic Compounds in Groundwater at Building 602 Solvent Pit (Site 12A)

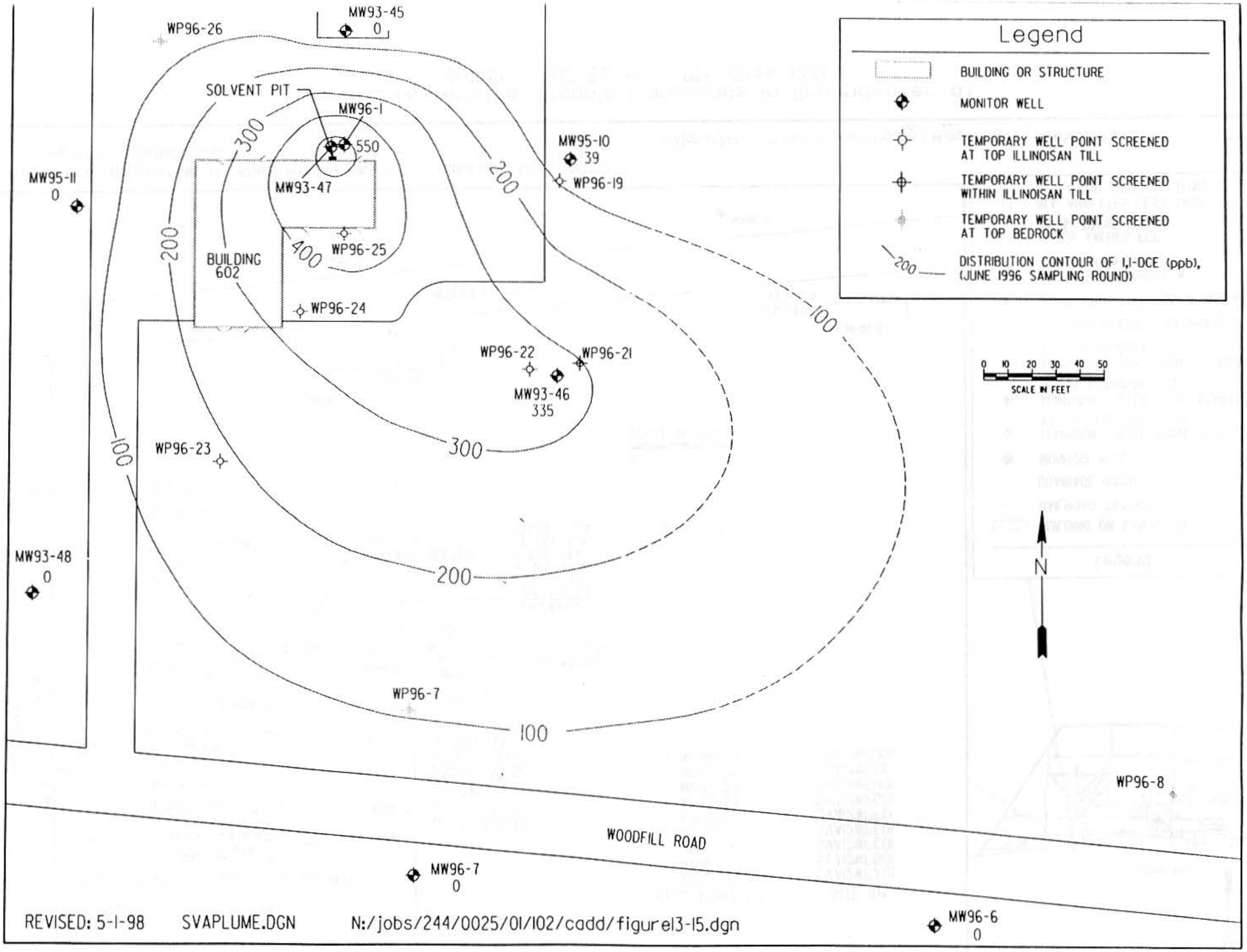
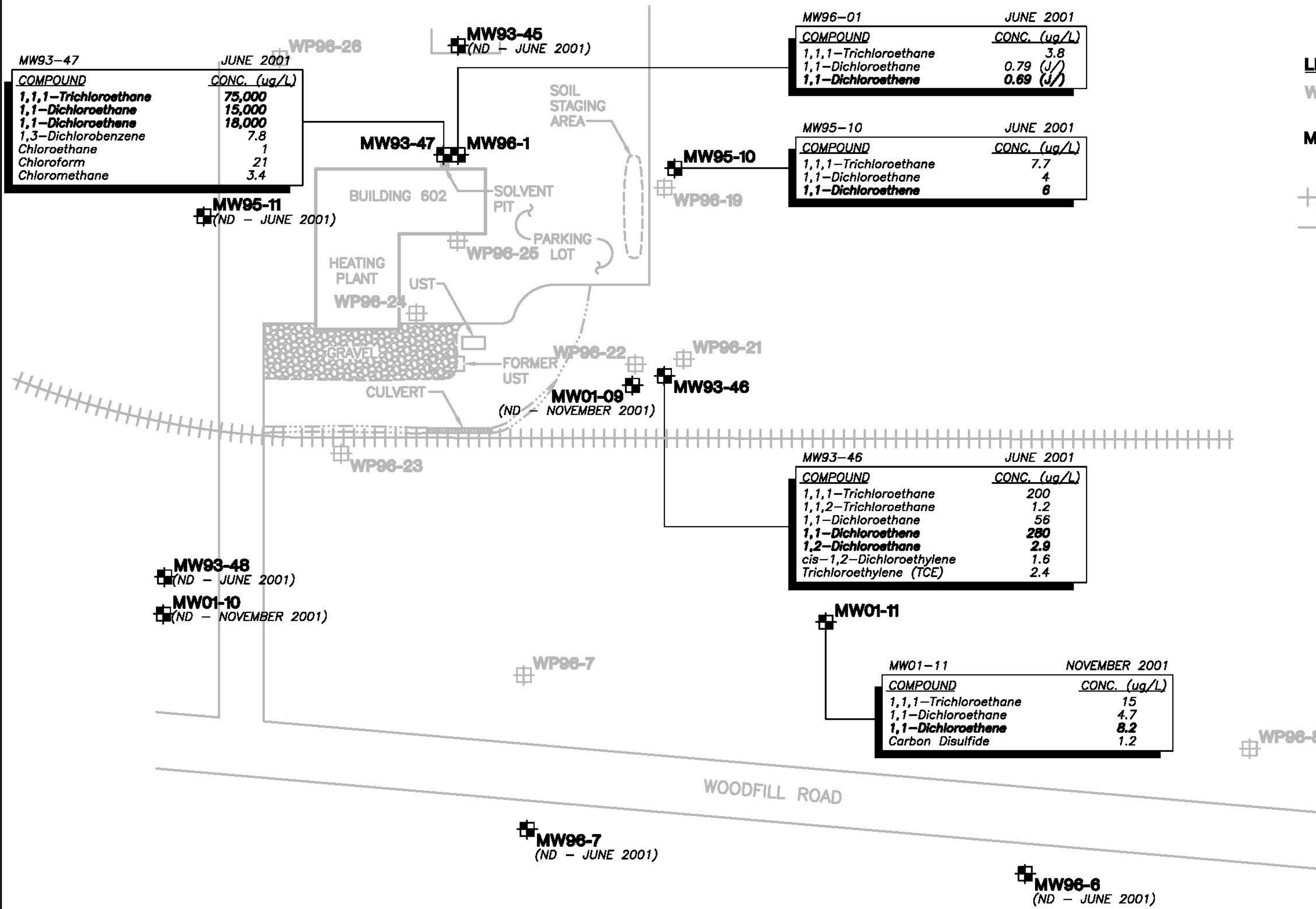


Figure 13-15. Distribution of 1,1-Dichloroethene as of June 1996 Sampling Round at Building 602 Solvent P[illegible] Site 12A)



LEGEND

- WP96-26 — TEMPORARY WELL LOCATION AND NUMBER
- MW93-45 — MONITORING WELL LOCATION AND NUMBER
- RAILROAD TRACKS
- SURFACE WATER DRAINAGE
- ND — NO VOCs DETECTED
- ug/L — MICROGRAMS PER LITER

NOTES

1. BASE MAP DEVELOPED FROM FIGURE 13-7 FROM A REPORT BY RUST ENVIRONMENT & INFRASTRUCTURE, DATED: 3-18-98.
2. MONITORING WELLS AND TEMPORARY WELLS TAKEN FROM FIGURE 13-12, VOLATILE ORANANIC COMPOUNDS IN GROUNDWATER AT BUILDING 602 SOLVENT PIT (SITE 12A), PREPARED BY RUST E&I, DATED 8-6-98.
3. ONLY COMPOUNDS WHICH WERE DETECTED ARE SHOWN ON THIS MAP. SEE ANALYTICAL LABORATORY REPORT FOR PARAMETER LIST, DETECTION LIMITS, AND EXPLANATION OF LABORATORY NOTES.
4. RESULT IN BOLD FONT INDICATES THAT CONCENTRATION EXCEEDS THE USEPA REGION 9 PRELIMINARY REMEDIATION GOAL FOR TAP WATER (2000) FOR THAT COMPOUND.

north

0 50 100

SCALE IN FEET

FIGURE 13-15a

VOC CONCENTRATIONS IN GROUNDWATER (JUNE AND NOVEMBER 2001)
BUILDING 602 SOLVENT PIT (SITE 12A)

SOUTH OF THE FIRING LINE
JEFFERSON PROVING GROUND
MADISON, INDIANA

Developed By TAPB
Drawn By DLF
Approved By
Date
Reference 2440025.040201-B5
Revisions

Drawing Number 2440025 010102 B12

MWH MONTGOMERY WATSON HARZA

QUALITY CONTROL			
Graphic Standards	DLF	2-19-02	
Lead Professional	TAPB	2-22-02	
Technical Review	LBL	3-13-02	
Project Manager	LAB	3-14-02	
Management Review			
Other			

14.0 BUILDING 617 SOLVENT PIT (SITE 12B)

14.1 SITE CHARACTERISTICS

Building 617 is located north of Woodfill Road about one-third of a mile east of Tokyo Road (Figure 2-1). Building 617 was an ammunition-assembly plant in the past. It was inactive at the time of the RI. The solvent disposal pit of concern iswas located immediately adjacent to the building (Figure 14-1) and consisteds of a gravel-filled pit approximately 3 feet in diameter and 3 feet deep. It was used from 1970 to 1978 to dispose of waste solvents/degreasers, including trichloroethene 1,1,1-trichloroethane (TCA) used during routine maintenance and sonic cleaning of gauges. It is estimated that a maximum of 500 gallons of trichloroethene TCA was disposed in the pit. Other unknown solvents and degreasers were also likely disposed in the pit. This disposal practice resulted in VOC contamination of the surrounding soils.

Three steel USTs, used to store fuel oil, were formerly located south of Building 617 (Figure 14-1). All of tThe tanks have since been removed. The soil-sample results from the tank-removal excavation were reviewed, and it appeareds that there may have been some residual subsurface-soil contamination at the site.

The area around the site is relatively flat. Surface-water runoff from Building 617 flows generally to the east and enters a tributary to Middle Fork Creek about 1,500 feet away (Figure 2-1). The building is surrounded by a combination of open grassy areas and pavement. Woods encroach on the south and west at Building 617. The soils at Buildings 617 belong to the Cobbsfork soil series. The glacial till is about 20 feet thick at this site and underlain by the Jeffersonville Limestone or the Geneva Dolomite, both of Devonian age. The Phase I monitoring well cross section shows the soil types, the bedrock unconsolidated formations, screened intervals, and water levels (Figure 14-2). The Phase II cross-section shows the unconsolidated (glacial till) and bedrock formations and the screened intervals for temporary and permanent monitoring wells (Figure 14-3).

The VOC contaminated soils in the vicinity of the solvent pit were excavated and disposed of during the solvent pit removal activities conducted from July 19 through September 21, 2000. Approximately 130 tons of soils were excavated. Confirmation sampling was performed to assess the remedial action. Minor residual contamination was detected in the confirmation samples. However, additional excavation was not performed due to the proximity of building structures and the potential of undermining those structures. Following receipt of analytical results, contaminated soils were transported for disposal at an off-site regulated disposal facility. The excavation site was backfilled with clean fill material that was compacted, and 10-10-10 fertilizer was added to the backfill to promote biological activity in the soils. A perforated PVC pipe was also added along the footprint of Building 617 so that additional fertilizer could be added to the soil if needed. A detailed description of the construction activities and sample results is contained in the *Draft-Final Construction Completion Report,*

Remedial Removal Actions, Sites 12A, 12B, 12C, and 33 (Montgomery Watson, February 2002).

14.1.1 Groundwater

At Building 617, groundwater is encountered in ~~exists in two distinct zones:~~ the bedrock aquifer system and in the ~~perched zone on top of Illinoian~~ glacial till. A total of ~~11~~ 17 groundwater monitoring wells have been installed at Site 12B~~in the bedrock to depths of 50 feet below ground surface~~ (Figure 14-1~~3~~). ~~Nine~~Eleven of the wells are screened across the ~~almost entirely in the Jeffersonville Limestone~~ bedrock/till interface. ~~, and~~. ~~approximately 1 foot in the overlying Illinoian till. Occasionally, the lower portions of the well screen extends down into the upper 1 foot of the Geneva Dolomite.~~ The remaining ~~two~~ six wells ~~(MW96-2 and MW96-4)~~ were completed at the bottom of ~~deeper zones in~~ the Louisville Limestone ~~and Geneva Dolomite~~ above the Waldron Shale. The Waldron Shale is an aquitard unit and is considered to be the lower boundary of the first ~~encountered~~ bedrock ~~groundwater~~ aquifer (Figure 14-3). A summary of monitoring well information is shown in Table 14-1a.

Groundwater elevation data were collected ~~11~~ at least 15 separate times over a period of ~~3~~ nine years at Building 617, and are presented in Table 14-1b. ~~Contour~~ Potentiometric surface maps based on these data have been ~~constructed~~ prepared for ~~perched and bedrock~~ Site 12B. ~~groundwater at Building 617.~~ The bedrock/till interface groundwater data are contoured for November 1995 and February, April, June, September, October, November, and December 1996 (Figures 14-4 through 14-7). The well points used to evaluate the ~~perched~~ shallow groundwater ~~zone~~ in the till were installed in April 1996, and their water levels are presented on Table 14-1c. Contour maps of the apparent ~~perched~~ groundwater ~~surface~~ head in the till (shallow groundwater) were ~~constructed~~ also prepared for April, June, September, October, November, and December 1996 (Figures 14-8 through 14-10). With the installation of the additional wells in 2001, subsequent water-level measurements were used to prepare potentiometric surface maps for the bedrock/till interface in June and November 2001 (Figures 14-10a & 14-10b). ~~The relationship between the perched and bedrock groundwater systems are illustrated by the conceptual model presented in Section 13.3.1.1, Figure 13-3.~~

14.1.1.1 ~~Perched~~ Shallow Groundwater. Small diameter well points were installed on top of, and in some instances, within the ~~Illinoian~~ glacial till during the ~~F~~field ~~S~~screening work performed at the solvent sites during April 1996 (Rust E&I 1996). The well points were designed to assess aquifer hydraulics and groundwater flow near the water table surface, and to evaluate groundwater quality in the till at the solvent pit site. ~~The groundwater elevation in these wellpoints was monitored during April, June, September, October, November, and December 1996.~~

The elevation of groundwater in the ~~perched zone~~ glacial till ~~is~~ was typically from 0.5 to 1.5 feet higher than the apparent potentiometric surface of groundwater in the bedrock ~~system~~ aquifer (Figure 14-3). The till at Site 12B is comprised of silt and clay with some sand and gravel. Groundwater recharge through such material can give the appearance of high potentiometric head during wet periods versus low potentiometric head during dry periods.

This is due to the aquifer material's susceptibility to high tension head following precipitation events, further slowing the potential for recharge through the till. The area in the aquifer where this occurs is known as a tension-saturated zone (Freeze and Cherry, 1979).

The ground-surface elevation at Building 617 varies from 2 to 4 feet. The vertical potential gradient in the perched groundwater at Building 617 was down during the above referenced months with values ranging between 0.01 and 0.10 ft/ft. Groundwater elevations increase and decrease as a direct result of the changing seasons. Groundwater elevations appear are observed to be highest in April and December, lowest in October and November (Table 14-1b).

An inverse relationship between precipitation and groundwater gradient has been observed at the site and has attributed to the existence of a tension-saturated zone in the glacial till. The groundwater gradient measured in the till apparently decreases during times when precipitation increases. This typically occurs when the pore spaces fill with water. As the moisture content in the soil increases, the pressure head and hydraulic head increase while the downward hydraulic gradient decreases. This decrease in downward hydraulic gradient is balanced by an increase in hydraulic conductivity values under the influence of rising pressure head. Thus, infiltration continues to decrease until a time when the gradients and hydraulic conductivity can no longer accept all of the infiltration due to the high tension head that has been developed. When that occurs, ponding, interflow, and overland flow can occur (Freeze and Cherry, 1979).

Shallow groundwater in the glacial till at Building 617 occurs at depths between 3 and 8 feet below ground surface. The apparent horizontal hydraulic gradient of the shallow groundwater was calculated to be between 0.00065 ft/ft (April 1996) and 0.06 ft/ft (October 1996), with an average of 0.043 ft/ft. Groundwater in the till appears to flow to the northeast during April and December 1996 (Figures 14-8 and 14-10), and to southwest in October and November 1996 (Figures 14-9 and 14-10). Based on precipitation values reported for 1996, April and December were wetter months than October and November.

Groundwater perched on top of the Illinoian till at Building 617 occurs at a depth between 3 and 8 feet bgs. The horizontal hydraulic gradient of the perched groundwater varied significantly between 0.00065 ft/ft (April 1996) and 0.06 ft/ft (October 1996), with an average of 0.02 ft/ft. The perched groundwater flow direction inferred from the contour maps varied from northeast during April and December 1996 (Figures 14-8 and 14-10), to southwest in October and November 1996 (Figures 14-9 and 14-10). Based on precipitation values reported for 1996, April and December were wetter months than October and November. For the months investigated in 1996, perched groundwater flowed northeast during wetter months and southwest during dryer months, indicating a correlation between precipitation and the perched groundwater flow direction. Small fracture porosities could also contribute to the relatively large vertical variations in water levels, which in turn can cause the variation in hydraulic gradient. Seasonal or storm-based changes in groundwater recharge can rapidly fill the low porosity fracture network causing a rapid rise in water levels in piezometers connected to the fracture system.

~~The perched groundwater is in communication with the bedrock aquifer as demonstrated by the pumping test results. Drawdown associated with the pumping test performed on bedrock well MW93-39 was recorded in wellpoints WP-15, WP-17, and WP-31 screened on top of the Illinoian till (Appendix B). Groundwater levels in the perched zone never recovered to pre-test levels after the test was complete, as shown by the recovery data in Appendix B. It was noted that the background water levels in the perched zone prior to the pumping test showed a slow decline with time. However, perched groundwater continued to decline at a slower rate even after the pump was shut off~~

Groundwater in the glacial till is in communication with the bedrock aquifer as demonstrated by the pumping test results. Drawdown associated with the pumping test performed on bedrock well MW93-39 was recorded in temporary well points WP-15, WP-17, and WP-31 screened in the glacial till. The drawdown results are plotted in Appendix B (Figure B-2). The background water levels in the till prior to performing the pumping test showed a slow decline with time. Groundwater levels in the till did not recover to pre-test levels after the test was complete, as shown by the recovery data in Appendix B. Shallow groundwater continued to decline even after the pump was shut off. The decline in head observed after the pump test is a characteristic response to a reduction in tension head in the till (Freeze and Cherry, 1979). The rate of decline during the pumping test, compared to the decline following it, indicates that the till is hydraulically connected to the bedrock aquifer, and the drawdown observed in the till was in direct response to the pumping test in the bedrock aquifer.

Groundwater in the glacial till also migrates to the bedrock aquifer as flow through porous media and through vertical fractures in the till. The relationship between the glacial till and bedrock groundwater systems are illustrated by the conceptual model presented in Figure 13-11. ~~The rate of decline during, compared to following, the pumping test indicates that most of the drawdown was in response to this test.~~

Field experiments by McKay et al. (1993a and 1993b) yield values of hydraulic conductivity for till similar to those measured at the JPG. Relatively large test volumes, similar in size to the volumes sampled by slug tests, yield K values of about 10^{-5} cm/sec. Smaller scale *in situ* and laboratory tests reveal that the till matrix is typically about 10^{-8} cm/sec. Fractures in the till, however, can cause bulk permeability as high as 10^{-4} cm/sec.

McKay and others (1993a and 1993b) found till matrix porosity to be about 0.40. This relatively high porosity likely leads to significant diffusion of solutes into the till matrix. The strong tendency for matrix diffusion can complicate active remediation efforts in the till because solutes stored in the till matrix are readily attenuated and may be difficult to extract. Fracture porosity is much lower, on the order of 10^{-5} to 10^{-3}.

Thus, although the fractures may provide important pathways for solute transport, they will hold only relatively small volumes of solute. As a consequence, only small spills are required to cause contamination of large areas of the subsurface. Small fracture porosity could also contribute to the relatively large vertical variations in water levels. Seasonal or storm-based

changes in groundwater recharge can rapidly fill the low porosity fracture network, causing a rapid rise in water levels in piezometers connected to the fracture system, and promoting tension-saturated zones, as discussed above.

Insight into the process of vertical transport of solutes through fractured till has been examined by numerical simulations (Harrison et al. 1992). Small hydraulically active fractures that are very difficult to detect or identify within clayey deposits may cause rapid and large-scale contamination of the underlying groundwater. Significant transport can occur through fractures with aperture on the order of 10 to 50 µm or greater. Small, deep, widely spaced fractures can be significant yet difficult to detect.

14.1.1.2 Bedrock Groundwater Elevation and Hydraulic Gradients. The bedrock aquifer at Site 12B pertains to that groundwater encountered above the Waldron Shale. ~~and focuses on the upper 10 feet of the Jeffersonville Limestone.~~ Groundwater in the bedrock equilibrates at depths of approximately 3 to 9 feet bgs depending on well location and the time of year. The bedrock groundwater contour maps (~~see~~ Figures 14-4 through 14-7) illustrate the apparent hydraulic gradient over a 13-month period from November 1995 to December 1996. Based on these maps, notable variation of the hydraulic gradient of the bedrock groundwater has occurred. The groundwater flow in ~~hydraulic gradient from~~ November 1995 was to the southwest, which corresponds to the flow direction~~gradient~~ observed during Phase I (June to September 1993).

The horizontal hydraulic gradient averaged 0.0055 ft/ft in June through September 1993, but increased ~~significantly~~ in November 1995 to 0.014 ft/ft. Only wells MW93-38 through MW93-41 existed in June, August, and September 1993, and therefore only the gradient near the building was represented. During 1996, with additional wells installed to the south of Building 617, the hydraulic gradient ranged between 0.002 and 0.025 ft/ft with an average of 0.008 ft/ft. The apparent horizontal gradient ~~appeared to~~ remained consistently in a southerly direction (south, southeast, or southwest) (Table 14-2). This apparent flow direction matches well with observed groundwater contamination plume (see Section 14.5.2).

~~As with Building 602, t~~The magnitude of the hydraulic gradient appears to be inversely proportional to the amount of precipitation. Higher precipitation usually equates to a smaller ~~lower~~ hydraulic gradient, whereas lower rates of precipitation appear to result in higher apparent hydraulic gradients. ~~and visa versa.~~ The steepest apparent hydraulic gradient occurred in October 1996, which was also a low precipitation month for that year. This illustrates the relationship between the tension-saturated zone in the till and the bedrock aquifer.

The ~~hydraulic gradients calculated from~~ groundwater flow directions as interpreted by water level measurements collected from 1993 through 1996 are in agreement with the distribution of ~~solvent~~ VOC contaminants in the groundwater at Building 617. Groundwater samples collected from wells MW93-39, MW93-40, MW95-1, and MW95-2 have repeatedly contained dissolved ~~solvent~~ VOC concentrations. These wells are located ~~either~~ to the southwest, south, or southeast of the former solvent pit, which is consistent with the downgradient direction

~~based~~ shown on the potentiometric maps.~~ However, the ultimate flow path of the groundwater system in the bedrock is controlled by the facility-wide head distribution~~.

Vertical ~~potential~~hydraulic gradients were examined using the groundwater elevation data from wells MW93-41 and MW96-2 located near the former solvent pit, and wells MW96-4 and MW96-5 located approximately 540 feet southwest of the former solvent pit. The groundwater elevation data for these well clusters are presented in Table 14-1b. At well cluster MW93-41 and MW96-2, the vertical potential gradient was down with an average value of 0.50 ft/ft. At well cluster MW96-4 and MW96-5, the vertical potential gradient was also down with an average value of 0.39 ft/ft. Similarly, the vertical hydraulic gradients were calculated for four new well nests in 2001. Table 13-2a presents the results and indicates that vertical hydraulic gradients range from 2.03 to 0.016 ft/ft and that direction is generally downward. However, the MW96-4 and MW96-5 well nest did have a relatively small upward gradient during the two most recent measurements, which is a change from the historical observations. Based on the majority of observed vertical ~~potential~~hydraulic gradients, the bedrock aquifer was generally receiving recharge at Building 617.

14.1.1.3 Pumping Test Results. A pumping test was performed at Building 617 to determine the hydraulic conductivity of the bedrock aquifer, to evaluate the hydraulic connection between the till and underlying bedrock, and to examine the effective radius of the pumping well in the event extraction of contaminated groundwater was identified as a viable option in the feasibility study. The pumping test was conducted before the installation of the six 2001 monitoring wells occurred. Appendix B contains detailed information on the pumping test. (EPA19)~~and to evaluate the effective radius of the pumping well in the event extraction of contaminated groundwater is determined to be a viable option during the Feasibility Study.~~

Well MW93-39 was pumped at a constant rate of 1 gallon-per-minute (gpm) for 25.5 hours, producing 14.24 feet of drawdown (in pumping well). Drawdown was recorded in~~ all of~~ the wells at the site except for MW96-2 through MW96-5. Drawdown amounts in the observation wells ranged from a low of 0.4 feet in well MW93-38, to a high of over 2 feet in well MW93-41. Drawdown was measured at 0.5 feet in well MW95-2 located furthest from the pumping well at a distance of approximately 175 feet.

The results of the pumping test at Building ~~602~~ 617 are presented in Table 14-3. ~~A number of~~Various analytical solutions were used to calculate hydraulic conductivity (K) from the drawdown results of each well to illustrate the sensitivity, or lack of sensitivity, of the computed results to the analytical method applied. As shown in Table 14-4, the average K value for each well was determined from~~ all~~ K values computed from the ~~different~~ various methods. The results indicate that K is not very sensitive to the method applied. The averaged K values for each well using~~ all~~ various solutions~~ methods~~ ranged from a low of 1.~~83~~ 5 x 10^{-3} cm/sec to a high of 1.~~55~~04 x 10^{-2} cm/sec. The site average K value computed from the pumping test was ~~4.8~~3.35 x 10^{-3} cm/sec.

The test results obtained at Building 617 clearly indicate a ~~dominate~~preferential K direction of north-south. The lower K values may reflect the impact of a set of horizontal fractures that exhibit internal anisotropy within the horizontal fracture plane(s), combined with the influence of anisotropy found within subhorizontal and bedding-controlled fractures and regions of solution-enhanced permeability.

As mentioned previously, groundwater in the ~~perched zone~~glacial till responded to pumping of the bedrock aquifer. Since the drawdown in the ~~perched zone~~till was in response to pumping in the bedrock aquifer below, the results confirm that the bedrock and till are hydraulically connected. ~~may be more representative of vertical hydraulic conductivity values.~~ Hydraulic conductivity values ranged from a low of 1.5 x 10^{-3} cm/sec at WP-17 to a high of 1.~~1~~04 x 10^{-2} cm/sec at WP-15 (Table 14-4). Well points WP-17 and WP-15 are located approximately 65 and 15 feet from the pumping well (MW93-39). ~~These K values are considered to be slightly overestimated because some of the drawdown was attributed to background draining of perched groundwater into the bedrock aquifer.~~ The uncharacteristically high hydraulic conductivities probably indicate that the calculated hydraulic conductivities are a combination of horizontal flow at the bedrock/till interface and vertical flow through microfractures in the glacial till.

14.1.1.4 Seepage Velocity Determination. The range of seepage velocities are presented in Table 14-5. In Table 14-5, the highest, lowest, and average K value derived from the pumping test were used with a range of hydraulic gradients and effective porosity values to determine the range of seepage velocities for the bedrock groundwater. The effective porosity of fractured bedrock reportedly can range from 1 to 30 percent (Fetter 1988). As evident by the range in values in Table 14-5, the seepage velocity is very sensitive to hydraulic gradient and the effective porosity. The data presented in Table 14-5 suggest that the groundwater at Building 617 could flow as little as 20 feet per year or as much as 19,000 feet per year. Both of these end member values are unreasonable given the location of wells where ~~solvent~~ VOC contamination has been detected.

For instance, the furthest downgradient detection of ~~any~~ dissolved contamination in the groundwater occurred in well MW96-3, located approximately 600 feet downgradient of the former solvent pit. The compound 1,1,1-TCA was detected at 11 ppb in well MW96-3 in April 1996. The levels detected in the groundwater were near the detection limit, suggesting the furthest downgradient extent of dissolved contaminants. Assuming the former solvent pit was discontinued as a disposal receptacle in 1978, and that in 1978 solvents had impacted the groundwater beneath the solvent pit that year, a travel time of approximately 30 feet per year (600 feet/20 years = 30 ft/year) was calculated. The combination of parameters that best fit this seepage rate, if the average K value of ~~4.8~~2.84 x 10^{-3} cm/sec is used, are a hydraulic gradient of 0.0018 ft/ft and an effective porosity of ~~either~~ 0.15 ~~or 0.30~~.

14.1.1.5 Downhole Flow Meter Results. The flow meter was used in wells MW93-40 and MW93-41 on the basis of the groundwater contour maps constructed for Building 617. Flow measurements were collected at three different vertical positions within the screened interval of each well in an attempt to measure flow near fluid transmitting fractures in the bedrock.

The flow meter results showing groundwater flow direction and velocity for wells MW93-40 and MW93-41 are presented in Figure 14-11. The flow meter results for well MW93-40 generally agree with the south-southwest flow direction inferred from the groundwater contour maps generated for Building 617 (Figures 14-4 through 14-7). Based on the flow meter, groundwater in well MW93-40 flows to the southwest and west. at velocities ranging from 2.1 to 4.5 ft/day. Using the average K value from the pumping test of 4.86 x 10^{-3} cm/sec, the hydraulic gradient and effective porosity that most closely agrees with the flow meter velocities are a hydraulic gradient of 0.0018 and an effective porosity of 0.01.

14.2 PREVIOUS INVESTIGATIONS

A previous RI/FS was conducted at this location by ESE (1989). The investigation consisted of a soil-gas survey and soil sampling. Results of the soil-gas sampling indicated the presence of VOC contamination. Soil samples collected immediately adjacent to the pit (within 2 to 3 feet laterally) contained the following contaminants:

- Acetone
- Benzene
- Chloroform
- 1,1-Dichloroethane
- 1,2-Dichloroethane
- 1,1-Dichloroethylene
- 1,2-Dichloroethylene
- Toluene
- 1,1,1-Trichloroethane
- Trichloroethene

No wells were installed and no groundwater samples were collected at the Building 617 solvent pit prior to the current RI. The previous RI report (ESE 1989) recommended that the soil in and around the former solvent disposal area pit be removed or remediated. to satisfy federal criteria. Installation of groundwater-monitoring wells was recommended to determine the horizontal and vertical extent of groundwater contamination, strength magnitude of the contaminant sources, and groundwater flow characteristics. It was recommended that three

shallow wells be installed around the immediate disposal site, while an additional well be installed downgradient of the source area. Sampling and slug testing were recommended.

This site was also included in the *Enhanced PA Report* (Ebasco 1990a) and the *Master Environmental Plan* (Ebasco 1990b), which suggested that the recommendations of the previous RI (ESE 1989) be implemented. This site is listed in the *Enhanced PA Report* as SWMU 28.

14.3 STUDY AREA INVESTIGATIONS

14.3.1 Phase I RI Field Activities

14.3.1.1 Surface Soils. To characterize the soil contamination at this site and confirm the results of the previous soil-gas survey, four surface soil samples (A to D) were collected from boreholes installed adjacent to the solvent pit at Building 617 during Phase I of the RI (Figure 14-11). ~~All~~The samples were analyzed for VOCs. (EPA13f)

14.3.1.2 Subsurface Soils. Eight Phase I subsurface-soil samples were collected from four soil borings (A to D) drilled in the Building 617 area, including one borehole that was hand-augured inside the building (Figure 14-11). Soil core/cuttings were scanned for VOCs using a PID. Intervals identified with the PID as being potentially contaminated were sampled as well as predetermined soil depths. The samples ~~taken~~ collected from depths between 4 and 9.8 feet were analyzed for VOCs. (EPA13f)

14.3.1.3 Geoprobe Field-Screening Survey. Detection of VOC soil contamination during drilling of soil borings resulted in the recommendation for a Geoprobe field-screening survey to be conducted at this site. The Geoprobe field-screening survey was conducted during Phase I to delineate shallow groundwater and subsurface soil contamination. A total of 20 probeholes (PH01 to PH20) were completed and sampled for VOC analysis (Figure 14-11). This information was then used to optimize the location of monitoring wells ~~(Figure 14-11)~~. (EPA13f)

14.3.1.4 Monitoring Wells. Collection of groundwater data for Building 617 was proposed because the effectiveness of the previous soil-gas surveys for detecting contaminants potentially present in the groundwater was considered questionable. As previously recommended, four Phase I monitoring wells (MW93-38, MW93-39, MW93-40, and MW93-41) were installed and groundwater samples were collected and analyzed for VOCs (Figure 14-1). Well locations were selected on the basis of soil boring sample and field-screening survey results (Figures 14-1 & 14-2). (EPA13f)

14.3.2 Phase II RI Field Activities

14.3.2.1 Surface Soils. ~~No a~~Additional surface soil samples were not collected during Phase II of the RI.

14.3.2.2 Subsurface Soils. ~~No a~~Additional subsurface soil samples were not collected during Phase II of the RI.

14.3.2.3 Groundwater. Phase II fieldwork was designed to permit better understanding of groundwater flow direction and the distribution of VOC contamination in groundwater. Thirteen temporary well points (WP96-10 through WP96-18 and WP96-27 through WP96-31) were installed as part of a second field screening program designed to better define VOC contaminant distribution and groundwater flow direction in both the glacial till and bedrock (Figure 14-1).

Based on the field screening results from the temporary well points, ~~Six~~ seven additional downgradient wells were installed ~~at the top of bedrock~~ during the Phase II RI to further define groundwater flow conditions and to determine the nature and extent of VOC contamination (see Figure 14-3). Five of the additional monitoring wells (MW95-01, MW95-02, MW96-03, MW96-05, MW96-08) were installed as bedrock/till interface wells, and two deep bedrock monitoring wells (MW96-02 and MW96-04) were installed to determine vertical extent of contamination.

Four rounds of sampling were conducted at the ~~four~~ two new wells (MW95-01 and MW95-02), as well as at the four existing wells (MW93-38, MW93-39, MW93-40, and MW93-41) for VOC analysis. Only two rounds of sampling were conducted at wells MW96-02, ~~and~~ MW96-03, MW96-04, and MW96-05 because they were installed after the first two rounds of Phase II sampling were completed. Monitoring well MW96-08 was not sampled during the Phase II RI, but was sampled during the supplemental groundwater monitoring in June 2001. ~~During the last round, wells MW96-04 and MW96-05 were drilled~~. ~~Two deep bedrock monitoring wells, MW96-02 and MW96-04, were installed to determine vertical extent of contamination.~~

~~Following Phase I field efforts, the distribution of solvent contamination in soils and groundwater was not well understood at Site 12B. Additional field screening (geoprobe temporary well points) was performed during Phase II to better define groundwater flow, to determine extent of contamination at the site, and to optimize the placement of additional monitoring wells downgradient of the solvent pit. The additional downgradient wells provided the necessary information for determining groundwater flow characteristics and nature and extent of solvent contamination.~~

In June 2001, the eleven monitoring wells at the site were sampled to collect more recent groundwater quality data and to evaluate the potential for natural attenuation. Water samples were analyzed for VOCs and the natural attenuation parameters: total iron, total manganese, total organic carbon, dissolved gases (ethene, ethane, methane, and carbon dioxide), sulfate, sulfide, nitrate, total kjeldahl nitrogen, chloride, and alkalinity. In addition, field indicators for natural attenuation were also measured including dissolved oxygen (DO), oxidation-reduction potential (ORP), pH, conductivity, and temperature.

Based on the June 2001 monitoring results, six additional monitoring wells were installed at Site 12B in November 2001 to augment the existing site monitoring well network (Figure 14-1). (EPA81) Wells MW01-12, MW01-13, MW01-14, and MW01-16 were installed as bedrock wells in the Louisville Limestone, and wells MW01-15 and MW01-17 were installed at the bedrock/till interface. Well MW01-12 was installed near well MW96-03 to form a well nest to the south of the former solvent pit, while well MW01-13 was installed near well MW95-01 to form a well nest to the southwest of the former solvent pit. Well MW01-14 and MW01-15 were installed as a nest to the southeast of the former solvent pit, and wells MW01-16 and well MW01-17 were installed as a nest northeast of the former solvent pit. Groundwater samples were collected in November 2001 from the six new wells. Water samples were analyzed for VOCs and natural attenuation parameters. Field indicators for natural attenuation were also measured.

14.3.3 Interim Measures Removal Action

The VOC contaminated soils in the vicinity of the solvent pit were excavated and disposed of during the solvent pit removal activities conducted from July 19 through September 21, 2000. Approximately 130 tons of soils were excavated. Confirmation sampling was performed to assess the remedial action. Minor residual contamination was detected in the confirmation samples. However, additional excavation was not performed due to the proximity of building structures and the potential of undermining those structures. Following receipt of analytical results, contaminated soils were transported for disposal at an off-site regulated disposal facility. The excavation site was backfilled with clean fill material that was compacted, and 10-10-10 fertilizer was added to the backfill to promote biological activity in the soils. A perforated PVC pipe was also added along the footprint of Building 617 so that additional fertilizer could be added to the soil if needed. A detailed description of the construction activities and sample results is contained in the *Draft-Final Construction Completion Report, Remedial Removal Actions, Sites 12A, 12B, 12C, and 33* (Montgomery Watson, February 2002).

14.4 DATA EVALUATION

14.4.1 Data Validation Results

During Phase I, one VOC (chloromethane) had a low calibration response, and ~~all~~ the results were rejected. The CRLs were elevated for several compounds due to high solvent concentrations in soil and groundwater; the CRL for methyl-N-butyl ketone (MNBK) (EPA86) (in soil) exceeded the USEPA Region 5 DQL. The Phase I VOC groundwater results were not used for the human health risk assessment other than for providing qualitative information. None of the soil sample data were rejected.

The following groundwater sample results were rejected during Phase I:

- Chloromethane in SVB12GWA01, -B01, -C01, and -D01.

For the Phase II data (four rounds of groundwater samples), the results for three VOCs MEK, acetone, and vinyl acetate), and two SVOCs (kepone and an unknown) were rejected due to insufficient calibration or low response in the calibration in several analytical batches. Positive results for acetone were estimated due to calibration outliers. Analytes associated with rejected data were not included in the database used for the risk assessment. The following groundwater sample results were rejected from the Phase II database:

- November 1995
  - Acetone in SVB12GWA02, -B02, and -F01
  - Vinyl acetate in SVB12GWA02, -B02, -C02, -D02, -G02, -E01, and -F01
  - MEK in SVB12GWA02, -E01, -F01, and -I02

- Spring 1996
  - MEK in SVB12GWA04, -C04, -B04, -D04, -E03, -F03, -I01, -H01, -J01, -K01, and -WPP01
  - Kepone in SVB12GWA04, -C04, -B04, -D04, -E03, F03, I01, -H01, -J01, and -K01
  - Unknown (UNK) 585 in SVB12GWA04

- February 1996
  - None.

- Summer 1996
  - MEK in SVB12GWA05, -B05, -D05, -E04, -F04, -G05, -H02, J02, and -K02
  - Kepone in SVB12GWA05, -B05, -C05, -D05, -E04, -F04, -G05, -I02, -J02, and -K02

For supplemental groundwater data, three VOCs (acetone , 2-butanone, and vinyl acetate) were rejected when not detected due to low relative response factors in initial and/or continuing calibration and/or low laboratory control sample results. In addition, 3 VOCs (dibromochloromethane, hexachlorobutadiene, and bromoform), were rejected when not detected due to low method reporting limit (MRL) continuing calibration verification (CCV) results. In addition iron in eight samples were rejected when not detected due to low MRL CCV results. The following supplemental groundwater sample results were rejected when not detected.

- acetone - S12BMW01-51, S12BMW01-52, S12BMW93-38, S12BMW93-39, S12BMW93-41, S12BMW95-01, S12BMW95-02, S12BMW96-02, S12BMW96-03, S12BMW96-04, S12BMW96-05, S12BMW96-08

- bromoform - S12BMW01-51, S12BMW01-52, S12BMW93-38, S12BMW95-02, S12BMW96-03, S12BMW96-05, S12BMW96-08, S12BMW95-01

- dibromochloromethane - S12BMW01-51, S12BMW01-52, S12BMW93-38, S12BMW95-01, S12BMW95-02, S12BMW96-03, S12BMW96-04, S12BMW96-05, S12BMW96-08

- hexachlorobutadiene - S12BMW01-51, S12BMW01-52, S12BMW93-38, S12BMW95-01, S12BMW95-02, S12BMW96-03, S12BMW96-04, S12BMW96-05, S12BMW96-08

- 2-butanone - S12BMW01-51, S12BMW01-52, S12BMW93-38, S12BMW93-39, S12BMW93-41, S12BMW95-01, S12BMW95-02, S12BMW96-02, S12BMW96-03, S12BMW96-04, S12BMW96-05, S12BMW96-08

- vinyl acetate - S12BMW93-39, S12BMW93-41, S12BMW96-02, S12BMW96-08

- iron - - S12BMW01-70 (total and dissolved), S12BMW01-15 (total and dissolved), S12BMW01-17 (total and dissolved), S12BMW01-12 (dissolved), and SB12BMW01-14 (dissolved)

The data qualified unusable are not compounds of concern and will not negatively impact the groundwater data.

14.4.1.1 Evaluation of Non-Detected Values. A comparison was made between the USEPA Region 5 DQLs and the project CRLs for chemicals that were analyzed for but not detected in environmental media at this site. ~~No e~~Exceedances were not identified for soils.

The following VOCs exceeded the DQLs for more than half of the sampling events and sampled wells: 1,2-dichloropropane, acrylonitrile, bromodichloromethane, bromoform, carbon tetrachloride, cis-1,3-dichloropropane, dibromochloromethane, methylene chloride, tetrachloroethylene, and trans-1,3-dichloropropane. In addition, several other VOCs had reported non-detected values from one to three orders of magnitude greater than DQLs for at least one event and one location. However, these latter compounds were limited to less than half of the sampling events; acceptable CRLs were achieved at the other site wells for the same VOCs during the same events.

MRL's for compounds analyzed during the supplemental groundwater monitoring were sufficiently low to meet MCLs provided in the Supplemental Groundwater Monitoring QAPP.

14.4.2 Data Quality Summary

14.4.2.1 Blank Assessment. When blank contamination exists, the investigative results must exceed the blank result by a factor of 5 (all compounds) or 10 (common laboratory contaminants such as phthalates) in order to be considered positive. Positive results were changed to nondetects ("U") if the concentrations were less than this 5 times or 10 times criterion. In these cases, the associated sample quantitation limit became either the concentration in the sample, if the detected value was above the quantitation limit, or the

quantitation limit, if detected results were less than the quantitation limit. None of the soil or groundwater samples were qualified as nondetected during Phase I.

Two VOCs (methylene chloride and 1,1,1-trichloroethane) and two SVOCs (di-n-butylphthalate and diethyl phthalate) were detected in rinse or lab blanks associated with the following Phase II groundwater samples, which were qualified as nondetected:

- November 1995
  - 1,1,1-trichloroethane in SVB12GWB02
  - Methylene chloride in SVB12GWB02, -D02, and -G02

- February 1996
  - Methylene chloride in SVB12GWD03

- Spring 1996
  - Methylene chloride in SVB12WPP01
  - Di-n-butylphthalate in SVB12GWA04, -C04, -B04, -D04, -E03, -F03, -I01, -H01, -J01, and -K01

- Summer 1996
  - Methylene chloride in SVB12GWB05, -F04 -G02, and -H02
  - Diethyl phthalate (DEP) in SVB12GWA05, -B05, -E04, -F04, -J02, and -K02
  - Di-n-butylphthalate in SVB12GWC05, -D05, -G05, and -I02

No analytes were qualified based on blank contamination for the supplemental groundwater samples.

14.4.3 Background Screening

14.4.3.1 Surface Soil. Since surface soil samples, subsurface soil samples, and groundwater at this site were not analyzed for inorganic constituents or dioxins/furans, ~~no~~ background screening was not performed.

14.4.4 Summary of Analytical Results

Table 14-6 presents the results for organic contaminants detected in soil samples at Site 12B. Table 14-7 presents the results for organic contaminants detected in groundwater samples at Site 12B. Table 14-7a presents the field and laboratory results for natural attenuation parameters. These tables include analytes that were detected in at least one sample for each media. Nondetected and below reporting limit analytes are included in the complete data listings in Appendix N. Pyrene was detected in two groundwater samples during Phase II; however, those results are not shown in Table 14-7. Monitoring well MW95-01 (Sample ID SVB12BWE03) sampled in late April 1996 contained pyrene at 0.34 µg/L, and MW96-05 (Sample ID SVB12GWK02) sampled in May 1996 contained pyrene at 0.22 µg/L. The analytical database used for the Site 12B human health risk assessment consists of the 4 Phase

I surface soil samples, the 8 Phase I subsurface soil samples, and the 36 Phase II groundwater samples from the downgradient wells (9 wells x 4 rounds). The one round of groundwater data collected during the Phase I RI is discussed qualitatively as historical data in this report.

14.5 NATURE AND EXTENT OF CONTAMINATION

14.5.1 Soil

Four boreholes (A to D) were drilled during Phase I around the solvent pit, including one borehole that was hand-augured inside the building (Figure 14-11). Three samples were collected per boring and analyzed for VOCs. The soil types and the sampled intervals are illustrated on the borehole cross section shown in Figure 14-2. The results of the soil sampling indicate that the sample collected at 4.6 feet bgs in borehole A contained detectable 1,1-dichloroethane at concentrations below USEPA Region 9 criteria (see Table 14-61.) The sample collected at 4.6 feet bgs in borehole B contained detectable 1,1-dichloroethane and 1,1,1-trichloroethane at concentrations below USEPA Region 9 action level criteria. The sample collected at 4.8 feet bgs in borehole C contained detectable 1,1-dichloroethane, 1,1-dichloroethylene, toluene, and 1,1,1-trichloroethane also at concentrations below USEPA Region 9 criteria. The sample from the deepest interval (9.8 to 10.3 feet bgs) in the same borehole contained detectable but below criteria concentrations of 1,1,1-trichloroethane, 1,1-dichloroethylene, and 1,1-dichloroethane. The mid-depth soil sample (4.0 feet bgs) collected from borehole D contained detectable 1,1,1-trichloroethane at a concentration below USEPA Region 9 criteria. Based on these results, a Geoprobe field-screening survey was recommended to further define the extent of VOC contamination.

The Geoprobe field-screening survey results for this investigation summarized in Appendix G. A total of 20 probeholes (SVB-PH01 through SVB-PH20) were completed in April 1993 (Figure 14-11). The site was very muddy during this period, causing access problems for the van. The initial probehole, PH-01, was located adjacent to the solvent pit, which was considered the source area for the contamination. PH-02, PH-06, and PH-07 were arranged as offsets to the solvent disposal pit. The distribution of 1,1,1-tricholorethane in soil is illustrated in cross-section on Figure 14-11a. The distribution of 1,1,1-trichloroethane in groundwater is illustrated in Figure 14-1211b. PH-01 was pushed to refusal at 16 feet deep, which was assumed to be the top of bedrock in the area. The soil in PH-01 was contaminated from the surface to at least 16 feet deep with the most contaminated zone lying from 2 to 4 feet bgs. The predominant contaminant at this depth was identified as 1,1,1-trichloroethane at 38 ppm. The contaminant concentrations appear to decrease gradually in the deeper zones down to 16 feet, but total VOCs were still calculated as 0.273 ppm at this depth. The shallow groundwater sample from PH-01 taken collected at 14 feet bgs contained 51 ppm 1,1,1-trichloroethane. Probeholes PH-02, 06, and 07, offsets to PH-01, revealed similar VOC contamination in both soil oreither soil or groundwater, but at lower concentrations. This was taken as evidence that the solvent contamination was spreading and dispersing away from the solvent pit.

The solvent plume VOC contamination was detected as far south as the railroad tracks in PH-03 and PH-04; however, no additional offsets were performed because of the access being blocked by the forest and the railroad tracks. The contaminant concentrations appeared to be dropping with distance from the solvent pit; however, it was impossible to determine the southerly or westerly extent of contamination could only be estimated from the available data. The bedrock surface appears to be extremely irregular in this area based on refusal depths of the probeholes, which ranged from 14 to 26 feet deep. Therefore, bedrock monitoring wells were recommended to determine if the contamination had entered the bedrock groundwater as discussed in the following section. The soil chlorinated VOC contamination resulting from the solvent disposal pit existsappeared to be present over a relatively large area. On the other hand, the soilpetroleum VOC contamination related to the former USTs isappeared to be limited to the backfilled excavation pits.

14.5.2 Groundwater

During Phase I, four groundwater-monitoring wells (MW93-38, -39, -40, and -41) were installed aroundat the site and sampled for VOCs (Figure 14-1). instead of the three recommended in the Work Plans. The wells (MW93-38, -39, -40, and -41) were sampled for VOCs. A sample from the upgradient well was also analyzed for anions and metals. The results of the Phase I groundwater sampling indicate that three of the four wells at the site are contaminated with solvent-related VOCs (see Table 14-7).(EPA47 and EPA48) Wells MW93-39, MW93-40, and MW93-41 contained 1,1-dichloroethane, 1,1-dichloroethylene, and 1,1,1-trichloroethane contamination. The distribution of 1,1,1-TCA from the Phase I sampling is shown on Figure 14-11b. The 1,1-dichloroethane concentrations and the 1,1,1-trichloroethane concentration in all the three wells are far below the USEPA Region 9 action level criteria. The 1,1-dichloroethylene concentration in all the three wells, however, is above USEPA Region 9 action level criteria. Because these compounds are solvent-related and not fuel-oil-related, the groundwater contamination appears to be associated only with the solvent pit and not the former USTs.

During Phase II, thirteen temporary wells (WP96-10 through WP96-18 and WP96-27 through WP96-31) were installed and had groundwater analyzed for VOCs to provide information to locate the Phase II monitoring wells. Figure 14-12 presents the results and locations of the temporary well survey. Based on those results, the Phase II monitoring wells were installed and sampled. Wells MW93-39, MW93-40, MW93-41, MW95-1, MW95-2, MW96-2, MW96-3, MW96-4, and MW96-5 were all found to contain VOC and/or SVOC contamination (Table 14-7). As with Phase I, the primary contaminant is was 1,1,1-trichloroethane. Maximum concentrations include 4,600 µg/L in MW93-39, 7,400 µg/L in MW93-40, 47,500 µg/L in MW93-41, 22,000 µg/L in MW95-1, 450 µg/L in MW95-2, and 3,900 µg/L in MW96-2. In addition, 1,1-dichloroethylene was present in the same wells above the USEPA Region 9 criteria. with maximum concentrations of 3,800 µg/L in MW93-39, 2,200 µg/L in MW93-40, 12,000 µg/L in MW93-41, 13,000 in MW95-1, 500 µg/L in MW95-02, and 183 µg/L in MW96-2.

The supplemental groundwater monitoring performed in 2001 indicated that VOCs were detected in nine (MW93-39, MW93-40, MW93-41, MW95-01, MW95-02, MW96-02, MW96-04, MW96-08, and MW01-13) of the seventeen wells at this site (Table 14-7). 1,1,1-TCA and 1,1-DCE were also detected above their PRGs at seven wells (MW93-39, MW93-40, MW93-41, MW95-01, MW95-02, MW96-02, and MW96-08). Concentrations of these compounds were also detected in monitoring wells MW96-04 and MW01-13. Concentrations of 1,1,1-TCA ranged from nondetect to 8,700 µg/L, and concentrations of 1,1-DCE ranged from nondetect to 3,500 µg/L. Other VOCs that were detected and occasionally exceeded their PRG included 1,1,2-TCA; 1,1-DCA; 1,2-DCA; vinyl chloride; and trichloroethene (TCE). The results of the supplemental groundwater monitoring and from the additional wells installed in 2001 are presented on Figure 14-12a.

14.5.3 Summary of ~~Solvent Pit~~ Contamination

An overall picture of solvent-pit-related contamination can be constructed from a combination of the borehole, field screening, and monitoring well data. The lack of detection of significant contamination in the boreholes or probeholes surrounding the solvent pit indicate that the lateral extent of the contamination is very limited in the glacial till. The probehole that was located within the former solvent pit detected contamination from the surface to a depth of about 16 feet (EPA14b), with the most contaminated zone occurring from 2 to 7 feet bgs. Other nearby boreholes and probeholes showed no detection or only slight detection of VOCs in the top 10 to 12 feet of soil. The solvent pit was removed in 2000. Contaminated soils were excavated to the extent that was practical and disposed off-site at a regulated disposal facility. A detailed description of the construction activities and sample results are contained in the *Draft-Final Construction Completion Report, Remedial Removal Actions, Sites 12A, 12B, 12C, and 33 (Montgomery Watson, February 2002).*

Shallow groundwater samples also revealed few detections of VOC contamination except in probeholes 1, 2, 6, 7, and 12 (Figure 14-11b). Probehole 1 was located very near the current location of well MW93-41, as seen in Figure 14-11. (EPA45) The occurrence of chlorinated compounds in groundwater samples from the top of bedrock collected south of the solvent pit, indicates that chlorinated solvents have migrated laterally along the till/bedrock interface. The occurrence of downward vertical groundwater gradients at the site also suggests that chlorinated VOC contaminated groundwater may have migrated downward through the glacial till to the top of the bedrock. (EPA14c) The additional Phase II monitoring wells helped to define the lateral extent of the contaminant plume that exceeds regulatory criteria.

In addition, ~~T~~the analytical data from the temporary well field screening survey ~~and from till and bedrock groundwater sampling~~ support the existence of a contaminant plume extending to the south and southwest from the former solvent pit (see Figure 14-12). These results indicate that ~~Solvent~~VOC concentrations in the ~~shallow~~ glacial till reduce rapidly with lateral distance from the pit, indicating that the solvents infiltrated downward to the groundwater before migrating laterally. The ~~plume geometry~~observed extent of contamination supports the conclusion that ~~both the glacial till and bedrock~~ groundwater ~~are~~ is generally moving to the southwest. ~~The lateral extent of the contaminant plume has not been defined by the existing~~

wells at Site 12B. However,Contaminant concentrations are shown to decrease rapidly with increasing distance from the solvent pit as shown by the distribution of TCE, 1,1,1-TCA, and 1,1-DCE from the latest June 1996 sampling round of June 1996 as shown on (Figures 14-13a, 14-13b, and 14-13c, respectively).

Because of the high concentrations of VOCs detected in the deep bedrock monitoring well (MW96-02), four of the six additional monitoring wells installed in 2001 were screened at the bottom of the Louisville Limestone above the Waldron Shale. The results from the groundwater samples collected in these deep bedrock wells indicates that elevated concentrations of VOCs are present from MW96-02, located at the former source, and extends to just beyond MW01-13 (an approximate distance of 350 ft), located southwest of the former source. The four other deep bedrock monitoring wells (MW96-05, MW01-12, MW01-14, and MW01-16), located around the former source area, did not have VOCs related to the former source detected.

The VOC plume detected at the bedrock/till interface appears to extend from the MW93-41, located at the source area, to MW96-04, located southwest of the former source and nested with MW96-05. The low concentration detected at MW96-04 indicate that it is at the very fringe of the VOC plume. The VOC plume is characterized by results from wells MW93-39, MW93-40, MW95-01, MW95-02, and MW96-08 that have concentrations of 1,1,1-TCA that range from 170 to 2,600 µg/L. The extent of the VOC plume detected at the bedrock/till interface is defined by monitoring wells MW93-38, MW96-03, MW01-15, and MW01-17, located around the former source area, that did not have VOCs related to the former source detected. These observations and assessment of the extent of contamination is discussed further in the next section below.(EPA14b)

14.5.4 Assessment Of Site 12B For Natural Attenuation

Site 12B was assessed as a candidate for natural attenuation using the U.S. EPA screening criteria contained within the BIOCHLOR model (USEPA, 2000). Suitability of a candidate site is based on a list of criteria contained in Table 14-7b. Numerical scores are given for each criterion. If a candidate site scores 0 to 5 points there is inadequate evidence to support a natural attenuation by reductive dechlorination decision at the site. A score of 6 to 14 means that there is limited evidence for natural attenuation by reductive dechlorination at the site. A score of 15 to 20 indicates that adequate evidence exists that natural attenuation by reductive dechlorination may be supported at the site. Scores over 20 strongly support natural attenuation by reductive dechlorination at a site.

These scoring criteria can be used as general guidance for determining the site's initial suitability for natural attenuation by reductive dechlorination. Accordingly, these criteria were applied to Site 12B (Table 14-7b), and were used in combination with field and laboratory data (Table 14-7a) to evaluate Site 12B.

Using the field and fixed laboratory results for DO, nitrogen, ferrous iron, sulfate, methane, ORP, pH, TOC, temperature, alkalinity, sulfate, chloride, ethane, methane, and ethene present

at locations where chlorinated VOCs were detected, Site 12B scored 19 points. Therefore, based on this assessment, Site 12B is an adequate candidate site for natural attenuation by reductive dechlorination.

The field and laboratory data from wells MW93-40, MW93-41, MW95-01, MW95-02, and MW96-02 supports this assessment. Wells MW93-41 and MW96-02 are located immediately adjacent to the contaminant source area. Relatively strong concentrations of 1,1,1-TCA and associated daughter products including 1,1-DCA and 1,1-DCE were detected at wells MW93-41 and MW96-02 in June 2001. 1,1,2-TCA and TCE were also detected as primary compounds in small concentrations. Chloroethane, chloroform, cis-1,2-DCE, TCE and vinyl chloride (daughter products) were detected in relatively minor amounts. This is expected near the contaminant source area, as first order kinetics would support rapid reductive dechlorination of the parent compound and successively lesser reduction of sequential daughter products to lower order daughter products (such as chloroethane and vinyl chloride) at the expense of the first order reduction.

At downgradient locations from the source area, natural attenuation by reductive dechlorination is also apparent. Wells MW93-39 and MW93-40 (approximately 100 ft downgradient), MW95-01 and MW95-02 (approximately 200 ft down gradient), and MW96-08 (approximately 50 ft down gradient) each show significant concentrations of parent and daughter products in samples collected from these locations, including lower order products such as chloroethane and vinyl chloride. Also, approximately 500 ft down gradient from the source area, the sample from well MW96-04 contained only 1,1-DCE at low concentration (5.1 ug/L). Well MW96-04 is likely at the downgradient edge of the chlorinated solvent contaminant plume, based on the presence of 1,1-DCE as the only chlorinated VOC detected and the known mobility of 1,1-DCE. The remaining wells furthest down gradient from the source area (wells MW96-03 and MW96-04) contained no VOCs in the samples collected in June 2001. Accordingly, the limit of the VOC plume in groundwater at Site 12B appears to be defined.

Examining the remaining indicator parameter, field, metals, and gas data also shows that reductive dechlorination is progressing slowly Site 12B. For example, the highest detected concentrations of total iron, carbon dioxide, manganese, methane, and chloride at Site 12B in June 2001 were observed in the samples collected nearest to the source area, indicating that bacterial activity is occurring at this location. However, anaerobic processes including methanogenesis, and iron and manganese reduction, are countered by a nearly neutral ORP in and around the source area, and the low concentrations of total organic carbon observed in the analytical results. Also, the presence of DO in excess of 1.0 mg/L combined with the production of carbon dioxide during respiration by aerobic bacteria suggests that cometabolic processes may be the primary mechanism working to degrade contaminants. In summary, although Site 12B groundwater may be amenable to natural attenuation, primary bacterial activity in the source area of Site 12B may tend to be aerobic, and natural reduction of contaminant mass will be a successful, but lengthy, process.

14.6 HUMAN HEALTH RISK ASSESSMENT

Since the Draft RI was submitted, a Remedial Removal Action was performed at Site 12B. The soils in the vicinity of the solvent pit were excavated and disposed during construction activities. The excavation at this particular location was 16 ft by 18 ft and approximately 12 feet deep. Confirmation sampling was performed to assess the remedial action. Minor residual contamination (i.e., slightly above IX soil PRGs) was detected in the confirmation samples. However, additional excavation was not performed due to the proximity of building structures and the potential of undermining those structures. Because soil remediation has already been performed at Site 12B to a depth of 12 ft, the soil risk estimates for Site 12B provided in the Draft RI have not been updated. Rather the original draft risk calculations are provided for informational purposes to document, in part, why soil removal was considered warranted at this site. Rather, for purposes of the human health risk assessment, a new exposure pathway was assessed which considered if vapor from subsurface soil contamination (post-remediation) and groundwater contamination could pose a health concern if the buildings were used as commercial/industrial facilities. Soil vapor intrusion modeling was performed to estimate the potential for exposure. It should be noted that the original risk assessment contained in this section was performed under the assumption that the area would be residential in the future. Currently, it is planned that the site will continue to be used as commercial property, and so the indoor air modeling was based on a commercial land use scenario.

14.6.1 Selection of the Contaminants of Potential Concern for Site 12B

14.6.1.1 Surface Soil. No chemicals were detected in surface soil at Site 12B.

14.6.1.2 Surface/Subsurface Soil Combined.

14.6.1.2.1 Frequency of Detection. Evaluation of frequency of detection was not undertaken at this site because of too few soil samples.

14.6.1.2.2 Nutrient Screening. Soil samples collected at this site were not analyzed for inorganic constituents. Therefore, nutrient screening was not performed.

14.6.1.2.3 Summary of Preliminary COPCs. Table 14-8 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95% UCL of the mean, and the exposure point concentration for the preliminary COPCs in surface/subsurface soil at Site 12B.

14.6.1.2.4 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for each of the preliminary COPCs was compared to the chemical-specific Region 9 residential soil PRG (Table 14-9). One-tenth of the PRG was used for

noncarcinogens. As a result of the screening, 1,1-dichloroethylene is the only chemical retained as a COPC in surface/subsurface soil at this site.

14.6.1.3 Air.

14.6.1.3.1 Summary of Preliminary COPCs. Ambient air concentrations to which future receptors at this site might be exposed were estimated using air emission/dispersion modeling, as described in Appendix R. In the site-specific conceptual model, discussed below in Section 14.6.2.1, Site 12B is evaluated under two future site-specific scenarios: as a residential site and as an industrial site.

In the future industrial land use scenario for the facility, ~~all~~ the sites were assumed to be industrial, except for the five sites designated agricultural sites. Each site with particulate-bound COPCs in surface soil (metals, SVOCs, and dioxins/furans) and/or volatile COPCs in surface/subsurface soil combined was assumed to contribute to the air concentrations at ~~all of~~ the sites. In the future residential scenario for the facility, ~~all~~ **the** sites were assumed to be residential except for the five sites designated agricultural. It was assumed that particulate and VOC emissions from the strictly residential sites would be negligible because the home sites would be covered with dense vegetation (lawns) and pavement. Therefore, under the residential scenario only the five agricultural sites contribute to the air concentrations at ~~all of~~ the sites. The list of preliminary air COPCs is therefore the same for every site for a given, scenario, but the concentrations of the COPCs vary. Tables R-4 and R-6 in Appendix R present the estimated ambient air concentrations at Site 12B under the future industrial and residential scenarios, respectively.

14.6.1.3.2 Region 9 Preliminary Remediation Goal Screening. The exposure point concentrations for each preliminary air COPC at Site 12B in the future residential scenario and the future industrial scenario were compared to chemical-specific Region 9 air PRGs (Table 14-10). One-tenth of the PRG was used for noncarcinogens. The exception was lead, for which the full PRG was used. As a result of the screening, aluminum, silver, thallium, vanadium, and zinc are retained as COPCs in air for future on-site residents. For future on-site workers, aluminum, chromium, silver, thallium, vanadium, and zinc were retained.

14.6.1.4 Groundwater.

14.6.1.4.1 Frequency of Detection. Evaluation of frequency of detection was not undertaken at this site because of too few groundwater samples.

14.6.1.4.2 Nutrient Screening. Groundwater samples collected at this site were not analyzed for inorganic constituents. Therefore, nutrient screening was not performed.

14.6.1.4.3 Summary of Preliminary COPCs. Table 14-11 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95% UCL of the mean, and the exposure point concentrations for the preliminary COPCs in groundwater

at Site 12B. Prior to the statistical analysis, the various validated sampling round results for each well were averaged to obtain a single data point for each location.

14.6.1.4.4 Region 9 Preliminary Remediation Goal Screening. The exposure point concentrations for the preliminary groundwater COPCs were compared to the chemical-specific Region 9 residential water PRG (Table 14-12). One-tenth of the PRG was used for noncarcinogens. As a result of the screening, 1,1-dichloroethane, 1,1-dichloroethylene, 1,1,1-trichloroethane, 1,1,2-trichloroethane, 1,2-dichloroethane, 1,2-dichloroethylene (mixed isomers), benzene, carbon disulfide, chloroform, pentachlorophenol, trichloroethylene, and vinyl chloride are retained as final COPCs in groundwater at Site 12B.

14.6.2 Exposure Assessment

14.6.2.1 Site Conceptual Model. **As discussed in Section 5.1.4.6** ~~T~~there are no people who **are known to** specifically work at or frequent Site 12B. There are, however, several types of individuals who could potentially be affected by the existing contamination at the facility. These are current trespassers to JPG and off-facility (nearby) rural residents and future hunters. In each case, these individuals would most likely be impacted simultaneously by multiple sites rather than by single units. Because of this, these current and future receptor populations are addressed on a facility-wide, cumulative basis rather than by specific sites (see Sections 28 and 29).

Therefore, this site-specific exposure scenario only addresses future land use development. Site 12B has two potential future land uses forwarded for evaluation:

- Residential
- Industrial

Residential Use. Under the future residential land use scenario, this site is assumed to be developed for residential purposes, with the supposition that a family would build a house directly on/within this area of potential concern.

With respect to a risk assessment analysis, resident populations are assumed to consist of both adults and toddlers. Each individual would be expected to come in contact with site contaminants in the following pathways at Site 12B:

- Inhalation of VOCs and fugitive particulates from soils
- Dermal contact with soil (surface or surface/subsurface combined) while gardening/playing outdoors
- Incidental ingestion of soil (surface or surface/subsurface combined) while gardening/playing outdoors

- Ingestion of fresh homegrown fruits and vegetables (grown in surface soil or surface/subsurface soil combined)

- Ingestion/dermal contact with groundwater

- Inhalation of VOCs while showering/bathing

On-site Worker. Industrial land use is considered to be a plausible future option for this site at JPG. On-site industrial workers ~~(adult males and females)~~ are assumed to be individuals who could be exposed directly to contaminated media through the following pathways:

- Inhalation of VOCs and fugitive particulates from soils **and vapors**

- Incidental ingestion/dermal contact with soil

- Ingestion of groundwater

14.6.2.2 Exposure Point Concentrations.

14.6.2.2.1 Air. The estimated ambient air concentrations of COPCs at this site for the future on-site residents and the future on-site workers are presented in Table 14-10.

14.6.2.2.2 Soil. No chemicals were detected in surface soil at this site. The concentrations of COPCs in surface/subsurface soil combined at Site 12B are presented in Table 14-6.

14.6.2.2.3 Fruits and Vegetables. The only COPC in surface/subsurface soil combined at this site is 1,1-dichloroethylene. Because VOCs such as 1,1-dichloroethylene are more likely to leach through the soil or volatilize into the air than be taken up by fruits and vegetables, fruit and vegetable concentrations were not estimated for this chemical.

14.6.2.2.4 Groundwater. The concentrations of COPCs in groundwater at Site 12B are presented in Table 14-7.

14.6.2.2.5 Shower Air. COPC concentrations in shower air were estimated using the methods described in Appendix T. Table 14-13 summarizes the shower air concentrations for Site 12B.

14.6.2.3 Human Exposure Doses.

14.6.2.3.1 Inhalation of Contaminated Air. Inhalation of airborne contaminants (VOCs and particulates) is a potential route of exposure for future on-site residents (adults and children) and future on-site workers at this site. The equation used for calculating human exposure doses of COPCs due to inhalation of volatile and dust-bound contaminants is provided in Section 5.1.5.3.1, Table 5-**11**~~12~~. Table V-8, Appendix V, documents the calculation of human exposure doses at Site 12B due to inhalation of contaminated air.

As discussed in Section 5.1.5.3.1, the potential for VOCs at Site 12B to migrate from soil or groundwater into indoor air was evaluated as part of this risk assessment. Indoor air risk estimates were made using the Johnson and Ettinger model (1991, revised) for subsurface vapor intrusions into buildings, using U.S. Environmental Protection Agency (EPA) software (U.S. EPA, 2000a). Doses were estimated by modeling maximum detected concentrations of VOCs in groundwater and soil at this location. Cancer risk and hazard estimates were prepared for an industrial worker scenario, because this is the current and most likely future land use at this location. The details of this evaluation are provided in an addendum to Appendix R. (EPA120d)

14.6.2.3.2 Ingestion of Contaminated On-site Soil. Mouthing behavior (toddlers) and incidental ingestion of soil with recreational or work-related activities may expose human receptors to contaminated soil at a site via the oral route of exposure. The equation used to calculate the human exposure dose due to incidental ingestion of contaminated soil is presented in Section 5.1.5.3.2, Table 5-**12**~~13~~. This pathway was assumed to be complete at Site 12B for future on-site residents (adults and children). Future workers are assumed to be exposed to surface soil only, and no chemicals were detected in surface soil at this site. Table V-8, Appendix V, documents the calculation of human exposure doses due to incidental ingestion of soil at Site 12B.

14.6.2.3.3 Dermal Contact with Contaminated On-site Soil. The chemicals in contaminated soil also may be absorbed into a receptor's body through dermal contact. The equation that was used to calculate chemical doses due to dermal contact with contaminated soil is presented in Section 5.1.5.3.3, Table 5-**13**~~14~~. This pathway is relevant for future on-site residents (adults and children). Future workers are assumed to be exposed to surface soil only, and no chemicals were detected in surface soil at this site. Table V-8, Appendix V, documents the calculation of human exposure doses due to dermal contact with soil at Site 12B.

14.6.2.3.4 Ingestion of Contaminated Groundwater. Contaminated drinking water may be a source of chemical exposure for future on-site residents (adults and children) and future workers. The equation used to calculate human exposure doses due to ingestion of contaminated drinking water is provided in Section 5.1.5.3.4, Table 5-**14**~~15~~. Table V-8, Appendix V, documents the calculation of human exposure doses at Site 12B due to ingestion of contaminated groundwater.

14.6.2.3.5 Dermal Contact with Contaminated Groundwater. Exposure via dermal contact with chemicals in groundwater may occur when receptors (future residents) shower or bathe. The equation used to calculate daily chemical doses due to dermal contact with contaminated groundwater is provided in Section 5.1.5.3.5, Table 5-15~~16~~. Table V-8, Appendix V, documents the calculation of human exposure doses at Site 12B due to dermal contact with contaminated groundwater.

14.6.2.3.6 Inhalation of Volatile Organic Chemicals While Showering/Bathing. Inhalation of VOCs while showering/bathing is a potential route of exposure when these contaminants are present in residential water systems. The equation that was used to calculate human

exposure dose due to inhalation of VOCs while showering/bathing is provided in Section 5.1.5.3.6, Table 5-~~18~~17. Table V-8, Appendix V, documents the calculation of human exposure doses at Site 12B due to inhalation of VOCs while showering.

For Site 12B, the estimated cancer risk is 7 x 10^{-5} for groundwater and 5 x 10^{-7} for soil. This cancer risk is also derived almost entirely from 1,1-DCE in groundwater. The groundwater and soil cancer risk estimates are less than 1 x 10^{-4}; therefore, further attention is not necessarily required. Also note that these cancer risk estimates apply to future conditions only, both because the existing building is unoccupied and the source of contamination is on the downgradient side of this building. Average constituent concentrations under the building are likely non-detects and risks could be zero. Consequently, the risk estimates apply only to a building constructed in the future over the groundwater plume. The estimated hazard indices for the inhalation of indoor air at Site 12B were 0.006 and 0.1 for groundwater and soil, respectively. These values are much less than 1, and there is no expectation of adverse non-cancer type health effects. (EPA120d)

14.6.3 Risk Characterization

14.6.3.1 Chronic Health Hazards. The noncancer daily exposure doses calculated in the exposure assessment were used to calculate HQs for each of the COPCs possessing RfDs. Pathway-specific and overall HIs were then calculated for each receptor. The calculations of HQs and HIs are described in Section 5.1.7.1. If an overall HI is calculated to be greater than 1.0 for a particular receptor, then the exposure pathway(s) primarily responsible for the result is identified as a "critical pathway(s)." For each critical pathway, those chemical contaminants responsible for the majority of the HI are listed as COCs. Table W-8, Appendix W, documents the calculation of the pathway- and chemical-specific HQs for the human receptors at Site 12B. The pathway-specific and overall HIs are summarized in Table 14-14.

14.6.3.1.1 Future On-Site Residents. The overall HIs for the future on-site adult and toddler residents at Site 12B are calculated to be 86 and 195, respectively. Both of these HIs exceed USEPA's risk management criterion of 1.0. The critical pathways are ingestion of and dermal contact with groundwater and inhalation of shower VOCs. The chemical responsible for most of the hazard for ~~all~~ **the** pathways is 1,1,1-trichloroethane. Other noncarcinogenic COCs for the ingestion of groundwater pathway are 1,1-dichloroethane, 1,1-dichloroethylene, and 1,1,2-trichloroethane. The compound 1,2-dichloroethane is also a noncarcinogenic COC for the child inhaling shower VOCs.

14.6.3.1.2 Future On-Site Workers. The overall HI for the future on-site worker at Site 12B is calculated to be 29. This value exceeds the USEPA's risk management criterion of 1.0. The critical exposure pathway is ingestion of groundwater. The compound 1,1,1-trichloroethane is responsible for most of the hazard; 1,1-dichloroethylene is also a noncarcinogenic COC for this receptor.

14.6.3.2 Excess Lifetime Cancer Risks. The cancer risks for each receptor were determined from the pathway-specific exposure doses and the route-specific SFs, as described in Section 5.1.7.2. To assess the simultaneous exposure of a receptor population to multiple carcinogens from multiple exposure routes, ~~all~~ **the** of the cancer risks calculated for a receptor population were summed. Each overall receptor cancer risk was then compared to USEPA's target risk range (1.0E-06 to 1.0E-04). If the total cancer risk for a receptor from ~~all~~ **the** exposure pathways is less than 1.0E-04, then it is concluded that the site(s) does not pose a significant risk to that receptor. If the overall cancer risk exceeds the target risk range, ~~any~~a chemical that individually is associated with a risk level greater than 1.0E-05 is identified as a COC. COCs represent the primary contributors to the potential cancer risk for the receptor-specific exposure pathway under evaluation. Table W-8, Appendix W, documents the calculation of the pathway- and chemical-specific cancer risks for the human receptors at Site 12B. The pathway-specific and overall cancer risks are summarized in Table 14-14.

14.6.3.2.1 Future On-Site Residents. The overall cancer risks calculated for the future adults and toddlers living at Site 12B are 6.7E-02 and 3.0E-02, respectively. Both of these cancer risks exceed the USEPA's target risk range of 1.0E-06 to 1.0E-04. The critical pathways are ingestion of and dermal contact with groundwater and inhalation of shower VOCs. Most of the cancer risk is due to exposure to 1,1-dichloroethylene. Other carcinogenic COCs for both receptors are 1,1,2-trichloroethane, 1,2-dichloroethane, and vinyl chloride. Trichloroethylene
is also a carcinogenic COC for the future adult resident for the groundwater ingestion pathway.

14.6.3.2.2 Future On-Site Workers. The overall cancer risk calculated for the future workers at Site 12B is 1.8E-02, which exceeds the USEPA's target risk range of 1.0E-06 to 1.0E-04. The critical exposure pathway is ingestion of groundwater. The primary carcinogenic COC for this receptor is 1,1-dichloroethylene. Other COCs are 1,1,2-trichloroethane, 1,2-dichloroethane, and vinyl chloride.

14.6.3.3 Uncertainty/Sensitivity Analysis. The numerical risks/hazards that are calculated for Site 12B represent *conditional* estimates of risk based on various simplifying assumptions concerning contaminant exposure and toxicity. These estimates of risk/hazard are derived using a series of conservative procedures that address contaminant concentrations at the site, their fate in the environment, how someone currently or in the future might be exposed to these contaminants, and the toxicity of each chemical toward humans. The uncertainty analysis specifies, when appropriate, the critical assumptions made for the site so that the site-specific results can be interpreted by risk managers in a proper context.

To assist the risk managers in this project, a qualitative uncertainty analysis has been performed. The primary goals of a qualitative uncertainty analysis are (1) to itemize the major areas of uncertainty in the site-specific risk assessment and (2) to demonstrate that the assessment overall has been conservatively performed (i.e., that the potential risks/hazards at the site have not likely been underestimated, but may have been significantly overestimated).

The qualitative uncertainty analysis for this site is presented in Table 14-15. Based on this analysis, it can be concluded that this risk assessment is conservative. Some of the major uncertainties in this study that are most influential to the risks/hazards that were calculated include:

- Maximum detected groundwater concentrations used.
- Use of modeling to predict shower air concentrations.
- Use of modeling to predict indoor air concentrations.
- Mass-balance considerations suggest insufficient chemical mass present at site to maintain exposure concentrations throughout 30-year exposure period.
- Receptors' groundwater ingestion rate (2 L/day).
- Receptors' exposure frequency (350 days/year).

14.7 ECOLOGICAL RISK ASSESSMENT

Based on protocols established in the PERA (Rust E&I 1997g), there were no **apparent** potential ecological risks determined for Site 12B. As with Site 12A, the solvent-related contaminants at Site 12B are located in subsurface soils and groundwater making the ecological exposure pathways incomplete. As a result, ~~no~~ further ecological risk analysis has **not** been undertaken.

14.8 CONCLUSIONS AND RECOMMENDATIONS

Extensive groundwater flow and contamination studies were conducted at the Building 617 Solvent Pit (Site 12B) during the Phase I and Phase II RI. The results of these studies show that the chlorinated solvents 1,1,1-trichloroethane, 1,1-dichloroethylene, and 1,1-dichloroethane are the primary COCs. **Based on information obtained during the Phase I and Phase II RI coupled with data obtained with new well installations in 2001, a**~~A~~ groundwater plume has migrated approximately ~~200~~ 500 feet in a southwest direction (IN22). The highest concentrations of solvents ~~are located immediately downgradient~~ **remain in the vicinity** of the former solvent pit. The levels ~~drop dramatically~~ **decrease (IN2)** with distance away from the **former** solvent pit.

Results of borehole soil sampling indicate no surface contamination exists **at the sampled locations**. Solvent-related soil contamination is present, however, in low concentrations at approximately 4 feet below the **ground** surface in each of four boreholes drilled during Phase I. Results from 20 probeholes confirmed that soil contamination in the subsurface exists over a relatively large area. The highest concentrations were found to be 2 to 4 feet below the

surface with concentrations gradually decreasing with depth but extending to the water table. **The solvent pit was removed in 2000. Contaminated soils were excavated to the extent practical and disposed off-site at a regulated disposal facility.**

Site 12B was assessed to evaluate whether natural attenuation was occurring at the site. Reductive dechlorination of TCA to daughter products is occurring near the source of contamination. Field measurements, coupled with indicator parameter results, also suggest that natural attenuation of VOCs is occurring. Accordingly, natural attenuation appears to be a viable remedial alternative for treatment of groundwater below Site 12B. However, natural attenuation in groundwater at Site 12B may take a significant period of time.

The results of the human health risk assessment indicate that risks under future land use scenarios exceed USEPA risk-based criteria primarily due to exposure to contaminated groundwater. These elevated risks are related to potential ingestion, dermal contact, and inhalation of VOCs associated with the solvent-related groundwater contamination.

~~Due to the potential risks to future residents and industrial workers, it is recommended that this site be carried through the FS process. Due to the extensive amount of information collected during Phase I and Phase II at this site, no additional remedial investigation activities are warranted. The extensive groundwater studies provided the information necessary to evaluate potential groundwater remedial action technologies.~~ **Due to the elevated risks associated with the VOC-contaminated groundwater, it is recommended that this site be carried through the FS. Sufficient data were collected during the Phase I and Phase II RI and the installation of new wells in 2001 to evaluate potential remedial alternatives. Therefore, no further remedial investigation activities are necessary at this time, but may be needed during future remedial design activities (IN21).**

TABLES

TABLE 14-1a

Groundwater Monitoring Well Information Summary
Site 12B - Building 617
Jefferson Proving Ground
South of the Firing Line
Madison, Indiana

Site	Well ID	Date Installed	Location (ft)		Elevation (ft)		Well Depth (ft)	Depth to Top of Rock (ft)	Well Diameter (In)	Screen Length (ft)	Screen Interval (ft)	Screened Unit	Gradient Relation
			Northing	Easting	TOC	Ground							
Site 12B	MW93-38	05/18/93	487242.39	564840.99	855.17	853.23	31.5	22.5	4.0	10.5	21-31.5	Till/Bedrock	Up
	MW93-39	05/19/93	487171.32	564691.91	854.36	852.54	26.0	17.3	4.0	10.3	15.7-26	Till/Bedrock	Down/Side
	MW93-40	05/20/93	487109.12	564722.31	855.58	853.32	35.5	26.0	4.0	10.5	25-35.5	Till/Bedrock	Down
	MW93-41	05/20/93	487193.92	564770.87	855.94	853.51	28.5	19.0	4.0	10.5	18-28.5	Till/Bedrock	Down
	MW95-01	10/21/95	487027.16	564685.70	854.27	852.39	26.0	NR	4.0	10.0	16-26	Till/Bedrock	Down
	MW95-02	10/22/95	487028.53	564798.04	853.85	851.76	30.0	19.0	4.0	10.0	20-30	Till/Bedrock	Down
	MW96-02	04/11/96	487196.56	564782.15	856.15	853.53	49.5	18.5	4.0	10.0	39.5-49.5	Louisville Lm.	Down
	MW96-03	04/16/96	486587.17	564756.52	853.80	851.38	29.5	21.5	4.0	10.0	19.5-29.5	Till/Bedrock	Down
	MW96-04	04/26/96	486771.41	564446.92	856.08	854.92	52.0	17.7	4.0	10.5	41.5-52	Louisville Lm.	Down/Side
	MW96-05	04/27/96	486762.00	564449.45	856.47	855.71	27.5	17.7	4.0	10.5	17-27.5	Till/Bedrock	Down/Side
	MW96-08	05/02/96	487151.96	564747.22	855.73	853.40	27.2	18.0	4.0	10.2	17-27.2	Till/Bedrock	Down
	MW01-12	11/05/01	486623.70	564762.76	853.97	850.94	43.8	22.0	3.0	5.0	38.8-43.8	Louisville Lm.	Down
	MW01-13	11/06/01	487024.66	564705.82	854.09	851.87	42.5	22.0	3.0	5.0	37.5-42.5	Louisville Lm.	Down
	MW01-14	11/07/01	486925.00	564910.96	854.17	851.42	42.5	23.0	3.0	5.0	37.5-42.5	Louisville Lm.	Down
	MW01-15	11/07/01	486931.96	564908.42	854.06	851.47	26.7	22.0	3.0	10.0	16.7-26.7	Till/Bedrock	Down
	MW01-16	11/08/01	487375.00	564713.72	854.78	851.67	42.3	20.0	3.0	5.0	37.3-42.3	Louisville Lm.	Up
	MW01-17	11/09/01	487372.30	564705.85	854.40	851.76	25.8	20.0	3.0	10.0	15.8-25.8	Till/Bedrock	Up

Notes:
1. Information summarized in this table was taken from the Draft Phase II Remedial Investigation (RI) by Rust Environmental and Infrastructure dated August 1998.
2. Horizontal coordinates relative to Indiana State Coordinates - East Zone, 1983. Vertical coordinate tied to JPG monuments relative to NAD1929.
3. NR = Information not reported in the Draft Phase II RI.
4. Well location and elevation data for sites 12A and 12B are from a December 2001 survey performed by Classickle Inc.

TABLE 14-1b

Summary of Monitoring Well Survey Data and Groundwater Elevations
Site 12B - Building 617
Jefferson Proving Ground
Madison, Indiana

	MW93-38	MW93-39	MW93-40	MW93-41	MW95-01	MW95-02	MW96-02	MW96-03	MW96-04	MW96-05	MW96-08	MW01-12	MW01-13	MW01-14	MW01-15	MW01-16	MW01-17
Elevations																	
Top of Casing	855.17	854.36	855.58	855.94	854.27	853.85	856.15	853.80	856.08	856.47	855.73	853.97	854.09	854.17	854.06	854.78	854.40
Land Surface	853.23	852.54	853.32	853.51	852.39	851.76	853.53	851.38	854.92	855.71	853.40	850.94	851.87	851.42	851.47	851.67	851.76
Top of Screen	832.2	836.8	828.3	835.5	836.4	831.8	814.0	831.9	813.4	838.7	836.4	812.1	814.4	813.9	834.8	814.4	836.0
Well Bottom	821.7	826.5	817.8	825.0	826.4	821.8	804.0	821.9	802.9	828.2	826.2	807.1	809.4	808.9	824.8	809.4	826.0
Top of Rock	830.7	835.2	827.3	834.5	NA	832.8	835.0	829.9	837.2	838.0	835.4	828.9	829.9	828.4	829.5	831.7	831.8
Well Depth	31.5	26.0	35.5	28.5	26.0	30.0	49.5	29.5	52.0	27.5	27.2	43.8	42.5	42.5	26.7	42.3	25.8
Screen Length	10.5	10.3	10.5	10.5	10.0	10.0	10.0	10.0	10.5	10.5	10.2	5.0	5.0	5.0	10.0	5.0	10.0
Top of Rock (ft)	22.5	17.3	26.0	19.0		19.0	18.5	21.5	17.7	17.7	18.0	22.0	22.0	23.0	22.0	20.0	20.0

Depth to Groundwater Below Top of Casing, In Feet

Date	MW93-38	MW93-39	MW93-40	MW93-41	MW95-01	MW95-02	MW96-02	MW96-03	MW96-04	MW96-05	MW96-08	MW01-12	MW01-13	MW01-14	MW01-15	MW01-16	MW01-17
06/29/93	5.83	6.02	7.14	6.90													
08/13/93	6.80	6.94	8.40	8.08													
09/13/93	5.63	5.22	6.61	6.54													
11/19/95	6.39	8.01	9.41	8.43	9.34	8.64											
02/11/96	4.32	3.26	4.57	4.95	3.24	2.99											
04/24/96	3.90	2.98	4.24	4.55	2.96	2.63											
06/19/96	4.42	3.94	6.16	5.22	4.06	3.76	20.95	4.46	15.34	6.23	5.16						
09/11/96	6.88	8.15	9.35	8.55	9.02	9.57	23.13	8.76	NA	11.40	NA						
10/03/96	5.44	6.11	7.64	7.00	7.44	7.20	23.23	7.60	17.19	9.83	7.31						
11/25/96	4.71	4.85	6.25	5.93	5.61	5.54	22.12	5.89	12.99	8.41	6.08						
12/25/96	4.26	3.17	4.56	4.89	3.18	2.91	21.30	3.86	8.25	5.60	4.69						
06/05/01	4.31	3.24	4.50	4.82	3.18	3.00	20.74	3.74	4.43	5.55	4.69						
09/21/01	4.78	3.95	5.37	5.49	4.34	4.61	22.04	5.27	4.91	6.44	5.45						
11/26/01	4.51	3.24	4.56	5.06	3.17	3.05	20.72	3.88	4.64	5.64	4.81	18.27	41.53	18.78	3.63	34.15	3.47
01/25/02	4.09	3.02	4.29	4.70	2.94	2.73	19.41	3.48	4.38	5.37	4.48	17.22	35.83	3.62	3.22	29.63	3.17

Groundwater Elevation, in Feet above MSL

Date	MW93-38	MW93-39	MW93-40	MW93-41	MW95-01	MW95-02	MW96-02	MW96-03	MW96-04	MW96-05	MW96-08	MW01-12	MW01-13	MW01-14	MW01-15	MW01-16	MW01-17
06/29/93	849.34	848.34	848.44	849.04													
08/13/93	848.37	847.42	847.18	847.86													
09/13/93	849.54	849.14	848.97	849.40													
11/19/95	848.78	846.35	846.17	847.51	844.93	845.21											
02/11/96	850.85	851.10	851.01	850.99	851.03	850.86											
04/24/96	851.27	851.38	851.34	851.39	851.31	851.22											
06/19/96	850.75	850.42	849.42	850.72	850.21	850.09	835.20	849.34	840.74	850.24	850.57						
09/11/96	848.29	846.21	846.23	847.39	845.25	844.28	833.02	845.04	NA	845.07	NA						
10/03/96	849.73	848.25	847.94	848.94	846.83	846.65	832.92	846.20	838.89	846.64	848.42						
11/25/96	850.46	849.51	849.33	850.01	848.66	848.31	834.03	847.91	843.09	848.06	849.65						
12/25/96	850.91	851.19	851.02	851.05	851.09	850.94	834.85	849.94	847.83	850.87	851.04						
06/05/01	850.86	851.12	851.08	851.12	851.09	850.85	835.41	850.06	851.65	850.92	851.04						
09/21/01	850.39	850.41	850.21	850.45	849.93	849.24	834.11	848.53	851.17	850.03	850.28						
11/26/01	850.66	851.12	851.02	850.88	851.10	850.80	835.43	849.92	851.44	850.83	850.92	835.70	812.56	835.39	850.43	820.63	850.93
01/25/02	851.08	851.34	851.29	851.24	851.33	851.12	836.74	850.32	851.70	851.10	851.25	836.75	818.26	850.55	850.84	825.15	851.23

Notes:
1. All elevations recorded in Mean Sea Level (MSL) datum.
2. All depth measurements in feet.
3. NA = Data not available. Measurements were not collected on this day.

TABLE 14-1c

Summary of Monitoring Well Survey Data and Groundwater Elevations
Site 12 B - Building 617
Jefferson Proving Ground
Madison, Indiana

	WP96-09	WP96-10	WP96-11	WP96-12	WP96-13	WP96-14	WP96-15	WP96-16	WP96-17	WP96-18	WP96-27	WP96-28	WP96-29	WP96-30	WP96-31
Elevations															
Top of Casing	857.17	857.36	853.82	852.39	852.19	853.78	853.92	853.59	854.80	854.80	855.89	854.47	853.12	853.90	853.83
Land Surface															
Top of Screen															
Well Bottom															
Top of Rock															
Well Depth															
Screen Length															
Top of Rock (ft)															

Date — **Depth to Groundwater Below Top of Casing, in Feet**

Date	WP96-09	WP96-10	WP96-11	WP96-12	WP96-13	WP96-14	WP96-15	WP96-16	WP96-17	WP96-18	WP96-27	WP96-28	WP96-29	WP96-30	WP96-31
04/24/96	11.87	6.37	2.44	2.52	2.24	2.55	2.94	17.56	3.32	3.42	4.61	3.25	4.81	2.61	2.4
06/19/96	6.47	7.02	3.42	3.59	3.36	3.2	3.09	9.46	4.14	3.84	7.00	3.63	3.19	3.43	3.08
09/11/96	11.55	11.15	N	6.69	6.67	7.14	7.42	6.84	8.29	6.27	N	6.44	9.14	5.85	6.41
10/03/96	N	9.16	N	5.98	5.86	4.81	5.03	6.79	6.64	4.85	9.61	4.94	7.46	4.34	3.79
11/25/96	7.94	7.84	3.87	4.61	4.41	4.03	4.21	5.27	5.32	4.11	8.08	4.09	6.41	3.49	3.25
12/25/96	6.45	6.67	N	3.03	N	2.32	2.48	4.61	3.54	3.81	4.83	3.66	3.03	2.87	2.61

Date — **Groundwater Elevation, in Feet above MSL**

Date	WP96-09	WP96-10	WP96-11	WP96-12	WP96-13	WP96-14	WP96-15	WP96-16	WP96-17	WP96-18	WP96-27	WP96-28	WP96-29	WP96-30	WP96-31
04/24/96	845.30	850.99	851.38	849.87	849.95	851.23	850.98	836.03	851.48	851.38	851.28	851.22	848.31	851.29	851.43
06/19/96	850.70	850.34	850.40	848.80	848.83	850.58	850.83	844.13	850.66	850.96	848.89	850.84	849.93	850.47	850.75
09/11/96	845.62	846.21		845.70	845.52	846.64	846.50	846.75	846.51	848.53		848.03	843.98	848.05	847.42
10/03/96		848.20		846.41	846.33	848.97	848.89	846.80	848.16	849.95	846.28	849.53	845.66	849.56	850.04
11/25/96	849.23	849.52	849.95	847.78	847.78	849.75	849.71	848.32	849.48	850.69	847.81	850.38	846.71	850.41	850.58
12/25/96	850.72	850.69		849.36		851.46	851.44	848.98	851.26	850.99	851.06	850.81	850.09	851.03	851.22

Notes:

1. All elevations recorded in Mean Sea Level (MSL) datum.
2. All depth measurements in feet.
3. NA = Data not available. Measurements were not collected on this day.

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TABLE 14-2

Horizontal Hydraulic Gradients
Site 12B - Building 617
Jefferson Proving Ground
Madison, Indiana

Date	Hydraulic Gradient (feet/feet)	Direction (From Solvent Pit)
June 1993	0.007	West-Southwest
August 1993	0.0067	Southwest
September 1993	0.0034	Southwest
November 1995	0.014	Southwest
February 1996	0.0018	East-Southeast
April 1996	0.002	Southwest-Southeast
June 1996	0.004	South
September 1996	0.025	South
October 1996	0.014	South
November 1996	0.008	South-Southeast
December 1996	0.002	East-Southeast
June 2001	0.002	Southeast
November 2001	0.0028	Southeast

Notes:
The maximum gradient equals 0.025; the minimum gradient, 0.0018; and the average gradient, 0.008.

TABLE 14-2a

Vertical Hydraulic Gradients at Well Nests
Site 12B - Building 617
Jefferson Proving Ground
Madison, Indiana

Site	Well Nest (shallow)	Deep)	Gradient 5-Jun-01	Gradient 21-Sep-01	Gradient 26-Nov-01	Gradient 25-Jan-02	General Direction
12B	MW93-41	MW96-02	-0.739	-0.769	-0.727	-0.682	Down
	MW95-01	MW01-13	NA	NA	-2.028	-1.741	Down
	MW96-03	MW01-12	NA	NA	-0.846	-0.808	Down
	MW96-05	MW96-04	0.030	0.047	0.025	0.024	Up
	MW01-15	MW01-14	NA	NA	-0.822	-0.016	Down
	MW01-17	MW01-16	NA	NA	-1.595	-1.373	Down

Notes:
1. A negative sign (-) indicates a downgradient gradient.
2. NA = Water level data not available for this date.

TABLE 14-3

Pumping Test Results Hydraulic Conductivity Values
Site 12B - Building 617
Jefferson Proving Ground
Madison, Indiana

OBSERVATION WELLS

INPUT	MW93-38	MW93-39	MW93-40	MW93-41	MW95-01	MW95-02	MW96-02	MW96-03	MW96-04	MW96-05	MW96-08	Site Average
Confined Solutions centimeter per second (cm/sec)												
Theis	$2.3\ 10^{-3}$	PW[a]	$2.65\ 10^{-3}$	$2.35\ 10^{-3}$	$9.7\ 10^{-3}$	$4.6\ 10^{-3}$	NA[b]	NA	NA	NA	$3.0\ 10^{-3}$	$3.52\ 10^{-3}$
Cooper-Jacob	$2.3\ 10^{-3}$	PW	$2.66\ 10^{-3}$	$2.35\ 10^{-3}$	$1.1\ 10^{-2}$	$5.3\ 10^{-3}$	NA	NA	NA	NA	$3.0\ 10^{-3}$	$3.69\ 10^{-3}$
Papadopulos Cooper	$2.3\ 10^{-3}$	PW	$2.82\ 10^{-3}$	$2.35\ 10^{-3}$	$1.1\ 10^{-2}$	$4.6\ 10^{-3}$	NA	NA	NA	NA	$3.5\ 10^{-3}$	$3.73\ 10^{-3}$
Leaky Solutions (cm/sec)												
Hantush	$2.4\ 10^{-3}$	PW	$1.63\ 10^{-3}$	$2.34\ 10^{-3}$	$8.4\ 10^{-3}$	$4.6\ E^{-3}$	NA	NA	NA	NA	$1.98\ 10^{-3}$	$2.98\ 10^{-3}$
Moench	$2.6\ 10^{-4}$	PW	$1.3\ 10^{-3}$	$2.29\ 10^{-3}$	$3.2\ 10^{-2}$	$3.5\ E^{-3}$	NA	NA	NA	NA	$1.41\ 10^{-3}$	$2.23\ 10^{-3}$
Fractured Solutions (cm/sec)												
Moench	$1.2\ 10^{-3}$	PW	$2.54\ 10^{-3}$	$2.17\ 10^{-3}$	$2.1\ 10^{-2}$	$3.5\ E^{-3}$	NA	NA	NA	NA	$2.25\ 10^{-3}$	$8.87\ 10^{-3}$
Hydraulic Conductivity (cm/sec)												
K-max (method)	$2.4\ 10^{-3}$ (Leaky)	PW	$2.82\ 10^{-3}$ (Confined)	$2.35\ 10^{-3}$ (Confined)	$3.2\ 10^{-2}$ (Leaky)	$5.3\ 10^{-3}$ (Confined)	NA	NA	NA	NA	$3.5\ 10^{-3}$ (Confined)	$4.59\ 10^{-3}$
K-min (method)	$2.6\ 10^{-4}$ (Leaky)	PW	$1.3\ 10^{-3}$ (Leaky)	$2.17\ 10^{-3}$ (Fractured)	$8.4\ 10^{-3}$ (Leaky)	$3.4\ 10^{-3}$ (Fractured)	NA	NA	NA	NA	$1.41\ 10^{-3}$ (Leaky)	$1.76\ 10^{-3}$
K-average	$7.90\ 10^{-4}$	PW	$1.91\ 10^{-3}$	$2.25\ 10^{-3}$	$1.64\ 10^{-2}$	$4.25\ 10^{-3}$	NA	NA	NA	NA	$2.52\ 10^{-3}$	$2.84\ 10^{-3}$

TABLE 14-3

Hydraulic Conductivity Values from Pumping Test Results
Site 12B - Building 617
Jefferson Proving Ground
Madison, Indiana

OBSERVATION WELLS

INPUT	MW93-38	MW93-39	MW93-40	MW93-41	MW95-01	MW95-02	MW96-02	MW96-03	MW96-04	MW96-05	MW96-08	Site Average
						Pumping Test Drawdown (feet)						
Total Drawdown	0.4	14.24	2.03	1.24	0.18	0.5	NA	NA	NA	NA	1.56	1.25
						Observation Well Location (feet)						
Distance from Pumping Well	165	0	69	83	143	175	93	585	470	475	56	87
						Bedrock Formation						
Rock Type & Name	Jeffersonville Limestone 90% Geneva Dolomite 10%	Jeffersonville Limestone	Jeffersonville Limestone 50% Geneva Dolomite 50%	Jeffersonville Limestone	Jeffersonville Limestone	Jeffersonville Limestone 90% Geneva Dolomite10%	Louisville Limestone	Jeffersonville Limestone	Geneva Dolomite Louisville Limestone	Jeffersonville Limestone	Jeffersonville Limestone	NA

Footnotes:
(a) Pumping well.
(b) Well not influenced by pumping test.

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TABLE 14-4

Hydraulic Conductivity (K) Values
Site 12B - Building 617
Jefferson Proving Ground
Madison, Indiana

K Values Top of Illinoisan Till Wellpoint Drawdown Results

Wellpoint	Drawdown (feet)	Distance From Pumping Well (feet)	Screen Interval (feet below ground surface)
WP-15	0.64	15	9.5 - 12.5
WP-17	0.42	65	10-13
WP-31	0.32	95	10-13

K Values Derived From Pumping Test Drawdown Results

Wellpoint	Method	K Value (centimeter/second)	Average K Value (centimeter/second)
WP-15	Theis	1.0 10^{-2}	
	Cooper-Jacob	1.1 10^{-2}	1.05 10^{-2}
WP-17	Cooper-Jacob	1.5 10^{-3}	1.5 10^{-3}
WP-31	Theis	1.9 10^{-3}	
	Cooper-Jacob	2.6 10^{-3}	
	Quick Neuman	1.6 10^{-3}	2.0 10^{-3}

Note:
Site average K value: 3.31 x 10^{-3} centimeter/second.

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TABLE 14-5

Groundwater Seepage Velocities Sensitivity Analysis
Site 12B - Building 617
Jefferson Proving Ground
Madison, Indiana

Hydraulic Conductivity (K) (centimeter/second) (cm/sec)	Gradient (feet/feet)	Effective Porosity (Dimensionless)	Seepage Velocity (feet/day)	Seepage Velocity (feet/year)
4.59×10^{-3}				
Average K-max	0.025	0.01	32	11,873
	0.025	0.15	2.2	792
	0.025	0.30	1.1	395
	0.0018	0.01	2.3	855
	0.0018	0.15	0.16	57
	0.0018	0.30	0.08	28
	0.008	0.01	10	3,799
	0.008	0.15	0.69	253
	0.008	0.30	0.35	127
1.76×10^{-3} cm/sec				
Average K-min	0.025	0.01	12	4,552
	0.025	0.15	0.83	303
	0.025	0.30	0.42	152
	0.0018	0.01	0.90	328
	0.0018	0.15	0.06	22
	0.0018	0.30	0.03	11
	0.008	0.01	4	1,457
	0.008	0.15	0.27	97
	0.008	0.30	0.13	49
2.84×10^{-3} cm/sec				
Average K Value	0.025	0.01	20	7,346
	0.025	0.15	1.3	490
	0.025	0.30	0.7	245
	0.0018	0.01	1.4	529
	0.0018	0.15	0.09	35
	0.0018	0.30	0.05	18
	0.008	0.01	6.4	2,351
	0.008	0.15	0.43	157
	0.008	0.30	0.21	78

TABLE 14-6

Summary of Organic Contaminants Detected in Soil Samples
Site 12B - Building 617
Jefferson Proving Ground
Madison, Indiana

Sample ID	Depth (ft)	Contaminant	Concentration (µg/g)[a]	Sample Date
SVB12BHA02	4.3-4.8	1,1-Dichloroethane	1.70	11/17/92
SVB12BHB02	4.3-4.8	1,1,1-Trichloroethane	0.29	11/17/92
		1,1-Dichloroethane	2.20	
SVB12BHC02	4.3-4.8	1,1,1-Trichloroethane	10.0	11/18/92
		1,1-Dichloroethylene	0.57	
		1,1-Dichloroethane	3.20	
		Toluene	0.62	
SVB12BHC03	9.3-9.8	1,1,1-Trichloroethane	1.50	11/18/92
		1,1-Dichloroethylene	0.69	
		1,1-Dichloroethane	1.10	
SVB12BHD02	4.0-4.5	1,1,1-Trichloroethane	0.32	12/04/92

Footnote:
(a) Micrograms per gram.

TABLE 14-7

Summary of Organic Contaminants Detected in Groundwater Samples
Site 12B - Building 617
Jefferson Proving Ground
Madison, Indiana

				VOCs (ug/L)																					SVOCs (ug/L)		
Field Identification	**Location Identification**	**Sample Date**	**Sample Type**	1,1,1-TRICHLOROETHANE	1,1,2-TRICHLOROETHANE	1,1-DICHLOROETHANE	1,1-DICHLOROETHENE	1,2,4-TRIMETHYLBENZENE	1,2-DICHLOROETHANE	1,3-DICHLOROBENZENE	ACETONE	BENZENE	CARBON DISULFIDE	CHLOROETHANE	CHLOROFORM	cis-1,2-DICHLORO-ETHENE [3]	TOTAL XYLENES	METHYL ETHYL KETONE (2-BUTANONE)	METHYLENE CHLORIDE	TOLUENE	trans-1,2-DICHLORO-ETHENE [3]	TRICHLOROETHYLENE (TCE)	TRICHLOROFLUORO-METHANE	VINYL CHLORIDE	DIETHYL PHTHALATE	PENTACHLORO-PHENOL	NAPHTHALENE
JPG-S12BMW93-38	**MW93-38**	11/7/1995	N	LT 1.0	LT 1.00	LT 1.00	LT 1.00	ND	LT 1.00	ND	LT 5.00 R	ND	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 5.00 R	ND	LT 1.00	ND	LT 1.00	ND	LT 1.00	LT 10.0	LT 50.0	LT 10.0
		2/20/1996	N	LT 1.0	LT 1.00	LT 1.00	LT 1.00	ND	LT 1.00	ND	LT 5.00	ND	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 5.00 R	ND	LT 1.00	ND	LT 1.00	ND	LT 1.00	LT 10.0	LT 50.0	LT 10.0
		5/1/1996	N	0.65	LT 1.00	LT 1.00	LT 1.00	ND	LT 1.00	ND	LT 5.00	ND	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 5.00	ND	LT 1.00	ND	LT 1.00	ND	LT 1.00	LT 10.0	LT 50.0	LT 10.0
		6/26/1996	N	LT 1.0	LT 1.00	LT 1.00	LT 1.00	ND	LT 1.00	ND	LT 5.00	ND	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 5.00 R	ND	LT 1.00	ND	LT 1.00	ND	LT 1.00	10	LT 50.0	LT 10.0
		6/8/2001	N	1(U /)	1(U /)	1(U /)	1(U /)	1(U / UJ)	1(U /)	1(U / UJ)	10(U / R)	1(U / UJ)	1(U / UJ)	1(U /)	1(U /)	1(U /)	1(U / UJ)	10(U / R)	5(U /)	1(U / UJ)	1(U /)	1(U /)	1(U /)	1(U /)	NA	NA	NA
JPG-S12BMW01-51	**MW93-38**	6/8/2001	FD	1(U /)	1(U / UJ)	1(U /)	1(U /)	1(U / UJ)	1(U /)	1(U / UJ)	10(U / R)	1(U / UJ)	1(U / UJ)	1(U /)	1(U /)	1(U /)	1(U / UJ)	10(U / R)	0.74(J / 5U)	1(U / UJ)	1(U /)	1(U /)	0.41(J / 1U)	1(U /)	NA	NA	NA
JPG-S12BMW93-39	**MW93-39**	11/7/1995	N	**4,600 U**	**42.0**	**1,360**	**3,800**	ND	**83.0**	ND	LT 5.00 R	ND	LT 1.00	2.3	**13.0**	42.0	1.10	28.0	ND	18.0	ND	**43.0**	ND	**2.4**	LT 10.0	LT 50.0	LT 10.0
		2/20/1996	N	**1,700**	**18.0**	700	**1,400**	ND	**33.0**	ND	LT 5.00	ND	LT 1.00	1.2	**4.70**	16.0	LT 1.00	LT 5.00 R	ND	5.5	ND	**17.0**	ND	**0.9**	LT 10.0	LT 50.0	LT 10.0
		5/1/1996	N	**1,650**	**21.3**	775	**1,880**	ND	**40.0**	ND	LT 5.00	ND	LT 25	LT 25	LT 25	16.0	LT 25	LT 125 R	ND	LT 25	ND	**20.8**	ND	LT 25	LT 10.0	LT 50.0	0.45
		6/26/1996	N	**3,250**	**32.5**	**1,270**	**3,250**	ND	**57.5**	ND	LT 125	ND	LT 25	LT 25	**9.25**	LT 25	LT 25	LT 125 R	ND	11.8	ND	**32.5**	ND	LT 25	LT 10.0	LT 50.0	0.77
		6/11/2001	N	170	**1.3**	130	**270**	1(U /)	**2.8**	1(U /)	10(U / UJ)	1(U /)	1(U /)	0.81(J / 1U)	**0.42(J / 1U)**	0.76(J / 1U)	1(U /)	10(U / R')	5(U /)	0.36(J / 1U)	1(U /)	1.3	1(U /)	1(U /)	NA	NA	NA
JPG-S12BMW96-08	**MW93-40**	11/7/1995	N	**7,000**	**24.0**	650	**2,200**	ND	**50.0**	ND	42.0	ND	LT 1.00	1.9	**8.1**	15.0	LT 1.00	14.0	ND	LT 1.00	ND	**20.0**	ND	**2.2**	LT 10.0	LT 50.0	LT 10.0
		2/20/1996	N	**7,400**	**30.0**	780	**1,880**	ND	**68.0**	ND	LT 5.00	ND	LT 1.00	2.1	**10.0**	19.0	LT 1.00	LT 5.00 R	ND	2.8	ND	**28.0**	ND	**3.0**	200	LT 50.0	LT 10.0
		5/1/1996	N	**5,500**	LT 50	**850**	**2,050**	ND	**60.0**	ND	LT 50	ND	LT 50	LT 50	LT 50	LT 50	LT 50	LT 250 R	ND	LT 50	ND	**20.0**	ND	LT 50	LT 10.0	**2.80**	LT 10.0
		6/26/1996	N	**5,250**	**21.5**	**800**	**1,900**	ND	**60.0**	ND	LT 250	ND	12.5	LT 50	LT 50	LT 50	LT 500	LT 250 R	ND	LT 50	ND	**19.5**	ND	LT 50	LT 10.0	**2.50**	LT 10.0
		6/11/2001	N	**2,300**	**10(/ J)**	450	**840**	1(U / UJ)	**22(/ J)**	1(U /)	10(U /)	1(U /)	1(U /)	1.59(/ J)	**3(/ J)**	3.7(/ J)	1(U /)	10(U / R)	5(U /)	1(U /)	1(U /)	**7.8(/ J)**	1(U /)	**0.37(J / 1U)**	NA	NA	NA
JPG-S12BMW93-41	**MW93-41**	11/7/1995	N	**30,000**	**62**	**1,500**	**5,500**	ND	**110.0**	ND	47.0	ND	LT 1.00	3.6	**22.0**	39.0	0.46	50.0	ND	13.0	ND	**53.0**	ND	**3.8**	LT 10.0	LT 50.0	LT 10.0
		2/20/1996	N	**25,000**	**110**	**3,600**	**9,200**	ND	**230.0**	ND	26.0	ND	LT 1.00	**5.0**	**42.0**	**79.0**	1.20	LT 5.00	ND	39.0	ND	**96.0**	ND	**5.4**	LT 10.0	LT 50.0	LT 10.0
		5/1/1996	N	**45,000**	**120**	**3,950**	**12,000**	ND	**260.0**	ND	LT 5000	ND	LT 500	LT 500	**40.0**	**68.0**	LT 500	LT 2500 R	ND	LT 500	ND	**92.0**	ND	LT 500	LT 10.0	**2.1**	0.33
		6/26/1996	N	**40,000**	LT 500	**3,100**	**8,000**	ND	**185.0**	ND	LT 2500	ND	LT 500	LT 500	LT 500	LT 500	LT 500	LT 2500 R	ND	LT 500	ND	LT 500	ND	LT 500	LT 10.0	**0.88**	0.29
		6/11/2001	N	**7,200**	**27**	**2,300**	**3,500**	0.23(J / 1U)	1000(U /)	0.15(J / 1U)	10(U / R)	0.3(J / 1U)	1(U /)	2.9	**10.0**	9.1	0.17(J / 1U)	10(U / R)	5(U /)	0.64(J / 1U)	1(U /)	**18.0**	1(U /)	**3.9**	NA	NA	NA
JPG-S12BMW95-01	**MW95-01**	11/7/1995	N	**4,400**	**16.0**	660	**2,000**	ND	**38**	ND	LT 5.00	ND	LT 1.00	0.82	**5.7**	7.9	LT 1.00	LT 5.00 R	ND	LT 1.00	ND	**16.0**	ND	**2.2**	LT 10.0	LT 50.0	LT 10.0
		2/20/1996	N	**22,000**	**47.0**	**3,700**	**13,000**	ND	**130**	ND	LT 500	ND	LT 100	LT 100	LT 100	LT 100	LT 100	LT 500	ND	LT 100	ND	**110.0**	ND	LT 100	LT 10.0	LT 50.0	LT 10.0
		5/1/1996	N	**2,750**	**16.5**	575	**1,580**	ND	LT 25	ND	LT 125	ND	LT 25	LT 25	LT 25	LT 25	LT 25	LT 125 R	ND	LT 25	ND	**16.8**	ND	LT 25	LT 10.0	**0.59**	LT 10.0
		6/26/1996	N	**2,750**	**13.0**	525	**1,380**	ND	**32.5**	ND	LT 125	ND	LT 25	LT 25	LT 25	LT 25	LT 25	LT 125 R	ND	LT 25	ND	**14.8**	ND	LT 25	10	0.31	LT 10.0
		6/8/2001	N	**2,600**	**13(/ J)**	610	**1,800**	1(U / UJ)	**32**	1(U /)	10(U / R)	1(U / J)	1(U / J)	0.76(J /)	**7.2**	7.6	1(U / J)	10(U / R)	5(U /)	1(U / J)	1(U /)	**12.0**	1(U /)	**1.2**	NA	NA	NA
JPG-S12BMW95-02	**MW95-02**	11/7/1995	N	400	**1.9**	97.5	**300**	ND	**6.9**	ND	40	ND	LT 1.00	LT 1.00	LT 10	1.2	LT 1.00	LT 5.00 R	ND	LT 1.00	ND	1.40	ND	LT 1.00	LT 10.0	LT 50.0	LT 10.0
		2/20/1996	N	350	LT 10	91	**280**	ND	**6.3**	ND	LT 50.0	ND	LT 10	LT 10	LT 1.00	LT 10	LT 10	LT 50	ND	LT 10	ND	LT 10	ND	LT 10	LT 10.0	LT 50.0	LT 10.0
		5/1/1996	N	525	**3.3**	110	**450**	ND	**9.0**	ND	LT 25	ND	LT 5.00	LT 5.00	LT 5.00	LT 5.00	LT 5.00	LT 25 R	ND	LT 5.00	ND	**2.75**	ND	LT 5.00	LT 10.0	LT 50.0	LT 10.0
		6/26/1996	N	**650**	**2.75**	145	**500**	ND	**10.5**	ND	LT 25	ND	LT 5.00	LT 5.00	LT 1.00	LT 5.00	LT 5.00	LT 25 R	ND	LT 5.00	ND	**3.85**	ND	LT 5.00	10	**0.66**	LT 10.0
		6/8/2001	N	**660**	**2.9(/ J)**	160	**550**	1(U / UJ)	**7.7**	1(U /)	10(U / R)	1(U / UJ)	1(U / UJ)	1(U / UJ)	**1.3**	1.5	1(U / J)	10(U / R)	5(U /)	1(U / J)	1(U /)	**2.3**	1(U /)	**0.41(J / 1U)**	NA	NA	NA
JPG-S12BMW01-52	**MW95-02**	6/8/2001	FD	**790**	**3.3(/ J)**	180	**690**	1(U / UJ)	**8.8**	1(U /)	10(U / R)	1(U / UJ)	1(U / UJ)	1(U / UJ)	**1.3**	1.6	1(U / J)	10(U / R)	5(U /)	1(U / J)	1(U /)	**2.6**	1(U /)	**0.57(J / 1U)**	NA	NA	NA
JPG-S12BMW96-02	**MW96-02**	5/1/1996	N	**3,900**	LT 25	163	**183**	ND	LT 25	ND	LT 125	ND	LT 25	LT 25	LT 25	LT 25	LT 25	LT 125 R	ND	LT 25	ND	LT 25	ND	LT 25	LT 10.0	LT 50.0	LT 10.0
		6/26/1996	N	**2,750**	LT 25	180	**92.5**	ND	LT 25	ND	LT 125	ND	LT 25	LT 25	LT 25	LT 25	LT 25	LT 125 R	ND	LT 25	ND	LT 25	ND	LT 25	0.25	LT 50.0	LT 10.0
		6/11/2001	N	**8,700**	4.4	**6,100**	**1,400(J /)**	0.13(J / 1U)	2500(U /)	1(U /)	10(U /)	1(U /)	1(U /)	**5.8**	**17.0**	6.4	1(U /)	25000(U /)	2(J /)	2.3	1(U /)	**5.9**	1(U /)	**14.0**	NA	NA	NA
JPG-S12BMW96-03	**MW96-03**	5/1/1996	N	11.0	LT 1.00	LT 1.00	**1.50**	ND	LT 1.00	ND	LT 5.00	ND	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 5.00	ND	LT 1.00	ND	LT 1.00	ND	LT 1.00	LT 10.0	LT 50.0	LT 10.0
		6/26/1996	N	LT 1.0	LT 1.00	0.59	LT 1.00	ND	LT 1.00	ND	LT 5.00	ND	0.49	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 5.00	ND	LT 1.00	ND	LT 1.00	ND	LT 1.00	LT 10.0	LT 50.0	LT 10.0
		6/8/2001	N	1(U /)	1(U / UJ)	1(U /)	1(U /)	1(U / UJ)	1(U /)	1(U /)	10(U / R)	1(U / UJ)	1(U / UJ)	1(U /)	1(U /)	1(U /)	1(U / UJ)	10(U / R)	0.86(J / 5U)	1(U / UJ)	1(U /)	1(U / UJ)	1(U /)	1(U /)	NA	NA	NA
JPG-S12BMW96-04	**MW96-04**	5/1/1996	N	LT 1.0	LT 1.00	0.55	LT 1.00	ND	LT 1.00	ND	LT 5.00	ND	LT 1.00	LT 1.00	LT 1.00	2.4	LT 1.00	LT 5.00	ND	LT 1.00	ND	LT 1.00	ND	LT 1.00	LT 10.0	LT 50.0	LT 10.0
		6/26/1996	N	LT 1.0	LT 1.00	LT 1.00	LT 1.00	ND	LT 1.00	ND	32.0	ND	0.54	LT 1.00	**2.0**	LT 1.00	LT 1.00	LT 5.00	ND	LT 1.00	ND	LT 1.00	ND	LT 1.00	10.0	LT 50.0	LT 10.0
		6/8/2001	N	1(U /)	1(U / UJ)	1(U /)	**5.10**	1(U / UJ)	1(U /)	1(U /)	10(U / R)	**0.49(J / 1UJ)**	0.5(J / 1UJ)	1(U /)	1(U /)	1(U /)	0.74(J / 1UJ)	10(U / R)	1(J / 5U)	1(U / UJ)	1(U /)	1(U /)	0.73(J /)	1(U /)	NA	NA	NA
JPG-S12BMW96-05	**MW96-05**	5/1/1996	N	LT 1.0	LT 1.00	LT 1.00	LT 1.00	ND	LT 1.00	ND	LT 5.00	ND	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 5.00	ND	LT 1.00	ND	LT 1.00	ND	LT 1.00	LT 10.0	LT 50.0	LT 10.0
		6/26/1996	N	LT 1.0	LT 1.00	LT 1.00	LT 1.00	ND	LT 1.00	ND	LT 5.00	ND	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 5.00	ND	LT 1.00	ND	LT 1.00	ND	LT 1.00	LT 10.0	LT 50.0	LT 10.0
		6/8/2001	N	1(U /)	1(U / UJ)	1(U /)	1(U /)	1(U / UJ)	1(U /)	1(U /)	10(U / R)	1(U / UJ)	1(U / UJ)	1(U /)	1(U /)	1(U /)	1(U / UJ)	10(U / R)	1.4(J / 5U)	1(U / UJ)	1(U /)	1(U /)	1(U /)	1(U /)	NA	NA	NA

TABLE 14-7

Summary of Organic Contaminants Detected in Groundwater Samples
Site 12B - Building 617
Jefferson Proving Ground
Madison, Indiana

				VOCs (ug/L)																					SVOCs (ug/L)		
Field Identification	**Location Identification**	**Sample Date**	**Sample Type**	1,1,1-TRICHLOROETHANE	1,1,2-TRICHLOROETHANE	1,1-DICHLOROETHANE	1,1-DICHLOROETHENE	1,2,4-TRIMETHYLBENZENE	1,2-DICHLOROETHANE	1,3-DICHLOROBENZENE	ACETONE	BENZENE	CARBON DISULFIDE	CHLOROETHANE	CHLOROFORM	cis-1,2-DICHLORO-ETHENE (3)	TOTAL XYLENES	METHYL ETHYL KETONE (2-BUTANONE)	METHYLENE CHLORIDE	TOLUENE	trans-1,2-DICHLORO-ETHENE (3)	TRICHLOROETHYLENE (TCE)	TRICHLOROFLUORO-METHANE	VINYL CHLORIDE	DIETHYL PHTHALATE	PENTACHLORO-PHENOL	NAPHTHALENE
JPG-S12BMW96-08	**MW96-08**	6/8/2001	N	**2,300**	**4.3**	380	**690**	1(U /)	**14**	1(U /)	10(U /)	1(U /)	1(U /)	**10**	**2.4**	3.4	1(U / UJ)	10(U /)	5(U /)	1.3(/ J)	1.2	**4.6**	1(U /)	**1.3**	NA	NA	NA
JPG-S12BMW01-12	**MW01-12**	11/27/2001	N	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	10(U /)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	10(U /)	5(U /)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	NA	NA	NA
JPG-S12BMW01-13	**MW01-13**	11/30/2001	N	230	**6.1**	130	**110**	1(U /)	**13**	1(U /)	10(U / UJ)	1(U /)	4.2	1(U /)	**1.5**	1.9	1(U /)	10(U /)	5(U /)	1(U /)	1(U /)	**2.5**	1(U /)	1(U /)	NA	NA	NA
JPG-S12BMW01-14	**MW01-14**	11/27/2001	N	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	10(U /)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	10(U /)	5(U /)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	NA	NA	NA
JPG-S12BMW01-15	**MW01-15**	11/27/2001	N	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	10(U / UJ)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	10(U /)	5(U /)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	NA	NA	NA
JPG-S12BMW01-70	**MW01-15**	11/27/2001	FD	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	10(U / UJ)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	10(U /)	5(U /)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	NA	NA	NA
JPG-S12BMW01-16	**MW01-16**	11/28/2001	N	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	10(U / UJ)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	10(U /)	5(U /)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	NA	NA	NA
JPG-S12BMW01-17	**MW01-17**	11/28/2001	N	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	10(U / UJ)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	10(U /)	5(U /)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	NA	NA	NA
			PRGs (1)	540	0.2	810	0.046	12	0.12	5.5	610	0.35	1000	4.6	0.16	61	1400 (2)	1900	4.3	720	120	1.6	1300	0.041	29000	0.56	NSE

General Notes:

1. (LF / VF) = Lab Flag / Validation Flag
2. Only detected compounds are listed in table
3. ug/L = Micrograms per liter
4. VOCs = Volatile organic compounds
5. Sample Types:
   "N" = Normal field Sample
   "FD" = Field Duplicate
6. LT = Less than the reporting limit
7. ND = Not detected
8. NA = Not analyzed
9. PRGs = Preliminary Remediation Goals
10. NSE = No standard established
11. U = Compound was not detected
12. J = Estimated value. The result is less than the reporting limit, but greater than the maximum detection limit.
13. Bolded results indicate a PRG exceedance

Footnotes:

(1) PRGs = Preliminary Remediation Goals from US EPA Region 9 for Tap Water
(2) PRG is for both m,p-xylene and o-xylene combined
(3) Proir to 2001, results for 1, 2-dichloroethylene (1, 2-DCE) were reported as the total of cis- and trans- isomers with the total result reported in the column for cis-1, 2-DCE

TABLE 14-7a

Summary of Inorganic and Indicator Parameters Detected in Groundwater Samples
Site 12B - Building 617
Jefferson Proving Ground
Madison, Indiana

				Metals				General Chem							Gas				Field NA						
Field Identification	Location Identification	Sample Date	Sample Type	IRON	DISSOLVED IRON	MANGANESE	DISSOLVED MANGANESE	ALKALINITY, TOTAL (AS CaCO3)	CHLORIDE (AS CL)	NITROGEN, KJELDAHL, TOTAL	NITROGEN, NITRATE (AS N)	SULFATE (AS SO4)	SULFIDE	TOTAL ORGANIC CARBON	CARBON DIOXIDE	ETHANE	ETHENE	METHANE	DISSOLVED OXYGEN	FERROUS IRON	OXIDATION-REDUCTION POTENTIAL	pH	SPECIFIC CONDUCTANCE	TEMPERATURE	TURBIDITY
				ug/L	ug/L	ug/L	ug/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	ug/L	mg/L	mg/L	mV	S.U.	umhos/cm	Deg C	NTU
JPG-S12BMW93-38	**MW93-38**	6/8/2001	N	0.0456	NA	0.0208	NA	538	7.56	0.154	0.1(U /)	30.6	1(U /)	5(U /)	98.1	1.3(U /)	1.2(U / UJ)	0.37(J / 1UJ)	7.86	0.1	104	7.07	1120	17.1	1.1
JPG-S12BMW01-51	**MW93-38**	6/8/2001	FD	0.0227(J / 0.025U)	NA	0.0057(J / 0.01U)	NA	556	8.05	0.302	0.1(U /)	33.3	1(U /)	5(U /)	127	1.3(U /)	1.2(U / UJ)	0.38(J / 1UJ)	NA	NA	NA	NA	NA	NA	NA
JPG-S12BMW93-39	**MW93-39**	6/11/2001	N	0.764	NA	0.0986	NA	435	19	0.1(U /)	0.1(U /)	69.3	1(U /)	5(U /)	41.2	1.3(U /)	1.2(U / UJ)	8.9	0	0.2	-6	6.9	1020	16.86	24.3
JPG-S12BMW96-08	**MW93-40**	6/11/2001	N	0.558	NA	0.272	NA	600	42.1	0.238	0.1(U /)	16.5	1(U /)	5(U /)	111	1.3(U /)	1.2(U / UJ)	21	1.7	0.1	174	7	1240	14.52	8
JPG-S12BMW93-41	**MW93-41**	6/11/2001	N	0.29	NA	0.387	NA	431	53.3	0.54	0.1(U /)	22.1	1(U /)	5(U /)	217	1.3(U /)	1.2(U / UJ)	210	5.08	0.3	0	6.57	1070	16.3	0
JPG-S12BMW95-01	**MW95-01**	6/8/2001	N	0.214	NA	0.0696	NA	605	94.6	0.6	0.1(U /)	29.9	1(U /)	5(U /)	99.2	1.3(U /)	1.2(U / UJ)	26	0	0.5	56	6.94	1490	14.19	16.3
JPG-S12BMW95-02	**MW95-02**	6/8/2001	N	0.102	NA	0.0734	NA	528	69.4	0.431	0.1(U /)	14.4	1(U /)	5(U /)	142	1.3(U /)	1.2(U / UJ)	13	0	0	85	6.86	1340	14.95	12.8
JPG-S12BMW01-52	**MW95-02**	6/8/2001	FD	0.15	NA	0.131	NA	518	68.8	0.193	0.1(U /)	14.4	1(U /)	5(U /)	132	1.3(U /)	1.2(U / UJ)	13	NA	NA	NA	NA	NA	NA	NA
JPG-S12BMW96-02	**MW96-02**	6/11/2001	N	11.5	NA	0.0554	NA	549	104	3.44	0.1(U /)	1.09	2.98	116	50	33	5.7(/ UJ)	21	5.33	10	-171	6.98	1600	16.1	0.1
JPG-S12BMW96-03	**MW96-03**	6/8/2001	N	0.12	NA	0.118	NA	487	192	0.276	0.1(U /)	41.8	1(U /)	5(U /)	87	1.3(U /)	1.2(U / UJ)	8.3(/ J)	6.22	0	62	7.18	1660	17.9	5.9
JPG-S12BMW96-04	**MW96-04**	6/8/2001	N	4.77	NA	0.198	NA	118	9.27	4.88	0.1(U /)	3.99	1.26	30.6	2.96	0.37(J /)	0.67(J /)	1300	0	0.5	-278	11.71	1160	15.33	22.7
JPG-S12BMW96-05	**MW96-05**	6/8/2001	N	3.02	NA	0.615	NA	805	13.4	0.296	0.1(U /)	80.1	1(U /)	5(U /)	182	1.3(U /)	1.2(U /)	63	0.41	0.2	-39	6.81	1710	15.31	25.2
JPG-S12BMW96-08	**MW96-08**	6/8/2001	N	6.35	NA	0.83	NA	477	33.2	0.218	0.1(U /)	24.7	1(U /)	5(U /)	97.3	130(U /)	120(U / UJ)	620(/ J)	5.64	4.5	-123	6.93	1110	18	2.2
JPG-S12BMW01-12	**MW01-12**	11/27/2001	N	111(/ J)	100(U /)	2170	2250	448	23.3	1.45	0.1(U /)	30.6	1(U /)	5(U /)	4000	1.3(U /)	1.2(U /)	6.7	0	0.1	-7	7.2	960	16.78	7
JPG-S12BMW01-13	**MW01-13**	11/30/2001	N	NA	NA	NA	NA	311	75.8	0.649	0.1(U /)	87.5	1(U /)	20.6	3100(E /)	1.3(U /)	1.2(U /)	1(U /)	0.6	0.1	4	7.1	1010	16.65	325
JPG-S12BMW01-14	**MW01-14**	11/27/2001	N	230(/ J)	100(U /)	931	942	401	23	0.474	0.1(U /)	57.5	1(U /)	5(U /)	2900	1.3(U /)	1.2(U /)	3.3	0	0.1	33	7.1	1090	15.91	1.4
JPG-S12BMW01-15	**MW01-15**	11/27/2001	N	100(U / R)	100(U /)	133	99.6	521	36.9	0.105	0.1(U /)	29.6	1(U /)	5(U /)	3000	1.3(U /)	1.2(U /)	1.1	0.95	0.1	83	7	1120	16.1	1.8
JPG-S12BMW01-70	**MW01-15**	11/27/2001	FD	100(U / R)	100(U / R)	165	82.6	500	37	0.453	0.1(U /)	30.1	1(U /)	5(U /)	2800	1.3(U /)	1.2(U /)	1.5	NA	NA	NA	NA	NA	NA	NA
JPG-S12BMW01-16	**MW01-16**	11/28/2001	N	24200(/ J)	100(U / R)	1290	366	552	137	0.748	0.195	42.4	1.84	2.35	4200	1.7	1.2(U /)	10	0	0.1	-15	7.1	1590	14.9	6.9
JPG-S12BMW01-17	**MW01-17**	11/28/2001	N	100(U / R)	100(U / R)	23.4	19.2	604	137	0.1(U /)	0.077(J / U)	38.3	1(U /)	5(U /)	6500	1.3(U /)	1.2(U /)	2.4	0	0.2	66	6.8	1590	11.47	0

General Notes:
1. (LF / VF) = Lab Flag / Validation Flag
2. ug/L = Micrograms per liter.
3. mg/L = Milligrams per liter
4. Sample Types:
   "N" = Normal field Sample
   "FD" = Field Duplicate
5. NA = Sample not analyzed for this analyte
6. S.U. = Standard Units
7. NTU = Nephelometric Turbidity Units
8. R = Analytical data was rejected
9. U = Compound was not detected
10. J = Estimated value. The result is less than the reporting limit, but greater than the maximum detection limit.

TABLE 14-7b

Reductive Dechlorination Scoring
Site 12B - Building 617
Jefferson Proving Ground
Madison, Indiana

Natural Attenuation Screening Protocol

The following is taken from the USEPA protocol (USEPA, 1998). The results of this scoring process have no regulatory significance.

Interpretation	Score
Inadequate evidence for anaerobic biodegradation* of chlorinated organics	0 to 5
Limited evidence for anaerobic biodegradation* of chlorinated organics	6 to 14
Adequate evidence for anaerobic biodegradation* of chlorinated organics	15 to 20
Strong evidence for anaerobic biodegradation* of chlorinated organics	>20

*reductive dechlorination

Score: 19

Scroll to End of Table

Analysis	Concentration in Most Contam. Zone	Interpretation	Yes	No	Points Awarded
Oxygen*	<0.5 mg/L	Tolerated, suppresses the reductive pathway at higher concentrations		●	0
	>5 mg/L	Not tolerated; however, VC may be oxidized aerobically			0
Nitrate*	<1 mg/L	At higher concentrations may compete with reductive pathway	●		2
Iron II*	>1 mg/L	Reductive pathway possible; VC may be oxidized under Fe(III)-reducing conditions		●	0
Sulfate*	<20 mg/L	At higher concentrations may compete with reductive pathway	●		2
Sulfide*	>1 mg/L	Reductive pathway possible		●	0
Methane*	<0.5 mg/L	VC oxidizes		●	0
	>0.5 mg/L	Ultimate reductive daughter product, VC Accumulates	●		3
Oxidation Reduction Potential* (ORP)	<50 millivolts (mV)	Reductive pathway possible	●		1
	<-100 mV	Reductive pathway likely			0
pH*	5 < pH < 9	Optimal range for reductive pathway	●		0
	5 > pH > 9	Outside optimal range for reductive pathway			0
TOC	>20 mg/L	Carbon and energy source; drives dechlorination; can be natural or anthropogenic		●	0
Temperature*	>20°C	At T > 20°C biochemical process is accelerated		●	0
Carbon Dioxide	>2x background	Ultimate oxidative daughter product	●		1
Alkalinity	>2x background	Results from interaction of carbon dioxide with aquifer minerals		●	0
Chloride*	>2x background	Daughter product or organic chlorine	●		2
Hydrogen	>1 nM	Reductive pathway possible, VC may accumulate			0
	<1 nM	VC oxidized			0
Volatile Fatty Acids	>0.1 mg/L	Intermediates resulting from biodegradation of aromatic compounds; carbon and energy source			0
BTEX*	>0.1 mg/L	Carbon and energy source; drives dechlorination		●	0
PCE*		Material released		●	0
TCE*		Material released	●		0
		Daughter product of PCE(a)			0
DCE*		Material released			0
		Daughter product of TCE. If cis is greater than 80% of total DCE, it is likely a daughter product of TCE(a), 1,1-DCE can be a chem. reaction product of TCA	●		2
VC*		Material released			0
		Daughter product of DCE(a)	●		2
1,1,1-Trichloroethane*		Material released	●		0
DCA		Daughter product of TCA under reducing conditions	●		2
Carbon Tetrachloride		Material released			0
Chloroethane*		Daughter product of DCA or VC under reducing conditions	●		0
Ethene/Ethane	>0.01 mg/L	Daughter product of VC/ethene	●		2
	>0.1 mg/L	Daughter product of VC/ethene			0
Chloroform		Material released	●		0
		Daughter product of Carbon Tetrachloride		●	0
Dichloromethane		Material released			0
		Daughter product of Chloroform			0

*required analysis.
(a) points awarded only if it can be shown that the compound is a daughter product (i.e., not a constituent of the source NAPL).

SCORE Reset

End of Form

TABLE 14-8

Soil Exposure Point Concentrations of Contaminants of Potential Concern
Site 12B - Building 617
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/g)[b]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[c] (µg/g)
Surface Soil						
No chemicals were detected in surface soil at this site.						
Surface/Subsurface Soil						
1,1-Dichloroethane	4/12	1.10 - 3.20	0.49	0.85	2.20	2.20
1,1-Dichloroethylene	2/12	0.57 - 0.69	0.27	0.22	0.32	0.32
1,1,1-Trichloroethane	4/12	0.29 - 10.0	0.20	1.10	3.57	3.57
Toluene	1/12	0.62	0.10	0.10	0.14	0.14

Footnotes:

(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Micrograms per gram.
(c) The 95% UCL (upper confidence limit of the mean) or the maximum detected value, whichever is lower (USEPA 1989b).

TABLE 14-9

Selection of Contaminants of Potential Concern (COPC) in Soil Based on USEPA Region 9 Preliminary Remediation Goals (PRGs) Site 12B - Building 617 Jefferson Proving Ground Madison, Indiana

	USEPA Region 9 PRG Screening Data		
Chemical	**Residential PRG (µg/g)[a]**	**Exposure Point Concentration (µg/g)**	**Retained as Soil COPC?**
Surface/Subsurface Soil			
1,1-Dichloroethane	50.0	2.20	No
1,1-Dichloroethylene	0.037	0.32	**YES**
1,1,1-Trichloroethane	122	3.57	No
Toluene	79.3	0.14	No

Note:

PRGs were taken directly from the Region 9 PRG Table (USEPA 1998). Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnote:

(a) Micrograms per gram.

TABLE 14-10

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 12B - Building 617
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Ambient Air PRG (µg/m³)[(a)]**	**Exposure Point Conc. (µg/m³)**	**Retained as Air COPC?**
Residential Scenario			
Aluminum	NA[(b)]	1.06E-02	**YES**
Arsenic	4.5E-04	5.42E-06	No
Barium	5.2E-02	1.22E-05	No
Beryllium	8.0E-04	4.23E-07	No
Cadmium	1.1E-03	2.37E-08	No
Chromium	2.3E-05	1.50E-05	No
Lead	1.5E+00[(c)]	1.76E-06	No
Manganese	5.1E-03	7.54E-04	No
Silver	NA	2.98E-05	**YES**
Thallium	NA	2.12E-06	**YES**
Vanadium	NA	2.70E-06	**YES**
Zinc	NA	1.21E-06	**YES**
Dioxins/Furans	4.5E-08	1.45E-13	No
Benzo(a)anthracene	9.2E-03	2.18E-09	No
Benzo(a)pyrene	9.2E-04	6.33E-09	No
Benzo(b)fluoranthene	9.2E-03	1.23E-08	No
DDE	2.0E-02	1.28E-09	No
Dibenz(a,h)anthracene	9.2E-04	2.56E-10	No
Dieldrin	4.2E-04	NA	No
Indeno(1,2,3-cd)pyrene	9.2E-03	1.30E-09	No
1,1-Dichloroethylene	3.8E-02	2.79E-04	No
Chlorobenzene	2.1E+00	4.16E-06	No
Industrial Scenario			
Aluminum	NA	1.43E-02	**YES**
Arsenic	4.5E-04	7.13E-06	No

TABLE 14-10

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 12B - Building 617
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Ambient Air PRG (µg/m^3)[(a)]**	**Exposure Point Conc. (µg/m^3)**	**Retained as Air COPC?**
Industrial Scenario			
Barium	5.2E-02	1.27E-05	No
Beryllium	8.0E-04	6.58E-07	No
Cadmium	1.1E-03	1.41E-07	No
Chromium	2.3E-05	2.60E-05	**YES**
Lead	1.5E+00[(c)]	1.76E-06	No
Manganese	5.1E-03	1.03E-03	No
Silver	NA	2.98E-05	**YES**
Thallium	NA	2.12E-06	**YES**
Vanadium	NA	5.10E-06	**YES**
Zinc	NA	1.28E-04	**YES**
Dioxins/Furans	4.5E-08	5.09E-12	No
Benzo(a)anthracene	9.2E-03	2.18E-09	No
Benzo(a)pyrene	9.2E-04	6.39E-09	No
Benzo(b)fluoranthene	9.2E-03	1.23E-08	No
DDE	2.0E-02	1.28E-09	No
Dibenz(a,h)anthracene	9.2E-04	2.56E-10	No
Dieldrin	4.2E-04	2.70E-09	No
Indeno(1,2,3-cd)pyrene	9.2E-03	1.28E-09	No
1,1-Dichloroethylene	3.8E-02	2.79E-04	No
Chlorobenzene	2.1E+00	4.16E-06	No

Note:
PRGs were taken directly from the Region 9 PRG Table (USEPA 1998). Values for noncarcinogens are 1/10 of the Region 9 PRG.
EPCs are calculated and presented in Tables R-4 and R-6 in Appendix R.

Footnote:
(a) Micrograms per cubic meter.
(b) Not applicable.
(c) Federal ambient air quality criterion for lead.

TABLE 14-11

Groundwater Exposure Point Concentrations of Contaminants of Potential Concern
Site 12B - Building 617
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/L)[b]	Range of Reporting Limits (µg/L)	Arithmetic Mean Concentration (µg/L)	95% UCL Concentration (µg/L)	Exposure Point Concentration[c] (µg/L)
1,1-Dichloroethane	8/9	0.55 - 2,931	1.0	708	7.7E+10	2,931
1,1-Dichloroethylene	7/9	1.5 - 8,560	1.0	2,018	1.7E+13	8,560
1,1,1-Trichloroethane	7/9	11.0 - 37,812	1.0	6,522	4.3E+14	37,812
1,1,2-Trichloroethane	5/9	2.6 - 99.0	1.0 - 25.0	21.4	3,586	99.0
1,2-Dichloroethane	5/9	8.18 - 223	1.0 - 25.0	45.8	45,832	223
1,2-Dichloroethylene	6/9	1.2 - 37.8	1.0 - 25.0	11.3	328	37.8
Acetone	3/9	17.3 - 37.8	5.0 - 125	18.1	152	37.8
Benzene	1/9	0.54	1.0 - 25.0	1.8	4.7	0.54
Benzoic acid	1/9	12.0	50.0	23.5	28.3	12.0
Butyl benzyl phthalate	1/9	1.4	10.0	4.6	6.7	1.4
Carbon disulfide	2/9	0.52 - 4.5	1.0 - 25.0	2.3	9.9	4.5
Chloroethane (ethyl chloride)	4/9	0.82 - 4.4	1.0 - 25.0	2.8	12.4	4.4
Chloroform	6/9	1.2 - 35.3	1.0 - 25.0	8.4	149	35.3
Diethyl phthalate	1/9	0.25	10.0	4.5	18.5	0.25
Dimethyl phthalate	1/9	0.73	10.0	4.5	8.9	0.73
Di-n-butyl phthalate	2/9	0.93 - 3.9	10.0	4.4	7.6	3.9

TABLE 14-11

Groundwater Exposure Point Concentrations of Contaminants of Potential Concern
Site 12B - Building 617
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/L)[b]	Range of Reporting Limits (µg/L)	Arithmetic Mean Concentration (µg/L)	95% UCL Concentration (µg/L)	Exposure Point Concentration[c] (µg/L)
Methyl ethyl ketone	3/6[d]	8.3 - 27.5	5.0 - 500	54.8	4,488	27.5
Methyl isobutyl ketone	1/9	0.23	5.0 - 125	8.9	68.2	0.23
Naphthalene	2/9	0.31 - 0.61	10.0	4.0	19.9	0.61
Pentachlorophenol	4/9	0.45 - 2.65	50.0	14.5	641	2.65
Pyrene	2/9	0.22 - 0.34	10.0	4.0	36.0	0.34
Toluene	3/9	2.3 - 31.8	1.0 - 25.0	6.8	186	31.8
Trichloroethylene	5/9	2.7 - 82.7	1.0 - 25.0	21.0	3,842	82.7
Vinyl chloride	4/9	1.65 - 4.7	1.0 - 25.0	2.8	13.7	4.7
Xylene, o-	2/9	0.80 - 0.85	1.0 - 25.0	1.9	5.0	0.85
Xylene	2/9	0.73 - 0.76	1.0 - 25.0	1.9	4.9	0.76

Footnotes:
(a) Number of locations in which the analyte was detected/total number of locations sampled. Data from the nine downgradient wells (MW93-39, MFW93-40, MW93-41, MW95-1, MW95-2, MW96-2, MW-96-3, MW96-4, and MW96-5) were used in the calculations.
(b) Micrograms per liter.
(c) The 95% UCL (upper confidence limit of the mean) or the maximum detected value, whichever is lower (USEPA 1989b).
(d) All methyl ethyl ketone results were rejected for three wells.

TABLE 14-12

Selection of Contaminants of Potential Concern (COPC) in Groundwater Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 12B - Building 617
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screening Data		
Chemical	**Tap Water PRG (µg/L)[(a)]**	**Exposure Point Concentration (µg/L)**	**Retained as GW COPC?**
1,1-Dichloroethane	81	2,931	**YES**
1,1-Dichloroethylene	0.046	8,560	**YES**
1,1,1-Trichloroethane	79	37,812	**YES**
1,1,2-Trichloroethane	0.20	99.0	**YES**
1,2-Dichloroethane	0.123	223	**YES**
1,2-Dichloroethylene (mixed isomers)	5.48	37.8	**YES**
Acetone	60.8	37.8	No
Benzene	0.386	0.54	**YES**
Benzoic acid	14,600	12.0	No
Butyl benzyl phthalate	730	1.4	No
Carbon disulfide	2.1	4.5	**YES**
Chloroethane (ethyl chloride)	70.5	4.4	No
Chloroform	0.165	35.3	**YES**
Diethyl phthalate	2,920	0.25	No
Dimethyl phthalate	36,500	0.73	No
Di-n-butyl phthalate	365	3.9	No
Methyl ethyl ketone	190	27.5	No
Methyl isobutyl ketone	15.8	0.23	No
Naphthalene	24.3	0.61	No
Pentachlorophenol	0.56	2.65	**YES**
Pyrene	18.3	0.34	No
Toluene	72.3	31.8	No

TABLE 14-12

Selection of Contaminants of Potential Concern (COPC) in Groundwater Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 12B - Building 617
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screening Data		
Chemical	**Tap Water PRG (µg/L)[a]**	**Exposure Point Concentration (µg/L)**	**Retained as GW COPC?**
Trichloroethylene	1.64	82.7	**YES**
Vinyl chloride	0.02	4.7	**YES**
Xylene, o-	143	0.85	No
Xylenes (total)	143	0.76[b]	No

Note:
PRGs were taken directly from the Region 9 PRG Table (USEPA 1998).
Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:
(a) Micrograms per liter.
(b) Value for mixed xylenes.

TABLE 14-13

Shower Air Concentrations of Volatile Chemicals
Site 12B - Building 617
Jefferson Proving Ground
Madison, Indiana

Volatile Chemical	Exposure Point Concentration in Groundwater (µg/L[a] = mg/m^3 [b])	Exposure Point Concentration in Shower Air (mg/m^3)
1,1-Dichloroethane	2,931	9.77E+00
1,1-Dichloroethene	8,560	2.97E+01
1,1,1-Trichloroethane	37,812	1.11E+02
1,1,2-Trichloroethane	99	2.32E-01
1,2-Dichloroethane	223	6.05E-01
1,2-Dichloroethene	37.8	1.28E-01
Benzene	0.54	2.02E-03
Carbon disulfide	4.5	1.75E-02
Chloroform	35.3	1.03E-01
Trichloroethene	82.7	2.43E-01
Vinyl chloride	4.7	2.05E-02

Notes:
EPCs for shower air are estimated using methods described in Appendix T.

Footnotes:
(a) Micrograms per liter.
(b) Milligrams per cubic meter.

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TABLE 14-14

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 12B - Building 617
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
	Future On-site Resident Adult (surface/subsurface soil combined)			
Ingestion of soil	1.13E-07		0.0000	
Dermal contact with soil	9.41E-08		NA	
Inhalation of VOCs[a] and fugitive dusts	NA[b]		0.0015	
Ingestion of groundwater	5.89E-02	1,1-DCE (99%); 1,1,2-TCA (<1%); 1,2-DCA (<1%); TCE (<1%); vinyl chloride (<1%)	79.9342	1,1-DCE (33%); 1,1,1-TCA (65%)
Dermal contact with groundwater	2.92E-03	1,1-DCE	3.8492	1,1,1-TCA (98%)
Inhalation of shower VOCs	5.28E-03	1,1-DCE; 1,1,2-TCA; 1,2-DCA	2.2411	
Total	6.71E-02		86.0260	
	Future On-site Resident Child (surface/subsurface soil combined)			
Ingestion of soil	2.10E-07		0.0005	
Dermal contact with soil	5.42E-08		NA	
Inhalation of VOCs and fugitive dusts	NA		0.0056	
Ingestion of groundwater	2.79E-02	1,1-DCE (99%); 1,1,2-TCA (<1%); 1,2-DCA (<1%); TCE (<1%); vinyl chloride (<1%)	186.5131	1,1-DCA (1%); 1,1-DCE (33%); 1,1,1-TCA (65%); 1,1,2-TCA (<1%)
Dermal contact with groundwater	5.58E-04	1,1-DCE (99.8%)	3.6647	1,1,1-TCA (98%)
Inhalation of shower VOCs	2.05E-03	1,1-DCE (98%); 1,2-DCA (1%)	4.3418	1,1,1-TCA (40%); 1,2-DCA (44%)
Total	3.05E-02		194.5257	

TABLE 14-14

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 12B - Building 617
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
		Future On-site Worker		
Inhalation of VOCs and fugitive dusts	1.78E-08		0.0005	
Ingestion of groundwater	1.79E-02	1,1-DCE (99%); 1,1,2-TCA (<1%); 1,2-DCA (<1%); vinyl chloride (<1%)	28.5479	1,1-DCE (33%); 1,1,1-TCA (65%)
Total	1.79E-02		28.5484	

Note:
1,1-DCE = 1,1-Dichloroethene; 1,1,2-TCA = 1,1,2-Trichloroethane; 1,2-DCA = 1,2-Dichloroethane; 1,1-DCA = 1,1-Dichloroethane; 1,1,1-TCA = 1,1,1-Trichloroethane; TCE = Trichloroethene.

Footnotes:
(a) Volatile organic compounds.
(b) Not applicable.

TABLE 14-15

Qualitative Uncertainty Analysis
Site 12B - Building 617
Jefferson Proving Ground
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
A. Human Behavior				
Future receptors' exposure duration	30 years	Medium	Medium	National upper-bound time (90th percentile) at one residence
Future receptors' exposure frequency	350 days/year	Medium	Medium	High-end value
Future receptors' water ingestion rate	2 liters/day	Low	High	Water consumption rates are high-end values obtained from published distribution data
Exclusion of certain exposure pathways in the quantitative analysis	NA[(a)]	Low	Low	Pathways eliminated are those that have low possibility of contributing risk to these receptors
B. Chemical Fate/Transport in the Environment				
Groundwater exposure point concentration of COC[(b)]	Maximum detected value	Low	High	Site average would be lower
Mass balance	NA	Low	High	Insufficient mass of chemicals likely present in groundwater to maintain exposure throughout 30-year exposure duration due to highly limited contaminated area
Use of modeling to predict shower air concentrations	NA	Low	High	Conservative assumptions and input parameters

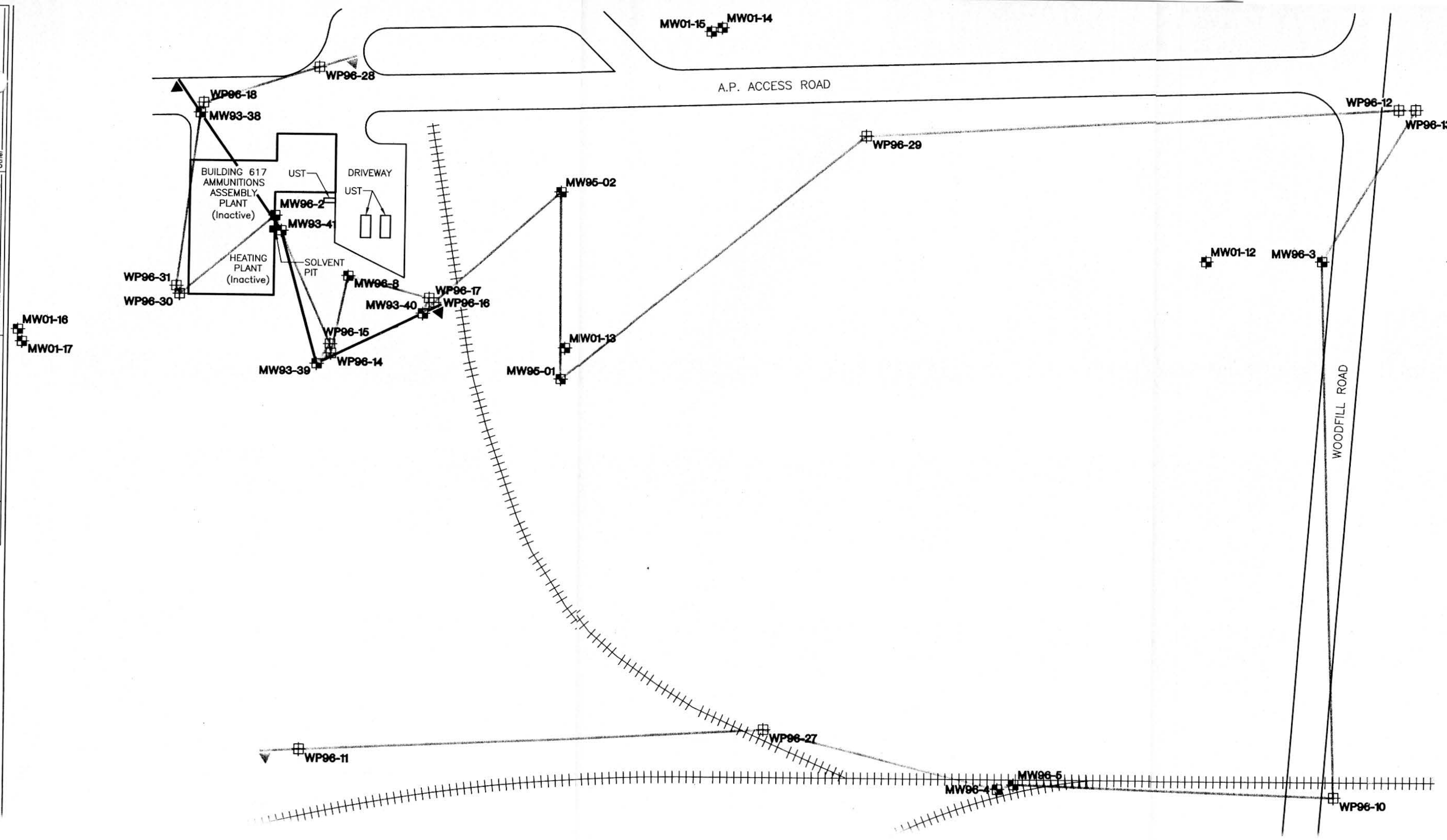
TABLE 14-15

Qualitative Uncertainty Analysis
Site 12B - Building 617
Jefferson Proving Ground
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
C. Chemical Toxicity				
Assumption that USEPA[(c)] reference doses truly represent toxicological thresholds	NA	Low	High	High degree of conservativeness utilized by USEPA in deriving RfDs[(d)] from toxicological literature
Assumption that USEPA carcinogenic slope factors truly represent dose-response phenomena	NA	Low-moderate	Moderate-high	Use of linearized, multi-stage mathematical model to predict cancer incidence at low exposure levels is USEPA policy; not currently supported by scientific data
Assumption of risk/hazard additivity	NA	Moderate	Moderate	Summation of chemical-specific risks/hazards may over- or under-predict risks/hazards to receptors
Screening out of certain contaminants based on USEPA criteria	NA	Low	Low	Chemicals present in concentrations less than USEPA criteria eliminated

Footnotes:
(a) Not available or not applicable.
(b) Contaminant of concern.
(c) United States Environmental Protection Agency.
(d) Reference doses.

FIGURES



LEGEND

WP96-27	TEMPORARY WELL LOCATION AND NUMBER
MW93-39	MONITORING WELL LOCATION AND NUMBER
	RAILROAD TRACKS
	PHASE I LINE OF CROSS SECTION
	PHASE II LINE OF CROSS SECTION

NOTES

1. BASE MAP DEVELOPED FROM FIGURE 14–1 FROM A REPORT BY RUST ENVIRONMENT & INFRASTRUCTURE, DATED: 3–16–98.
2. MONITORING WELLS AND TEMPORARY WELLS TAKEN FROM FIGURE 14–12, VOLATILE ORANANIC COMPOUNDS DETECTED IN BUILDING 617 SOLVENT PIT (SITE 12B) TEMPORARY WELL POINTS, PREPARED BY RUST E&I, DATED 8–5–98.
3. PHASE I CROSS SECTION SHOWN ON FIGURE 14–2. PHASE II CROSS SECTION SHOWN ON FIGURE 14–3. BOTH PREPARED BY EARTHTECH.

north

0 50 100
SCALE IN FEET

FIGURE 14-1

QUALITY CONTROL | Graphic Standards / Lead Professional | 2-22-02 / 2-22-02 | Technical Review / PM Review | LBL 3-12-02 | Management Review / Other

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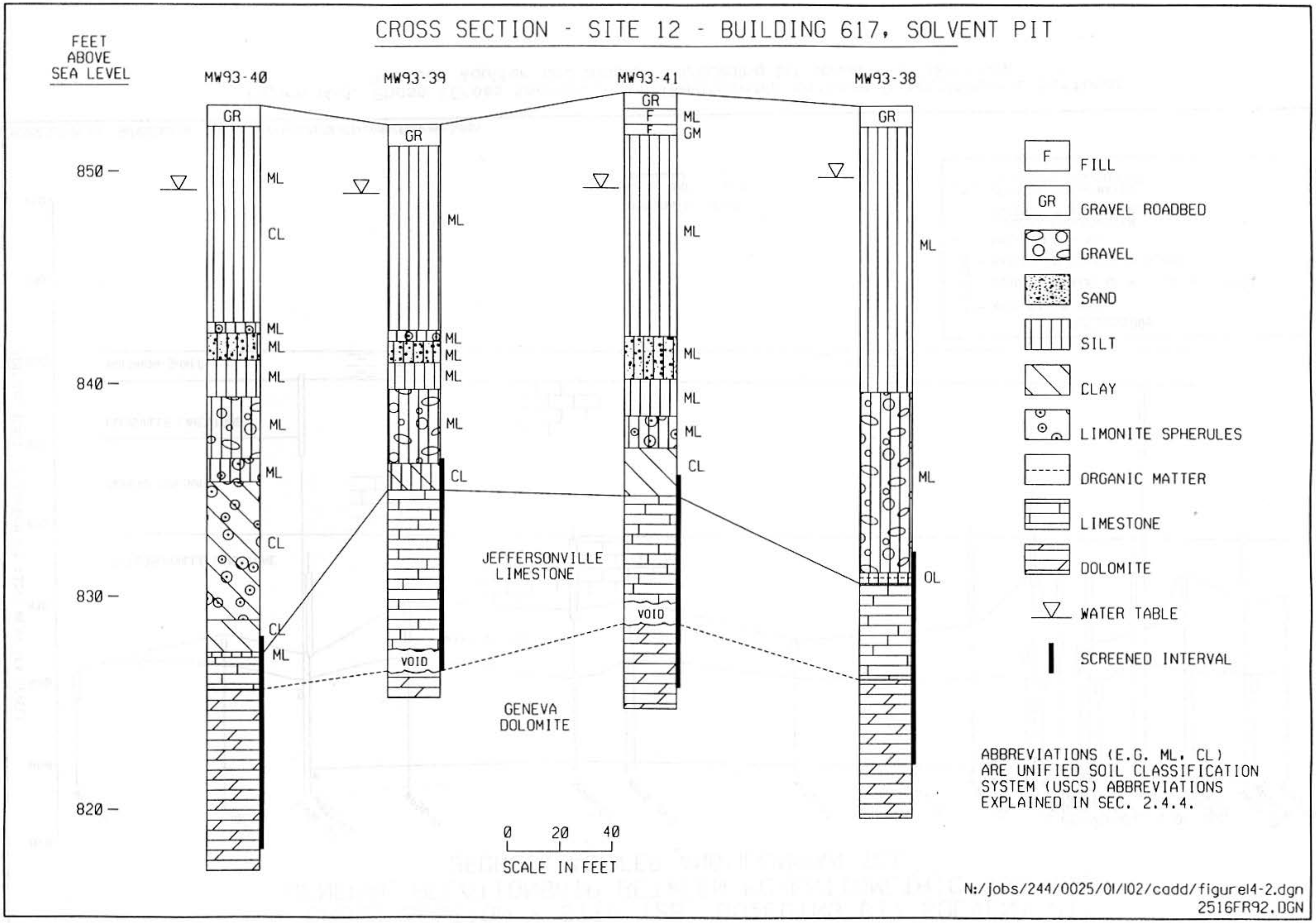
Developed By TAPB | Drawn By DLF
Approved By [signature] | Date 3.19.02
Reference 2440025.040201-B6
Revisions

MONITORING WELL LOCATION MAP - BUILDING 617 SOLVENT PIT (SITE 12B)
SOUTH OF THE FIRING LINE
JEFFERSON PROVING GROUND
MADISON, INDIANA

Drawing Number
2440025
010102
B14

MWH



...igure 14-2. Phase I Cross Section Using Monit...ing Well Data, Building 617 Solvent Pit (Site 12F

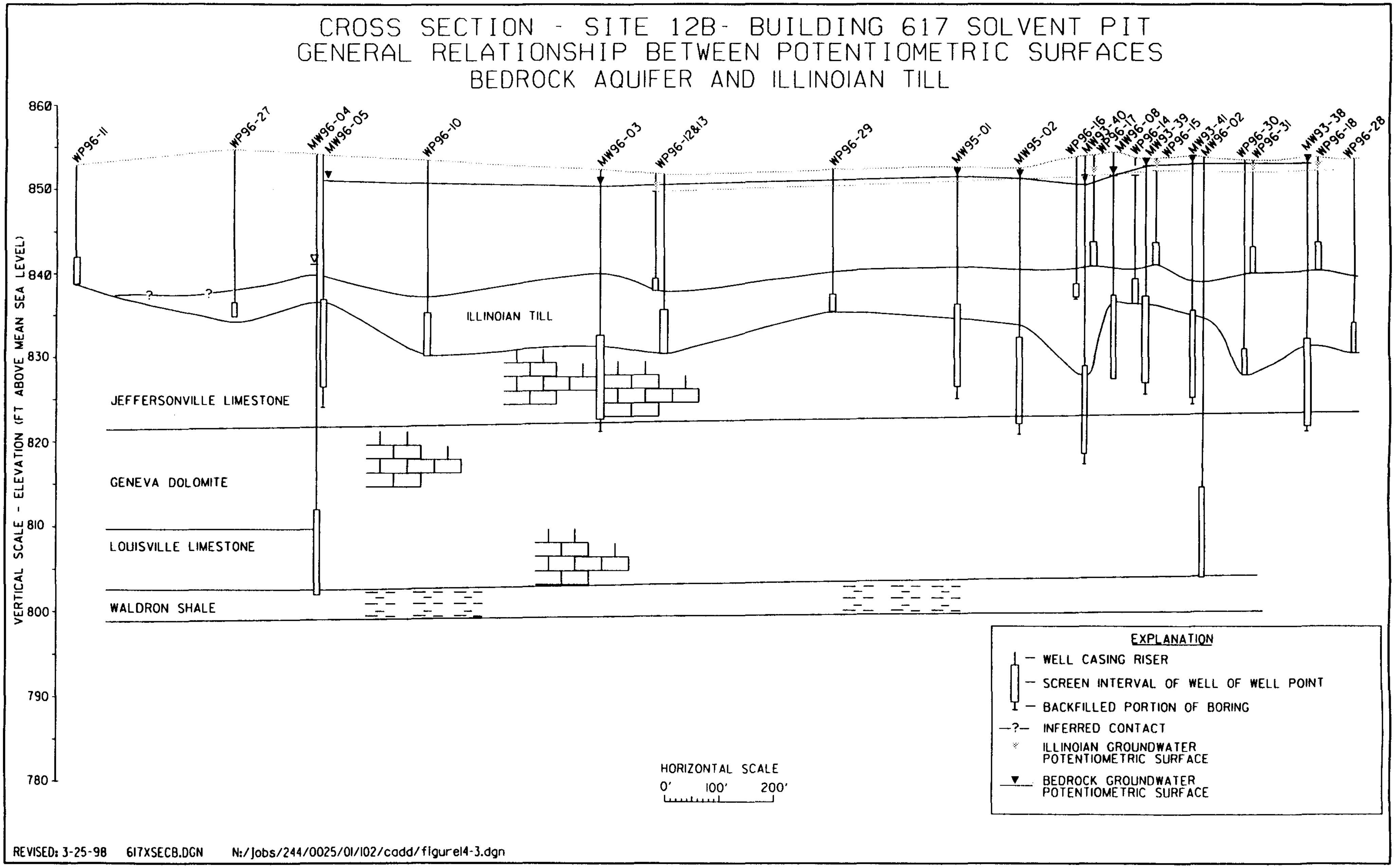
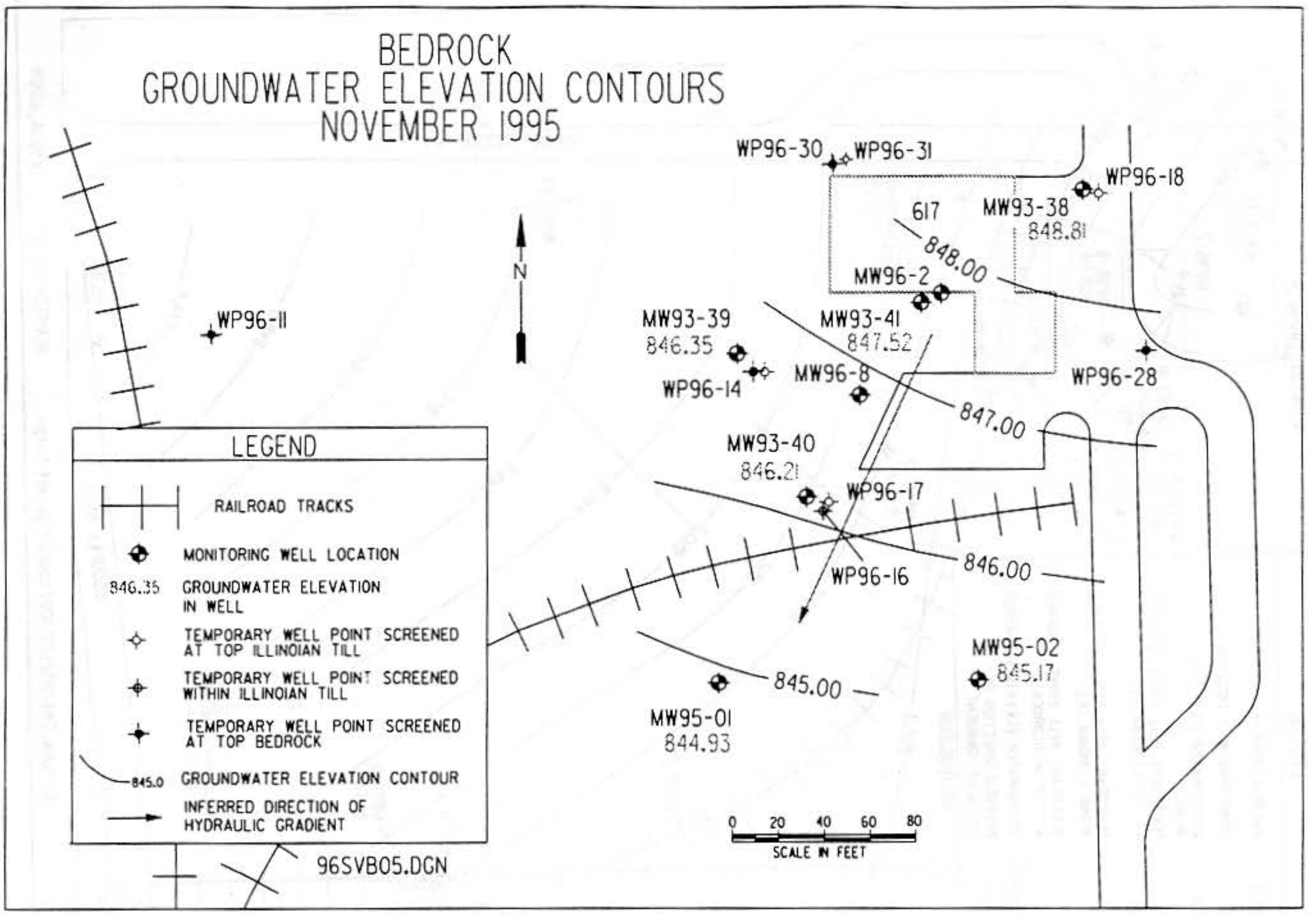


Figure 14-3. Phase II Cross Section General Relationship Between Potentiometric Surfaces Bedrock Aquifer and Illinoian Till, Building 617 Solvent Pit (Site 12B)



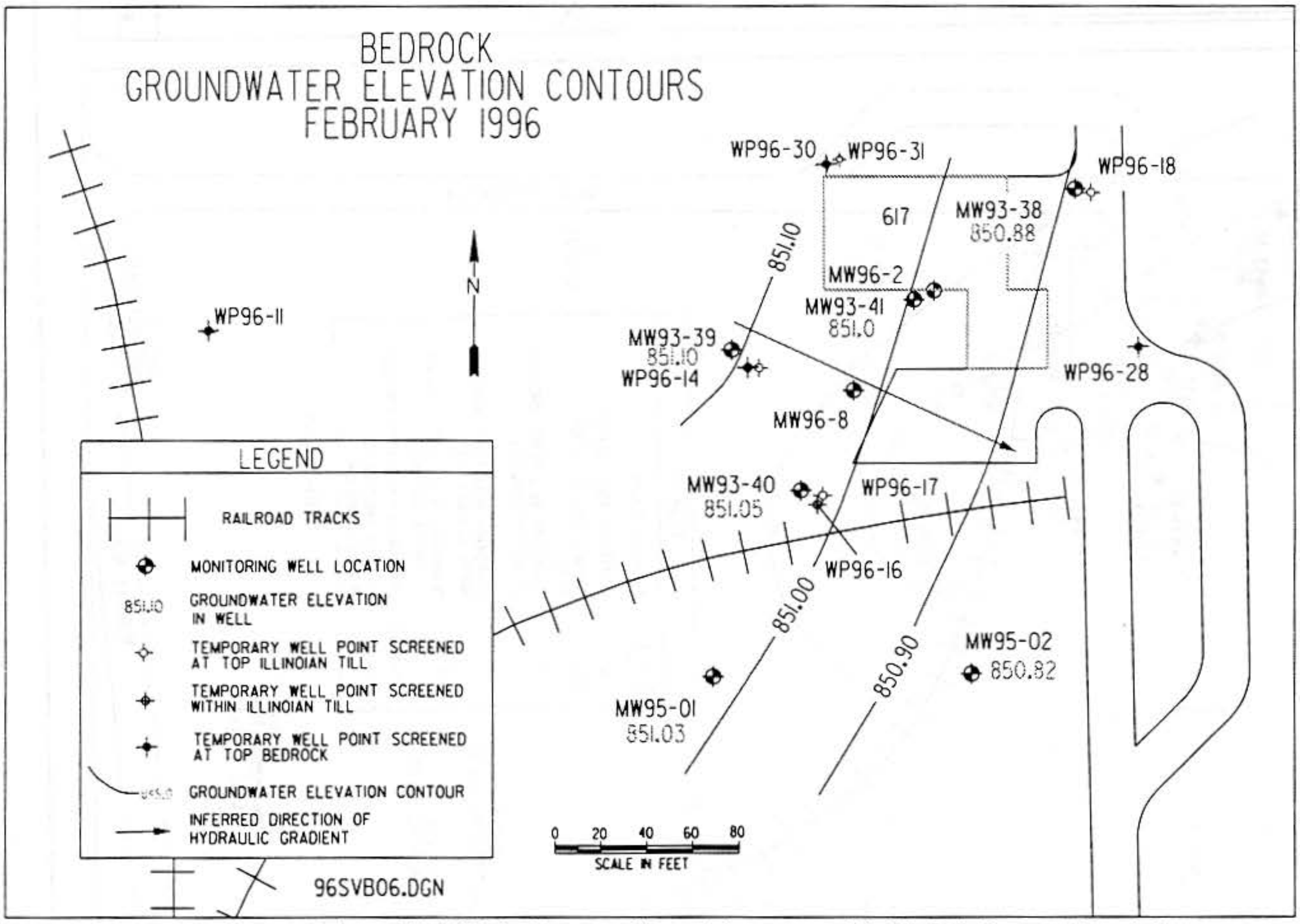


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Figure 14-4. Bedrock Potentiometric Contour Map - November 1995 and February 1996, Building 617 Solvent Pit (Site 12B)

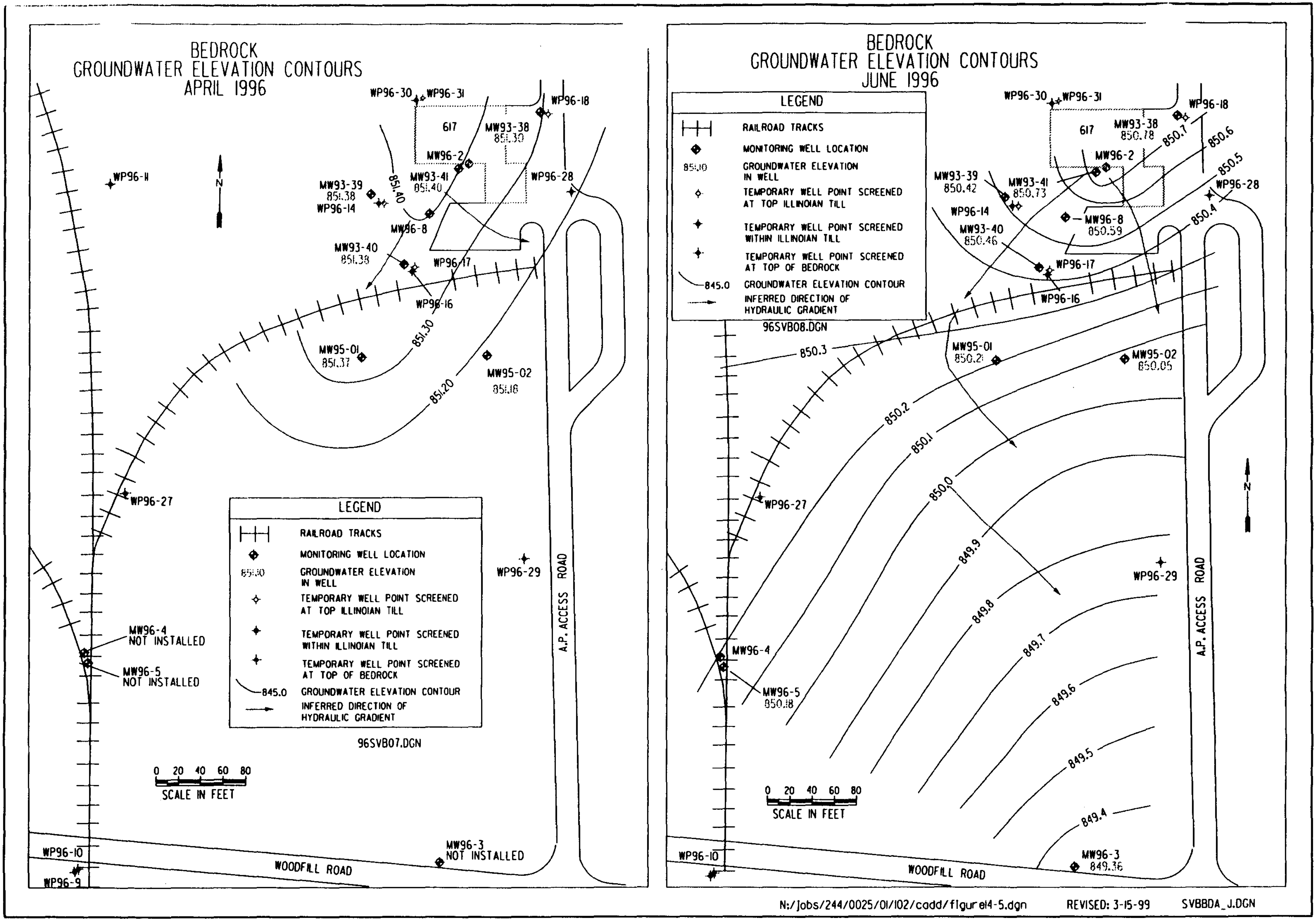


Figure 14-5. Bedrock Potentiometric Contour Map - April and June 1996, Building 617 Solvent Pit (Site 12B)

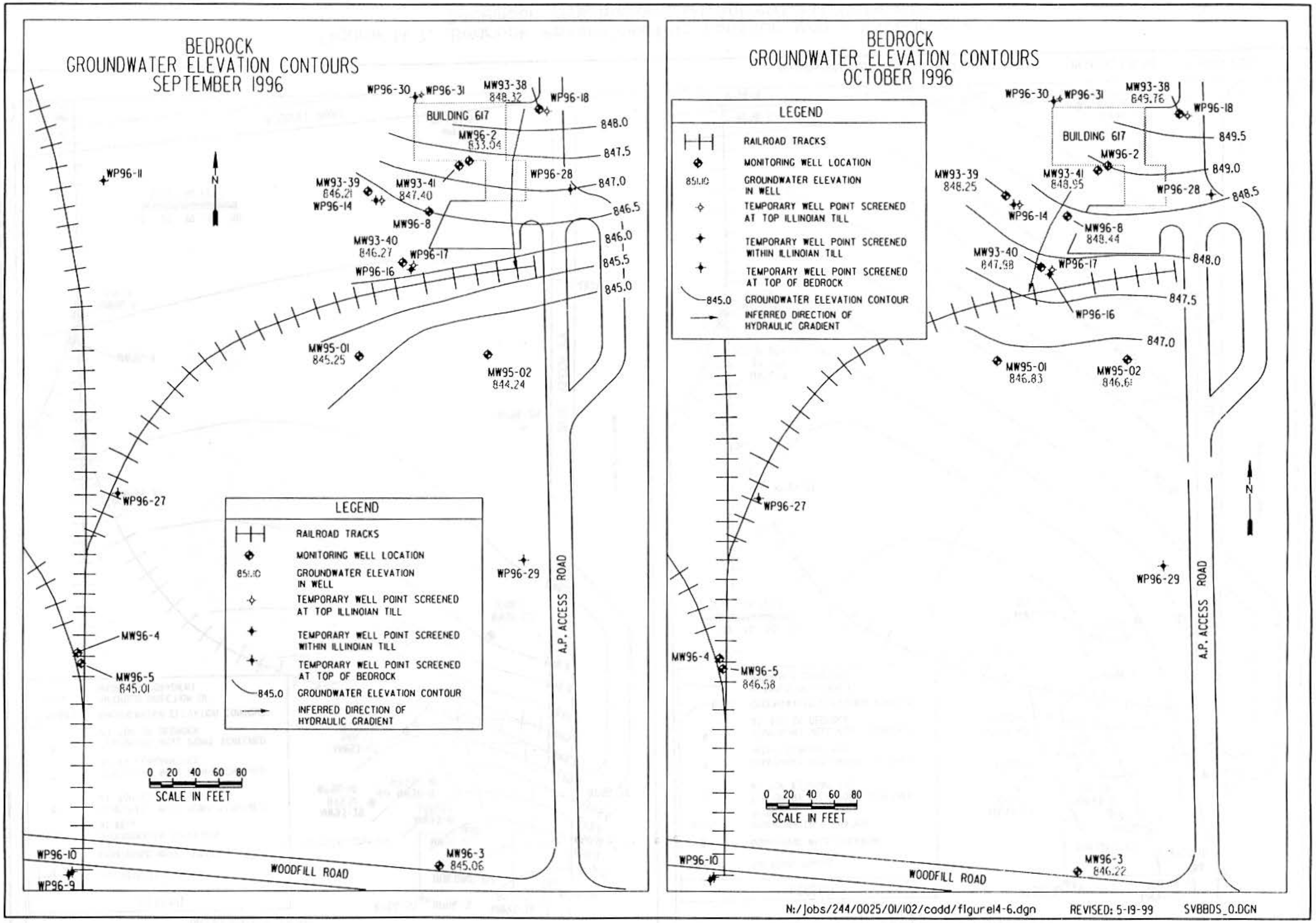


Figure 14-6. Bedrock Potentiometric Contour Map - September and October 1996, Bu g 617 Solvent Pit (Site 12B)

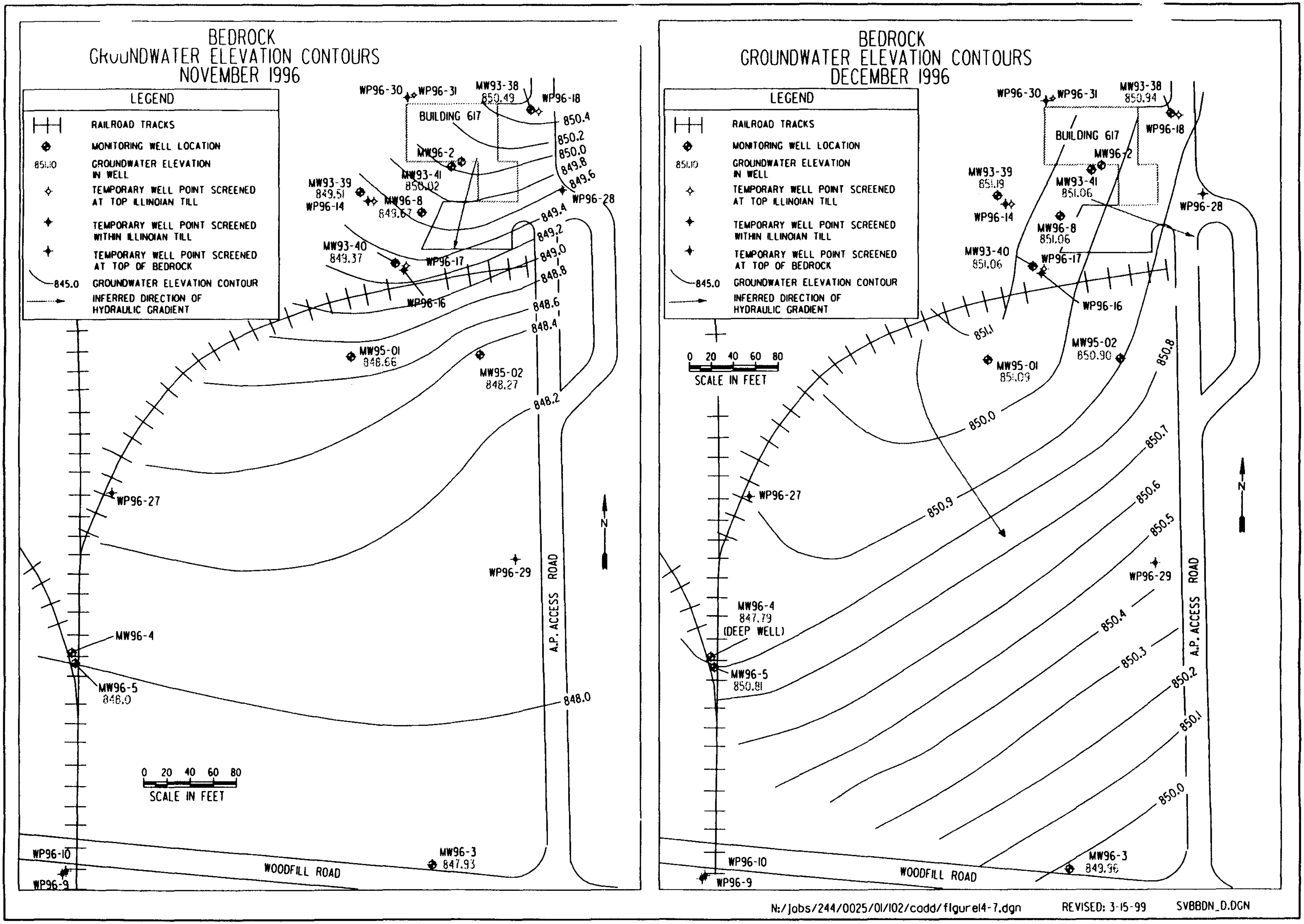


Figure 14-7. Bedrock Potentiometric Contour Map - November and December 1996, Builidng 617 Solvent Pit (Site 12B)

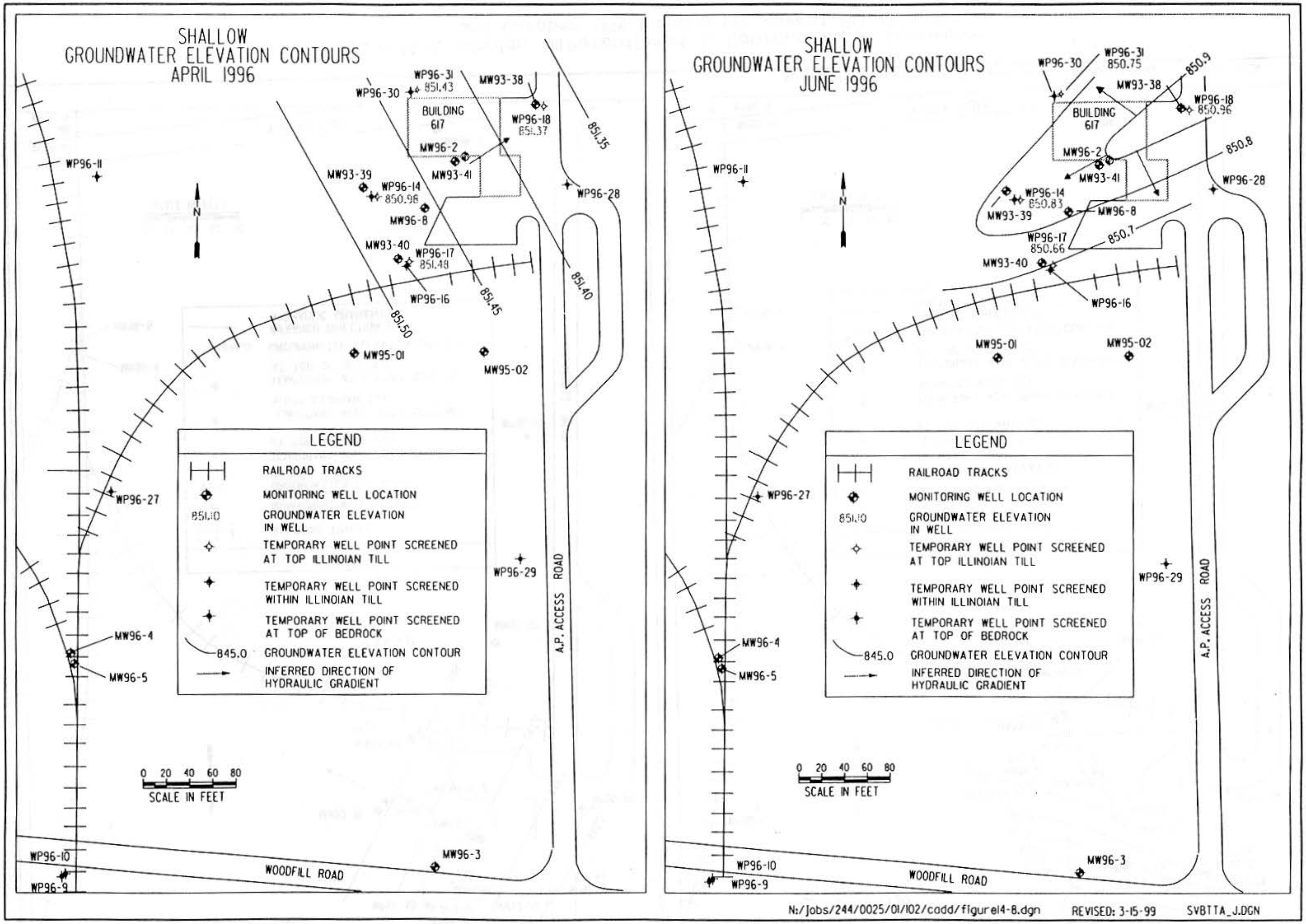


Figure 14-8. Illinoian Till Potentiometric Contour Map - April and June 1996, [Buil]ding 617 Solvent Pit (Site 12B)

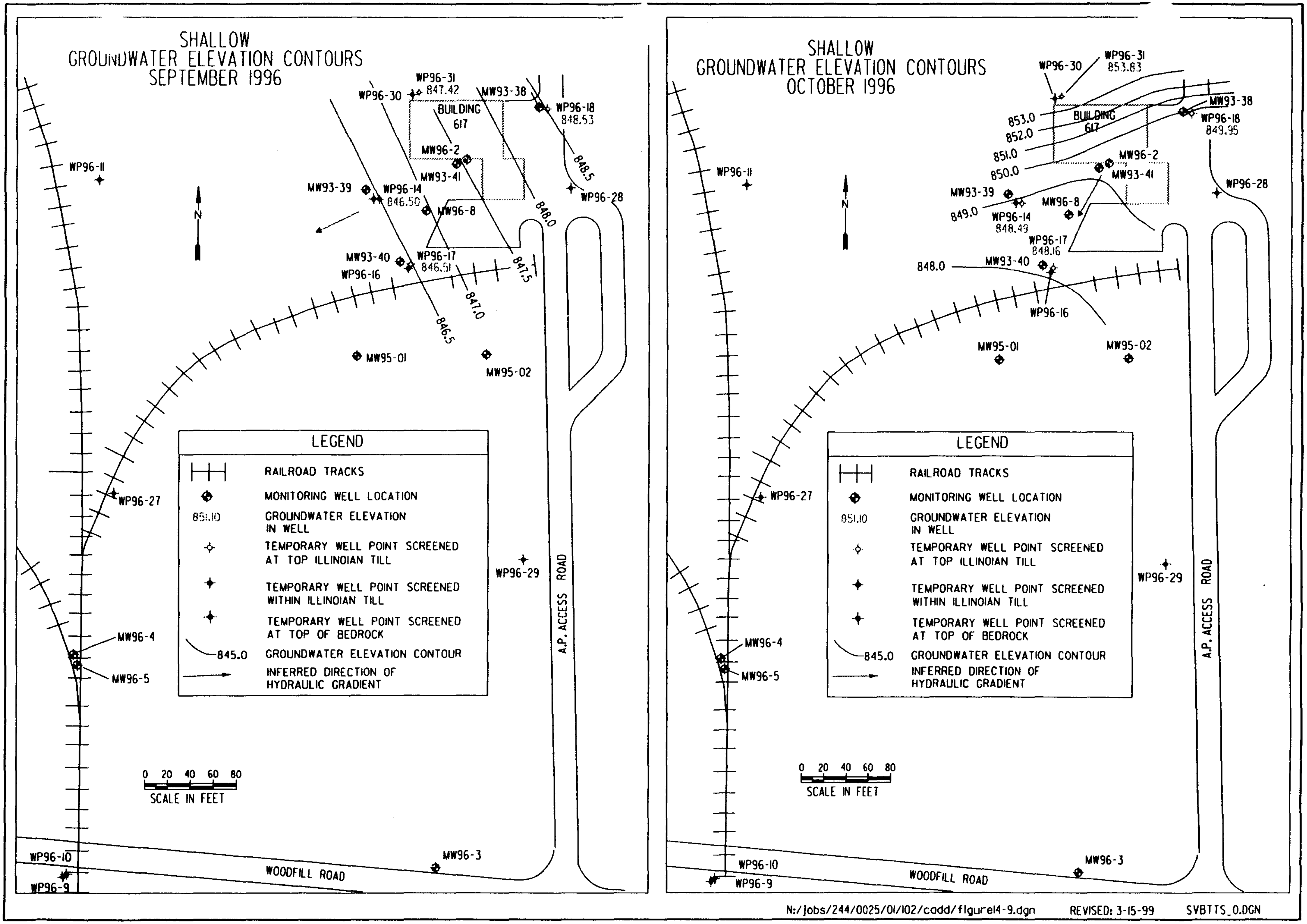


Figure 14-9. Illinoian Till Potentiometric Contour Map - September and October 1996, Building 617 Solvent Pit (Site 12B)

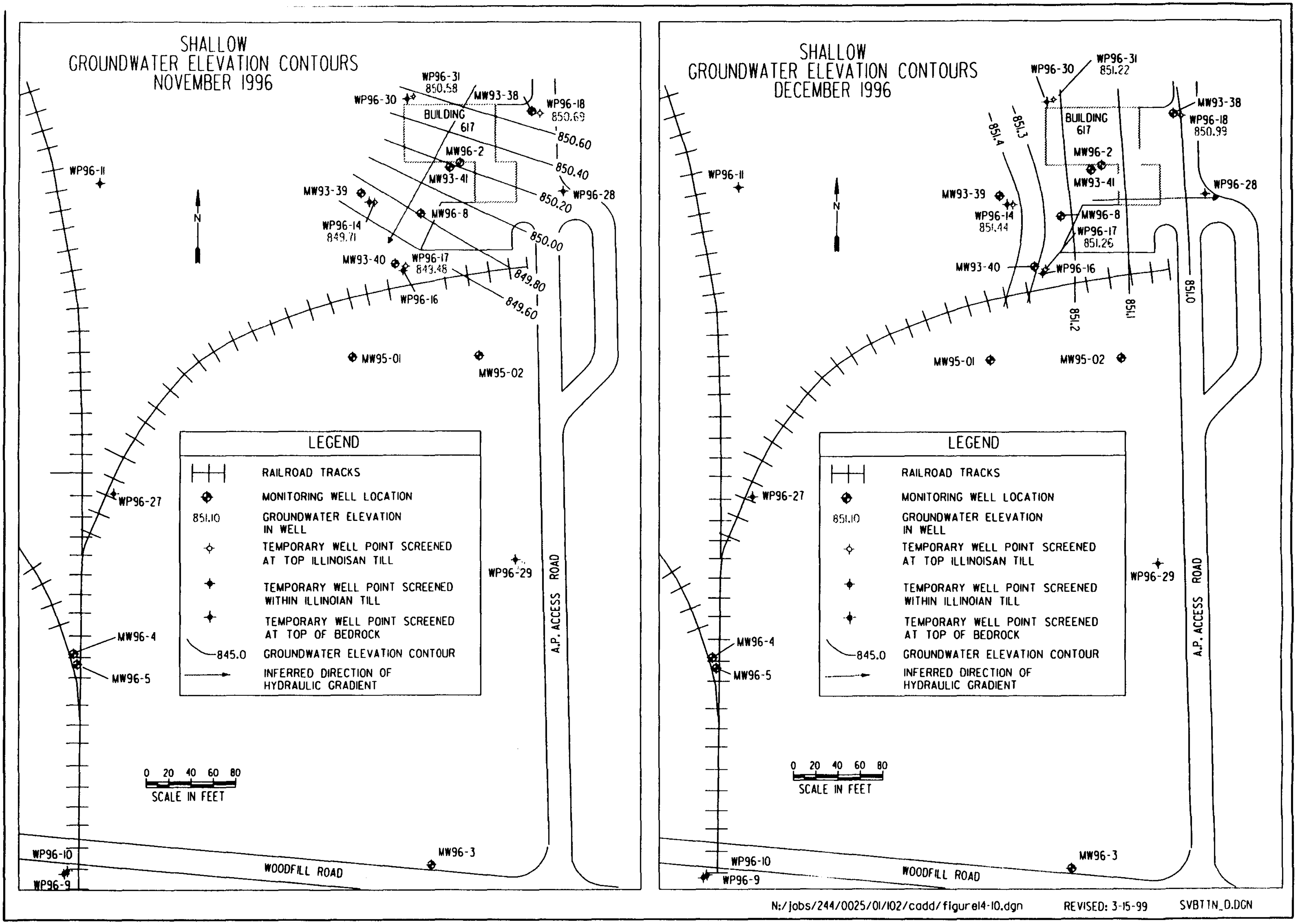
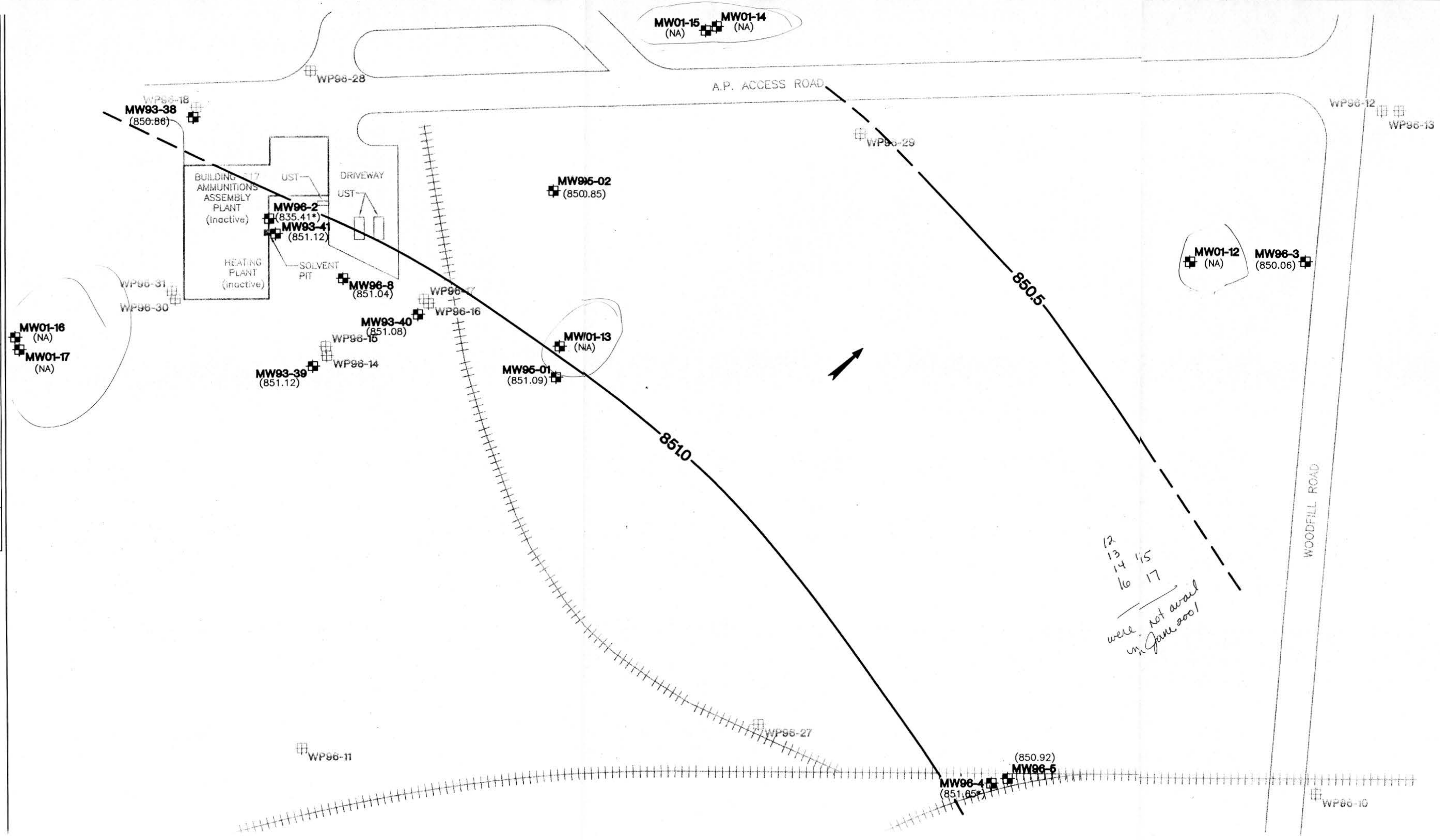


Figure 14-10. Illinoian Till Potentiometric Contour Map - November and December 19[illegible] [illegible]uilding 617 Solvent Pit (Site 12B)



LEGEND

WP96-27 — TEMPORARY WELL LOCATION AND NUMBER

MW93-39 (851.12) — MONITORING WELL LOCATION, NUMBER, AND GROUNDWATER POTENTIOMETRIC SURFACE ELEVATION, IN FEET ABOVE MEAN SEA LEVEL

—851.0— POTENTIOMETRIC SURFACE CONTOUR (CONTOUR INTERVAL: 0.5 FT)

(NA) NOT AVAILABLE

ESTIMATED GROUNDWATER FLOW DIRECTION

RAILROAD TRACKS

NOTES

1. BASE MAP DEVELOPED FROM FIGURE 14–1 FROM A REPORT BY RUST ENVIRONMENT & INFRASTRUCTURE, DATED: 3–16–98.
2. MONITORING WELLS AND TEMPORARY WELLS TAKEN FROM FIGURE 14–12, VOLATILE ORANANIC COMPOUNDS DETECTED IN BUILDING 617 SOLVENT PIT (SITE 12B) TEMPORARY WELL POINTS, PREPARED BY RUST E&I, DATED 8–5–98.
3. GROUNDWATER ELEVATIONS DENOTED BY AN "*" ARE NOT INCLUDED IN THE INTERPRETATION OF THE CONTOURED SURFACE.

north

0 50 100
SCALE IN FEET

FIGURE 14-10a

Developed By TAPB | Drawn By DLF
Approved By Julie Busse | Date 3.19.02
Reference 2440025.040201-B6
Revisions

POTENTIOMETRIC SURFACE MAP (JUNE 5, 2001) - BUILDING 617 SOLVENT PIT (SITE 12B)

SOUTH OF THE FIRING LINE
JEFFERSON PROVING GROUND
MADISON, INDIANA

Drawing Number 2440025 010102 B15

MWH MONTGOMERY WATSON HARZA

QUALITY CONTROL | Graphic Standards | Lead Professional | 2-19-02 | 2-22-02 | Technical Review | PM Review LBL 3-12-02 | Management Review | Other

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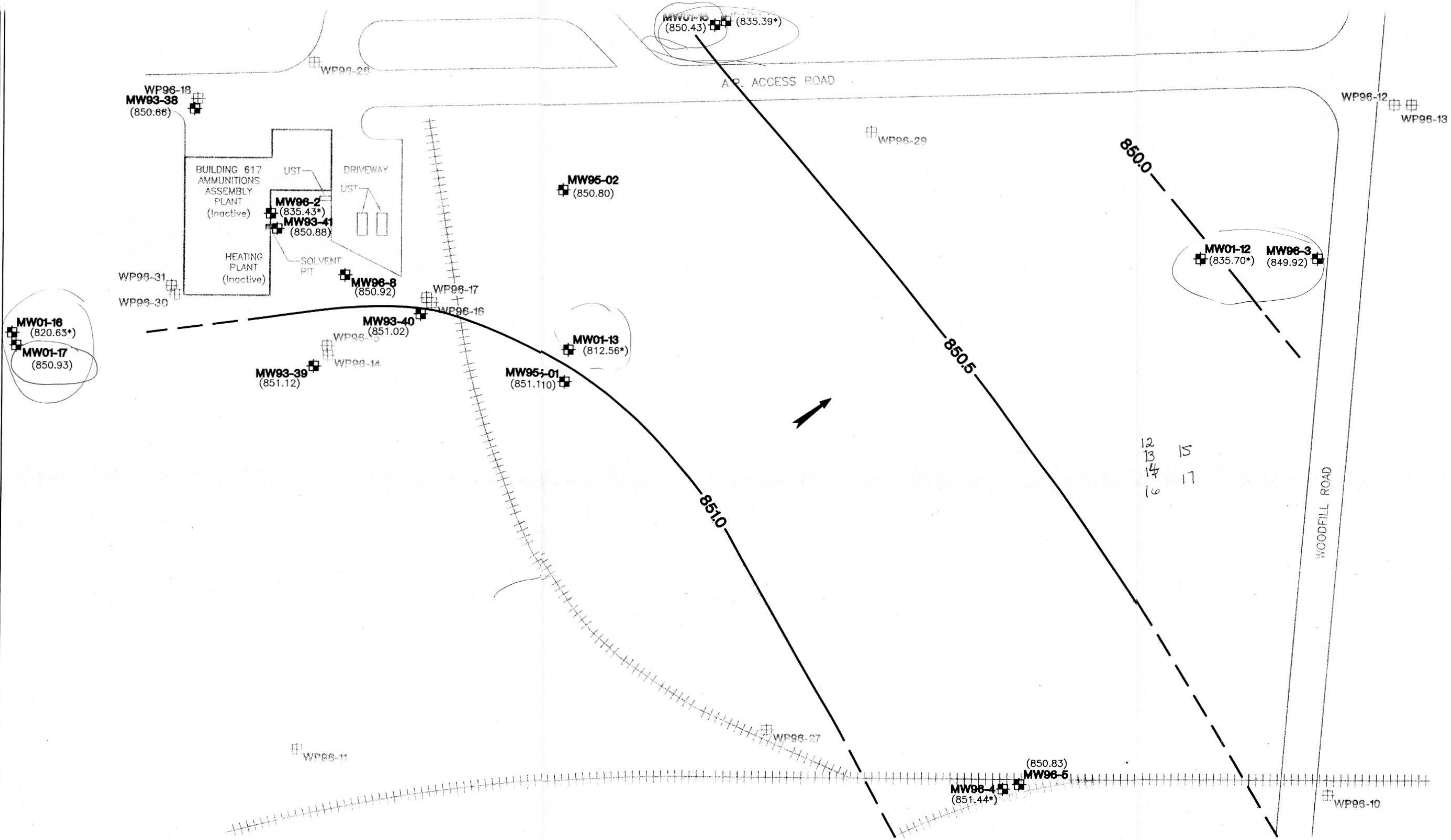

LEGEND

WP96-27 — TEMPORARY WELL LOCATION AND NUMBER

MW93-39 (851.12) — MONITORING WELL LOCATION, NUMBER, AND GROUNDWATER POTENTIOMETRIC SURFACE ELEVATION, IN FEET ABOVE MEAN SEA LEVEL

—851.0— POTENTIOMETRIC SURFACE CONTOUR (CONTOUR INTERVAL: 0.5 FT, DASHED WHERE INFERRED)

ESTIMATED GROUNDWATER FLOW DIRECTION

RAILROAD TRACKS

NOTES

1. BASE MAP DEVELOPED FROM FIGURE 14–1 FROM A REPORT BY RUST ENVIRONMENT & INFRASTRUCTURE, DATED: 3–16–98.
2. MONITORING WELLS AND TEMPORARY WELLS TAKEN FROM FIGURE 14–12, VOLATILE ORANANIC COMPOUNDS DETECTED IN BUILDING 617 SOLVENT PIT (SITE 12B) TEMPORARY WELL POINTS, PREPARED BY RUST E&I, DATED 8–5–98.
3. GROUNDWATER ELEVATIONS DENOTED BY AN "*" ARE NOT INCLUDED IN THE INTERPRETATION OF THE CONTOURED SURFACE.

north

0 50 100

SCALE IN FEET

Head in bedrock

FIGURE 14-10b

POTENTIOMETRIC SURFACE MAP (NOVEMBER 28, 2001) - BUILDING 617 SOLVENT PIT (SITE 12B)

SOUTH OF THE FIRING LINE
JEFFERSON PROVING GROUND
MADISON, INDIANA

Developed By TAPB | Drawn By DLF
Approved By Julie Busse | Date 3.19.02
Reference 2440025.040201-B6
Revisions

Drawing Number 2440025 010102 B16

MWH MONTGOMERY WATSON HARZA

QUALITY CONTROL			
Graphic Standards	DLF	2-19-02	
Lead Professional	TAPB	2-22-02	
Technical Review	LBL	3-12-02	
PM Review			
Management Review			
Other			

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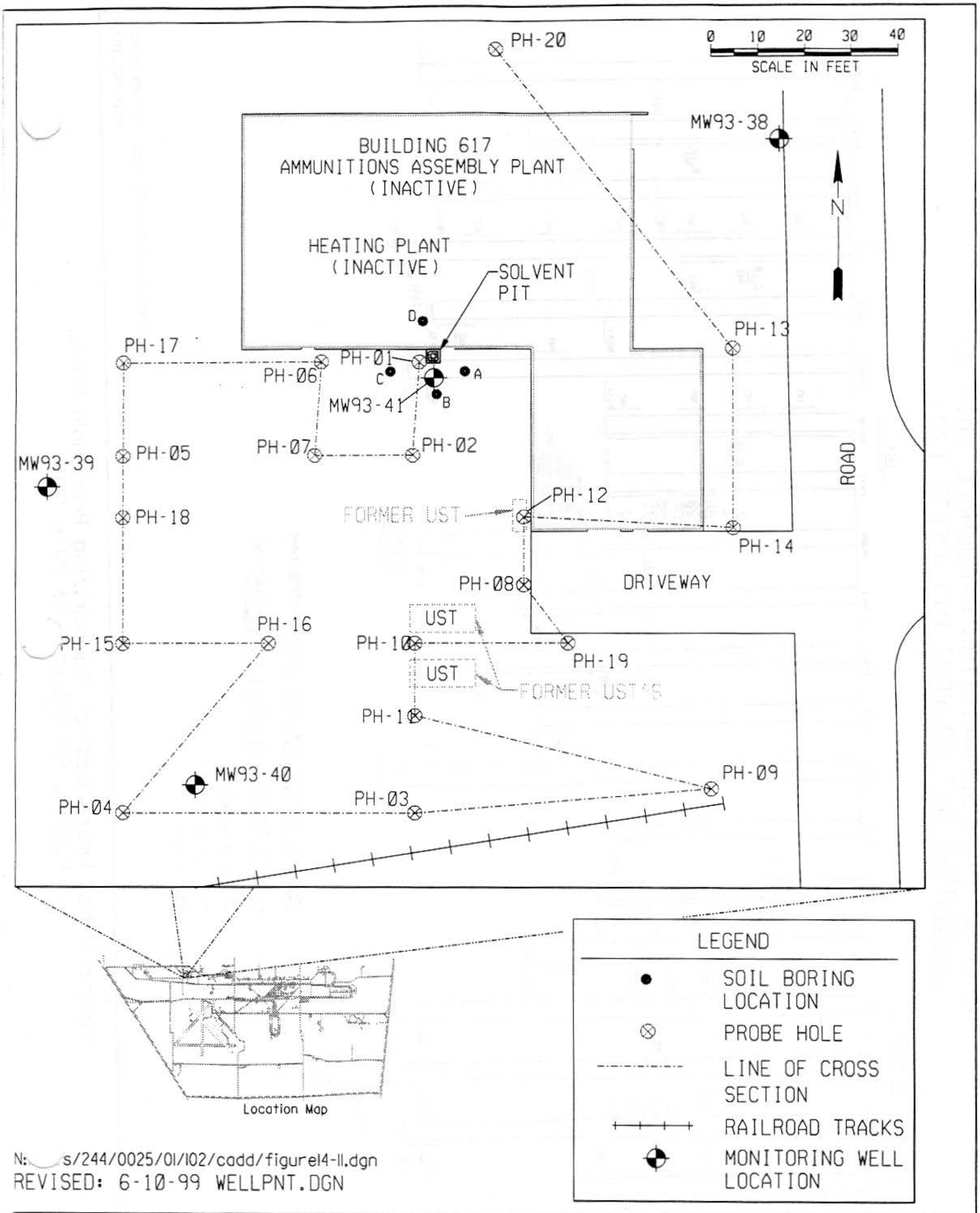


Figure 14-11. Sampling Location Map of Building 617 Solvent Pit (Site 12B)

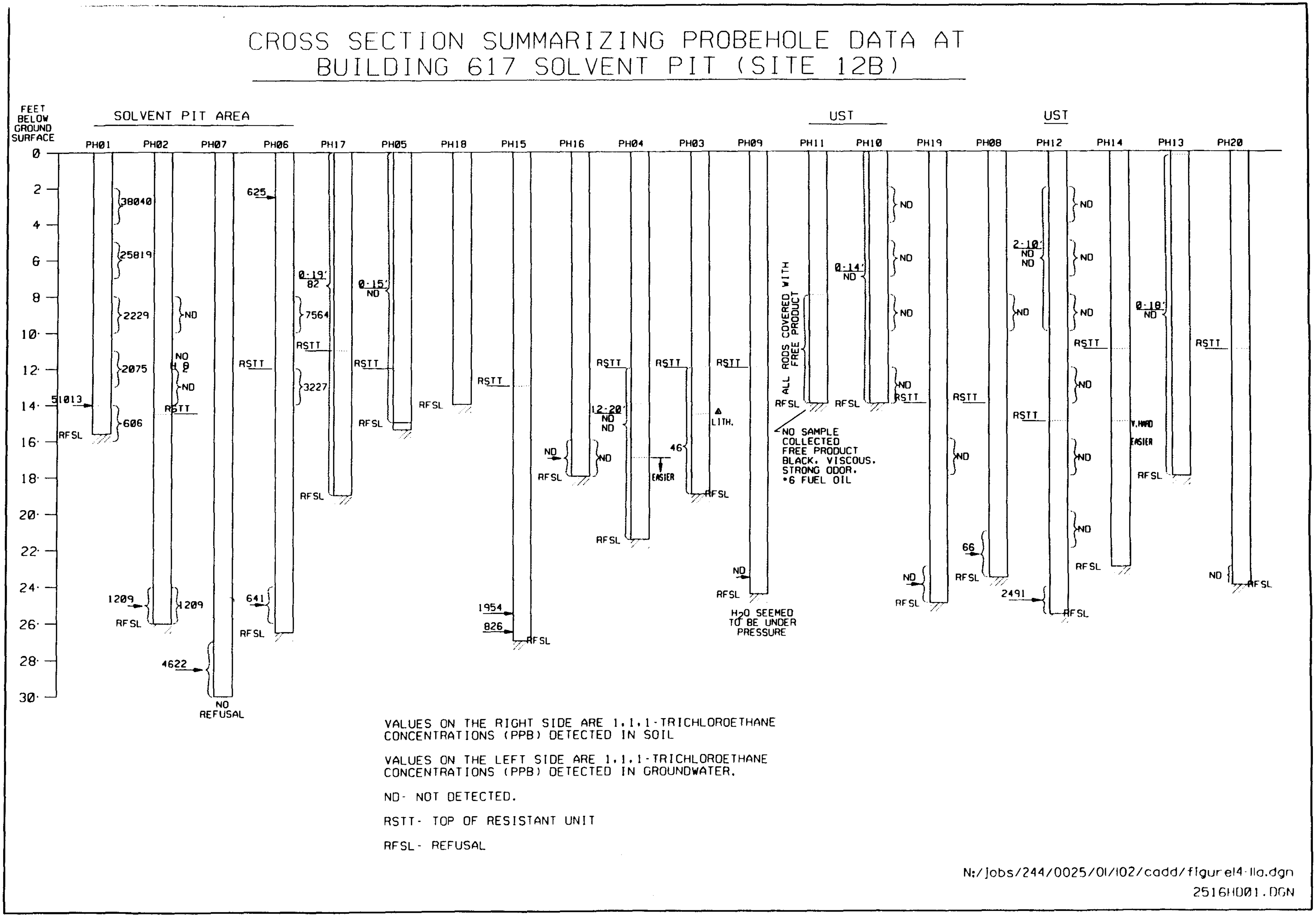


Figure 14-11a. Cross Section Summarizing Probehole Data, Building 617 Solvent Pit (Site 12B)

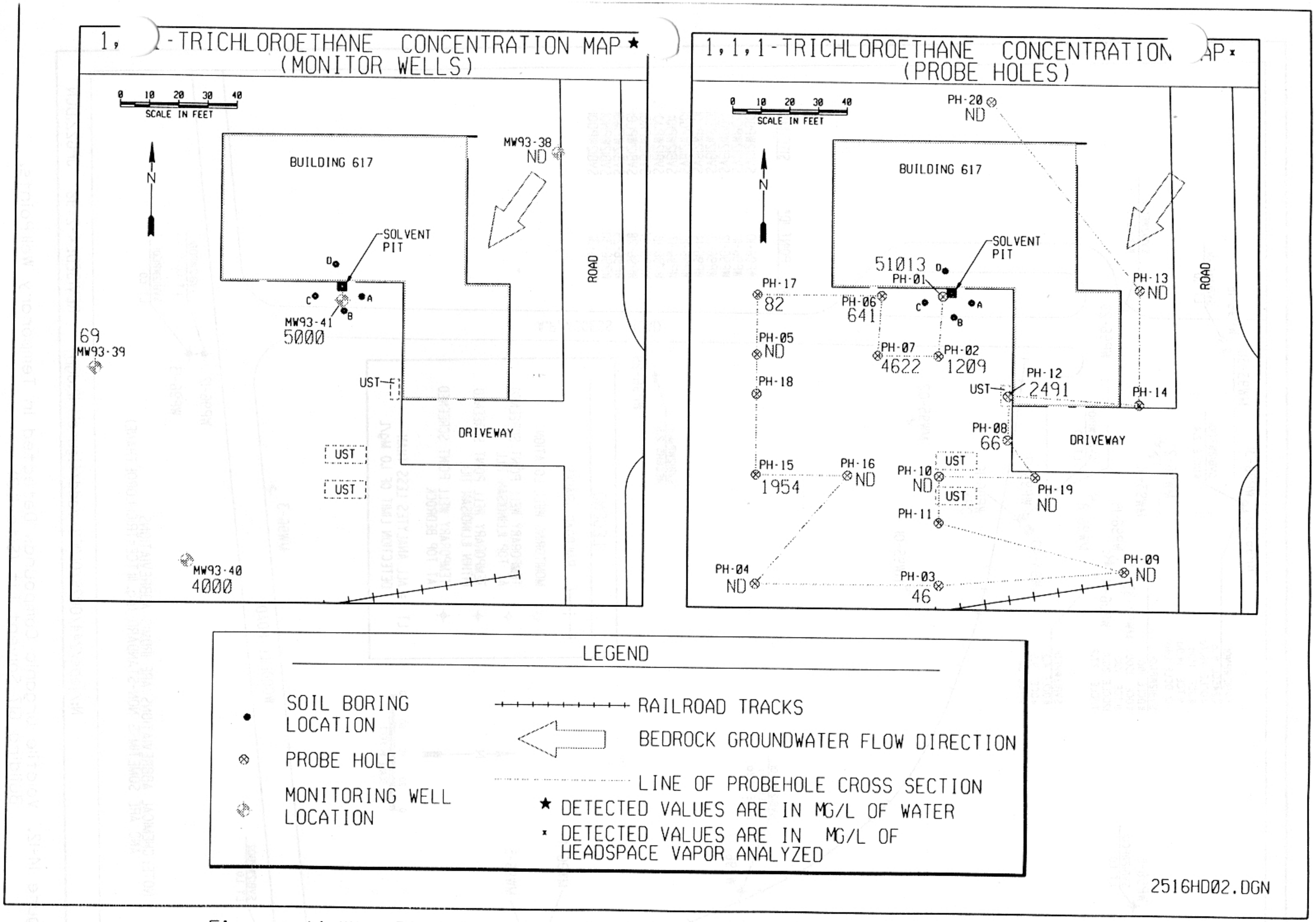


Figure 14-11b. Distribution of 1,1,1-Trichloroethane Contamination in Monitoring Well and Probehole Groundwater Samples, Building 617 Solvent Pit (Site 12B)

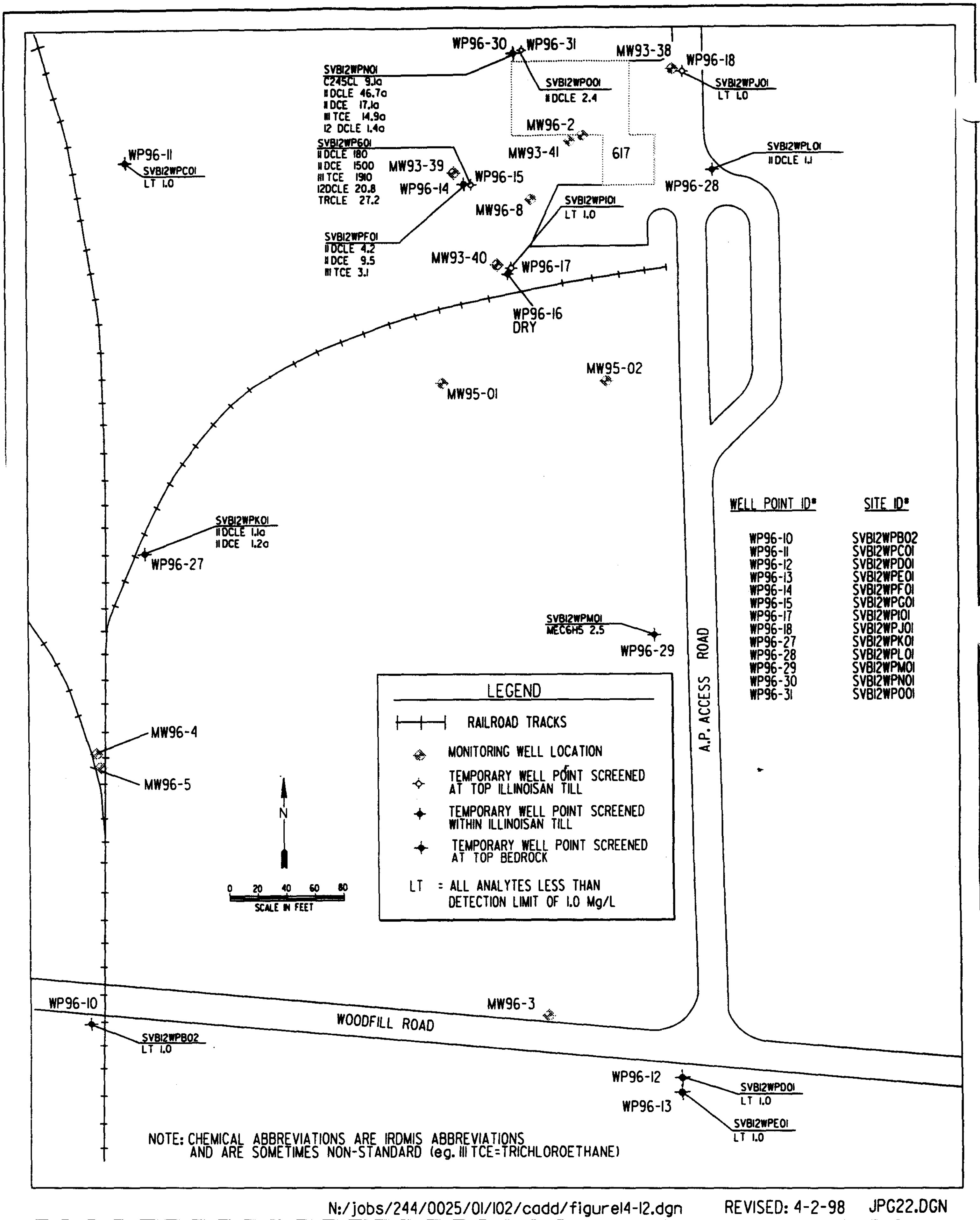
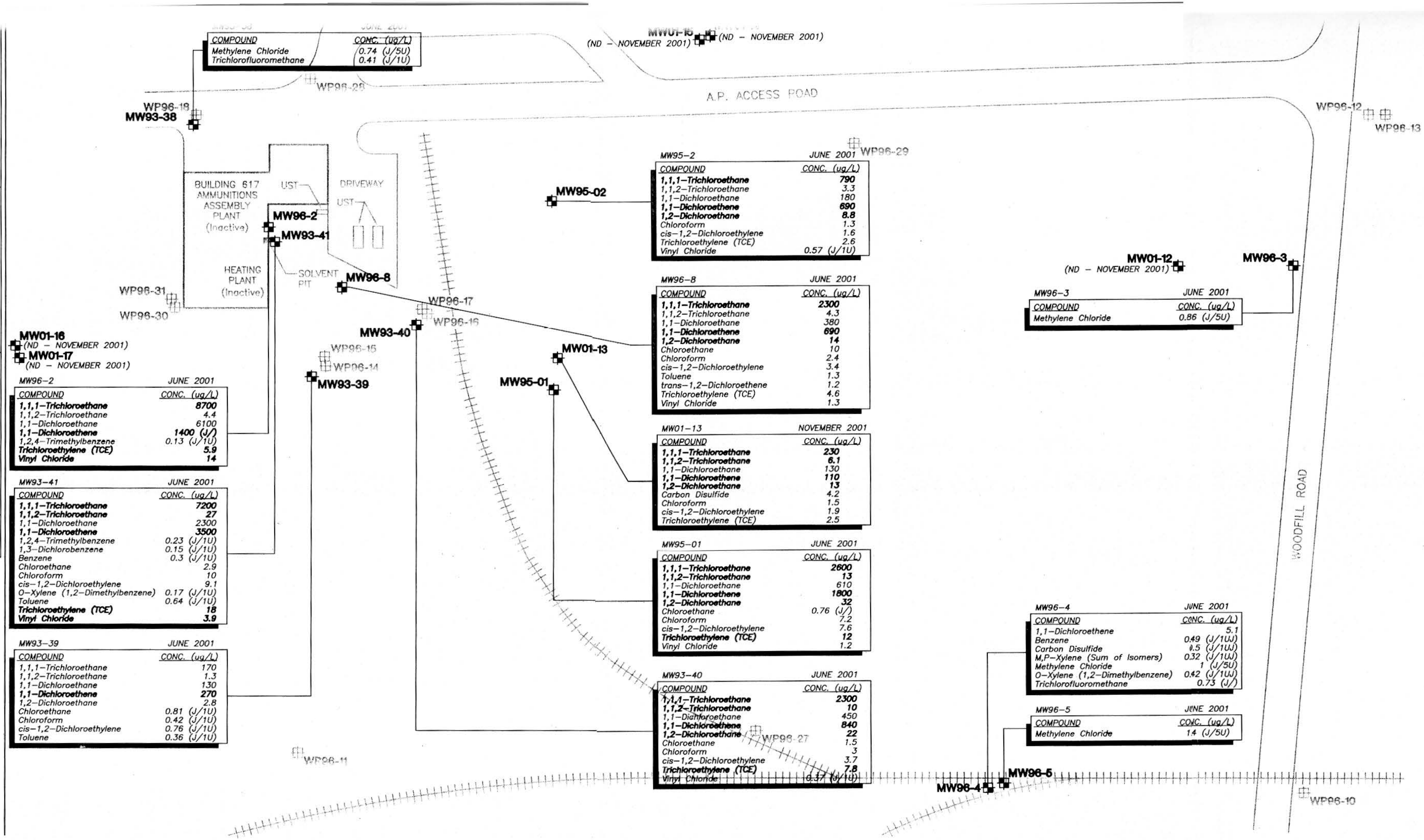


Figure 14-12. Volatile Organic Compounds Detected in Temporary Well Points, Building 617 Solvent Pit (Site 12B)



COMPOUND	CONC. (ug/L)
Methylene Chloride	0.74 (J/5U)
Trichlorofluoromethane	0.41 (J/1U)

MW96-2 — JUNE 2001

COMPOUND	CONC. (ug/L)
1,1,1-Trichloroethane	**8700**
1,1,2-Trichloroethane	4.4
1,1-Dichloroethane	6100
1,1-Dichloroethene	**1400 (J/)**
1,2,4-Trimethylbenzene	0.13 (J/1U)
Trichloroethylene (TCE)	**5.9**
Vinyl Chloride	**14**

MW93-41 — JUNE 2001

COMPOUND	CONC. (ug/L)
1,1,1-Trichloroethane	**7200**
1,1,2-Trichloroethane	**27**
1,1-Dichloroethane	2300
1,1-Dichloroethene	**3500**
1,2,4-Trimethylbenzene	0.23 (J/1U)
1,3-Dichlorobenzene	0.15 (J/1U)
Benzene	0.3 (J/1U)
Chloroethane	2.9
Chloroform	10
cis-1,2-Dichloroethylene	9.1
O-Xylene (1,2-Dimethylbenzene)	0.17 (J/1U)
Toluene	0.64 (J/1U)
Trichloroethylene (TCE)	**18**
Vinyl Chloride	**3.9**

MW93-39 — JUNE 2001

COMPOUND	CONC. (ug/L)
1,1,1-Trichloroethane	170
1,1,2-Trichloroethane	1.3
1,1-Dichloroethane	130
1,1-Dichloroethene	**270**
1,2-Dichloroethane	2.8
Chloroethane	0.81 (J/1U)
Chloroform	0.42 (J/1U)
cis-1,2-Dichloroethylene	0.76 (J/1U)
Toluene	0.36 (J/1U)

MW95-2 — JUNE 2001

COMPOUND	CONC. (ug/L)
1,1,1-Trichloroethane	**790**
1,1,2-Trichloroethane	3.3
1,1-Dichloroethane	180
1,1-Dichloroethene	**690**
1,2-Dichloroethane	**8.8**
Chloroform	1.3
cis-1,2-Dichloroethylene	1.6
Trichloroethylene (TCE)	2.6
Vinyl Chloride	0.57 (J/1U)

MW96-8 — JUNE 2001

COMPOUND	CONC. (ug/L)
1,1,1-Trichloroethane	**2300**
1,1,2-Trichloroethane	4.3
1,1-Dichloroethane	380
1,1-Dichloroethene	**690**
1,2-Dichloroethane	**14**
Chloroethane	10
Chloroform	2.4
cis-1,2-Dichloroethylene	3.4
Toluene	1.3
trans-1,2-Dichloroethene	1.2
Trichloroethylene (TCE)	4.6
Vinyl Chloride	1.3

MW01-13 — NOVEMBER 2001

COMPOUND	CONC. (ug/L)
1,1,1-Trichloroethane	**230**
1,1,2-Trichloroethane	**6.1**
1,1-Dichloroethane	130
1,1-Dichloroethene	**110**
1,2-Dichloroethane	**13**
Carbon Disulfide	4.2
Chloroform	1.5
cis-1,2-Dichloroethylene	1.9
Trichloroethylene (TCE)	2.5

MW95-01 — JUNE 2001

COMPOUND	CONC. (ug/L)
1,1,1-Trichloroethane	**2600**
1,1,2-Trichloroethane	**13**
1,1-Dichloroethane	610
1,1-Dichloroethene	**1800**
1,2-Dichloroethane	**32**
Chloroethane	0.76 (J/)
Chloroform	7.2
cis-1,2-Dichloroethylene	7.6
Trichloroethylene (TCE)	**12**
Vinyl Chloride	1.2

MW93-40 — JUNE 2001

COMPOUND	CONC. (ug/L)
1,1,1-Trichloroethane	**2300**
1,1,2-Trichloroethane	**10**
1,1-Dichloroethane	450
1,1-Dichloroethene	**840**
1,2-Dichloroethane	**22**
Chloroethane	1.5
Chloroform	3
cis-1,2-Dichloroethylene	3.7
Trichloroethylene (TCE)	**7.8**
Vinyl Chloride	0.37 (J/1U)

MW96-3 — JUNE 2001

COMPOUND	CONC. (ug/L)
Methylene Chloride	0.86 (J/5U)

MW96-4 — JUNE 2001

COMPOUND	CONC. (ug/L)
1,1-Dichloroethene	5.1
Benzene	0.49 (J/1UJ)
Carbon Disulfide	0.5 (J/1UJ)
M,P-Xylene (Sum of Isomers)	0.32 (J/1UJ)
Methylene Chloride	1 (J/5U)
O-Xylene (1,2-Dimethylbenzene)	0.42 (J/1UJ)
Trichlorofluoromethane	0.73 (J/)

MW96-5 — JUNE 2001

COMPOUND	CONC. (ug/L)
Methylene Chloride	1.4 (J/5U)

LEGEND

- WP96-27 — TEMPORARY WELL LOCATION AND NUMBER
- MW93-39 — MONITORING WELL LOCATION AND NUMBER
- RAILROAD TRACKS
- ND — NO VOCs DETECTED
- ug/L — MICROGRAMS PER LITER

NOTES

1. BASE MAP DEVELOPED FROM FIGURE 14-1 FROM A REPORT BY RUST ENVIRONMENT & INFRASTRUCTURE, DATED: 3-16-98.
2. MONITORING WELLS AND TEMPORARY WELLS TAKEN FROM FIGURE 14-12, VOLATILE ORANANIC COMPOUNDS DETECTED IN BUILDING 617 SOLVENT PIT (SITE 12B) TEMPORARY WELL POINTS, PREPARED BY RUST E&I, DATED 8-5-98.
3. ONLY COMPOUNDS WHICH WERE DETECTED ARE SHOWN ON THE MAP. SEE ANALYTICAL LABORATORY REPORT FOR PARAMETER LIST, DETECTION LIMITS, AND EXPLANATION OF LABORATORY NOTES.
4. RESULT IN BOLD FONT INDICATES THAT CONCENTRATION EXCEEDS THE USEPA REGION 9 PRELIMINARY REMEDIATION GOAL FOR TAP WATER (2000) FOR THAT COMPOUND.

north

0 50 100
SCALE IN FEET

FIGURE 14-12a

VOC CONCENTRATIONS IN GROUNDWATER (JUNE AND NOVEMBER 2001) - BUILDING 617 SOLVENT PIT (SITE 12B)

SOUTH OF THE FIRING LINE
JEFFERSON PROVING GROUND
MADISON, INDIANA

Developed By TAPB | Drawn By DLF
Approved By [signature] | Date 3-19-02
Reference 2440025.040201-B6
Revisions

Drawing Number 2440025 010102 B17

MWH MONTGOMERY WATSON HARZA

Management Review / Other
Technical Review LBL 3-12-02 / PM Review
Graphic Standards DLF 2-19-02 / Lead Professional TAPB 2-22-02
QUALITY CONTROL

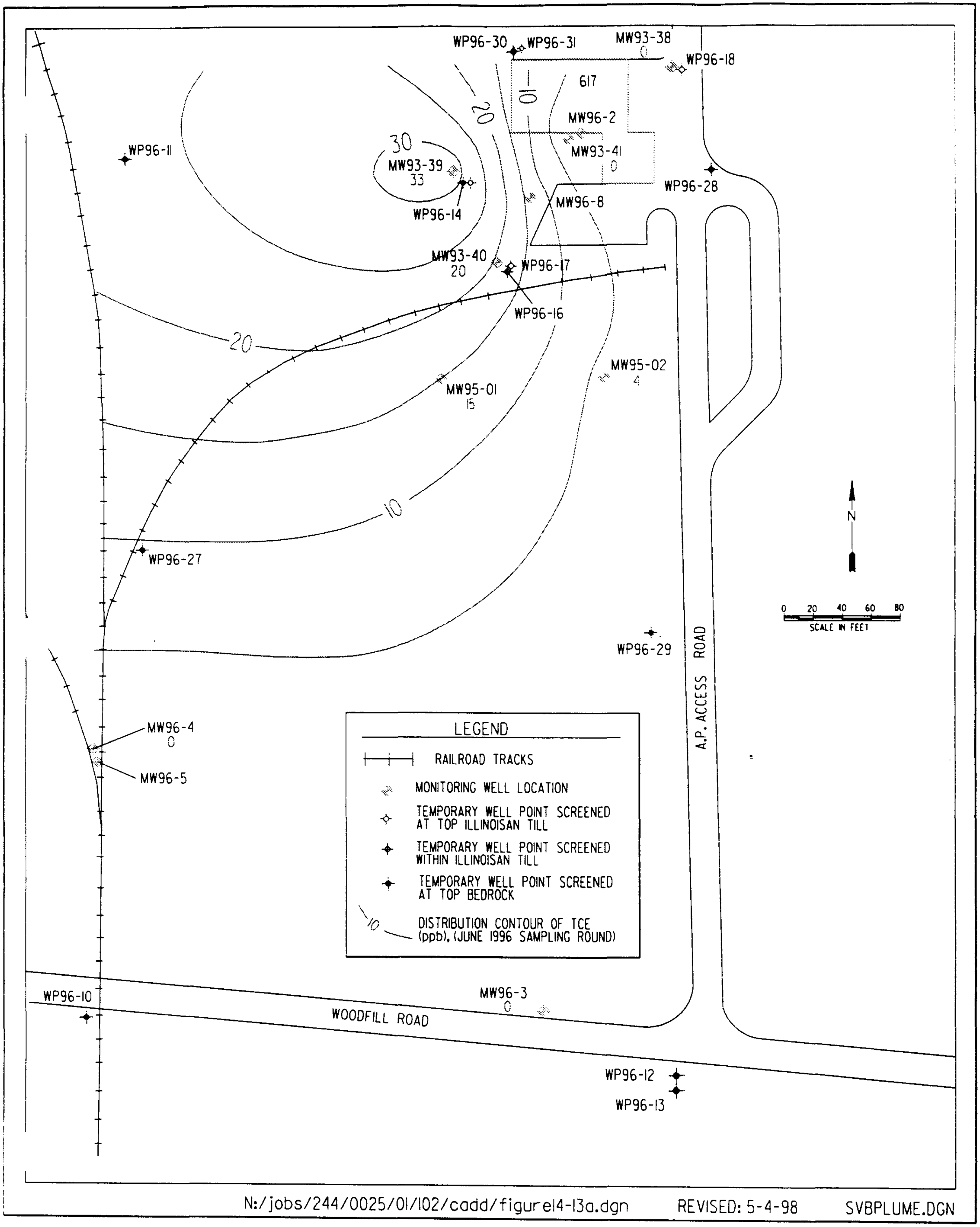
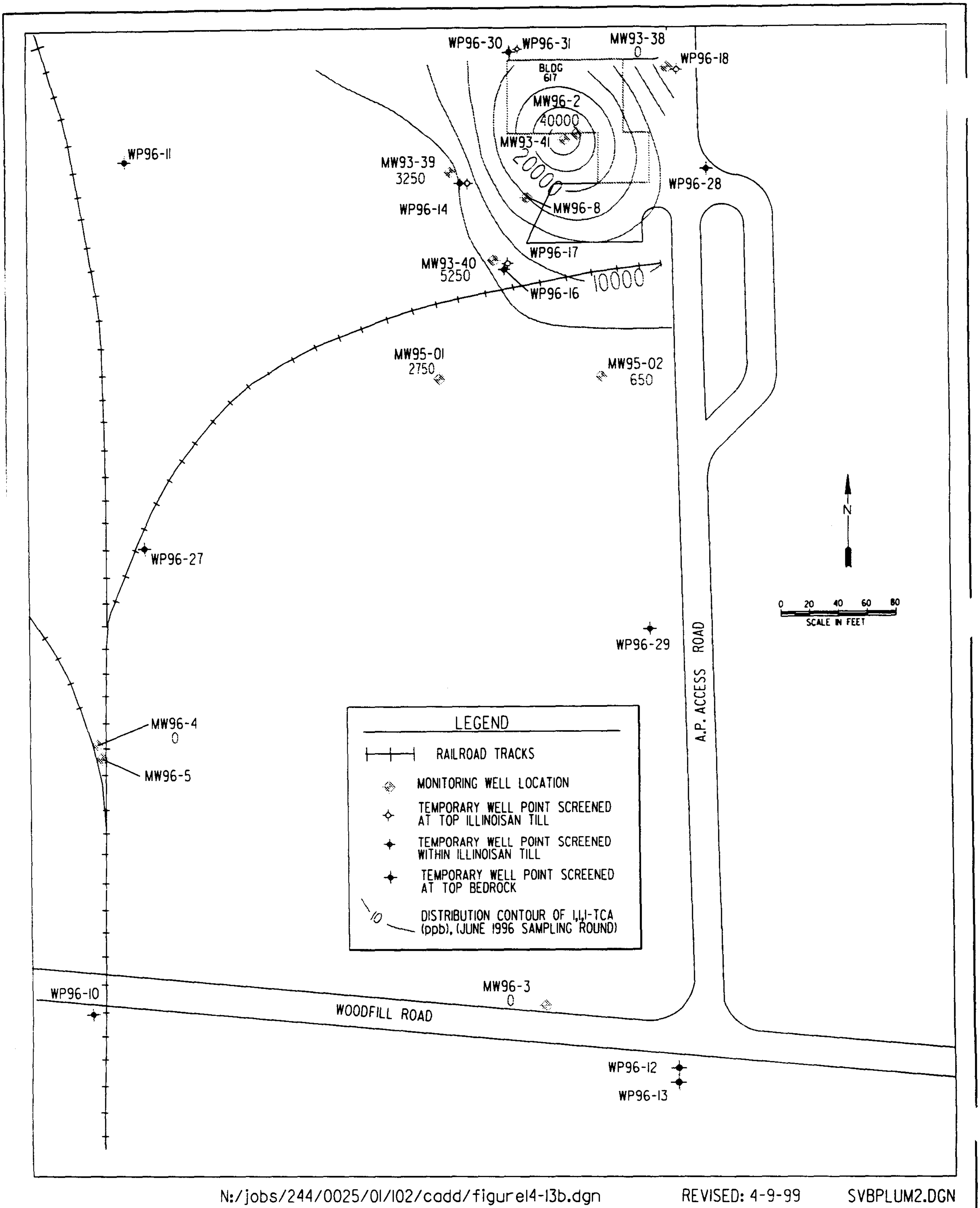


Figure 14-13a. Distribution of TCE in Groundwater from the June 1996 Sampling Round, Building 617 Solvent Pit (Site 12B)



N:/jobs/244/0025/01/102/cadd/figure14-13b.dgn REVISED: 4-9-99 SVBPLUM2.DGN

Figure 14-13b. Distribution of 1,1,1-TCA in Groundwater from the June 1996 Sampling Round, Building 617 Solvent Pit (Site 12B)

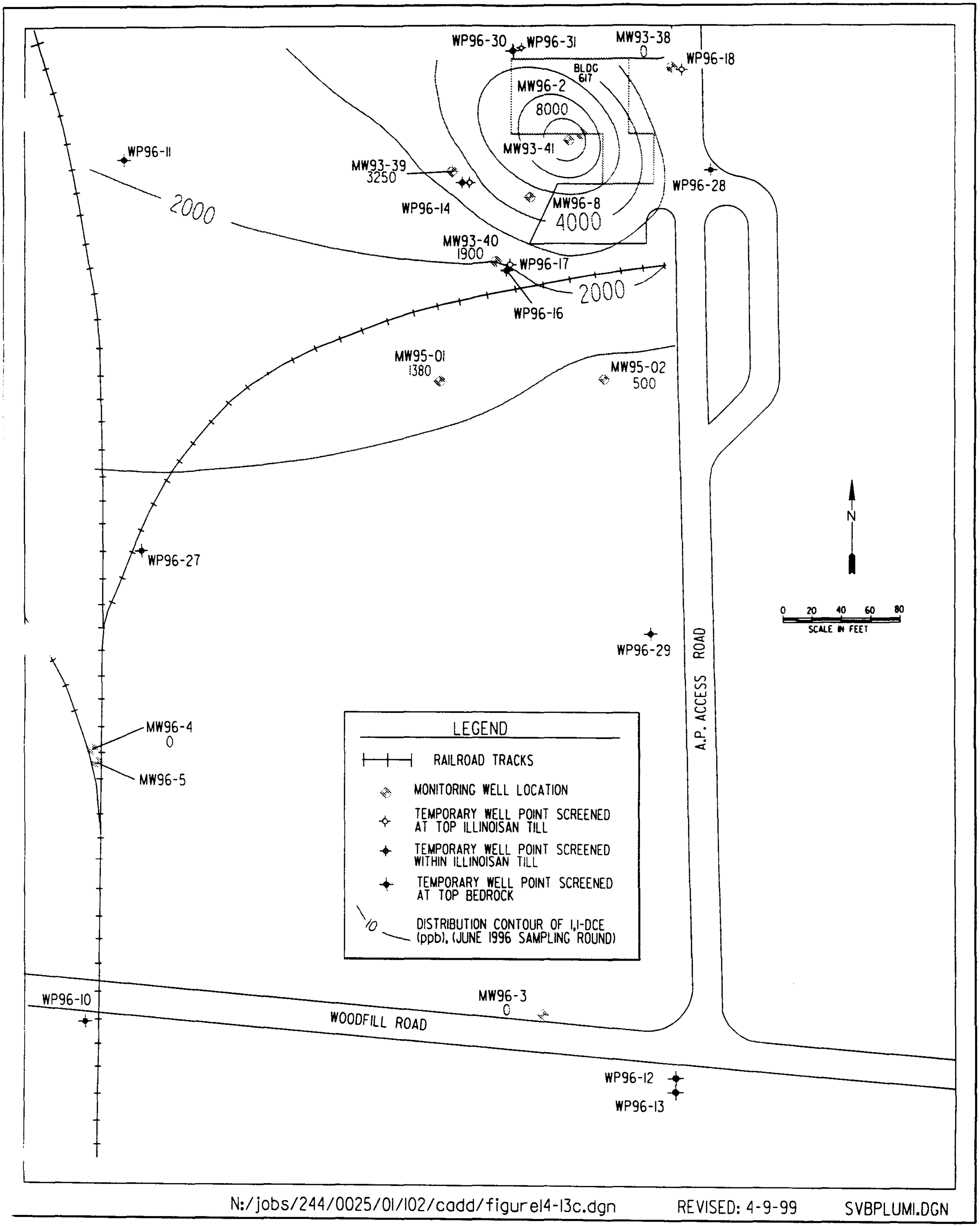


Figure 14-13c. Distribution of 1,1,1-DCE in Groundwater from the June 1996 Sampling Round, Building 617 Solvent Pit (Site 12B)

15.0 BUILDING 279 SOLVENT PIT (SITE 12C)

15.1 SITE CHARACTERISTICS

Building 279, a former ammunition-assembly plant, is located 1 block north of Woodfill Road and 2 blocks west of Meridian Road along the Firing Line (Figure 2-1~~15-1~~). The building is no longer used except for equipment storage.

The area around the building is very flat and is covered with either grass or pavement. The surface-water runoff is directed via a network of shallow roadside ditches to the northwest and eventually discharges into Middle Fork Creek (Figure 2-1). The vegetation at the site is not regularly mowed or burned. The soils in the area belong to the Cobbsfork soil series. The glacial till is about 40 feet thick at this site and underlain by the Laurel Dolomite of Silurian age. The Phase I monitoring well and borehole cross section shows the soil types, the ~~bedrock~~ unconsolidated formations, screened intervals, water levels, and sampled intervals (Figure 15-2). The Phase II cross section shows the unconsolidated (glacial till) and bedrock formations and the screened intervals for temporary and permanent monitoring wells (Figure 15-3).

The solvent disposal pit ~~is~~ was located immediately adjacent to Building 279 (Figure 15-1). The pit consisted~~s~~ of a gravel-filled pit approximately 3 feet in diameter and 3 feet deep. It was used from 1970 to 1978 to dispose of waste solvents/degreasers, including ~~trichloroethene~~ 1,1,1-trichloroethane (TCA) used during routine maintenance and sonic cleaning of gauges. It is estimated that a maximum of 500 gallons of ~~trichloroethene~~ TCA was disposed ~~of~~ in the pit. ~~Other unknown solvents and degreasers were also likely disposed of in the pit.~~ This disposal practice resulted in VOC contamination of the surrounding soils.

The VOC contaminated soils in the vicinity of the solvent pit were excavated and disposed of during solvent pit removal activities conducted at JPG from July 19 through September 21, 2000. Approximately 40 tons of soils were excavated. Confirmation sampling was performed to assess the remedial action. Results indicated no PRG exceedances. Following receipt of analytical results, contaminated soils were transported for disposal at an off-site regulated disposal facility. The excavation site was backfilled with clean fill material that was compacted and seeded. A detailed description of the construction activities and sample results is contained in the *Draft-Final Construction Completion Report, Remedial Removal Actions, Sites 12A, 12B, 12C, and 33* (Montgomery Watson, February 2002).

15.1.1 Groundwater

At Building 279, groundwater ~~exists in two zones. These zones are not as distinct as those encountered at Buildings 602 and 617 (Sites 12A and 12B). Groundwater~~ is encountered in the bedrock aquifer and ~~above and~~ within the ~~Illinoian~~ glacial till. A total of eight groundwater monitoring wells have been installed at Building 279. Of these eight wells, five of the wells are installed in the bedrock and three of the wells are installed in the ~~Illinoian~~

glacial till (Figure 15-3). The bedrock wells (MW93-42, MW93-43, MW95-7, MW95-8, and MW95-9) are screened almost entirely within the Laurel Dolomite, with approximately 1 foot extending into the overlying ~~Illinoian~~ glacial till. The ~~Illinoian~~ glacial till wells (MW88-14, MW88-15, and MW88-16) are screened entirely within the ~~Illinoian~~ glacial till, except for MW88-14 where the screen extends approximately 1 foot into bedrock. Well MW88-14 is grouped with the bedrock wells when evaluating groundwater elevations since the well is partially constructed in the bedrock. A summary of monitoring well information is shown on Table 15-1a.

Groundwater elevations have been measured more than 11 ~~separate~~ times over the past six ~~3~~ years at Building 279. The data are presented in Table 15-1b. Groundwater contour maps were prepared ~~constructed~~ for groundwater occurring in both the bedrock and the ~~Illinoian~~ glacial till at Building 279. The bedrock groundwater data were contoured for November 1995, and February, April, June, September, October, November, and December 1996 (Figures 15-4 through 15-7). Contour maps of the groundwater surface in the ~~Illinoian~~ glacial till were constructed for April, June, September, October, November, and December 1996 (Figures 15-8 through 15-10). The relationships between the ~~perched~~ glacial till and bedrock groundwater systems are illustrated by the conceptual model presented in Section 13.1.1, Figure 13-11~~3~~.

During supplemental groundwater monitoring conducted in 2001, additional water levels were measured, and two additional potentiometric surface maps for June and November 2001 were produced for the bedrock wells (Figures 15-10a and 15-10b).

15.1.1.1 Bedrock Groundwater Elevation and Hydraulic Gradients. The bedrock aquifer discussed in this section pertains to groundwater encountered in the upper 10 feet of the Laurel Dolomite. Groundwater in the bedrock equilibrates at a depth from approximately 9 to 13 feet bgs depending on well location and the time of year. The groundwater potentiometric surface of the bedrock aquifer was consistently lower than the potentiometric surface created by the wells screened in and above the ~~Illinoian~~ glacial till (Figure 15-3). Figures 15-4 through 15-7 illustrate the hydraulic gradient over a 13-month period from November 1995 to December 1996. Based on these maps, variation of the hydraulic gradient direction and magnitude varies in the bedrock groundwater (Table 15-2). For the months of November 1995, and February, April, June, October, and November 1996, the hydraulic gradient from the former solvent pit was consistently to the west-southwest. For September and December 1996, the hydraulic gradient direction from the former solvent pit was north. Generally, the west-southwest hydraulic gradient ranged in value from a low of 0.002 to a high of 0.011 ft/ft, with an average of 0.0065 ft/ft. The north hydraulic gradient ranged from 0.010 to 0.017 ft/ft and averaged 0.013 ft/ft. The hydraulic gradient measured in June and November 2001 trends to the northeast in both months and range from 0.003 to 0.004 ft/ft. ~~Since s~~Solvent contamination is primarily found only in one well screened in the ~~Illinoian~~ glacial till (MW88-15) with no contamination observed in the bedrock. Based on these observations, further interpretation of the bedrock groundwater gradient does not appear to be ~~warranted~~ necessary ~~at this time~~.

15.1.1.2 ~~Illinoian~~ Glacial Till Groundwater Characteristics. The ~~Illinoian~~ glacial till beneath Building 279 appears to contain more interbedded sand lenses than observed at

Building 602~~, which may account for the greater saturated conditions within the till~~. Small-diameter wellpoints were installed on top of and within the ~~Illinoian~~ glacial till during the field screening work performed at the solvent sites in April 1996 to evaluate the vertical variability in groundwater characteristics. Additionally, existing wells MW88-15 and MW88-16 were also used to monitor groundwater characteristics of the ~~Illinoian~~ glacial till since these wells are screened entirely within the till. The groundwater elevations in these wellpoints and wells were monitored during April, June, September, October, November, and December 1996 (Table 15-1c).

The groundwater elevation in the ~~Illinoian~~ glacial till was typically about 2 to 4 feet higher than the potentiometric surface of groundwater in the bedrock system (Figure 15-3). The ground-surface elevations at Building ~~617~~ 279 only vary approximately 1 to 3 feet. The vertical potential gradient in the till at Building 279 was down during the above referenced months with averaged values ranging between 0.08 and 0.31 ft/ft (Table 15-2a). Seasonal variation of the groundwater elevations were measured at Building 279, but the variations were less than those measured at Buildings 602 and 617 (Table 15-1c).

Groundwater at Building 279 occurs at depths of approximately 1 to 6 feet bgs. This groundwater occurs ~~on top and~~ within the ~~Illinoian~~ glacial till. ~~The presence of sand lenses within the Illinoian till allows fluids to be readily transmitted through the till. The distinct separation of perched groundwater and bedrock groundwater that was observed at Buildings 602 and 617 was not evident at Building 279. However, b~~Based on samples of the till removed during well drilling, discontinuous sand lenses are present in the glacial till.~~ some zones of the till are lacking the fluid transmitting sand lenses.~~ This vertical heterogeneity in the ~~Illinoian~~ glacial till ~~has apparently~~ mitigated potential downward migration of ~~prevented~~ solvent contamination ~~from reaching~~to the bedrock.~~ groundwater~~

Temporary well points within the ~~Illinoian~~ glacial till were screened between 13 and 22 feet bgs and within the first encountered sand lenses observed in each particular boring. The slope and position of the water table can be a good indicator of the relative hydraulic conductivity of the till. In general, the water table will have a steeper gradient in areas of low hydraulic conductivity and a shallower gradient in areas of higher hydraulic conductivity. The average value of the horizontal hydraulic gradient in the till was 0.03 ft/ft. ~~The average value for the vertical potential gradient was 0.20 ft/ft. This order of magnitude difference provides evidence that solute transport in the till may tend to be lateral within the more permeable sand lenses.~~

The apparent horizontal hydraulic gradient direction from well points screened within the ~~Illinoian~~ glacial till was consistently to the southeast and steeper in the south portion of the site when compared to the north portion. This may have allowed~~e implications of this observation is that potential lateral solute migration in sand lenses from~~ for contaminants disposed in the solvent pit ~~would be~~to migrate to the southeast within the ~~Illinoian~~ glacial till. However, groundwater from well point WP96-32 located southeast of the former solvent pit did not contain ~~dissolved~~ solvent contaminants.

The groundwater within the ~~Illinoian~~ glacial till is in communication with the bedrock aquifer as demonstrated by the pumping test results. Drawdown associated with the pumping test performed on well MW93-42 installed in the bedrock was recorded in ~~Illinoian~~ glacial till wells MW88-14, MW88-16, and well point WP96-32. Drawdown amounts in the ~~Illinoian~~ glacial till through the pumping test were 2.3 feet in well MW88-14, 1.22 feet in MW88-16, and 0.72 feet in well point WP96-32. Further interpretation of the pumping test results are discussed in the following section.

15.1.1.3 Pumping Test Results. Two pumping tests were performed at Building 279. One test was performed in the ~~Illinoian~~ glacial till, the other in the bedrock aquifer. The first test was designed to evaluate the feasibility of long-term extraction of contaminated groundwater from the ~~Illinoian~~ glacial till, and the radius of influence of such pumping. The second test was designed to evaluate the hydraulic conductivity of the bedrock aquifer, and the effect on ~~Illinoian~~ glacial till groundwater levels from extraction of groundwater from the bedrock aquifer.

15.1.1.3.1 ~~Illinoian~~ Glacial Till Test. The first test consisted of pumping well MW88-15 at a rate of 0.15 gpm. The well was pumped dry in approximately 2.5 hours and measurable drawdown was produced in only one of the observation wells, well point WP96-32, installed approximately 7 feet from well MW88-15. However, meaningful information was obtained from the test. First, using only the drawdown data from WP96-32, the till in the vicinity of the former solvent pit has a hydraulic conductivity (K) value of approximately 6.2 x 10^{-5} cm/sec. This value was derived by taking the average value from two different methods used to reduce the drawdown data, Cooper-Jacob (1946) and Theis (1935) (Table 15-3). The result of a third method of data reduction, the distance drawdown method, has a value of 2.4 x 10^{-4} cm/sec. The ~~Illinoian~~ glacial till drawdown results from the bedrock pumping test were used in the distance drawdown method. The K value derived from the distance drawdown method may be an overestimate since the till wells do not penetrate the bedrock aquifer. However, it is presented in Table 15-3 as an upper end K value for the ~~Illinoian~~ glacial till. Secondly, the water level in well point WP96-32 continued to decline after the pump in MW88-15 was shut off, indicating lateral recharge of groundwater into well MW88-15. Continued recharge to the depleted well after the pump was shut off is further indication of the low K-value soils in the vicinity of the former solvent pit. Since the majority of known contamination resides in well MW88-15, the potential for that contamination to migrate may also be low. Thirdly, well MW88-15 was pumped with an electric pump at a flow rate of 0.15 gpm. Well MW88-15 had difficulty sustaining this flow rate. ~~Since the well could not sustain this rate, and this rate is near the lower limit for electric pumps, groundwater removal from this well during potential remediation would be more efficiently accomplished using a pneumatic pump with level sensors.~~

15.1.1.3.2 Bedrock Aquifer Test. The second test consisted of pumping well MW93-42 at a constant rate of 0.25 gpm for 4.23 hours. The pumping test produced 31 feet of drawdown in the pumping well. The test was terminated at 4.23 hours because the well would have gone dry had the test been allowed to continue. Drawdown was recorded in wells MW88-14, MW88-16, MW93-43, MW95-7, MW95-8, and MW95-9. Drawdown was not recorded in ~~any~~

~~of~~ the well points except for WP96-32. Additionally, well MW88-15, used as the pumping well during the first test, had been depleted of water and was not observed during the second test. Drawdown amounts in the observation wells during the bedrock pumping test ranged from a low of 1.23 feet in well MW95-7 located 90 feet from the pumping well, to a high of 2.32 feet in MW88-14 located 60 feet from the pumping well. The second greatest drawdown (1.42 feet) was recorded in well MW95-8 located furthest away from the pumping well (120 feet).

The results of the bedrock pumping test at Building 279 are presented in Table 15-4. A number of analytical solutions were used to calculate K from the drawdown results of each well to illustrate the sensitivity, or lack of sensitivity, of the computed results to the analytical method applied.

As shown in Table 15-4, the average K value for each well was determined using ~~all of~~ the K values computed from the ~~different~~ various methods. The results indicate that K was more sensitive to the method applied than previously observed at Buildings 602 and 617. In general, the lower K values resulted from using confined or leaky methods of data reduction. The averaged K values for each well using ~~all~~ each of the various methods ranged from a low of 7.3×10^{-5} cm/sec to a high of 1.3×10^{-3} cm/sec. The site average K value based on ~~all~~ the drawdown results from the observation wells was 2.48×10^{-4} cm/sec.

It is obvious from the drawdown results in well MW88-16 (screened within the ~~Illinoian~~ glacial till) that the groundwater in the till is in communication with the bedrock groundwater. The groundwater level in well MW88-16 was lowered by 1.3 feet. The well also recovered to near pre-test conditions following the completion of the pumping test. In the vicinity of well MW88-15 (only contaminated well), the drawdown in the till may have been 1.28 feet, which is the amount of drawdown recorded in well point WP96-32 located approximately 7 feet from well MW88-15.

The test results obtained at Building 279 indicate a fairly isotropic K distribution around the pumping well except for one direction. There appears to be a slight dominant K direction of northwest-southeast based on the results from observation well MW88-14. This northwest-southeast direction may explain why the drawdown amount in well MW95-8 was the second greatest from the pumping test even though well MW95-8 is located furthest away from the pumping well.

15.1.1.4 Seepage Velocity Determination. The range of seepage velocities in the ~~Illinoian~~ glacial till are presented in Table 15-5. The maximum, minimum, and average K values for the ~~Illinoian~~ glacial till were combined with the average hydraulic gradient value of 0.03 ft/ft, and two different values for effective porosity of 0.15 and 0.30. The results are seepage velocities in the ~~Illinoian~~ glacial till that range from a low of 3 feet per year (ft/yr) to a high of 51 ft/yr. The range of seepage velocities may explain why potential migration of dissolved solvent has not ~~impacted~~ affected the surrounding wells at Building 279.

The ~~range of seepage velocities for the bedrock aquifer are~~range of seepage velocities for the bedrock aquifer is presented in Table 15-5. In Table 15-5, the highest, lowest, and average K value derived from the pumping test were used with a range of hydraulic gradients and effective porosity values to determine the range of seepage velocity~~ies~~ for the bedrock groundwater. The effective porosity of fractured bedrock reportedly can range from 1 to 30 percent (Fetter 1988). As evident by the range in values in Table 15-5, the seepage velocity is very sensitive to hydraulic gradient and the effective porosity. The data presented in Table 15-5 suggest that the groundwater in the bedrock at Building 279 could flow as little as 1 foot per year or as much as 1,350 feet per year. Both of these end member values may be unreasonable given the value used for effective porosity. Using the average K value derived from the pumping tests of 2.6 x 10^{-4} cm/sec, an average hydraulic gradient of 0.009 ft/ft, and an approximate effective porosity of 0.15, the seepage velocity of groundwater in the bedrock may be approximately 15 feet per year.

15.1.1.5 Downhole Flow Meter Results. ~~The~~ A downhole flow meter was used in wells MW88-14, MW88-15, MW88-16, MW93-42, and MW93-43 at Building 279. These wells were the only existing wells at Building 279 at the time of the test (October 1995). Flow measurements were collected at three different vertical positions within the screen interval of each well in an attempt to measure flow near fluid transmitting zones in the till.

The downhole flow meter results for Building 279 are shown on polar plots in Appendix B, Figure B-9. As shown by the groundwater contour maps (Figures 15-4 through 15-7), the flow direction is seasonally variable. Since the downhole flow meter was used on October 22, 1995, the results were compared to the November 1995 data. As shown in Appendix B, Figure 9, the flow meter results generally agree with the inferred flow directions from the November 1995 contour map. The difference in the data presented are the groundwater velocities computed from the flow meter compared to the velocities computed from the hydraulic gradient. The hydraulic gradient for November 1995 was the lowest measured at 0.002 ft/ft, which also results in a low groundwater velocity measurement.

The flow meter velocity measurements may have been influenced by vertical flow in the well, which also could influence the resulting flow direction.

15.2 PREVIOUS INVESTIGATIONS

A previous RI/FS was conducted at this site by ESE (1989). The investigation consisted of soil-gas surveys, soil sampling, and groundwater sampling. Soil samples collected immediately adjacent to the pits (within 2 to 3 feet laterally) contained the following contaminants:

- 1,1,1-Trichloroethane
- Hexane

- Trichlorofluoromethane
- 1,1-Dichloroethylene

In addition to the soil sampling, three groundwater-monitoring wells installed during the investigation at Building 279 were sampled to determine if groundwater contamination existed at the site. Of the three monitoring wells, only water samples from one well, MW88-15 (Figure 15-1), contained elevated concentrations of VOCs, including 1,1-dichloroethane, 1,1,1-trichloroethane, and trichloroethene. This well is located within 5 feet of the solvent pit, indicating contamination had not migrated very far from the source area, at least toward the south.

The ESE RI report (1989) recommended that the soils near the solvent disposal area be removed to a point where the remaining soil meets background criteria. The report concluded that groundwater contamination is most likely localized; it recommended that a second well be placed near the solvent disposal area to be used as an extraction well to pump the contaminated groundwater and treat the effluent to remove contaminants. In addition, the report recommended that JPG personnel measure the groundwater levels in the existing wells on a monthly basis for 1 year to determine if groundwater gradient or direction changes occur (ESE 1989). This site was also included in the *Enhanced PA Report* (Ebasco 1990a) and the *Master Environmental Plan* (Ebasco 1990b), which suggested following the recommendations of the previous RI (ESE 1988). This site is listed in the *Enhanced PA Plan* as SWMU 29.

15.3 STUDY AREA INVESTIGATIONS

15.3.1 Phase I RI Field Activities

15.3.1.1 Surface Soils. Previous site investigations did not completely characterize the potential contamination at Building 279, so additional site characterization was performed for this RI. Because solvent-related contamination in soils was suspected at this site, four soil samples (A to D) ~~(~~to depths of 1.3 feet~~)~~ were collected from soil borings near the solvent pit at Building 279 and analyzed for VOCs during Phase I (Figure 15-1). These samples were collected to confirm the results of the previous soil-gas survey (Figure 15-11a) and to assist in determining the extent of contaminants contributing to the previously observed groundwater contamination at this site.

15.3.1.2 Subsurface Soils. Eight Phase I subsurface soil samples were collected from four soil borings (A to D) near the solvent pit (Figure 15-1). The samples, ~~taken~~ collected at depths of 5 and 10 feet, were analyzed for VOCs. Soil core/cuttings were scanned for VOCs using a PID. Intervals identified with the PID as being potentially contaminated were sampled as well as predetermined soil depths.

15.3.1.3 Geoprobe Field-Screening Survey. Based on detections of VOC soil contamination during the drilling of soil borings, a field screening survey using direct-push techniques was

performed in 1993 at the solvent pit to provide additional information on the nature and extent of solvent contamination. Three probeholes were completed with one located on the east side (PH-01), one on the west side (PH-03), and one adjacent to the solvent pit on the north side (PH-02) of Building 279. Solvents were only detected in subsurface soils in probehole PH-02 nearest the solvent pit (Figure 15-11b). (EPA49 & 50)

15.3.1.4 Groundwater. As part of the Phase I RI, groundwater samples were collected from five wells and analyzed for VOCs at Building 279. Three existing wells (MW88-14, -15, and -16) were resampled, and two additional wells (MW93-42 and -43) were installed to establish the extent of the groundwater-contaminant plume. Well locations were selected based on the results of soil boring samples and the field-screening surveys.

15.3.2 Phase II Field Activities

15.3.2.1 Surface Soils. No additional surface soil samples were collected during Phase II of the RI.

15.3.2.2 Subsurface Soils. No additional subsurface soil samples were collected during Phase II of the RI.

15.3.2.3 Groundwater. To better assess the extent of groundwater contamination and groundwater flow conditions, six temporary well points (WP96-01 to WP96-06) were installed at Building 279 during the Phase II RI (Figure 15-1). Depths of the well points ranged from 10 to 28 ft bgs (Figure 15-3). Appendix I contains additional construction details for the temporary well points. The well points were installed within the glacial till to determine groundwater flow conditions and contaminant distribution. The well point samples were analyzed for VOCs utilizing an on-site portable laboratory. (EPA13i)

Based on the temporary well screening survey, three additional top of bedrock wells were installed during the Phase II RI (MW95-07, MW95-08, and MW95-09). Four rounds of sampling were conducted on this larger well network (eight wells) for VOC analysis.

In June 2001, the eight monitoring wells at the site were sampled to collect more recent groundwater quality data and to evaluate the potential for natural attenuation. Water samples were analyzed for VOCs and the natural attenuation parameters: total iron, total manganese, total organic carbon, dissolved gases (ethene, ethane, methane, and carbon dioxide), sulfate, sulfide, nitrate, total kjeldahl nitrogen, chloride, and alkalinity. In addition, field indicators for natural attenuation were also measured including dissolved oxygen (DO), oxidation-reduction potential (ORP), pH, conductivity, and temperature.

15.3.3 Interim Measures Removal Action

The VOC contaminated soils in the vicinity of the solvent pit were excavated and disposed of during solvent pit removal activities conducted at JPG from July 19 through September 21, 2000. Approximately 40 tons of soils were excavated. Confirmation sampling was performed

to assess the remedial action. Results indicated no PRG exceedances. Following receipt of analytical results, contaminated soils were transported for disposal at an off-site regulated disposal facility. The excavation site was backfilled with clean fill material that was compacted and seeded. A detailed description of the construction activities and sample results is contained in the *Draft-Final Construction Completion Report, Remedial Removal Actions, Sites 12A, 12B, 12C, and 33* (Montgomery Watson, February 2002).

15.4 DATA EVALUATION

15.4.1 Data Validation Results

During Phase I, one VOC (chloromethane) had a low calibration response, and ~~all~~ the results were rejected. The CRLs were elevated for several compounds because of high solvent concentrations in soil and because the CRL for methyl-N-butyl ketone (MNBK) (EPA86) (in soil) exceeded the USEPA Region 5 DQL. The Phase I VOC results were not used for the human health risk assessment other than for qualitative information. None of the soil sample data were rejected. The following sample results were rejected during Phase I:

- Chloromethane in SVC12GWA01, -MW14B, and -MW15B.

For Phase II data (four rounds ~~of samples~~of samples), the results for three VOC compounds (MEK, acetone, and vinyl acetate) were rejected due to insufficient calibration or low response in the calibration in several analytical batches. Analytes associated with rejected data were not included in the database used for the risk assessment. The following sample results were rejected from the Phase II database:

- February 1996
  - MEK in SVC12GWA03, -B03, -C02, -D02, -E02, -MW14C, MW15C, -MW15C field duplicate (FD), and -MW16C.

- Spring 1996
  - MEK in SVC12GWA04, -B04, -C03, -D03, -E03, -WPG01, -MW14D, -MW15D, and -MW16D.

- Summer 1996
  - MEK in SVC12GWA05, -B05, -C04, -D04, -E04, -MW14E, -MW15E, -MW15E (FD), -MW16E, and -MW17E.

- January 1997
  - Acetone in SVC12GWA02, -C01, -D01, -E01, and -MW14B.
  - Vinyl acetate in SVC12GWA02, -B02, -C01, -D01, -E01, -MW14B, -MW15B, MW16B, and -MW17B.
  - MEK in SVC12GWA02, -C01, -D01, -E01, and -MW14B.

For supplemental groundwater monitoring several VOCs were qualified "R" as unusable. Three VOCs (acetone, 2-hexanone, 2-butanone) were qualified unusable when not detected due to low relative response factors (<0.05). Four VOCs chloroethane, 1,2-dichloroethane, 1,1,2-trichloroethane, and vinyl acetate were qualified unusable when not detected due to low method reporting limit continuing calibration verification (MRL CCV) and/or a low laboratory control sample (LCS) recoveries. The following sample results were qualified unusable:

- 1,1,2-trichloroethane - S12CMW01-55, S12CMW88-14, S12CMW88-15, S12CMW93-42, S12CMW93-43, S12CMW95-07, S12CMW95-09
- 2-hexanone - S12CMW01-55, S12CMW88-14, S12CMW88-15, S12CMW93-42, S12CMW93-43, S12CMW95-07, S12CMW95-09
- acetone - S12CMW01-55, S12CMW88-14, S12CMW88-15, S12CMW88-16, S12CMW93-42, S12CMW93-43, S12CMW95-07, S12CMW95-08, S12CMW95-09
- chloroethane - S12CMW01-55, S12CMW88-14, S12CMW88-15, S12CMW93-42, S12CMW93-43, S12CMW95-07, S12CMW95-09
- vinyl acetate - S12CMW01-55, S12CMW88-14, S12CMW88-15, S12CMW88-16, S12CMW93-42, S12CMW93-43, S12CMW95-07, S12CMW95-08, S12CMW95-09
- 1,2-dichloroethane - S12CMW88-15

The compounds qualified unusable will not negatively impact the interpretation of the site data.

15.4.1.1 Evaluation of Non-Detected Values. A comparison was made between the USEPA Region 5 DQLs and the project CRLs for chemicals that were analyzed for but not detected in environmental media at this site. No exceedances were identified for soils.

Several VOCs had reported non-detected values from one to three orders of magnitude greater than the DQLs for at least one event and one location. However, these were limited to less than half the sampling events; acceptable CRLs were achieved at the other site wells for the same VOCs during the same events. Therefore, none of the VOCs ~~warranted~~ necessitated identification as having exceeded the DQLs. No exceedances for SVOCs were found.

MRL's for supplemental groundwater monitoring analyses were sufficiently low to meet MCLs stated in the Supplemental Groundwater Monitoring QAPP.

15.4.2 Data Quality Summary

15.4.2.1 Blank Assessment. When blank contamination exists, the investigative results must exceed the blank result by a factor of 5 (all compounds) or 10 (common laboratory contaminants such as phthalates) to be considered positive. Positive results were changed to

nondetects ("U") when the concentrations were less than the 5 or 10 times criterion. In these cases, the associated sample quantitation limit became either the concentration in the sample, if the detected value was above the quantitation limit, or the quantitation limit, if detected results were less than the quantitation limit. None of the soil or groundwater samples were qualified as nondetected because of blank contamination during Phase I.

Three VOCs (methylene chloride, 1,1,1-trichloroethylene, and chloroform) were detected in the lab blanks associated with the following groundwater samples, which were qualified as nondetected during Phase II:

- February 1996
  - Methylene chloride in SVC12GWD03.
- Spring 1996
  - Methylene chloride in SVC12GWA04.
- Summer 1996
  - Methylene chloride in SVC12MW15E.
- January 1997
  - 1,1,1-trichloroethylene in SVC12GWC01, -D01, -E01, and -MW16B.
  - Methylene chloride in SVC12MW15B and -MW17B.
  - Chloroform in SVC12MW15B and -MW17B.

No compounds were qualified not detected based on blank contamination during the supplemental groundwater monitoring activity at Site 12C.

15.4.3 Background Screening

Samples at this site were not analyzed for inorganic constituents or dioxins/furans during Phase II. Therefore, Metals were analyzed in groundwater during the Phase I, but no background screening was performed.

15.4.4 Summary of Analytical Results

Table 15-6 provides a summary of organic contaminants detected in groundwater at Site 12C during Phase I and II. Table 15-6a presents the field and laboratory results for natural attenuation parameters. A complete listing of the data for Site 12C, including nondetected and below reporting limit analytes, is presented in Appendix N.

15.5 NATURE AND EXTENT OF CONTAMINATION

15.5.1 Soil

Four boreholes (A to D) were drilled around the solvent pit during Phase I, including one borehole that was hand-augured inside the building (Figure 15-1). Three samples were collected per boring and analyzed for VOCs. No VOC contamination was detected in any of the borehole samples. However, based on VOC contamination detected during the ESE investigation conducted in 1988, a field-screening survey was recommended. The field-screening survey was conducted at Building 279 on April 17, 1993. A total of three probeholes (SVC-PH01 through SVC-PH03) were completed (Figure 15-11b). The initial probehole, PH-01, was located on the eastern side of the building about midway between MW88-14 and MW88-15. Probehole PH-02 was located near the solvent pit, which is considered the source area for the contamination. Probehole PH-03 was located midway between MW88-15 and MW88-16. PH-01 was pushed to refusal at 24 feet deep, which was determined from nearby well logs to be about 16 feet above the top of bedrock in the area. The probehole screening information is located in Appendix G. (EPA49)

Because groundwater contamination was the main concern, the soil in PH-01 was not sampled. The groundwater sample revealed total VOC contamination of 43 ppb. Probehole PH-02, which was located adjacent to the solvent pit, contained several solvent-related compounds in the groundwater. The predominant contaminant was identified as 1,1,1-trichloroethane at 42,809 ppb. The shallow groundwater sample from PH-03 taken collected at 22 to 24 feet bgs revealed only 4 ppb of total VOCs with no specific compounds identified (Figure 15-11b). (EPA50)

15.5.2 Groundwater

The solvent VOC plume in groundwater at Site 12C appears to be fairly small, and the contaminant concentrations appear to dropdecrease rapidly with lateral distance from the former solvent pit. Temporary well points installed at Building 279 did not identify significant

VOC contamination in shallow groundwater (Figure 15-11c). Three VOC detections occurred (methyl isobutyl ketone at well points WP96-01 and WP96-04, and 1,2-dichloroethane at well point WP96-04), but the concentrations were just above the method detection limit of 1.0 mg/L. The lateral extent of VOCs in the shallow groundwater appears to be limited. (EPA13i)

Two bedrock monitoring wells were drilled in 1993 and three bedrock wells were drilled in 1995 to determine the ~~extent~~ presence of contamination in the bedrock groundwater. These five wells and the three previously existing wells were sampled for VOCs (Figure 15-11d). Of the VOCs detected in groundwater from the glacial till well MW88-15 ~~(Table 15-6)~~, the compounds 1,1,1-trichloroethane ~~(ranging from 27,500 to 71,500 µg/L)~~, 1,1-dichloroethylene ~~(ranging from 750 to 3,850 µg/L)~~, 1,1-dichloroethane ~~(ranging from 3,750 to 7,000 µg/L)~~, and trichloroethene ~~(ranging from 930 to 2,400 µg/L)~~ were detected at concentrations greater than the USEPA Region 9 action level criteria (Table 15-6).

During the Phase II, VOC contamination was detected in only three (MW93-43, MW95-07, and MW95-08) of the other seven wells sampled at this site at very low concentrations. Groundwater contamination appears to be limited in the glacial till near the former solvent pit. The vertical extent is also limited in the glacial till as indicated by the elevated VOC concentrations in the till well MW88-15 and no detections of the same VOCs (EPA51) in well MW95-09, located in the bedrock adjacent to and vertically below well MW88-15. (EPA52)

Supplemental groundwater monitoring samples were also collected from the Site 12C monitoring wells in June 2001. Analytical results were similar to previous sampling rounds for monitoring well MW88-15, which still has VOCs that exceed the PRGs. However, no other wells at Site 12C had detectable concentrations of VOCs in 2001.

15.5.3 Summary of ~~Solvent Pit~~ Contamination

The existing data suggest that solvent contamination is limited in the glacial till to the immediate vicinity of the former solvent pit (Figure 15-11d). No bedrock groundwater ~~solvent~~ VOC contamination was detected at this site. Also, the probehole data indicate that solvent-contaminated groundwater in the glacial till is mostly restricted to the immediate area near the solvent pit. Since the bedrock groundwater beneath the former solvent pit does not appear to be contaminated, vertical migration is limited. ~~to the bottom of the glacial till.~~

The solvent pit was removed in 2000, and contaminated soils were excavated to the extent that was practical and disposed off-site at a regulated disposal facility. A detailed description of the construction activities and sample results are contained in the *Draft-Final Construction Completion Report, Remedial Removal Actions, Sites 12A, 12B, 12C, and 33 (Montgomery Watson, February 2002).*

15.5.4 Assessment Of Site 12C For Natural Attenuation

Site 12C was assessed as a candidate for natural attenuation using the U.S. EPA screening criteria contained within the BIOCHLOR model (USEPA, 2000). Suitability of a candidate site is based on a list of criteria contained in Table 15-6b. Numerical scores are given for each criterion. If a candidate site scores 0 to 5 points there is inadequate evidence to support a natural attenuation by reductive dechlorination decision at the site. A score of 6 to 14 means that there is limited evidence for natural attenuation by reductive dechlorination at the site. A score of 15 to 20 indicates that adequate evidence exists that natural attenuation by reductive dechlorination may be supported at the site. Scores over 20 strongly support natural attenuation by reductive dechlorination at a site.

These scoring criteria can be used as general guidance for determining the site's initial suitability for natural attenuation by reductive dechlorination. Accordingly, these criteria were applied to Site 12C (Table 15-6b), and were used in combination with field and laboratory data (Table 15-6a) to evaluate Site 12C.

Using the field and fixed laboratory results for DO, nitrogen, ferrous iron, sulfate, methane, ORP, pH, TOC, temperature, alkalinity, sulfate, chloride, ethane, methane, and ethene present at locations where chlorinated VOCs were detected, Site 12C scored 21 points. Therefore, based on this assessment, Site 12C is a strong candidate site for natural attenuation by reductive dechlorination.

The field and laboratory data from well MW88-15 supports this assessment. Well MW88-15 is located adjacent to the contaminant source area and is screened in the till. Relatively strong concentrations of 1,1,1-TCA and TCE and associated daughter products including 1,1-DCA and 1,1-DCE were detected at wells MW93-41 and MW96-02 in June 2001. Data from previous rounds of sampling show a significant reduction of chlorinated VOCs had occurred by June 2001.

Chloroethane, chloroform, cis-1,2-DCE, and vinyl chloride (daughter products) were detected in relatively minor amounts. This is expected near the contaminant source area, as first order kinetics would support rapid reductive dechlorination of the parent compound and successively lesser reduction of sequential daughter products to lower order daughter products (such as chloroethane and vinyl chloride) at the expense of the first order reduction.

However, samples collected from well MW95-09, located as a deep well in a well nest next to well MW88-15, contains no chlorinated VOCs in spite of a downward hydraulic gradient between the two wells. Well MW95-09 does, however, contain concentrations of methane and carbon dioxide above background levels. Well MW95-09 also contains low DO, high temperature, and low ORP, which are all indications of favorable conditions for biodegradation.

At downgradient locations relative to the source area, natural attenuation by reductive dechlorination appears to have taken place. Concentrations of chloride, iron, and carbon dioxide down gradient are characteristically elevated when compared to background concentrations at upgradient well MW88-14. Accordingly, the glacial till serves to attenuate

the movement of chlorinated VOCs, and provides an appropriate environment to promote reductive dechlorination.

15.6 HUMAN HEALTH RISK ASSESSMENT

Since the Draft RI was submitted, a Remedial Removal Action was performed at Site 12C. The soils in the vicinity of the solvent pit were excavated and disposed during construction activities. Sample results confirmed that the remaining soils met the residential Region IX PRGs. Because remediation has already been completed at Site 12C, and have met USEPA residential Region IX PRGs, the risk estimates for Site 12C provided in the Draft RI have not been updated. Rather the original draft risk calculations are provided for informational purposes to document, in part, why remedial action was considered warranted at this site.

15.6.1 Selection of the Contaminants of Potential Concern at Site 12C

15.6.1.1 Surface Soil. No chemicals were detected in surface soil at Site 12C.

15.6.1.2 Surface/Subsurface Soil Combined.

15.6.1.2.1 Frequency of Detection. Evaluation of frequency of detection was not undertaken at this site because of too few samples.

15.6.1.2.2 Nutrient Screening. Soil samples collected at this site were not analyzed for inorganic constituents. Therefore, nutrient screening was not performed.

15.6.1.2.3 Summary of Preliminary COPCs. Table 15-7 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95% UCL of

the mean, and the exposure point concentration for the preliminary COPC in surface/ subsurface soil at Site 12C.

15.6.1.2.4 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for the preliminary COPC, toluene, was compared to the chemical-specific Region 9 residential soil PRG (Table 15-8). One-tenth of the PRG was used. As a result of the screening, toluene was eliminated as a COPC in surface/subsurface soil at this site.

15.6.1.3 Air.

15.6.1.3.1 Summary of Preliminary COPCs. Ambient air concentrations to which future receptors at this site might be exposed were estimated using air emission/dispersion modeling, as described in Appendix R. In the site-specific conceptual model, discussed below in Section 15.6.2.1, Site 12C is evaluated under two future site-specific scenarios: as a residential site and as an industrial site.

In the future industrial land use scenario for the facility, ~~all~~ the sites were assumed to be industrial, except for the five sites designated agricultural sites. Each site with particulate-bound COPCs in surface soil (metals, SVOCs, and dioxins/furans) and/or volatile COPCs in surface/subsurface soil combined was assumed to contribute to the air concentrations at ~~all of~~ the sites. In the future residential scenario for the facility, ~~all~~ the sites were assumed to be residential except for the five sites designated agricultural. It was assumed that particulate and VOC emissions from the strictly residential sites would be negligible because the home sites would be covered with dense vegetation (lawns) and pavement. Therefore, under the residential scenario only the five agricultural sites contribute to the air concentrations at ~~all of~~ the sites. The list of preliminary air COPCs is therefore the same for every site for a given scenario, but the concentrations of the COPCs vary. Tables R-4 and R-6 in Appendix R present the estimated ambient air concentrations at Site 12C under the future industrial and residential scenarios, respectively.

15.6.1.3.2 Region 9 Preliminary Remediation Goal Screening. The exposure point concentrations for each preliminary air COPC at Site 12C in the future residential scenario and the future industrial scenario were compared to chemical-specific Region 9 air PRGs (Table 15-9). One-tenth of the PRG was used for noncarcinogens. The exception was lead, for which the full PRG was used. As a result of the screening, aluminum, silver, thallium, vanadium, and zinc are retained as COPCs in air for future on-site residents. For future on-site workers, aluminum, chromium, silver, thallium, vanadium, and zinc were retained.

15.6.1.4 Groundwater.

15.6.1.4.1 Frequency of Detection. Evaluation of frequency of detection was not undertaken at this site because of too few groundwater samples.

15.6.1.4.2 Nutrient Screening. Groundwater samples collected at this site were not analyzed for inorganic constituents. Therefore, nutrient screening was not performed.

15.6.1.4.3 Summary of Preliminary COPCs. Table 15-10 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95% UCL of the mean, and the exposure point concentration for the preliminary COPC in groundwater at Site 12C. Prior to this statistical analysis, the various validated sampling round data for each well were averaged to obtain a single data point for each location.

15.6.1.4.4 Region 9 Preliminary Remediation Goal Screening. The exposure point concentrations for the preliminary groundwater COPCs were compared to the chemical-specific Region 9 residential tap water PRGs (Table 15-11). One-tenth of the PRG was used for noncarcinogens. As a result of the screening, 1,1-dichloroethane, 1,1-dichloroethylene, 1,1,1-trichloroethane, 1,1,2-trichloroethane, 1,2-dichloroethane, 1,2-dichloroethylene (mixed isomers), toluene, trichloroethylene, and vinyl chloride are retained as final COPCs in groundwater at Site ~~21C~~12C.

15.6.2 Exposure Assessment

15.6.2.1 Site Conceptual Model. There are no people who are known to specifically work at or frequent Site 12C. There are, however, several types of individuals who could potentially be affected by the existing contamination at the facility. These are current trespassers to JPG, off-facility (nearby) rural residents, and future hunters. In each case, these individuals would most likely be impacted simultaneously by multiple sites rather than by single units. Because of this, these current and future receptor populations are addressed on a facility-wide, cumulative basis rather than by specific sites (see Sections 28 and 29).

Therefore, this site-specific exposure scenario only addresses future land use development. Site 12C has two potential future land uses forwarded for evaluation:

- Residential
- Industrial

Residential Use. Under the future residential land use scenario, this site is assumed to be developed for residential purposes with the supposition that a family would build a house directly on or within this area of potential concern.

With respect to a risk assessment analysis, resident populations are assumed to consist of both adults and toddlers. Each individual would be expected to come in contact with site contaminants in the following pathways at Site 12C:

- Inhalation of VOCs and fugitive particulates from soils
- Dermal contact with soil while gardening/playing outdoors
- Incidental ingestion of soil while gardening/playing outdoors
- Ingestion of fresh homegrown fruits and vegetables.
- Ingestion/dermal contact with groundwater
- Inhalation of VOCs while showering/bathing

On-site Worker. Industrial land use is considered to be a plausible future option for this site at JPG. On-site industrial workers ~~(adult males and females)~~ are assumed to be individuals who could be exposed directly to contaminated media through the following pathways:

- Inhalation of VOCs and fugitive particulates from soils
- Incidental ingestion/dermal contact with soil
- Ingestion of groundwater

15.6.2.2 Exposure Point Concentrations.

15.6.2.2.1 Air. The estimated ambient air concentrations of COPCs at this site for the future on-site residents and the future on-site workers are presented in Table 15-9.

15.6.2.2.2 Soil. No soil COPCs were selected at this site.

15.6.2.2.3 Fruits and Vegetables. Fruit and vegetable concentrations were not calculated because there are no soil COPCs at this site.

15.6.2.2.4 Groundwater. The concentrations of COPCs in groundwater at Site 12C are presented in Table 15-10.

15.6.2.2.5 *Shower Air*. COPC concentrations in shower air were estimated using the methods described in Appendix T. Table 15-12 summarizes the shower air concentrations for Site 12C.

15.6.2.3 Human Exposure Doses.

15.6.2.3.1 Inhalation of Contaminated Air. Inhalation of airborne contaminants (VOCs and particulates) is a potential route of exposure for future on-site residents (adults and children) and future on-site workers at this site. The equation used for calculating human exposure doses of COPCs due to inhalation of volatile and dust-bound contaminants is provided in Section 5.1.3.3.1, Table 5-11~~12~~. Table V-9, Appendix V, documents the calculation of human exposure doses at Site 12C due to inhalation of contaminated air.

15.6.2.3.2 Ingestion of Contaminated Groundwater. Contaminated drinking water may be a source of chemical exposure for future on-site residents (adults and children) and future workers. The equation used to calculate daily chemical doses due to dermal contact with contaminated groundwater is provided in Section 5.1.5.3.4~~5~~, Table 5-14~~16~~. Table V-9, Appendix V, documents the calculation of human exposure doses at Site 12C due to dermal contact with contaminated groundwater.

15.6.2.3.3 Inhalation of Volatile Organic Chemicals While Showering/Bathing. Inhalation of VOCs while showering/bathing is a potential route of exposure when these contaminants are present in residential water systems. The equation that was used to calculate human exposure dose due to inhalation of VOCs while showering/bathing is provided in

Section 5.1.5.3.6, Table 5-17~~18~~. Table V-9, Appendix V, documents the calculation of human exposure doses at Site 12C due to inhalation of VOCs while showering.

15.6.3 Risk Characterization

15.6.3.1 Chronic Health Hazards. The noncancer daily exposure doses calculated in the exposure assessment were used to calculate HQs for each of the COPCs possessing RfDs. Pathway-specific and overall HIs were then calculated for each receptor. The calculations of HQ and HI are described in Section 5.1.7.1. If an overall HI is calculated to be greater than 1.0 for a particular receptor, then the exposure pathway(s) primarily responsible for the result is identified as a "critical pathway(s)." For each critical pathway, those chemical contaminants responsible for the majority of the HI are listed as COCs. Table W-9, Appendix W, documents the calculation of the pathway- and chemical-specific HQs for the human receptors at Site 12C. The pathway-specific and overall HIs are summarized in Table 15-13.

15.6.3.1.1 Future On-Site Residents. The overall HIs for the future on-site adult and toddler residents at Site 12C are calculated to be 86 and 193, respectively. Both of these HIs exceed USEPA's risk management criterion of 1.0. The critical pathways are ingestion of and dermal contact with groundwater and inhalation of shower VOCs. The chemical responsible for most of the hazard for ~~all~~ the pathways is 1,1,1-trichloroethane. Other noncarcinogenic COCs for the ingestion of groundwater pathway are 1,1-dichloroethane, 1,1-dichloroethylene, and trichloroethylene.

15.6.3.1.2 Future On-Site Workers. The overall HI for the future on-site worker at Site 12C is calculated to be 28. This value exceeds the USEPA's risk management criterion of 1.0. The critical exposure pathway is ingestion of groundwater. The compound 1,1,1-trichloroethane is responsible for most of the hazard; 1,1-dichloroethylene and trichloroethylene are also noncarcinogenic COCs for this receptor.

15.6.3.2 Excess Lifetime Cancer Risks. The cancer risks for each receptor were determined from the pathway-specific exposure doses and the route-specific SFs, as described in Section 5.1.7.2. To assess the simultaneous exposure of a receptor population to multiple carcinogens from multiple exposure routes, ~~all of~~ the cancer risks calculated for a receptor population were summed. Each overall receptor cancer risk was then compared to USEPA's target risk range (1.0E-06 to 1.0E-04). If the total cancer risk for a receptor from ~~all~~ the exposure pathways is less than 1.0E-04, then it is concluded that the site(s) does not pose a significant risk to that receptor. If the overall cancer risk exceeds the target risk range, ~~any~~ a chemical individually associated with a risk level greater than 1.0E-05 is identified as a COC. COCs represent the primary contributors to the potential cancer risk for the receptor-specific exposure pathway under evaluation. Table W-9, Appendix W, documents the calculation of the pathway- and chemical-specific cancer risks for the human receptors at Site 12C. The pathway-specific and overall cancer risks are summarized in Table 15-13.

15.6.3.2.1 Future On-Site Residents. The overall cancer risks calculated for the future adults and toddlers living at Site 12C are 1.6E-02 and 7.3E-03, respectively. Both of these cancer risks exceed the USEPA's target risk range of 1.0E-06 to 1.0E-04. The critical

pathways are ingestion of and dermal contact with groundwater and inhalation of shower VOCs. Most of the cancer risk is due to exposure to 1,1-dichloroethylene. Other carcinogenic COCs for both receptors are 1,1,2-trichloroethane, trichloroethylene, and vinyl chloride. The compound 1,2-dichloroethane is also a carcinogenic COC for the future adult resident.

15.6.3.2.2 Future On-Site Workers. The overall cancer risk calculated for the future workers at Site 12C is 4.3E-03, which exceeds the USEPA's target risk range of 1.0E-06 to 1.0E-04. The critical exposure pathway is ingestion of groundwater. The primary carcinogenic COC for this receptor is 1,1-dichloroethylene. Other COCs are 1,1,2-trichloroethane, trichloroethylene, and vinyl chloride.

15.6.3.3 Uncertainty/Sensitivity Analysis. The numerical risks/hazards that are calculated for Site 12C represent *conditional* estimates of risk based on various simplifying assumptions concerning contaminant exposure and toxicity. These estimates of risk/hazard are derived using a series of conservative procedures that address contaminant concentrations at the site, their fate in the environment, how someone currently or in the future might be exposed to these contaminants, and the toxicity of each chemical toward humans. The uncertainty analysis specifies, when appropriate, the critical assumptions made for the site so that the site-specific results can be interpreted by risk managers in a proper context.

To assist the risk managers in this project, a qualitative uncertainty analysis has been performed. The primary goals of a qualitative uncertainty analysis are (1) to itemize the major areas of uncertainty in the site-specific risk assessment and (2) to demonstrate that the assessment overall has been conservatively performed (i.e., that the potential risks/hazards at the site have not likely been underestimated, but may have been significantly overestimated).

The qualitative uncertainty analysis for this site is presented in Table 15-14. Based on this analysis, it can be concluded that this risk assessment is conservative. Some of the major uncertainties in this study that are most influential to the risks/hazards that were calculated include:

- Maximum detected groundwater concentrations used

- Use of modeling to predict shower air concentrations

- Mass-balance considerations suggest insufficient chemical mass present at site to maintain exposure concentrations throughout 30-year exposure period

- Receptors' groundwater ingestion rate (2 L/day)

- Receptors' exposure frequency (350 days/year)

15.7 ECOLOGICAL RISK ASSESSMENT

Based on protocols established in the PERA (Rust E&I 1997g), there were no apparent potential ecological risks determined for Site 12C. As a result, no further ecological risk analysis has been undertaken.

15.8 CONCLUSIONS AND RECOMMENDATIONS

Unlike the other two solvent pit sites (Sites 12A and 12B), the Building 279 Solvent Pit (Site 12C) was found to contain solvent-related contamination in only one well located immediately downgradient of the former solvent pit. This indicates that the solvent contamination has not migrated very far from the source at this site.

Soil boring samples from the Phase I RI indicate that ~~no~~ soil contamination ~~remains~~was limited to the immediate area around the solvent pit. Four boreholes were drilled around the perimeter of the solvent pit, and the resulting soil samples did not contain detectable VOCs. The solvent pit and contaminated soils were excavated and disposed off-site at a regulated disposal facility in 2000. Confirmation sampling indicated that residual soils met PRGs.

Supplemental groundwater sampling performed in June 2001 confirmed previous sampling results at monitoring well MW88-15, but showed that chlorinated VOCs are being naturally attenuated and reduced. The 2001 data also showed that conditions in the groundwater near the source area at Site 12C appear to be favorable for continued natural attenuation of the chlorinated VOCs detected in groundwater samples. This assessment is based on an observed decrease of chlorinated VOC concentrations near the former source area, and the results of other indicator parameters at the site.

The results of the human health risk assessment indicate that risks to future residents exceed USEPA risk-based criteria. These risks are associated with potential exposure to contaminated groundwater. The chemical responsible for most of the estimated chronic health hazards is 1,1,1-trichloroethane. The chemical responsible for much of the cancer risk is 1,1-dichloroethylene. The risks to future on-site workers also were found to exceed USEPA risk-based criteria due primarily to exposure to the same two contaminants in groundwater.

Due to the elevated risks under potential future land use scenarios, it is recommended that Site 12C be carried forward to the FS for groundwater. Sufficient characterization of site contamination was performed during the Phase I and Phase II RI and no further investigation activities are ~~warranted~~necessary.

TABLES

TABLE 15-1a

Groundwater Monitoring Well Information Summary
Site 12C - Building 279
Jefferson Proving Ground
South of the Firing Line
Madison, Indiana

		Date	Location (ft)		Elevation (ft)		Well	Depth to Top	Well	Screen	Screen	Screened	Gradient
Site	Well ID	Installed	Northing	Easting	TOC	Ground	Depth (ft)	of Rock (ft)	Diameter (In)	Length (ft)	Interval (ft)	Unit	Relation
Site 12C	MW88-14	1988	NR	NR	867.30	NR	20.0	---	4.0	NR	NR	Till	Up/Side
	MW88-15	1988	NR	NR	867.75	NR	20.0	---	4.0	NR	NR	Till	Down
	MW88-16	1988	NR	NR	867.56	NR	20.0	---	4.0	NR	NR	Till	Down/Side
	MW93-42	05/21/93	486970.70	570792.05	864.72	865.06	48.0	39.2	4.0	10.4	37.6-48	Till/Bedrock	Up
	MW93-43	05/22/93	486982.22	570726.99	867.40	865.34	48.0	39.0	4.0	10.4	37.6-48	Till/Bedrock	Down
	MW95-07	11/07/95	487058.41	570823.79	867.79	868.36	48.3	38.5	4.0	10.0	38.3-48.3	Till/Bedrock	Up
	MW95-08	11/08/95	487054.61	570707.00	867.18	867.78	48.3	38.5	4.0	10.0	38.3-48.3	Till/Bedrock	Down
	MW95-09	11/09/95	487029.04	570770.40	867.59	868.18	47.8	38.5	4.0	10.0	37.8-47.8	Till/Bedrock	Down

General Notes:
1. Information summarized in this table was taken from the Draft Phase II Remedial Investigation (RI) by Rust Environmental and Infrastructure dated August 1998.
2. Horizontal coordinates relative to Indiana State Coordinates - East Zone, 1983. Vertical coordinate tied to JPG monuments relative to NAD1929.
3. NR = Information not reported in the Draft Phase II RI.
4. Well location and elevation data for sites 12A and 12B are from a December 2001 survey performed by Classickle Inc.

TABLE 15-1b

Summary of Monitoring Well Survey Data and Groundwater Elevations
Site 12C - Building 279
Jefferson Proving Ground
Madison, Indiana

	MW88-14	MW88-15	MW88-16	MW93-42	MW93-43	MW95-07	MW95-08	MW95-09
Elevations								
Top of Casing	867.30	867.75	867.56	864.72	867.40	867.79	867.18	867.59
Land Surface	NR	NR	NR	865.06	865.34	868.36	867.78	868.18
Top of Screen	NA	NA	NA	827.5	827.7	830.1	829.5	830.4
Well Bottom	NA	NA	NA	817.1	817.3	820.1	819.5	820.4
Top of Rock (ft)	NA	NA	NA	825.9	826.3	829.9	829.3	829.7
Well Depth	20.0	20.0	20.0	48.0	48.0	48.3	48.3	47.8
Screen Length	NR	NR	NR	10.4	10.4	10.0	10.0	10.0
Top of Rock (ft)	NR	NR	NR	39.2	39.0	38.5	38.5	38.5
Date	**Depth to Groundwater Below Top of Casing, In Feet**							
06/29/93	11.29	9.09	12.39	9.48	12.56	--	--	--
08/13/93	12.08	8.05	10.23	9.63	13.61	--	--	--
09/13/93	11.02	5.95	9.64	9.04	12.54	--	--	--
11/19/95	12.20	9.13	12.53	10.18	13.48	14.00	13.14	13.41
02/11/96	10.67	9.02	9.22	8.53	11.63	12.26	11.49	11.78
04/24/96	10.65	8.72	9.17	8.30	11.44	12.03	11.40	11.70
06/19/96	10.44	9.01	8.72	8.61	11.26	11.86	11.20	11.50
09/11/96	12.43	8.97	10.17	9.52	13.25	13.98	13.27	13.51
10/03/96	11.66	8.78	9.30	9.58	12.44	13.22	12.50	12.76
11/25/96	10.49	8.97	8.71	8.45	11.28	12.04	11.36	11.61
12/25/96	9.52	8.94	8.08	7.46	10.27	11.08	10.36	10.61
06/05/01	11.00	8.41	6.09	8.81	11.58	11.99	11.69	11.98
11/30/01	8.99	7.93	8.01	6.99	9.67	10.12	9.80	10.00
01/25/02	9.31	8.76	8.12	6.73	9.98	10.41	10.09	10.34
Date	**Groundwater Elevation, in Feet above MSL**							
06/29/93	856.01	858.66	855.17	855.24	854.84	--	--	--
08/13/93	855.22	859.70	857.33	855.09	853.79	--	--	--
09/13/93	856.28	861.80	857.92	855.68	854.86	--	--	--
11/19/95	855.10	858.62	855.03	854.54	853.92	853.79	854.04	854.18
02/11/96	856.63	858.73	858.34	856.19	855.77	855.53	855.69	855.81
04/24/96	856.65	859.03	858.39	856.42	855.96	855.76	855.78	855.89
06/19/96	856.86	858.74	858.84	856.11	856.14	855.93	855.98	856.09
09/11/96	854.87	858.78	857.39	855.20	854.15	853.81	853.91	854.08
10/03/96	855.64	858.97	858.26	855.14	854.96	854.57	854.68	854.83
11/25/96	856.81	858.78	NA	856.27	856.12	855.75	855.82	855.98
12/25/96	857.78	858.81	859.48	857.26	857.13	856.71	856.82	856.98
06/05/01	856.30	859.34	861.47	855.91	855.82	855.80	855.49	855.61
11/30/01	858.31	859.82	859.55	857.73	857.73	857.67	857.38	857.59
01/25/02	857.99	858.99	859.44	857.99	857.42	857.38	857.09	857.25

Notes:

1. All elevations recorded in Mean Sea Level (MSL) datum.
2. All depth measurements in feet.
3. NA = Data not available. Measurements were not collected on this day.
4. NR = Information not reported in the Draft Phase II RI.

TABLE 15-1c

Summary of Monitoring Well Survey Data and Groundwater Elevations
Site 12C - Building 279
Jefferson Proving Ground
Madison, Indiana

	WP96-01	WP96-02	WP96-03	WP96-04	WP96-05	WP96-06	WP96-32
Elevations							
Top of Casing	865.59	866.76	866.53	866.22	867.11	866.24	867.08
Land Surface							
Top of Screen							
Well Bottom							
Top of Rock (ft)							
Well Depth							
Screen Length							
Top of Rock (ft)							
Date	**Depth to Groundwater Below Top of Casing, In Feet**						
04/24/96	2.24	6.16	9.13	5.44	9.37	8.45	8.44
06/19/96	5.16	6.72	6.56	6.63	8.56	8.45	8.62
09/11/96	6.37	7.51	7.9	N	8.74	8.42	8.67
10/03/96	5.22	6.61	6.38	6.39	7.59	8.32	8.36
11/25/96	1.32	6.84	7.07	3.89	8.14	8.32	8.76
12/25/96	3.4	6.04	6.29	5.94	7.71	8.49	8.29
Date	**Groundwater Elevation, in Feet above MSL**						
04/24/96	863.35	860.60	857.4	860.78	857.74	857.79	858.64
06/19/96	860.43	860.04	859.97	859.59	858.55	857.79	858.46
09/11/96	859.22	859.25	858.63		858.37	857.82	858.41
10/03/96	860.37	860.15	860.15	859.83	859.52	857.92	858.72
11/25/96	864.27	859.92	859.46	862.33	858.97	857.92	858.32
12/25/96	862.19	860.72	860.24	860.28	859.4	857.75	858.79

Notes:

1. All elevations recorded in Mean Sea Level (MSL) datum.
2. All depth measurements in feet.
3. NA = Data not available. Measurements were not collected on this day.
4. NR = Information not reported in the Draft Phase II RI.

TABLE 15-2

Bedrock Groundwater Hydraulic Gradients
Site 12C - Building 279
Jefferson Proving Ground
Madison, Indiana

Date	Hydraulic Gradient (feet/feet)	Direction (From Solvent Pit)
June 1993	NA[a]	NA
August 1993	NA	NA
September 1993	NA	NA
November 1995	0.002	West
February 1996 *	0.011	West-Southwest
April 1996	0.0075	West-Southwest
June 1996 *	0.008	West-Southwest
September 1996	0.017	North
October 1996	0.0075	West-Southwest
November 1996	0.0075	West-Southwest
December 1996	0.010	North
June 2001	0.0003	Northeast
November 2001	0.0003	Northeast

Note:
The maximum gradient equals 0.017 feet/feet; the minimum gradient, 0.002 feet/feet; and the average gradient, 0.009 feet/feet.
*Groundwater high centered near solvent pit.

Footnote:
(a) Not applicable.

TABLE 15-2a

Vertical Hydraulic Gradients at Well Nests
Site 12C - Building 279
Jefferson Proving Ground
Madison, Indiana

Site	Well Nest (shallow)	Well Nest Deep)	Gradient 5-Jun-01	Gradient 30-Nov-01	Gradient 25-Jan-02
12C	MW88-15	MW095-09	-0.1340	-0.080	-0.063

Notes:
1. A negative sign (-) indicates a downgradient gradient.
2. NA = Water level data not available for this date.

TABLE 15-3

Hydraulic Conductivity (K) and Seepage Velocity of Glacial Till Near Site 12C
Site 12C - Building 279
Jefferson Proving Ground
Madison, Indiana

HYDRAULIC CONDUCTIVITY

Observation Well	Pumping Well	K cm/sec[(a)]	Method
WP96-32	MW88-15	$9.3\ 10^{-5}$	Cooper-Jacob
WP96-32	MW88-15	$3.1\ 10^{-5}$	Theis
MW88-14/MW88-16	MW93-42	$2.4\ 10^{-4}$	Distance Drawdown
	Average Value	$8.2\ 10^{-5}$	

SEEPAGE VELOCITY

Hydraulic Conductivity (cm/sec)	Gradient (foot/foot)	Effective Porosity (Dimensionless)	Seepage Velocity (feet/day)	(feet/year)
$2.4\ 10^{-4}$/K-max	0.03	0.15	0.14	50
	0.03	0.30	0.07	24
$3.1\ 10^{-5}$/K-min	0.03	0.15	0.02	6.4
	0.03	0.30	0.01	3.2
$1.2\ 10^{-4}$/K-average	0.03	0.15	0.07	25
	0.03	0.30	0.03	12

Footnote:
(a) Centimeter per second.

TABLE 15-14

Qualitative Uncertainty Analysis
Site 12C - Building 279
Jefferson Proving Ground
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
A. Human Behavior				
Future receptors' exposure duration	30 years	Medium	Medium	National upper-bound time (90th percentile) at one residence
Future receptors' exposure frequency	350 days/year	Medium	Medium	High-end value
Future receptors' water ingestion rate	2 L/day	Low	High	Water consumption rates are high-end values obtained from published distribution data
Exclusion of certain exposure pathways in the quantitative analysis	NA[(a)]	Low	Low	Pathways eliminated are those that have low possibility of contributing risk to these receptors
B. Chemical Fate/Transport in the Environment				
Groundwater exposure point concentration of COC[(b)]	Maximum detected value	Low	High	Site average would be lower
Mass balance	NA	Low	High	Insufficient mass of chemicals likely present in groundwater to maintain exposure throughout 30-year exposure duration due to highly limited contaminated area
Use of modeling to predict shower air concentrations	NA	Low	High	Conservative assumptions and input parameters

TABLE 15-14

Qualitative Uncertainty Analysis
Site 12C - Building 279
Jefferson Proving Ground
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
C. Chemical Toxicity				
Assumption that USEPA[c] reference doses truly represent toxicological thresholds	NA	Low	High	High degree of conservativeness utilized by USEPA in deriving RfDs[d] from toxicological literature
Assumption that USEPA carcinogenic slope factors truly represent dose-response phenomena	NA	Low-moderate	Moderate-high	Use of linearized, multi-stage mathematical model to predict cancer incidence at low exposure levels is USEPA policy; not currently supported by scientific data
Assumption of risk/hazard additivity	NA	Moderate	Moderate	Summation of chemical-specific risks/hazards may over- or under-predict risks/hazards to receptors
Screening out of certain contaminants based on USEPA criteria	NA	Low	Low	Chemicals present in concentrations less than USEPA criteria eliminated

Footnotes:
(a) Not applicable or not available.
(b) Contaminant of concern.
(c) U.S. Environmental Protection Agency.
(d) Reference doses.

TABLE 15-5

Groundwater Seepage Velocities Sensitivity Analysis
Site 12C - Building 279
Jefferson Proving Ground
Madison, Indiana

Hydraulic Conductivity (K) (centimeter/second)	Gradient (foot/foot)	Effective Porosity (Dimensionless)	Seepage Velocity (feet/day)	Seepage Velocity (feet/year)
7.67 10^{-4}				
Average K-max	0.017	0.01	3.7	1350
Bedrock Test	0.017	0.15	0.25	90
	0.017	0.30	0.12	45
	0.002	0.01	0.43	159
	0.002	0.15	0.03	11
	0.002	0.30	0.01	5
	0.009	0.01	1.9	714
	0.009	0.15	0.13	47
	0.009	0.30	0.07	24
1.28 10^{-4} cm/sec				
Average K-min	0.017	0.01	0.62	225
Bedrock Test	0.017	0.15	0.04	15
	0.017	0.30	0.02	7.5
	0.002	0.01	0.07	26
	0.002	0.15	0.005	2
	0.002	0.30	0.002	1
	0.009	0.01	0.33	119
	0.009	0.15	0.02	8
	0.009	0.30	0.01	4
2.6 10^{-4} cm/sec				
Average K Value	0.017	0.01	1.3	457
Bedrock Test	0.017	0.15	0.08	30
	0.017	0.30	0.04	15
	0.002	0.01	0.15	54
	0.002	0.15	0.01	4
	0.002	0.30	0.005	2
	0.009	0.01	0.67	242
	0.009	0.15	0.04	16
	0.009	0.30	0.02	8

TABLE 15-6

Summary of Organic Contaminants Detected in Groundwater Samples
Site 12C - Building 279
Jefferson Proving Ground
Madison, Indiana

Sample Identification	Sample Location	Sample Date	Sample Type	VOCs (ug/L) ACETONE	CARBON DISULFIDE	1,1,1-TRICHLOROETHANE	1,1,2-TRICHLOROETHANE	1,1-DICHLOROETHANE	1,1-DICHLOROETHENE	1,2-DICHLOROETHANE	CHLOROETHANE	cis-1,2-DICHLOROETHYLENE	METHYLENE CHLORIDE	TOLUENE	trans-1,2-DICHLOROETHENE	TRICHLOROETHYLENE (TCE)	VINYL CHLORIDE
JPG-S12CMW88-14	**MW88-14**	1/26/1994	N	LT 8.00	ND 5.00 R	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 8.00	LT 5.00	LT 1.00	LT 1.00	NA	LT 1.00	LT 12.0
		11/17/1995	N	LT 5.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	NA	LT 1.00	LT 1.00
		2/20/1996	N	LT 5.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	NA	LT 1.00	LT 1.00
		5/10/1996	N	LT 5.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	NA	LT 1.00	LT 1.00
		6/27/1996	N	LT 5.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	NA	LT 1.00	LT 1.00
		6/12/2001	N	10(U / R')	1(U /)	1(U /)	1(U / R2)	1(U /)	1(U /)	1(U / UJ)	1(U / R)	1(U /)	5(U /)	1(U /)	1(U /)	1(U /)	1(U /)
JPG-S12CMW88-15	**MW88-15**	1/26/1994	N	LT 2,000	ND 1,000 R	**10,000**	LT 200	**3,000**	LT 200	LT 200	LT 2000	LT 5.00	LT 200	LT 200	NA	**600**	LT 12.0
		11/17/1995	N	31	LT 1.00	**27,500**	**48.0**	**3,750**	**750**	**13.0**	LT 1.00	48.0	LT 1.00	180	NA	**930**	**3.60**
		2/20/1996	N	LT 500	LT 100	**32,000**	LT 100	**5,000**	**1,000**	LT 100	LT 1.00	LT 100	LT 1.00	130	NA	**1,100**	LT 100
		5/10/1996	N	LT 500	LT 100	**70,000**	**89.0**	**7,000**	**2,600**	LT 100	LT 1.00	LT 100	LT 1.00	260	NA	**1,900**	LT 100
		6/27/1996	N	LT 2500	LT 100	**71,500**	LT 500	**7,000**	**3,850**	LT 500	LT 1.00	LT 500	LT 1.00	335	NA	**2,400**	LT 500
		6/12/2001	N	10(U / R')	1(U /)	**1600**	**4.9**	**1200**	**120**	**2.2**	2.3(/ J)	3.6	0.32(J / 5U)	1(U /)	1.5	**77(J /)**	**0.87(J / 1U)**
JPG-S12CMW01-55	**MW88-15**	6/12/2001	FD	10(U / R')	1(U /)	**2000**	**6.4(/ J')**	**1300**	**130**	1(U / UJ)	2.6(/ J)	4.4	5(U /)	1.9	1(U /)	**140**	**2.1**
JPG-S12CMW88-16	**MW88-16**	8/17/1993	N	LT 8.00	ND 5.00 R	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 8.00	LT 5.00	LT 1.00	LT 1.00	NA	LT 1.00	LT 12.0
		11/17/1995	N	LT 5.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	NA	LT 1.00	LT 1.00
		2/20/1996	N	LT 5.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	NA	LT 1.00	LT 1.00
		5/10/1996	N	LT 5.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	NA	LT 1.00	LT 1.00
		6/27/1996	N	LT 5.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	NA	LT 1.00	LT 1.00
		6/11/2001	N	10(U / R')	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	5(U /)	1(U /)	1(U /)	1(U /)	1(U /)
JPG-S12CMW93-42	**MW93-42**	1/26/1994	N	LT 8.00	ND 5.00 R	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 8.00	LT 5.00	LT 1.00	LT 1.00	NA	LT 1.00	LT 12.0
		11/17/1995	N	LT 5.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	NA	LT 1.00	LT 1.00
		2/20/1996	N	LT 5.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	NA	LT 1.00	LT 1.00
		5/10/1996	N	LT 5.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	NA	LT 1.00	LT 1.00
		6/27/1996	N	LT 5.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	NA	LT 1.00	LT 1.00
		6/12/2001	N	10(U / R')	1(U /)	1(U /)	1(U / R2)	1(U /)	1(U /)	1(U / UJ)	1(U / R)	1(U /)	5(U /)	1(U /)	1(U /)	1(U /)	1(U /)
JPG-S12CMW93-43	**MW93-43**	1/26/1994	N	LT 8.00	ND 5.00 R	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 8.00	LT 5.00	LT 1.00	LT 1.00	NA	LT 1.00	LT 12.0
		11/17/1995	N	LT 5.00	LT 1.00	11	LT 1.00	LT 1.00	**0.25**	LT 1.00	LT 1.00	LT 1.00	LT 1.00	0.31	NA	**9.20**	LT 1.00
		2/20/1996	N	LT 5.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	NA	**4.40**	LT 1.00
		5/10/1996	N	LT 5.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	NA	**5.90**	LT 1.00
		6/27/1996	N	LT 5.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	NA	**4.30**	LT 1.00
		6/12/2001	N	10(U / R')	1(U /)	1(U /)	1(U / R2)	1(U /)	1(U /)	1(U / UJ)	1(U / R)	1(U /)	5(U /)	1(U /)	1(U /)	1(U /)	1(U /)
JPG-S12CMW95-07	**MW95-07**	11/17/1995	N	LT 5.00	LT 1.00	1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	NA	LT 1.00	LT 1.00
		2/20/1996	N	LT 5.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	NA	**91.0**	LT 1.00
		5/10/1996	N	LT 5.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	NA	LT 1.00	LT 1.00
		6/27/1996	N	LT 5.00 R	0.37	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	NA	**27.0**	LT 1.00
		6/12/2001	N	10(U / R')	1(U /)	1(U /)	1(U / R2)	1(U /)	1(U /)	1(U / UJ)	1(U / R)	1(U /)	5(U /)	1(U /)	1(U /)	1(U /)	1(U /)
JPG-S12CMW95-08	**MW95-08**	11/17/1995	N	LT 5.00	LT 1.00	1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	NA	LT 1.00	LT 1.00
		2/20/1996	N	LT 5.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	NA	LT 1.00	LT 1.00
		5/10/1996	N	LT 5.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	NA	LT 1.00	LT 1.00
		6/27/1996	N	LT 5.00 R	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	NA	LT 1.00	LT 1.00
		6/11/2001	N	10(U / R')	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	1(U /)	1(U/)	5(U /)	1(U /)	1(U /)	1(U /)	1(U /)
JPG-S12CMW95-09	**MW95-09**	11/17/1995	N	LT 5.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	NA	LT 1.00	LT 1.00
		2/20/1996	N	LT 5.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	NA	LT 1.00	LT 1.00
		5/10/1996	N	LT 5.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	NA	0.34	LT 1.00
		6/27/1996	N	LT 5.00 R	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	LT 1.00	NA	LT 1.00	LT 1.00
		6/12/2001	N	10(U / R')	1(U /)	1(U /)	1(U / R2)	1(U /)	1(U /)	1(U / UJ)	1(U / R)	1(U /)	5(U /)	1(U /)	1(U /)	1(U /)	1(U /)
			PRGs (1)	610	1000	540	0.2	810	0.046	0.12	4.6	61	4.3	720	120	1.6	0.041

General Notes:

1. (LF / VF) = Lab Flag / Validation Flag
2. Only detectd compounds are listed in this table
3. ug/L = Micrograms per liter
4. VOCs = Volatile organic compounds
5. Sample Types:
   "N" = Normal field Sample
   "FD" = Field Duplicate
6. LT = Less than the reporting limit, analytical results presented by Earthtech
7. ND = Not detected
8. NA = Prior to 2001, results for 1, 2-dichloroethylene (1, 2-DCE) were reported as the total of cis- and trans- isomers with the total result reported in the column for cis-1, 2-DCE
9. PRGs = Preliminary Remediation Goals
10. U = Compound was not detected
11. R = Analytical data was rejected
12. J = Estimated value. The result is less than the reporting limit, but greater than the maximum detection limit.
13. Bolded results indicate a PRG exceedance

Footnotes:

(1) PRGs = Preliminary Remediation Goals from US EPA Region 9 for Tap Water

TABLE 15-6a

Summary of Inorganic and Indicator Parameters Detected in Groundwater Samples
Site 12C - Building 279
Jefferson Proving Ground
Madison, Indiana

				Metals		General Chem					Gas				Field NA						
				IRON	MANGANESE	ALKALINITY, TOTAL (AS CaCO3)	CHLORIDE (AS CL)	NITROGEN, KJELDAHL, TOTAL	NITROGEN, NITRATE (AS N)	SULFATE (AS SO4)	CARBON DIOXIDE	ETHANE	ETHENE	METHANE	DISSOLVED OXYGEN	FERROUS IRON	OXIDATION-REDUCTION POTENTIAL	pH	SPECIFIC CONDUCTANCE	TEMPERATURE	TURBIDITY
Sample Identification	**Sample Location**	**Sample Date**	**Sample Type**	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	ug/L	mg/L	mg/L	mV	S. U.	umhos/cm	Deg C	NTU
JPG-S12CMW88-14	MW88-14	6/12/2001	N	0.0717	0.0048(J / U)	120	16.4	0.315(/ J)	0.1(U /)	8.82	0.338	1.3(U /)	1.2(U /)	56(/ J)	4.84	0.3	-56	11.49	486	22.6	4.9
JPG-S12CMW88-15	MW88-15	6/12/2001	N	0.105	0.036	379	34.9	0.263(/ J)	0.1(U /)	8.62	43.3	0.29(J / U)	1.2(U /)	0.77(J / U)	5.68	0.1	105	7.33	847	22.5	0.0
JPG-S12CMW01-55	MW88-15	6/12/2001	FD	0.0934	0.0626	369	37	0.347(/ J)	0.1(U /)	8.16	41.6	1.3(U /)	1.2(U /)	1.3(/ J)	NA	NA	NA	NA	NA	NA	NA
JPG-S12CMW88-16	MW88-16	6/11/2001	N	0.158	0.0986	454	16.1	0.456	0.1(U /)	8.22	30	1.3(U /)	1.2(U / UJ)	2.2	5.06	0.1	21	7.15	910	19.2	0.0
JPG-S12CMW93-42	MW93-42	6/12/2001	N	0.574	0.111	405	14.5	0.244(/ J)	0.168	7.74	42.9	1.3(U /)	1.2(U /)	0.96(J / U)	5.15	0.1	66	7.33	838	20.6	0.0
JPG-S12CMW93-43	MW93-43	6/12/2001	N	4.65	0.103	410	14.1	0.54(/ J)	0.1(U /)	8.27	37.5	1.3(U /)	1.2(U /)	2.1(/ J)	0.0	1.5	-172	7.23	828	18.11	23.9
JPG-S12CMW95-07	MW95-07	6/12/2001	N	0.334	0.0203	149	14.7	0.398(/ J)	0.1(U /)	9.07	0.382	0.58(J / U)	1.2(U /)	2.1(/ J)	1.01	2.5	-48	10.72	403	18.02	51.8
JPG-S12CMW95-08	MW95-08	6/11/2001	N	0.894	0.0351	438	1.76	0.283(/ J)	0.1(U /)	10.1	46.6	1.3(U /)	1.2(U / UJ)	1(U /)	2.2	0.2	127	7.22	813	21.42	20.2
JPG-S12CMW95-09	MW95-09	6/12/2001	N	1.88	0.0754	410	19.3	0.305(/ J)	0.1(U /)	11.2	44	1.3(U /)	1.2(U /)	2.1(/ J)	0.08	0.3	-97	7.24	899	20.1	66

General Notes:

1. (LF / VF) = Lab Flag / Validation Flag
2. S.U. = Standard Units
3. ug/L = Micrograms per liter.
4. mg/L = Milligrams per liter
5. Sample Types:
   "N" = Normal field Sample
   "FD" = Field Duplicate
6. NA = Sample not analyzed for this analyte
7. NTU = Nephelometric Turbidity Units
8. U = Compound was not detected
9. R = Analytical data was rejected
10. J = Estimated value. The result is less than the reporting limit, but greater than the maximum detection limit.

TABLE 15-6b

Reductive Dechlorination Scoring
Site 12C - Building 279
Jefferson Proving Ground
Madison, Indiana

Natural Attenuation Screening Protocol	Interpretation	Score	
The following is taken from the USEPA protocol (USEPA, 1998). The results of this scoring process have no regulatory significance.	Inadequate evidence for anaerobic biodegradation* of chlorinated organics	0 to 5	Score: 22
	Limited evidence for anaerobic biodegradation* of chlorinated organics	6 to 14	
	Adequate evidence for anaerobic biodegradation* of chlorinated organics	15 to 20	
	Strong evidence for anaerobic biodegradation* of chlorinated organics	>20	Scroll to End of Table

*reductive dechlorination

Analysis	Concentration in Most Contam. Zone	Interpretation	Yes	No	Points Awarded
Oxygen*	<0.5 mg/L	Tolerated, suppresses the reductive pathway at higher concentrations		●	0
	>5 mg/L	Not tolerated; however, VC may be oxidized aerobically		●	0
Nitrate*	<1 mg/L	At higher concentrations may compete with reductive pathway	●		2
Iron II*	>1 mg/L	Reductive pathway possible; VC may be oxidized under Fe(III)-reducing conditions	●		3
Sulfate*	<20 mg/L	At higher concentrations may compete with reductive pathway		●	0
Sulfide*	>1 mg/L	Reductive pathway possible			0
Methane*	<0.5 mg/L	VC oxidizes		●	0
	>0.5 mg/L	Ultimate reductive daughter product, VC Accumulates	●		3
Oxidation Reduction Potential* (ORP)	<50 millivolts (mV)	Reductive pathway possible	●		1
	<-100 mV	Reductive pathway likely	●		2
pH*	5 < pH < 9	Optimal range for reductive pathway	●		0
	5 > pH > 9	Outside optimal range for reductive pathway		●	0
TOC	>20 mg/L	Carbon and energy source; drives dechlorination; can be natural or anthropogenic	●		2
Temperature*	>20°C	At T > 20°C biochemical process is accelerated		●	0
Carbon Dioxide	>2x background	Ultimate oxidative daughter product	●		1
Alkalinity	>2x background	Results from interaction of carbon dioxide with aquifer minerals		●	0
Chloride*	>2x background	Daughter product or organic chlorine	●		2
Hydrogen	>1 nM	Reductive pathway possible, VC may accumulate			0
	<1 nM	VC oxidized			0
Volatile Fatty Acids	>0.1 mg/L	Intermediates resulting from biodegradation of aromatic compounds; carbon and energy source			0
BTEX*	>0.1 mg/L	Carbon and energy source; drives dechlorination		●	0
PCE*		Material released		●	0
TCE*		Material released		●	0
		Daughter product of PCE(a)		●	0
DCE*		Material released		●	0
		Daughter product of TCE. If cis is greater than 80% of total DCE, it is likely a daughter product of TCE(a), 1,1-DCE can be a chem. reaction product of TCA		●	0
VC*		Material released		●	0
		Daughter product of DCE(a)		●	0
1,1,1-Trichloroethane*		Material released	●		0
DCA		Daughter product of TCA under reducing conditions	●		2
Carbon Tetrachloride		Material released		●	0
Chloroethane*		Daughter product of DCA or VC under reducing conditions	●		2
Ethene/Ethane	>0.01 mg/L	Daughter product of VC/ethene		●	0
	>0.1 mg/L	Daughter product of VC/ethene		●	0
Chloroform		Material released		●	0
		Daughter product of Carbon Tetrachloride	●		2
Dichloromethane		Material released			0
		Daughter product of Chloroform			0

*required analysis.
(a) points awarded only if it can be shown that the compound is a daughter product (i.e., not a constituent of the source NAPL).

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TABLE 15-7

Soil Exposure Point Concentrations of Contaminants of Potential Concern
Site 12C - Building 279
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/g)[b]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[c] (µg/g)
Surface Soil						
No chemicals were detected in surface soil at this site.						
Surface/Subsurface Soil						
Toluene	1/12	0.620	0.10	0.098	0.14	0.14

Footnotes:
(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Micrograms per gram.
(c) The 95% UCL (upper confidence limit of the mean) or the maximum detected value, whichever is lower (USEPA 1989b).

TABLE 15-8

Selection of Contaminants of Potential Concern (COPCs) in Soil Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 12C - Building 279
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screening Data		
Chemical	**Residential PRG (μg/g)[(a)]**	**Exposure Point Concentration (μg/g)**	**Retained as Soil COPC?**
Surface/Subsurface Soil Combined			
Toluene	79.3	0.14	No

Note:
PRGs were taken directly from the Region 9 PRG Table (USEPA 1998).
Value for toluene was 1/10 of the Region 9 PRG.

Footnote:
(a) Micrograms per gram.

TABLE 15-9

Selection of Contaminants of Potential Concern (COPCs) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 12C - Building 279
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Ambient Air PRG (μg/m³)[(a)]**	**Exposure Point Concentration (μg/m³)**	**Retained as Air COPC?**
Residential Scenario			
Aluminum	NA[(b)]	7.11E-03	**YES**
Arsenic	4.5E-04	2.35E-06	No
Barium	5.2E-02	4.19E-05	No
Beryllium	8.0E-04	1.84E-07	No
Cadmium	1.1E-03	8.16E-08	No
Chromium	2.3E-05	1.15E-05	No
Lead	1.5E+00[(c)]	6.04E-06	No
Manganese	5.1E-03	6.15E-04	No
Silver	NA	1.27E-05	**YES**
Thallium	NA	2.50E-06	**YES**
Vanadium	NA	1.15E-06	**YES**
Zinc	NA	4.17E-06	**YES**
Dioxins/Furans	4.5E-08	1.81E-13	No
Benzo(a)anthracene	9.2E-03	7.50E-09	No
Benzo(a)pyrene	9.2E-04	2.60E-08	No
Benzo(b)fluoranthene	9.2E-03	5.17E-08	No
DDE	2.0E-02	4.41E-09	No
Dibenz(a,h)anthracene	9.2E-04	8.82E-10	No
Dieldrin	4.2E-04	NA	No
Indeno(1,2,3-cd)pyrene	9.2E-03	4.40E-09	No
1,1-Dichloroethylene	3.8E-02	1.56E-09	No
Chlorobenzene	2.1E+00	1.83E-06	No

TABLE 15-9

Selection of Contaminants of Potential Concern (COPCs) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 12C - Building 279
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Ambient Air PRG (µg/m³)(a)**	**Exposure Point Concentration (µg/m³)**	**Retained as Air COPC?**
Industrial Scenario			
Aluminum	NA	1.30E-02	**YES**
Arsenic	4.5E-04	6.21E-06	No
Barium	5.2E-02	5.33E-05	No
Beryllium	8.0E-04	4.22E-07	No
Cadmium	1.1E-03	1.33E-07	No
Chromium	2.3E-05	3.31E-05	**YES**
Lead	1.5E+00(c)	6.04E-06	No
Manganese	5.1E-03	8.79E-04	No
Silver	NA	1.27E-05	**YES**
Thallium	NA	2.50E-06	**YES**
Vanadium	NA	2.37E-06	**YES**
Zinc	NA	6.00E-05	**YES**
Dioxins/Furans	4.5E-08	2.83E-12	No
Benzo(a)anthracene	9.2E-03	7.50E-09	No
Benzo(a)pyrene	9.2E-04	2.75E-08	No
Benzo(b)fluoranthene	9.2E-03	5.17E-08	No
DDE	2.0E-02	4.41E-09	No
Dibenz(a,h)anthracene	9.2E-04	8.82E-10	No
Dieldrin	4.2E-04	4.41E-08	No
Indeno(1,2,3-cd)pyrene	9.2E-03	4.41E-09	No
1,1-Dichloroethylene	3.8E-02	1.56E-09	No
Chlorobenzene	2.1E+00	1.83E-06	No

Notes:

PRGs were taken directly from the Region 9 PRG Table (USEPA 1998). Values for noncarcinogens are 1/10 of the Region 9 PRG.
EPCs are calculated and presented in Tables R-4 and R-6 in Appendix R.

Footnotes:

(a) Micrograms per cubic meter.
(b) Not applicable.
(c) Federal ambient air quality criterion for lead.

TABLE 15-10

Groundwater Exposure Point Concentrations of Contaminants of Potential Concern
Site 12C - Building 279
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/L)[b]	Range of Reporting Limits (µg/L)	Arithmetic Mean Concentration (µg/L)	95% UCL Concentration (µg/L)	Exposure Point Concentration[c] (µg/L)
1,1-Dichloroethane	1/7	5,406	1.0	773	1.4E+11	5,406
1,1-Dichloroethylene	2/7	0.25 - 1,994	1.0	285	8.1E+8	1,994
1,1,1-Trichloroethane	2/7	3.13 - 47,100	1.0	6,729	4.8E+15	47,100
1,1,2-Trichloroethane	1/7	59.7	1.0	8.9	561	59.7
1,2-Dichloroethane	1/7	10.2	1.0	1.9	10.7	10.2
1,2-Dichloroethylene (mixed isomers)	1/7	37.5	1.0	12.9	13,027	37.5
Acetone	1/7	24.5	5.0	5.6	16.8	16.8
Carbon disulfide	1/7	0.37	1.0	0.48	0.53	0.37
Chloroethane	1/7	2.4	1.0	0.77	1.4	1.4
Methylene chloride	3/7	0.50 - 0.56	1.0	0.51	0.53	0.53
Toluene	2/7	0.31 - 210	1.0	30.3	31,571	210
Trichloroethylene	1/7	1,520	1.0	218	2.5E+8	1,520
Vinyl chloride (chloroethene)	1/7	2.7	1.0	0.81	1.7	1.7

Footnotes:
- (a) Number of locations in which the analyte was detected/total number of locations sampled. Data from the seven downgradient wells (MW93-42, MW93-43, MW95-7, MW95-8, MW95-9, MW88-15, and MW88-16) were used in the calculations.
- (b) Micrograms per liter.
- (c) The 95% UCL (upper confidence limit of the mean) or the maximum detected value, whichever is lower (USEPA 1989b).

TABLE 15-11

Selection of Contaminants of Potential Concern (COPCs) in Groundwater Based on USEPA Region 9 Preliminary Remediation Goals (PRGs) Site 12C - Building 279 Jefferson Proving Ground Madison, Indiana

	USEPA Region 9 PRG Screening Data		
Chemical	**Tap Water PRG (µg/L)[(a)]**	**Exposure Point Concentration (µg/L)**	**Retained as GW COPC?**
1.1-Dichloroethane	81	5.406	**YES**
1,1-Dichloroethylene	0.046	1,994	**YES**
1,1,1-Trichloroethane	79	47,100	**YES**
1,1,2-Trichloroethane	0.20	59.7	**YES**
1,2-Dichloroethane	0.123	10.2	**YES**
1,2-Dichloroethylene (mixed isomers)	5.48	37.5	**YES**
Acetone	60.8	16.8	No
Carbon disulfide	2.1	0.37	No
Chloroethane (ethyl chloride)	70.5	1.4	No
Methylene chloride	7.8	0.53	No
Toluene	72.3	210	**YES**
Trichloroethylene	1.64	1,520	**YES**
Vinyl chloride	0.02	1.7	**YES**

Notes:

PRGs were taken directly from the Region 9 PRG Table (USEPA 1998).
Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnote:

(a) Micrograms per liter.

TABLE 15-12

Shower Air Concentrations of Volatile Organic Compounds
Site 12C – Building 279 Solvent Pit
Jefferson Proving Ground
Madison, Indiana

Volatile Chemical	Exposure Point Concentration in Groundwater (µg/L[a] = mg/m^3 [b])	Exposure Point Concentration in Shower Air (mg/m^3)
1,1-Dichloroethane	5,406	1.80E+01
1,1-Dichloroethylene	1,994	6.92E+00
1,1,1-Trichloroethane	47,100	1.38E+02
1,1,2-Trichloroethane	59.7	1.40E-01
1,2-Dichloroethane	10.2	2.77E-02
1,2-Dichloroethylene	37.5	1.27E-01
Toluene	210	7.29E-01
Trichloroethylene	1,520	4.46E+00
Vinyl chloride	1.7	7.40E-03

Notes:
Exposure point concentrations in shower air are calculated in Appendix T.

Footnotes:
(a) Micrograms per liter.
(b) Milligrams per cubic meter.

TABLE 15-13

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 12C - Building 279
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
		Future On-site Resident Adult		
Inhalation of VOCs[a] and fugitive dusts	NA[b]		0.0010	
Ingestion of groundwater	1.42E-02	1,1-DCE (98%); 1,1,2-TCA (<1%); 1,2-DCA (<1%); TCE (1.4%); vinyl chloride (<1%)	79.5641	1,1-DCA (2%); 1,1-DCE (8%); 1,1,1-TCA (81%); TCE (9%)
Dermal contact with groundwater	6.93E-04	1,1-DCE (98%); TCE (2%)	4.7865	1,1,1-TCA (98%)
Inhalation of shower VOCs	1.25E-03	1,1-DCE (97%); TCE (2%)	1.6697	1,1,1-TCA (67%)
Total	1.61E-02	Total	86.0213	
		Future On-site Resident Child		
Inhalation of VOCs and fugitive dusts	NA		0.0038	
Ingestion of groundwater	6.67E-03	1,1-DCE (98%); 1,1,2-TCA (<1%); TCE (1.4%); vinyl chloride (<1%)	185.6496	1,1-DCA (2%); 1,1-DCE (8%); 1,1,1-TCA (81%); TCE (9%)
Dermal contact with groundwater	1.32E-04	1,1-DCE (98%)	4.5571	1,1,1-TCA (98%)
Inhalation of shower VOCs	4.85E-04	1,1-DCE (97%); TCE (2%)	3.2348	1,1,1-TCA (67%)
Total	7.29E-03	Total	193.4453	

TABLE 15-13

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 12C - Building 279
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
		Future On-site Worker		
Inhalation of VOCs and fugitive dusts	2.27E-08		0.0004	
Ingestion of groundwater	4.26E-03	1,1-DCE (98%); 1,1,2-TCA (<1%); TCE (1.4%); vinyl chloride (<1%)	28.4158	1,1-DCE (8%); 1,1,1-TCA (81%); TCE (9%)
Total	4.26E-03	Total	28.4162	

Notes:
1,1-DCE = 1,1-Dichloroethylene;
1,1,2-TCA = 1,1,2-Trichloroethane;
1,2-DCA = 1,2-Dichloroethane;
1,1-DCA = 1,1-Dichloroethane;
1,1,1-TCA = 1,1,1-Trichloroethane;
TCE = Trichloroethylene

Footnotes:
(a) Volatile organic compounds.
(b) Not applicable or not available.

TABLE 15-14

Qualitative Uncertainty Analysis
Site 12C - Building 279
Jefferson Proving Ground
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
A. Human Behavior				
Future receptors' exposure duration	30 years	Medium	Medium	National upper-bound time (90th percentile) at one residence
Future receptors' exposure frequency	350 days/year	Medium	Medium	High-end value
Future receptors' water ingestion rate	2 L/day	Low	High	Water consumption rates are high-end values obtained from published distribution data
Exclusion of certain exposure pathways in the quantitative analysis	NA[(a)]	Low	Low	Pathways eliminated are those that have low possibility of contributing risk to these receptors
B. Chemical Fate/Transport in the Environment				
Groundwater exposure point concentration of COC[(b)]	Maximum detected value	Low	High	Site average would be lower
Mass balance	NA	Low	High	Insufficient mass of chemicals likely present in groundwater to maintain exposure throughout 30-year exposure duration due to highly limited contaminated area
Use of modeling to predict shower air concentrations	NA	Low	High	Conservative assumptions and input parameters

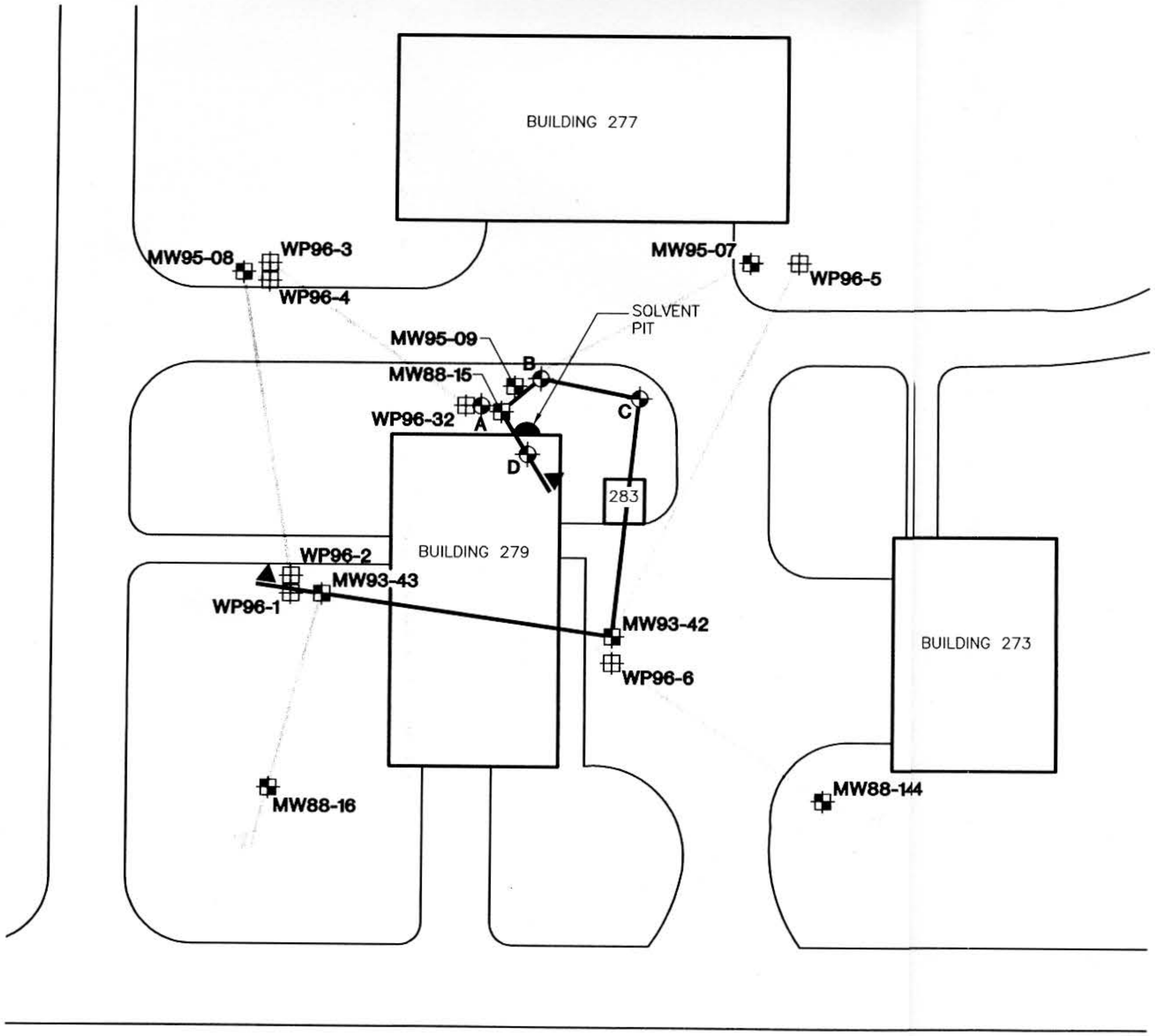
TABLE 15-14

Qualitative Uncertainty Analysis
Site 12C - Building 279
Jefferson Proving Ground
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
C. Chemical Toxicity				
Assumption that USEPA[c] reference doses truly represent toxicological thresholds	NA	Low	High	High degree of conservativeness utilized by USEPA in deriving RfDs[d] from toxicological literature
Assumption that USEPA carcinogenic slope factors truly represent dose-response phenomena	NA	Low-moderate	Moderate-high	Use of linearized, multi-stage mathematical model to predict cancer incidence at low exposure levels is USEPA policy; not currently supported by scientific data
Assumption of risk/hazard additivity	NA	Moderate	Moderate	Summation of chemical-specific risks/hazards may over- or under-predict risks/hazards to receptors
Screening out of certain contaminants based on USEPA criteria	NA	Low	Low	Chemicals present in concentrations less than USEPA criteria eliminated

Footnotes:
(a) Not applicable or not available.
(b) Contaminant of concern.
(c) U.S. Environmental Protection Agency.
(d) Reference doses.

FIGURES



LEGEND

Symbol	Description
B	SOIL BORING LOCATION AND LETTER DESIGNATION
WP96-5	TEMPORARY WELL LOCATION AND NUMBER
MW95-07	MONITORING WELL LOCATION AND NUMBER
▲——▲	PHASE I LINE OF CROSS SECTION
△ – – △	PHASE II LINE OF CROSS SECTION

NOTES

1. BASE MAP DEVELOPED FROM FIGURE 13-1 FROM A REPORT BY RUST ENVIRONMENT & INFRASTRUCTURE, DATED: 3-18-98
2. MONITORING WELLS AND TEMPORARY WELLS TAKEN FROM FIGURE 15-11, VOLATILE ORANANIC COMPOUNDS DETECTED IN BUILDING 279 SOLVENT PIT (SITE 12C) TEIMPORARY WELL POINTS, PREPARED BY RUST E&I, DATED 8-5-98.
3. PHASE I CROSS SECTION SHOWN ON FIGURE 15-2. PHASE II CROSS SECTION SHOWN ON FIGURE 15-3. BOTH PREPARED BY EARTHTECH.

north

0 30 60
SCALE IN FEET

FIGURE 15-1

QUALITY CONTROL

Graphic Standards TAPB	2-22-02	
Lead Professional	2-22-02	
Technical Review		
Project Manager LBL	3-12-02	
Management Review		
Other		

This document has been developed for a specific application and may not be used without the written approval of Montgomery Watson.

Developed By TAPB Drawn By DLF
Approved By Leslie Busse Date 3.19.02
Reference 2440025.040201-B7
Revisions

MONITORING WELL LOCATION MAP - BUILDING 279 SOLVENT PIT (SITE 12C)

SOUTH OF THE FIRING LINE
JEFFERSON PROVING GROUND
MADISON, INDIANA

Drawing Number
2440025
010102 **B1**

MWH
MONTGOMERY WATSON H.

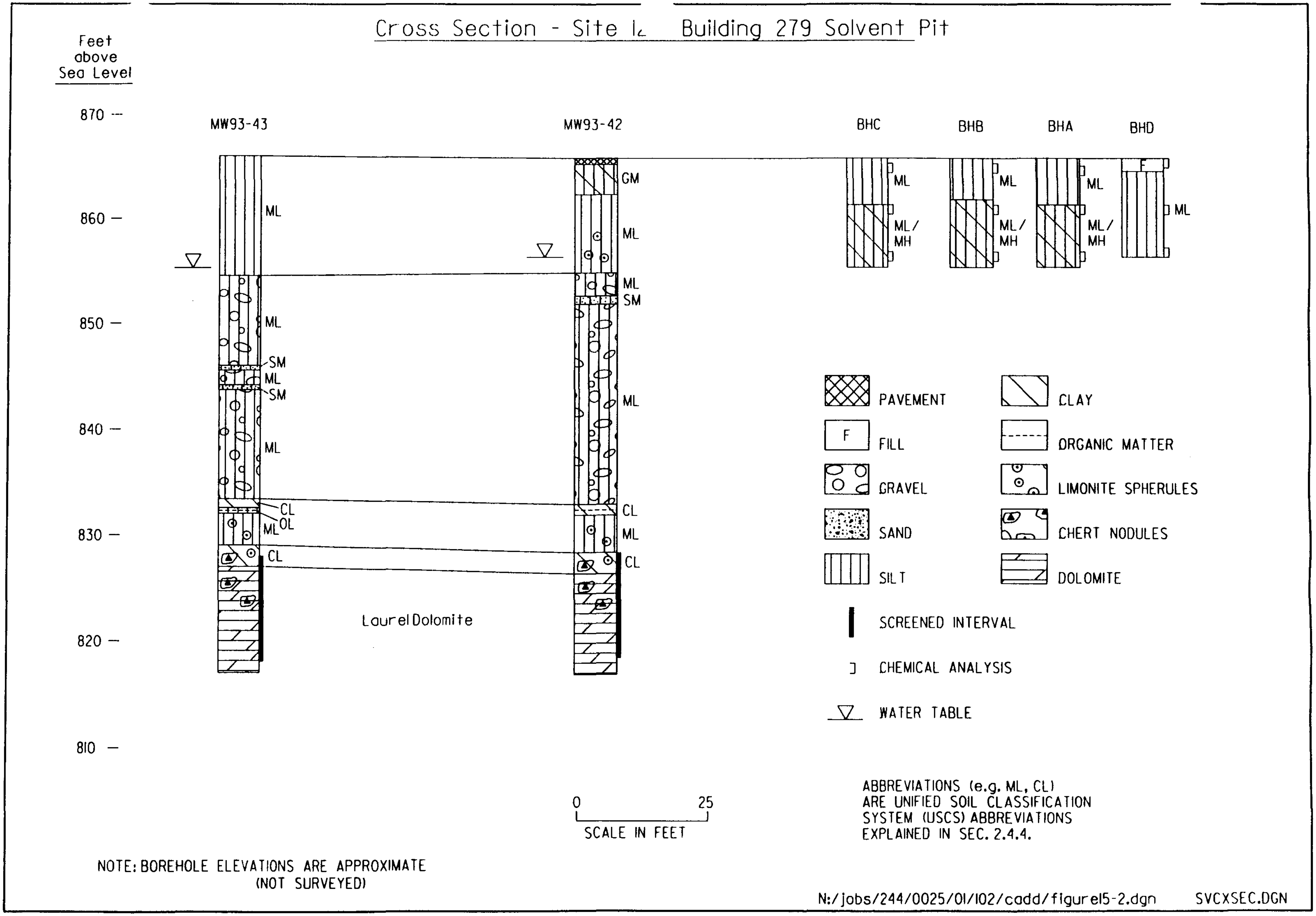


Figure 15-2. Phase I Cross Section Using Monitoring Well Data, Building 279 Solvent Pit (Site 12C)

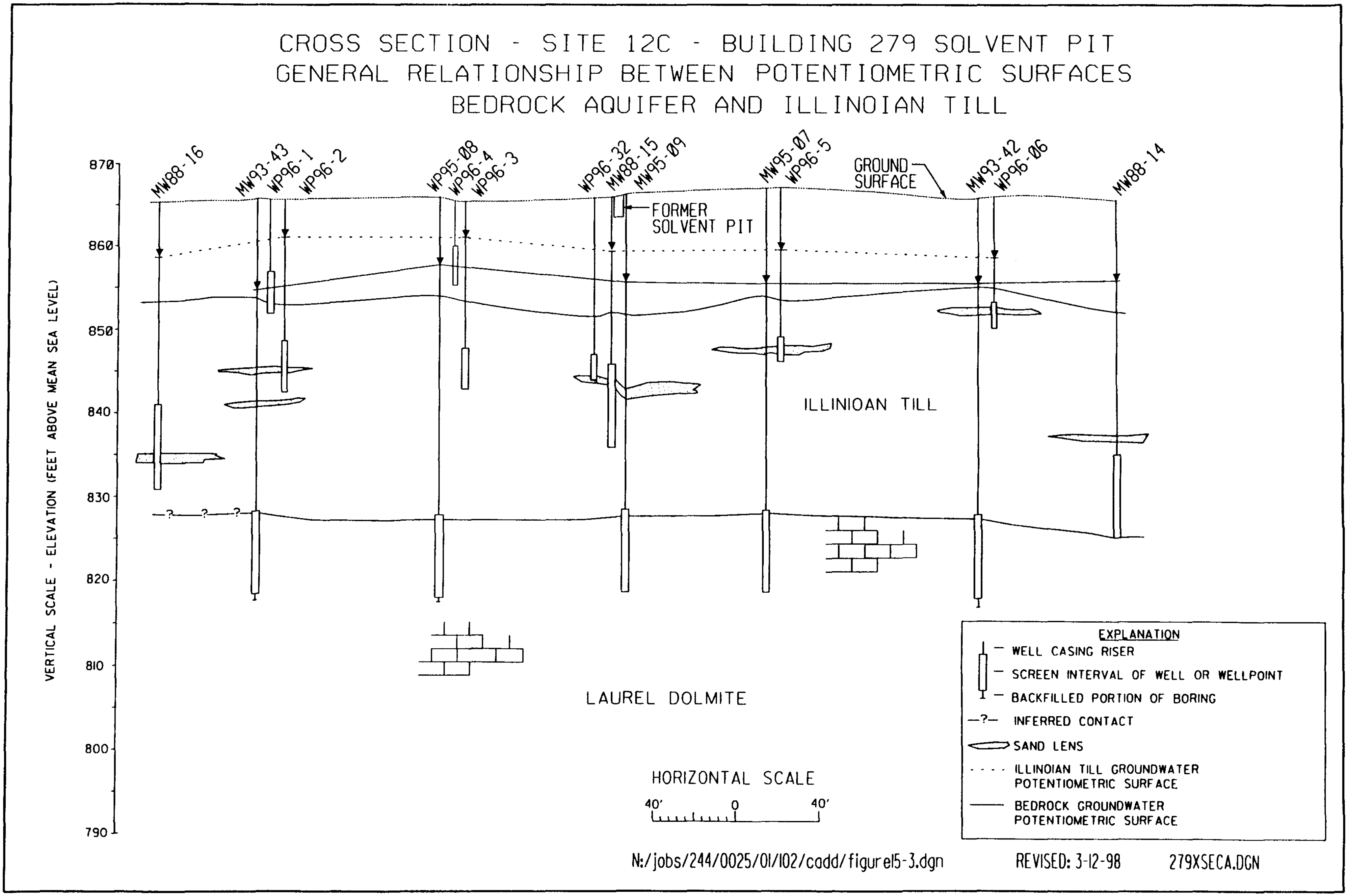


Figure 15-3. Phase II Cross Section, General Relationship Between Potentiometric Surfaces Bedrock Aquifer and Illinoian Till, Building 279 Solvent Pit (Site 12C)

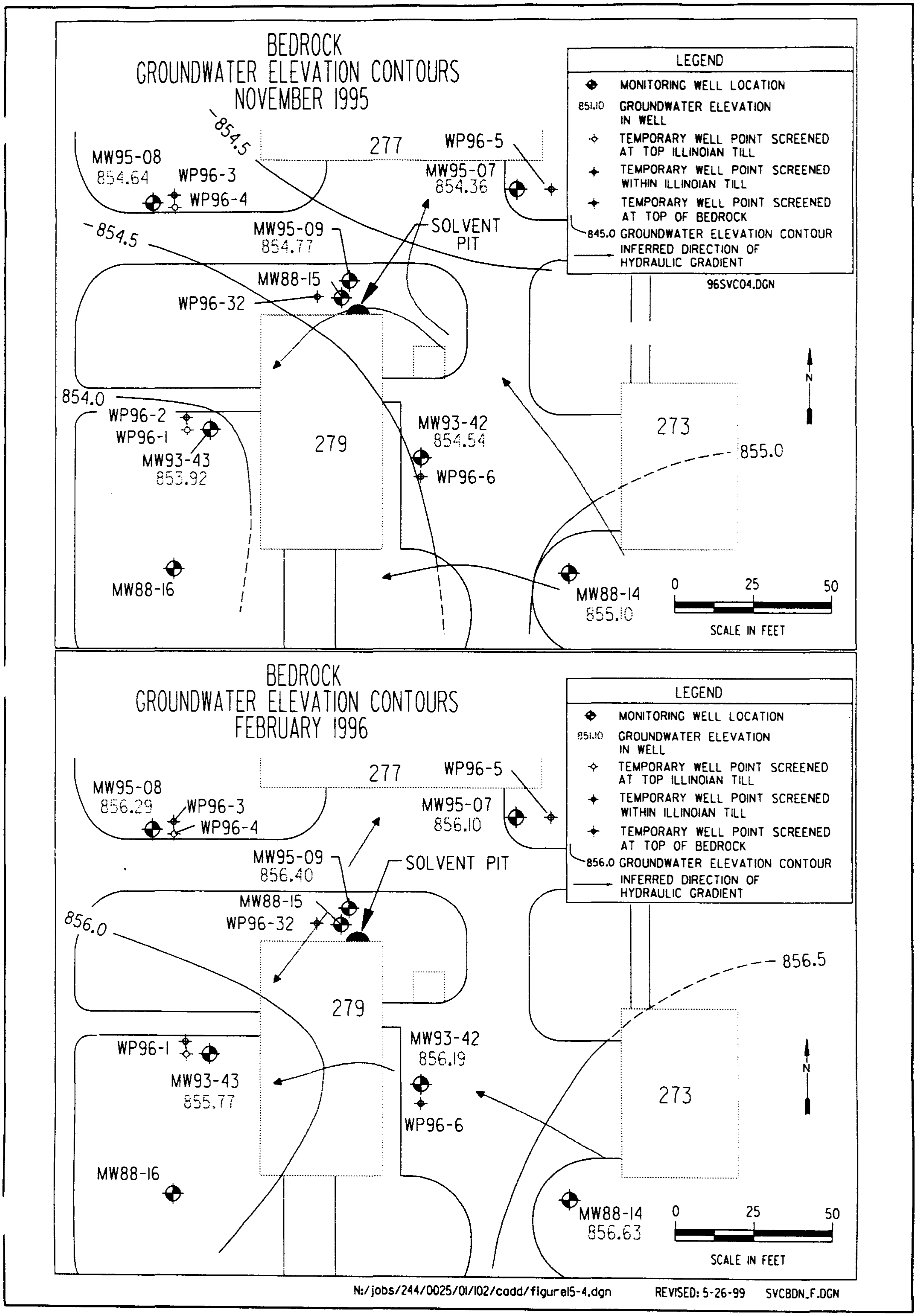


Figure 15-4. Bedrock Potentiometric Contour Map - November 1995 and February 1996, Building 279 Solvent Pit (Site 12C)

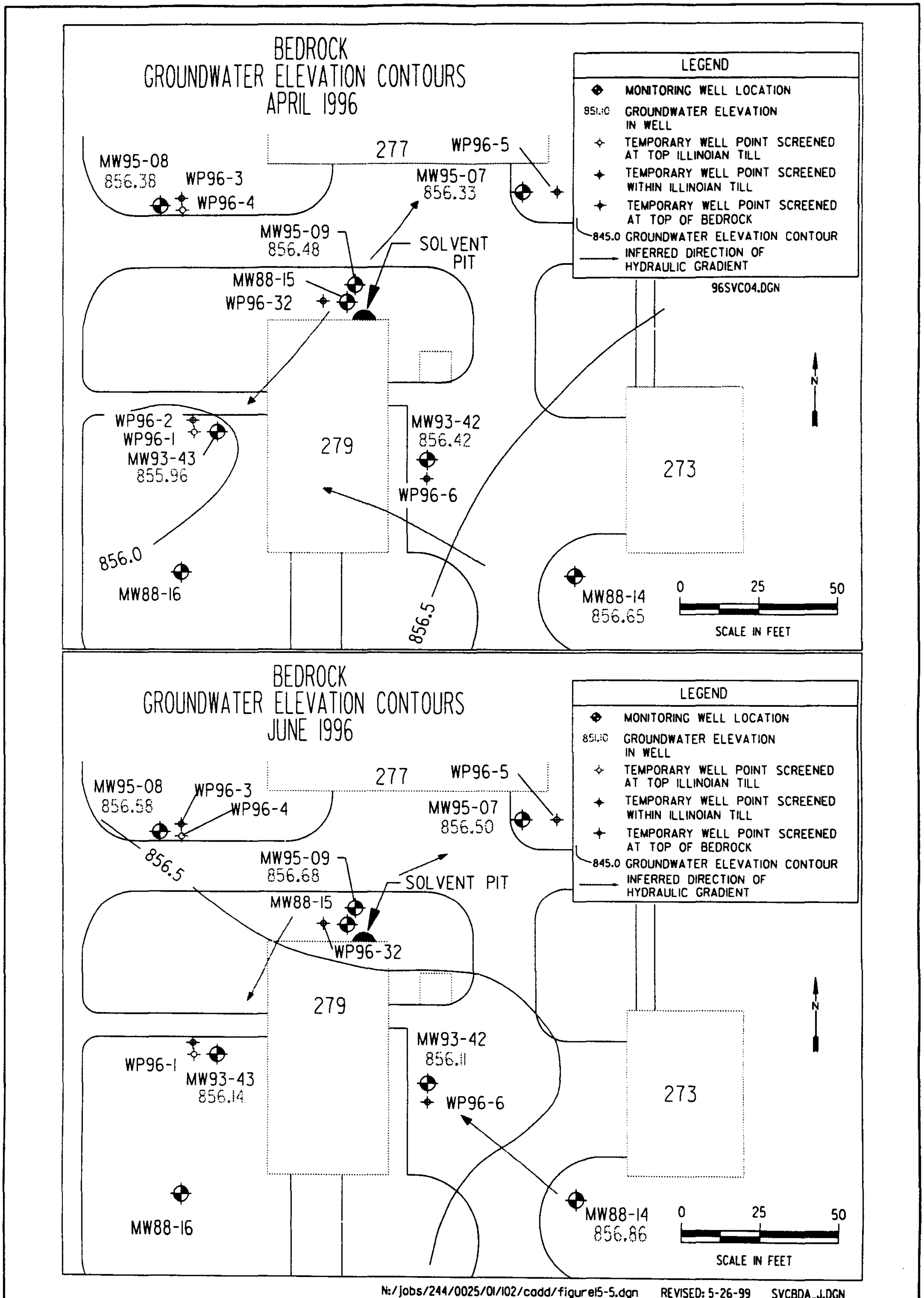


Figure 15-5. Bedrock Potentiometric Contour Map - April and June 1996, Building 279 Solvent Pit (Site 12C)

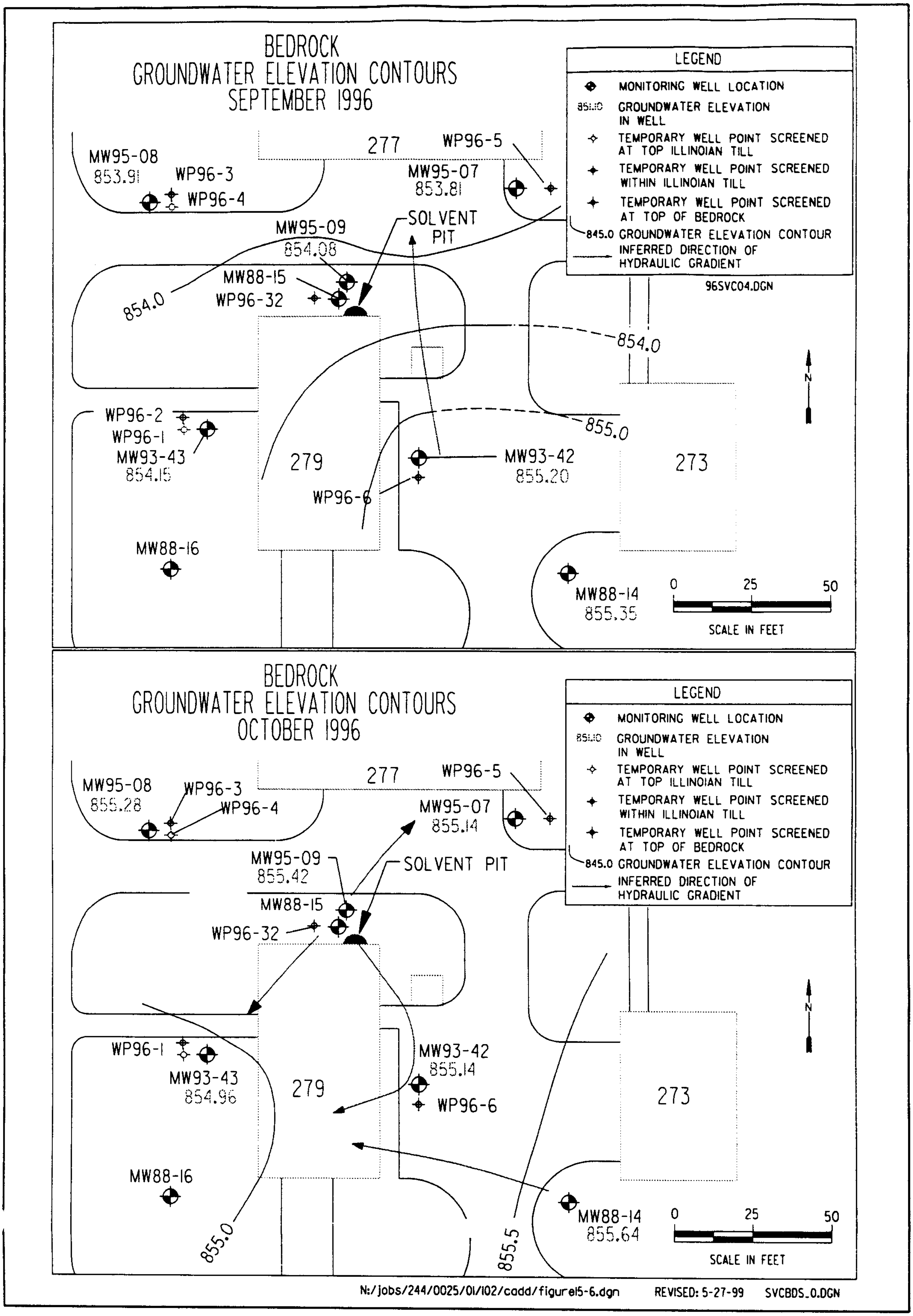


Figure 15-6. Bedrock Potentiometric Contour Map - September and October 1996, Building 279 Solvent Pit (Site 12C)

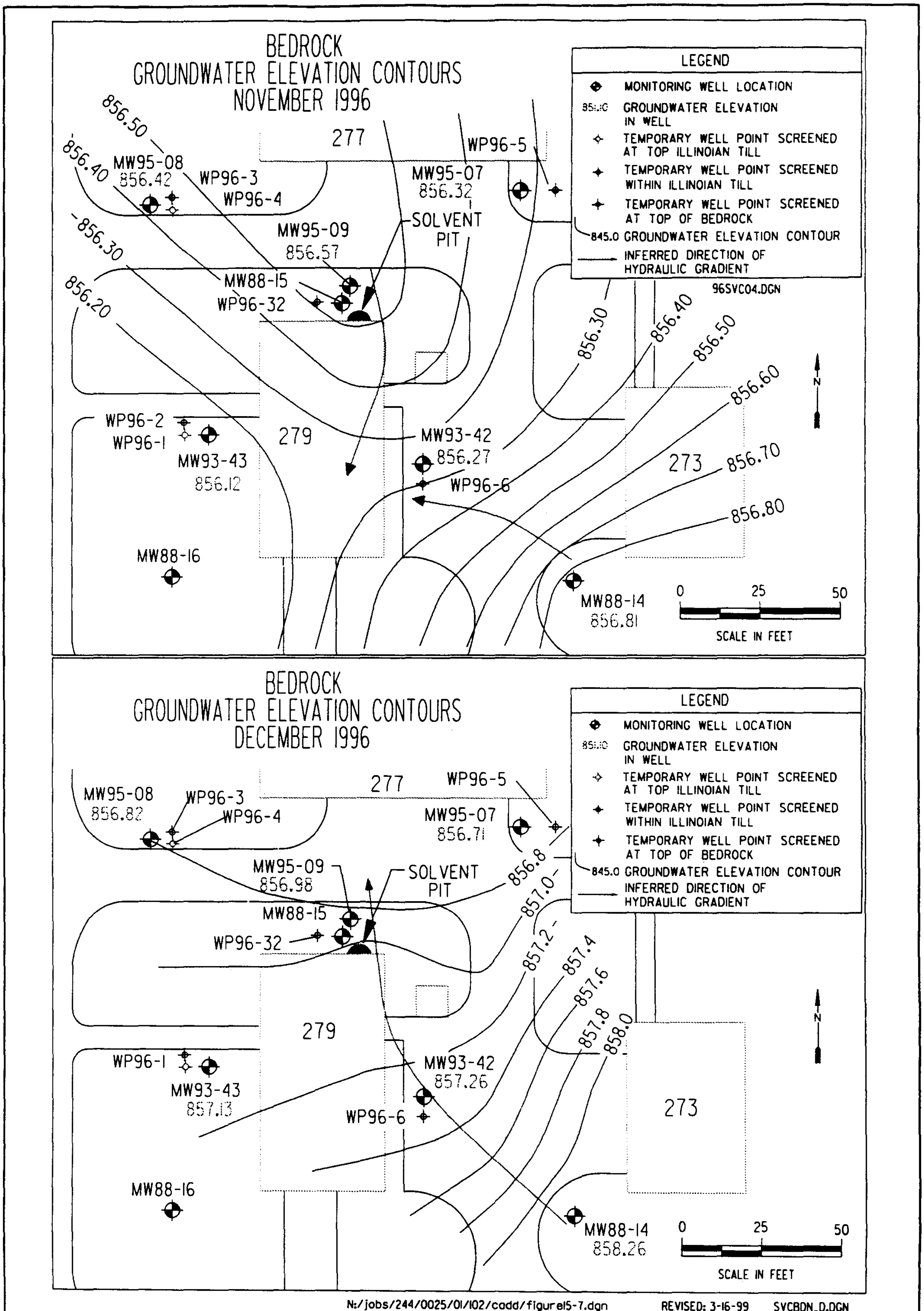


Figure 15-7. Bedrock Potentiometric Contour Map - November and December 1996.
Building 279 Solvent Pit (Site 12C)

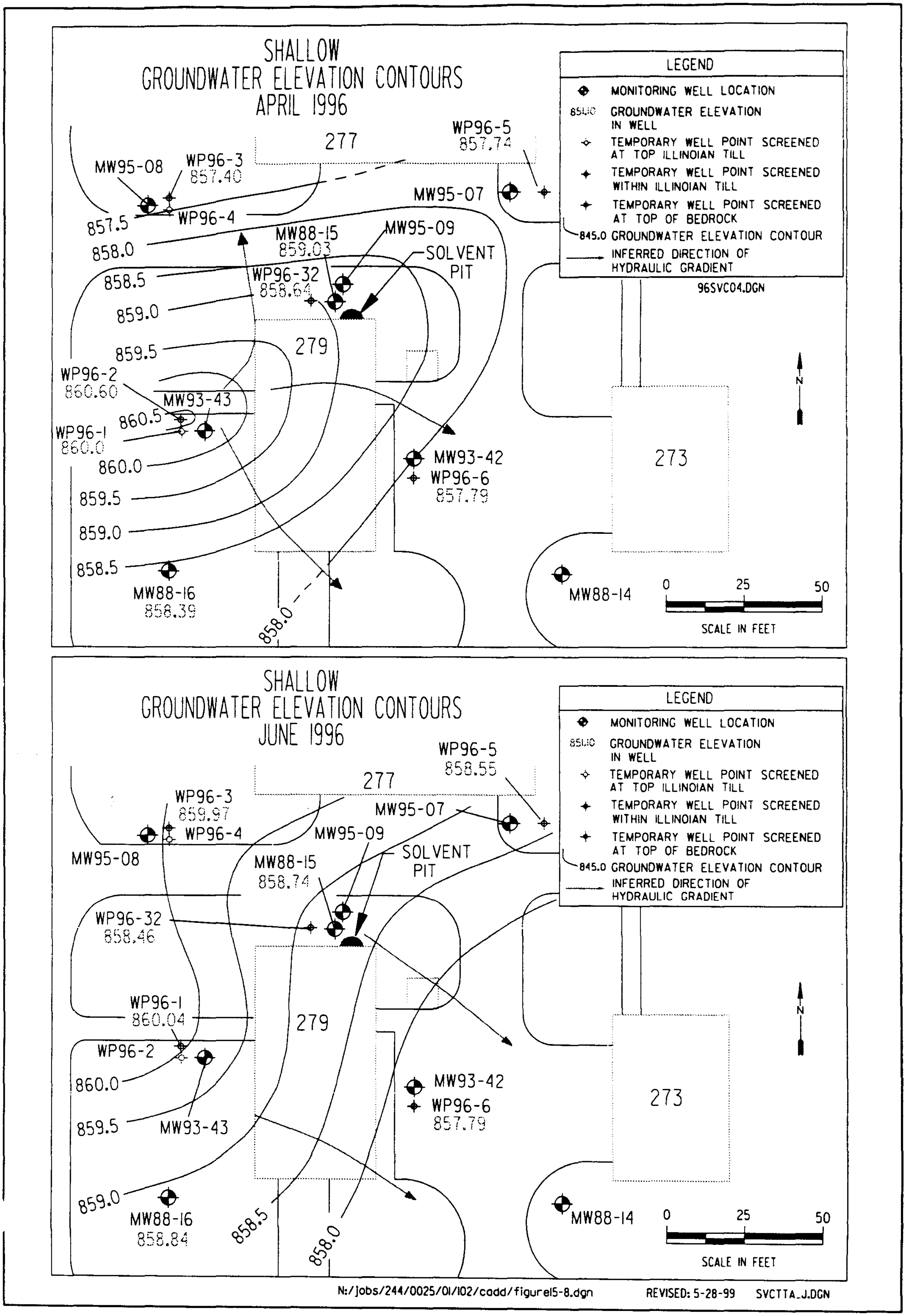


Figure 15-8. Illinoian Till Potentiometric Contour Map - April and June 1996, Building 279 Solvent Pit (Site 12C)

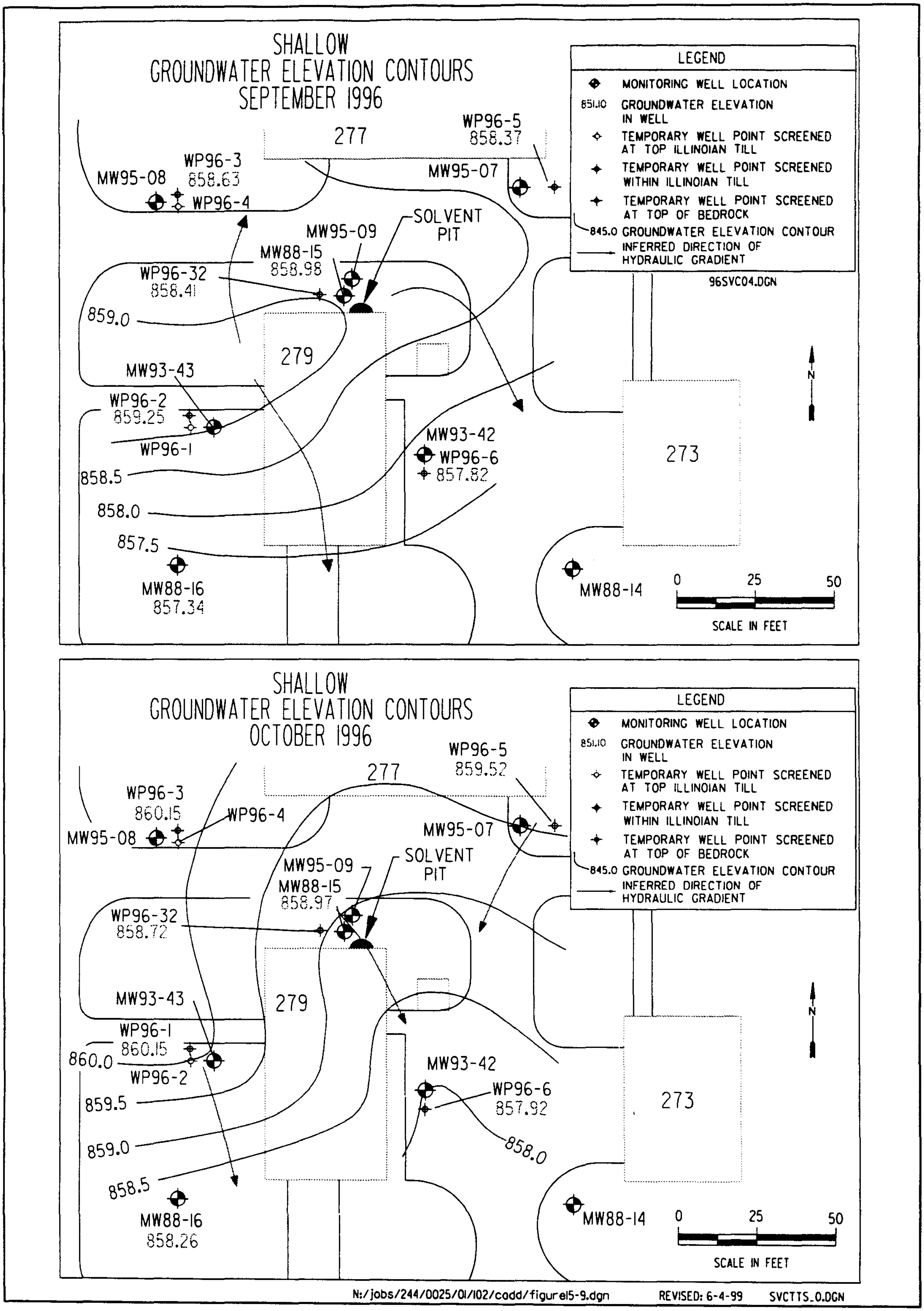
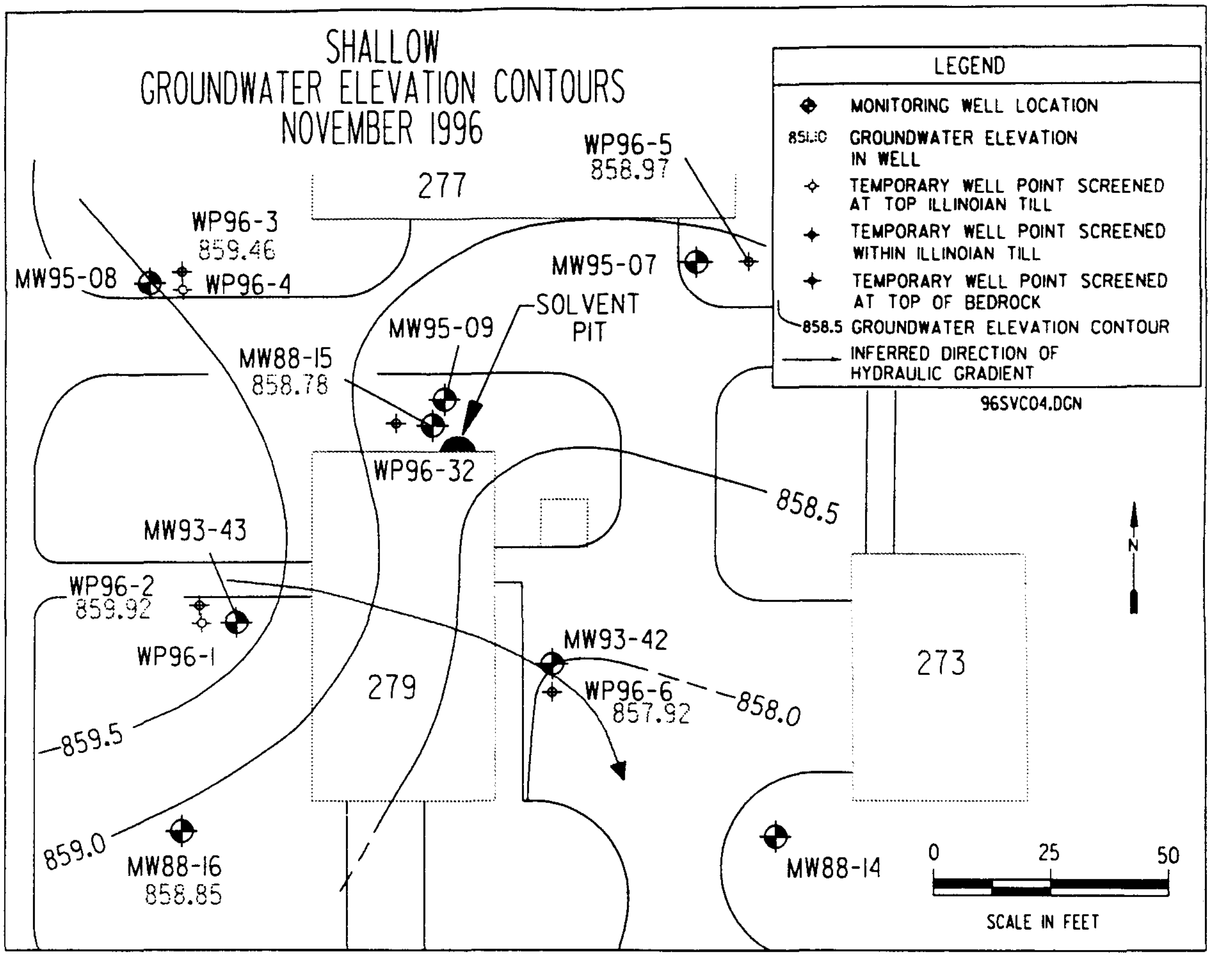
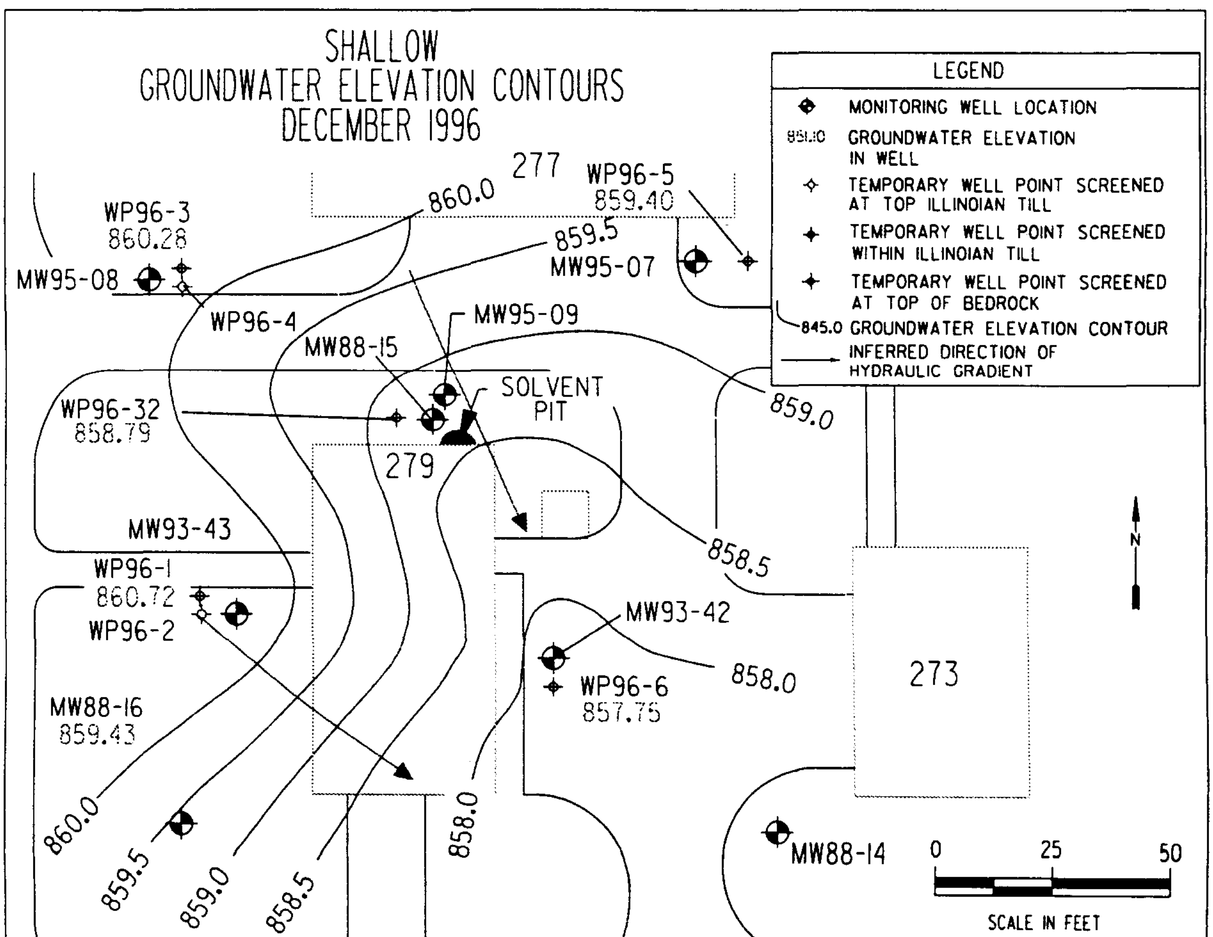


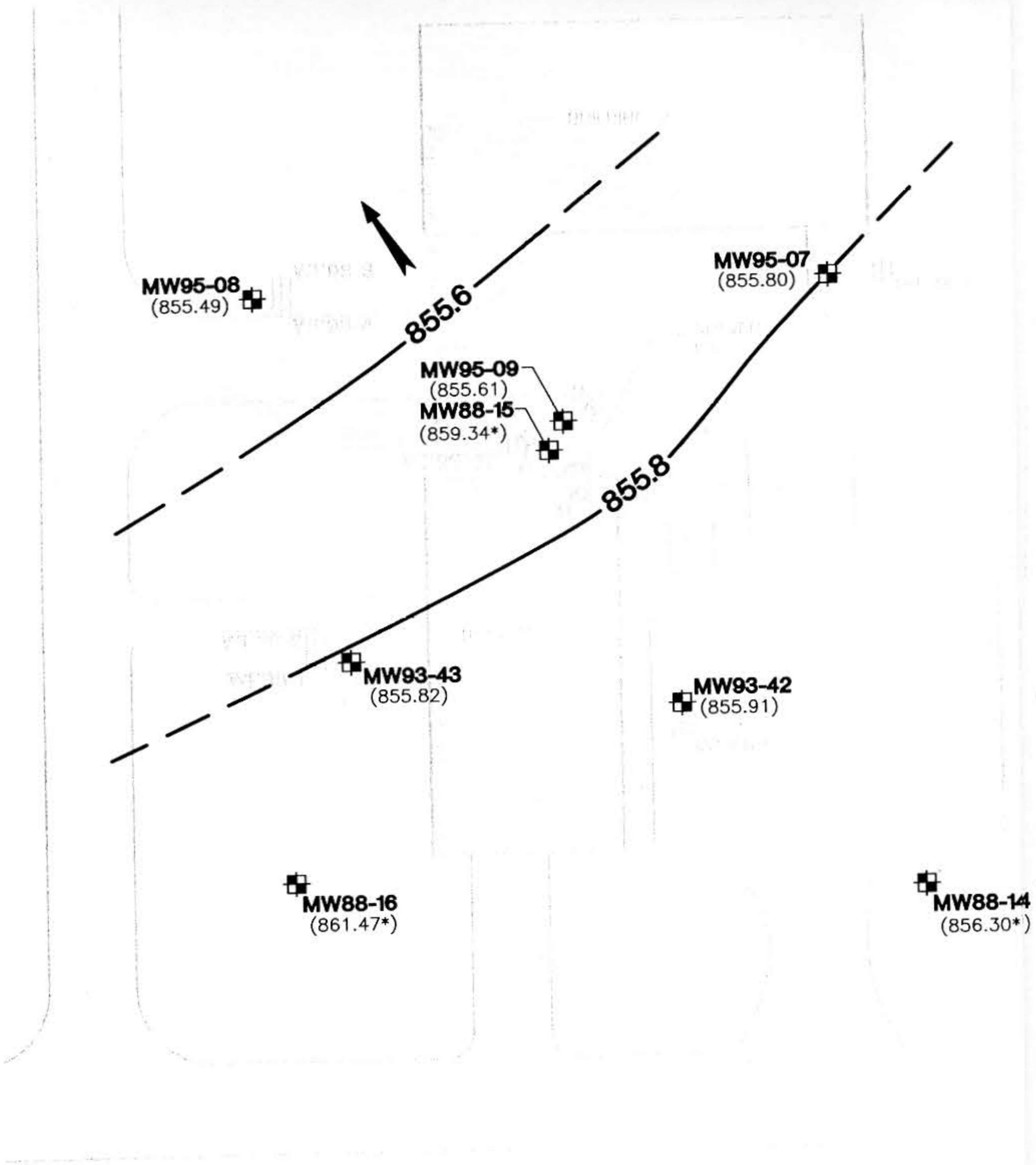
Figure 15-9. Illinoian Till Potentiometric Contour Map - September and October 1996, Building 279 Solvent Pit (Site 12C)





N:/jobs/244/0025/01/102/cadd/figure15-10.dgn REVISED: 3-16-99 SVCTTN_D.DGN

Figure 15-10. Illinoian Till Potentiometric Contour Map - November and December 1996, Building 279 Solvent Pit (Site 12C)



LEGEND

SOIL BORING LOCATION AND LETTER DESIGNATION

TEMPORARY WELL LOCATION AND NUMBER

MW95-07 (855.80) — MONITORING WELL LOCATION, NUMBER, AND GROUNDWATER POTENTIOMETRIC SURFACE ELEVATION, IN FEET ABOVE MEAN SEA LEVEL

—855.6— POTENTIOMETRIC SURFACE CONTOUR (CONTOUR INTERVAL: 0.2 FT)

ESTIMATED GROUNDWATER FLOW DIRECTION

NOTES

1. BASE MAP DEVELOPED FROM FIGURE 13-1 FROM A REPORT BY RUST ENVIRONMENT & INFRASTRUCTURE, DATED: 3-18-98
2. MONITORING WELLS AND TEMPORARY WELLS TAKEN FROM FIGURE 15-11, VOLATILE ORANANIC COMPOUNDS DETECTED IN BUILDING 279 SOLVENT PIT (SITE 12C) TEIMPORARY WELL POINTS, PREPARED BY RUST E&I, DATED 8-5-98.
3. GROUNDWATER ELEVATIONS DENOTED BY AND "*" ARE NOT INCLUDED IN THE INTERPRETATION OF THE CONTOURED SURFACE.

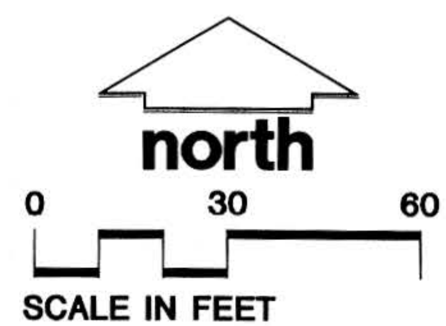


FIGURE 15-10a

POTENTIOMETRIC SURFACE MAP (JUNE 5, 2001) - BUILDING 279 SOLVENT PIT (SITE 12C)

SOUTH OF THE FIRING LINE
JEFFERSON PROVING GROUND
MADISON, INDIANA

Developed By TAFB | Drawn By DLF
Approved By [signature] | Date 3.19.02
Reference 2440025.040201-B7
Revisions

Drawing Number 2440025 010102 B2

MWH MONTGOMERY WATSON HA

QUALITY CONTROL	Graphic Standards		Technical Review		Management Review
	Lead Professional	2-19-02 / 2-22-02	Project Manager LBL	3-12-02	Other

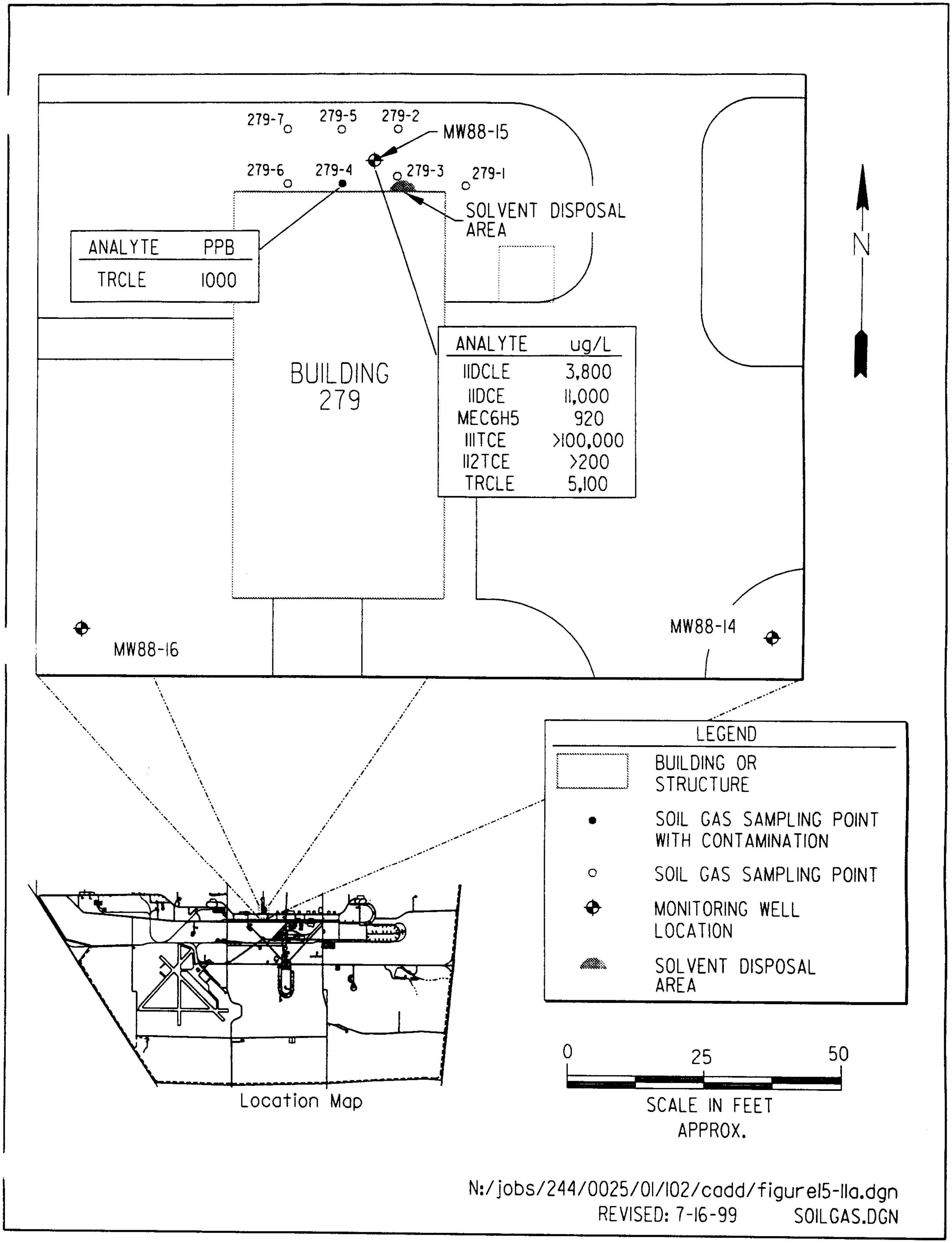


Figure 15-11a. Soil Gas and Groundwater Results from ESE 1989 RI, Building 279 Solvent Pit (Site 12C)

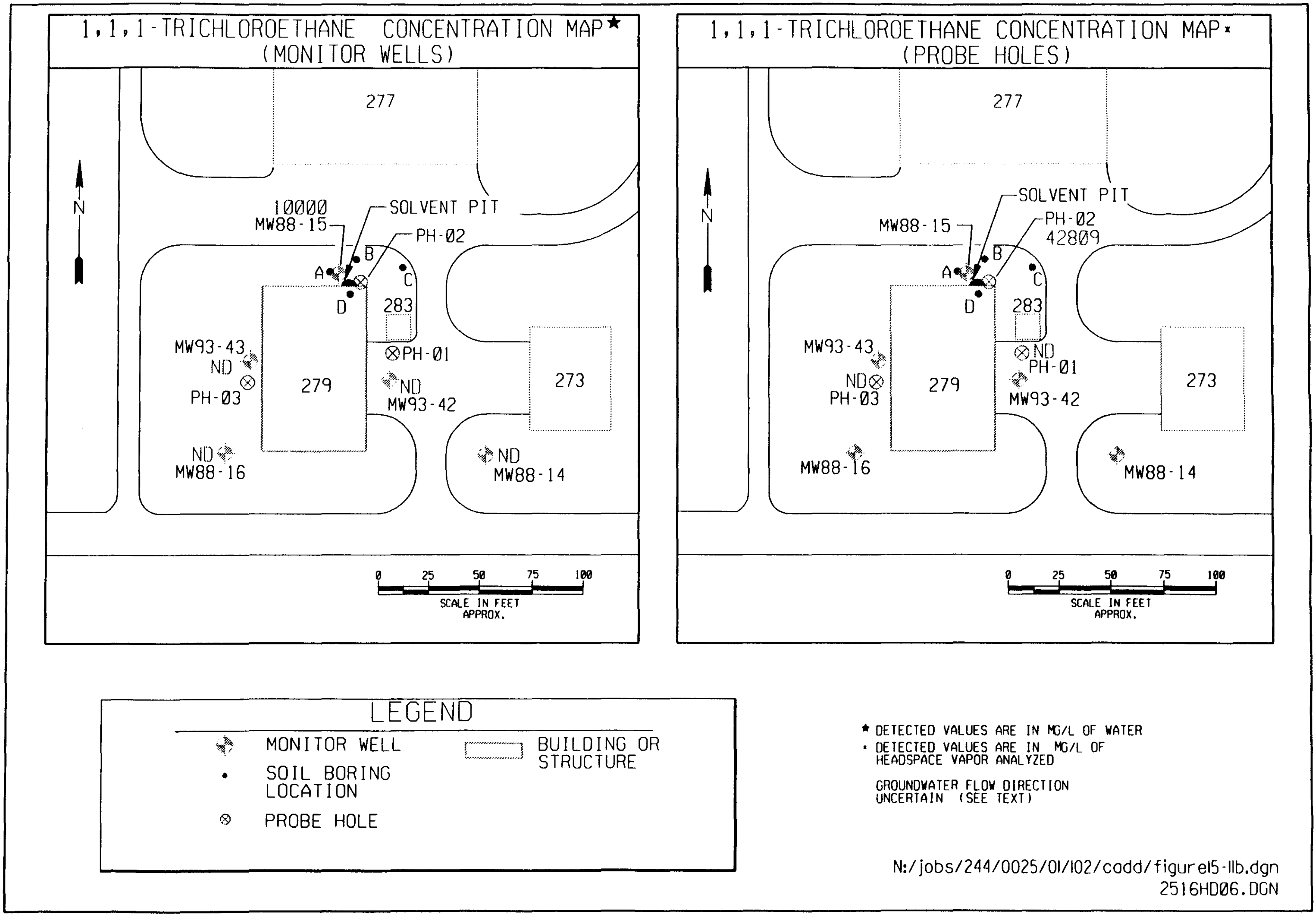
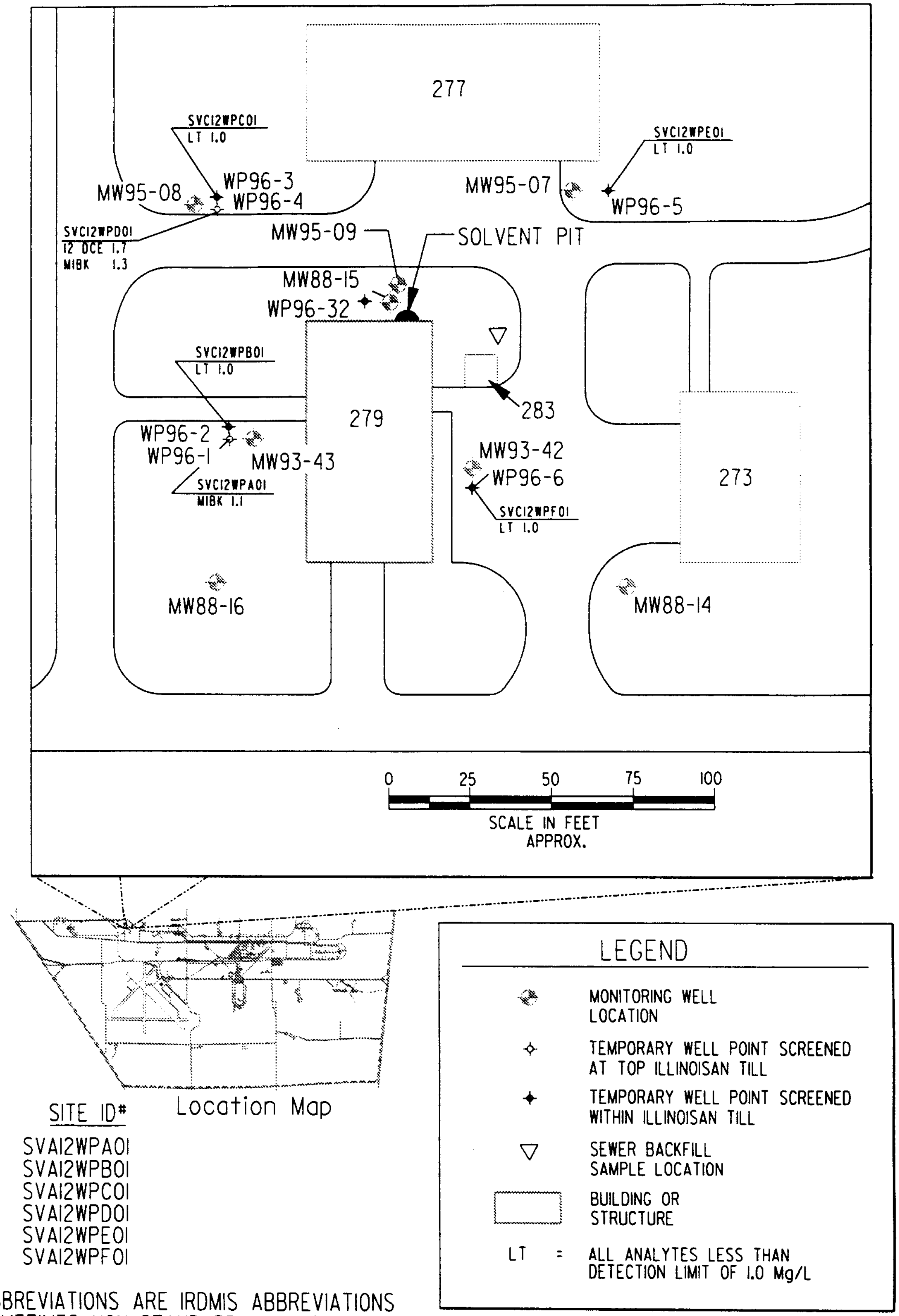


Figure 15-11b. Distribution of 1,1,1-Trichloroethane Contamination in Monitoring Well and Probehole Groundwater S[illegible]les, Building 279 Solvent Pit (Site 12C)

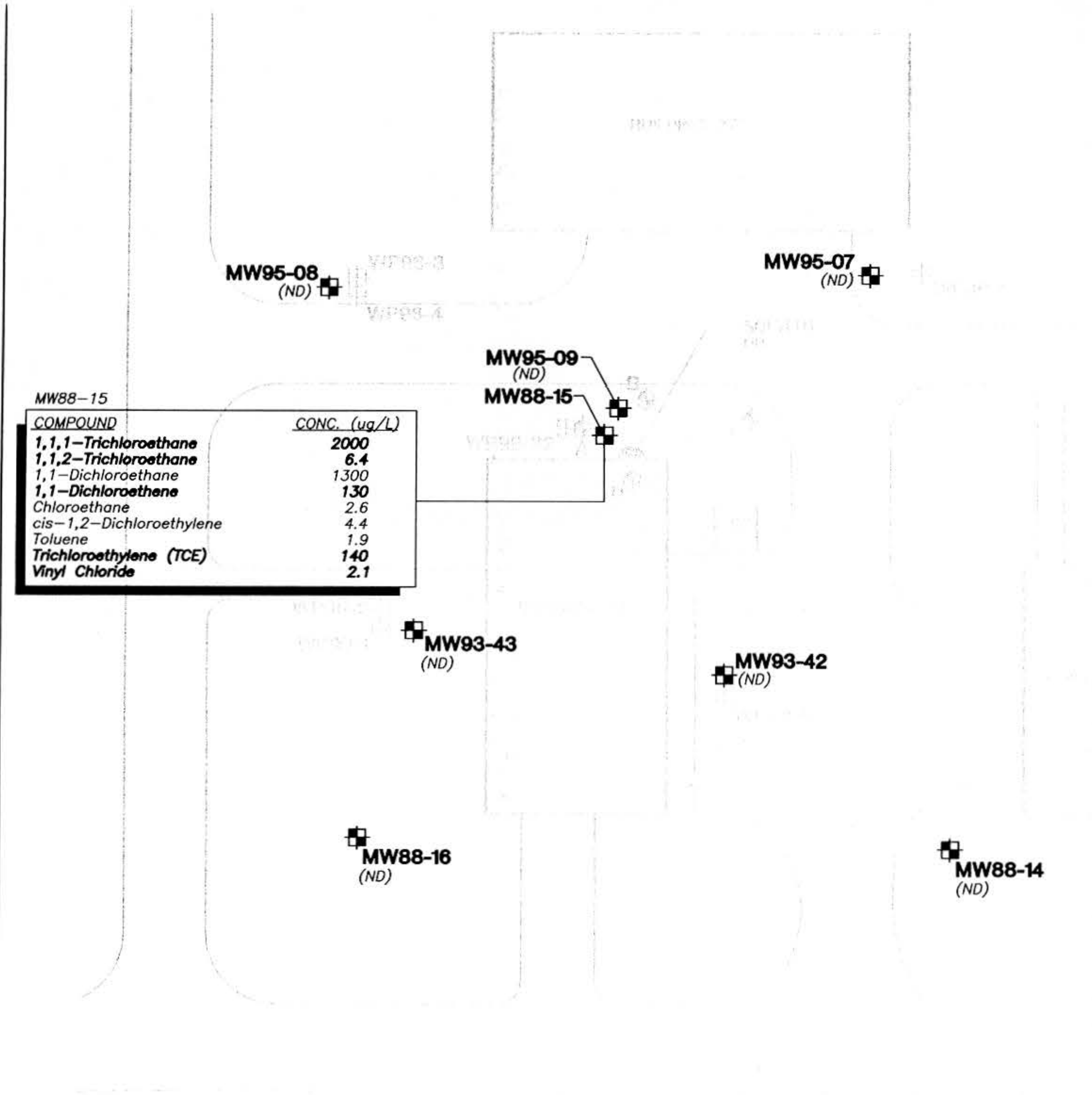


WELL POINT ID#	SITE ID#
WP96-01	SVA12WPA01
WP96-02	SVA12WPB01
WP96-03	SVA12WPC01
WP96-04	SVA12WPD01
WP96-05	SVA12WPE01
WP96-06	SVA12WPF01

.E: CHEMICAL ABBREVIATIONS ARE IRDMIS ABBREVIATIONS AND ARE SOMETIMES NON-STANDARD (eg. 111 TCE= TRICHLOROETHANE)

N:/jobs/244/0025/01/102/cadd/figure15-11c.dgn
REVISED: 4-2-98 JPG21.DGN

Figure 15-11c. Volatile Organic Compounds Detected in Temporary Well Points, Building 279 Solvent Pit (Site 12C)



LEGEND

- SOIL BORING LOCATION AND LETTER DESIGNATION
- TEMPORARY WELL LOCATION AND NUMBER
- MW95-07 — MONITORING WELL LOCATION AND NUMBER
- *ND* — NO VOCs DETECTED
- *ug/L* — MICROGRAMS PER LITER

NOTES

1. BASE MAP DEVELOPED FROM FIGURE 13-1 FROM A REPORT BY RUST ENVIRONMENT & INFRASTRUCTURE, DATED: 3-18-98
2. MONITORING WELLS AND TEMPORARY WELLS TAKEN FROM FIGURE 15-11, VOLATILE ORANANIC COMPOUNDS DETECTED IN BUILDING 279 SOLVENT PIT (SITE 12C) TEIMPORARY WELL POINTS, PREPARED BY RUST E&I, DATED 8-5-98.
3. ONLY COMPOUNDS WHICH WERE DETECTED ARE SHOWN ON THE MAP. SEE ANALYTICAL LABORATORY REPORT FOR PARAMETER LIST, DETECTION LIMITS, AND EXPLANATION OF LABORATORY NOTES.
4. RESULT IN BOLD FONT INDICATES THAT CONCENTRATION EXCEEDS THE USEPA REGION IV PRELIMINARY REMEDIATION GOALS FOR TAP WATER (2000) FOR THAT COMPOUND.

north

0 30 60

SCALE IN FEET

FIGURE 15-11d

VOC CONCENTRATIONS IN GROUNDWATER (JUNE 2001) - BUILDING 279 SOLVENT PIT (SITE 12C)

SOUTH OF THE FIRING LINE
JEFFERSON PROVING GROUND
MADISON, INDIANA

Developed By TAPB | Drawn By DLF
Approved By [signature] | Date 3·19·02
Reference 2440025.040201-B7
Revisions

Drawing Number 2440025 010102 **B22**

MWH MONTGOMERY WATSON HARZA

QUALITY CONTROL
Graphic Standards 2-19-02
Lead Professional
Technical Review 2-22-02
Project Manager LBL 3-12-02
Management Review
Other

16.0 OLD FIRE TRAINING PIT (SITE 13)

Since the Draft RI was submitted, a Remedial Removal Action was performed at Site 13, and was documented by the *Final Position Paper-Site 13*, dated March 2001. Based on confirmation testing, the removal action was successful in removing contaminated soils and Site 13 is recommended for NFA for residential use. Refer to Section 16.3.3.

16.1 SITE CHARACTERISTICS

The old fire training pit is located in the southeastern portion of the installation in the vicinity of the former airfield runways (Figure 16-1). The site is an unlined 200-square-foot (20 by 10 feet) pit that is approximately 2 feet deep. It is located adjacent to the intersection of two abandoned runways and was used for fire-training exercises from the 1970s through the 1980s. The standard practice for this fire training included soaking wood debris with diesel and other petroleum products and igniting the wood. Fire fighters then extinguished the resulting fire. Because of incomplete combustion of the fuel, it is likely that petroleum hydrocarbons entered subsurface soils. The fuels used may have also contained lead or other heavy metals. SVOCs may also have entered the soils at the fire-training pit.

The area is characterized as extremely flat. ~~All s~~Surface-water runoff is directed via underground storm sewers into Harberts Creek, about 3,000 feet south of the site (Figure 2-1). The fire training area is bounded on the west, north, and northeast by concrete runways. The remainder of the surrounding area is covered by grasses and other perennial vegetation. The area is not regularly mowed; however, it was included in the open burning program in the spring of 1993. There are no trees or shrubs in the vicinity.

The site is located in an area that has soils belonging to the Cobbsfork soil series. The glacial till is about 30 feet thick at this site and underlain by the Geneva Dolomite of Devonian age. The monitoring well cross section shows the soil types, the bedrock formations, screened intervals, water levels, and sampled intervals (Figure 16-2).

Three monitoring wells (MW93-12, MW93-13, and MW93-14) were installed at this site. As shown in Figure 16-2, each well was installed down to a total depth of approximately 44 feet bgs and is screened over the bottom 2 feet of the glacial till, across the Waldron Shale, and into the Laurel Dolomite (the water bearing zone). Slug tests completed on these three wells showed the Laurel at this location has a hydraulic conductivity ranging from 2.82×10^{-5} to 1.78×10^{-4} cm/sec. No large voids were encountered during the drilling of these wells.

Bedrock groundwater associated with this site is confined. Depth to the potentiometric surface ranges from approximately 7 to 9 feet bgs. Water-level data collected from the wells during June, August, and September 1993 indicated that the groundwater flow is toward the northeast with a gradient of 0.024 foot/foot. Subsequent Phase II water-level data from November 1995 and February, June, and November 1996 are shown in Figures 16-3 and 16-4. These data

support the conclusion that the bedrock groundwater flow is to the northeast and gradients were calculated to range from 0.0024 to 0.005 foot/foot based on the Phase II data.

16.2 PREVIOUS INVESTIGATIONS

The *AEHA Groundwater Contamination Survey—Evaluation of Solid Waste Management Units* (August 1988) recommended that the surface soils of the fire training pit be sampled at 1-foot and 5-foot depths and analyzed for EP Toxicity heavy metals, VOCs, SVOCs, and PCBs. The site was then included in the *Enhanced PA Report* (Ebasco 1990a), where it was listed as SWMU 30. A visual site inspection, records searches, and interviews with former JPG personnel were conducted to characterize the environmental impacts of the actions that occurred at the site. Ebasco (1990b) then recommended in the *Master Environmental Plan* that surface and subsurface soils be sampled. Prior to this RI, ~~no~~ environmental sampling activities had **not** been performed at this site.

16.3 STUDY AREA INVESTIGATIONS

16.3.1 Phase I RI Field Activities

16.3.1.1 Surface Soils. Four samples from the uppermost soils of four soil borings were collected during the Phase I RI to determine if contaminants had been released to the environment as a result of previous fire-training exercises at the site. These samples were analyzed for VOCs, SVOCs, total metals, and TPH. The SVOC results for the Phase I soil samples, however, were considered to be suspect due to problems identified during data validation.

16.3.1.2 Subsurface Soils. A total of 13 subsurface-soil samples were collected from 4 borings during Phase I. Three soil borings were drilled to a depth of 15 feet around the perimeter of the old fire-training pit, and one boring was drilled inside of the pit until auger refusal was reached at a depth of 21 feet. Subsurface samples were collected at approximate depths of 5, 10, and 15 feet and were analyzed for VOCs, SVOCs, total metals, and TPH. An additional sample was collected at 19 feet from the borehole drilled inside the pit.

16.3.1.3 Field-Screening Survey. A field-screening investigation was recommended prior to the installation of monitoring wells to determine extent of contamination and to optimize the location of the monitoring wells. A total of three probeholes—FTA-PH01, FTA-PH02, and FTA-PH03—were completed. Because groundwater contamination was the main concern, the soil was sampled only in FTA-PH-01.

16.3.1.4 Groundwater. Because contaminants detected in the soil boring samples were found to extend to the groundwater table, one upgradient and two downgradient monitoring wells were installed to provide water-quality and groundwater elevation data for the fire-training

area during Phase I of the RI. Well locations were selected based on the results of soil boring samples and the field-screening surveys.

16.3.2 Phase II RI Field Activities

16.3.2.1 Surface Soils. To confirm the presence or absence of SVOC contamination, two additional borings were drilled during the Phase II RI with surface samples collected at a 1-foot depth for SVOC analysis only.

16.3.2.2 Subsurface Soils. During Phase II, soil samples were collected from two additional borings at depths of 5, 10, and 15 feet to confirm the presence or absence of SVOCs in subsurface soils. At each boring, the depth interval with the highest PID reading was also selected for VOC analysis.

16.3.2.3 Groundwater. Four additional rounds of monitoring well sampling were conducted during Phase II for metals (total and dissolved), VOC, and SVOC analysis.

16.3.3 Remedial Removal Action (New Work)

A remedial removal action was performed at Site 13 from July through September 2000. Approximately 147.85 tons of soil was excavated and stored on site in roll-off boxes pending results of analytical testing. The soil was characterized as nonhazardous based on analytical results, and was transported to Waste Management of Kentucky LLC Outer Loop Landfill for disposal.

Confirmation sampling was performed on the residual soils in the excavation. Sample results confirmed that the remaining soils met the PRGs . The excavation was backfilled and the site was seeded. This removal action was documented in the *Final Position Paper-Site 13*, dated March 2001, which proposed the site for NFA for the residential use.

16.4 DATA EVALUATION

16.4.1 Data Validation Results

16.4.1.1 Blank Assessment. When blank contamination exists, the investigative results must exceed the blank result by a factor of 5 (all compounds) or 10 (common laboratory contaminants such as phthalates) in order to be considered positive. Based on comparisons to blanks, positive results were changed to nondetects ("U"). The associated sample quantitation limit became either the concentration detected in the sample, if the detected value was above the quantitation limit, or the quantitation limit, if detected results were less than the quantitation limit. Several metals, VOCs, and TPH were detected in blanks associated with the following soil samples, which were qualified as nondetected during Phase I:

- Beryllium—FTA13BHA02, -D02, -D03, -D04, -D05

- Cadmium—FTA13BHA01, -C01, -D01
- Cobalt—FTA13BHA03, -C03
- Mercury—FTA13BHA02, -A04, -B02, -B03, -B04, -C01, -C02, -C03, -C04, -D01, -D02, -D03, -D04, -D05
- Silver—FTA13BHB04, -C01
- Sodium—FTA13BHA01
- Benzene—FTA13BHA01, -C01, -D01
- Ethylbenzene—FTA13BHA01, -C01, -D01
- Monochlorobenzene—FTA13BHA01, -B02, -B03, -C01, -C02, -C03, -C04, -D01, -D02, -D03
- 1,3-Dimethylbenzene—FTA13BHA01, -C01, -D01
- Toluene—FTA13BHA01, -A02, -A03, -A04, -B03, -C01, -C02, -C03, -C04, -D02, -D03, -D04, -D05
- Xylenes—FTA13BHA01, -C01, -D01
- Total petroleum hydrocarbons (TPH)—FTA13BHA04, -B02, -B03, -B04, -C02, -C03, -C04, -D02, -D03, -D04, -D05

Several metals, one VOC, and one SVOC were detected in blanks associated with the following samples, which were qualified as nondetected during Phase II:

- Groundwater
  - Aluminum—FTA13GWA04
  - Beryllium—FTA13GWA04, -C04
  - Boron—FTA13GWC05
  - Cadmium—FTA13GWB02
  - Chromium—FTA13GWA05, -B05, -C05
  - Lead—FTA13GWA02, -C02
  - Molybdenum—FTA13GWA04, -B05, -C04, -C05
  - Nickel—FTA13GWB05
  - Potassium—FTA13GWA05, -B05, -C05
  - Tin FTA13GWC03
  - Vanadium—FTA13GWA04, -B05, -C05
  - Methylene chloride—FTA13GWA02

  - Di-n-butyl phthalate—FTA13GWA04, -A05 -B04, -B05, -C04, -C05

- Soil
  - Di-n-butyl phthalate—FTA13BHE04

16.4.1.2 Rejected Results. During Phase I, ~~all~~ **the** antimony soil results and four arsenic soil results were rejected due to poor MS/MSD recoveries. Results for two VOCs—2-chlorovinyl ether and methyl ethyl ketone— were also rejected. Additionally, analysis for 14 SVOCs, 5 pesticides in soils, 11 SVOCs in water, and ~~all~~ **the** PCBs in both media were rejected as a result of calibration problems. Due to these problems, ~~all~~ **the** SVOC analyses were subjected to the Tier 2 validation. The Phase I SVOC results were not used for the human health risk assessment other than for qualitative information. In general, the following concerns were noted:

- All results for PCB compounds and toxaphene were rejected because they were not included in the calibration standard.

- 4-nitrophenol and indeno(1,2,3-cd)pyrene were rejected in several samples because of poor response during calibration.

- Other low responses were noted, particularly for pesticides. Qualifiers were not assigned unless other calibration information was also unacceptable.

- Several PAHs had an elevated CRL because of calibration problems.

For Phase II data, the **results** for two VOC compounds (**MEK** and vinyl acetate) and one SVOC compound (kepone) were rejected due to insufficient calibration or low response in the calibration in one or more analytical batch. Non-target (unknown) SVOC compounds were rejected in several analyses due to blank contamination. Analytes associated with rejected data were not included in the database used for the human health risk assessment. The following list identifies rejected sample results:

- Groundwater
  <u>Phase I</u>
  - 2-Chloroethyl vinyl ether (2CLEVE)—FTA13GWA01, -B01, -C01
  - MEK—FTA13GWA01, -B01, -C01
  - 3,3'-Dichlorobenzidine (33DCBD)—FTA13GWA01, -B01, -C01
  - 3,5-Dinitroaniline (35DNA)—FTA13GWA01, -B01, -C01
  - 3-Nitroaniline (3NANIL)—FTA13GWA01, -B01, -C01
  - 4,6-Dinitro-2-cresol (46DN2C)—FTA13GWB01
  - 4-Chloroaniline (4CANIL)—FTA13GWA01, -B01, -C01
  - 4-Nitroaniline (4NANIL)—FTA13GWA01, -B01, -C01
  - Atrazine—FTA13GWA01, -B01, -C01
  - Bromacil—FTA13GWA01, -B01, -C01
  - imethyl methylphosphate (DMMP)—FTA13GWB01

- Hexachlorobutadiene (HCBD)—FTA13GWA01, -B01, -C01
- Polychlorinated biphenyls (PCBs) (1016, 1221, 1232, 1242, 1248, 1254, and 1260)—FTA13GWA01, -B01, -C01
- Toxaphene—FTA13GWA01, -B01, -C01

Phase II
- Kepone—FTA13GWA02, -A03, -A04, -A05, -B02, -B03, -B04, -B05, -C02, -C03, -C04, -C05
- Vinyl acetate—FTA13GWA02, -B02, -C02
- MEK - FTA13GWA04, -A05, -B04, -B05, -C04, -C05
- Unknown (UNK)571—FTA13GWA03, -B03, -C03
- UNK578—FTA13GWA03, -B03, -C03
- UNK585—FTA13GWB04
- UNK603—FTA13GWA03, -B03
- UNK614—FTA13GWA03

- **Soil**

  Phase I
  - 2,4-Dinitrophenol (24DNP)—FTA13BHA01, -A02, -A03, -A04, -B01, -B02, -B03, -B04, C01, -C02, -C03, -C04, -D01, -D02, -D03, -D04, -D05
  - 3,3'-Dichlorobenzidine (33DCBD)—FTA13BHA01, -A02, -A03, -A04, -B01, -B02, -B03, -B04, -C01, -C02, -C03, -C04, -D01, -D02, -D03, -D04, -D05
  - 3,5-Dinitroaniline (35DNA)—FTA13BHA01, -A02, -A03, -A04, -B01, -B02, -B03, -B04, -C01, -C02, -C03, -C04, -D01, -D02, -D03, -D04, -D05
  - 3-Nitroaniline (3NANIL)—FTA13BHA01, -A02, -A03, -A04, -B01, -B02, -B03, -B04, -C01, -C02, -C03, -C04, -D01, -D02, -D03, -D04, -D05
  - 4-Chloroaniline (4CANIL)—FTA13BHA01, -A02, -A03, -A04, -B01, -B02, -B03, -B04, -C01, -C02, -C03, -C04, -D01, -D02, -D03, -D04, -D05
  - 4-Nitrophenol (4NP)—FTA13BHA01, -A02, -A03, -A04, -B01, -B02, -B03, -B04, -C01, -C02, -C03, -C04, -D01, -D02, -D03, -D04, -D05
  - Atrazine—FTA13BHA01, -A02, -A03, -A04, -B01, -B02, -B03, -B04, -C01, -C02, -C03, -C04, -D01, -D02, -D03, -D04, -D05
  - Endosulfan II (BENSLF)—FTA13BHA01, -A02, -A03, -A04, -B01, -B02, -B03, -B04, -C01, -C02, -C03, -C04, -D01, -D02, -D03, -D04, -D05
  - Benzoic acid (BENZOA)—FTA13BHA01, -A02, -A03, -A04, -B01, -B02, -B03, -B04, -C01, -C02, -C03, -C04, -D01, -D02, -D03, -D04, -D05
  - Hexachlorocyclopentadiene (CL6CP)—FTA13BHA01, -A02, -A03, -A04, -B01, -B02, -B03, -B04, -C01, -C02, -C03, -C04, -D01, -D02, -D03, -D04, -D05
  - Dicyclopentadiene (DCPD)—FTA13BHA01, -A02, -A03, -A04, -B01, -B02, -B03, -B04, -C01, -C02, -C03, -C04, -D01, -D02, -D03, -D04, -D05
  - Endrin—FTA13BHA01, -A02, -A03, -A04, -B01, -B02, -B03, -B04, -C01, -C02, -C03, -C04, -D01, -D02, -D03, -D04, -D05
  - Endrin aldehyde—FTA13BHA01, -A02, -A03, -A04, -B01, -B02, -B03, -B04, -C01, -C02, -C03, -C04, -D01, -D02, -D03, -D04, -D05

- Indeno(1,2,3-cd) pyrene—FTA13BHA01, -A02, -A03, -A04, -B01, -B02, -B03, -B04, -C01, -C02, -C03, -C04, -D01, -D02, -D03, -D04, -D05
- Methoxychlor—FTA13BHA01, -A02, -A03, -A04, -B01, -B02, -B03, -B04, -C01, -C02, -C03, -C04, -D01, -D02, -D03, -D04, -D05
- N-Nitrosodimethylamine (NNDMEA)—FTA13BHA01, -A02, -A03, -A04, -B01, -B02, -B03, -B04, -C01, -C02, -C03, -C04, -D01, -D02, -D03, -D04, -D05
- PCBs (1016, 1221, 1232, 1242, 1248, 1254, 1260, and 1262)—FTA13BHA01, -A02, -A03, -A04, -B01, -B02, -B03, -B04, -C01, -C02, -C03, -C04, -D01, -D02, -D03, -D04, -D05
- Pentachlorophenol (PCP)—FTA13BHA01, -A02, -A03, -A04, -B01, -B02, -B03, -B04, -C01, -C02, -C03, -C04, -D01, -D02, -D03, -D04, -D05
- PPDDT—FTA13BHA01, -A02, -A03, -A04, -B01, -B02, -B03, -B04, -C01, -C02, -C03, -C04, -D01, -D02, -D03, -D04, -D05
- Toxaphene—FTA13BHA01, -A02, -A03, -A04, -B01, -B02, -B03, -B04, -C01, -C02, -C03, -C04, -D01, -D02, -D03, -D04, -D05
- Antimony—FTA13BHA01, -A02, -A03, -A04, -B01, -B02, -B03, -B04, -C01, -C02, -C03, -C04, -D01, -D02, -D03, -D04, -D05
- Arsenic—FTA13BHA03, -B01, -B03, -C03

Phase II
- Kepone—FTA13BHE01, -E02, E03, -E04, -F01, -F02, -F03, -F04
- UNK536—FTA13BHE02, -E03, -E04, -F01, -F02, -F03, -F04
- UNK537—FTA13BHE01, -E02, -E03, -E04, -F01, -F02, -F03, -F04
- UNK538—FTA13BHE01, -E02, -E03, -E04, -F01, -F02, -F03, -F04
- UNK541—FTA13BHE02

16.4.1.3 Evaluation of Non-Detected Values. A comparison was made between the USEPA Region 5 DQLs and the project CRLs for chemicals that were analyzed for but not detected in environmental media at this site. Exceedances for beryllium were noted for soil samples.

Several groundwater VOCs had reported non-detected values from one to three orders of magnitude greater than the DQLs for at least one event and one location. However, these were limited to less than half the sampling events; acceptable CRLs were achieved at the other site wells for the same VOCs during the same events. Therefore, none of the VOCs ~~warranted~~ **merited** identification as having exceeded the DQLs. No exceedances for metals or SVOCs were found.

16.4.2 Data Quality Summary

16.4.2.1 Soil. A number of Phase I soil sample SVOC results (including PCBs and some pesticides) were rejected due to calibration problems. Resampling and analysis for these compounds during Phase II showed that with the exception of phenanthrene, SVOCs are not present in soils at this site. Therefore, the rejected SVOC data do not significantly impact the conclusions of the risk assessment. ~~All~~ **The** soil antimony results from Phase I soil samples were rejected, and ~~no~~ Phase II soil samples were **not** analyzed for this metal~~.~~ **As a result,**

potential antimony contamination has not been characterized in soil. However, the confirmation sampling (including antimony) performed during the soil removal action in 2000 indicated that residual soils met PRGs. (EPA100). ~~Therefore, antimony in soil at this site has not been well characterized.~~ The few rejected arsenic results (one out of four Phase I soil surface soil samples and three out of eight Phase I subsurface soil samples) do not significantly impact the conclusions of the risk assessment.

Positive results were changed to nondetects ("U") for several metals analyzed during Phase I. In particular, soil mercury results were affected by blank contamination. Positive results for several VOCs were also changed to nondetects. Most of the detections in the affected samples were below quantitation limits. Therefore, blank contamination does not significantly impact the conclusions of the risk assessment.

In summary, the number of samples, the comprehensiveness of the parameter list (with the exception of antimony), and the quality of the data are adequate to characterize the nature and magnitude of soil contamination at the exposure area addressed in the risk assessment.

16.4.2.2 Groundwater. Relatively few Phase II groundwater results were rejected. Most affected were chemicals not expected to be present in groundwater at this site. Therefore, rejected groundwater results do not significantly impact the conclusions of the risk assessment. Positive results were changed to nondetects ("U") for several metals analyzed during Phase II. The detections in the affected samples were below quantitation limits, and relatively few samples were affected. Therefore, blank contamination does not significantly impact the conclusions of the risk assessment.

In summary, the number of samples, the comprehensiveness of the parameter list, and the quality of the data are adequate to characterize the nature and magnitude of groundwater contamination at this site.

16.4.3 Background Screening

16.4.3.1 Surface Soil. Surface samples at this site were collected within an area less than the size of a residential lot. Therefore, ~~all~~ **the** samples were grouped together for background screening. The background screening protocol is described in Section 5.1.4.5.2. The results of the background screening procedure for surface soil at Site 13 are presented in Table 16-1. Since there were four surface soil samples that were analyzed for inorganic constituents, the t-test and Mann-Whitney test were used, where appropriate.

Site 13 samples were compared with background samples from the Cobbsfork soil series. As shown in Table 16-1, cadmium, chromium, cobalt, copper, nickel, silver, vanadium, and zinc are above background in surface soil at this site. These inorganics are carried forward to the COPC selection process.

16.4.3.2 Subsurface Soil. ~~All~~ **The** subsurface soil samples (□ 10 feet) were combined for the purposes of the background screening. Since there were eight subsurface soil samples that were analyzed for inorganic constituents, the t-test and the Mann-Whitney test were

performed, as appropriate. As shown in Table 16-1, beryllium, cobalt, copper, mercury, nickel, and silver are above background in subsurface soil at Site 13.

16.4.3.3 Groundwater. For the purposes of background screening, the four unfiltered sample results for each of the two downgradient wells were averaged to derive two well-specific data points. Since there were only two groundwater data points, the maximum of the two well-specific groundwater concentrations of a chemical was compared to the calculated background groundwater threshold (described in Section 5.1.4.5.2). Background screening of inorganic chemicals detected in groundwater at this site is documented in Table 16-2. As shown in the table, aluminum, boron, mercury, molybdenum, and zinc are above background in groundwater and are therefore retained as preliminary COPCs.

16.4.4 Summary of Analytical Results

Table 16-3 presents the analytical results for soil samples collected at the Old Fire Training Pit (Site 13). Table 16-4 presents the analytical results for groundwater samples from Site 13.

The soil analytical database for Site 13 that was utilized for the human health risk assessment consists of the six Phase I and Phase II surface soil samples (VOC, metals, and TPH from Phase I samples; VOCs (one sample only) and SVOCs from Phase II samples), and the 11 Phase I and Phase II subsurface soil samples collected to a depth of 10 feet (VOCs, metals, and TPH from Phase I samples; VOCs and SVOCs from Phase II samples). The five Phase I and two Phase II subsurface soil samples collected from depths below 10 feet were not included in the risk assessment database. The groundwater analytical database consists of the eight Phase II groundwater samples collected from the downgradient wells (two wells times four rounds of each sampling). The downgradient wells are FTA13GWA and FTA13GWB. The four sample results from each of these wells were averaged for the risk assessment to derive a single data point for each well.

16.5 NATURE AND EXTENT OF CONTAMINATION

16.5.1 Soil

Data from the four soil borings drilled at the site in November 1992 indicated that soil contamination existed at the site. The detection of fuel-related compounds, such as benzene, ethylbenzene, and fluoranthene, were restricted to the near surface sample (1.0 to 1.5 feet) of borehole B (Table 16-5). The solvent-related compounds toluene, xylene, and monochloro-benzene were also concentrated in the near surface sample of borehole B; however, they were also detected in borehole A (samples 1, 2, and 4) and borehole B (samples 4 and 5). Other SVOC and VOC compounds were detected in the near surface soil sample of borehole B and in borehole A (samples 1, 2, and 3). Total petroleum hydrocarbon results were as high as 59,000 ppm in the near surface sample from borehole B. Two other borehole soil samples had TPH concentrations that exceeded the state action level criteria of 100 ppm: sample 1 from borehole A (420 µg/g) and sample 2 from borehole A (320 µg/g).

Phase II soil sampling resulted in the detection of the VOC compounds methylene chloride (0.00131µg/g) and monochlorobenzene (0.119µg/g) in the near surface sample from borehole E. The only other organic contaminant detected was the SVOC phenanthrene at 0.0234µg/g in the near surface sample of Borehole E.

Analysis for metals in soil revealed the following metals at concentrations exceeding their background values: arsenic (4 samples), barium (9 samples), beryllium (8 samples), cadmium (1 sample), chromium (5 samples), cobalt (13 samples), copper (15 samples), lead (3 samples), manganese (8 samples), mercury (1 sample), nickel (17 samples), silver (17 samples), vanadium (8 samples), and zinc (12 samples). Cadmium, chromium, vanadium, and zinc also exceeded USEPA Region 9 criteria.

The data quality assessment performed on analytical data for the Phase I fire training pit borehole samples revealed that the results for several SVOC compounds were suspect. The data quality assessment for Phase II samples determined that results for SVOCs in Phase II samples were acceptable and that SVOC contamination is not a concern at this site.

The field-screening survey was conducted at this site in April 1993. A total of three probeholes (FTA-PH01 through FTA-PH03) were completed (See Figure 16-1). Piezometers were installed in ~~all~~ **the** three probeholes to serve as water-level monitoring points. The initial probehole, PH-01, was located on the northern side of the former burn pit. Probehole PH-02 was located about 50 feet southeast of the pit, and PH-03 was located 50 feet southwest of the pit. PH-01 was pushed to refusal at 21.5 feet deep, which was assumed to be bedrock for the area. The probehole information is summarized in Appendix G.

Because groundwater contamination was the main concern, the soil was sampled only in PH-01. The soil samples contained detectable VOCs in only two intervals sampled, from 3 to 5 feet bgs and from 6 to 8 feet bgs. The total VOCs were only 12 and 16 ppb, respectively. The groundwater sample revealed no **detection of** contamination. Probehole PH-02 groundwater contained hexane, a solvent-related compound. Groundwater collected from PH-03 at 11.5 to 17.5 feet bgs contained 16 ppb of total VOCs, with acetone and hexane being the only specific compounds identified. Because of the low concentrations of compounds detected and the small apparent extent of contamination, no additional probeholes were deemed necessary.

Remedial action performed during the period of July through September 2000 included soil excavation, waste characterization, confirmation sampling within the excavation, transportation and disposal of the excavated soil, backfilling, and seeding the excavation site. Details of this activity are contained in the *Position Paper – Site 13* prepared by Montgomery Watson (MWH, 2001). A Quality Control Summary Report, which details the results of data validation, is also included in the *Position Paper - Site 13*. (New Work)

16.5.2 Groundwater

Based on the field screening and borehole soils data, the site appears to contain significant contamination related to the fire training pit; however, the contamination did not appear to have spread ~~any~~ **a** significant distance outside of the pit area. Because the Geoprobe was incapable of obtaining bedrock groundwater samples, three groundwater-monitoring wells were installed around the site to provide bedrock groundwater sampling points.

The results of the Phase I monitoring well drilling and sampling indicate that lead and toluene were present in MW93-14 groundwater. Both results, however, were determined to be questionable. Lead was detected in the filtered sample but was not detected in the unfiltered sample that was collected. Toluene was detected in the associated trip blank at the same concentration as the MW93-14 sample. Furthermore, the potentiometric surface maps for all **the** three rounds of Phase I water level measurements show that MW93-14 is upgradient from the fire training pit. With the exception of the qualified toluene detection, ~~no~~ VOC**s** or SVOC**s** ~~compounds~~ were **not** detected in ~~any of~~ the groundwater samples. Boron, which was not detected in ~~any of~~ the background water samples, was detected in both the unfiltered and filtered samples of MW93-12 and in the filtered sample of MW93-14. ~~All~~ **The** ~~of~~ these boron detections are ~~far~~ below the USEPA Region 9 and MCL criteria.

The data quality assessment performed on Phase I analytical data for fire training pit groundwater samples revealed that instrument sensitivity for several SVOC compounds (see Appendix P) had possibly changed since the certification process and that it was possible that these compounds would not be detected in a field sample, even if present at concentrations equal to or slightly above the CRLs. Data from four additional Phase II rounds of sampling were deemed to be acceptable. MW93-12 contained pyrene and three tentatively identified SVOC compounds (round 2) and one VOC, chloromethane (round 4). MW93-13 was found to contain three tentatively identified SVOCs and one tentatively identified VOC during round 2. MW93-14 contained one tentatively identified VOC during round 2.

Several metals were found to exceed their respective background criteria from Phase II groundwater samples. These metals include aluminum, arsenic, boron, calcium, cobalt, chromium, iron, lead, potassium, manganese, molybdenum, nickel, selenium, tin, and vanadium. Of these metals, only aluminum was found to exceed USEPA Region 9 criteria.

16.6 HUMAN HEALTH RISK ASSESSMENT

As discussed in Section 16.3.3, since the Draft RI was submitted, a Remedial Removal Action was performed at Site 13, and was documented by the *Position Paper-Site 13*, dated March 2001. Confirmation sampling was performed on the residual soils in the excavation. Sample results confirmed that the remaining soils met the residential Region IX PRGs. Based on confirmation testing, the removal action was successful in removing contaminated soils and Site 13 is recommended for NFA for residential use. Because remediation has already been completed at Site 13, and have met USEPA residential

Region 9 PRGs, the risk estimates for Site 13 provided in the Draft RI have not been updated. Rather the original draft risk calculations are provided for informational purposes to document, in part, why remedial action was considered warranted at this site. (IN23)

16.6.1 Selection of Contaminants of Potential Concern

16.6.1.1 Surface Soil.

16.6.1.1.1 Data Grouping. Surface samples at this site were collected within an area less than the size of a residential lot. Therefore, ~~all~~ **the** samples were grouped together for the risk assessment.

16.6.1.1.2 Frequency of Detection. Evaluation of frequency of detection was not undertaken at this site because of too few samples.

16.6.1.1.3 Nutrient Screening. The maximum value of each of the nutrients detected in surface soil at this site is less than the corresponding nutrient screening value: calcium (maximum - 3,910 µg/g; screening value 1,000,000 µg/g), iron (maximum 21,000 µg/g; screening value 70,000 µg/g), magnesium (maximum 6,870 µg/g; screening value 1,000,000 µg/g), potassium (maximum 2,880 µg/g; screening value 150,000 µg/g), and sodium (maximum 1,440 µg/g; screening value 1,000,000 µg/g). Nutrients are, therefore, eliminated as COPCs in surface soil at this site.

16.6.1.1.4 Summary of Preliminary COPCs. Table 16-6 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95% UCL of the mean, and the exposure point concentrations for each preliminary COPC in surface soil at Site 13. Soil preliminary COPCs are chemicals that have been detected above background (and/or above the nutrient screening value) at a frequency of greater than 5 percent in soil samples.

16.6.1.1.5 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for each preliminary surface soil COPC was compared to the chemical-specific Region 9 residential soil PRG (Table 16-7 and Figure 16-5). One-tenth of the PRG was used for most noncarcinogens. The exceptions were lead and other noncarcinogens, the values of which were based on soil saturation limits. For these noncarcinogens the full PRG was used. As a result of this screening, the following chemicals have been selected as COPCs in surface soil at Site 13: cadmium, chromium, vanadium, and zinc.

16.6.1.2 Surface/Subsurface Soil Combined.

16.6.1.2.1 Frequency of Detection. Evaluation of frequency of detection was not undertaken at this site because of too few samples.

16.6.1.2.2 Nutrient Screening. The maximum value of each of the nutrients detected in surface/subsurface soil combined was less than the corresponding nutrient screening value: calcium (maximum 3,910 µg/g; screening value 1,000,000 µg/g), iron (maximum 51,300 µg/g; screening value 70,000 µg/g), magnesium (maximum 6,870 µg/g; screening value 1,000,000 µg/g), potassium (maximum 2,880 µg/g; screening value 150,000 µg/g), and sodium (maximum 1,440 µg/g; screening value 1,000,000 µg/g). Therefore, nutrients are eliminated as COPCs in surface/subsurface soil combined at Site 13.

16.6.1.2.3 Summary of Preliminary COPCs. Table 16-6 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95% UCL of the mean, and the exposure point concentrations for each preliminary COPC in surface/ subsurface soil combined at Site 13. Soil preliminary COPCs are chemicals that have been detected above background in either or both surface and subsurface soil (and/or above the nutrient screening value) at a frequency of greater than 5 percent in samples.

16.6.1.2.4 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for each preliminary surface/subsurface soil COPC was compared to the chemical-specific Region 9 residential soil PRG (Table 16-7 and Figure 16-5). One-tenth of the PRG was used for most noncarcinogens. The exceptions were lead and values for other noncarcinogens that were based on soil saturation limits where the full PRG was used. As a result of this screening, monochlorobenzene is the only chemical selected as a COPC in surface/subsurface soil combined at Site 13.

16.6.1.3 Air.

16.6.1.3.1 Summary of Preliminary COPCs. Ambient air concentrations to which future receptors at this site might be exposed were estimated using air emission/dispersion modeling, as described in Appendix R. In the site-specific conceptual model, discussed below in Section 16.6.2.1, Site 13 is evaluated under two future site-specific scenarios: as a residential site and as an industrial site.

In the future industrial land use scenario for the facility, ~~all~~ **the** sites were assumed to be industrial, except for the five sites designated agricultural sites. Each site with particulate-bound COPCs in surface soil (metals, SVOCs, and dioxins/furans) and/or volatile COPCs in surface/subsurface soil combined was assumed to contribute to the air concentrations at ~~all of~~ the sites. In the future residential scenario for the facility, ~~all~~ **the** sites were assumed to be residential except for the five sites designated agricultural. It was assumed that particulate and VOC emissions from the strictly residential sites would be negligible because the home sites would be covered with dense vegetation (lawns) and pavement. Therefore, under the residential scenario only the five agricultural sites contribute to the air concentrations at ~~all of~~ the sites. The list of preliminary air COPCs is therefore the same for every site for a given scenario, but the concentrations of the COPCs vary. Tables R-4 and R-6 in Appendix R present the estimated ambient air concentrations at Site 13 under the future industrial and residential scenarios, respectively.

16.6.1.3.2 Region 9 Preliminary Remediation Goal Screening. The exposure point concentrations for each preliminary air COPC at Site 13 in the future residential scenario and the future industrial scenario were compared to chemical-specific Region 9 air PRGs (Table 16-8). One-tenth of the PRG was used for noncarcinogens. The exception was lead, for which the full PRG was used. As a result of the screening, aluminum, chromium, silver, thallium, vanadium, and zinc are retained as COPCs in air for future on-site residents. For future on-site workers, aluminum, chromium, silver, thallium, vanadium, and zinc were retained as COPCs.

16.6.1.4 Groundwater.

16.6.1.4.1 Data Grouping. The data from each of the two downgradient wells (FTA13GWA and FTA13GWB) were averaged to derive a single data point for each well.

16.6.1.4.2 Frequency of Detection. Evaluation of frequency of detection was not undertaken at this site because of too few samples.

16.6.1.4.3 Nutrient Screening. The maximum value of each of the nutrients detected in groundwater at this site is less than the corresponding nutrient screening value: calcium (maximum to 99.6 mg/L; screening value 510 mg/L), iron (maximum 3.6 mg/L; screening value 9.4 mg/L), magnesium (maximum 36 mg/L; screening value 200 mg/L), potassium (maximum 2.6 mg/L; screening value 20 mg/L), and sodium (maximum 46.8 mg/L; screening value 730 mg/L). Nutrients are therefore eliminated as COPCs in groundwater at this site.

16.6.1.4.4 Summary of Preliminary COPCs. Table 16-9 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95% UCL of the mean, and the exposure point concentrations for each preliminary COPC in groundwater at Site 13. Groundwater preliminary COPCs are chemicals that have been detected above background (and/or above the nutrient screening value) at a frequency of greater than 5 percent in groundwater samples.

16.6.1.4.5 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for each preliminary groundwater COPC was compared to the chemical-specific Region 9 tap water PRG (Table 16-10). One-tenth of the PRG was used for noncarcinogens. As a result of this screening, aluminum is selected as the only groundwater COPC at Site 13.

16.6.2 Exposure Assessment

16.6.2.1 Site Conceptual Model. JPG is currently a closed, fenced, former munitions/weapons testing facility, and the fire training area is abandoned. As such, there are no people who specifically **are known to** work at or frequent Site 13. There are, however, several types of individuals who could potentially be affected by the existing contamination at the facility. These are current trespassers to JPG and off-facility (nearby) rural residents and future hunters. In each case, these individuals would most likely be impacted simultaneously by multiple sites rather than by single units. Because of this, these current receptor

populations are addressed on a facility-wide, cumulative basis rather than by specific sites (see Sections 28 and 29).

Therefore, this site-specific exposure scenario only addresses future land use development. Site 13 has three potential future land uses forwarded for evaluation:

- Residential
- Industrial

Residential Use. Under the future residential land use scenario, this site is assumed to be developed for residential purposes, with the supposition that a family would build a house directly on/within this area of potential concern. Since there are subsurface soil COPCs at these sites, it was assumed that subsurface soil may or may not be excavated to a depth of 10 feet during the construction of homes. In the excavation scenario, subsurface soil was assumed to be mixed and dispersed with surface soil across the ground surface at each home-site.

With respect to a risk assessment analysis, resident populations were assumed to consist of both adults and toddlers. Each individual would be expected to come in contact with site contaminants via the following pathways at Site 13:

- Inhalation of VOCs and fugitive particulates from soils
- Dermal contact with soil (surface or surface/subsurface combined) while gardening/playing outdoors
- Incidental ingestion of soil (surface or surface/subsurface combined) while gardening/playing outdoors
- Ingestion of fresh homegrown fruits and vegetables (grown in surface soil or surface/subsurface soil combined)
- Ingestion/dermal contact with groundwater
- Inhalation of VOCs while showering/bathing

On-site Worker. Industrial land use is considered to be a plausible future option for this site at JPG. On-site industrial workers (adult males and females) are assumed to be individuals who could be exposed directly to contaminated media through the following pathways at Site 13:

- Inhalation of VOCs and fugitive particulates from soils
- Incidental ingestion/dermal contact with surface soil

16.6.2.2 Exposure Point Concentrations.

16.6.2.2.1 Air. The estimated ambient air concentrations of COPCs at these sites for the future on-site residents and the future on-site workers are presented in Table 16-8.

16.6.2.2.2 Soil. The concentrations of COPCs in surface soil and surface/subsurface soil combined at these sites are presented in Table 16-7.

16.6.2.2.3 Fruits and Vegetables. COPC concentrations in homegrown fruits and vegetables were estimated using the methods described in Section 5.1.5.2.8. Chlorobenzene is the only COPC in surface/subsurface soil combined at this site. Because VOCs such as chlorobenzene are more likely to leach through the soil or volatilize into the air than be taken up by fruits and vegetables, fruit and vegetable concentrations were not estimated for this chemical. Appendix U, Table U-10, documents the calculation of contaminant concentrations in fruits and vegetables grown in surface soil at Site 13.

16.6.2.2.4 Groundwater. The concentrations of COPCs in groundwater at Site 13 are presented in Table 16-10.

16.6.2.2.5 Shower Air. There are no VOC COPCs in groundwater at Site 13; therefore, inhalation of VOCs in shower air is an incomplete pathway at this site.

16.6.2.3 Human Exposure Doses.

16.6.2.3.1 Inhalation of Contaminated Air. Inhalation of airborne contaminants (VOCs and particulates) is a potential route of exposure for future on-site residents (adults and children) and future on-site workers at this site. The equation used for calculating human exposure doses of contaminants of potential concern due to inhalation of volatile and dust-bound contaminants is provided in Section 5.1.5.3.1, Table 5-**11**~~12~~. Table V-10, Appendix V, documents the calculation of human exposure doses at Site 13 due to inhalation of contaminated air.

16.6.2.3.2 Incidental Ingestion of Contaminated On-site Soil. Mouthing behavior (toddlers) and incidental ingestion of soil with recreational or work-related activities may expose human receptors to contaminated soil at a site via the oral route of exposure. The equation used to calculate the human exposure dose due to incidental ingestion of contaminated soil is presented in Section 5.1.5.3.2, Table 5-**12**~~13~~. This pathway was assumed to be complete at Site 13 for future on-site residents (adults and children) and future on-site workers. Table V-10, Appendix V, documents the calculation of human exposure doses due to incidental ingestion of soil at Site 13.

16.6.2.3.3 Dermal Contact with Contaminated On-site Soil. The chemicals in contaminated soil also may be absorbed into a receptor's body through dermal contact. The equation that was used to calculate chemical doses due to dermal contact with contaminated

soil is presented in Section 5.1.5.3.3, Table 5-**13**~~14~~. This pathway is relevant for future on-site residents (adults and children) and future on-site workers at Site 13. Table V-10, Appendix V, documents the calculation of human exposure doses due to dermal contact with soil at this site.

16.6.2.3.4 Ingestion of Contaminated Fruits and Vegetables. Consumption of contaminated homegrown fruits and vegetables may be a source of chemical exposure for future on-site residents (adults and children). The equation used to calculate human exposure dose due to ingestion of contaminated fruits and vegetables is provided in Section 5.1.5.3.11, Table 5-**22**~~23~~. Table V-10, Appendix V, documents the calculation of human exposure doses due to ingestion of contaminated fruits and vegetables grown in surface soil at Site 13.

16.6.2.3.5 Ingestion of Contaminated Groundwater. Contaminated drinking water may be a source of chemical exposure for future on-site residents (adults and children) and future workers. The equation used to calculate human exposure doses due to ingestion of contaminated drinking water is provided in Section 5.1.5.3.4, Table 5-**14**~~15~~. Table V-10, Appendix V, documents the calculation of human exposure doses at Site 13 due to ingestion of contaminated groundwater.

16.6.2.3.6 Dermal Contact with Contaminated Groundwater. Exposure via dermal contact with chemicals in groundwater may occur when receptors (future residents) shower or bathe. The equation used to calculate daily chemical doses due to dermal contact with contaminated groundwater is provided in Section 5.1.5.3.5, Table 5-**15**~~16~~. Table V-10, Appendix V, documents the calculation of human exposure doses at Site 13 due to dermal contact with contaminated groundwater.

16.6.3 Risk Characterization

16.6.3.1 Chronic Health Hazards. The noncancer daily exposure doses calculated in the exposure assessment were used to calculate HQs for each of the COPCs possessing RfDs. Pathway-specific and overall HIs were then calculated for each receptor. The calculations of HQ and HI are described in Section 5.1.7.1. If an overall HI is calculated to be greater than 1.0 for a particular receptor, then the exposure pathway(s) primarily responsible for the result is identified as a "critical pathway(s)." For each critical pathway, those chemical contaminants responsible for the majority of the HI are listed as COCs. Table W-10, Appendix W, documents the calculation of the pathway- and chemical-specific HQs for the human receptors at Site 13. The pathway-specific and overall HIs are summarized in Table 16-11.

16.6.3.1.1 Future On-Site Residents. If these receptors are exposed to COPCs in surface soil only, the overall HIs for the future on-site adult and toddler residents at Site 13 are calculated to be 4.8 and 6.6, respectively. Both of these HIs exceed the USEPA's risk management criterion of 1.0. The critical exposure pathway for both receptors is ingestion of fruits/vegetables grown in surface soil at these sites. Zinc is the sole noncarcinogenic COC.

If subsurface soil is assumed to be mixed and dispersed with surface soil across the ground surface at the home-site, the overall HIs for the future on-site adult and toddler residents are calculated to be 0.13 and 0.32, respectively. Since both of these values are less than USEPA's risk management criterion of 1.0, ~~no~~ critical exposure pathways or noncarcinogenic COCs are **not** identified for these receptors under the excavation scenario.

Zinc is naturally occurring in soils at the JPG facility. The relative contributions of background soil concentrations of zinc to the soil hazards at Site 13 were estimated by comparing the average soil background concentration of zinc (in Cobbsfork soils) to the average concentration in site soils. Background zinc accounts for less than 1 percent of the total zinc concentration in soils at this site, and background zinc would contribute less than 1 percent to the hazard associated with exposure to surface soil.

16.6.3.1.2 Future On-Site Workers. The overall HI for the future on-site worker at Site 13 is calculated to be 0.07, which is less than USEPA's risk management criterion. Thus, ~~no~~ critical exposure pathways or chemicals of concern are **not** identified for this receptor population at this site.

16.6.3.2 *Excess Lifetime Cancer Risks*. The cancer risks for each receptor were determined from the pathway-specific exposure doses and the route-specific SFs, as described in Section 5.1.7.2. To assess the simultaneous exposure of a receptor population to multiple carcinogens from multiple exposure routes, ~~all of~~ the cancer risks calculated for a receptor population were summed. Each overall receptor cancer risk was then compared to USEPA's target risk range (1.0E-06 to 1.0E-04). If the total cancer risk for a receptor from ~~all~~ **the** exposure pathways is less than 1.0E-04, then it is concluded that the site(s) does not pose a significant risk to that receptor. If the overall cancer risk exceeds the target risk range, ~~any~~ **a** chemical individually associated with a risk level greater than 1.0E-05 is identified as a COC. COCs represent the primary contributors to the potential cancer risk for the receptor-specific exposure pathway under evaluation. Table W-10, Appendix W, documents the calculation of the pathway- and chemical-specific cancer risks for the human receptors at Site 13. The pathway-specific and overall cancer risks are summarized in Table 16-11.

16.6.3.2.1 Future On-Site Residents. No carcinogenic COPCs were selected for surface soil or surface/subsurface soil combined, or for groundwater at Site 13. The future resident receptors' only exposure to carcinogens is via inhalation of fugitive dusts. The cancer risks calculated for the future adults and toddlers via this pathway are calculated to be 1.2E-07 and 8.6E-08, respectively. Both of these cancer risks are below the USEPA's target risk range of 1.0E-06 to 1.0E-04. Therefore, ~~no~~ critical exposure pathways or carcinogenic COCs are **not** identified for future residents at Site 13.

16.6.3.2.2 Future On-Site Workers. No carcinogenic COPCs were selected for surface soil or for groundwater at Site 13. The future worker receptor's only exposure to carcinogens is via inhalation of fugitive dusts. The cancer risk calculated for the future worker via this pathway is 6.4E-06. Since this estimated cancer risk is within USEPA's target risk range of

1.0E-06 to 1.0E-04, ~~no~~ critical exposure pathways or chemicals of concern are **not** identified for future workers.

16.6.3.3 Uncertainty/Sensitivity Analysis. The numerical risks/hazards that are calculated for Site 13 represent *conditional* estimates of risk based on various simplifying assumptions concerning contaminant exposure and toxicity. These estimates of risk/hazard are derived using a series of conservative procedures that address contaminant concentrations at the site, their fate in the environment, how someone currently or in the future might be exposed to these contaminants, and the toxicity of each chemical toward humans. The uncertainty analysis specifies, when appropriate, the critical assumptions made for the site so that the site-specific results can be interpreted by the risk managers in a proper context.

To assist the risk managers in this project, a qualitative uncertainty analysis has been performed. The primary goals of a qualitative uncertainty analysis are (1) to itemize the major areas of uncertainty in the site-specific risk assessment and (2) to demonstrate that the assessment overall has been conservatively performed (i.e., that the potential risks/hazards at the site have not likely been underestimated, but may have been significantly overestimated).

The qualitative uncertainty analysis for this site is presented in Table 16-12. Based on this analysis, it can be concluded that this risk assessment is conservative. Some of the major uncertainties in this study that are most influential to the risks/hazards that were calculated include:

- Use of RDA values as toxicity criteria for zinc
- Receptors' exposure time (24 hours/day) and exposure frequency (350 days/year)
- Receptors' food-stuff ingestion rate (95th percentile of U.S. population)
- Maximum soil concentration used
- Food-chain concentrations modeled rather than measured

There are a number of uncertainties associated with the fruit and vegetable ingestion pathway. A major source of uncertainty is attributable to uncertainty in soil-to-plant transfer factors. Many site-specific factors can affect the extent of uptake of chemicals into plants. Some of these factors include pH, the organic carbon content of the soil, and the presence of other chemicals. Site conditions may vary from those in studies used to derive the uptake factors used in the assessment. Some of the equations used to estimate plant uptake from soil utilize chemical-specific properties such as K_d and K_{ow}. For each chemical there may be a range of values for these parameters reported in the literature. Professional judgment was used to select the values used in the assessment. Another source of uncertainty for this pathway is the assumption that the intake rates for fruits and vegetables, which are based on data collected during a nationwide survey by Pao *et al*. (1982), would be representative of actual exposure conditions at this site. The percent of fruit and vegetable intake, which is homegrown produce,

also cannot be known for a future population, and conservative estimates were used in the assessment based on national surveys. Because of these uncertainties, the HIs and cancer risks calculated for receptors ingesting fruits and vegetables grown at this site may be over- or underestimated by an order of magnitude.

16.7 ECOLOGICAL RISK ASSESSMENT

Utilizing established protocol, the Preliminary Ecological Risk Assessment (Rust E&I 1997g) determined that arsenic, barium, cadmium, and zinc are contaminants of concern for potential ecological receptors at Site 13. However, it was determined in the analysis leading to the September 1997 Technical Memorandum (Rust E&I 1997f) that (1) the suspected area of contamination is small (less than 0.1 acre), (2) exceedances are slight and based on maximum detected values rather than average concentrations, and (3) the area surrounding the site includes frequently mowed and burned grassland and concrete airport runways. Therefore, no further ecological action is ~~warranted~~**needed**.

16.8 CONCLUSIONS AND RECOMMENDATIONS

Data from surface and subsurface soil samples at the Old Fire Training Site (Site 13) indicate that metals, VOC, and SVOC contaminants ~~are~~ **were** present. Fuel-related contamination and solvent-related contamination were both identified in surface and near-surface soils. Elevated metals were also found to be present in the soils of Site 13. Of these contaminants, COPCs retained for surface soils were the metals cadmium, chromium, vanadium, and zinc. For surface and subsurface soils combined, monochlorobenzene was the only COPC retained.

Groundwater was found to contain low concentrations of VOC and SVOC compounds. In addition, several metals were found to exceed their respective background concentrations. Of these contaminants, only aluminum was retained as a COPC for the human health risk assessment.

Results of the human health risk assessment indicate that soil contamination at Site 13 poses little risk to future on-site workers. For the future on-site resident, chronic health hazards, due primarily to ingestion of homegrown produce contaminated with zinc in surface soils, exceed USEPA's risk management criterion of an HI of 1.0. Using results from surface and subsurface soils combined indicates that these hazards would be below USEPA's goal of 1.0. Cancer risks due to inhalation of fugitive dusts are estimated to be below the USEPA's target range of 1.0E-04 to 1E-06.

The preliminary ecological risk assessment conducted during Phase I identified arsenic, cadmium, barium, and zinc as potential contaminants of concern for ecological receptors at Site 13. However, it was determined that due to the fact that the contaminated area is small, the exceedances are slight and based on maximum detected values, and the surrounding site

incorporates airport runways, no adverse impacts to ecological receptors was predicted. As a result, no further ecological analysis was required for Site 13.

Sufficient data were collected during the Phase I and Phase II investigations to characterize the nature and extent of soil and groundwater contamination and to evaluate ecological risk and potential remedial alternatives, which have been performed. Therefore, no further action is recommended for Site 13.

In July through September 2000, soil was excavated from Site 13. Approximately 147.85 tons of soil was transported for landfill disposal following waste characterization. Confirmation soil samples were collected from the excavation. Analytical laboratory results of the samples confirmed that the remaining soil met PRGs. Montgomery Watson prepared and submitted a Position Paper (March 2001) to the USEPA documenting the remedial action and proposing NFA for residential use. USEPA concurred with these recommendations in June 2001. Therefore, no further action is currently planned for soil at Site 13.~~Since there are potential health hazards present for future residents, this site will be carried forward to the FS.~~**(IN23)**

~~Sufficient data were collected during the Phase I and Phase II investigations to characterize the nature and extent of **soil and groundwater** contamination and to evaluate **ecological risk and** potential remedial alternatives**, which have been performed**. Therefore, no further remedial investigation activities are warranted**necessaryaction is recommended for Site 13**.~~

TABLES

TABLE 16-1

Background Screening of Inorganic Chemicals Detected in Soil
Site 13 – Old Fire Training Pit
Jefferson Proving Ground
Madison, Indiana

Chemical	Location	Frequency of Detection[a]	Maximum Detected Value (mg/kg)	Average Concentration (mg/kg)	Median Concentration (mg/kg)	Background Threshold[b] (mg/kg)	Data Distribution	Test Performed	p value	Site > Background?
Surface Soil										
Aluminum	Site	4/4	12,000	8,722	9,580		Normal	Mann-Whitney	0.29	No
	Background	**10/10**	**10,900**	**7,673**	**7,845**	**11,000**	**Lognormal**			
Arsenic	Site	3/3	8.56	6.1	5.2		NA	Extreme value	NA	No
	Background	**10/10**	**9.46**	**4.8**	**3.9**	**9.26**	**Neither**			
Barium	Site	4/4	261	102	49.4		Neither	Mann-Whitney	0.13	No
	Background	**10/10**	**74.1**	**49.8**	**45.7**	**84.5**	**Lognormal**			
Cadmium	Site	1/4	5.34	1.8	0.60		Neither	NA	NA	**YES**
	Background	**0/10**	**NA**	**NA**	**NA**	**NA**	**NA**			
Chromium (total)	Site	4/4	81.2	29.1	12.1		Neither	Mann-Whitney	0.01	**YES**
	Background	**10/10**	**15.5**	**9.7**	**9.9**	**15.1**	**Lognormal**			
Cobalt	Site	4/4	5.32	4.2	4.1		Lognormal	t test	0.001	**YES**
	Background	**10/10**	**3.6**	**1.9**	**1.9**	**3.5**	**Lognormal**			
Copper	Site	4/4	15.7	9.9	9.7		Normal	t test	0.035	**YES**
	Background	**7/10**	**4.96**	**3.5**	**4.1**	**5.64**	**Normal**			
Lead	Site	4/4	60.0	21.5	8.9		Neither	NA[c]	NA	No
	Background	**10/10**	**14.6**	**13.6**	**13.6**	**14.9**	**Normal**			
Manganese	Site	4/4	169	130	149		Normal	Mann-Whitney	0.20	No
	Background	**10/10**	**344**	**115**	**85.9**	**302**	**Lognormal**			

TABLE 16-1

Background Screening of Inorganic Chemicals Detected in Soil
Site 13 – Old Fire Training Pit
Jefferson Proving Ground
Madison, Indiana

Chemical	Location	Frequency of Detection[a]	Maximum Detected Value (mg/kg)	Average Concentration (mg/kg)	Median Concentration (mg/kg)	Background Threshold[b] (mg/kg)	Data Distribution	Test Performed	p value	Site > Background?
Surface Soil (cont'd)										
Nickel	Site	4/4	25.0	9.8	5.0		Neither	Extreme value	NA	**YES**
	Background	**1/10**	**2.30**	**2.0**	**2.0**	**2.23**	**Neither**			
Silver	Site	3/4	0.05	0.03	0.03		Normal	NA	NA	**YES**
	Background	**0/10**	**NA**	**NA**	**NA**	**NA**	**NA**			
Vanadium	Site	4/4	109	46.5	26.7		Neither	Mann-Whitney	0.006	**YES**
	Background	**10/10**	**27.6**	**19.8**	**19.2**	**27.0**	**Lognormal**			
Zinc	Site	4/4	5,800	1,494	77.4		Lognormal	Mann-Whitney	0.003	**YES**
	Background	**10/10**	**18.5**	**14.7**	**14.7**	**19.5**	**Normal**			
Subsurface Soil										
Aluminum	Site	8/8	17,000	9,770	8,495		Lognormal	t test	0.055[d]	No
	Background	**10/10**	**10,900**	**7,673**	**7,845**	**11,000**	**Lognormal**			
Arsenic	Site	5/5[e]	16.2	7.1	5.3		Lognormal	Mann-Whitney	0.07	No
	Background	**10/10**	**9.46**	**4.8**	**3.9**	**9.26**	**Neither**			
Barium	Site	8/8	170	80.3	67.6		Lognormal	t test	0.056[f]	No
	Background	**10/10**	**74.1**	**49.8**	**45.7**	**84.5**	**Lognormal**			
Beryllium	Site	5/8	1.70	0.70	0.69		Normal	t test	0.038	**YES**
	Background	**10/10**	**0.45**	**0.32**	**0.32**	**0.52**	**Normal**			
Chromium (total)	Site	8/8	15.2	10.1	8.8		Lognormal	t test	0.40[g]	No
	Background	**10/10**	**15.5**	**9.7**	**9.9**	**15.1**	**Lognormal**			

TABLE 16-1

Background Screening of Inorganic Chemicals Detected in Soil
Site 13 – Old Fire Training Pit
Jefferson Proving Ground
Madison, Indiana

Chemical	Location	Frequency of Detection[a]	Maximum Detected Value (mg/kg)	Average Concentration (mg/kg)	Median Concentration (mg/kg)	Background Threshold[b] (mg/kg)	Data Distribution	Test Performed	p value	Site > Background?
Subsurface Soil (cont'd)										
Cobalt	Site	6/8	51.0	11.4	6.4		Lognormal		0.02	t test
	Background	**10/10**	**3.6**	**1.9**	**1.9**	**3.5**	**Lognormal**			
Copper	Site	8/8	18.7	9.6	6.3		Lognormal	Mann-Whitney	<0.001	**YES**
	Background	**7/10**	**4.96**	**3.5**	**4.1**	**5.64**	**Normal**			
Lead	Site	8/8	23.5	9.7	8.1		Lognormal	NA[c]	NA	No
	Background	**10/10**	**14.6**	**13.6**	**13.6**	**14.9**	**Normal**			
Manganese	Site	8/8	2,500	511	182		Lognormal	t test	0.13[h]	No
	Background	**10/10**	**344**	**115**	**85.9**	**302**	**Lognormal**			
Mercury	Site	1/8	0.19	0.05	0.03		Neither	NA	NA	**YES**
	Background	**0/10**	**NA**	**NA**	**NA**	**NA**	**NA**			
Nickel	Site	8/8	15.2	9.2	9.2		Normal	Extreme value	NA	**YES**
	Background	**1/10**	**2.30**	**2.0**	**2.0**	**2.23**	**Neither**			
Silver	Site	8/8	0.056	0.03	0.03		Lognormal	NA	NA	**YES**
	Background	**0/10**	**NA**	**NA**	**NA**	**NA**	**NA**			
Vanadium	Site	8/8	35.4	22.2	26.9		Lognormal	t test	0.45[I]	No
	Background	**10/10**	**27.6**	**19.8**	**19.2**	**27.0**	**Lognormal**			
Zinc	Site	8/8	36.3	20.2	15.0		Lognormal	Mann-Whitney	0.47	No
	Background	**10/10**	**18.5**	**14.7**	**14.7**	**19.5**	**Normal**			

TABLE 16-1

Background Screening of Inorganic Chemicals Detected in Soil
Site 13 – Old Fire Training Pit
Jefferson Proving Ground
Madison, Indiana

Notes:

Concentrations are in milligrams per kilogram, mg/kg.
NA = Not applicable.

Footnotes:

(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) See Section 5.1.2.4.2 for an explanation of how the soil background screening values were calculated.
(c) The Mann-Whitney test was not performed because the median site concentration is less than the median background concentration.
(d) The difference between the means of the log-transformed Al data is 0.22; the 95% confidence interval (CI) for the difference between the means is -0.04 to 0.48.
(e) Three arsenic results were rejected.
(f) The difference between the means of the log-transformed Ba data is 0.38; the 95% CI is -0.1 to 0.87.
(g) The difference between the means of the log-transformed Cr data is 0.04; the 95% CI is -0.23 to 0.31.
(h) The difference between the means of the log-transformed Mn data is 0.75; the 95% CI is -0.61 to 2.1.
(i) The difference between the means of the log-transformed V data is 0.03; the 95% CI is -0.41 to 0.46.

TABLE 16-2

Background Screening of Inorganic Chemicals Detected in Groundwater
Site 13 – Old Fire Training Pit
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Maximum Detected Value (µg/L)[b]	Groundwater Background Screening Value[c] (µg/L)	Exceeds Groundwater Background?
Aluminum, Total	2/2	1,165	553	**YES**
Barium, Total	2/2	239.7	509.3	No
Boron, Total	2/2	143.3	140	**YES**
Chromium, Total	1/2	2.35	6.24	No
Manganese, Total	2/2	120.8	290	No
Mercury, Total	1/2	0.069	0.056	**YES**
Molybdenum, Total	1/2	11.5	9.67	**YES**
Tin, Total	1/2	49.4	55.7	No
Vanadium, Total	1/2	2.3	2.89	No
Zinc, Total	2/2	6.0	NA[d]	**YES**

Footnotes:
(a) Number of samples in which the analyte was detected/total number of samples analyzed. The two downgradient wells at this site (FTA13GWA and FTA13GWB) were used in the background screening analysis.
(b) Micrograms per liter.
(c) See Section 5.1.2.4.2 for an explanation of how the groundwater background screening values were calculated.
(d) Not available or not applicable.

TABLE 16-3

Analytical Results for Metals in Soil Samples
Site 13 – Old Fire Training Pit
Jefferson Proving Ground
Madison, Indiana

Sample ID Sample No. Depth (feet) Sample Date Analyte	FTA13BHA 01 0.3 11/9/92	FTA13BHA 02 4.6 11/9/92	FTA13BHA 03 9.6 11/9/92	FTA13BHA 04 14.6 11/9/92	FTA13BHB 01 0.5 11/9/92	FTA13BHB 02 4.6 11/9/92	FTA13BHB 03 9.6 ft 11/9/92	FTA13BHB 04 14.3 ft 11/9/92	Background (µg/g) [(a)]
Aluminum	12,000	7,720	7,370	12,400	3,730	17,000	9,250	9,250	11,000
Antimony	LT[(b)] 19.6 R[(c)]	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	0.49
Arsenic	3.42	3.70	LT 2.50 R	19.0	LT 2.50 R	5.53	LT 2.50 R	11.2	6.30
Barium	49.5	119	34.4	225	261	170	54.1	105	95.0
Beryllium	LT 0.427	LT 0.427	0.621	0.771	LT 0.427	0.754	1.70	0.918	0.52
Boron	LT 6.64	LT 6.64	LT 6.64	LT 6.64	LT 6.64	LT 6.64	LT 6.64	LT 6.64	0
Cadmium	LT 1.20	LT 1.20	LT 1.20	LT 1.20	5.34	LT 1.20	LT 1.20	LT 1.20	0
Calcium	1,030	1,110	1,160	3,950	3,910	2,400	2,840	2,390	750
Chromium	12.6	10.0	8.28	35.9	81.2	15.2	8.21	20.0	15.1
Cobalt	4.43	51.00	LT 2.50	14.7	5.32	5.27	10.4	13.8	3.50
Copper	4.77	5.75	4.46	25.6	7.92	15.7	15.1	27.7	5.64
Iron	11,900	11,300	13,700	55,400	4,500	42,600	25,800	52,800	14,800
Lead	7.78	11.2	5.02	15.6	60.0	9.37	6.18	13.9	14.9
Magnesium	907	1,350	638	2,260	6,870	1,990	1,150	1,740	7,000
Manganese	131	2,500	20.0	1,700	53.1	238	125	794	302
Mercury	LT 0.05	LT 0.05	0.186	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	0
Molybdenum	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	0
Nickel	4.42	7.69	4.00	30.0	25.0	10.8	13.8	23.4	2.23
Potassium	463	385	223	898	2,880	471	195	600	681
Selenium	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	0.74
Silver	0.0508	0.038	0.0198	0.0228	0.0369	0.0534	0.0556	LT 0.0124	0
Sodium	LT 38.7	97.0	91.9	138	1,440	398	183	147	50.5
Thallium	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	0.43
Tin	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	0
Vanadium	23.4	15.6	26.9	45.9	109	27.7	35.4	58.6	27.0
Zinc	108	31.5	8.33	78.4	5,800	36.3	9.36	66.4	19.5

TABLE 16-3

Analytical Results for Metals in Soil Samples
Site 13 – Old Fire Training Pit
Jefferson Proving Ground
Madison, Indiana

Sample ID Sample No. Depth (feet) Sample Date Analyte	FTA13BHC 01 0.6 11/10/92	FTA13BHC 02 4.6 11/10/92	FTA13BHC 03 9.6 11/10/92	FTA13BHC 04 14.6 11/10/92	FTA13BHD 01 0.6 11/10/92	FTA13BHD 02 4.6 11/10/92	FTA13BHD 03 9.6 11/10/92	FTA13BHD 04 14.6 11/10/92	FTA13BHD 05 19.2 11/10/92	Background (µg/g)
Aluminum	11,600	12,400	7,740	11,700	7,560	7,070	9,610	6,660	10,000	11,000
Antimony	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	0.49
Arsenic	4.42	16.2	LT 2.50 R	9.17	5.21	4.74	5.27	4.37	4.48	9.26
Barium	49.2	81.0	35.6	711	48.3	104	44.6	157	98.1	84.5
Beryllium	LT 0.427	1.08	0.804	0.609	LT 0.427	LT 0.427	LT 0.427	LT 0.427	LT 0.427	0.52
Boron	LT 6.64	LT 6.64	LT 6.64	LT 6.64	LT 6.64	LT 6.64	LT 6.64	LT 6.64	LT 6.64	0
Cadmium	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	0
Calcium	3,050	1,530	1,510	4,900	1,270	1,170	2,300	3,280	4,440	750
Chromium	11.6	14.5	6.93	17.4	10.9	8.28	9.33	10.9	13.3	15.1
Cobalt	3.82	11.7	LT 2.50	20.2	3.34	7.43	2.99	8.63	4.83	3.50
Copper	11.5	18.7	6.08	40.9	15.7	6.52	4.47	9.38	7.08	5.64
Iron	21,000	51,300	8,120	25,600	19,200	12,200	6,260	9,630	8,940	14,800
Lead	8.70	23.5	6.30	13.3	8.33	7.92	8.34	7.18	7.78	14.9
Magnesium	1,290	1,660	733	3,140	756	1,050	1,090	2,040	2,480	7,000
Manganese	169	466	51.4	3,000	167	628	60.9	715	319	302
Mercury	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	0.0717	0
Molybdenum	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 13.6	0
Nickel	5.43	11.8	5.71	21.4	4.52	15.2	4.48	8.38	9.09	2.23
Potassium	390	417	170	1,210	362	348	325	573	698	681
Selenium	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	0.74
Silver	LT 0.0124	0.0260	0.0309	0.0245	0.0295	0.0215	0.0294	0.0161	0.0237	0
Sodium	55.3	320	131	244	82.0	163	132	111	149	50.5
Thallium	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 1.0	0.43
Tin	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.3	LT 7.3	10.0	0
Vanadium	23.5	31.7	13.7	27.3	29.9	19.1	7.60	9.30	7.22	27.0
Zinc	23.3	36.3	9.36	66.4	46.7	14.2	10.3	32.4	38.5	19.5

Footnotes:
(a) All values are in micrograms per gram.
(b) Less than the reporting limit.
(c) Rejected, value is unusable.

TABLE 16-4

Analytical Results for Groundwater Samples
Site 13 – Old Fire Training Pit
Jefferson Proving Ground
Madison, Indiana

Analyte	WELL ID: SAMPLE ID: Sampling Round[a]	MW93-12 FTA13GWA	MW93-13 FTA13GWB	MW93-14 FTA13GWC
Aluminum	1	LT[b] 112	LT 112	240
	2	17,800	3,110	4,980
	3	44.3	63.9	14,200
	4	LT 200	76.8	11,300
	5	LT 200	1,410	784
Arsenic	1	LT 2.35	LT 2.35	LT 2.35
	2	LT 5.00	LT 5.00	LT 5.00
	3	ND[c] 5.00	ND 5.00	4.46
	4	LT 5.56	LT 5.56	5.48
	5	LT 5.00	LT 5.00	3.63
Antimony	1	LT 60.0	LT 60.0	LT 60.0
	2	LT 10.0	LT 10.0	LT 10.0
	3	ND 10.0	ND 10.0	ND 10.0
	4	LT 10.0	LT 10.0	2.43
	5	LT 10.0	LT 10.0	LT 10.0
Barium	1	242	207	250
	2	327	263	227
	3	230	182	225
	4	241	190	227
	5	246	206	172
Beryllium	1	LT 1.12	LT 1.12	LT 1.12
	2	LT 5.00	LT 5.00	LT 5.00
	3	LT 5.00	LT 5.00	LT 5.00
	4	LT 5.00	LT 5.00	LT 5.00
	5	LT 5.00	LT 5.00	LT 5.00
Boron	1	278	251	LT 230
	2	169	137	67.0
	3	130	131	87.4
	4	154	156	82.5
	5	143	149	LT 100
Cadmium	1	LT 6.78	LT 6.78	LT 6.78
	2	5.00	LT 5.00	LT 5.00
	3	LT 5.00	LT 5.00	LT 5.00
	4	LT 5.00	LT 5.00	LT 5.00
	5	LT 5.00	LT 5.00	LT 5.00

TABLE 16-4

Analytical Results for Groundwater Samples
Site 13 – Old Fire Training Pit
Jefferson Proving Ground
Madison, Indiana

Analyte	WELL ID: SAMPLE ID: Sampling Round[(a)]	MW93-12 FTA13GWA	MW93-13 FTA13GWB	MW93-14 FTA13GWC
Calcium	1	106,000	102,900	107,000
	2	117,000	99,900	98,800
	3	91,500	96,700	91,400
	4	93,600	97,100	94,600
	5	95,500	96,600	90,900
Chromium	1	LT 16.8	LT 16.8	LT 16.8
	2	17.3	LT 10.0	8.80
	3	LT 10.0	LT 10.0	32.5
	4	LT 10.0	2.35	34.2
	5	LT 10.0	LT 10.0	LT 10.0
Cobalt	1	LT 25.0	LT 25.0	LT 25.0
	2	7.00	LT 50.0	LT 50.0
	3	LT 50.0	LT 50.0	LT 50.0
	4	LT 50.0	LT 50.0	8.16
	5	LT 50.0	LT 50.0	LT 50.0
Copper	1	LT 18.8	LT 18.8	LT 18.8
	2	8.70	LT 20.0	LT 20.0
	3	LT 20.0	LT 20.0	LT 7.70
	4	LT 20.0	LT 20.0	LT 20.0
	5	LT 20.0	LT 20.0	LT 20.0
Iron	1	LT 77.5	367	1,290
	2	12,400	2,600	4,010
	3	439	1,540	8,770
	4	904	1,400	7,950
	5	567	1,900	949
Lead	1	LT 4.47	LT 4.47	LT 4.47
	2	LT 6.63	LT 3.00	LT 3.00
	3	ND 3.00	ND 3.00	8.09
	4	LT 3.33	LT 3.33	6.87
	5	LT 3.00	LT 3.00	LT 3.00
Magnesium	1	37,300	37,200	40,100
	2	43,800	36,600	36,700
	3	32,700	33,000	34,500
	4	33,500	35,100	35,900
	5	34,100	35,700	33,700

TABLE 16-4

Analytical Results for Groundwater Samples
Site 13 – Old Fire Training Pit
Jefferson Proving Ground
Madison, Indiana

Analyte	WELL ID: / SAMPLE ID: / Sampling Round[(a)]	MW93-12 FTA13GWA	MW93-13 FTA13GWB	MW93-14 FTA13GWC
Manganese	1	66.7	550	480
	2	306	165	312
	3	68.9	86.1	276
	4	81.3	110	379
	5	41.0	122	381
Mercury	1	LT 0.10	LT 0.10	LT 0.10
	2	LT 0.20	0.069	LT 0.20
	3	ND 0.20	ND 0.20	ND 0.20
	4	LT 0.20	LT 0.20	LT 0.20
	5	LT 0.20	LT 0.20	LT 0.20
Molybdenum	1	LT 52.7	LT 52.7	LT 52.7
	2	LT 100	LT 100	LT 100
	3	LT 100	LT 100	LT 100
	4	LT 100	11.5	LT 100
	5	100	LT 100	LT 100
Nickel	1	LT 32.1	LT 32.1	LT 32.1
	2	LT 40.0	LT 40.0	LT 40.0
	3	LT 40.0	LT 40.0	22.2
	4	LT 40.0	LT 40.0	19.5
	5	LT 40.0	LT 40.0	LT 40.0
Potassium	1	1,700	1,820	1,420
	2	5,840	2,400	2,300
	3	1,160	1,400	4,650
	4	1,570	1,360	3,270
	5	LT 3,000	LT 3,000	LT 3,000
Selenium	1	LT 2.53	LT 2.53	LT 2.53
	2	2.90	LT 5.00	LT 5.00
	3	ND 5.00	ND 5.00	ND 5.00
	4	LT 5.56	LT 5.56	LT 5.56
	5	LT 5.00	LT 5.00	LT 5.00
Silver	1	LT 0.333	LT 0.333	LT 0.333
	2	LT 10.0	LT 10.0	LT 10.0
	3	LT 10.0	LT 10.0	LT 10.0
	4	LT 10.0	LT 10.0	LT 10.0
	5	LT 10.0	LT 10.0	LT 10.0

TABLE 16-4

Analytical Results for Groundwater Samples
Site 13 – Old Fire Training Pit
Jefferson Proving Ground
Madison, Indiana

Analyte	WELL ID: SAMPLE ID: Sampling Round[a]	MW93-12 FTA13GWA	MW93-13 FTA13GWB	MW93-14 FTA13GWC
Sodium	1	47,800	47,600	50,500
	2	49,200	46,000	57,300
	3	44,900	44,200	52,800
	4	45,800	45,600	54,000
	5	46,900	45,800	55,600
Thallium	1	LT 125	LT 125	LT 125
	2	LT 10.0	LT 10.0	LT 10.0
	3	ND 10.0	ND 10.0	ND 10.0
	4	LT 11.1	LT 11.1	LT 11.1
	5	LT 10.0	LT 10.0	LT 10.0
Tin	1	NA	NA	NA
	2	LT 100	LT 100	LT 100
	3	LT 100	100	LT 100
	4	LT 100	49.4	LT 100
	5	LT 100	LT 100	LT 100
Vanadium	1	LT 27.6	LT 27.6	LT 27.6
	2	25.0	2.30	11.0
	3	LT 50.0	LT 50.0	26.9
	4	LT 50.0	LT 50.0	28.2
	5	LT 50.0	LT 50.0	LT 50.0
Zinc	1	LT 18.0	LT 18.0	LT 18.0
	2	44.3	7.50	19.0
	3	3.86	4.50	41.0
	4	LT 20.0	LT 20.0	24.4
	5	LT 20.0	LT 20.0	LT 20.0
Benzene	1	LT 2.00	LT 2.00	LT 2.00
	2	LT 1.00	0.31	LT 1.00
	3	LT 1.00	LT 1.00	LT 1.00
	4	LT 1.00	LT 1.00	LT 1.00
	5	LT 1.00	LT 1.00	LT 1.00
Chloromethane	1	LT 2.00	LT 1.00	LT 1.00
	2	LT 1.00	LT 1.00	LT 1.00
	3	LT 1.00	LT 1.00	LT 1.00
	4	LT 1.00	LT 1.00	LT 1.00
	5	0.49	LT 1.00	LT 1.00

TABLE 16-4

Analytical Results for Groundwater Samples
Site 13 – Old Fire Training Pit
Jefferson Proving Ground
Madison, Indiana

Analyte	WELL ID: SAMPLE ID: Sampling Round[(a)]	MW93-12 FTA13GWA	MW93-13 FTA13GWB	MW93-14 FTA13GWC
Pyrene	1	LT 2.00	LT 2.00	LT 2.00
	2	LT 10.0	LT 10.0	LT 10.0
	3	0.41	LT 10.0	LT 10.0
	4	LT 10.0	LT 10.0	LT 10.0
	5	LT 10.0	LT 10.0	LT 10.0
Toluene	1	LT 1.00	LT 1.00	1.20
	2	LT 1.00	LT 1.00	LT 1.00
	3	LT 1.00	LT 1.00	LT 1.00
	4	LT 1.00	LT 1.00	LT 1.00
	5	LT 1.00	LT 1.00	LT 1.00
Xylene	1	LT 2.00	LT 2.00	LT 2.00
	2	LT 1.00	0.19	LT 1.00
	3	LT 1.00	LT 1.00	LT 1.00
	4	LT 1.00	LT 1.00	LT 1.00
	5	LT 1.00	LT 1.00	LT 1.00

Footnotes:

(a) Round 1: 06/16/93;
Round 2: 11/03-17/95;
Round 3: 02/13-20/96;
Round 4: 04/25-05/10/96;
Round 5: 06/20-27/96. (EPA 18)

(b) Less than the reporting limit.

(c) Not detected.

TABLE 16-5

Analytical Results for Organic Contaminants Detected in Soil Samples
Site 13 – Old Fire Training Pit
Jefferson Proving Ground
Madison, Wisconsin

Sample ID	Contaminant	Concentration (µg/g)[a]	Date Sampled
FTA13BHA01	Total Petroleum Hydrocarbons	420	11/09/92
FTA13BHB01	1,3-Dimethylbenzene	1.20	11/09/92
	Benzene	0.24	
	Ethylbenzene	0.26	
	Monochlorobenzene	0.51	
	Toluene	1.00	
	Total Petroleum Hydrocarbons	59,000	
	Xylene	2.00	
FTA13BHC01	Total Petroleum Hydrocarbons	10.0	11/10/92
FTA13BHD01	Total Petroleum Hydrocarbons	10.0	11/10/92
FTA13BHE01	Methylene Chloride	0.00131	05/10/96
	Monochlorobenzene	0.119	
	Phenanthrene	0.0234	

Footnote:
(a) Micrograms per gram.

TABLE 16-6

Soil Exposure Point Concentrations of Contaminants of Potential Concern
Site 13 – Old Fire Training Pit
Jefferson Proving Ground
Madison, Wisconsin

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/g)[b]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL[e] Concentration (µg/g)	Exposure Point Concentration[c] (µg/g)
Surface Soil						
Cadmium	1/4	5.34	1.20	1.79	182	5.34
Chromium	4/4	10.9 - 81.2	NA[d]	29.1	1,279	81.2
Cobalt	4/4	3.34 - 5.32	NA	4.23	5.65	5.32
Copper	4/4	4.77 - 15.7	NA	9.97	15.5	15.5
Nickel	4/4	4.42 - 25.0	NA	9.84	187	25.0
Silver	3/4	0.029 - 0.051	0.012	0.031	0.053	0.051
Vanadium	4/4	23.4 - 109	NA	46.5	480	109
Zinc	4/4	23.3 - 5,800	NA	1,495	4.6E+13	5,800
1,3-Dimethylbenzene	1/4	1.20	0.23	0.39	87.3	1.20
Benzene	1/5	0.24	0.005 - 0.10	0.08	112	0.24
Ethylbenzene	1/5	0.26	0.005 - 0.19	0.11	0.20	0.20
Methylene chloride	1/5	0.0013	4.40	1.76	6.7E+13	0.0013
Monochlorobenzene	2/5	0.119 - 0.51	0.10	0.16	2.32	0.51
Phenanthrene	½	0.0234	0.67	0.18	NC	0.0234
Toluene	1/5	1.0	0.005 - 0.10	0.23	22,744	1.0
Xylene	1/5	2.0	0.005 - 0.78	0.64	2.3E+07	2.0

TABLE 16-6

Soil Exposure Point Concentrations of Contaminants of Potential Concern
Site 13 – Old Fire Training Pit
Jefferson Proving Ground
Madison, Wisconsin

Chemical	Frequency of Detection[(a)]	Range of Detected Values (µg/g)[(b)]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL[(e)] Concentration (µg/g)	Exposure Point Concentration[(c)] (µg/g)
			Surface/Subsurface Soil			
Cadmium	1/12	5.34	1.20	1.0	1.7	1.7
Chromium	12/12	6.93 - 81.2	NA	14.7	23.9	23.9
Cobalt	10/12	2.99 - 51.0	2.50	8.1	21.8	21.8
Copper	12/12	4.46 - 18.7	NA	9.7	14.3	14.3
Nickel	12/12	4.0 - 25	NA	9.3	14.3	14.3
Silver	11/12	0.019 - 0.056	0.012	0.033	0.041	0.041
Vanadium	12/12	7.6 - 109	NA	29.3	47.7	47.7
Zinc	12/12	8.33 - 5,800	NA	133	1,914	1,914
1,3-Dimethylbenzene	1/12	1.20	0.34	0.21	0.37	0.37
Acetone	1/13	0.012	3.30	2.5	11.8	0.012
Benzene	1/14	0.24	0.005 - 0.10	0.069	0.214	0.214
Ethylbenzene	1/14	0.26	0.005 - 0.19	0.032	0.39	0.26
Methylene chloride	2/14	0.006 - 0.0013	4.40	1.9	6,600	0.0013
Methylethyl ketone	1/14	0.065	0.10 - 4.30	2.8	11.0	0.065

TABLE 16-6

Soil Exposure Point Concentrations of Contaminants of Potential Concern
Site 13 – Old Fire Training Pit
Jefferson Proving Ground
Madison, Wisconsin

Chemical	Frequency of Detection[(a)]	Range of Detected Values (µg/g)[(b)]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL[(e)] Concentration (µg/g)	Exposure Point Concentration[(c)] (µg/g)
Surface/Subsurface Soil (cont'd)						
Monochlorobenzene	4/14	0.119 - 10.0	0.005 - 0.10	0.79	26.3	10.0
Phenanthrene	1/6	0.023	0.67	0.34	3.3	0.023
Toluene	2/14	0.14 - 1.0	0.005 - 0.10	0.11	0.55	0.55
Xylene	1/14	2.0	0.005 - 0.78	1.0	16.6	2.0

Footnotes:
(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Micrograms per gram.
(c) The 95% UCL or the maximum detected value, whichever is lower (USEPA 1989b).
(d) Not applicable.
(e) UCL = upper confidence limit of the mean

TABLE 16-7

Selection of Contaminants of Potential Concern (COPC) in Soil Based on USEPA Region 9 Preliminary Remediation Goal (PRGs)
Site 13 – Old Fire Training Pit
Jefferson Proving Ground
Madison, Indiana

Chemical	USEPA Region 9 PRG Screen		
	Residential PRG (μg/g)[(a)]	Exposure Point Conc. (μg/g)	Retained as Soil COPC?
Surface Soil			
Cadmium	3.83	5.34	**YES**
Chromium	30.1	81.2	**YES**
Cobalt	457	5.32	No
Copper	285	15.5	No
Nickel	153	25.0	No
Silver	38.3	0.051	No
Vanadium	53.7	109	**YES**
Zinc	2,300	5,800	**YES**
1,3-Dimethylbenzene	320[(b)]	1.20	No
Benzene	0.632	0.24	No
Ethylbenzene	230[(b)]	0.20	No
Methylene chloride	7.8	0.0013	No
Monochlorobenzene	6.5	0.51	No
Phenanthrene	100[(b,c)]	0.0234	No
Toluene	79.3	1.0	No
Xylene	320[(b)]	2.0	No
Surface/Subsurface Soil Combined			
Cadmium	3.83	1.7	No
Chromium	30.1	23.9	No
Cobalt	457	21.8	No
Copper	285	14.3	No
Nickel	153	14.3	No

TABLE 16-7

Selection of Contaminants of Potential Concern (COPC) in Soil Based on USEPA Region 9 Preliminary Remediation Goal (PRGs)
Site 13 – Old Fire Training Pit
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Residential PRG (µg/g)[a]**	**Exposure Point Conc. (µg/g)**	**Retained as Soil COPC?**
Surface/Subsurface Soil Combined (continued)			
Silver	38.3	0.041	No
Vanadium	53.7	47.7	No
Zinc	2,300	1,914	No
1,3-Dimethylbenzene	320[b]	0.37	No
Acetone	209	0.012	No
Benzene	0.632	0.214	No
Ethylbenzene	230[b]	0.26	No
Methylene chloride	7.8	0.0013	No
Methylethyl ketone	710	0.065	No
Monochlorobenzene	6.5	10.0	**YES**
Phenanthrene	100[b,c]	0.023	No
Toluene	79.3	0.55	No
Xylene	320[b]	2.0	No

Notes:

PRGs were taken directly from the Region 9 PRG Table (USEPA 1996c) except as noted in the footnotes. Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:

(a) Micrograms per gram.
(b) Values for noncarcinogens based on soil saturation limits were not divided by 10.
(c) Value for pyrene.

TABLE 16-8

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs) Site 13 – Old Fire Training Pit Jefferson Proving Ground Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Ambient Air PRG (µg/m^3)[(a)]**	**Exposure Point Concentration (µg/m^3)**	**Retained as Air COPC?**
Residential Scenario			
Aluminum	NA[(b)]	2.42E-02	**YES**
Arsenic	4.5E-04	1.24E-04	No
Barium	5.2E-02	3.13E-05	No
Beryllium	8.0E-04	9.63E-07	No
Cadmium	1.1E-03	6.09E-08	No
Chromium	2.3E-05	3.32E-05	**YES**
Lead	1.5E+00[(c)]	4.51E-06	No
Manganese	5.1E-03	1.74E-03	No
Silver	NA	6.84E-05	**YES**
Thallium	NA	4.56E-06	**YES**
Vanadium	NA	6.20E-06	**YES**
Zinc	NA	3.11E-06	**YES**
Dioxins/Furans	4.5E-08	2.37E-13	No
Benzo(a)anthracene	9.2E-03	5.59E-09	No
Benzo(a)pyrene	9.2E-04	1.14E-08	No
Benzo(b)fluoranthene	9.2E-03	2.09E-08	No
DDE	2.0E-02	3.29E-09	No
Dibenz(a,h)anthracene	9.2E-04	6.58E-10	No
Dieldrin	4.2E-04	NA	No
Indeno(1,2,3-cd)pyrene	9.2E-03	3.30E-09	No
1,1-Dichloroethylene	3.8E-02	1.86E-09	No
Chlorobenzene	2.1E+00	2.16E-02	No

TABLE 16-8

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 13 – Old Fire Training Pit
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Ambient Air PRG (μg/m³)[a]**	**Exposure Point Conc. (μg/m³)**	**Retained as Air COPC?**
Industrial Scenario			
Aluminum	NA	2.70E-02	**YES**
Arsenic	4.5E-04	1.38E-05	No
Barium	5.2E-02	3.20E-05	No
Beryllium	8.0E-04	2.40E-06	No
Cadmium	1.1E-03	6.07E-04	No
Chromium	2.3E-05	9.28E-03	**YES**
Lead	1.5E+00[c]	4.51E-06	No
Manganese	5.1E-03	1.91E-03	No
Silver	NA	6.84E-05	**YES**
Thallium	NA	4.56E-06	**YES**
Vanadium	NA	1.24E-02	**YES**
Zinc	NA	6.60E-01	**YES**
Dioxins/Furans	4.5E-08	1.73E-11	No
Benzo(a)anthracene	9.2E-03	5.59E-09	No
Benzo(a)pyrene	9.2E-04	1.15E-08	No
Benzo(b)fluoranthene	9.2E-03	2.09E-08	No
DDE	2.0E-02	3.29E-09	No
Dibenz(a,h)anthracene	9.2E-04	6.58E-10	No
Dieldrin	4.2E-04	3.48E-09	No
Indeno(1,2,3-cd)pyrene	9.2E-03	3.29E-09	No
1,1-Dichloroethylene	3.8E-02	1.86E-09	No
Chlorobenzene	2.1E+00	2.16E-02	No

Notes:

PRGs were taken directly from the Region 9 PRG Table (USEPA 1996c). Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:

(a) Micrograms per cubic meter.
(b) Not applicable.
(c) Federal ambient air quality criterion for lead.

TABLE 16-9

Groundwater Exposure Point Concentrations of Contaminants of Potential Concern (COPC)
Site 13 – Old Fire Training Pit
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/L)[b]	Range of Reporting Limits (µg/L)	Arithmetic Mean Concentration (µg/L)	95% UCL[f] Concentration (µg/L)	Exposure Point Concentration[c] (µg/L)
Aluminum, Total	2/2	1,165 - 4,512	NA[d]	2,839	NC[e]	4,512
Boron, Total	2/2	143.3 - 149.1	NA	146	NC	149.1
Mercury, Total	1/2	0.069	0.20	0.085	NC	0.069
Molybdenum, Total	1/2	11.5	100	30.8	NC	11.5
Zinc, Total	2/2	6.0 - 17.6	NA	11.8	NC	17.6
Benzene	1/2	0.310	1.0	0.405	NC	0.310
Chloromethane	1/2	0.490	1.0	0.495	NC	0.490
Pyrene	1/2	0.410	10.0	2.71	NC	0.410
Xylene	1/2	0.190	1.0	0.345	NC	0.190

Footnotes:
(a) Number of samples in which the analyte was detected/total number of samples analyzed. Data from the two downgradient wells (FTA13GWA and FTA13GWB) were used in the calculations.
(b) Micrograms per liter.
(c) The 95% UCL or the maximum detected value, whichever is lower (USEPA 1989b).
(d) Not applicable.
(e) Not calculated due to insufficient data.
(f) UCL = upper confidence limit of the mean

TABLE 16-10

Selection of Contaminant of Potential Concern (COPC) in Groundwater Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 13 - Old Fire Training Pit
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Tap Water PRG (μg/L)[(a)]**	**Exposure Point Concentration (μg/L)**	**Retained as Groundwater COPC?**
Aluminum, Total	3,650	4,512	**YES**
Boron, Total	328.5	149.1	No
Mercury, Total	1.10[(b)]	0.069	No
Molybdenum, Total	18.3	11.5	No
Zinc, Total	1,095	17.6	No
Benzene	0.386	0.310	No
Chloromethane	1.51	0.490	No
Pyrene	18.3	0.410	No
Xylene	143[(c)]	0.190	No

Notes:

PRGs were taken directly from the Region 9 PRG Table (USEPA 1996c) except as noted in the footnotes. Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:

(a) Micrograms per liter.
(b) Value for mercuric chloride.
(c) Value for total xylenes.

TABLE 16-11

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 13 – Old Fire Training Pit
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
		Future On-site Resident Adult (surface soil only)		
Ingestion of soil	NA[a]		0.0774	
Dermal contact with soil	NA		0.0065	
Ingestion of homegrown fruits/vegetables	NA		4.6187	Zinc (94%)
Inhalation of VOCs[b] and fugitive dusts	1.15E-07		0.0034	
Ingestion of groundwater	NA		0.1236	
Dermal contact with groundwater	NA		0.0009	
Total	1.15E-07	Total	4.8305	
		Future On-site Resident Child (surface soil only)		
Ingestion of soil	NA		0.5874	
Dermal contact with soil	NA		0.0151	
Ingestion of homegrown fruits/vegetables	NA		5.7082	Zinc (89%)
Inhalation of VOCs and fugitive dusts	8.64E-08		0.0219	
Ingestion of groundwater	NA		0.2884	
Dermal contact with groundwater	NA		0.0009	
Total	8.64E-08	Total	6.6219	

TABLE 16-11

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 13 – Old Fire Training Pit
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
Future On-site Resident Adult (surface/subsurface soil combined)				
Ingestion of soil	NA		0.0007	
Dermal contact with soil	NA		NA	
Inhalation of VOCs and fugitive dusts	1.15E-07		0.0034	
Ingestion of groundwater	NA		0.1236	
Dermal contact with groundwater	NA		0.0009	
Total	1.15E-07	Total	0.1286	
Future On-site Resident Child (surface/subsurface soil combined)				
Ingestion of soil	NA		0.0064	
Dermal contact with soil	NA		NA	
Inhalation of VOCs and fugitive dusts	8.64E-08		0.0219	
Ingestion of groundwater	NA		0.2884	
Dermal contact with groundwater	NA		0.0009	
Total	8.64E-08	Total	0.3176	

TABLE 16-11

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 13 – Old Fire Training Pit
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
		Future On-site Worker (surface soil only)		
Incidental ingestion of soil	NA		0.0199	
Dermal contact with soil	NA		0.0020	
Inhalation of VOCs and fugitive dusts	6.36E-06		0.0015	
Ingestion of groundwater	NA		0.0441	
Total	6.36E-06		0.0675	

Footnotes:

(a) Not applicable.

(b) Volatile organic compounds.

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TABLE 16-12

Qualitative Uncertainty Analysis
Site 13 – Old Fire Training Pit
Jefferson Proving Ground
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
A. Human Behavior				
Future receptors' exposure duration	30 years	Medium	Medium	National upper-bound time (90th percentile) at one residence
Future receptors' exposure frequency	350 days/year	Medium	Medium	High-end value
Future receptors' foodstuff ingestion rate	NA[a]	Low	High	Nearly impossible for an average weight receptor to ingest daily the 95th percentile U.S. population consumption amounts
Exclusion of certain exposure pathways in the quantitative analysis	NA	Low	Low	Pathways eliminated are those that have low possibility of contributing risk to these receptors
B. Chemical Fate/Transport in the Environment				
Soil exposure point concentration of COC[b]	Maximum detected value	Low	High	Site average likely to be lower
Modeling used to predict concentrations in fruits/vegetables	NA	Low	High	Conservative assumptions and input parameters
Use of air dispersion modeling to predict air concentrations	NA	Low	High	Conservative assumptions and input parameters

TABLE 16-12

Qualitative Uncertainty Analysis
Site 13 – Old Fire Training Pit
Jefferson Proving Ground
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
C. Chemical Toxicity				
Assumption that USEPA[(c)] reference doses truly represent toxicological thresholds	Zinc oral RfD[(d)] (6.6E-01 mg/kg-d)	Low	High	Value for child is recommended daily allowance (RDA)
Assumption that USEPA carcinogenic slope factors truly represent dose-response phenomena	NA	Low-moderate	Moderate-high	Use of linearized, multi-stage mathematical model to predict cancer incidence at low exposure levels is USEPA policy; not currently supported by scientific data
Assumption of risk/hazard additivity	NA	Moderate	Moderate	Summation of chemical-specific risks/hazards may over- or under-predict risks/hazards to receptors
Screening out of certain contaminants based on USEPA criteria	NA	Low	Low	Chemicals present in concentrations less than Region 9 criteria eliminated

Footnotes:
- (a) Not applicable or not available.
- (b) Contaminant of concern.
- (c) United States Environmental Protection Agency.
- (d) Reference dose.

FIGURES

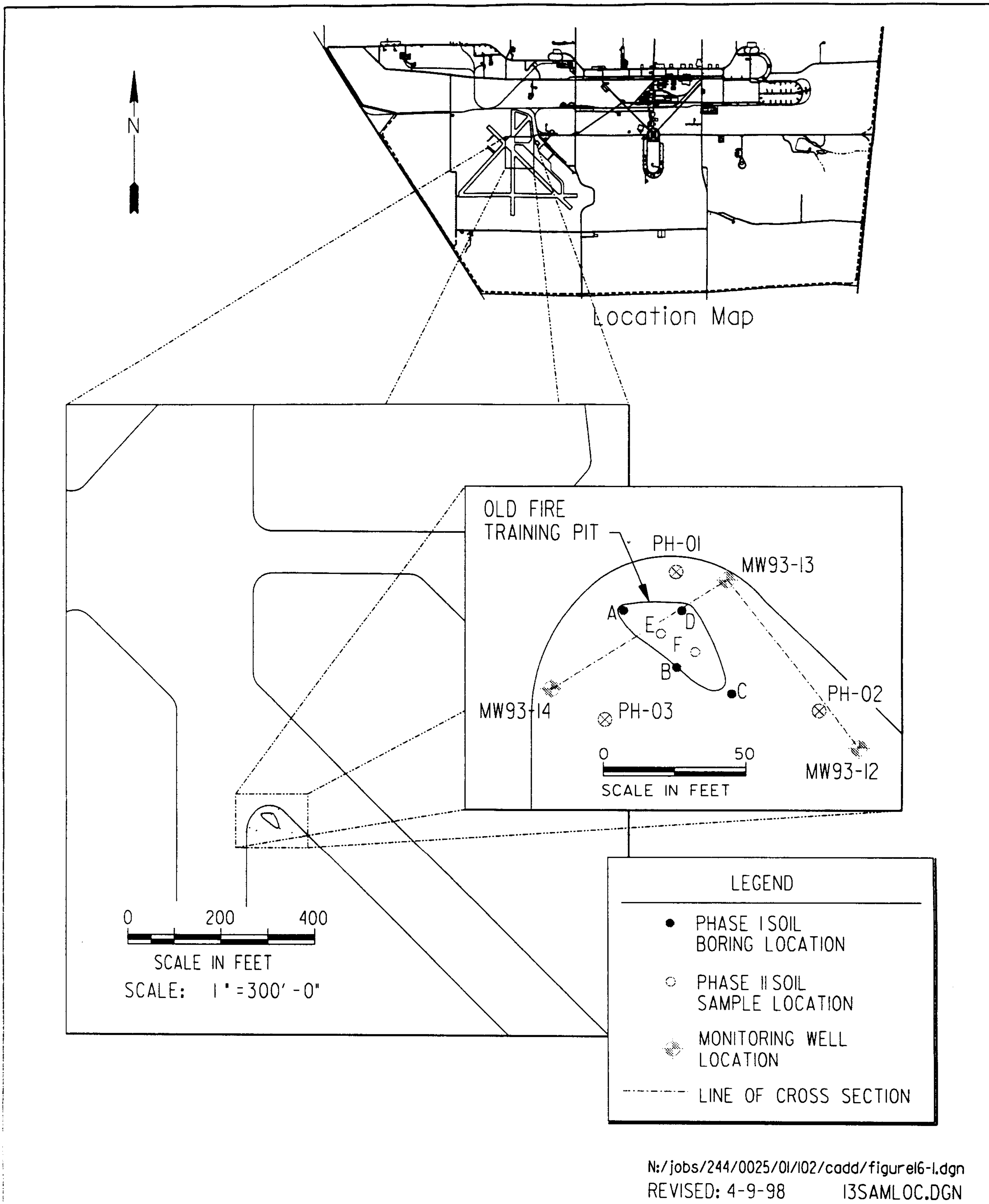

Figure 16-1. Sampling Locations at the Old Fire Training Pit (Site 13)

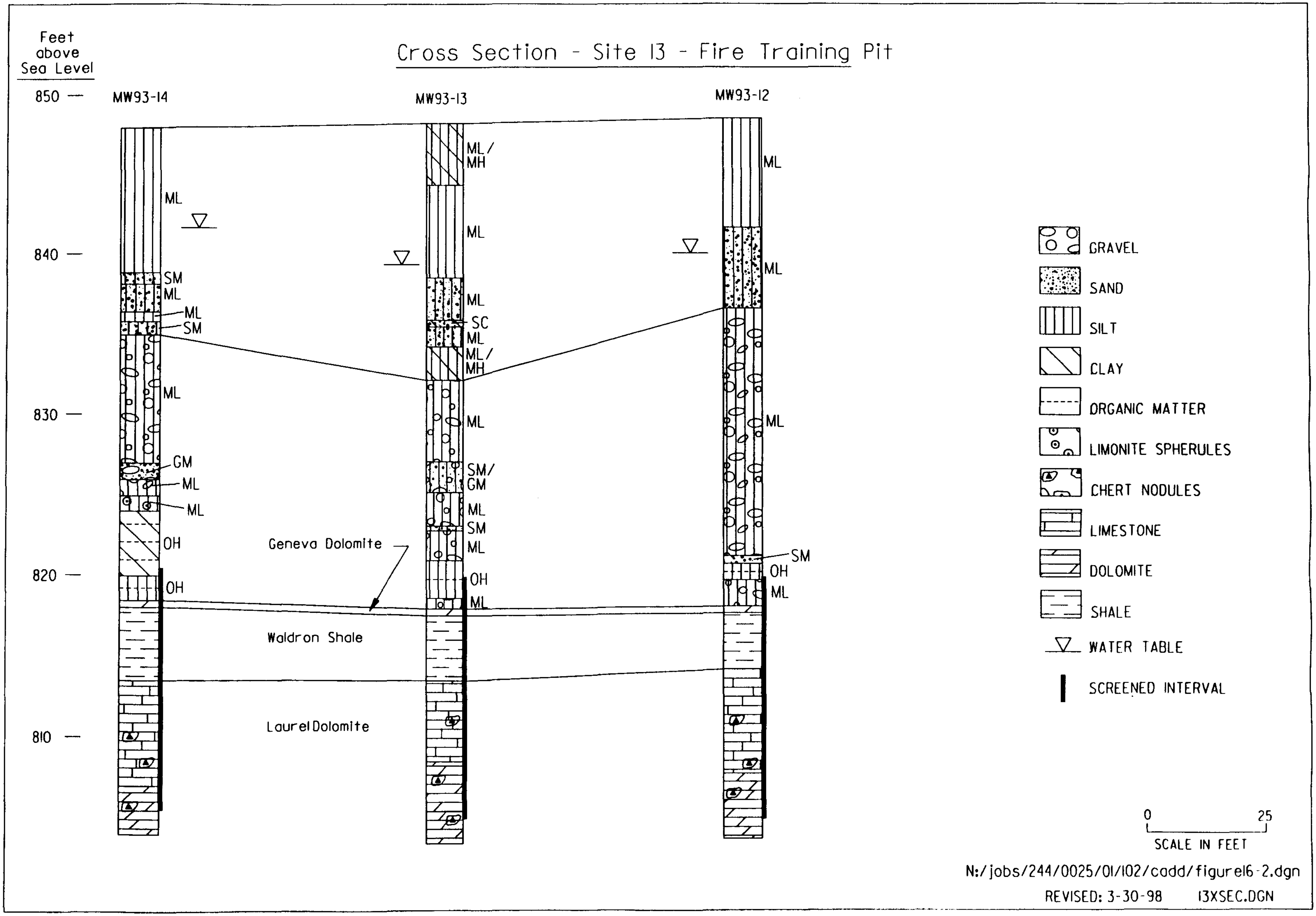

Figure 16-2. Cross Section of Old Fire Training Pit (Site 13)

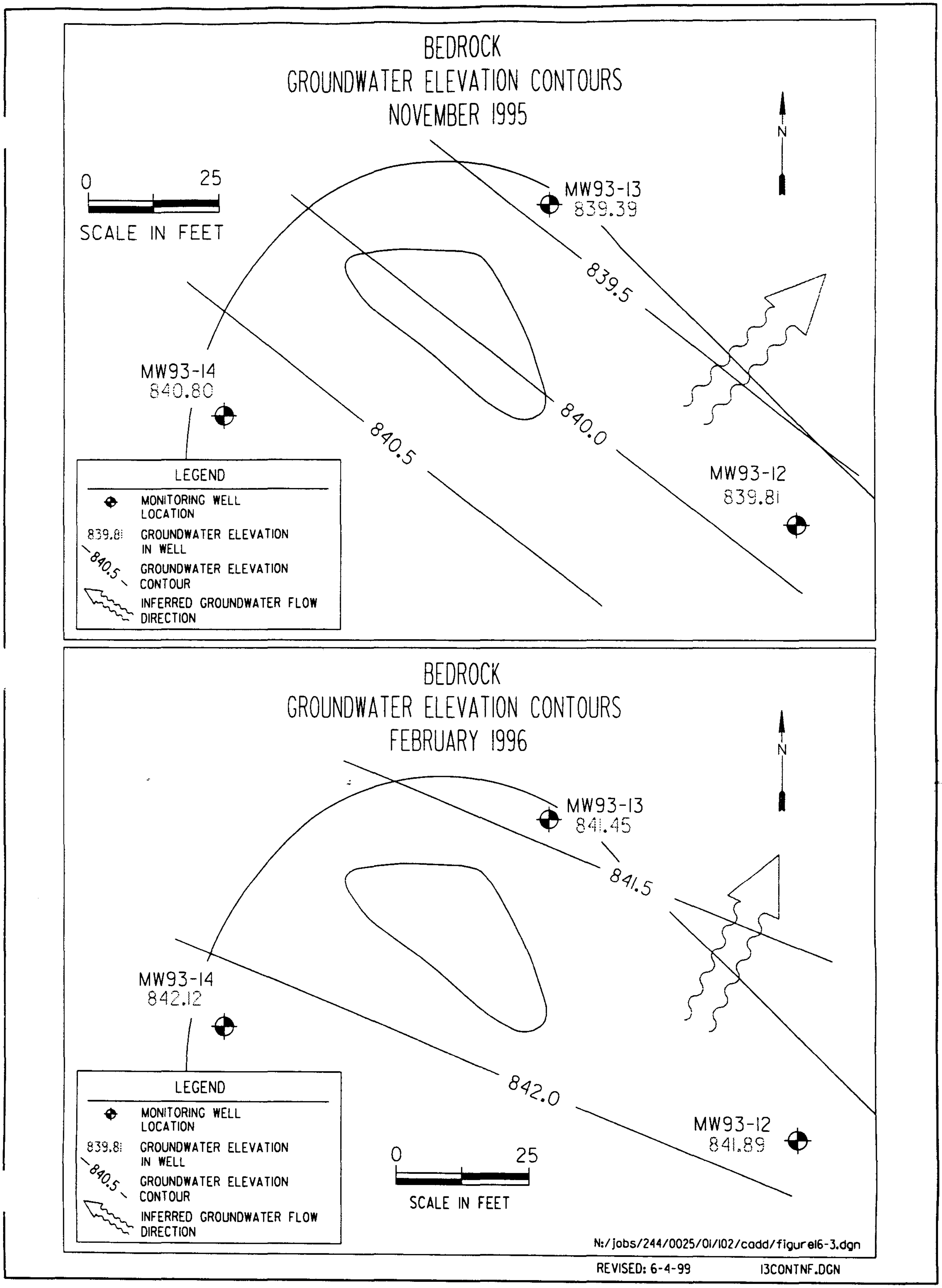

Figure 16-3. Bedrock Potentiometric Contour Maps - November 1995 and February 1996, Old Fire Training Pit (Site 13)

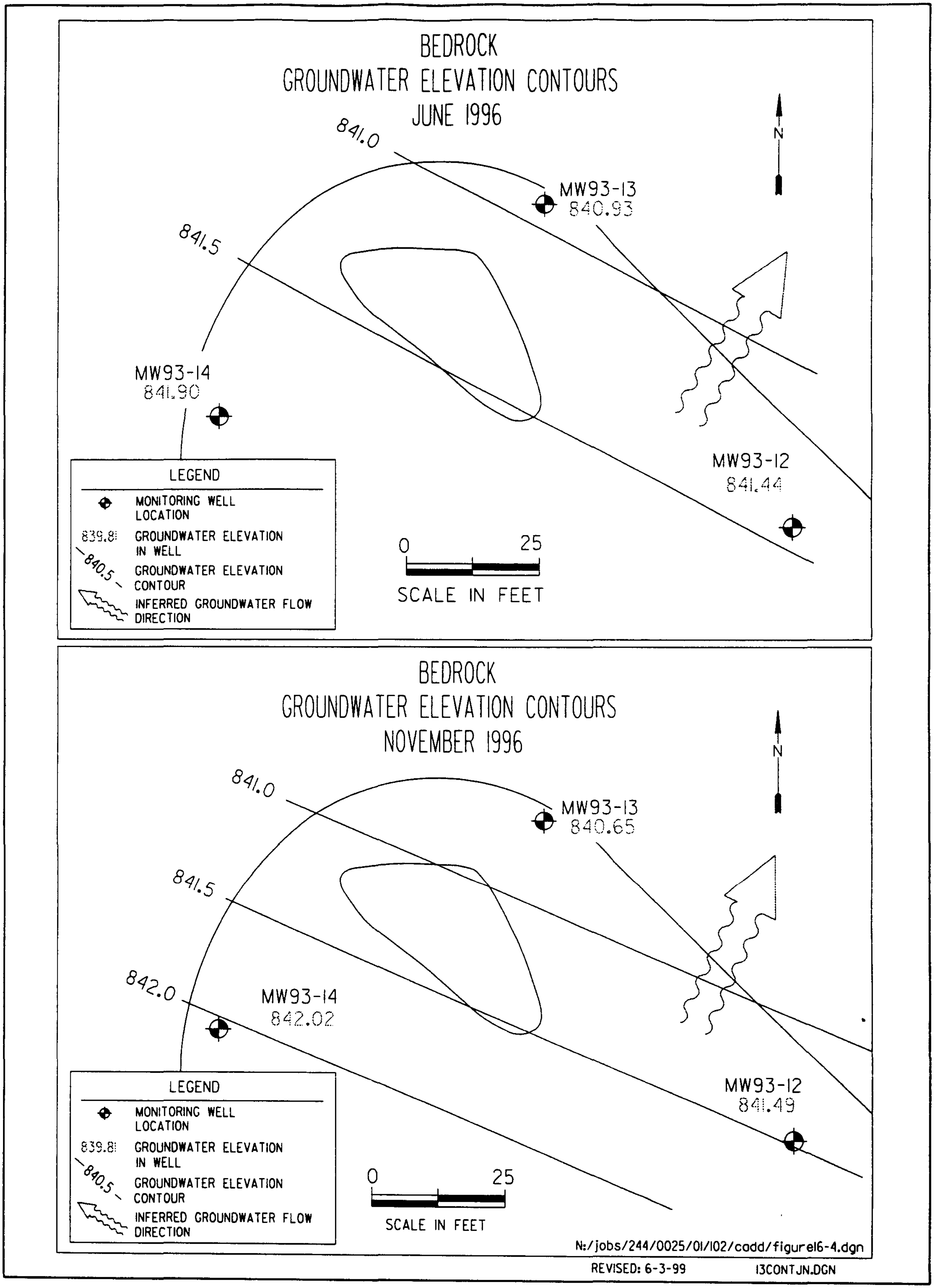

Figure 16-4. Bedrock Potentiometric Contour Maps - June and November 1996, Old Fire Training Pit (Site 13)

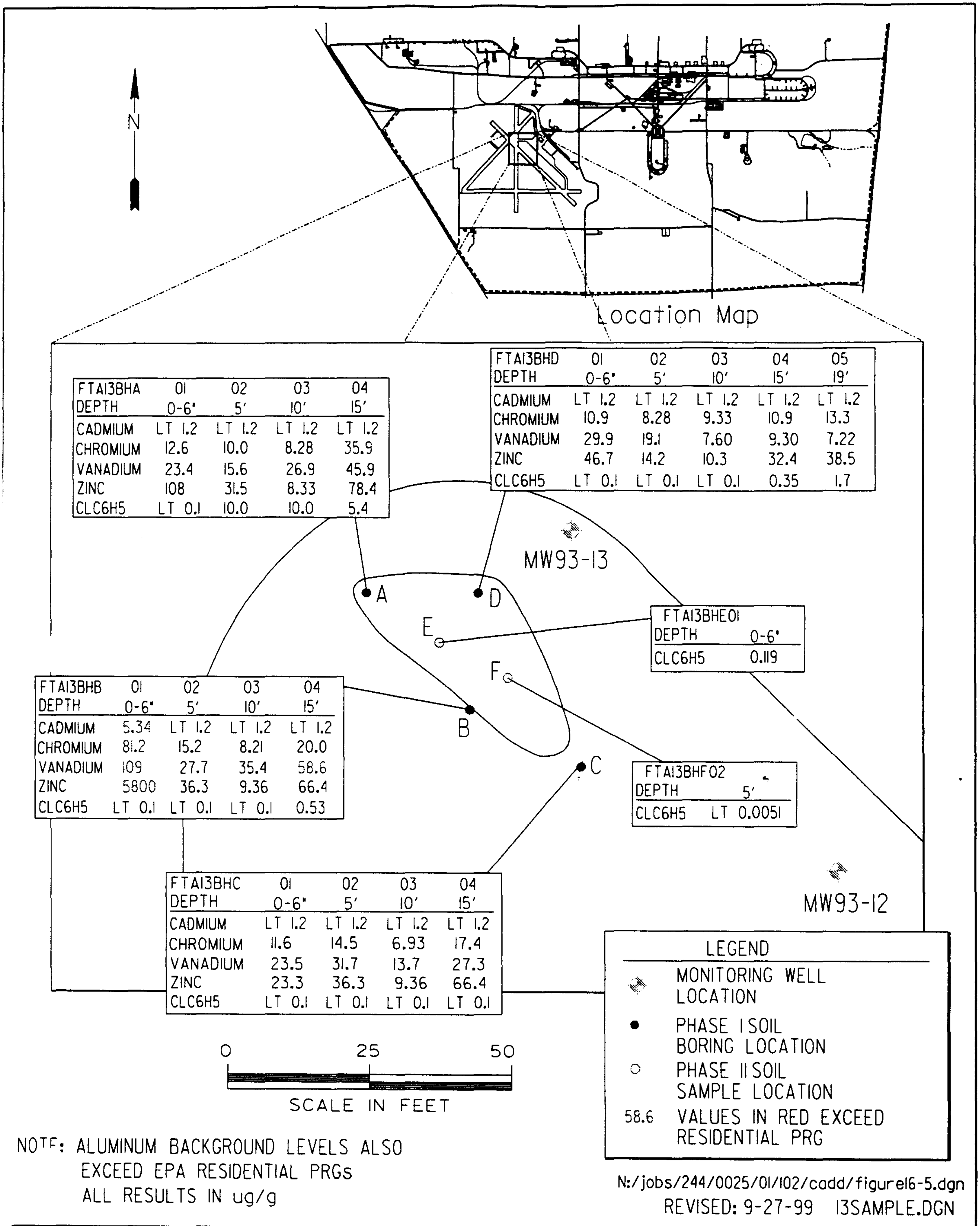

Figure 16-5. Summary of Contaminants Exceeding Background and Regulatory Risk-Based Concentrations (Site 13)

17.0 YELLOW SULFUR DISPOSAL AREA (SITE 14)

17.1 SITE CHARACTERISTICS

The yellow sulfur disposal area (Site 14) is located just west of the intersection of Papermill Road and Infantry Road (Figure 17-1). In addition to the sulfur, other debris such as melted glass was present. The source of these materials was not determined. Sulfur was observed extending for about 50 feet from a gravel road down to an intermittent drainage. As a result of the sulfur dissolution, the pH of the surrounding soils had been lowered. Because of the lack of information concerning the source of the sulfur waste and associated debris, the exact nature of the potential contamination was not determined.

The area slopes gently to the south into a small intermittent drainage. There is also a ditch alongside the gravel access road on the north side of the disposal site. Both the intermittent drainage and the ditch discharge surface runoff into a branch of Middle Fork Creek (Figure 2-1). During the Phase I RI, the ground in the area was bare of vegetation, and large chunks of raw sulfur were scattered around the site (approximately 500 square feet). The soil was also stained red because of the oxidation of iron caused by the action of sulfuric acid on the soil. The acid was produced when ~~rain~~ precipitation dissolved the sulfur. ~~Following the Phase I RI~~ In August 1996, an interim remedial action was conducted in the area containing the yellow sulfur. An area of approximately 45 by 80 feet was excavated to an approximate depth of 5 feet. In September 1997, during the ecological risk assessment field investigation at Site 14, it was observed that the resulting excavation remained open with the floor of the excavation being covered with black plastic pending approval of the confirmation sample results. The area surrounding the sulfur disposal site is covered with grasses and other perennial vegetation. A magnetometer survey conducted in September 1997 to clear sampling locations for possible UXO indicated that there is scattered buried metal debris throughout the area surrounding the current excavation. There are woods on the south side of the intermittent drainage and numerous willows and other phreatophytes along the drainage. There are no trees on the north side of the drainage in the vicinity of the sulfur disposal area.

The soils in this area belong to the Avonburg soil series. The glacial till is about 35 feet thick as determined from monitoring well boring logs for wells drilled at this site. The bedrock beneath the glacial till is the Laurel Dolomite of Devonian age. The monitoring well cross section shows the soil types, the bedrock formations, screened intervals, water levels, and sampled intervals (Figure 17-2).

Monitoring wells MW93-24, MW93-25, and MW93-26 were installed during Phase I at this site. Each well was constructed at a depth of approximately 44 feet bgs. As shown in Figure 17-2, the screened interval covers the bottom foot of the glacial till and the top 9 feet of the Laurel Dolomite. Based on slug test results, the hydraulic conductivity of the Laurel Dolomite at this location ranges from 2.95×10^{-5} (MW93-24) to 1.14×10^{-3} cm/sec (MW93-25). According to the boring logs, the bedrock encountered during the drilling of both MW93-25 and MW93-26 (with a hydraulic conductivity of 2.75×10^{-3} cm/sec) was very

fractured, producing a rather high hydraulic conductivity at these two locations. Furthermore, the linear intermittent drainage just to the south of these wells (Figure 17-1) was mapped as a fracture trace by Greeman (1981) (see Figure 2-8).

Water-level data collected in June, August, and September of 1993 indicated that the gradient at Site 14 is extremely flat. Figures 17-3 and 17-4 represent Phase II water-level data collected in November 1995 and February, April, and June 1996. Again, the bedrock groundwater gradient appears essentially flat. Potentiometric surface maps show that the flow appears to change directions. This apparent changing of direction of the gradient may be a function of the accuracy of the water level recording equipment (accurate only to ~~0.001~~0.01 foot) rather than actual changes in flow.

17.2 PREVIOUS INVESTIGATIONS

During the Enhanced Preliminary Assessment site visit (Ebasco 1990a), field team personnel identified what appeared to be yellow sulfur in what was suspected to be a former disposal area. JPG personnel collected samples of the yellow material and had the material chemically analyzed. The material contained sulfur, and five out of eight samples analyzed had a pH of less than 2. A review of previous studies and discussion with facility personnel did not provide any additional information concerning this site. The yellow sulfur area was hand excavated to a depth of 3 to 5 feet below the surface where more rocks stained with a yellow color were found. No soil samples were collected at this site during these previous investigations. The existing conditions and proposed sampling activities were summarized in the *Master Environmental Plan* (Ebasco 1990b).

17.3 STUDY AREA INVESTIGATIONS

17.3.1 Phase I RI Field Activities

17.3.1.1 Surface Soils. At the Yellow Sulfur Disposal Area, six surface samples (A to F) from six borings were collected during the Phase I RI (Figure 17-1). These samples were analyzed for total metals and pH. One of the surface samples was also analyzed for VOCs based on PID field screening results.

17.3.1.2 Subsurface Soils. Leaching of the sulfur-disposal area during periods of precipitation may have resulted in the downward migration of potentially hazardous contaminants. Thus, subsurface soils in the disposal area were sampled to determine the extent of contaminant migration. A total of 13 subsurface-soil samples were collected from 4six borings (A to F) during Phase I at the Yellow Sulfur Disposal Area (Figure 17-1). Samples were collected from depths between 3.3 and 10.1 feet and analyzed ~~*Figure 17-1. Monitoring Well Locations at the Yellow Sulfur Disposal Area (Site 14)*~~ for total metals and pH. Two of these samples were also analyzed for VOCs on the basis of PID field screening.

17.3.1.3 Surface Water and Sediment. With the exception of a positive identification of sulfur with a pH less than 2, no other environmental sampling had been conducted at the site prior to the RI. Since the site is adjacent to a surface-water pathway, sediment samples from the drainage were collected to determine if contaminants have been released to the surface-water pathway. During Phase I, four sediment samples (1 to 4) were collected from points located adjacent to and downstream of the sulfur-disposal site. These locations were spaced every 50 feet starting at the intersection of the sulfur disposal site and the drainage. ~~Since~~ Because ~~there was~~ no water was flowing in the drainage at the time of Phase I sample collection, four planned surface-water samples could not be obtained. The sediment samples were analyzed for sulfur and metals.

17.3.1.4 Geoprobe Field-Screening Survey. The results of the soil sampling and analysis indicated that contamination may have spread to the top of the water table, so a field-screening survey was performed at the site to help locate monitoring wells. The field-screening survey was conducted at this site in April 1993. A total of five probeholes (YSA-PH01 through YSA-PH05) were completed (see Figure 17-1). (EPA55) The initial probehole, PH-01, was located on the northwestern side of the sulfur-covered area. The remaining probeholes, PH-02 through PH-05, were located to complete an arc around the perimeter of the sulfur area. PH-01 was pushed to refusal at 18 feet deep. The probehole screening information is summarized in Appendix I.

17.3.1.5 Groundwater. During Phase I of the RI, three wells (MW93-24, MW93-25, and MW93-26) were installed to determine groundwater quality and flow direction in the immediate area of the disposal site (Figure 17-1). Two downgradient monitoring wells and one upgradient monitoring well were installed and sampled for total metals, sulfur, VOCs, and SVOCs. Two samples were also analyzed for filtered metals. In addition, water-level measurements and aquifer testing were performed to determine groundwater flow direction and hydraulic conductivity.

Arsenic was detected above regulatory health criteria in monitoring well MW93-25 during Phase I sampling. Regulator comments to the Final Draft Phase I RI Report indicated that an additional downgradient well should be installed.

17.3.2 Phase II RI Field Activities

17.3.2.1 Surface Soils. No surface soil samples were collected during Phase II of the RI with the exception of five soil samples collected from the surface to a depth of 2 feet and analyzed for metals during the ecological risk assessment field effort.

17.3.2.2 Subsurface Soil. No subsurface soil samples were collected during Phase II of the RI.

17.3.2.3 Surface Water and Sediments. No surface water or sediment samples were collected during Phase II of the RI.

17.3.2.4 Groundwater. One additional monitoring well (MW95-03) was installed during Phase II in the downgradient direction to further characterize the extent of groundwater contamination (Figure 17-1). Four rounds of groundwater sampling were then performed at the new monitoring well (MW95-03) and at the three existing monitoring wells (MW93-24, MW93-25, and MW93-26) for total and dissolved metals analysis. during Phase II.

17.3.3 Interim Measures Activities

In August 1996, excavation activities began at the Yellow Sulfur Disposal Area (Site 14). During the excavation activities, the excavated soils were placed adjacent to the excavation and covered with plastic sheeting. As excavation activities progressed, UXO was encountered and the excavation activities were halted. The stockpiled soils were transported to an area north of the firing line for temporary storage in a bermed and plastic-lined containment area to allow screening of the soil for possible UXO prior to off-site disposal. In January 1997, Human Factors Applications (HFA), Inc. was contracted to conduct an area-wide search of potential UXO areas using a magnetometer. Resulting anomalies were marked with utility flags. UXO was also discovered within the soil stockpile. A total of 121 UXOs were discovered which consisted of 57-, 75-, 90-, and 105-mm shells, projectiles, and other anomalies. HFA exploded 15 UXOs on site behind sandbag barriers. (EPA11) (IN24) In late January and early February 1997, excavation activities resumed with approximately 640 cubic yards of soil being moved to the stockpile area north of the firing line and covered with plastic.

During the excavation activities, a total of 43 soil samples were collected from the surface to a depth of 1 foot for RCRA hazardous waste characteristics testing to aid in the proper disposal of the excavated soils. In addition, in February 1997, SAIC conducted confirmatory sampling at Site 14, which included 24 grab surface samples (Figure 17-5). Sverdrup (1997) also collected 10 excavation samples that included, 8 2 samples (YSA-SW-1 and YSA-SW-2) from the sidewalls and eight samples (YSA-B-1 to YSA-B-8) from the bottom of the excavation. and In addition, 12 sulfur-contaminated locations (YSA-SE-1 to YSA-SE-12) were also sampled to determine the adequacy of the remedial action. Sample locations are shown on Figure 17-5 (EPA53). These samples were analyzed for metals, sulfur (total), and pH.

17.4 DATA EVALUATION

It should be noted that as a result of the ongoing interim measures soil-removal action, the soil exposure pathways were not evaluated for the human health risk assessment. As a result, discussions of soil data are not included in the following sections concerning data quality, background screening, and risk characterization.

17.4.1 Data Validation Results

17.4.1.1 Blank Assessment. When blank contamination exists, the investigative results must exceed the blank result by a factor of 5 (all compounds) or 10 (common laboratory contaminants such as phthalates) to be considered positive. Based on comparisons to blanks,

positive results were changed to nondetects ("U"). The associated sample quantitation limit became either the concentration detected in the sample, if the detected value was above the quantitation limit, or the quantitation limit, if detected results were less than the quantitation limit.

Phase I groundwater samples collected at this site were used qualitatively for this risk assessment and are not listed here. Several metals were detected in blanks associated with the following groundwater samples qualified as nondetected during Phase II:

Spring 1996

- Aluminum—YSA14GWD02
- Arsenic—YSA14GWA03, -C03, -C03dup.
- Cadmium—YSA14GWE03
- Chromium—YSA14GWA03
- Nickel—YSA14GWA03, -A03dup, -B03, -B03dup, -C03
- Potassium—YSA14GWA03, -A03dup, -B03, -C03
- Vanadium—YSA14GWC03
- Tin—YSA14GWA03, -A03dup, -C03, -D02, -E03
- Mercury—YSA14GWA03, -A03dup, -B03, -B03dup, -C03, -C03dup, -D02, -D02dup, -E03, -E03dup
- Molybdenum—YSA14GWA05, -C03, -D02, -D02dup, -E03, -E03dup

Summer 1996

- Beryllium—YSA14GWA04, -A04dup, -B04, -B04dup, C04, -C04dup, D03, -D03dup
- Chromium—YSA14GWA04
- Nickel—YSA14GWA04, -A04dup, -B04, -B04dup, C04, -C04dup, D03, -D03dup
- Potassium—YSA14GWA04dup, -B04, -B04dup, C04, -C04dup, D03, -D03dup
- Vanadium—YSA14GWA04, -C04, D03, -D03dup
- Tin—YSA14GWA04, -A04dup, -B04, -B04dup, C04, -C04dup, D03, -D03dup
- Molybdenum—YSA14GWA04, -A04dup, -B04, -B04dup, C04, -C04dup, -D03, -D03dup

Fall 1996

- Arsenic—YSA14GWA05, -A05dup
- Chromium—YSA14GWA05, -B05, -B05dup, -C05, -D04, -D04dup, E05
- Potassium—YSA14GWA05, -A05dup, -B05, -B05dup, -C05, -C05dup, -D04, E05, -E05dup
- Vanadium—YSA14GWA05, -D04, E05
- Thallium—YSA14GWC05
- Mercury—YSA14GWA05, -A05dup, -B05, -B05dup, -C05, -C05dup, -D04, -D04dup, -E05, -E05dup
- Molybdenum—YSA14GWA05, -B05, -C05

Winter 1996

- Cadmium—YSA14GWA02, -B02, B02dup, -D01, -D01dup
- Copper—YSA14GWA02
- Mercury—YSA14GWA02, -A02dup, -B02, -B02dup, -C02, -C02dup, -D01, -D01dup, -E02, -E02dup
- Vanadium—YSA14GWA02

17.4.1.2 Rejected Results. The Phase I groundwater sample results for SVOCs were used qualitatively as historical data. All antimony and selenium results for sediment were rejected due to low LCS and MS/MSD. None of the Phase II data were reported as rejected. The following list identifies rejected sample results.

Phase I

- Sediment
  - Antimony—YSA14SD001, -002, -003, -004
  - Selenium—YSA14SD001, -002, -003, -004

17.4.1.3 Evaluation of Non-Detected Values. A comparison was made between the USEPA Region 5 DQLs and the project CRLs for chemicals that were analyzed for but not detected in environmental media at this site, and no exceedances were found.

17.4.2 Data Quality Summary

Positive results were changed to nondetects ("U") for a number of metals analyzed in groundwater during Phase II. Most of the detections in the affected samples, however, were below quantitation limits. Therefore, blank contamination does not significantly affect the conclusions of the risk assessment.

17.4.3 Background Screening

17.4.3.1 Groundwater. The groundwater background screening protocol is described in Section 5.1.4.5.2. ~~Since there were 10 site samples, there were sufficient samples analyzed for inorganic constituents to perform the t-test or Mann-Whitney test where appropriate.~~ Because there were only three downgradient groundwater monitoring well locations (MW93-24, MW93-25, and MW93-26) sampled during the RI, the average maximum detected concentration of each inorganic in site groundwater was compared to the groundwater background threshold value (Table 17-1). The four rounds of Phase II sample results from each of these wells were averaged to derive a single data point for each chemical for each well. ~~Table 17-1 documents the groundwater background screening at Site 14.~~ As shown in the table, arsenic, beryllium, cobalt, molybdenum, selenium, vanadium, and zinc are above background; therefore, these inorganic constituents are carried through the groundwater COPC selection process.

17.4.3.2 Sediment - Surface Water Drainage Pathway. The methodology used to establish sediment background is described in Section 5.1.4.5.2. ~~5.1.2.4.2.~~ The only inorganic constituent detected in both background sediment and the drainage pathway sediment is arsenic. Drainage pathway arsenic data were compared to background arsenic using the t-test, which indicated that arsenic is present in the creek at levels consistent with background (Table 17-2). All of the other metals detected in the drainage pathway sediment (aluminum, barium, beryllium, chromium, cobalt, copper, lead, manganese, nickel, silver, vanadium, and zinc) are therefore retained as preliminary sediment COPCs for the risk assessment.

17.4.4 Summary of Analytical Results

Table 17-3 summarizes the analytical results for metals in Phase I soil samples at the Yellow Sulfur Area. Table 17-4 summarizes the analytical results for metals in groundwater samples at the Yellow Sulfur Area. A complete listing on all analytical results, including nondetected and below reporting limit analytes, is presented in Appendix N.

17.5 NATURE AND EXTENT OF CONTAMINATION

17.5.1 Soil

The results of borehole soil sampling performed during the Phase I RI indicate that sulfur was detectable in the soil samples collected from the near surface (0 to 2 feet deep) and from the 4-to-6-foot interval at boreholes A, B, C, D, and E. Borehole E was the only boring with sulfur detected at the 9-to-11-foot depth. Another indicator of sulfur contamination was pH. The pH of soil samples for the near surface-soil samples ranged from 1.4 in boreholes B and E to 7.9 in borehole D, with an average of 2.8 for all six near-surface samples. The pH values for the 9-to-11-foot samples from all boreholes were greater than 4 and averaged 6.6. These data demonstrate that the sulfur contamination had caused dramatic soil pH changes in the near surface and that the effects diminished with depth.

The concentrations of certain metals may be affected by the changes in soil pH as shown from borehole soil-sample results (Figure 17-6). An examination of the Phase I metals results reveals that the following list of metals were detected at concentrations above their background values: arsenic (6 samples), barium (14 samples), beryllium (10 samples), boron (3 samples), cadmium (1 sample), chromium (16 samples), cobalt (13 samples), copper (19 samples), lead (8 samples), manganese (9 samples), molybdenum (2 samples), nickel (18 samples), silver (6 samples), tin (2 samples), vanadium (12 samples), and zinc (19 samples). Of these metals, arsenic, beryllium, chromium, and lead exceeded USEPA Region 9 criteria. Arsenic above background ranged from 11.6 to 110 µg/g. ~~The USEPA Region 9 criteria for carcinogenic risk from arsenic is 0.38 µg/g. It should be noted, h~~ However, ~~that~~ background levels of arsenic at JPG also exceed this risk-based concentration. Beryllium concentrations above background ranged from 0.614 to 1.58 µg/g with all of the samples exceeding the USEPA Region 9 criteria. ~~of 0.14 µg/g. As with arsenic, background concentrations of beryllium at JPG also exceed the criteria.~~ Chromium above background ranged from 17.1 to

1,300 μg/g with three samples exceeding the USEPA Region 9 criteria. ~~of 210 μg/g.~~ Lead was detected in concentrations ranging from 19.2 to 16,000 μg/g. The only sample exceeding the criteria of 400 μg/g for lead was the near surface sample from borehole E at 16,000 μg/g. Borehole E contained the highest concentrations of other contaminants at depths of 5 and 10 feet.

Possible VOC contamination was detected by air monitoring with a PID during drilling. Biased samples collected from 3.7 to 4.2 and from 5.1 to 5.6 feet deep in borehole E and from 1.1 to 1.6 feet deep in borehole F, however, revealed no detectable VOC contamination. Because VOC contamination had previously been detected with a PID in soil at borehole E at 3.3 feet bgs, a probehole screening survey was conducted to evaluate the potential for VOC contamination. The probehole soil samples were collected from intervals deeper than 3.3 feet bgs to evaluate potential vertical extent. No VOCs were detected in the soil samples.

17.5.2 Sediment

The metals analysis for the sediment samples revealed the following metals concentrations exceeded their ~~95th percentile~~ screening criteria for background soils: arsenic (one sample), barium (four samples), beryllium (two samples), boron (four samples), chromium (four samples), copper (two samples), lead (four samples), nickel (two samples), silver (one sample), and zinc (two samples). However, only arsenic and beryllium concentrations in the sediment samples exceeded USEPA Region 9 criteria. Lead concentrations ranged from 67 to 110 μg/g, which are 4 to 6 times its background criteria. Boron was found in the sediment samples but did not exceed USEPA Region 9 criteria. Because none of the metal concentrations show a predictable decrease away from the sulfur disposal area, it is unclear what effect the sulfur contamination is having on metals distribution.

17.5.3 Surface Water

Four surface-water samples were proposed in the Work Plan. Because there was no water flowing in the drainage at the time the sediment samples were collected, no water samples could be taken. However, the analytical results for the sediment samples provide information regarding possible contamination of the surface water pathway (Figure 17-1). The results of the sediment sampling along the intermittent drainage indicate that pH changes have resulted from sulfur contamination. The sediment sampled at the upstream intersection of the bare soil of the sulfur disposal area and the intermittent drainage had a pH of 3.7. The next location, sample location 3, about 50 feet downstream, had a pH of 2.7, then the pH of the next two samples downstream, locations 2 and 1, had pH values of 4.1 and 6.5, respectively. This indicates that the direct acidification effects of the sulfur contamination are decreasing rapidly downstream of the site. Total sulfur was detected in two of the sediment samples, locations 1 and 4. This distribution is not easily explained because the sulfur concentration should decrease away from the source, and sample location 1 is farthest away from the sulfur disposal area.

17.5.4 Groundwater

Because VOC contamination had previously been detected with a PID in soil at borehole E at 3.3 feet bgs, a probehole screening survey was conducted to evaluate the potential for VOC contamination and to help locate monitoring wells. Groundwater samples were obtained from the probeholes and analyzed for VOCs. Because of the no VOCs were detected, no additional probeholes were deemed necessary. The site did not appear to contain significant VOC contamination related to the sulfur disposal area; however, because the geoprobe was incapable of obtaining bedrock groundwater samples, it was still deemed appropriate to install three groundwater-monitoring wells around the site to provide bedrock groundwater sampling points.

Phase I groundwater samples were collected from the three wells installed at the site in 1993. No VOCs or SVOCs were detected in the groundwater samples. Aluminum (one sample), arsenic (three samples), barium (one sample), iron (two samples), manganese (three samples), and zinc (one sample) exceeded background levels for JPG groundwater. Of these metals, only arsenic was found to exceed USEPA Region 9 criteria. Groundwater results are presented on Table 17-4 and Figure 17-7.

Phase II groundwater samples indicate that arsenic is present in all four wells at concentrations ranging from 4.5 µg/L to 39.2 µg/L, with the highest concentrations found in well MW93-25 (greater than 30 µg/L in all five rounds of sampling). MW95-3 also contained elevated arsenic ranging from 16.1 to 21.6 µg/L. These concentrations exceed both background concentrations ~~(2.60 µg/L)~~ and USEPA Region 9 criteria ~~(0.045 µg/L)~~. Lead at 6.57 µg/L (round 1) and 4.26 µg/L (round 3) was present in MW93-24 at concentrations exceeding USEPA Region 9 criteria. ~~of 4.0 µg/L.~~ Cobalt at 6.4 µg/L (round 1) and 6.03 µg/L (round 4) was also present above the USEPA Region 9 criteria ~~of 0.16 µg/L~~ in MW93-24. Cobalt exceeding criteria was also present in MW95-3 at 5.61 and 8.53 µg/L during rounds 1 and 3, respectively.

Aluminum, barium, chromium, iron, manganese, nickel, and vanadium were also detected in above background concentrations but were all well below their respective USEPA Region 9 criteria. The metals contamination from Site 14 is likely related to the abundant metal debris shown to be present in the subsurface soils during excavation of the sulfur contamination. The low pH conditions at the site most likely promoted leaching of these metals from the debris and surrounding soils.

~~17.5.5 Geoprobe Field-Screening Survey~~

~~A field-screening survey was conducted at this site in April 1993. A total of five probeholes (YSA-PH01 through YSA-PH05) were completed (see Figure 17-1).(EPA55) The initial probehole, PH-01, was located on the northwestern side of the sulfur-covered area. The remaining probeholes, PH-02 through PH-05, were located to complete an arc around the perimeter of the sulfur area. PH-01 was pushed to refusal at 18 feet deep. The probehole screening information is summarized in Appendix G.~~

~~Because VOC contamination had previously been detected with a PID in soil at borehole E at 3.3 feet bgs, the probehole soil samples were collected from deeper intervals to evaluate vertical extent. No VOCs were detected in any of the soil samples. Groundwater samples were also obtained from all of the probeholes. The analytical results indicate no detectable VOCs in the groundwater. Because of the non-detection of VOCs, no additional probeholes were deemed necessary. The site does not appear to contain significant VOC contamination related to the sulfur disposal area; however, because the geoprobe was incapable of obtaining bedrock groundwater samples, it was still deemed appropriate to install three groundwater-monitoring wells around the site to provide bedrock groundwater sampling points.~~

17.5.~~6~~5 Interim Measures Confirmation Sampling

A review of the sample results from 24 confirmation samples collected by SAIC from the excavation following removal of sulfur-contaminated soil and UXO show that most metals are at levels below USEPA Region 9 criteria (Table 17-5 and Figure 17-5) (IN25). One exception is chromium, which was found to exceed the criteria of 210 µg/g in six samples, including S14013 (3,000 µg/g), S14014 (530 µg/g), S14015 (320 µg/g), S14016 (430 µg/g), S14018 (730 µg/g), and S14020 (380 µg/g). These results support the findings of elevated chromium in subsurface soil boring samples during the Phase I RI. In spite of these elevated chromium results, groundwater data at Site 14 show that chromium is at background levels. This indicates that chromium contamination in the subsurface soils has not migrated vertically to the groundwater pathway. All confirmation samples for the Yellow Sulfur Area were collected from a depth of 0 to 1 foot on February 12, 1997 by SAIC. Arsenic concentrations ranged from 1.5 to 8.1 µg/g, which is consistent with background concentrations for JPG. No other metals were found to exceed USEPA Region 9 criteria in the confirmation samples. Soil pH was found to range from 2.3 to 7.6 with 13 of the 24 samples having a pH of less than 4, indicating that an acidic environment still exists within portions of the yellow sulfur area following contaminant removal.

Based on additional UXO screening conducted by EODT during the ecological risk assessment sampling at Site 14 in September 1997, it appears that potential UXO still exists outside the open excavation in the shallow subsurface (within 2 feet of the surface). UXO was also encountered during the excavation of the yellow sulfur contamination. Additional UXO screening and removal would be necessary before unrestricted access to the site could be given. (IN26)

17.6 HUMAN HEALTH RISK ASSESSMENT

As noted in Section 17.4, soil exposure pathways were not evaluated due to the ~~ongoing~~ interim measures soil removal activities.

17.6.1 Selection of the Contaminants of Potential Concern at Site 14

17.6.1.1 Air.

17.6.1.1.1 Summary of Preliminary COPCs. Ambient air concentrations to which future receptors at this site might be exposed were estimated using air emission/dispersion modeling, as described in Appendix R. In the site-specific conceptual model, discussed below in Section 17.6.2.1, Site 14 is evaluated under two future site-specific scenarios: (1) as a residential site and (2) as an industrial site.

In the future industrial land use scenario for the facility, all sites were assumed to be industrial, except for the five sites designated agricultural sites. Each site with particulate-bound COPCs in surface soil (metals, SVOCs, and dioxins/furans) and/or volatile COPCs in surface/subsurface soil combined was assumed to contribute to the air concentrations at all of the sites. In the future residential scenario for the facility, all sites were assumed to be residential except for the five sites designated agricultural. It was assumed that particulate and VOC emissions from the strictly residential sites would be negligible because the home sites would be covered with dense vegetation (lawns) and pavement. Therefore, under the residential scenario only the five agricultural sites contribute to the air concentrations at all of the sites. The list of preliminary air COPCs is therefore the same for every site for a given scenario, but the concentrations of the COPCs vary. Tables R-4 and R-6 in Appendix R present the estimated ambient air concentrations at Site 14 under the future industrial and residential scenarios, respectively.

17.6.1.1.2. **Region 9 Preliminary Remediation Goal Screening**. The exposure point concentrations for each preliminary air COPC at Site 14 in the future residential scenario and the future industrial scenario were compared to chemical-specific Region 9 air PRGs (Table 17-6). One-tenth of the PRG was used for noncarcinogens. The exception was lead, for which the full PRG was used. As a result of the screening, aluminum, silver, thallium, vanadium, and zinc are retained as COPCs in air for future on-site residents. For future on-site workers, aluminum, chromium, silver, thallium, vanadium, and zinc were retained.

17.6.1.2 Sediment.

17.6.1.2.1 Frequency of Detection. Evaluation of frequency of detection was not undertaken for drainage pathway sediment because of too few samples.

17.6.1.2.2 Nutrient Screening. The maximum value of each of the nutrients detected in sediment from the drainage pathway was less than the corresponding nutrient screening value: calcium (maximum 4,770 μg/g; screening value 1,000,000 μg/g), iron (maximum 29,600 μg/g; screening value 70,000 μg/g), magnesium (maximum 1,030 μg/g; screening value 1,000,000 μg/g), potassium (maximum 909 μg/g; screening value 150,000 μg/g), and sodium (maximum 260 μg/g; screening value 1,000,000 μg/g). Therefore, all nutrients were eliminated as preliminary COPCs for drainage pathway sediment.

17.6.1.2.3 Summary of Preliminary COPCs. Table 17-7 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95% UCL of the mean, and the exposure point concentrations for each preliminary COPC in Harberts Creek

sediment. Sediment preliminary COPCs are chemicals which have been detected above background (or above the nutrient screening value) at a frequency of greater than 5 percent in sediment samples.

17.6.1.2.4 Region 9 Preliminary Remediation Goal Screening. The exposure point concentrations for each preliminary drainage pathway sediment COPC was compared to the chemical-specific Region 9 residential soil PRG (Table 17-8). One-tenth of the PRG was used for noncarcinogens, with the exception of lead, for which the full PRG was used. As a result of this screening, aluminum, barium, beryllium, and chromium were selected as COPCs in drainage pathway sediment.

17.6.1.3 Groundwater.

17.6.1.3.1 Frequency of Detection. Evaluation of frequency of detection was not undertaken because of too few groundwater samples.

17.6.1.3.2 Nutrient Screening. The maximum value of each of the nutrients detected in groundwater at Site 4 was less than its groundwater nutrient screening value: calcium (maximum 100 mg/L; screening value 510 mg/L), iron (maximum 5.0 mg/L; screening value 9.4 mg/L), magnesium (maximum 37.7 mg/L; screening value 200 mg/L), potassium (maximum 1.7 mg/L; screening value 20 mg/L), and sodium (maximum 49.6 mg/L; screening value 730 mg/L). Therefore, all nutrients were eliminated as preliminary COPCs in groundwater.

17.6.1.3.3 Summary of Preliminary COPCs. Table 17-9 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95% UCL of the mean, and the exposure point concentration for each preliminary COPC in groundwater at Site 14. Preliminary groundwater COPCs are those chemicals detected above background (or nutrient screening values) in more than 5 percent of groundwater samples.

17.6.1.3.4 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for each preliminary groundwater COPC was compared to the chemical-specific Region 9 tap water PRG (Table 17-10). One-tenth of the PRG was used for noncarcinogens, with the exception of lead, for which the full PRG was used. As a result of the screening, aluminum, arsenic, beryllium, and molybdenum are retained as COPCs in groundwater.

17.6.2 Exposure Assessment

17.6.2.1 Site Conceptual Model. Site 14 is currently fenced and access is restricted. There are no people who specifically work at or frequent Site 14. There are, however, several types of individuals who could potentially be affected by the existing contamination at the facility. These are trespassers to JPG, off- facility (nearby) rural residents, and future hunters. In each case, these individuals would most likely be impacted simultaneously by multiple sites rather than by single units. Because of this, these current and future receptor populations are

addressed on a facility-wide, cumulative basis rather than by specific sites (see Sections 28 and 29).

Therefore, this site-specific exposure scenario only addresses future land use development.

Site 14 has two potential future land uses forwarded for evaluation:

- Residential
- Industrial

Residential Use. Under the future residential land use scenario, this site is assumed to be developed for residential purposes, with the supposition that a family would build a house directly on or within this area of potential concern.

With respect to a risk assessment analysis, resident populations are assumed to consist of both adults and toddlers. Each individual would be expected to come in contact with site contaminants in the following pathways at Site 14:

- Inhalation of VOCs and fugitive particulates from soils
- Ingestion/dermal contact with groundwater
- Inhalation of VOCs while showering/bathing
- Ingestion/dermal contact with sediment in the surface water drainage pathway

On-site Worker. Industrial land use is considered to be a plausible future option for this site at JPG. On-site industrial workers ~~(adult males and females)~~ are assumed to be individuals who could be exposed directly to contaminated media through the following pathways:

- Inhalation of VOCs and fugitive particulates from soils; and
- Ingestion of groundwater

17.6.2.2 Exposure Point Concentrations.

17.6.2.2.1 Air. The estimated ambient air concentrations of COPCs at this site for the future on-site residents and the future on-site workers are presented in Table 17-6.

17.6.2.2.2 Groundwater. The concentrations of COPCs in groundwater at Site 14 are presented in Table 17-10.

17.6.2.2.3 Shower Air. There are no VOC COPCs in groundwater at Site 14. Therefore, this pathway is incomplete.

17.6.2.2.4 Sediment. The concentrations of COPCs in sediment in the drainage pathway are provided in Table 17-8~~5~~.

17.6.2.3 Human Exposure Doses.

17.6.2.3.1 Inhalation of Contaminated Air. Inhalation of airborne contaminants (VOCs and particulates) is a potential route of exposure for future on-site residents (adults and children) and future on-site workers at this site. The equation used for calculating human exposure doses of contaminants of potential concern due to inhalation of volatile and dust-bound contaminants is provided in Section 5.1.5.3.1, Table 5-11~~12~~. Table V-11, Appendix V, documents the calculation of human exposure doses at Site 14 due to inhalation of contaminated air.

17.6.2.3.2 Ingestion of Contaminated Groundwater. Contaminated drinking water may be a source of chemical exposure for future on-site residents (adults and children) and future workers. The equation used to calculate human exposure doses due to ingestion of contaminated drinking water is provided in Section 5.1.5.3.4, Table 5-14~~15~~. Table V-11, Appendix V, documents the calculation of human exposure doses at Site 14 due to ingestion of contaminated groundwater.

17.6.2.3.3 Dermal Contact with Contaminated Groundwater. Exposure via dermal contact with chemicals in groundwater may occur when receptors (future residents) shower or bathe. The equation used to calculate daily chemical doses due to dermal contact with contaminated groundwater is provided in Section 5.1.5.3.5, Table 5-15~~16~~. Table V-11, Appendix V, documents the calculation of human exposure doses at Site 14 due to dermal contact with contaminated groundwater.

17.6.2.3.4 Incidental Ingestion of Sediment in the Drainage Pathway. Receptors may be exposed to contaminated sediments while walking in the drainage pathway. The equation to calculate human exposure doses due to incidental ingestion of contaminated sediments is provided in Section 5.1.5.3.9, Table 5-20~~21~~. Table V-11, Appendix V, documents the calculation of human exposure doses due to incidental ingestion of contaminated sediments. This pathway is complete for future on-site residents.

17.6.2.3.5 Dermal Contact with Sediment in the Drainage Pathway. Future on-site residents walking in the drainage pathway may also come into dermal contact with sediment-bound contaminants. The equation to calculate human exposure doses due to dermal contact with contaminated sediments is provided in Section 5.1.5.3.10, Table 5-21~~22~~. Table V-11, Appendix V, documents the calculation of human exposure doses due to dermal contact with contaminated sediments.

17.6.3 Risk Characterization

17.6.3.1 Chronic Health Hazards. The noncancer daily exposure doses calculated in the exposure assessment were used to calculate HQs for each of the COPCs possessing RfDs. Pathway-specific and overall HIs were then calculated for each receptor. The calculations of HQ and HI are described in Section 5.1.7.1. If an overall HI is calculated to be greater than 1.0 for a particular receptor, then the exposure pathway(s) primarily responsible for the result is identified as a "critical pathway(s)." For each critical pathway, those chemical contaminants responsible for the majority of the HI are listed as COCs. Table W-11, Appendix W, documents the calculation of the pathway- and chemical-specific HQs for the human receptors at Site 14. The pathway-specific and overall HIs are summarized in Table 17-11.

17.6.3.1.1 Future On-Site Residents. The overall HIs for the future on-site adult and toddler residents at Site 14 are calculated to be 3.3 and 7.8, respectively. Both of these HIs exceed USEPA's risk management criterion of 1.0. The critical pathway for both receptors is ingestion of groundwater and arsenic is the noncarcinogenic COC.

Arsenic is naturally occurring in groundwater at the JPG facility. The relative contributions of background groundwater concentrations of arsenic to the groundwater hazards at this site were estimated by comparing the average groundwater background concentration of arsenic to the average concentration in site groundwater. Background arsenic accounts for approximately 12 percent of the total arsenic concentration in groundwater at this site.

Background arsenic in groundwater would contribute 11 percent to the total HI estimated for the groundwater exposure pathways at this site.

17.6.3.1.2 Future On-Site Workers. The overall HI for the future on-site worker at Site 14 is calculated to be 1.6~~1.5~~. This value exceeds the USEPA's risk management criterion of 1.0. The critical exposure pathway is ingestion of groundwater, and arsenic is the noncarcinogenic COC for this receptor.

17.6.3.2 Excess Lifetime Cancer Risks. The cancer risks for each receptor were determined from the pathway-specific exposure doses and the route-specific SFs, as described in Section 5.1.7.2. To assess the simultaneous exposure of a receptor population to multiple carcinogens from multiple exposure routes, all of the cancer risks calculated for a receptor population were summed. Each overall receptor cancer risk was then compared to USEPA's target risk range (1.0E-06 to 1.0E-04). If the total cancer risk for a receptor from all exposure pathways is less than 1.0E-04, then it is concluded that the site(s) does not pose a significant risk to that receptor. If the overall cancer risk exceeds the target risk range, any chemical individually associated with a risk level greater than 1.0E-05 is identified as a COC. COCs represent the primary contributors to the potential cancer risk for the receptor-specific exposure pathway under evaluation. Table W-11, Appendix W, documents the calculation of the pathway- and chemical-specific cancer risks for the human receptors at Site 14. The pathway-specific and overall cancer risks are summarized in Table 17-11.

17.6.3.2.1 Future On-Site Residents. The overall cancer risks calculated for the future adults and toddlers living at Site 14 are 6.0E-04~~6.7E-04~~ and 2.8E-04~~3.1E-04~~, respectively.

Both of these cancer risks exceed the USEPA's target risk range of 1.0E-06 to 1.0E-04. The critical pathway for both receptors is ingestion of groundwater, and arsenic is the carcinogenic COC.

17.6.3.2.2 Future On-Site Workers. The overall cancer risk calculated for the future workers at Site 14 is 1.8E-04 ~~2.0E-04~~, which exceeds the USEPA's target risk range of 1.0E-06 to 1.0E-04. The critical exposure pathway is ingestion of groundwater and arsenic is the carcinogenic COC.

Background arsenic in groundwater would contribute 11 percent to the total cancer risks estimated for the groundwater exposure pathways at this site. In April 1998, after the completion of this draft RI, the USEPA withdrew the oral slope factor for beryllium. Beryllium is therefore no longer a carcinogenic COC in groundwater at this site.

17.6.3.3 Uncertainty/Sensitivity Analysis. The numerical risks/hazards that are calculated for Site 14 represent *conditional* estimates of risk based on various simplifying assumptions concerning contaminant exposure and toxicity. These estimates of risk/hazard are derived using a series of conservative procedures that address contaminant concentrations at the site, their fate in the environment, how someone currently or in the future might be exposed to these contaminants, and the toxicity of each chemical toward humans. The uncertainty analysis specifies, when appropriate, the critical assumptions made for the site so that the site-specific results can be interpreted by risk managers in a proper context.

To assist the risk managers in this project, a qualitative uncertainty analysis has been performed. The primary goals of a qualitative uncertainty analysis are (1) to itemize the major areas of uncertainty in the site-specific risk assessment and (2) to demonstrate that the assessment overall has been conservatively performed (i.e., that the potential risks/hazards at the site have not likely been underestimated, but may have been significantly overestimated).

The qualitative uncertainty analysis for this site is presented in Table 17-12. Based on this analysis, it can be concluded that this risk assessment is conservative. Some of the major uncertainties in this study that are most influential to the risks/hazards that were calculated include:

- Receptors' exposure frequency (350 days/year)
- Receptors' groundwater ingestion rate (2 L/day)
- Maximum detected concentration of arsenic in groundwater used

17.7 ECOLOGICAL RISK ASSESSMENT

It should be noted that an interim measure (i.e., excavation of contaminated soil) occurred at Site14. These results have been evaluated in the ecological risk assessment to address the

effectiveness of the interim measure to reduce ecological risks. The original ecological risk calculations are provided for informational purposes to support the need for the interim measures.

17.7.1 Ecological Site Description

The Yellow Sulfur Disposal Area (Site 14) consists of infrequently mowed grassland interspersed with wetlands vegetation (i.e., cattails) surrounding the wetlands area (Figure 17.7-1). Cattails were also present upstream from the sulfur disposal area in drainage channels, but none were noted downstream. Flatwoods occur about 20 feet south of the wetland. The sulfur disposal area is located on a ridge that drains south into the wetland area and north towards the adjacent road. Soils in the sulfur-contaminated areas were yellowish green to red and eroded. Mid-story shrubs and immature trees were present within the wetland area. While vegetation in adjacent areas is in excellent condition, the vegetation appeared stressed in the sulfur disposal area. Typical vegetation observed included hop-clover, rush, broomsedge, chickweed, dock, steeplebush, red cedar, willow, dewberry, milkweed, buttonbush, red maple, plantain, blue-eyed grass, and grape. Refer to Figure 5.3-13 for a map of habitat types at JPG. **(EPA184)** -Wildlife species observed included redwing blackbirds, turkey vultures, crayfish, and white-tailed deer. Numerous small mammal tracks were observed in barren soil near drainage areas. Refer to Table 17.7-a1 for a summary of Site 14 ecological habitat characteristics identified during site visits. **(EPA184)**

As part of the IM confirmation sampling program, the site was fenced and approximately 600 cubic yards of contaminated soil were removed from the contaminated area, which ~~will be~~ was backfilled with clean soil ~~presumably sometime in 1998~~ following approval from the State of Indiana.

17.7.2 Site 14 Investigations

For convenience to the reader, summary statistics, EPCs, risk driver HQs, and total RME and CT HIs are provided in this section. All intakes ~~and other non risk-driving~~ HQs are located in Appendix AA. The COPCs for each medium which were evaluated in the DERA are presented on the EPC tables in this section. Refer to Appendix AA for details pertaining to the specific data sets (e.g., sample numbers, depths, dates, etc.) used in the risk assessment for Site 14. **(EPA179)**

17.7.2.1 Phase I Activities. The Phase I summary statistics for Site 14 are provided in Table 17.7-1 and include data for sediment and soil. Table 17.7-2 provides the EPCs for Site 14.

17.7.2.2 Phase II Activities. Phase II data were not collected at this location.

17.7.2.3 Interim Measures and Phase III Activities. IM soil data for metals were collected at Site 14. Table 17.7-3 reports the summary statistics available for the IM sampling; Table 17.7-4 presents the EPCs. IM confirmation samples were collected from an excavated

area from surface to 1 foot in depth. Phase III soil data for metals were collected at Site 14. Table 17.7-5 reports the summary statistics available for the Phase III sampling; Table 17.7-6 presents the EPCs.

17.7.3 Exposure and Ecological Effects Profile

Fish, amphibians, reptiles, aquatic invertebrates, aquatic macrophytes, birds, ~~Birds~~ and mammals may be exposed to COPCs by direct contact with or ingestion of sediments and soil. No surface water data were available at Site 14. To determine the estimated intakes of the COPCs, various key receptor species were selected to evaluate the impacts to area wildlife. The key receptors evaluated for Site 14 include mourning dove, chimney swift, American kestrel, wild turkey, white-footed mouse, eastern cottontail, red fox, little brown myotis, plants, and soil fauna. The key aquatic receptors evaluated for Site 14 (Phase I) included creek chub, Pickerel frog, crayfish, great blue heron, and raccoon.

The conceptual site model (CSM) for Site 14 provides an overview of the ecological receptors and exposure pathways evaluated in the ecological risk assessment. Refer to Figure 17.7-1a for a schematic of the CSM. Multiple lines of evidence were evaluated for the ecological assessment conducted at Site 14. For Site 14 both terrestrial and aquatic lines of evidence were evaluated. The lines of evidence were primarily hazard index (HI) calculations for a number of different receptors, but for the terrestrial ecosystem toxicity testing was also conducted. Refer to Table 7.7-11a for a summary of the terrestrial and aquatic ecosystem lines of evidence. **(EPA180a,b)**

The exposure pathways and receptors evaluated at this site are as follows:

- Aquatic Ecosystem (Phase I data only)
  - Great blue heron—sediment ingestion or direct contact
  - Raccoon— sediment ingestion or direct contact
  - Creek chub, pickerel frog, crayfish— direct contact with sediment
  - Aquatic invertebrates—direct contact with sediment

- Terrestrial Ecosystem
  - All wildlife receptors—soil ingestion
  - All wildlife receptors—dietary ingestion
  - Plants—direct contact with soil
  - Soil fauna—direct contact with soil

Note: TRVs for aquatic plants were unavailable from the literature; it was assumed that risks to other aquatic life would be representative of aquatic plants.

17.7.3.1 Selection of COPCs. Inorganic analytes from soil data collected during Phases I, II, and III were compared to the JPG Phase II background data set (Section 5.3.2.1). Analytes that were not statistically elevated relative to background were removed from consideration

as COPCs. The COPCs for Sites 2/2714 in the various media are presented in Tables 17.7-1 through 17.7-6.

Selenium was not detected in soil at Site 14 (Phase I). Aluminum, arsenic, beryllium, cobalt, iron, manganese, nickel, lead, and vanadium were removed as COPCs in the Phase I data since they were not statistically elevated above background.

Neither cobalt nor thallium was detected in the Phase III data for the combined ecological study Site 14/15. Aluminum, arsenic, beryllium, iron, manganese, lead, vanadium, and zinc were removed as COPCs since their concentrations were not statistically elevated above background.

IM confirmation sampling data for Site 14 showed no detects of molybdenum. In addition, arsenic, cobalt, lead, vanadium, and zinc were removed as COPCs since their concentrations were not statistically elevated above background.

17.7.3.2 Comparison of Site Data to Reference Area Concentrations. Barium was significantly different in the Phase III soil data (p=0.0045). Site 14/15 had obviously higher barium concentrations than those observed at the reference areas.

Boron, cadmium, chromium, copper, molybdenum, antimony, and tin did not differ significantly by location. No other COPC besides barium was significantly elevated at Site 14/15 compared to the reference areas based on the evaluation of the Phase III data.

TOC of reference area soils ranged from 1920 to 11,500 mg/kg. TOC of Site 14/15 soils ranged from 2100 to 11,600 mg/kg. Thus, the TOC concentrations of Site 14/15 soils are basically within the range of the TOC concentrations of reference site soils. **(EPA192)**

The pH of reference area soils ranged from 4.93 to 6.16. The pH of Site 14/15 soils ranged from 6.09 to 9.33. Thus, the pH of Site 14/15 soils is higher than the pH of reference site soils. In general, as pH increases, bioavailability of some micronutrients and heavy metals decreases. Therefore, it is possible that some micronutrients and heavy metals are less bioavailable in Site 14/15 soils than in reference soils, which would reduce their toxicity. **(EPA192)**

17.7.3.3 Earthworm Toxicity Test. Earthworm mortality at Site 14/15 ranged from 0 to 10 percent. Refer to Table 8.7-12a for results of the earthworm toxicity testing. **(EPA191)** The null hypothesis is that "the number of dead earthworms is similar among all locations." The χ^2 test statistic was 49.25 with a degree of freedom of 40, which resulted in a p value of 0.1498. Since this p-value exceeds 0.1, the hypothesis that row and columns are independent cannot be rejected. Therefore, the site location may bear no relation to earthworm mortality when this test is used.

ANOVA on the arcsine-transformed data provides a different interpretation. The p-value for ANOVA is 0.0016, indicating a significant difference between the mean mortality from one

location to another at the 95 percent confidence level. A 95 percent LSD test indicated that mortality was not significantly different at Site 14/15 than at Avonburg, Cobbsfork, or Rossmoyne reference area. The statistical analysis therefore indicates that earthworm mortality is not likely to be significantly affected by existing site conditions at Site 14/15.

17.7.3.4 Phytotoxicity Test. The phytotoxicity early seedling growth test resulted in data for percent germination and biomass. The results are summarized in Appendix Z. There was little variability in germination rates. The germination data were neither normal nor log-normal. The biomass data on a wet-weight basis were lognormal. Percent germination at Site 14 ranged from 95 to 100 percent.

ANOVA of the germination data resulted in a p-value of 0.1480, which is greater than 0.05, indicating that location does not have a statistically significant effect on germination at the 95 percent confidence level. ANOVA of the biomass data resulted in a p-value of 0.0037, indicating site location has a significant effect on wet weight biomass at the 95 percent confidence level. The lowest biomass observed in the study was the biomass for the Cobbsfork reference area. An LSD multiple range test revealed that the wet-weight biomass overlapped (was not significantly different from) the biomass measurements from the three reference areas.

The germination and biomass data indicate that existing site conditions at Site 14 will not significantly decrease plant growth or reproduction relative to effects observed in controls.

17.7.3.5 Soil Fauna Community Structure. The number of individuals per sample (density) was log-normal. The number of species was neither normal nor log-normal. Diversity ranged from 0 to 97 percent at the reference areas, indicating that this parameter is so inherently variable at JPG that it possibly may not be useful for the identification of contaminant-related effects. The density was not significantly different by location when the log transformed data were analyzed by ANOVA. The number of invertebrate species was not statistically significantly different at the 95 percent confidence level when analyzed by the Kruskal-Wallis test. There does not appear to be any effect of site location on soil invertebrate biometrics., although community similarity may be examined in a later version.

17.7.4 Risk Characterization

17.7.4.1 Risk Estimation. The HIs are summarized for each sampling event and receptor below. The HIs are presented in chronological order of sampling data sets (Phase I first, IM second, and Phase III third). The HIs have been grouped by order of magnitude for discussion purposes. HIs based on RME and CT exposure parameters are presented. In addition, a conservative NOAEL-based TRV and a dose at which population-level effects may occur (LOAEL-based TRV) were used to establish the lower and upper bounds on toxicity, respectively. These values define the risk boundaries. There are thus four sets of HI values for each location and sampling event (NOAEL-RME, NOAEL-CT, LOAEL-RME, and LOAEL-CT). The exposure intakes, HQs, and HIs are presented in Appendix AA. Figures 17.7-2 through 17.7-13 show the total NOAEL and LOAEL-based HI risks for both the RME

and CT exposure scenarios by receptor. The reference area RME-NOAEL HIs were presented graphically only on the RME-NOAEL site graphs due to the low risks generally observed.

Site 14

Phase I RME NOAEL HIs
(See Figure 17.7-2)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Red Fox, Little Brown Myotis, Eastern Cottontail, Raccoon,
HI Range 1.1-10: ~~None~~Great Blue Heron
HI Range 10.1-100: White-footed Mouse, Plants, Benthic Invertebrates, Creek Chub, Pickerel Frog
HI Range 100.1-1000: Soil Fauna

Phase I RME LOAEL HIs
(See Figure 17.7-3)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Red Fox, Little Brown Myotis, Eastern Cottontail, Great Blue Heron, Raccoon
HI Range 1.1-10: Soil Fauna, Plants, White-footed Mouse
HI Range 10.1-100: ~~None~~ Benthic Invertebrates, Creek Chub, Pickerel Frog
HI Range 100.1-1000: None

Phase I CT NOAEL HIs
(See Figure 17.7-4)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Red Fox, Little Brown Myotis, Eastern Cottontail, Great Blue Heron, Raccoon
HI Range 1.1-10: None
HI Range 10.1-100: White-footed Mouse, Benthic Invertebrates, Creek Chub, Pickerel Frog
HI Range 100.1-1000: None

Phase I CT LOAEL HIs
(See Figure 17.7-5)
Key Receptors with HI range 0-1: Wild Turkey, Red Fox, American Kestrel, Mourning Dove, Chimney Swift, Little Brown Myotis, Eastern Cottontail, Great Blue Heron, Raccoon
HI Range 1.1-10: White-footed Mouse
HI Range 10.1-100: ~~None~~Benthic Invertebrates, Creek Chub, Pickerel Frog
HI Range 100.1-1000: None

Site 14

IM RME NOAEL HIs
(See Figure 17.7-6)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Red Fox, Little Brown Myotis
HI Range 1.1-10: Eastern Cottontail

HI Range 10.1-100: None
HI Range 100.1-1000: White-footed Mouse, Plants
HI > 1000: Soil Fauna

IM RME LOAEL HIs
(See Figure 17.7-7)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Red Fox, Little Brown Myotis, Eastern Cottontail
HI Range 1.1-10: Soil Fauna
HI Range 10.1-100: White-footed Mouse, Plants
HI Range 100.1-1000: None

IM CT NOAEL HIs
(See Figure 17.7-8)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel,, Red Fox, Little Brown Myotis, Eastern Cottontail
HI Range 1.1-10: None
HI Range 10.1-100: White-footed Mouse
HI Range 100.1-1000: None

IM CT LOAEL HIs
(See Figure 17.7-9)
Key Receptors with HI range 0-1: Wild Turkey, Red Fox, American Kestrel, Mourning Dove, Chimney Swift, Little Brown Myotis, Eastern Cottontail
HI Range 1.1-10: White-footed Mouse
HI Range 10.1-100: None
HI Range 100.1-1000: None

Site 14/15

Phase III RME NOAEL HIs
(See Figure 17.7-10)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Little Brown Myotis, Red Fox
HI Range 1.1-10: Eastern Cottontail
HI Range 10.1-100: Plants
HI Range 100.1-1000: White-footed Mouse, Soil Fauna

Phase III RME LOAEL HIs
(See Figure 17.7-11)
Key Receptors with HI range 0-1: Mourning Dove, Wild Turkey, American Kestrel, Red Fox, Chimney Swift, Little Brown Myotis, Soil Fauna, Plants, Eastern Cottontail
HI Range 1.1-10: None
HI Range 10.1-100: White-footed Mouse
HI Range 100.1-1000: None

Phase III CT NOAEL HIs
(See Figure 17.7-12)
Key Receptors with HI range 0-1: Wild Turkey, American Kestrel, Mourning Dove, Chimney Swift, Red Fox, Little Brown Myotis, Eastern Cottontail
HI Range 1.1-10: None
HI Range 10.1-100: White-footed Mouse
HI Range 100.1-1000: None

Phase III CT LOAEL HIs
(See Figure 17.7-13)
Key Receptors with HI range 0-1: Wild Turkey, Red Fox, American Kestrel, Mourning Dove, Chimney Swift, Eastern Cottontail, Little Brown Myotis
HI Range 1.1-10: White-footed Mouse
HI Range 10.1-100: None
HI Range 100.1-1000: None

17.7.4.2 Risk Description. Only one Phase III analyte was statistically elevated at Site 14/15 relative to the reference areas. Barium was statistically elevated at Site 14/15 relative to the soil concentrations observed in the reference areas. All other COPCs at Site 14/15 appeared to be within the expected ambient concentrations predicted by the data from the reference areas.

The soils at Site 14/15 did not produce elevated levels of mortality in earthworms relative to that observed at the reference areas, nor was the soil fauna diversity or other biometrics obviously affected. Plant germination and biomass were not significantly different at Site 14/15 compared to the reference areas.

Aquatic receptors were evaluated at Site 14 because of the presence of wetlands in the area. Phase I RME NOAEL-based HIs and RME LOAEL-based HIs exceeded 10 for aquatic life, and the Phase I RME NOAEL-based HI for great blue heron exceeded 1. Note that the total RME LOAEL-based HIs exceed the total RME NOAEL-based HIs for aquatic life. There are two reasons for this. (1) LOAEL values are available for aluminum, iron, and manganese, but NOAEL values are not available for these metals. (2) The nickel sediment benchmark chosen as a NOAEL is actually higher in magnitude than the sediment benchmark chosen as a LOAEL. No comparison to reference area conditions can be made since the Phase III reference area samples were all from terrestrial habitat.

RME NOAEL-based risks at Site 14 are higher than those at the reference areas only for soil fauna (Figure 17.7-2) based on evaluation of the Phase I and III data (Figure 17.7-10). The IM confirmation sampling data indicated that risks are elevated only for plants as well as soil fauna (Figure 17.7-6). The HIs for each reference area and the inherent JPG Phase II background risks can be found in Section 32.

Risks based on the LOAEL indicate a potential for population-level effects. The Phase I RME LOAEL-based HIs for Site 14 exceeded 1 for only white-footed mouse, plants, and soil fauna (Figure 17.7-3). The HI results are therefore in direct conflict with the results of the biometric studies, which measured a lack of population and individual level effects in earthworms and other soil invertebrates at Site 14/15. All Phase III RME LOAEL-based HIs for Site 14/15 were similar to or less than those at the reference areas, indicating no increased risk of population level effects relative to the reference areas for any receptor.

The results suggest that the NOAEL TRVs are overly conservative for this site, since ambient levels of inorganics in the reference areas produce high risk estimates for all receptors. Given that few analytes statistically exceed those at reference areas, that HIs for receptors other than plants or soil fauna are not significantly higher than HIs at the reference areas, and that the biometric data failed to detect adverse effects in plants and soil fauna in direct contact with soils from Site 14/15, it appears that contamination at Site 14 is not a likely threat to ecological health at JPG.

17.7.4.2.1 Risk Drivers/Summary of Lines of Evidence. Risk drivers associated with Site 14 are summarized in Tables 17.7-7 through 17.7-12. A COPC was categorized as a risk driver if it produced an HQ greater than or equal to 1 for any exposure pathway.

In addition, to provide an overall summary of the multiple lines of evidence that were evaluated for the Site, a summary table was developed. The lines of evidence were primarily hazard index (HI) calculations for a number of different receptors, but for the terrestrial ecosystem, toxicity testing was also conducted. Refer to Table 7.7-11a for a summary of the lines of evidence. A number of measurement endpoints were assessed for both aquatic and terrestrial ecosystems. An evaluation was made of which measurement endpoints were most sensitive in determining the potential for an ecological concern by terrestrial or aquatic ecosystem. **(EPA180a,b)**

Terrestrial Ecosystem

The most sensitive of the terrestrial measurement endpoints are plants, soil fauna, and white-footed mice HQs. The reasonable maximum exposure (RME) no observed adverse effect level (NOAEL)-based hazard quotients (HQs) for each of these receptors are as follows: 2424 (plants), 1325 (soil fauna), and 354 (white-footed mice). The primary contributors of risk to plants are nickel (RME NOAEL HQ of 2240), chromium (RME NOAEL HQ of 98), and copper (RME NOAEL HQ of 81) from direct contact with soil. These HQs were derived using Phase I data. The primary contributors of risk to soil fauna are chromium (RME NOAEL HQ of 1230) and copper (RME NOAEL HQ of 96) from direct contact with soil. These HQs were derived using Phase I data. The primary contributor of risk to white-footed mice is lead through dietary ingestion (RME NOAEL HQ of 256) and soil ingestion (RME NOAEL HQ of 52). These HQs were derived using Phase I data.

An interim measure was conducted at this site, and levels of contamination have been reduced. Based on Phase III data, none of the metals listed as primary contributors to ecological risk

are present at concentrations that exceed reference area concentrations. Thus, copper, chromium, lead, and nickel would not be expected to contribute to ecological risk exceeding that in the reference areas. **(EPA180a,b)**

Aquatic Ecosystem

The most sensitive of the aquatic measurement endpoints are benthic invertebrates, creek chub, and pickerel frog. The maximum RME NOAEL and LOAEL HQs for these receptors are 23 and 78, respectively. The primary contributor of risk to great blue heron is vanadium (RME NOAEL HQ of 34) through ingestion of sediment. This HQ was derived using Phase I data. **(EPA180a,b)**

17.7.4.3 Uncertainty Analysis. Phase I, IM and Phase III data were collected at Site 14. The collection of three sets of data at Site 14 helps to reduce the uncertainty associated with the risk assessment results for this location. Although no Phase II data were collected at Site 14, the number of samples collected in this general area of Site 14/15 should provide adequate coverage and reduce overall uncertainty.

Uncertainty in the exposure estimates is due primarily to:

- Variability in the exposure parameters, which produce a natural distribution of the variables in the intake equations for each of the receptors;
- Exposure parameters derived from literature and not measured on site; uncertainty in the dietary ingestion pathway, which utilized BAFs to predict dietary concentrations;
- Variation in the concentrations of COPCs in the environment; and
- Uncertainty as to whether the most conservative pathways have been addressed and evaluated.

The predicted effect of each of these sources of uncertainty on the risk assessment is as follows:

Variability in the exposure parameters—Because both the average and RME scenarios were quantitatively addressed, this source of uncertainty is expected to have no overall effect on the risk assessment results.

Exposure parameters derived from literature—Because so many ecological receptors were quantitatively considered in the ecological risk assessment, this source of uncertainty is expected to have no overall effect on the risk assessment.

Uncertainty in the dietary ingestion pathway—The use of literature-based BAFs or BCFs is expected to overestimate as opposed to underestimate concentrations in the dietary pathway.

This is because under laboratory conditions, animals are chronically exposed on a daily basis and supposedly reach steady state. In the wild, as animals move in and out of contaminated areas, metabolism and excretion are expected to reduce the body burden. Use of field-based BAFs from TEAD is not expected to overestimate or underestimate risk for these analytes, since these data were measured in conjunction with co-located soil samples.

Variation in the concentrations of COPCs in the environment—This uncertainty is not expected to bias the risk assessment towards underestimation of risk since maximum or UCL95 concentrations were used in all exposure scenarios to estimate the EPCs.

Uncertainty whether most conservative pathways have been addressed—The receptors were considered carefully by the DSG, and typically have high exposure rates due to their life-histories (i.e., ground-feeding or burrowing). Therefore, this source of uncertainty is not expected to impact the risk assessment.

Uncertainty in ecological analysis is less than the uncertainty in exposure estimates— These data were gathered as part of a site-specific, controlled field study. There were sufficient samples collected at each site (n=5) to identify within and between site variability. The data identify the potential for adverse effects to species that form the basis of the JPG food web, that is, the plants and soil fauna.

17.7.5 Ecological Risk Assessment Summary

The conceptual site model (CSM) for Site 14/15 provides an overview of the ecological receptors and exposure pathways evaluated in the ecological risk assessment. Refer to Figure 17.7-1a for a schematic of the CSM. Site 14/15 will likely be used for agricultural and industrial purposes in the future. This future land use will alter the current CSM.

Multiple lines of evidence were evaluated for the ecological assessment conducted at Site 14. For Site 14 both terrestrial and aquatic lines of evidence were evaluated. The lines of evidence were primarily hazard quotient (HQ) calculations for a number of different receptors, but for the terrestrial ecosystem, toxicity testing was also conducted. Refer to Table 7.7-11a for a summary of the terrestrial and aquatic ecosystem lines of evidence. **(EPA180a,b)**

The following is an overall summary of the key results of the ecological assessment for Site 14.~~and conclusions are based on an initial review of the data. A full evaluation of whether or not the data meet all DQOs, and further statistical examination, will be made prior to finalizing these results for the next version of this report.~~

- Based on the ~~ecological effects data~~ toxicity test results, there are no apparent adverse ecological effects at this site.

- Based on the analytical data, there are few COPCs statistically elevated above those at the reference areas. Barium was the only analyte that was statistically elevated at Site 14/15 relative to the reference areas.

Phase I HIs are within the same order of magnitude, or lower than, those observed at the reference areas for all receptors except plants and soil fauna. HIs indicated the potential for adverse population-level effects on these~~is~~ groups of receptors. However, Phase III HIs are similar to reference HIs. The Phase III HI calculations indicate that the interim measure excavation activities led to reduced ecological risk at Site 14. In addition, ~~Other lines of evidence refute the HI results, however.~~ ~~E~~effects on earthworm mortality and phytotoxicity were not observed, nor were effects on soil fauna diversity.

- There is no significant ecological risk at this location based on evaluation of the different lines of evidence.

17.8 CONCLUSIONS AND RECOMMENDATIONS

Phase I results for the Yellow Sulfur Area (Site 14) indicated that soils and sediments contain a variety of metals that exceed their respective background concentrations and several were found to exceed USEPA Region 9 PRGs. Sulfur in the soils resulted in acidic conditions where pH values ranged from 1.4 to 7.9, depending on the sample's proximity to the sulfur contamination. The most acidic conditions were found in the near-surface soils. The concentrations of other metals appear to be affected by these changes in pH. Field screening results for VOCs in soils showed that no VOC contamination is present in site soils or groundwater.

~~Groundwater sample results from both Phase I and Phase II indicate that no contamination is present as a result of previous site activities.~~Groundwater at Site 14 was found to contain arsenic, beryllium, cobalt, molybdenum, selenium, vanadium, and zinc exceeding their respective background concentrations. Of these contaminants, only the metals arsenic, beryllium, and molybdenum were found to exceed USEPA Region 9 PRGs and were retained as COPCs for the human health risk assessment.

In the fall of 1997, IM activities were conducted at the Yellow Sulfur Area. Excavation of the sulfur contamination and associated metals contamination was hampered by the discovery of UXO within the area to be excavated. Several UXO items were recovered from the excavated soils. Confirmation samples were taken from the excavation in February 1997, and the results indicate that chromium levels are still present that exceed USEPA Region 9 PRGs. In addition, the potential for the discovery of additional UXO is considered high for this site. As a result, it is recommended that additional UXO clearance of Site 14 be included as part of the ongoing IM activities.(IN26)

Although much of the contaminated soil has been successfully removed and disposed of at an off-site location, it appears that additional remedial action would be required before the site can be cleared for unrestricted use. It is recommended that additional UXO characterization and removal be conducted at the site. Also, additional excavation of chromium-contaminated

soils may be warranted. Acidic conditions still exist within the excavation, indicating that sulfur contamination impacts are still present on the site soils.

The results of a human health risk assessment conducted for the air and groundwater pathways indicate that the overall HIs for chronic health risks for the future on-site resident and the future on-site worker exceed the USEPA goal of 1.0. For both scenarios, the critical exposure pathway is ingestion of arsenic in groundwater. The cancer risks for both scenarios also exceed the USEPA target range of 1E-04 to 1E-06 due to ingestion of arsenic in groundwater.

Results of the ecological risk assessment indicate that, based on the ecological effects data, there are no adverse ecological effects at this site. Of the contaminants detected in Site 14 soils, only barium was elevated in comparison to levels found at the reference areas at JPG. The HIs based on Phase I data are within the same order of magnitude, or lower, as those observed at the reference areas. There were no effects observed on earthworm mortality and there appeared to be no effects on soil fauna diversity at Site 14. Using all of the lines of evidence, it appears that there is no significant ecological risk at this location.

Due to the suspected presence of additional UXO, the presence of chromium exceeding PRGs, the presence of arsenic in groundwater that would produce risks to future on-site residents and workers, and due to residual acidic conditions in the soil, it is recommended that this site be carried forward to the FS. ~~Since IM activities are on-going at this site, some of these concerns may be addressed in the near future.~~

TABLES

TABLE 17-5

Summary of Analytical Results for Confirmation Samples by SAIC
Site 14 – Yellow Sulfur Area
Jefferson Proving Ground
Madison, Indiana

Sample I.D. Analyte	S14001 (mg/kg)[(a)]	S14002 (mg/kg)	S14003 (mg/kg)	S14004 (mg/kg)	S14005 (mg/kg)	S14006 (mg/kg)	S14007 (mg/kg)	S14008 (µg/g)[(b)]	S14009 (µg/g)	S14010 (µg/g)	S14011 (µg/g)	S14012 (µg/kg)	S14013 (µg/g)
Silver	1.4 U[(c)]	1.2 U	1.3 U	1.4 BU	1.3 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 BU	1.2 U	1.2 U
Aluminum	11000.00	6300.00	10000.00	19000.00	14000.00	14000.00	11000.00	18000.00	12000.00	7500.00	8500.00	9600.00	22000.00
Arsenic	4.9 J[(d)]	5.2 J	6.0 J	5.6 J	5 J	4.2 J	4.9 J	5.2 J	4.4 J	3.3 J	5.1 J	3.2 J	5.8 J
Boron	6.2 BJ[(e)]	10 BUJ	4.9 BJ	6.4 BJ	10 BUJ	10 BUJ	10 BUJ	10 BUJ	10 BUJ	4.0 BJ	10 BUJ	10 BUJ	5.7 BJ
Barium	270.00	55.00	240.00	180.00	110.00	120.00	92.00	55.00	40.00	63.00	52.00	40.00	57.00
Beryllium	0.28 BJ	0.29 BJ	0.28 BJ	0.59 BJ	0.39 BJ	0.23 BJ	0.18 BJ	0.36 BJ	0.24 BJ	0.19 BJ	0.49 BJ	0.20 BJ	0.29 BJ
Calcium	15000 J	5700 J	37000 J	3700 J	1900 J	4300 J	1600 J	1200 J	1100 J	16000 J	560 BJ	1800 J	720 BJ
Cadmium	0.55 BJ	0.66	0.61 BJ	0.34 BJ	0.26 BJ	0.37 BJ	0.52 BJ	0.21 BJ	0.45 BJ	0.39 BJ	0.20 BJ	0.68	0.50 BJ
Cobalt	2.0 BJ	2.9 BJ	2.6 BJ	5.2 BJ	5.0 BJ	4.1 BJ	2.0 BJ	3.0 BJ	2.3 BJ	1.9 BJ	5.2 BJ	0.99 BJ	4.8 BJ
Chromium	39 J	11 J	28 J	29 J	16 J	33 J	27 J	20 J	13 J	9.7 J	10 J	13 J	3,000 J
Copper	22 J	5.9 J	21 J	56 J	8.1 J	13 J	15 J	15 J	6.9 J	7.1 J	2.6 BJ	1.7 BJ	21 J
Iron	13000.00	10000.0	12000.00	17000.00	15000.00	17000.00	17000.00	23000.00	10000.00	11000.00	15000.00	10000.00	32000.00
Mercury	0.14 U	0.12 U	0.13 U	0.14 U	0.13 U	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U
pH	6.9	7.2	7.6	7.2	6.9	4.2	3.4	3.6	3.5	3.6	6	4.9	3.2
Potassium	810 U	300 BU	710 U	890 U	510 BU	500 BU	590 BU	590 BU	320 BU	410 BU	490 BU	610 U	1200 U
Magnesium	4300 J	2500 J	9600 J	2100 J	2200 J	1800 J	1300 J	1700 J	770 J	8000 J	680 J	1400 J	1400 J
Manganese	170.00	210.00	170.00	250.00	130.00	250.00	56.00	86.00	33 U	100.00	490.00	38 U	230.00
Molybdenum	5.2 BUJ[(f)]	3.8 BUJ	1.7 BUJ	2.0 BUJ	1.0 BUJ	2.5 BUJ	1.7 BUJ	1.9 BUJ	1.6 BUJ	0.9 BUJ	3.1 BUJ	2.2 BUJ	4.9 BUJ
Sodium	52 BJ	48 BJ	60 BJ	64 BJ	62 BJ	59 BJ	76 BJ	52 BJ	32 BJ	31 BJ	26 BJ	41 BJ	71 BJ
Nickel	12 J	4.4 BJ	12 J	16 J	9.7 J	7.7 J	8.2 J	10 J	5.8 J	5.7 J	5.2 J	5.5 J	8.5 J
Lead	54.00	20.00	40.00	41.00	15.00	15.00	16.00	14.00	13.00	11.00	12.00	9.20	16.00
Selenium	0.37 BUJ	0.35 UJ	0.13 UJ	0.34 BUJ	0.15 BUJ	0.61 UJ	0.38 BJ	0.33 BJ	0.18 BJ	0.62 UJ	0.25 BJ	0.19 BJ	0.37J
Thallium	8.50	6.10	3.60	0.71 U	0.66 U	0.61 U	1.20	0.62 U	7.50	7.40	5.80	0.59 U	7.90
Total Sulfur	0.306	0.046	0.172	0.052	0.042	0.316	0.193	0.204	0.14	0.385	0.059	2.89	0.365
Vanadium	26.00	22.00	24.00	31.00	22.00	22.00	23.00	22.00	16.00	18.00	26.00	24.00	46.00
Zinc	38.00	21.00	40.00	74.00	29.00	31.00	21.00	30.00	15.00	27.00	15.00	14.0	28.00

TABLE 17-5

Summary of Analytical Results for Confirmation Samples by SAIC
Site 14 – Yellow Sulfur Area
Jefferson Proving Ground
Madison, Indiana

Sample I.D. / Analyte	S14014 (µg/g)	S14015 (mg/kg)	S14016 (mg/kg)	S14017 (mg/kg)	S14018 (mg/kg)	S14019 (mg/kg)	S14020 (mg/kg)	S14021 (mg/kg)	S14022 (mg/kg)	S14023 (mg/kg)	S14024 (mg/kg)
Silver	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.3 U	1.3 U
Aluminum	13,000.00	11000.00	11000.00	7000.00	11000.00	12000.00	7700.00	4900.00	740.00	3200.00	1500.00
Arsenic	7.7 J	2.9 J	4.0 J	2.3 J	3.2 J	3.3 J	4.7 J	6.7 J	1.9 J	3.3 J	1.5 J
Boron	4.8 BJ	10 BUJ	3.9 BJ	3.1 UJ	10 BUJ	4.3 BJ	10 BUJ	10 BUJ	4.2 BJ	3.8 BJ	5.0 BJ
Barium	49.00	83.00	47.00	64.00	60.00	160.00	48.00	41.00	45.00	1000.00	72.00
Beryllium	0.19 BJ	0.12 BJ	0.13 BJ	0.096 BJ	0.22 J	0.25 BJ	0.12 BU	0.056 BU	0.62 BU	0.079 BU	0.63 BU
Calcium	450 BJ	1900 J	2800 J	1900 J	3200 J	13000 J	440 BUJ	280 BUJ	690 J	8000 J	920 J
Cadmium	0.23 BJ	0.50 BJ	0.25 BJ	0.29 BJ	0.29 BJ	0.36 BJ	0.24 BJ	0.091 BJ	0.62 U	0.13 BJ	0.63 U
Cobalt	1.4 BJ	0.75 BJ	0.60 BJ	0.38 BJ	0.96 BJ	2.3 BJ	0.98 BJ	1.0 BJ	18 U	1.7 BJ	19 U
Chromium	530 J	320 J	430 J	65 J	730 J	140 J	380 J	69 J	5.8 J	19 J	17 J
Copper	5.9 J	11.0 J	7.9 J	3.2 J	16 J	20 J	6.6 J	6J	1.8 BJ	11 J	2.1 BJ
Iron	23000.00	12000.00	23000.00	12000.00	14000.00	13000.00	16000.00	9400.00	290.00	10000.00	2400.00
Mercury	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U	0.12 U	0.12	0.12 U	0.13 U	0.13 U
pH	3	4.8	2.5	2.3	3	6.7	3.4	2.4	2.9	4.4	2.5
Potassium	1100 U	430 BU	880 U	1000 U	610 U	500 BU	320 BU	360 BU	100 BU	340 BU	430 BU
Magnesium	1200 U	1100 J	850 J	570 BJ	650 J	2900 J	1100 J	380 BJ	190 BJ	420 BJ	250 BJ
Manganese	53.00	27 U	24 U	25 U	60.00	91.00	27 U	11 U	6.6 U	42.00	13 U
Molybdenum	1.9 BUJ	2.2 BUJ	1.8 BUJ	2.3 BUJ	3.1 BUJ	10 BUJ	10 BUJ	10 BUJ	3.9 BUJ	3.6 BUJ	2.0 BUJ
Sodium	580 BJ	51 BJ	550 BJ	94 BJ	37 BJ	49 BJ	210 BJ	110 BJ	622 U	51 BJ	42 BJ
Nickel	5.5 J	5.8 J	5.4 J	3.5 BJ	4.7 BJ	8.2 J	3.1 BJ	0.95 BJ	4.9 U	2.7 BJ	1.1 BJ
Lead	13.00	17.00	14.00	17.00	13.00	28.0	9.70	53.00	15.00	190.00	9.50
Selenium	0.64 J	0.58 UJ	0.31 BJ	0.61 UJ	0.13 BJ	0.62 U	0.33 BJ	0.20 UJ	0.62 U	0.63 U	0.63 U
Thallium	6.00	5.40	5.00	3.1 U	4.00	5.00	0.60 UJ	0.62 U	4.10	7.40	0.97 J
Total Sulfur	0.35	0.33	1.01	0.44	3.12	0.562	0.18	0.594	0.364	0.462	0.161
Vanadium	50.00	24.00	36.00	22.00	42.00	26.00	27.00	13.00	1.9 BJ	20.00	4.3 BJ
Zinc	16.00	18.00	14.00	9.00	15.00	45.00	12.00	8.60	2.5 U	11.00	2.2 BJ

Notes:
Units for total sulfur are in percent; pH results are in pH units.
A description of data qualifiers is located in Appendix N.
All sample depths are from 0-1 foot. Sample collected on 2/12/97.

Footnote:
(a) Milligrams per kilogram.
(b) ug/g = microgram per gram
(c) U = not detected
(d) J = estimated value
(e) B = value between the MDL and RL

TABLE 17-6

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs) Site 14 – Yellow Sulfur Disposal Area Jefferson Proving Ground Madison, Wisconsin

	USEPA Region 9 PRG Screen		
Analyte	Ambient Air PRG (µg/m^3)[a]	Exposure Point Conc. (µg/m^3)	Retained as Air COPC?
Residential Scenario			
Aluminum	NA[b]	8.92E-03	**YES**
Arsenic	4.5E-04	4.22E-06	No
Barium	5.2E-02	1.98E-05	No
Beryllium	8.0E-04	3.29E-07	No
Cadmium	1.1E-03	3.86E-08	No
Chromium	2.3E-05	1.32E-05	No
Lead	1.5E+00[c]	2.86E-06	No
Manganese	5.1E-03	6.69E-04	No
Silver	NA	2.33E-05	**YES**
Thallium	NA	2.15E-06	**YES**
Vanadium	NA	2.11E-06	**YES**
Zinc	NA	1.97E-06	**YES**
Dioxins/Furans	4.5E-08	1.19E-13	No
Benzo(a)anthracene	9.2E-03	3.54E-09	No
Benzo(a)pyrene	9.2E-04	1.20E-08	No
Benzo(b)fluoranthene	9.2E-03	2.39E-08	No
DDE	2.0E-02	2.08E-09	No
Dibenz(a,h)anthracene	9.2E-04	4.17E-10	No
Dieldrin	4.2E-04	NA	No
Indeno(1,2,3-cd)pyrene	9.2E-03	2.10E-09	No
1,1-Dichloroethylene	3.8E-02	4.71E-09	No
Chlorobenzene	2.1E+00	7.11E-06	No

TABLE 17-6

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 14 – Yellow Sulfur Disposal Area
Jefferson Proving Ground
Madison, Wisconsin

	USEPA Region 9 PRG Screen		
Chemical	**Ambient Air PRG (µg/m^3)[(a)]**	**Exposure Point Conc. (µg/m^3)**	**Retained as Air COPC?**
Industrial Scenario			
Aluminum	NA	2.54E+00	**YES**
Arsenic	4.5E-04	7.21E-06	No
Barium	5.2E-02	2.13E-05	No
Beryllium	8.0E-04	1.07E-06	No
Cadmium	1.1E-03	2.38E-07	No
Chromium	2.3E-05	3.24E-05	**YES**
Lead	1.5E+00	2.86E-06	No
Manganese	5.1E-03	8.01E-02	**YES**
Silver	NA	2.33E-05	**YES**
Thallium	NA	2.15E-06	**YES**
Vanadium	NA	6.21E-06	**YES**
Zinc	NA	2.19E-04	**YES**
Dioxins/Furans	4.5E-08	1.05E-08	No
Benzo(a)anthracene	9.2E-03	3.54E-09	No
Benzo(a)pyrene	9.2E-04	1.22E-08	No
Benzo(b)fluoranthene	9.2E-03	2.39E-08	No
DDE	2.0E-02	2.08E-09	No
Dibenz(a,h)anthracene	9.2E-04	4.17E-10	No
Dieldrin	4.2E-04	7.38E-09	No
Indeno(1,2,3-cd)pyrene	9.2E-03	2.08E-09	No
1,1-Dichloroethylene	3.8E-02	4.71E-09	No
Chlorobenzene	2.1E+00	7.11E-06	No

Notes:
1. PRGs were taken directly from the Region 9 PRG Table (USEPA 1998). Values for noncarcinogens are 1/10 of the Region 9 PRG.
2. EPCs are calculated and presented in Tables R-4 and R-6 in Appendix R.

Footnotes:
(a) Micrograms per cubic meter.
(b) Not available or not applicable.
(c) Federal ambient air quality criterion for lead.

TABLE 17-7

Sediment Exposure Point Concentrations of Preliminary Contaminants of Potential Concern (COPC)
Surface Water Drainage Pathway
Site 14 – Yellow Sulfur Disposal Area
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[(a)]	Range of Detected Values (µg/g)[(b)]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL[(c)] Concentration (µg/g)	Exposure Point Concentration[(d)] (µg/g)
Aluminum	4/4	6,730 - 18,100	NA[(e)]	12,883	36,777	18,100
Arsenic	4/4	4.77 - 11.6	NA	6.8	16.6	11.6
Barium	4/4	490 - 696	NA	582	725	696
Beryllium	2/4	0.93 - 1.0	0.427	0.59	1.1	1.0
Chromium	4/4	22.8 - 87.9	NA	593	387	87.9
Cobalt	2/4	6.45 - 9.29	2.5	4.6	9.3	9.29
Copper	4/4	9.61 - 59.9	NA	30.9	59.3	59.3
Lead	4/4	67 - 110	NA	90.6	138	110
Manganese	4/4	42.7 - 240	NA	144	5,625	240
Nickel	3/4	5.07 - 16.4	2.74	9.0	17.2	16.4
Silver	4/4	0.06 - 0.43	NA	0.14	6.8	0.43
Vanadium	4/4	21.1 - 32.5	NA	28.6	34.8	32.5
Zinc	4/4	11 - 118	NA	57	119	118

Footnotes:
(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Micrograms per gram.(c)
(c) UCL = upper confidence level
(d) The 95% UCL (upper confidence limit of the mean) or the maximum detected value, whichever is lower (USEPA 1989b).
(e) Not applicable.

TABLE 17-8

Selection of Contaminants of Potential Concern (COPC) in Sediment Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Surface Water Drainage Pathway
Site 14 – Yellow Sulfur Disposal Area
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Residential PRG (µg/g)[(a)]**	**Exposure Point Conc. (µg/g)**	**Retained as Sediment COPC?**
Aluminum	7,667	18,100	**YES**
Barium	527	696	**YES**
Beryllium	0.143	1.0	**YES**
Chromium	30.1[(b)]	87.9	**YES**
Cobalt	456	9.26	No
Copper	285	59.3	No
Lead	400[(c)]	110	No
Manganese	318	240	No
Nickel	153	16.4	No
Silver	38.3	0.43	No
Vanadium	53.7	32.5	No
Zinc	2,300	118	No

Notes:

1. PRGs were taken directly from the Region 9 PRG Table (USEPA 1998). Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:

(a) Micrograms per gram.
(b) Value for chromium VI.
(c) Value for lead is full PRG.

TABLE 17-9

Groundwater Exposure Point Concentrations of Contaminants of Potential Concern (COPC)
Site 14 – Yellow Sulfur Disposal Area
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[(a)]	Range of Detected Values (µg/L)[(b)]	Range of Reporting Limits (µg/L)	Arithmetic Mean Concentration (µg/L)	95% UCL[(c)] Concentration (µg/L)	Exposure Point Concentration[(d)] (µg/L)
Arsenic	3/3	9.63 - 34.1	NA[(e)]	20.6	1,310	34.1
Beryllium	1/3	1.18	5.0	2.1	15.7	1.18
Cobalt	1/3	8.53	50	19.5	1,161	8.53
Molybdenum	1/3	34.8	100	44.9	83.4	34.8
Selenium	1/3	3.12	5	2.7	3.7	3.12
Vanadium	1/3	3.81	50	17.9	1.36E+06	3.81
Zinc	2/3	3.85 - 5.36	20	6.4	61.6	5.36

Footnotes:
(a) Number of locations in which the analyte was detected/total number of locations sampled. Data from the three downgradient wells MW93-24, MW93-25, and MW93-26) were used in the calculations.
(b) Micrograms per liter.
(c) UCL = upper confidence level
(d) The 95% UCL (upper confidence limit of the mean) or the maximum detected value, whichever is lower (USEPA 1989b).
(e) Not applicable.

TABLE 17-10

Selection of Contaminants of Potential Concern (COPC) in Groundwater Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 14 – Yellow Sulfur Disposal Area
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Tap Water PRG (µg/L)[(a)]**	**Exposure Point Concentration (µg/L)**	**Retained as GW COPC?**
Arsenic, Total	0.045	34.1	**YES**
Beryllium, Total	0.016	1.18	**YES**
Cobalt, Total	219	8.53	No
Molybdenum, Total	18.3	34.8	**YES**
Selenium, Total	18.3	3.12	No
Vanadium, Total	25.6	3.81	No
Zinc, Total	1,095	5.36	No

Notes:
1. PRGs were taken directly from the Region 9 PRG Table (USEPA 1998) except as noted in the footnotes. Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnote:
(a) Micrograms per liter.

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TABLE 17-11

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 14 – Yellow Sulfur Disposal Site
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern		Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
		Future On-site Resident Adult			
Ingestion of groundwater	6.00E-04	Arsenic (100%)		3.3210	Arsenic (94%)
Dermal contact with groundwater	1.09E-06			0.0060	
Incidental ingestion of sediment in the drainage pathway	NA			0.0028	
Dermal contact with sediment in the drainage pathway	NA			0.0039	
Inhalation of VOCs[(a)] and fugitive dusts	NA[(b)]			NA	
Total	6.01E-04		Total	3.3337	
		Future On-site Resident Child			
Ingestion of groundwater	2.8E-04	Arsenic (100%)		7.7490	Arsenic (94%)
Dermal contact with groundwater	2.08E-07			0.0057	
Incidental ingestion of sediment in the drainage pathway	NA			0.0261	
Dermal contact with sediment in the drainage pathway	NA			0.0094	
Inhalation of VOCs and fugitive dusts	NA			NA	
Total	2.8E-04		Total	7.7902	

TABLE 17-11

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 14 – Yellow Sulfur Disposal Site
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
		Future On-site Worker		
Ingestion of groundwater	1.79E-04	Arsenic (100%)	1.1861	Arsenic (94%)
Inhalation of VOCs and fugitive dusts	3.16E-08		0.3640	
Total	1.79E-04	Total	1.5501	

Footnotes:
(a) Volatile organic compounds.
(b) Not applicable.

RAB/PB
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TABLE 17-12

Qualitative Uncertainty Analysis
Site 14 – Yellow Sulfur Disposal Area
Jefferson Proving Ground
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
A. Human Behavior				
Future receptors' exposure duration	30 years	Medium	Medium	National upper-bound time (90th percentile) at one residence
Future receptors' exposure frequency	350 days/year	Medium	Medium	High-end value
Future receptors' exposure time	24 hours/day	Low	High	Maximum possible value
Future receptors' water ingestion rate	2 liters/day	Low	High	Water consumption rates are high-end values obtained from published distribution data
Exclusion of certain exposure pathways in the quantitative analysis	NA[(a)]	Low	Low	Pathways eliminated are those that have low possibility of contributing risk to these receptors
B. Chemical Fate/Transport in the Environment				
Groundwater exposure point concentration of COC[(b)]	Maximum detected value	Low	High	Site average would be lower
Use of air dispersion modeling to predict air concentrations	NA	Low	High	Conservative assumptions and input parameters

TABLE 17-12

Qualitative Uncertainty Analysis
Site 14 – Yellow Sulfur Disposal Area
Jefferson Proving Ground
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
C. Chemical Toxicity				
Assumption that USEPA[(c)] reference doses truly represent toxicological thresholds	NA	Low	High	High degree of conservativeness utilized by USEPA in deriving RfDs[(d)] from toxicological literature
Assumption that USEPA carcinogenic slope factors truly represent dose-response phenomena	NA	Low-moderate	Moderate-high	Use of linearized, multi-stage mathematical model to predict cancer incidence at low exposure levels is USEPA policy; not currently supported by scientific data
Assumption of risk/hazard additivity	NA	Moderate	Moderate	Summation of chemical-specific risks/hazards may over- or under-predict risks/hazards to receptors
Screening out of certain contaminants based on USEPA criteria	NA	Low	Low	Chemicals present in concentrations less than USEPA criteria eliminated

Footnotes:
- (a) Not applicable or not available.
- (b) Contaminant of concern.
- (c) United States Environmental Protection Agency.
- (d) Reference doses.

TABLE 17.7-1

Summary Statistics For Analytes in Surface Soil Phase I
Site 14 - Yellow Sulfur Disposal Area
Jefferson Proving Ground
Madison, Indiana

Analyte Code	Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Standard Deviation	UCL95[(a)]	EPC µg/g[(b)]	Exceed Background (Bkg)?	Retain as COPC[(c)]?	Comment
AG	Silver	3	6	50	0.020	0.1590	0.050	0.0538	0.094	0.094	Yes (Y)	Y	Not detected in Bkg.
AL	Aluminum	6	6	100	1220	19100	7925	6762	13488	13488	No (N)	N	
AS	Arsenic	4	6	67	1.25	22.10	7.41	8.38	14.30	14.30	N	N	
B	Boron	1	6	17	3.32	10.60	4.53	2.97	6.98	6.98	Y	Y	Not detected in Bkg.
BA	Barium	6	6	100	66.0	326.0	145.9	101.3	229.3	229.3	Y	Y	
BE	Beryllium	1	6	17	0.21	0.77	0.31	0.23	0.49	0.49	Y	Y	
CD	Cadmium	0	6	0	NC[(d)]	NC	NC	NC	NC	NC	NA[(e)]	N	Not a COPC
CO	Cobalt	2	6	33	1.25	6.21	2.77	2.37	4.73	4.73	Y	Y	
CR	Chromium	6	6	100	6.41	80.40	28.45	27.72	51.25	51.25	N	N	
CU	Copper	6	6	100	23.6	807.0	248.9	295.1	491.7	491.7	Y	Y	
FE	Iron	6	6	100	873	39400	16659	16815	30491	30491	N	N	
HG	Mercury	0	6	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
MN	Manganese	6	6	100	15.2	484.0	158.4	192.1	316.4	316.4	N	N	
MO	Molybdenum	0	6	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
NI	Nickel	4	6	67	1.37	18.70	6.62	6.71	12.14	12.14	Y	Y	
PB	Lead	6	6	100	6.99	16000	2688	6521	8053	8053	Y	Y	
SB	Antimony	0	6	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
SN	Tin	0	6	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
TE	Tellurium	0	6	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
TL	Thallium	0	6	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
TS	Total sulfur	5	6	83	0.05	9.63	2.51	3.90	5.60	5.60	NA	Y	Concentrations in percent
V	Vanadium	6	6	100	2.34	40.50	17.92	14.17	29.58	29.58	N	N	
ZN	Zinc	6	6	100	40.0	1170	359.6	474.3	749.8	749.8	Y	Y	

Note:

1.Calcium, magnesium, sodium and potassium were not included in risk assessment as they are macronutrients.

Footnotes:

(a) Upper 95% confidence limit.

(b) Exposure point concentration, micrograms per gram, equivalent to parts per million.

(c) Contaminant of potential concern.

(d) Not calculated. Not a COPC.

(e) Not applicable or not evaluated.

TABLE 17.7-3

Summary Statistics for Analytes in Surface Soil
Interim Measures Confirmation Sampling Data
Site 14 - Yellow Sulfur Disposal Area
Jefferson Proving Ground
Madison, Indiana

Site	Analte	Number of Detects	Number of Samples	Detection Frequency	Minimum	Maximum	Average	Standard Deviation	UCL95[(a)]	EPC µg/g[(b)]	Exceed Background (Bkg)?	Retain as COPC[(c)]?	Comment
14	Silver	0	27	0	NC[(d)]	NC	NC	NC	NC	NC	No (N)	N	Not a COPC
14	Aluminum	27	27	100	740.0	22000	10313	4940	11932	11932	Yes (Y)	Y	
14	Arsenic	27	27	100	1.50	7.70	4.40	1.60	4.93	4.93	N	N	
14	Boron	11	27	40.7	1.55	6.45	4.81	0.88	5.10	5.10	Y	Y	Not detected in Bkg.
14	Barium	27	27	100	40.00	1000	120.2	185.0	180.8	180.8	Y	Y	
14	Beryllium	22	27	81.5	0.03	0.59	0.24	0.13	0.28	0.28	N	N	
14	Cadmium	25	27	92.6	0.09	0.68	0.36	0.15	0.41	0.41	Y	Y	
14	Cobalt	25	27	92.6	0.38	9.50	2.84	2.38	3.62	3.62	N	N	
14	Chromium	27	27	100	5.80	3000	234.9	586.0	427.0	427.0	Y	Y	
14	Copper	27	27	100	1.70	56.00	11.51	10.81	15.06	15.06	Y	Y	
14	Iron	27	27	100	290.0	32000	13918	6373	16007	16007	Y	Y	
14	Mercury	0	27	0	NC	NC	NC	NC	NC	NC	N	N	Not a COPC
14	Manganese	17	27	63.0	3.30	490.00	99.33	111.61	135.91	135.91	N	N	
14	Molybdenum	0	27	0	NC	NC	NC	NC	NC	NC	N	N	Not a COPC
14	Nickel	26	27	96.3	0.95	16.00	6.36	3.44	7.49	7.49	Y	Y	
14	Lead	27	27	100	9.20	190.00	25.27	34.74	36.66	36.66	N	N	
14	Antimony	no data	no data	no data	no data	no data	no data	no data	no data	no data	NA[(e)]	NA	NA
14	Selenium	12	27	44.4	0.07	0.64	0.25	0.12	0.29	0.29	Y	Y	
14	Tin	no data	no data	no data	no data	no data	no data	no data	no data	no data	NA	NA	NA
14	Total Sulfur	27	27	100	0.033	3.12	0.57	0.82	0.84	0.84	Y	Y	Concentrations in %
14	Thallium	18	27	66.7	0.16	9.25	3.77	3.06	4.77	4.77	Y	Y	
14	Vanadium	27	27	100	1.90	50.00	24.38	10.59	27.85	27.85	N	N	
14	Zinc	26	27	96.3	1.25	74.00	22.82	15.48	27.89	27.89	N	N	

Note:

1.Calcium, magnesium, sodium and potassium were not included in risk assessment as they are macronutrients.

Footnotes:

(a) Upper 95% confidence limit.

(b) Exposure point concentration, micrograms per gram, equivalent to parts per million.

(mc) Contaminant of potential concern.

(d) Not calculated. Not a COPC.

(e) Not applicable or not evaluated.

TABLE 17-11

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 14 – Yellow Sulfur Disposal Site
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
		Future On-site Worker		
Ingestion of groundwater	1.79E-04	Arsenic (100%)	1.1861	Arsenic (94%)
Inhalation of VOCs and fugitive dusts	3.16E-08		0.3640	
Total	1.79E-04	Total	1.5501	

Footnotes:
(a) Volatile organic compounds.
(b) Not applicable.

RAB/PB
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TABLE 17.7-5

Summary Statistics For Analytes in Surface Soil
Sites 14/15 - Eco-Phase III
Jefferson Proving Ground
Madison, Indiana

Site	Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Standard Deviation	UCL95[(a)]	EPC µg/g[(b)]	Exceed Background (Bkg)?	Retain as COPC[(c)]?	Comment
14	Silver	0	5	0	NC[(d)]	NC	NC	NC	NC	NC	NA[(e)]	No (N)	Not a COPC
14	Aluminum	5	5	100	3860	11600	7674	2840	10381	10381	N	N	
14	Arsenic	5	5	100	3.54	4.74	4.17	0.43	4.57	4.57	N	N	
14	Boron	2	5	40	5.00	9.22	5.89	1.86	7.67	7.67	Yes (Y)	Y	Not detected in Bkg.
14	Barium	5	5	100	36.60	181.0	118.0	61.93	177.0	177.0	Y	Y	
14	Beryllium	5	5	100	0.10	0.57	0.26	0.19	0.44	0.44	N	N	
14	Cadmium	1	5	20	0.03	0.41	0.15	0.15	0.29	0.29	Y	Y	
14	Cobalt	0	5	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
14	Chromium	5	5	100	10.40	101.50	31.04	39.46	68.66	68.66	Y	Y	
14	Copper	5	5	100	4.70	32.10	11.55	11.66	22.67	22.67	Y	Y	
14	Cyanide	0	5	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
14	Iron	5	5	100	9395	20200	12499	4372	16668	16668	N	N	
14	Mercury	0	5	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
14	Manganese	5	5	100	36.40	356.0	165.6	130.1	289.6	289.6	N	N	
14	Molybdenum	1	5	20	3.61	5.00	4.72	0.62	5.31	5.00	Y	Y	Not detected in Bkg.
14	Nickel	5	5	100	2.08	11.70	6.80	3.87	10.49	10.49	Y	Y	
14	Lead	5	5	100	7.85	50.30	25.64	18.33	43.11	43.11	N	N	
14	Antimony	2	5	40	0.25	0.63	0.35	0.17	0.51	0.51	Y	Y	
14	Selenium	1	5	20	0.25	0.38	0.28	0.06	0.33	0.33	Y	Y	
14	Tin	1	5	20	4.67	5.00	4.93	0.15	5.07	5.00	Y	Y	Not detected in Bkg.
14	Thallium	0	5	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
14	Vanadium	5	5	100	16.50	22.90	19.35	2.50	21.73	21.73	N	N	
14	Zinc	5	5	100	7.97	47.20	21.57	15.08	35.96	35.96	N	N	

General Note:

1.Calcium, magnesium, sodium and potassium were not included in risk assessment as they are macronutrients.

Footnotes:

(a) Upper 95% confidence limit.

(b) Exposure point concentration, micrograms per gram, equivalent to parts per million.

(c) Contaminant of potential concern.

(d) Not calculated. Not a COPC.

(e) Not applicable or not evaluated.

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TABLE 17-12

Qualitative Uncertainty Analysis
Site 14 – Yellow Sulfur Disposal Area
Jefferson Proving Ground
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
C. Chemical Toxicity				
Assumption that USEPA[(c)] reference doses truly represent toxicological thresholds	NA	Low	High	High degree of conservativeness utilized by USEPA in deriving RfDs[(d)] from toxicological literature
Assumption that USEPA carcinogenic slope factors truly represent dose-response phenomena	NA	Low-moderate	Moderate-high	Use of linearized, multi-stage mathematical model to predict cancer incidence at low exposure levels is USEPA policy; not currently supported by scientific data
Assumption of risk/hazard additivity	NA	Moderate	Moderate	Summation of chemical-specific risks/hazards may over- or under-predict risks/hazards to receptors
Screening out of certain contaminants based on USEPA criteria	NA	Low	Low	Chemicals present in concentrations less than USEPA criteria eliminated

Footnotes:
- (a) Not applicable or not available.
- (b) Contaminant of concern.
- (c) United States Environmental Protection Agency.
- (d) Reference doses.

TABLE 17.7-7

Summary of Detailed Ecological Risk Assessment
Reasonable Maximum Exposure Risk Drivers Phase I
Site 14 - Yellow Sulfur Disposal Area
Jefferson Proving Ground
Madison, Indiana

14	NOAEL [a] -Based HQs[b] Due to Soil Ingestion or Direct Contact - RME[c]			NOAEL-Based HQs Due to Dietary Ingestion - RME	Total NOAEL-Based HQs Summed Across Pathways - RME		
Parameter	**White-footed Mouse**	**Plants**	**Soil Fauna**	**White-footed Mouse**	**White-footed Mouse**	**Plants**	**Soil Fauna**
Aluminum		4.59				4.59	
Barium				3.75	4.59		
Boron				4.19	4.24		
Chromium		98.34	1229.25			98.34	1229.25
Copper		80.53	96.10	23.57	24.55	80.53	96.10
Lead	52.30			256.29	308.59		
Nickel		2240.00				2240.00	
Zinc				10.19	10.53		
HI [d]_NOAEL	**52.30**	**2423.46**	**1325.35**	**298.00**	**352.51**	**2423.46**	**1325.35**

14	LOAEL[e]-Based HQs Due to Soil Ingestion - RME	LOAEL-Based HQs Due to Dietary Ingestion - RME	Total LOAEL-Based HQs Summed Across Pathways - RME	
Parameter	**Plants**	**White-footed Mouse**	**White-footed Mouse**	**Plants**
Barium				
Boron		2.10	2.12	
Chromium	2.46			2.46
Copper	7.58			7.58
Lead		6.03	7.26	
Nickel	1120.00			1120.00
Zinc		1.70	1.76	
HI_LOAEL	**1130.04**	**9.83**	**11.13**	**1130.04**

Footnotes:
(a) NOAEL = No Observed Adverse Effect Level
(b) HQ =- Hazard Quotient
(c) RME = Reasonable Maximum Exposure
(d) HI = Hazard Index
(e) LOAEL = Lowest Observed Adverse Effect Level

TABLE 17.7-a1

Site 14 Habitat Summary

Site 14 - Yellow Sulfur Disposal Area
Date: 4/17/93; 5/27/93
Acreage: 0.5
Soils mapping unit: AvRz
Vegetation mapping unit: Infrequently mowed grass/wetland

General site conditions: "Natural area"; infrequently mowed grass; wetland adjacent; flatwoods adjacent to wetland
Slope: Slight, rolling 0-5%
Aspect: South
Drainages: Along gravel road; within wetland
Surface water/wetlands: Cattail wetland drainage
Evidence of flood/fire: Flood
Description of surrounding area: Sulfur area on ridge; slopes to south via wide channel to wetland area and to north to flow along road ditch which intercepts wetland; flatwoods to south at 20 feet past wetland

Soils
Surface layer texture: Sulfur area is yellow green; soils and dead area are yellow tan, fine material; non-contaminated area typical; eroded soil in sulfur-contaminated area
Surface color: See above

Vegetation
Ground cover description: Infrequently mowed/wetland
Species: Cattail, shrubs, trees; see Paul McMillan list; cattails upstream of sulfur, some downstream
Canopy cover: Mid-story shrubs within wetland; immature trees in wetland
Species: Red maple in drainage just west of sulfur area; adjacent flatwoods - typical; though sparse and interspersed
Successional status: Intermediate grassland/mature wetland
Vegetation condition: Adjacent areas is excellent; within contaminated zone, extremely poor to sterile

Wildlife
Habitat type: Wetland/open grassland/flatwood
Species observations: Redwing blackbird, turkey vulture; deer, crow
Sign Observations: Deer track, crayfish holes, crows; many small mammal tracks in barren soil near drainage

Remarks: Considerable ecological damage within zone of contamination; dead and stressed vegetation, contaminated soil and sediments, probable effects on aquatic organisms; zone of contamination is approx. 50-75 yards by 50 yards; pathways - surface water to vegetation and aquatic organisms; potentially deer or other terresterial animals that could drink from the contaminated zone; contamination of vegetation and potentially animals that may ingest vegetation; soil contamination (& sediment)

TABLE 17.7-9

Summary of Detailed Environmental Risk Assessment
Reasonable Maximum Exposure Risk Drivers
Interim Measures Confirmation Sampling
Site 14 - Yellow Sulfur Disposal Area
Jefferson Proving Ground
Madison, Indiana

14	NOAEL[(a)] -Based HQs[(b)] Due to Soil Ingestion or Direct Contact - RME[(c)]			NOAEL-Based HQs Due to Dietary Ingestion - RME	Total NOAEL-Based HQs Summed Across Pathways - RME		
Parameter	**White-footed Mouse**	**Plants**	**Soil Fauna**	**White-footed Mouse**	**White-footed Mouse**	**Plants**	**Soil Fauna**
Aluminum	9.06	238.63	4.77	3.33	12.39	238.63	4.77
Barium				2.96	3.62		
Boron				3.06	3.09		
Cadmium				2.14	2.16		
Chromium	2.77	85.39	1067.38	2.58	5.35	85.39	1067.38
Iron	4.16		16.01		4.57		16.01
Selenium				85.30	85.50		
Thallium	1.24				1.36		
HI [(d)]_NOAEL	**17.23**	**324.02**	**1088.16**	**99.37**	**118.05**	**324.02**	**1088.16**

14	LOAEL[(e)]-Based HQs Due to Soil Ingestion - RME			LOAEL-Based HQs Due to Dietary Ingestion - RME	Total LOAEL-Based HQs Summed Across Pathways - RME		
Parameter	**White-footed Mouse**	**Plants**	**Soil Fauna**	**White-footed Mouse**	**White-footed Mouse**	**Plants**	**Soil Fauna**
Aluminum	4.60	16.34	4.26	1.69	6.28	16.34	4.26
Boron				1.53	1.54		
Chromium		2.13				2.13	
Iron	2.08				2.28		
Selenium				5.69	5.70		
HI_LOAEL	**6.68**	**18.48**	**4.26**	**8.90**	**15.81**	**18.48**	**4.26**

Footnotes:
(a) NOAEL = No Observed Adverse Effect Level
(b) HQ =- Hazard Quotient
(c) RME = Reasonable Maximum Exposure
(d) HI = Hazard Index
(e) LOAEL = Lowest Observed Adverse Effect Level

TABLE 17.7-2

Summary of Contaminants of Potential Concern Exposure Point Concentrations by Medium Phase I
Site 14 - Yellow Sulfur Disposal Area
Jefferson Proving Ground
Madison, Indiana

	Measured Concentrations in Abiotic Media				Estimated Concentrations in Biotic Media							
Analyte Name	Filtered Surface Water (µg/L) (a)	Sediment (mg/kg) (b)	Unfiltered Surface Water (mg/L) (c)	Soil (mg/kg)	Plant (mg/kg)	Invertebrate (mg/kg)	Mouse (mg/kg)	Swift (mg/kg)	Aquatic Plants (mg/kg)	Benthic Invertebrate (mg/kg)	Fish (mg/kg)	Frogs (mg/kg)
Aluminum		18100			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic		10.61			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Barium		688		229	3.37E+01	8.25E+00	4.09E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beryllium		1.00		0.49	1.96E-03	5.39E-03	1.35E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Boron				7.0	2.80E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium		87.9			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt		9.26		4.73	8.51E-02	1.66E-01	2.20E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper		59.29		492	4.87E+01	4.33E+02	3.76E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Iron		29600			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead		110		8053	1.05E+03	5.64E+02	7.73E-01	4.20E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Manganese		240			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel		16.40		12.14	5.34E-01	6.07E-01	2.44E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Silver		0.37		0.094	4.51E-03	1.13E-02	8.11E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sulfur		3300		56000	8.40E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Vanadium		32.50			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc		118.00		750	4.12E+02	4.95E+02	3.05E+01	5.73E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Footnotes:

(a) Micrograms per liter, equivalent to parts per billion.

(b) Milligrams per kilogram, equivalent to parts per million.

(c) Milligrams per liter, equivalent to parts per million.

TABLE 17.7-11

Summary of Detailed Environmental Risk Assessment Reasonable Maximum Exposure Risk Drivers
Site 14/15 - Phase III
Jefferson Proving Ground
Madison, Indiana

14/15	NOAEL[a]-Based HQs[b] Due to Soil Ingestion or Direct Contact - RME[c]			NOAEL-Based HQs Due to Dietary Ingestion - RME		Total NOAEL-Based HQs Summed Across Pathways - RME			
Parameter	**White-footed Mouse**	**Plants**	**Soil Fauna**	**White-footed Mouse**	**Eastern Cottontail**	**White-footed Mouse**	**Eastern Cottontail**	**Plants**	**Soil Fauna**
Barium				2.90		3.54			
Boron				4.59		4.64			
Cadmium				1.52		1.54			
Chromium		13.73	171.65					13.73	171.65
Copper				1.09		1.13			
Molybdenum				2.65		3.09			
Selenium				95.68	1.86	95.91	1.87		
Tin	7.73			5.68		13.42			
HI[d]_NOAEL	**7.73**	**13.73**	**171.7**	**114.12**	**1.86**	**123.3**	**1.87**	**13.73**	**171.7**

14/15	LOAEL[e]-Based HQs Due to Dietary Ingestion - RME	Total LOAEL-Based HQs Summed Across Pathways - RME
Parameter	**White-footed Mouse**	**White-footed Mouse**
Boron	2.30	2.32
Selenium	6.38	6.39
HI_LOAEL	**8.68**	**8.71**

Footnotes:

(a) NOAEL = No Observed Adverse Effect Level

(b) HQ =- Hazard Quotient

(c) RME = Reasonable Maximum Exposure

(d) HI = Hazard Index

(e) LOAEL = Lowest Observed Adverse Effect Level

TABLE 17.7-4

Summary of Contaminants of Potential Concern Exposure Point Concentrations by Medium
Interim Measures Confirmation Sampling Data
Site 14 - Yellow Sulfur Disposal Area
Jefferson Proving Ground
Madison, Indiana

	Measured Concentrations in Abiotic Media				Estimated Concentrations in Biotic Media							
Analyte Name	**Filtered Surface Water (µg/L)** [(a)]	**Sediment (mg/kg)** [(b)]	**Unfiltered Surface Water (mg/L)** [(c)]	**Soil (mg/kg)**	**Plant (mg/kg)**	**Invertebrate (mg/kg)**	**Mouse (mg/kg)**	**Swift (mg/kg)**	**Aquatic Plants (mg/kg)**	**Benthic Invertebrate (mg/kg)**	**Fish (mg/kg)**	**Frogs (mg/kg)**
Aluminum				11932	4.77E+01	1.31E+02	3.28E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Barium				180.8	2.66E+01	6.51E+00	3.23E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Boron				5.10	2.04E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium				0.41	1.63E-01	1.52E+00	2.04E-03	3.13E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium				427.0	5.12E+00	1.11E+01	8.33E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper				15.06	1.49E+00	1.32E+01	1.15E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Iron				16007	6.40E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel				7.49	3.30E-01	3.75E-01	1.51E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Selenium				0.29	2.79E+00	2.31E+00	5.33E-01	3.04E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sulfur				8400	1.26E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium				4.77	1.91E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Footnotes:

(a) Micrograms per liter, equivalent to parts per billion.

(b) Milligrams per kilogram, equivalent to parts per million.

(c) Milligrams per liter, equivalent to parts per million.

TABLE 17-1

Background Screening of Inorganic Chemicals Detected in Groundwater
Site 14 – Yellow Sulfur Disposal Area
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Maximum Detected Value (µg/L)[b]	Groundwater Background Screening Value[c] (µg/L)	Exceeds Groundwater Background?
Aluminum, Total	3/3	104.2	553	No
Arsenic, Total	3/3	34.1	2.60	**YES**
Barium, Total	3/3	494.8	509.3	No
Beryllium, Total	1/3	1.18	0.33	**YES**
Boron, Total	3/3	42.3	140	No
Chromium, Total	2/3	4.1	6.24	No
Cobalt, Total	1/3	8.53	ND[d]	**YES**
Lead, Total	1/3	1.7	1.71	No
Manganese, Total	3/3	290	290	No
Molybdenum, Total	1/3	34.8	9.67	**YES**
Selenium, Total	1/3	3.12	ND	**YES**
Vanadium, Total	1/3	3.81	2.89	**YES**
Zinc, Total	2/3	5.36	ND	**YES**

Footnotes:

(a) Number of locations in which the analyte was detected/total number of locations sampled. The three downgradient wells at this site (M93-24, MW93-25, and MW93-26) were used in the background screening analysis.
(b) Micrograms per liter.
(c) See Section 5.1.4.5.1 for an explanation of how the groundwater background screening values were calculated.
(d) Not detected.

TABLE 17-2

Background Screening of Inorganic Chemicals Detected in Sediment/Surface Water Drainage Pathway
Site 14 – Yellow Sulfur Disposal Area
Jefferson Proving Ground
Madison, Indiana

Chemical	Location	Frequency of Detection[a]	Maximum Detected Value (µg/g)[b]	Average Conc (µg/g)	Median Conc (µg/g)	Background Threshold (µg/g)	Data Distribution	Test Performed	p value	Site > Background?
Arsenic	Site	4/4	11.6	6.8	5.4		Lognormal	t test	0.29[c]	No
	Background	**6/6**	**11.0**	**6.1**	**5.7**	**13.7**	**Lognormal**			

Footnotes:

(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Micrograms per gram.
(c) The 95 percent confidence limit on the difference between the means of the log-transformed values is -0.7 to 1.2.

TABLE 17.7-6

Summary of Contaminants of Potential Concern Exposure Point Concentrations by Medium
Eco Site 14/15 - Phase III
Jefferson Proving Ground
Madison, Indiana

	Measured Concentrations in Abiotic Media				Estimated Concentrations in Biotic Media							
Analyte Name	Filtered Surface Water (µg/L) (a)	Sediment (mg/kg) (b)	Unfiltered Surface Water (mg/L) (c)	Soil (mg/kg)	Plant (mg/kg)	Invertebrate (mg/kg)	Mouse (mg/kg)	Swift (mg/kg)	Aquatic Plants (mg/kg)	Benthic Invertebrate (mg/kg)	Fish (mg/kg)	Frogs (mg/kg)
Antimony				0.51	1.34E-01	9.74E-02	1.17E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Barium				177.0	2.60E+01	6.37E+00	3.16E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Boron				7.67	3.07E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium				0.29	1.16E-01	1.08E+00	1.45E-03	2.22E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium				68.66	8.24E-01	1.79E+00	1.34E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper				22.67	2.24E+00	1.99E+01	1.73E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Molybdenum				5.00	1.25E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel				10.49	4.62E-01	5.25E-01	2.11E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Selenium				0.33	3.13E+00	2.59E+00	5.98E-01	3.41E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tin				5.00	1.50E-01	0.00E+00	1.70E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Footnotes:

(a) Micrograms per liter, equivalent to parts per billion.

(b) Milligrams per kilogram, equivalent to parts per million.

(c) Milligrams per liter, equivalent to parts per million.

TABLE 17-3

Analytical Results for Metals in Soil Samples
Site 14 – Yellow Sulfur Disposal Area
Jefferson Proving Ground
Madison, Indiana

Sample ID Sample No. Depth (feet) Sample Date Analyte	YSA14BHA 01 0.5 11/7/92	YSA14BHA 02 4.5 11/7/92	YSA14BHA 03 9.5 11/7/92	YSA14BHB 01 0.6 11/7/92	YSA14BHB 02 4.6 11/7/92	YSA14BHB 03 9.6 11/7/92	YSA14BHC 01 0.6 11/7/92	YSA14BHC 02 4.6 11/7/92	YSA14BHC 03 9.6 11/7/92	Background (µg/g)[(a)]
Aluminum	7,410	16,800	19,200	2,880	14,500	28,500	12,500	10,900	17,600	16,600
Antimony	LT[(b)] 19.6	LT 19.6	LT 19.6	LT 19.6	LT 19.6	LT 19.6	LT 19.6	LT 19.6	LT 19.6	0.44
Arsenic	3.60	3.10	4.46	3.44	30.3	15.4	12.8	7.01	4.40	6.30
Barium	66.0	119	295	74.3	202	115	190	47.5	269	95.0
Beryllium	LT 0.427	0.984	0.977	LT 0.427	1.49	1.16	LT 0.427	LT 0.427	0.614	0.48
Boron	LT 6.64	LT 6.64	LT 6.64	LT 6.64	LT 6.64	LT 6.64	LT 6.64	LT 6.64	9.70	0
Cadmium	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	0
Calcium	352	807	6,010	215	405	6,140	16,200	717	46,100	588
Chromium	80.4	20.2	25.3	6.79	37.9	32.3	35.2	412	21.2	18.0
Cobalt	LT 2.50	10.8	12.2	LT 2.50	15.4	14.1	5.43	3.17	12.4	5.60
Copper	59.0	11.7	25.6	164	54.0	32.1	101	63.2	23.1	5.71
Iron	22,900	22,300	38,100	2,020	85,000	58,200	31,400	19,800	22,900	11,800
Lead	9.16	11.6	6.92	11.3	20.6	20.6	85.0	7.64	8.37	16.2
Magnesium	674	2,250	3,010	305	1,350	2,820	5,440	701	16,100	1,000
Manganese	89.0	316	1,400	23.7	471	621	484	83.5	1,300	718
Mercury	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	0
Molybdenum	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	0
Nickel	4.64	17.6	23.6	2.74	29.2	32.3	18.7	5.48	21.1	6.31
pH	2.5	4	7.6	1.4	3.7	6.9	6.4	3.5	6.5	NA[(b)]
Potassium	350	658	1,580	369	580	1,540	529	397	1,840	2,360
Selenium	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	1.21
Silver	0.0379	0.0259	0.0313	0.0298	0.0216	0.0319	0.0541	0.0447	0.0310	0
Sodium	116	104	76.8	LT 38.7	LT 38.7	77.0	LT 38.7	LT 38.7	128	377
Thallium	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	0
Tin	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	0
Total Sulfur	0.23	LT 0.1	LT 0.1	0.298	0.306	LT 0.1	0.29	0.193	LT 0.1	NA
Vanadium	22.6	20.8	40.7	7.90	55.4	46.4	25.1	23.1	29.2	31.7
Zinc	41.6	50.1	70.4	90.1	84.9	77.7	102	92.6	63.3	23.9

TABLE 17-3

Analytical Results for Metals in Soil Samples
Site 14 – Yellow Sulfur Disposal Area
Jefferson Proving Ground
Madison, Indiana

Sample ID Sample No. Depth (feet) Sample Date Analyte	YSA14BHD 01 0.3 11/7/92	YSA14BHD 02 4.6 11/7/92	YSA14BHD 03 9.6 11/7/92	YSA14BHE 01 0.6 11/8/92	YSA14BHE 02 3.3 11/8/92	YSA14BHE 03 4.6 11/8/92	YSA14BHE 04 9.6 11/8/92	YSA14BHF 01 0.6 11/8/92	YSA14BHF 02 4.6 11/8/92	YSA14BHF 03 9.6 11/8/92	Background (µg/g)
Aluminum	4,440	29,100	17,300	1,220	10,600	16,800	28,900	19,100	17,000	20,900	16,600
Antimony	LT 19.6	LT 19.6	LT 19.6	LT 19.6	LT 19.6	LT 19.6	LT 19.6	LT 19.6	LT 19.6	LT 19.6	0.44
Arsenic	LT 2.50	LT 2.50	11.6	LT 2.50	110	3.85	3.55	22.1	5.98	7.00	6.30
Barium	147	72.7	145	326	128	84.4	90.4	72.0	100	252	95.0
Beryllium	LT 0.427	LT 0.427	0.871	LT 0.427	LT 0.427	LT 0.427	1.30	0.769	1.58	0.817	0.48
Boron	10.6	LT 6.64	LT 6.64	LT 6.64	LT 6.64	LT 6.64	LT 6.64	LT 6.64	LT 6.64	8.43	0
Cadmium	LT 1.20	LT 1.20	LT 1.20	LT 1.20	4.44	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	0
Calcium	73,000	467	76,000	43,900	5,300	305	1,750	3,150	2,330	21,000	588
Chromium	17.1	411	38.7	6.41	434	1,300	93.1	24.8	12.7	24.0	18.0
Cobalt	LT 2.50	4.50	12.2	LT 2.50	31.5	3.09	10.8	6.21	15.5	12.3	5.60
Copper	339	13.5	38.1	807	585	34.4	28.6	23.6	12.3	21.6	5.71
Iron	3,360	18,800	44,700	873	180,000	22,800	29,500	39,400	120,000	23,300	11,800
Lead	6.99	11.2	10.0	16,000	280	15.2	7.67	16.7	19.2	7.71	16.2
Magnesium	2,410	1,930	15,300	335	733	1,060	3,340	2,180	1,740	10,800	1,000
Manganese	37.5	59.6	769	15.2	218	66.5	217	301	165	1,030	718
Mercury	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	0
Molybdenum	LT 14.3	LT 14.3	LT 14.3	LT 14.3	51.9	LT 14.3	LT 14.3	LT 14.3	21.8	LT 14.3	0
Nickel	3.64	9.99	22.8	2.74	146	7.30	22.0	10.0	14.0	20.5	6.31
pH	1.7	3.6	7.9	1.4	4.9	3.2	4	3.5	7.5	6.8	
Potassium	693	660	1,680	292	387	588	1,740	718	268	1,890	2,360
Selenium	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	1.21
Silver	0.0497	0.0409	0.0273	0.159	0.406	0.0364	0.0213	0.0407	0.0374	0.0124	0
Sodium	84.6	93.1	155	55.4	LT 38.7	LT 38.7	115	56.1	65.4	121	377
Thallium	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	0
Tin	LT 7.43	LT 7.43	LT 7.43	LT 7.43	24.7	10.6	LT 7.43	LT 7.43	LT 7.43	LT 7.43	0
Total Sulfur	9.63	0.382	LT 0.1	4.56	21.4	0.203	0.331	LT 0.1	LT 0.1	LT 0.1	NA
Vanadium	9.08	28.4	39.8	2.34	36.9	50.9	32.7	40.5	32.9	31.7	31.7
Zinc	1,170	35.8	75.0	714	11,000	38.6	77.3	40.0	38.1	58.7	23.9

Note:
Units for total sulfur are in percent; pH results are in pH units.

Footnotes:
(a) Micrograms per gram.
(b) Less than the reporting limit.
(c) Not available.

TABLE 17.7-8

Summary of Detailed Environmental Risk Assessment Phase I
Central Tendency Risk Drivers
Site 14 - Yellow Sulfur Disposal Area
Jefferson Proving Ground
Madison, Indiana

14	NOAEL [a] - Based HQs[b] Due to Soil Ingestion or Direct Contact - CT[c]	NOAEL[a]-Based HQs[b] Due to Dietary Ingestion - CT[c]	Total NOAEL-Based HQs Summed Across Pathways - CT
Parameter	**White-footed Mouse**	**White-footed Mouse**	**White-footed Mouse**
Barium		1.72	2.11
Boron		1.93	1.95
Copper		10.82	11.27
Lead	24.02	117.69	141.71
Zinc		4.68	4.84
HI [d]_NOAEL	**24.02**	**136.85**	**161.88**

14	LOAEL[e]-Based HQs Due to Dietary Ingestion - CT	Total LOAEL-Based HQs Summed Across Pathways - CT
Parameter	**White-footed Mouse**	**White-footed Mouse**
Lead	2.77	3.33
HI_LOAEL	**2.77**	**3.33**

Footnotes:

(a) NOAEL = No Observed Adverse Effect Level

(b) HQ =- Hazard Quotient

(c) CT = Central Tendency

(d) HI = Hazard Index

(e) LOAEL = Lowest Observed Adverse Effect Level

TABLE 17-4

Analytical Results for Metals in Groundwater Samples
Site 14 – Yellow Sulfur Area
Jefferson Proving Ground
Madison, Indiana

Analyte	WELL ID: SAMPLE ID: Sampling Round*	MW93-24 YSA14GWA (µg/L)[(a)]	MW93-25 YSA14GWB (µg/L)	MW93-26 YSA14GWC (µg/L)	MW95-3 YSA14GWD (µg/L)
Aluminum	1	957	LT[(b)] 112	LT 112	NA[(c)]
	2	11,800	LT 200	58.0	190
	3	5,480	LT 200	LT 200	LT 200
	4	4,760	62.5	37.7	26.8
	5	1,070	57.8	LT 200	LT 200
Arsenic	1	3.39	21.1	4.99	NA
	2	4.50	31.5	8.36	16.1
	3	4.81	35.8	8.25	16.3
	4	6.44	39.2	12.4	21.6
	5	5.20	35.7	10.1	18.8
Antimony	1	LT 60.0	LT 60.0	LT 60.0	NA
	2	LT 10.0	LT 10.0	LT 10.0	LT 10.0
	3	ND 10.0	ND 10.0	ND 10.0	ND[(d)] 10.0
	4	LT 10.0	LT 10.0	LT 10.0	LT 10.0
	5	LT 10.0	LT 10.0	LT 10.0	LT 10.0
Barium	1	474	433	548	NA
	2	546	490	508	479
	3	626	494	491	485
	4	566	469	497	487
	5	523	468	483	489
Beryllium	1	LT 1.12	LT 1.12	LT 1.12	NA
	2	LT 5.00	LT 5.00	LT 5.00	LT 5.00
	3	LT 5.00	LT 5.00	LT 5.00	LT 5.00
	4	5.00	LT 5.00	LT 5.00	LT 5.00
	5	LT 5.00	LT 5.00	LT 5.00	LT 5.00
Boron	1	LT 230	LT 230	LT 230	NA
	2	52.0	45.0	35.0	33.0
	3	40.6	31.0	LT 100	LT 100
	4	60.7	48.1	37.0	49.0
	5	100	100	100	100
Cadmium	1	LT 6.78	LT 6.78	LT 6.78	NA
	2	LT 5.00	LT 5.00	LT 5.00	5.00
	3	LT 5.00	LT 5.00	LT 5.00	LT 5.00
	4	LT 5.00	LT 5.00	LT 5.00	LT 5.00
	5	LT 5.00	LT 5.00	LT 5.00	LT 5.00

TABLE 17-4

Analytical Results for Metals in Groundwater Samples
Site 14 – Yellow Sulfur Area
Jefferson Proving Ground
Madison, Indiana

Analyte	WELL ID: SAMPLE ID: Sampling Round*	MW93-24 YSA14GWA (µg/L)[(a)]	MW93-25 YSA14GWB (µg/L)	MW93-26 YSA14GWC (µg/L)	MW95-3 YSA14GWD (µg/L)
Calcium	1	87,200	91,200	104,000	NA
	2	86,600	91,300	96,200	100,000
	3	86,000	89,600	92,500	96,500
	4	93,600	85,800	91,900	94,300
	5	84,500	87,100	91,700	96,600
Chromium	1	LT 16.8	LT 16.8	LT 16.8	NA
	2	LT 10.0	LT 10.0	4.10	LT 10.0
	3	LT 10.0	LT 10.0	LT 10.0	LT 10.0
	4	LT 10.0	LT 10.0	LT 10.0	LT 10.0
	5	LT 10.0	10.0	10.0	10.0
Cobalt	1	LT 25.0	LT 25.0	LT 25.0	NA
	2	LT 50.0	LT 50.0	LT 50.0	LT 50.0
	3	LT 50.0	LT 50.0	LT 50.0	LT 50.0
	4	LT 50.0	LT 50.0	LT 50.0	8.53
	5	6.03	LT 50.0	LT 50.0	LT 50.0
Copper	1	LT 18.8	LT 18.8	LT 18.8	NA
	2	LT 20.0	LT 20.0	LT 20.0	LT 20.0
	3	2.58	LT 20.0	LT 20.0	LT 20.0
	4	LT 20.0	LT 20.0	LT 20.0	LT 20.0
	5	LT 20.0	LT 20.0	LT 20.0	LT 20.0
Iron	1	2,150	1,490	2,140	NA
	2	130	2,440	1,400	1,700
	3	5,030	2,100	888	1,360
	4	3,690	1,950	1,270	1,510
	5	1,070	2,320	1,240	1,720
Lead	1	LT 4.47	LT 4.47	LT 4.47	NA
	2	LT 3.00	LT 3.00	3.00	LT 3.00
	3	1.77	ND 3.00	ND 3.00	ND 3.00
	4	4.26	LT 3.33	LT 3.33	LT 3.33
	5	LT 3.00	LT 3.00	2.12	LT 3.00
Magnesium	1	36,600	32,100	37,200	NA
	2	36,400	31,900	34,900	35,700
	3	37,300	31,800	33,800	34,600
	4	37,700	30,500	34,000	34,400
	5	36,600	31,200	33,900	35,200

TABLE 17-4

Analytical Results for Metals in Groundwater Samples
Site 14 – Yellow Sulfur Area
Jefferson Proving Ground
Madison, Indiana

Analyte	WELL ID: SAMPLE ID: Sampling Round*	MW93-24 YSA14GWA (µg/L)[a]	MW93-25 YSA14GWB (µg/L)	MW93-26 YSA14GWC (µg/L)	MW95-3 YSA14GWD (µg/L)
Manganese	1	663	354	442	NA
	2	459	185	290	213
	3	526	136	292	194
	4	192	104	298	146
	5	260	109	280	165
Mercury	1	LT 0.10	LT 0.10	LT 0.10	NA
	2	LT 0.20	LT 0.20	LT 0.20	LT 0.20
	3	LT 0.20	LT 0.20	LT 0.20	LT 0.20
	4	0.058	LT 0.20	LT 0.20	LT 0.20
	5	LT 0.20	LT 0.20	LT 0.20	LT 0.20
Molybdenum	1	LT 52.7	LT 52.7	LT 52.7	NA
	2	LT 100	LT 100	LT 100	LT 100
	3	LT 100	LT 100	LT 100	LT 100
	4	LT 100	LT 100	LT 100	LT 100
	5	LT 100	LT 100	LT 100	LT 100
Nickel	1	LT 32.1	LT 32.1	LT 32.1	NA
	2	LT 40.0	LT 40.0	LT 40.0	LT 40.0
	3	LT 40.0	LT 40.0	LT 40.0	LT 40.0
	4	LT 40.0	LT 40.0	LT 40.0	LT 40.0
	5	8.71	LT 40.0	LT 40.0	LT 40.0
Potassium	1	1,330	LT 1,240	LT 1,240	NA
	2	870	450	690	870
	3	3,000	3,000	3,000	472
	4	1,700	3,000	3,000	3,000
	5	3,000	LT 3,000	LT 3,000	3,000
Selenium	1	LT 2.53	LT 2.53	LT 2.53	NA
	2	LT 5.00	LT 5.00	LT 5.00	LT 5.00
	3	ND 5.00	ND 5.00	ND 5.00	ND 5.00
	4	LT 5.56	LT 5.56	LT 5.56	LT 5.56
	5	LT 5.00	LT 5.00	LT 5.00	LT 5.00
Silver	1	LT 0.333	LT 0.333	LT 0.333	NA
	2	LT 10.0	LT 10.0	LT 10.0	LT 10.0
	3	LT 10.0	LT 10.0	LT 10.0	LT 10.0
	4	LT 10.0	LT 10.0	LT 10.0	LT 10.0
	5	LT 10.0	LT 10.0	LT 10.0	LT 10.0

TABLE 17-4

Analytical Results for Metals in Groundwater Samples
Site 14 – Yellow Sulfur Area
Jefferson Proving Ground
Madison, Indiana

Analyte	WELL ID: SAMPLE ID: Sampling Round*	MW93-24 YSA14GWA (µg/L)[a]	MW93-25 YSA14GWB (µg/L)	MW93-26 YSA14GWC (µg/L)	MW95-3 YSA14GWD (µg/L)
Sodium	1	36,400	36,800	52,500	NA
	2	34,400	37,800	49,600	49,300
	3	35,700	39,500	49,300	49,300
	4	36,700	37,300	49,400	48,100
	5	35,400	37,000	48,100	48,200
Thallium	1	LT 125	LT 125	LT 125	NA
	2	LT 10.0	LT 10.0	LT 10.0	LT 10.0
	3	ND 10.0	ND 10.0	ND 10.0	ND 10.0
	4	LT 11.1	LT 11.1	LT 11.1	LT 11.1
	5	LT 10.0	LT 10.0	10.0	LT 10.0
Tin	1	LT 59.9	LT 59.9	LT 59.9	NA
	2	LT 100	LT 100	LT 100	LT 100
	3	100	LT 100	LT 100	LT 100
	4	LT 100	LT 100	LT 100	LT 100
	5	LT 100	LT 100	LT 100	LT 100
Vanadium	1	LT 27.6	LT 27.6	LT 27.6	NA
	2	LT 50.0	LT 50.0	LT 50.0	LT 50.0
	3	50.0	LT 50.0	LT 50.0	LT 50.0
	4	50.0	4.70	LT 50.0	50.0
	5	LT 50.0	LT 50.0	LT 50.0	LT 50.0
Zinc	1	LT 18.0	33.0	LT 18.0	NA
	2	LT 20.0	LT 20.0	LT 20.0	LT 20.0
	3	15.1	6.79	LT 20.0	3.85
	4	8.26	LT 20.0	LT 20.0	LT 20.0
	5	LT 20.0	LT 20.0	LT 20.0	LT 20.0

Notes:
*Round 1: 06/16/93;
Round 2 : 11/03-17/95;
Round 3: 02/13-20/96;
Round 4: 04/25-05/10/96;
Round 5: 06/20-27/96.

Footnotes:
(a) Micrograms per liter.
(b) Less than the reporting limit. Reporting limit follows LT.
(c) Not applicable.
(d) Not detected. Detection limit follows ND.

TABLE 17.7-10

Summary of Detailed Risk Assessment Central Tendencies Risk Drivers
Interim Measures Confirmation Sampling
Site 14 - Yellow Sulfur Disposal Area
Jefferson Proving Ground
Madison, Indiana

14	NOAEL[a]-Based HQs[b] Due to Soil Ingestion - CT[c]	NOAEL-Based HQs Due to Dietary Ingestion - CT	Total NOAEL-Based HQs Summed Across Pathways - CT
Parameter	**White-footed Mouse**	**White-footed Mouse**	**White-footed Mouse**
Aluminum	4.16	1.53	5.69
Barium		1.36	1.66
Boron		1.40	1.42
Chromium	1.27	1.19	2.46
Iron	1.91		2.10
Selenium		39.17	39.26
HI[d]_NOAEL	**7.35**	**44.65**	**52.59**

14	LOAEL[e]-Based HQs Due to Soil Ingestion - CT	LOAEL-Based HQs Due to Dietary Ingestion - CT	Total LOAEL-Based HQs Summed Across Pathways - CT
Parameter	**White-footed Mouse**	**White-footed Mouse**	**White-footed Mouse**
Aluminum	2.11		2.89
Iron			1.05
Selenium		2.61	2.62
HI_LOAEL	**2.11**	**2.61**	**6.55**

Footnotes:
(a) NOAEL = No Observed Adverse Effect Level
(b) HQ =- Hazard Quotient
(c) RME = Reasonable Maximum Exposure
(d) HI = Hazard Index
(e) LOAEL = Lowest Observed Adverse Effect Level

TABLE 17-4

Analytical Results for Metals in Groundwater Samples
Site 14 – Yellow Sulfur Area
Jefferson Proving Ground
Madison, Indiana

Analyte	WELL ID: SAMPLE ID: Sampling Round*	MW93-24 YSA14GWA (µg/L)[a]	MW93-25 YSA14GWB (µg/L)	MW93-26 YSA14GWC (µg/L)	MW95-3 YSA14GWD (µg/L)
Calcium	1	87,200	91,200	104,000	NA
	2	86,600	91,300	96,200	100,000
	3	86,000	89,600	92,500	96,500
	4	93,600	85,800	91,900	94,300
	5	84,500	87,100	91,700	96,600
Chromium	1	LT 16.8	LT 16.8	LT 16.8	NA
	2	LT 10.0	LT 10.0	4.10	LT 10.0
	3	LT 10.0	LT 10.0	LT 10.0	LT 10.0
	4	LT 10.0	LT 10.0	LT 10.0	LT 10.0
	5	LT 10.0	10.0	10.0	10.0
Cobalt	1	LT 25.0	LT 25.0	LT 25.0	NA
	2	LT 50.0	LT 50.0	LT 50.0	LT 50.0
	3	LT 50.0	LT 50.0	LT 50.0	LT 50.0
	4	LT 50.0	LT 50.0	LT 50.0	8.53
	5	6.03	LT 50.0	LT 50.0	LT 50.0
Copper	1	LT 18.8	LT 18.8	LT 18.8	NA
	2	LT 20.0	LT 20.0	LT 20.0	LT 20.0
	3	2.58	LT 20.0	LT 20.0	LT 20.0
	4	LT 20.0	LT 20.0	LT 20.0	LT 20.0
	5	LT 20.0	LT 20.0	LT 20.0	LT 20.0
Iron	1	2,150	1,490	2,140	NA
	2	130	2,440	1,400	1,700
	3	5,030	2,100	888	1,360
	4	3,690	1,950	1,270	1,510
	5	1,070	2,320	1,240	1,720
Lead	1	LT 4.47	LT 4.47	LT 4.47	NA
	2	LT 3.00	LT 3.00	3.00	LT 3.00
	3	1.77	ND 3.00	ND 3.00	ND 3.00
	4	4.26	LT 3.33	LT 3.33	LT 3.33
	5	LT 3.00	LT 3.00	2.12	LT 3.00
Magnesium	1	36,600	32,100	37,200	NA
	2	36,400	31,900	34,900	35,700
	3	37,300	31,800	33,800	34,600
	4	37,700	30,500	34,000	34,400
	5	36,600	31,200	33,900	35,200

TABLE 17-4

Analytical Results for Metals in Groundwater Samples
Site 14 – Yellow Sulfur Area
Jefferson Proving Ground
Madison, Indiana

Analyte	WELL ID: SAMPLE ID: Sampling Round*	MW93-24 YSA14GWA (µg/L)[a]	MW93-25 YSA14GWB (µg/L)	MW93-26 YSA14GWC (µg/L)	MW95-3 YSA14GWD (µg/L)
Manganese	1	663	354	442	NA
	2	459	185	290	213
	3	526	136	292	194
	4	192	104	298	146
	5	260	109	280	165
Mercury	1	LT 0.10	LT 0.10	LT 0.10	NA
	2	LT 0.20	LT 0.20	LT 0.20	LT 0.20
	3	LT 0.20	LT 0.20	LT 0.20	LT 0.20
	4	0.058	LT 0.20	LT 0.20	LT 0.20
	5	LT 0.20	LT 0.20	LT 0.20	LT 0.20
Molybdenum	1	LT 52.7	LT 52.7	LT 52.7	NA
	2	LT 100	LT 100	LT 100	LT 100
	3	LT 100	LT 100	LT 100	LT 100
	4	LT 100	LT 100	LT 100	LT 100
	5	LT 100	LT 100	LT 100	LT 100
Nickel	1	LT 32.1	LT 32.1	LT 32.1	NA
	2	LT 40.0	LT 40.0	LT 40.0	LT 40.0
	3	LT 40.0	LT 40.0	LT 40.0	LT 40.0
	4	LT 40.0	LT 40.0	LT 40.0	LT 40.0
	5	8.71	LT 40.0	LT 40.0	LT 40.0
Potassium	1	1,330	LT 1,240	LT 1,240	NA
	2	870	450	690	870
	3	3,000	3,000	3,000	472
	4	1,700	3,000	3,000	3,000
	5	3,000	LT 3,000	LT 3,000	3,000
Selenium	1	LT 2.53	LT 2.53	LT 2.53	NA
	2	LT 5.00	LT 5.00	LT 5.00	LT 5.00
	3	ND 5.00	ND 5.00	ND 5.00	ND 5.00
	4	LT 5.56	LT 5.56	LT 5.56	LT 5.56
	5	LT 5.00	LT 5.00	LT 5.00	LT 5.00
Silver	1	LT 0.333	LT 0.333	LT 0.333	NA
	2	LT 10.0	LT 10.0	LT 10.0	LT 10.0
	3	LT 10.0	LT 10.0	LT 10.0	LT 10.0
	4	LT 10.0	LT 10.0	LT 10.0	LT 10.0
	5	LT 10.0	LT 10.0	LT 10.0	LT 10.0

TABLE 17-4

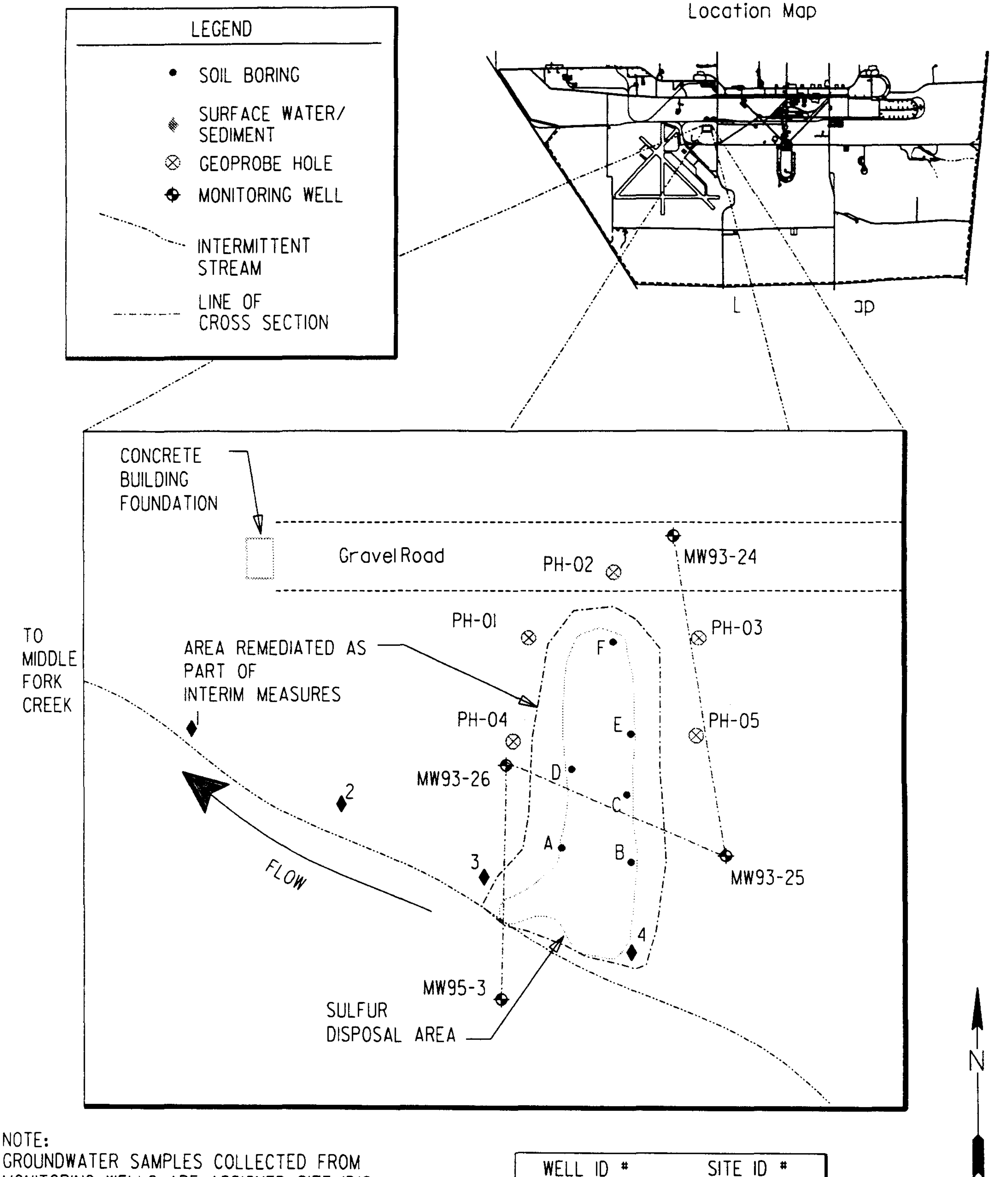
Analytical Results for Metals in Groundwater Samples
Site 14 – Yellow Sulfur Area
Jefferson Proving Ground
Madison, Indiana

Analyte	WELL ID: SAMPLE ID: Sampling Round*	MW93-24 YSA14GWA (µg/L)[(a)]	MW93-25 YSA14GWB (µg/L)	MW93-26 YSA14GWC (µg/L)	MW95-3 YSA14GWD (µg/L)
Sodium	1	36,400	36,800	52,500	NA
	2	34,400	37,800	49,600	49,300
	3	35,700	39,500	49,300	49,300
	4	36,700	37,300	49,400	48,100
	5	35,400	37,000	48,100	48,200
Thallium	1	LT 125	LT 125	LT 125	NA
	2	LT 10.0	LT 10.0	LT 10.0	LT 10.0
	3	ND 10.0	ND 10.0	ND 10.0	ND 10.0
	4	LT 11.1	LT 11.1	LT 11.1	LT 11.1
	5	LT 10.0	LT 10.0	10.0	LT 10.0
Tin	1	LT 59.9	LT 59.9	LT 59.9	NA
	2	LT 100	LT 100	LT 100	LT 100
	3	100	LT 100	LT 100	LT 100
	4	LT 100	LT 100	LT 100	LT 100
	5	LT 100	LT 100	LT 100	LT 100
Vanadium	1	LT 27.6	LT 27.6	LT 27.6	NA
	2	LT 50.0	LT 50.0	LT 50.0	LT 50.0
	3	50.0	LT 50.0	LT 50.0	LT 50.0
	4	50.0	4.70	LT 50.0	50.0
	5	LT 50.0	LT 50.0	LT 50.0	LT 50.0
Zinc	1	LT 18.0	33.0	LT 18.0	NA
	2	LT 20.0	LT 20.0	LT 20.0	LT 20.0
	3	15.1	6.79	LT 20.0	3.85
	4	8.26	LT 20.0	LT 20.0	LT 20.0
	5	LT 20.0	LT 20.0	LT 20.0	LT 20.0

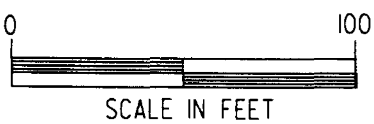
Notes:
*Round 1: 06/16/93;
Round 2 : 11/03-17/95;
Round 3: 02/13-20/96;
Round 4: 04/25-05/10/96;
Round 5: 06/20-27/96.

Footnotes:
(a) Micrograms per liter.
(b) Less than the reporting limit. Reporting limit follows LT.
(c) Not applicable.
(d) Not detected. Detection limit follows ND.

FIGURES



* NOTE:
GROUNDWATER SAMPLES COLLECTED FROM MONITORING WELLS ARE ASSIGNED SITE ID'S THAT ARE LISTED IN THE DATA TABLES. SITE ID DESIGNATION IS EXPLAINED IN SEC. 3.3.1.



WELL ID *	SITE ID *
MW93-24	YSA14GWA
MW93-25	YSA14GWB
MW93-26	YSA14GWC
MW95-3	YSA14GWD

* SEE NOTE

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JPG16.DGN

Figure 17-1. Sampling Locations at the Yellow Sulfur Disposal Area (Site 14)

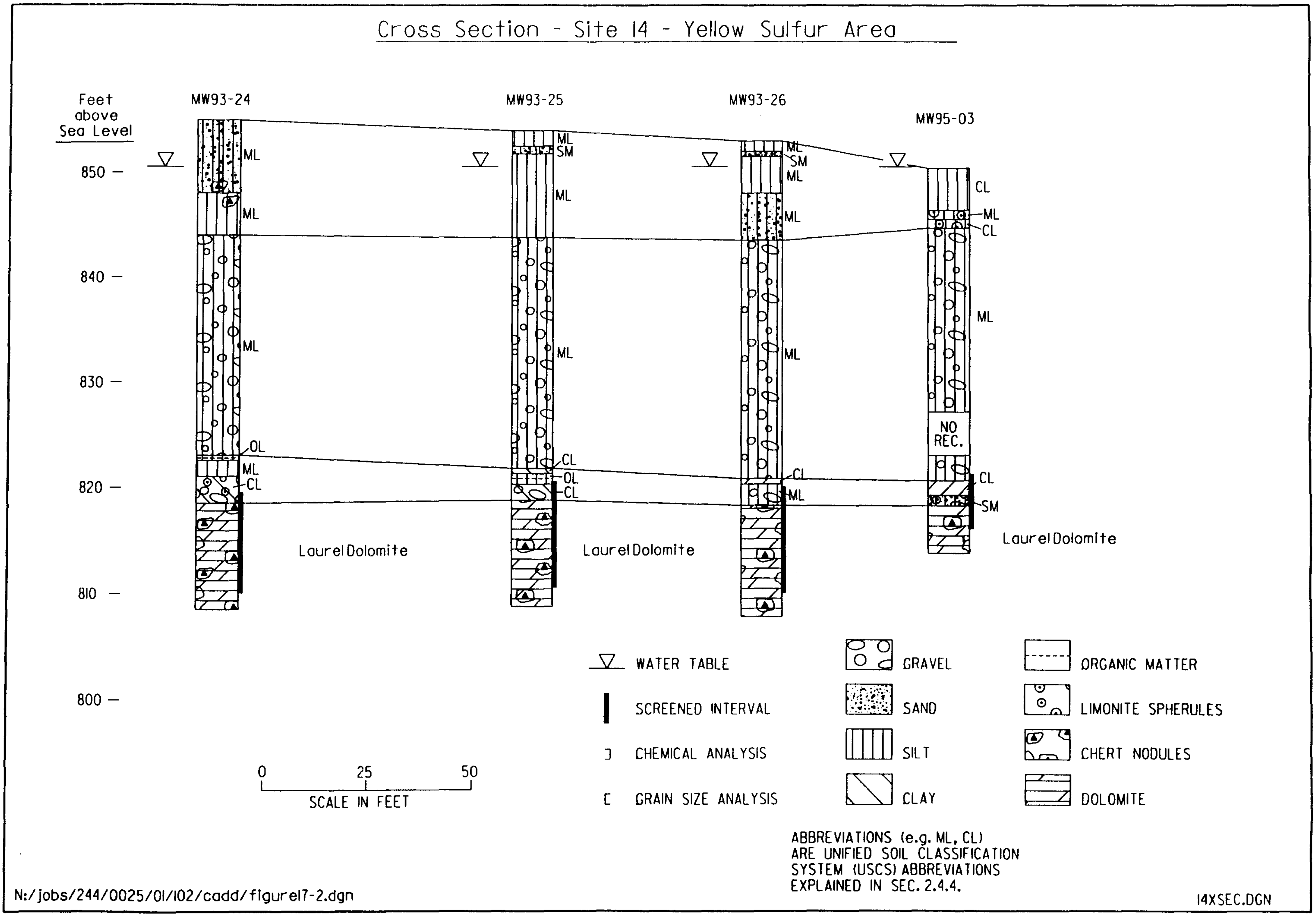
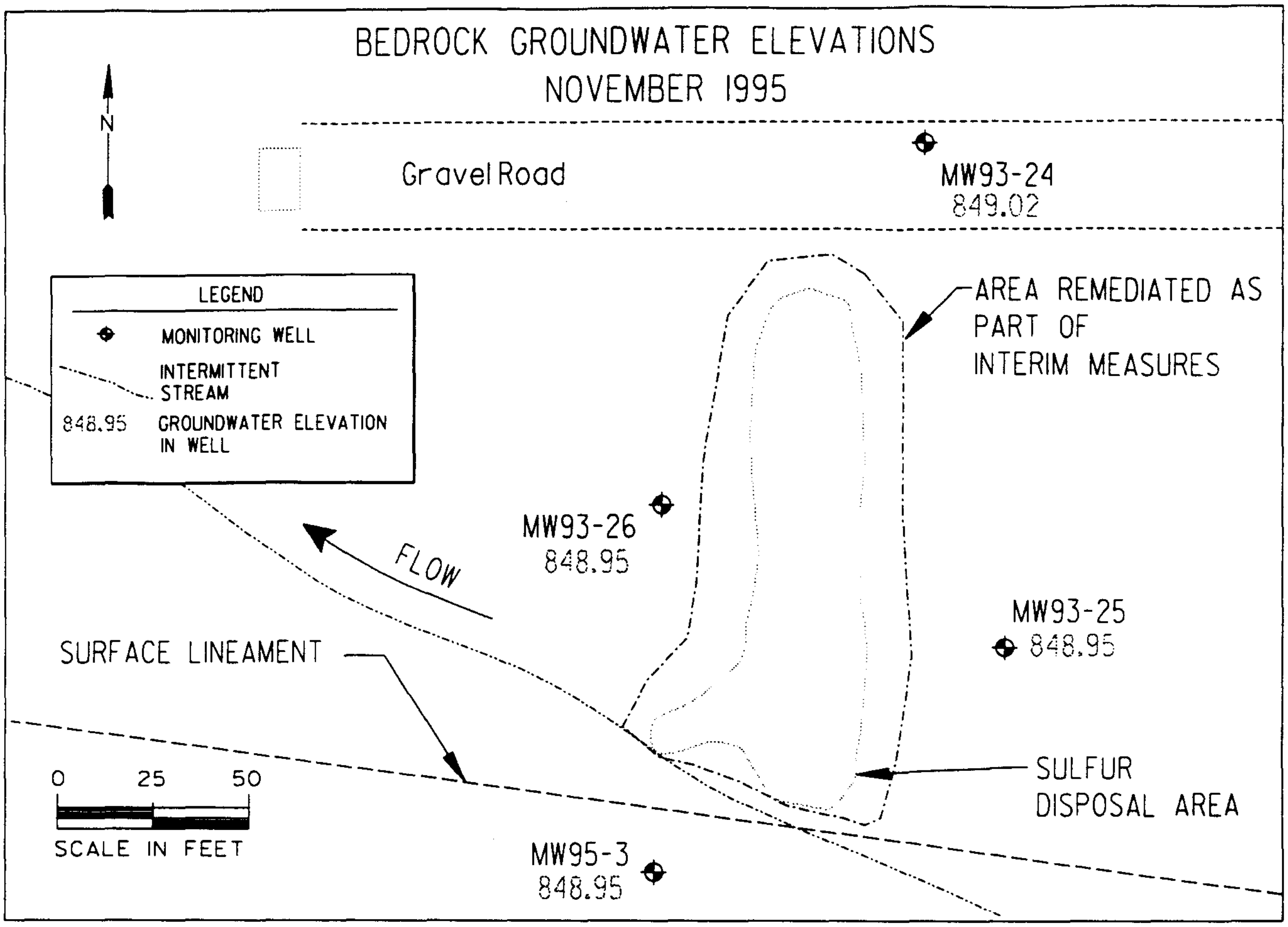
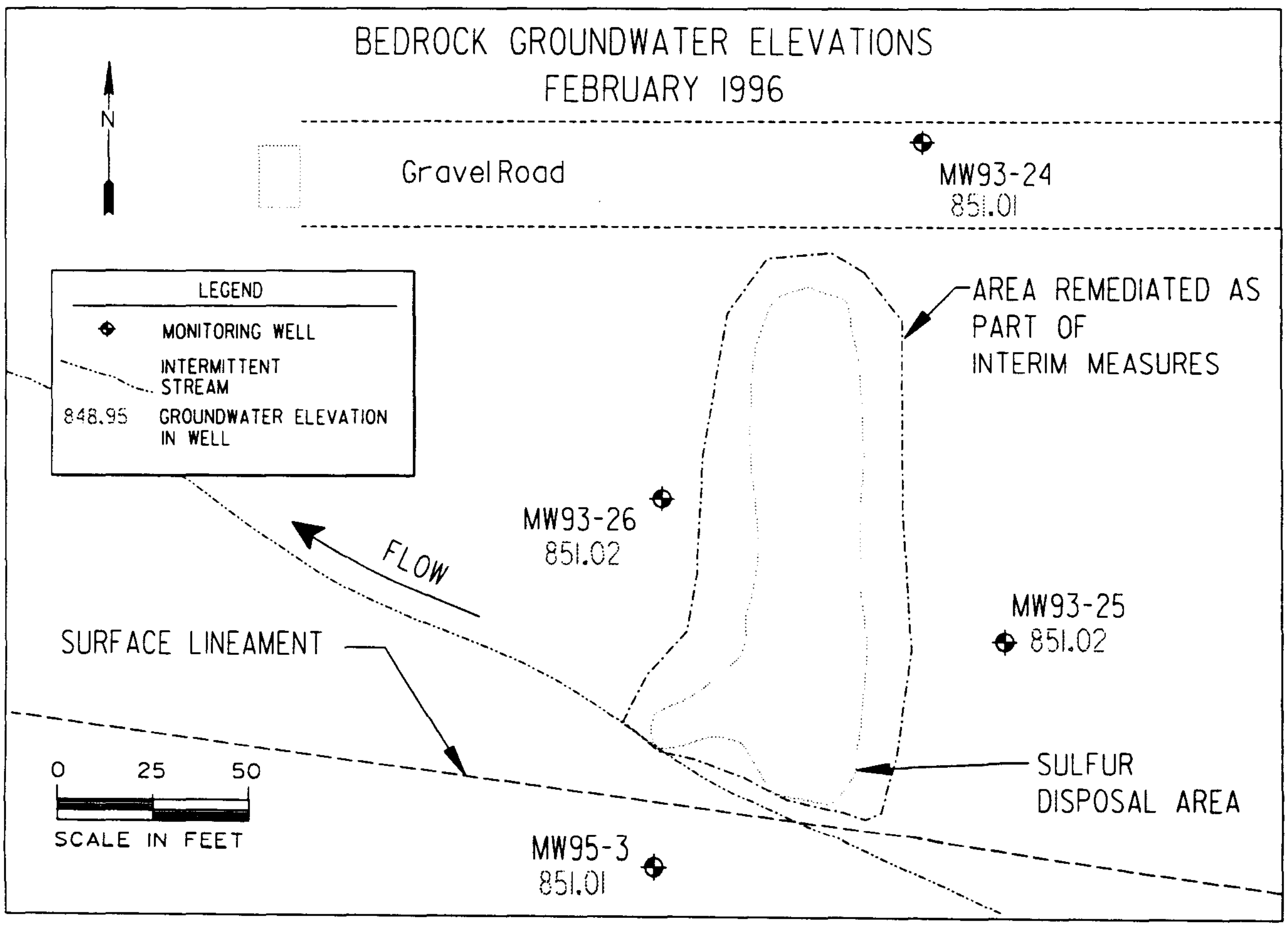


Figure 17-2. Cross Section of the Yellow Sulfer Disposal Area (Site 14)





N:/jobs/244/0025/01/102/cadd/figure17-3.dgn REVISED: 3-12-99 14CONTNF.DGN

Figure 17-3. Bedrock Groundwater Elevations - November 1995 and February 1996, Yellow Sulfur Disposal Area (Site 14)

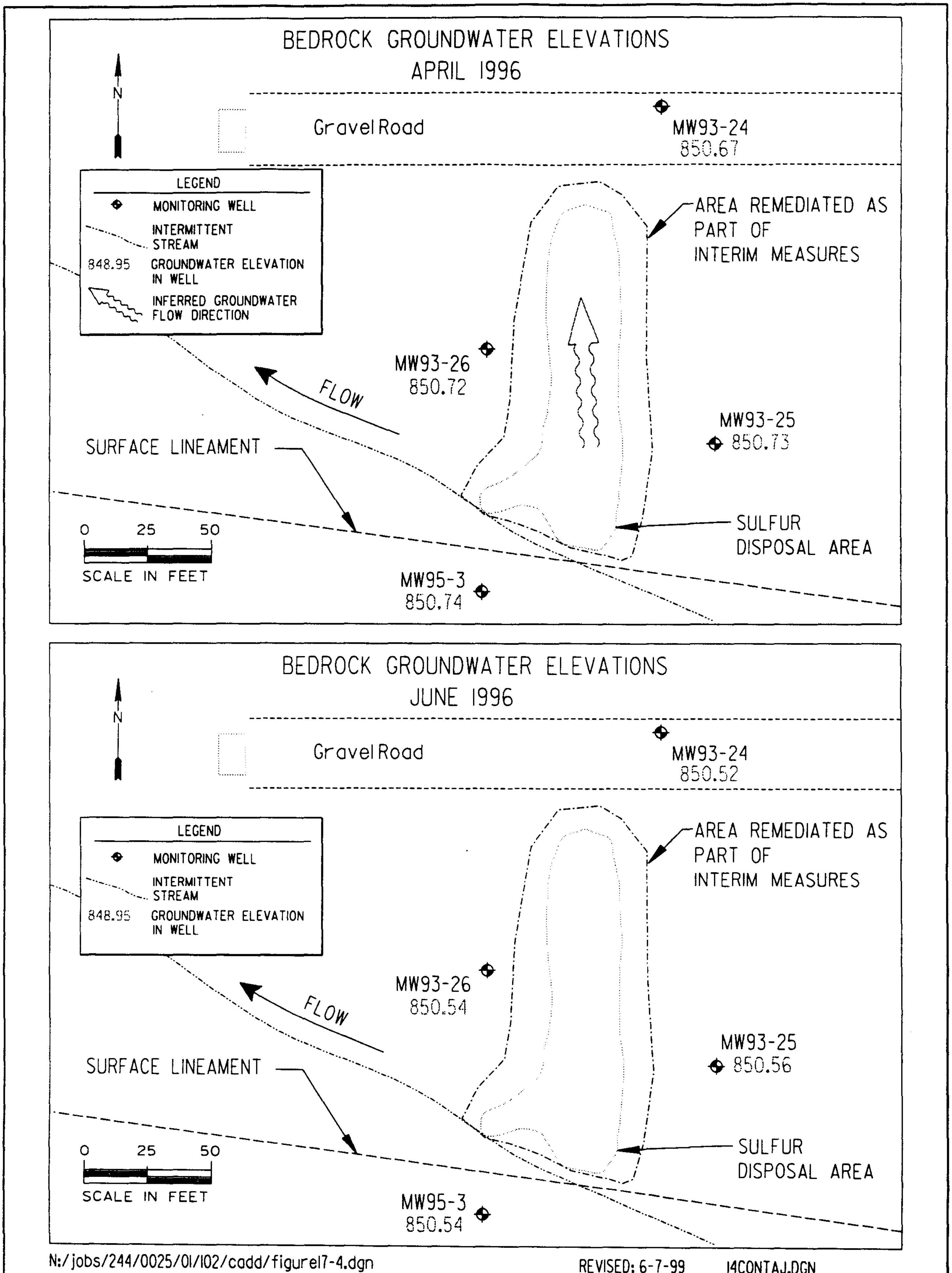


Figure 17-4. Bedrock Groundwater Elevations - April and June 1996, Yellow Sulfur Disposal Area (Site 14)

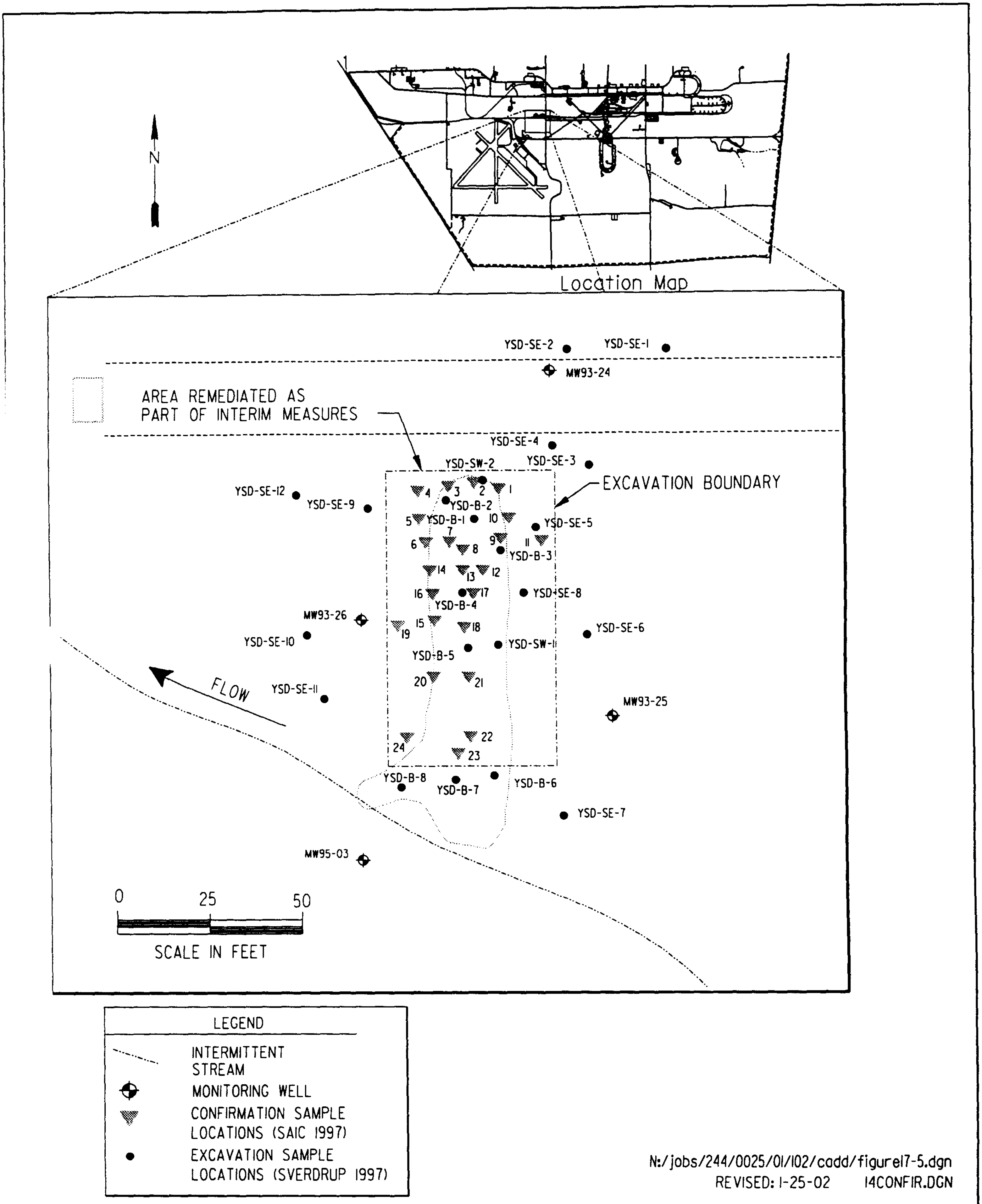
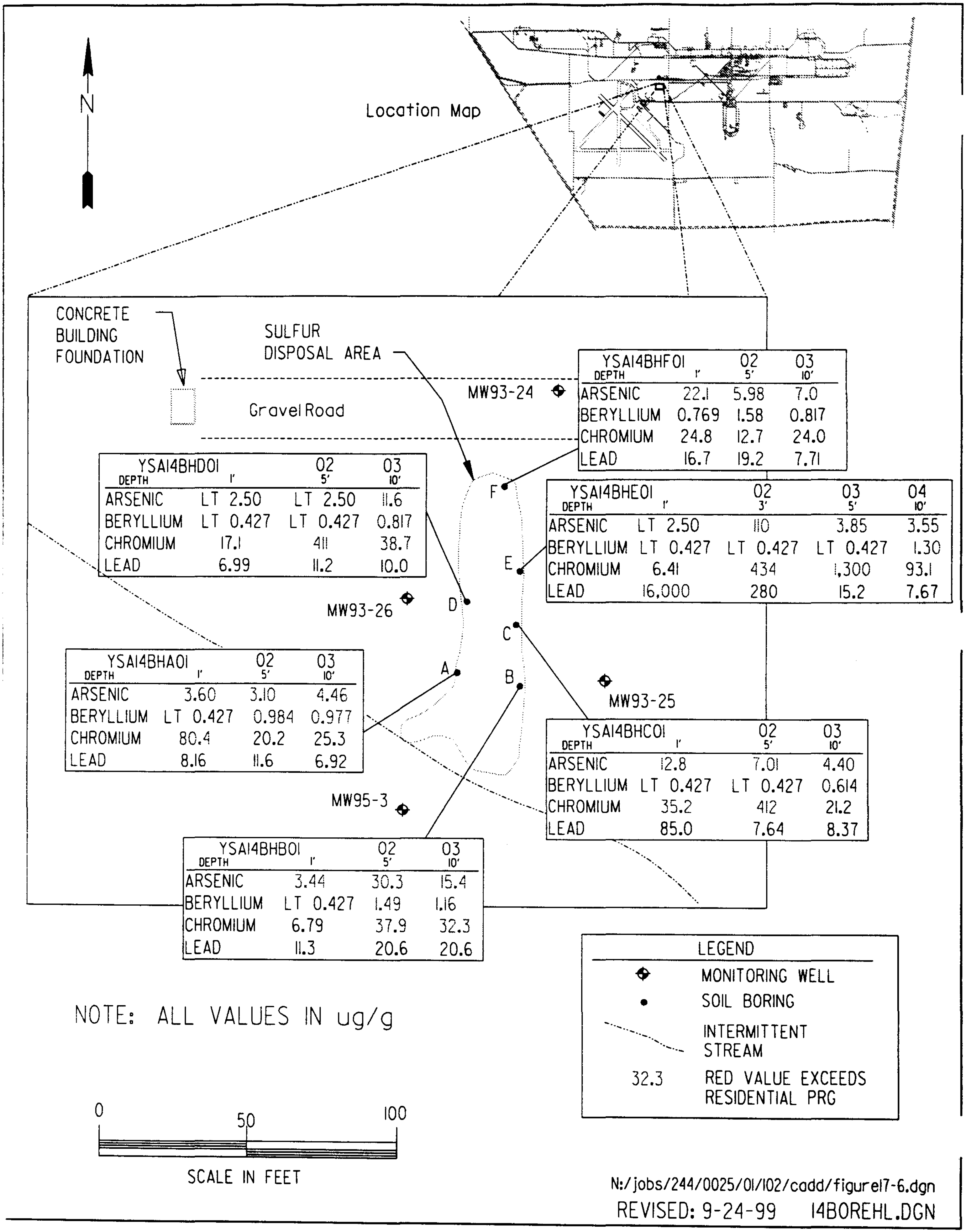


Figure 17-5. Confirmation Sample Locations at the Yellow Sulfur Disposal Area (Site 14)



YSA14BHF01 (DEPTH)	1'	02 (5')	03 (10')
ARSENIC	22.1	5.98	7.0
BERYLLIUM	0.769	1.58	0.817
CHROMIUM	24.8	12.7	24.0
LEAD	16.7	19.2	7.71

YSA14BHD01 (DEPTH)	1'	02 (5')	03 (10')
ARSENIC	LT 2.50	LT 2.50	11.6
BERYLLIUM	LT 0.427	LT 0.427	0.817
CHROMIUM	17.1	411	38.7
LEAD	6.99	11.2	10.0

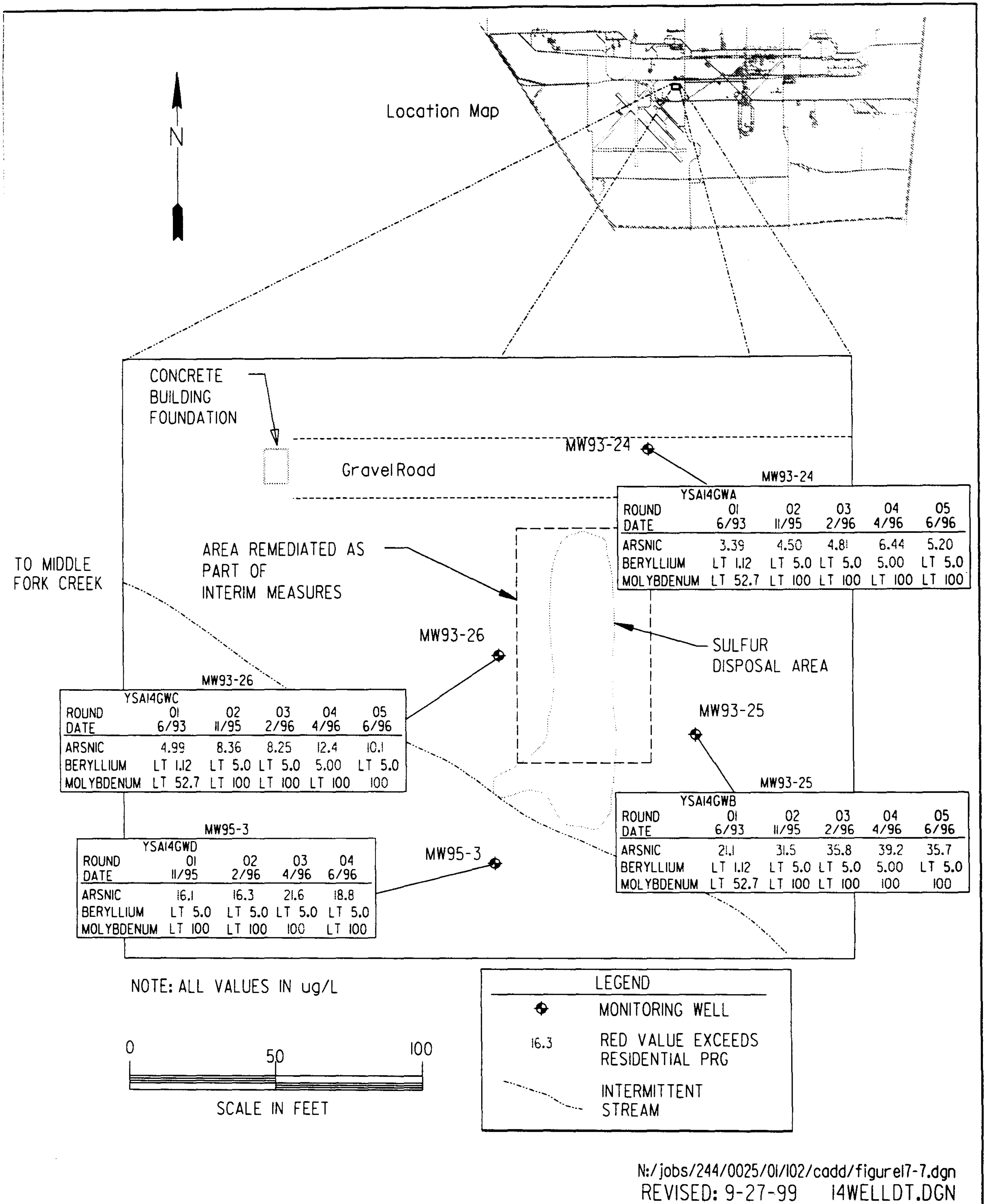
YSA14BHE01 (DEPTH)	1'	02 (3')	03 (5')	04 (10')
ARSENIC	LT 2.50	110	3.85	3.55
BERYLLIUM	LT 0.427	LT 0.427	LT 0.427	1.30
CHROMIUM	6.41	434	1,300	93.1
LEAD	16,000	280	15.2	7.67

YSA14BHA01 (DEPTH)	1'	02 (5')	03 (10')
ARSENIC	3.60	3.10	4.46
BERYLLIUM	LT 0.427	0.984	0.977
CHROMIUM	80.4	20.2	25.3
LEAD	8.16	11.6	6.92

YSA14BHC01 (DEPTH)	1'	02 (5')	03 (10')
ARSENIC	12.8	7.01	4.40
BERYLLIUM	LT 0.427	LT 0.427	0.614
CHROMIUM	35.2	412	21.2
LEAD	85.0	7.64	8.37

YSA14BHB01 (DEPTH)	1'	02 (5')	03 (10')
ARSENIC	3.44	30.3	15.4
BERYLLIUM	LT 0.427	1.49	1.16
CHROMIUM	6.79	37.9	32.3
LEAD	11.3	20.6	20.6

Figure 17-6. Metals Exceedances for Soils from Phase I Probeholes, Yellow Sulfur Disposal Area (Site 14)



MW93-24

YSA14GWA

ROUND DATE	01 6/93	02 11/95	03 2/96	04 4/96	05 6/96
ARSNIC	3.39	4.50	4.81	6.44	5.20
BERYLLIUM	LT 1.12	LT 5.0	LT 5.0	5.00	LT 5.0
MOLYBDENUM	LT 52.7	LT 100	LT 100	LT 100	LT 100

MW93-26

YSA14GWC

ROUND DATE	01 6/93	02 11/95	03 2/96	04 4/96	05 6/96
ARSNIC	4.99	8.36	8.25	12.4	10.1
BERYLLIUM	LT 1.12	LT 5.0	LT 5.0	5.00	LT 5.0
MOLYBDENUM	LT 52.7	LT 100	LT 100	LT 100	100

MW93-25

YSA14GWB

ROUND DATE	01 6/93	02 11/95	03 2/96	04 4/96	05 6/96
ARSNIC	21.1	31.5	35.8	39.2	35.7
BERYLLIUM	LT 1.12	LT 5.0	LT 5.0	5.00	LT 5.0
MOLYBDENUM	LT 52.7	LT 100	LT 100	100	100

MW95-3

YSA14GWD

ROUND DATE	01 11/95	02 2/96	03 4/96	04 6/96
ARSNIC	16.1	16.3	21.6	18.8
BERYLLIUM	LT 5.0	LT 5.0	LT 5.0	LT 5.0
MOLYBDENUM	LT 100	LT 100	100	LT 100

Figure 17-7. Groundwater Metals Results, Yellow Sulfur Disposal Area (Site 14)

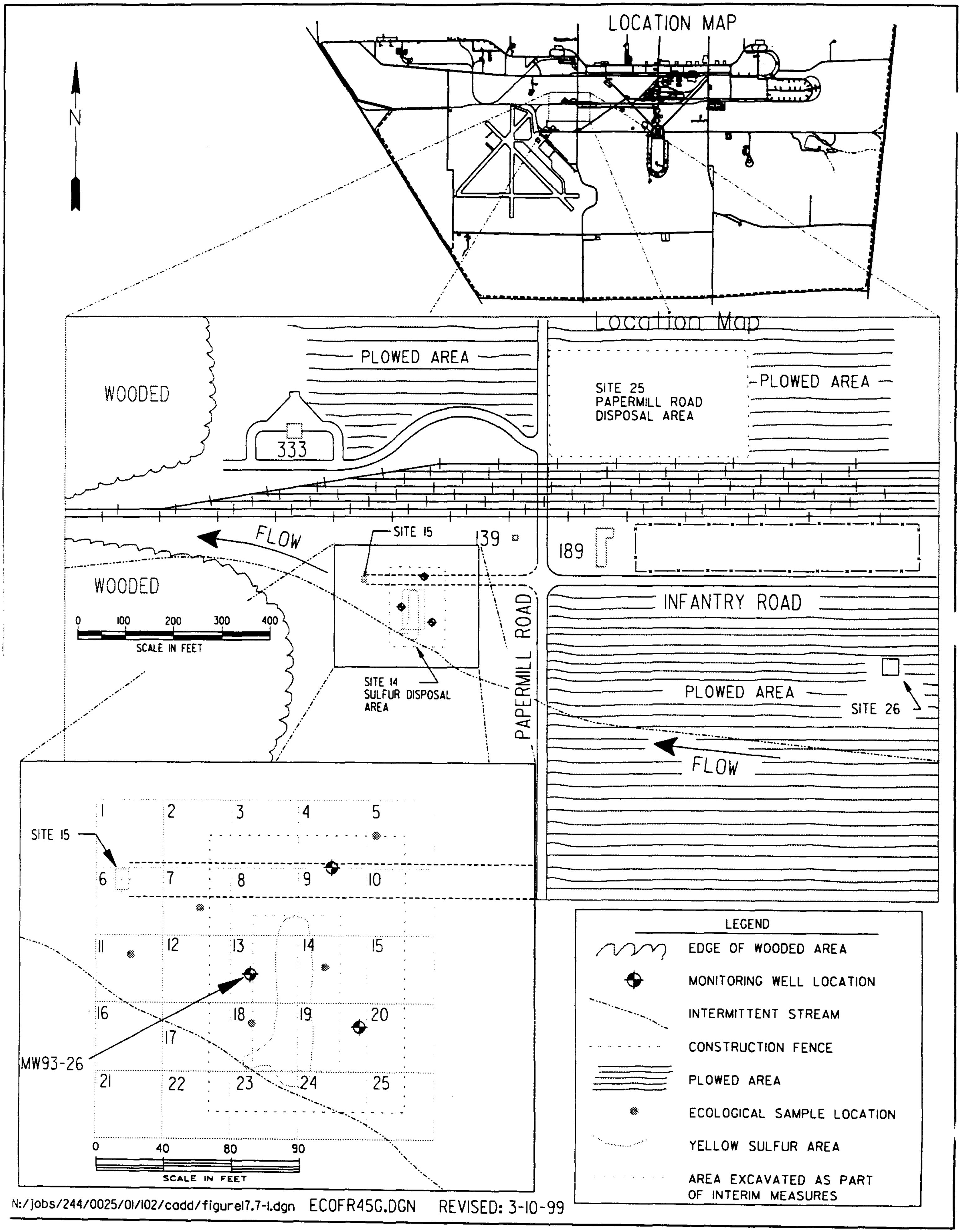


Figure 17.7-1. Yellow Sulfur Disposal Area (Site 14)

Receptor & Exposure Data

Primary Source	Primary Release	Primary Transport	Exposure Medium	Plants	Soil Fauna[1]	Mourning Dove	Chimney Swift	Wild Turkey	Great Blue Heron	American Kestrel	White-Footed Mouse	Eastern Cotton-tail	Little Brown Myotis	Raccoon	Red Fox	Pickerel Frog	Creek Chub	Benthic Inver-tebrates[1]
Spills, Leaks; Surface or Buried Wastes, Burning	Volatilization; Fugitive Dust	Air Movement	Air	NA	NA	INH	INH	INH	INH	INH	INH	INH	INH	INH	INH	INH	NA	NA
Contaminated Surface Soil	Leaching	Infiltration	Ground Water	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Surface Runoff	Water movement	Surface Water	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Deposition	Sediments	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Tracking		Soil	DC	DC	ING	ING	ING	ING	ING	ING	ING	ING	ING	ING	DC	NA	NA
	Biotic Uptake[a]	Biota[a]	Biota[a]	NA	ING	ING	ING	ING	NA	ING	ING	ING	ING	NA	ING	NA	NA	NA

(Ground Water → Surface Water)

Pathway may be significant; not evaluated because toxicity criteria lacking

Insignificant pathway; not quantitatively evaluated

NA Not Applicable

ING Ingestion

INH Inhalation

DC Direct Contact

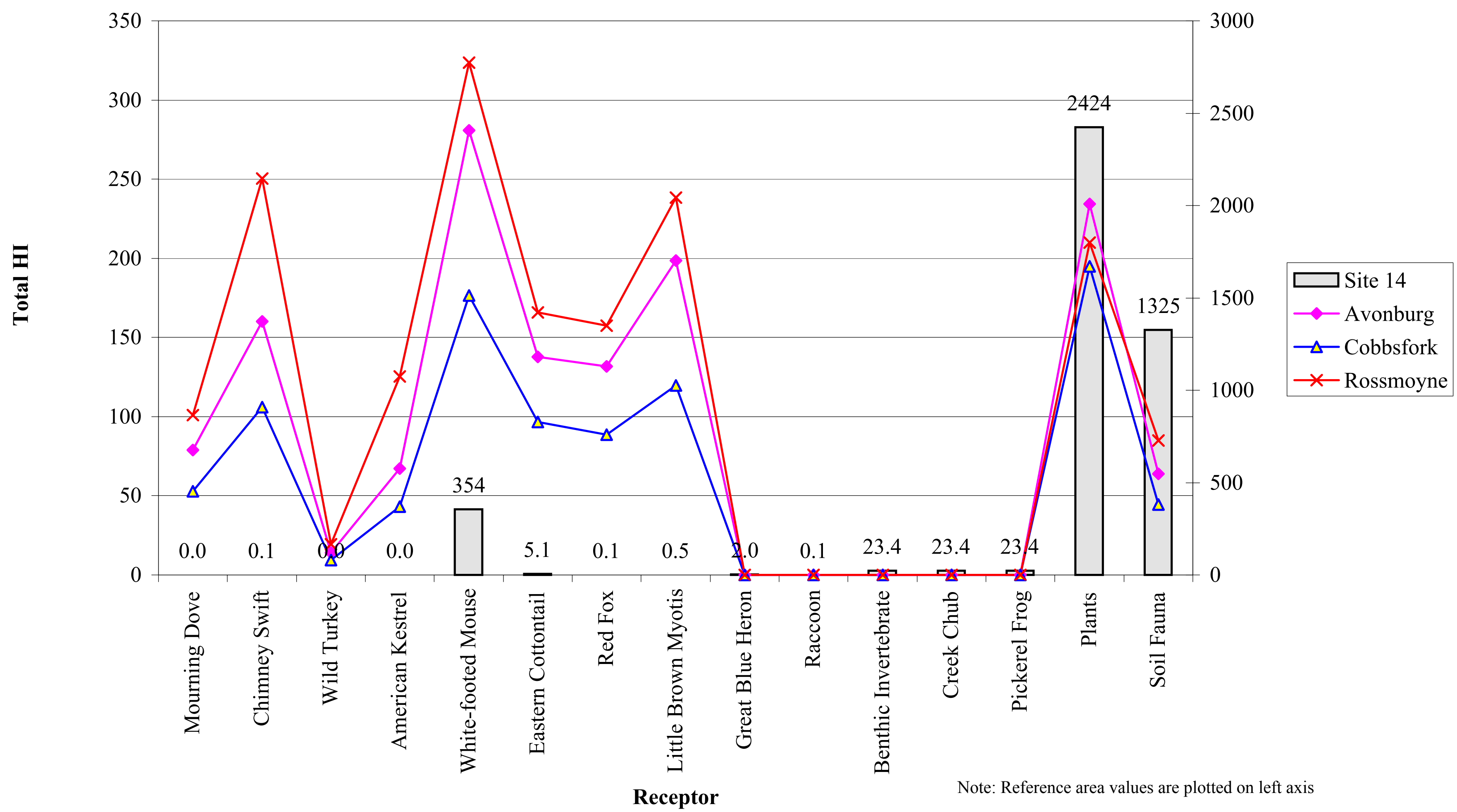
1 Includes the terrestrial or aquatic crayfish

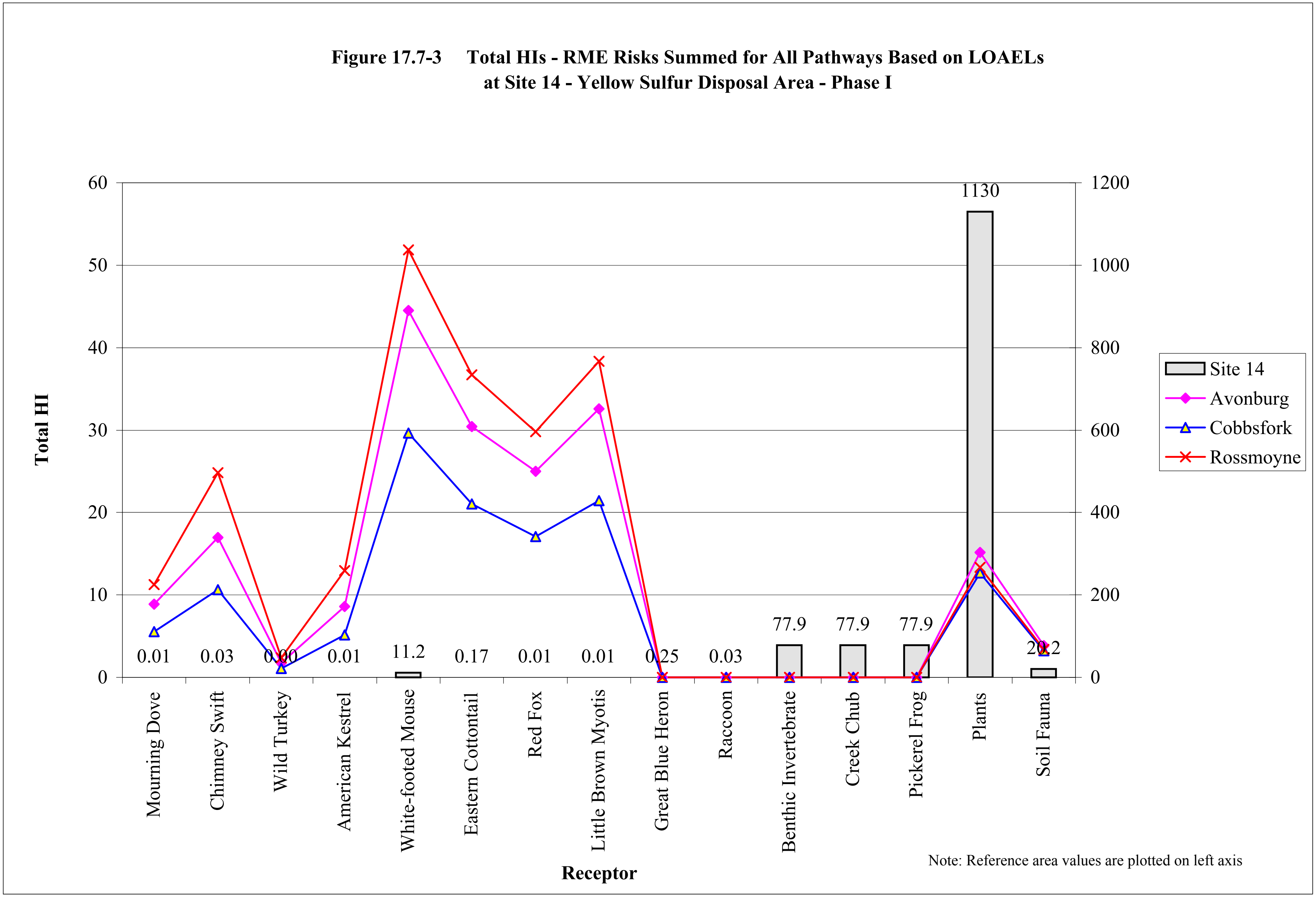
a Refer to JPG Food Web (Figure 5.3-5)

Figure 17.7-1a
JPG Conceptual Site Model
Site 14

N:Jobs 244 0025 01 102 cadd figure17.7-1a.ppt

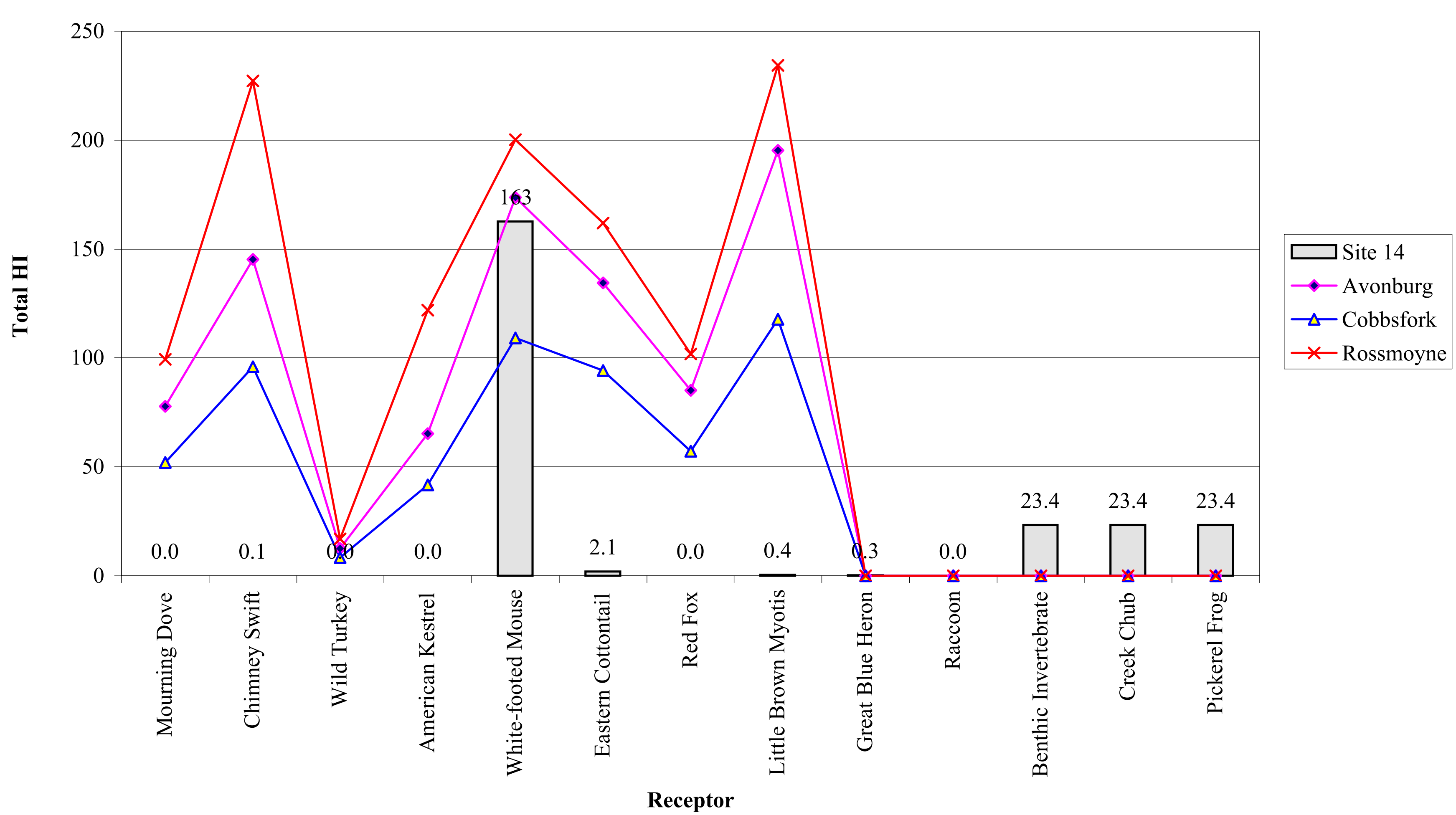
Figure 17.7-2 Total HIs - RME Risks Summed for All Pathways Based on NOAELs at Site 14 - Yellow Sulfur Disposal Area - Phase I

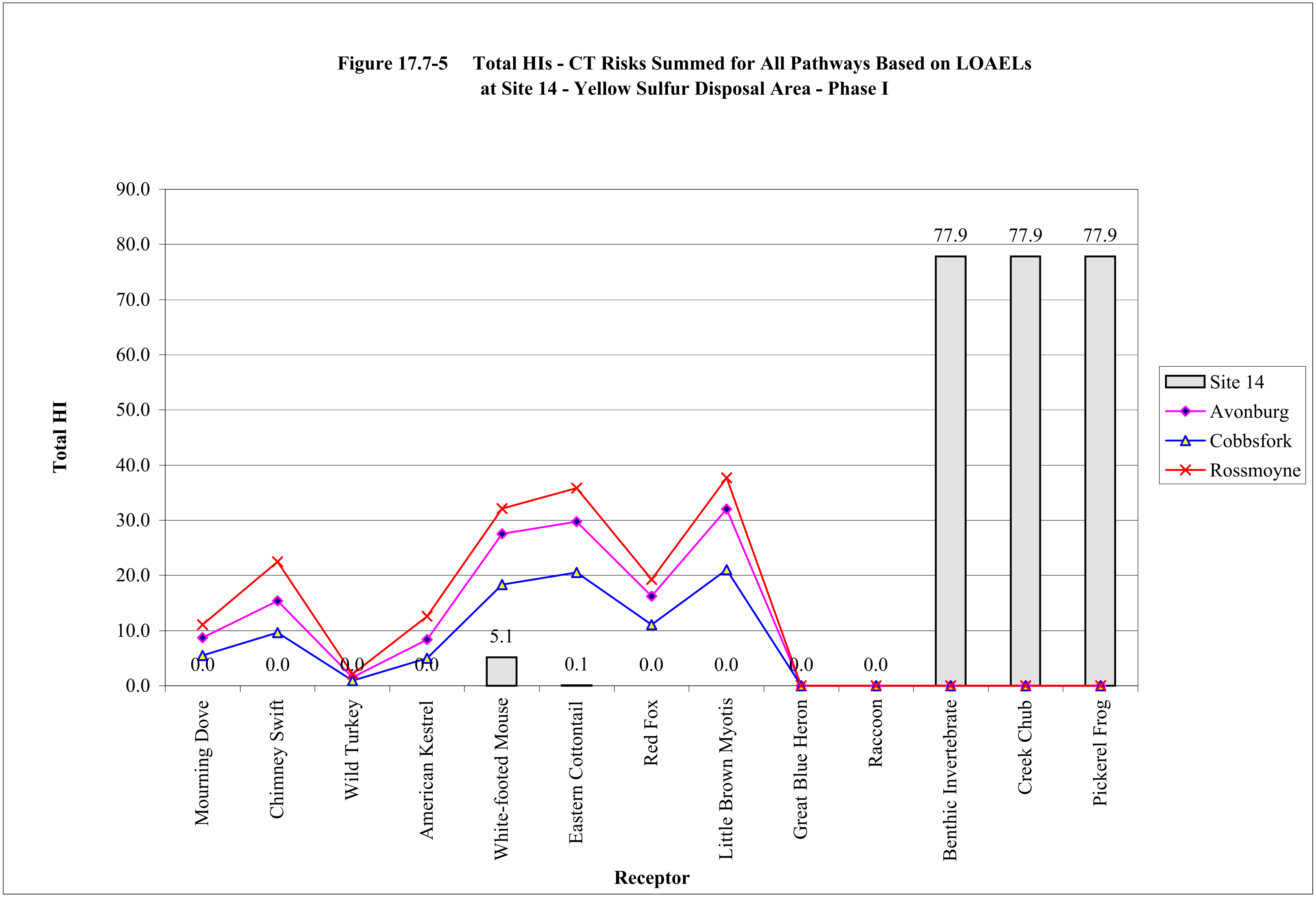




N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase1\Risk2\P1era_14MWH.xls Figure 17.7-3

Figure 17.7-4 Total HIs - CT Risks Summed for All Pathways Based on NOAELs at Site 14 - Yellow Sulfur Disposal Area - Phase I





N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase1\Risk2\P1era_14MWH.xls Figure 17.7-5

Figure 17.7-6 Total HIs - RME Risks Summed for All Pathways Based on NOAELs at Site 14 - Yellow Sulfur Disposal Area- IM Confirmation Sampling

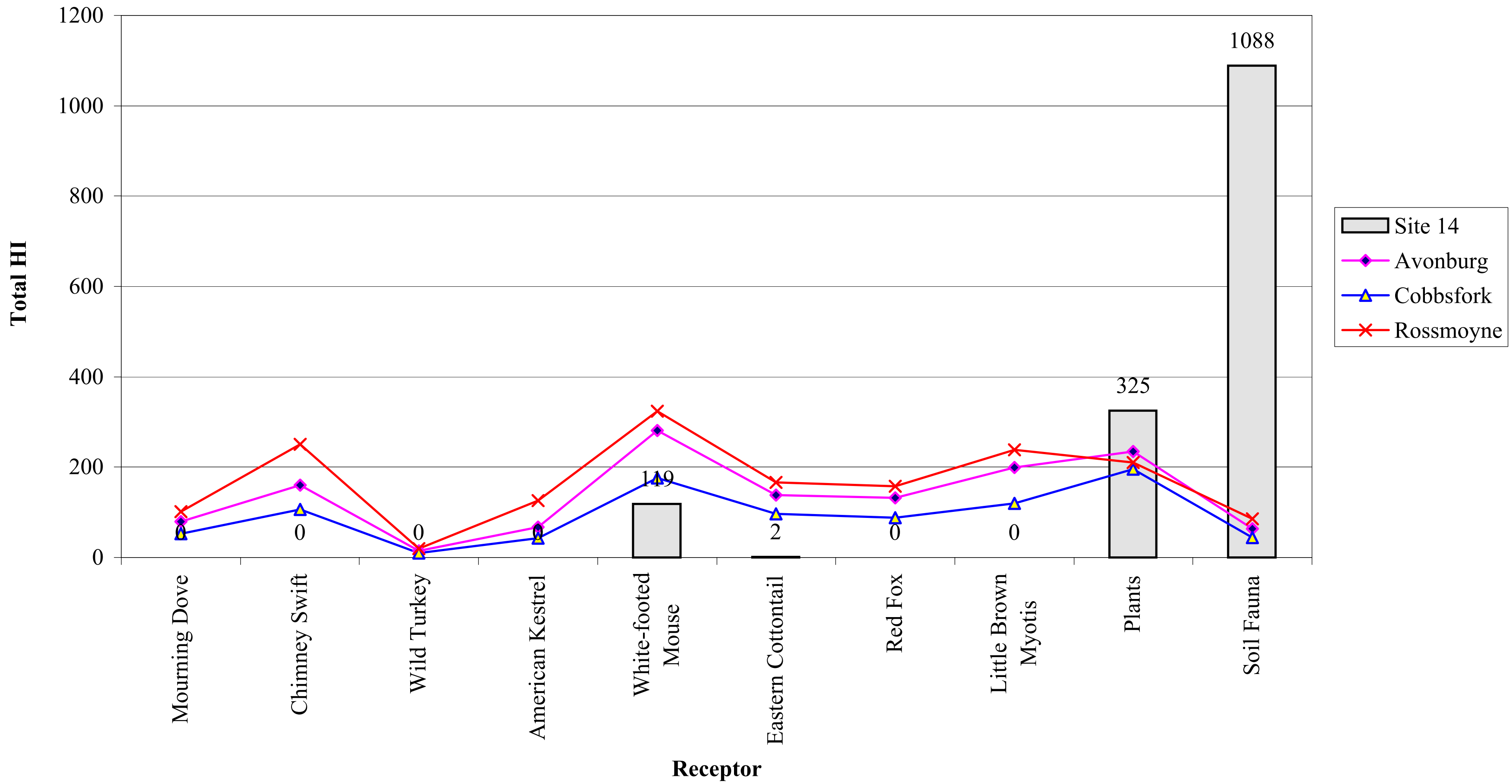
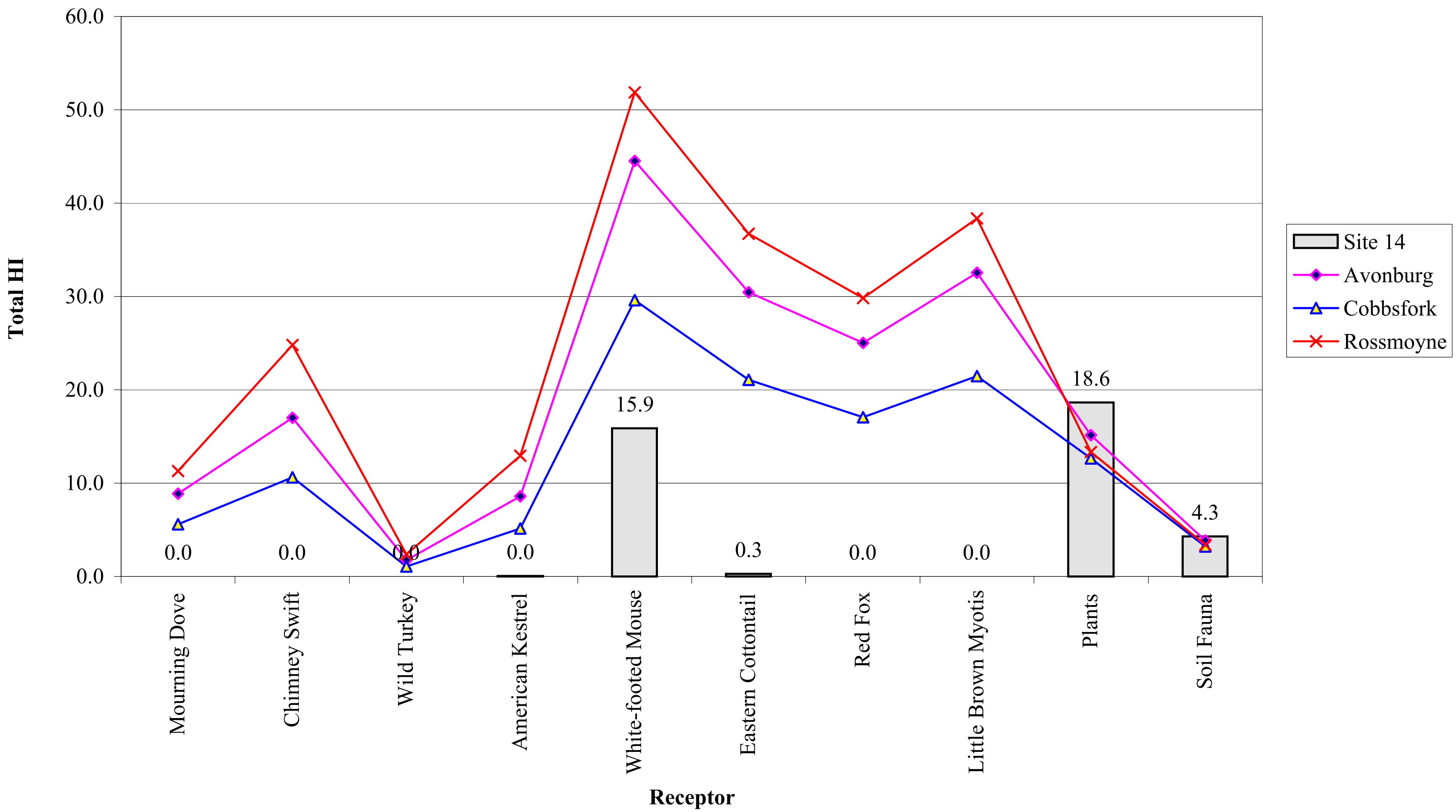


Figure 17.7-7 Total HIs - RME Risks Summed for All Pathways Based on LOAELs at Site 14 - Yellow Sulfur Disposal Area - IM Confirmation Sampling



N:\jobs\244\0025\01\ET ECO Files\Jpg\Im\Risk2\Eraim_14MWH.xls Figure 17.7-7

Figure 17.7-8 Total HIs - CT Risks Summed for All Pathways Based on NOAELs at Site 14 - Yellow Sulfur Disposal Area - IM Confirmation Sampling

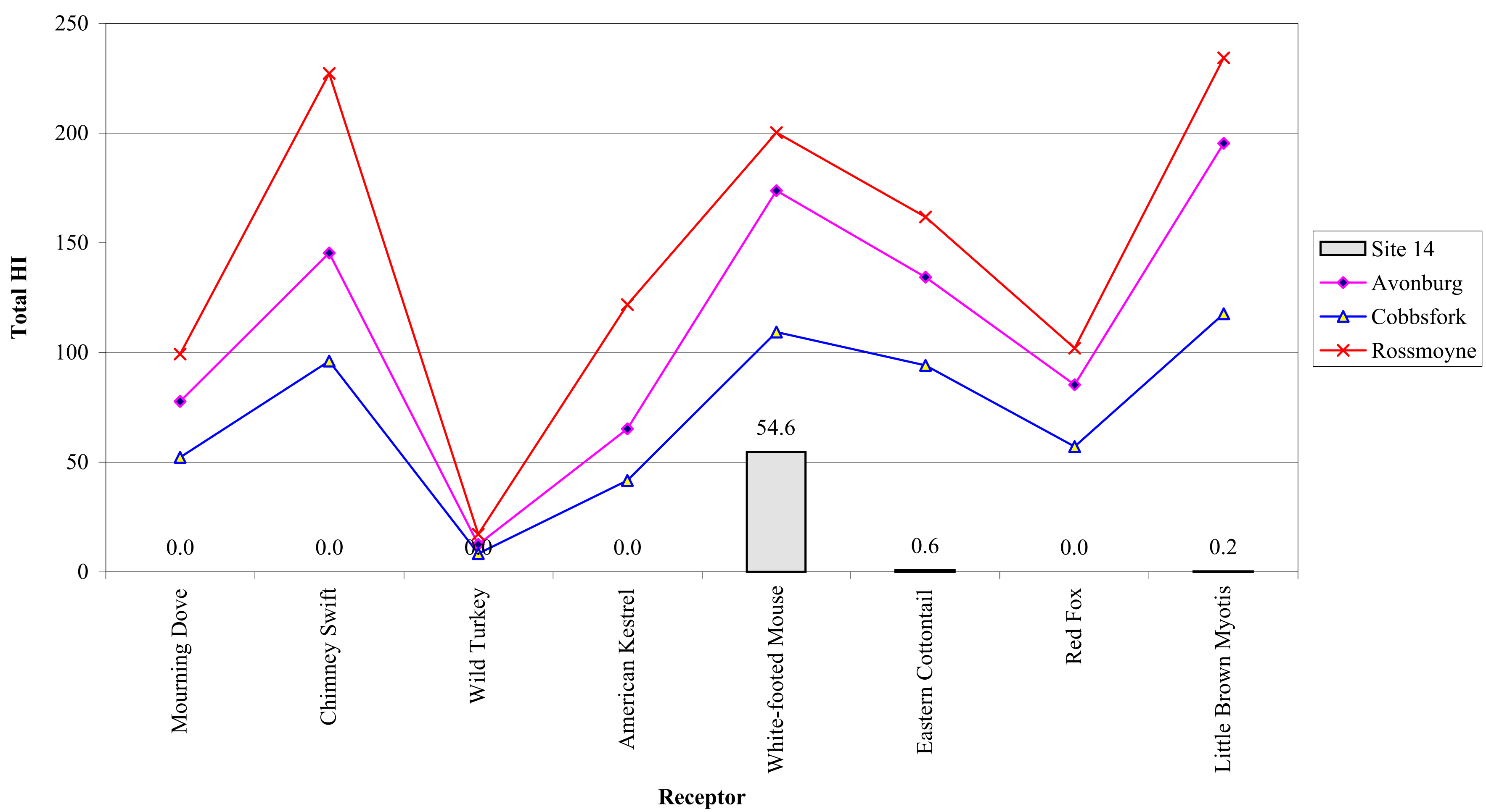
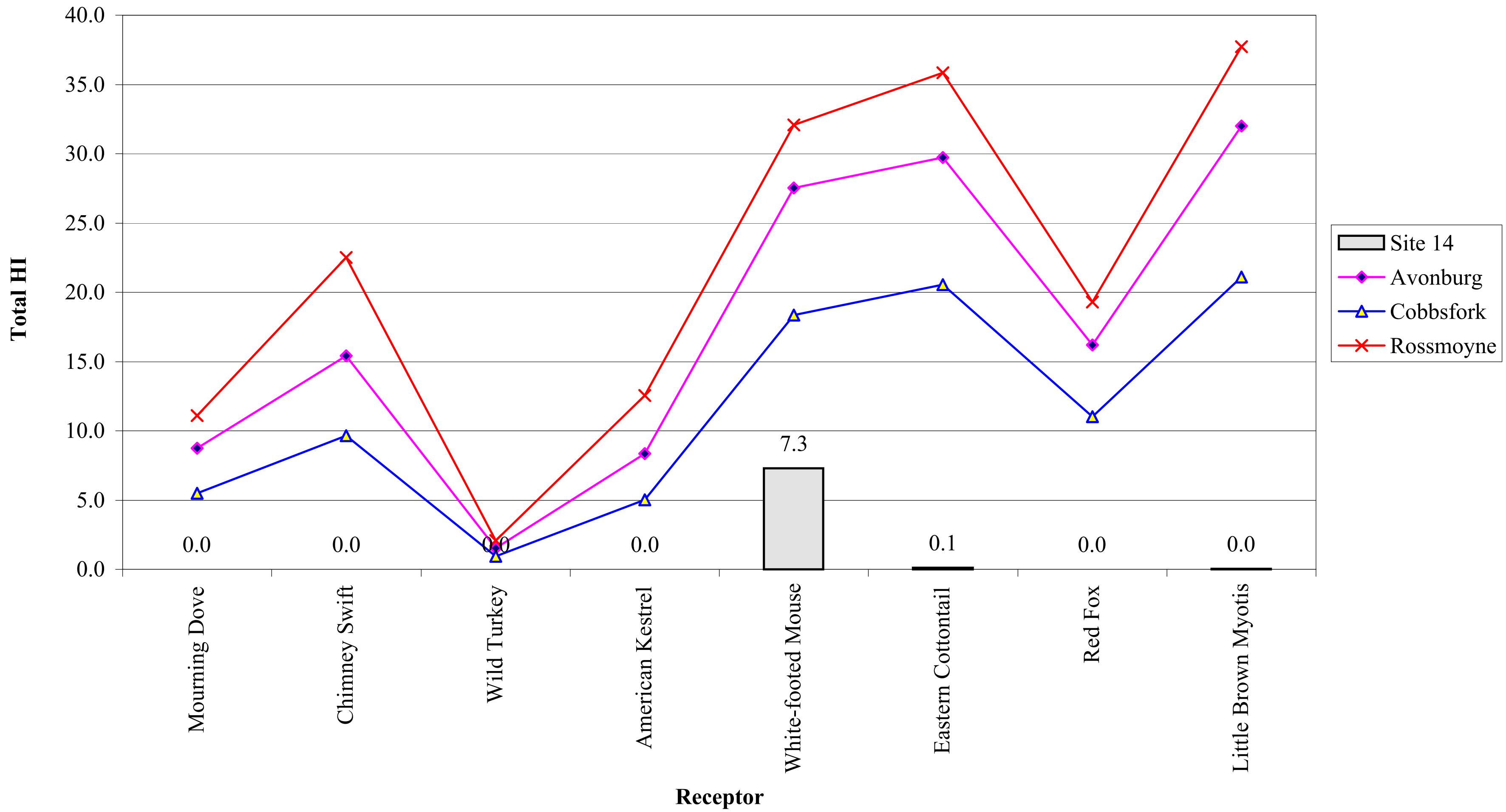
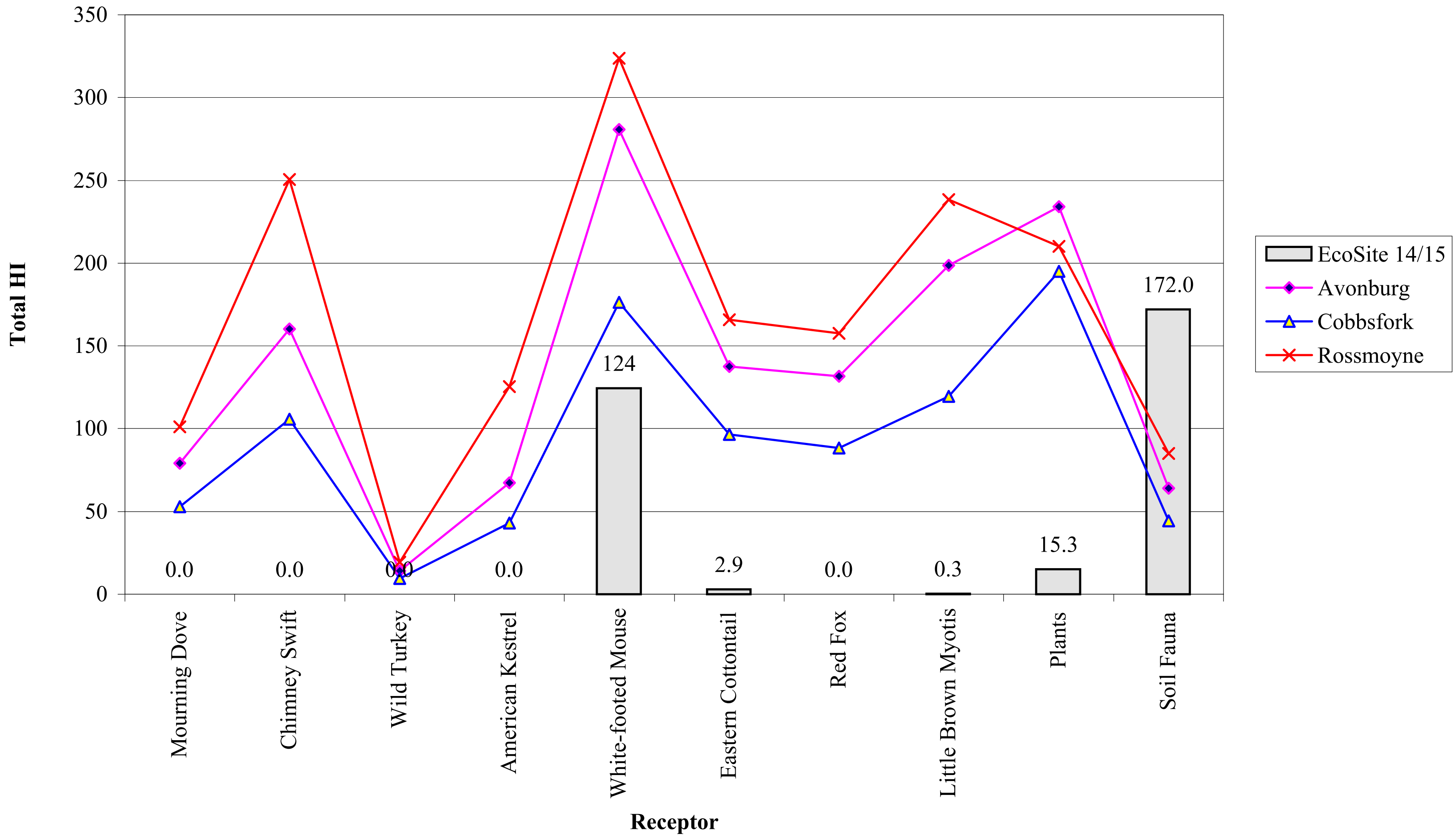


Figure 17.7-9 Total HIs - CT Risks Summed for All Pathways Based on LOAELs at Site 14 - Yellow Sulfur Disposal Area - IM Confirmation Sampling



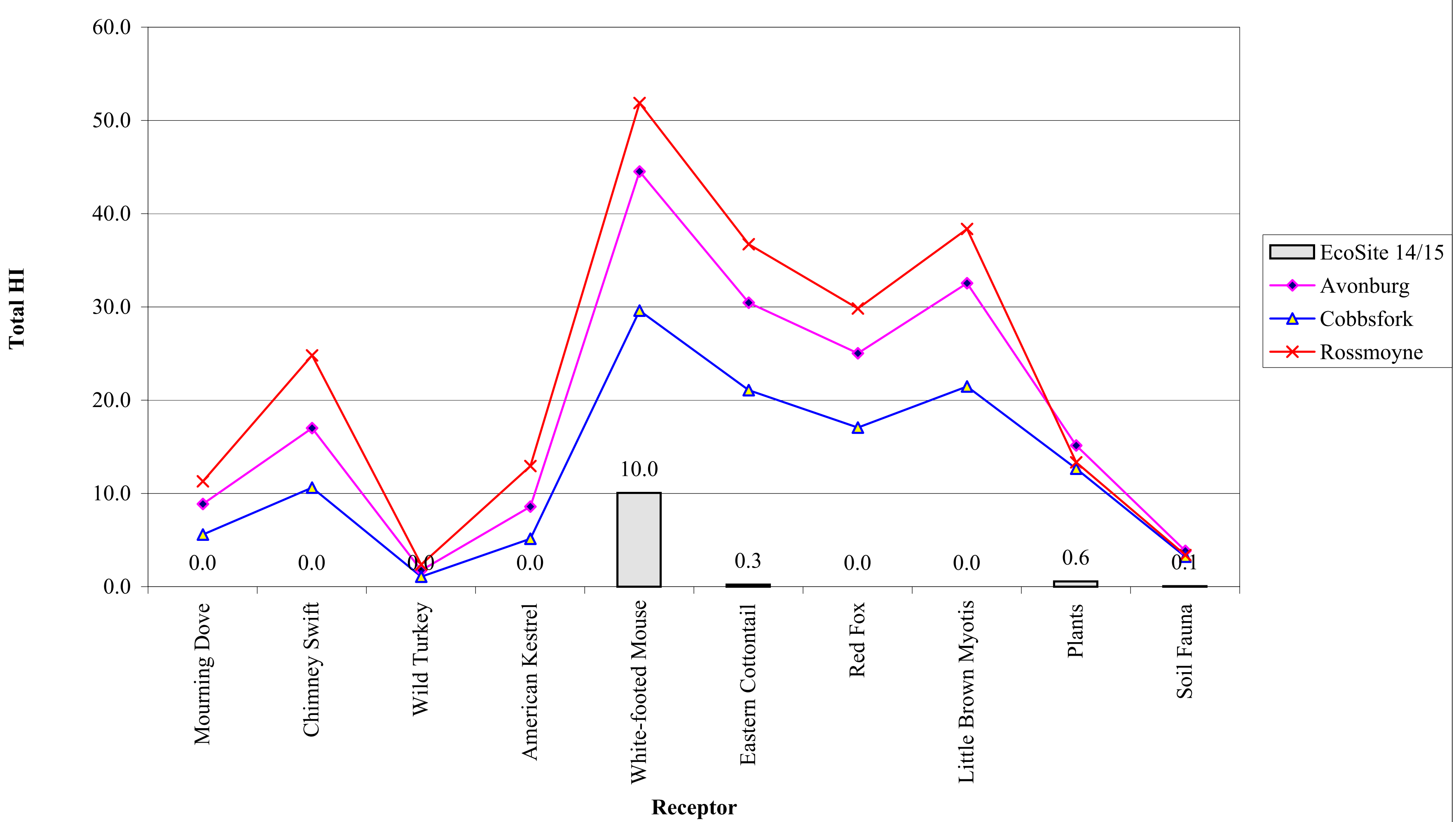
N:\jobs\244\0025\01\ET ECO Files\Jpg\Im\Risk2\Eraim_14MWH.xls Figure 17.7-9

Figure 17.7-10 Total HIs-RME Risks Summed for All Pathways Based on NOAELs at Eco Site 14/15 - Phase III



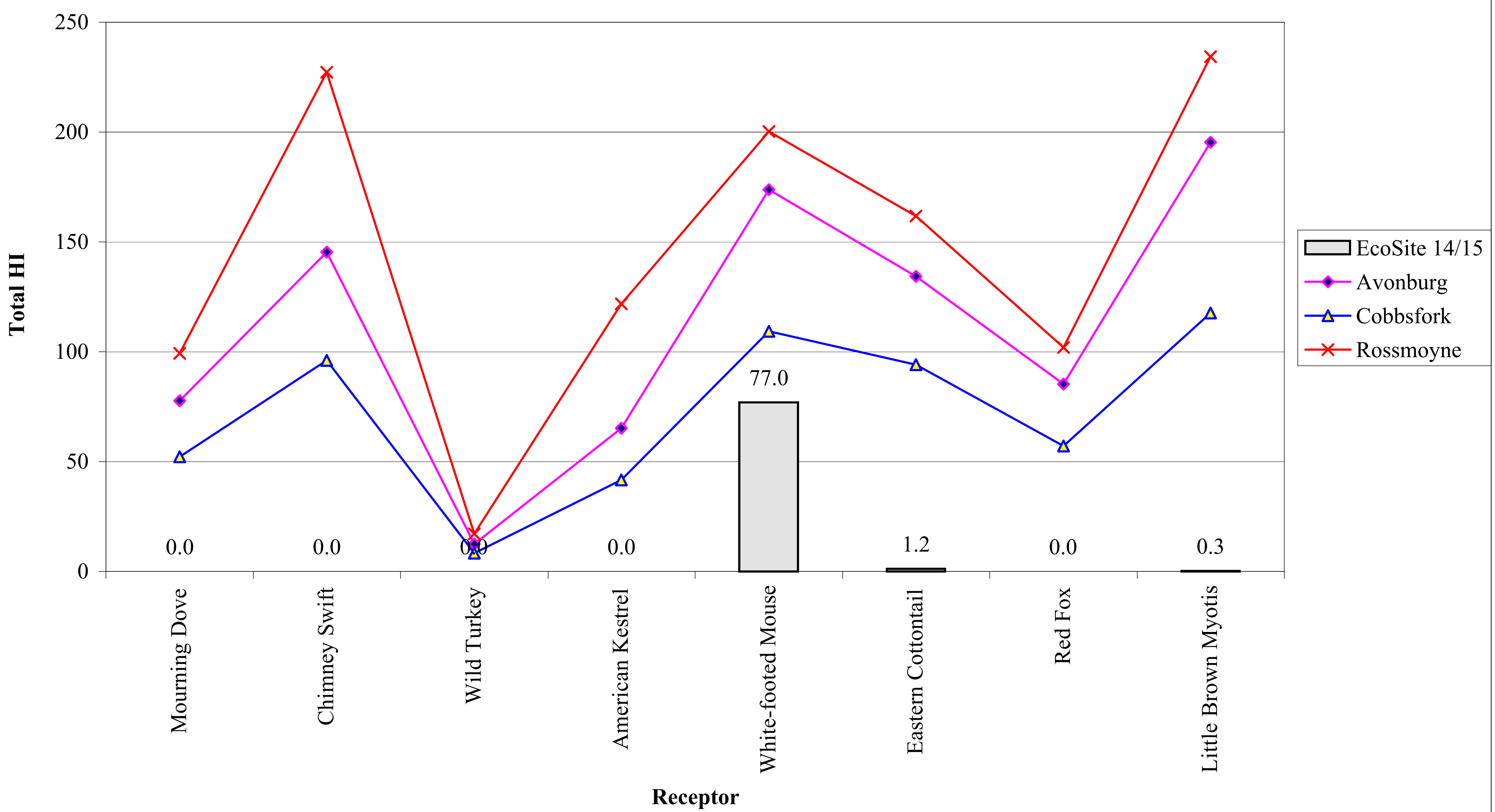
N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase 3\Risk2\P3era_14MWH.xls Figure 17.7-10

Figure 17.7-11 Total HIs-RME Risks Summed for All Pathways Based on LOAELs at Eco Site 14/15 - Phase III

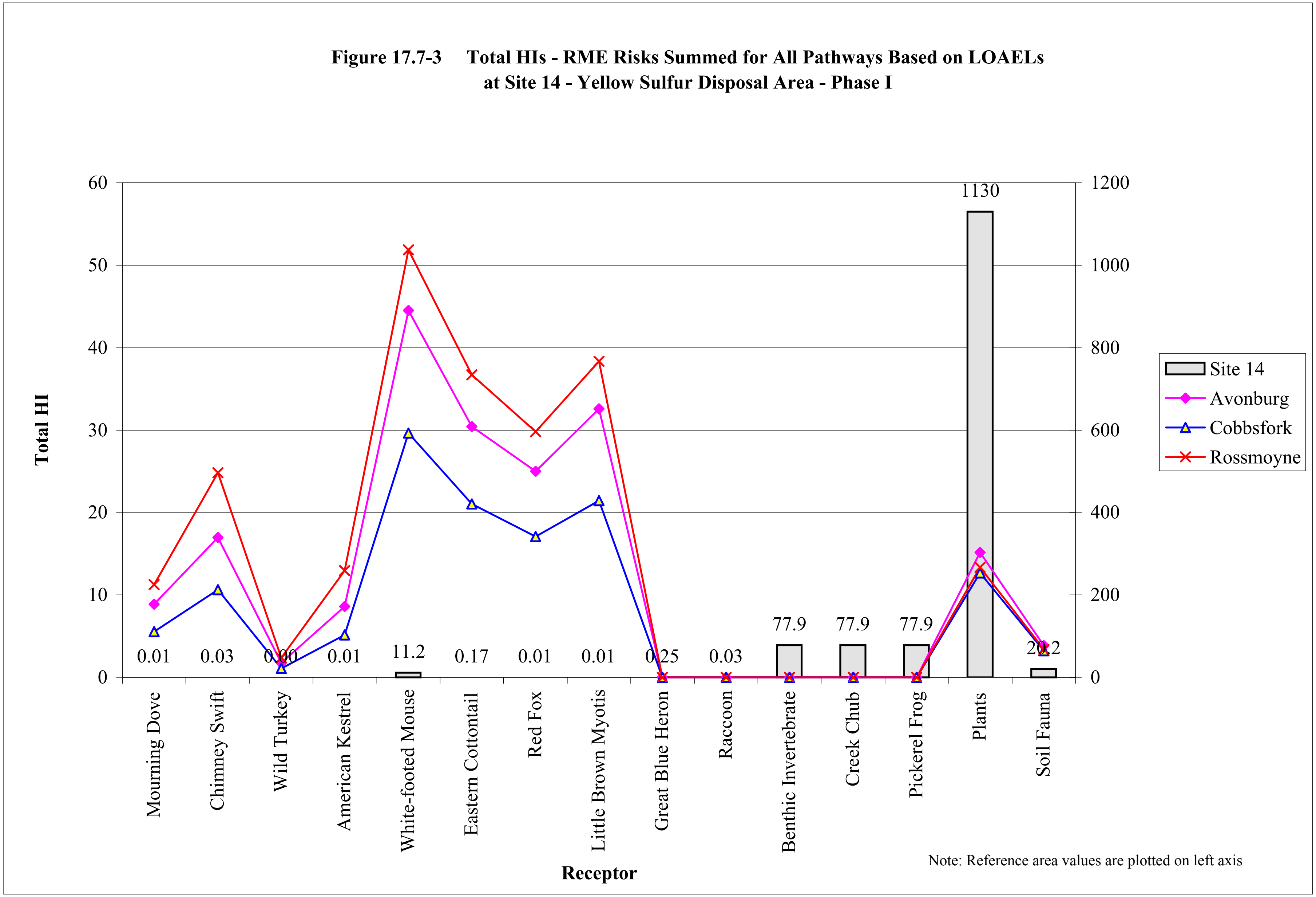


N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase 3\Risk2\P3era_14MWH.xls Figure 17.7-11

Figure 17.7-12 Total HIs-CT Risks Summed for All Pathways Based on NOAELs at Eco Site 14/15 - Phase III



N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase 3\Risk2\P3era_14MWH.xls Figure 17.7-12



N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase1\Risk2\P1era_14MWH.xls Figure 17.7-3

18.0 BURN AREA SOUTH OF NEW INCINERATOR (SITE 15)

18.1 SITE CHARACTERISTICS

Site 15 is located about 200 feet south of the railroad tracks and 500 feet west of the intersection of Infantry Road and Papermill Road at the end of an unnamed gravel road (Figure 18-1). The *Master Environmental Plan* (Ebasco 1990b) identified a burned area on the ground surface around a concrete pad south of Building 333 and the new incinerator (Site 33) and near the Yellow Sulfur Disposal Area (Site 14). The concrete-pad area also contained burned electrical wiring and other metal scrap. During the RI, miscellaneous burned debris was present on the ground surface about 2 to 3 feet out from the concrete pad at this site, and the ground had a scorched appearance. The ground adjacent to the pad was also devoid of vegetation. The most likely COCs resulting from the burning activities were suspected to be heavy metals released by the oxidation and corrosion of the metallic debris. During the ecological sampling in September 1997, it was observed that the concrete pad had been removed and contaminated soil removal had taken place as part of the interim measures conducted in January through February of 1997.

The area surrounding the site is flat to gently sloping with the slope dipping to the west toward a small intermittent surface water drainage. The drainage is about 100 feet away from the site (see Figure 2-1). The area surrounding the site is grass covered and is not regularly mowed. There are woods on the south side of the intermittent drainage and numerous willows and other phreatophytes along the drainage. There are no trees on the north side of the drainage in the vicinity of the site.

The soils in this area belong to the Avonburg soil series. The glacial till is about 35 feet thick as determined from monitoring well boring logs for wells drilled at the nearby yellow sulfur disposal site. The bedrock beneath the glacial till is the Laurel Dolomite of Devonian age. The groundwater contour maps constructed for the Yellow Sulfur Disposal Area (Site 14) indicate an extremely flat horizontal groundwater gradient.

18.2 PREVIOUS INVESTIGATIONS

The *Master Environmental Plan* (Ebasco 1990b) identified a burned area on the ground surface around a concrete pad south of the new incinerator and near the Yellow Sulfur Disposal Area during a visual site inspection. No sample data existed for this site prior to the RI, and no records of previous burning activities at this site were found in the records search. Ebasco (1990b) recommended a detailed investigation of this area to characterize this site.

18.3 STUDY AREA INVESTIGATIONS

18.3.1 Phase I RI Field Activities

Although most of the burning seemed to have occurred on a concrete pad, there was also evidence of burning on the ground surface during the RI. Surface soil samples were collected to determine if the burning activities released contaminants to soils surrounding the burn-pad area. Four surface soil samples were collected around the perimeter of the concrete pad. The samples were analyzed for explosives, metals, and TPH. Additionally, one wipe sample was taken from the concrete pad and analyzed for explosives, metals, and TPH. The sample locations are shown in Figure 18-1.

18.3.2 Phase II RI Field Activities

No additional surface soil sampling was conducted at this site during Phase II activities since the site was scheduled for an interim measures removal action.

18.3.3 Interim Measures Activities

The interim measures activities at the site included the removal of the concrete pad. The concrete was broken into manageable pieces and steam cleaned. The top 12 inches of soil around the perimeter of the concrete pad and immediately beneath the pad were then excavated and the soils were properly disposed of at an off-site disposal facility as hazardous waste. Confirmation samples were collected following excavation activities and analyzed for metals (Figure 18-2).

18.4 DATA EVALUATION

18.4.1 Data Validation Results

For the Phase I data, the majority of the data were acceptable for use. Metals data for cobalt, chromium, manganese, vanadium, and zinc were qualified as estimated, normally potentially biased high based on MS recoveries. Results for antimony were either rejected or heavily qualified based on low recoveries. Lot QC data for explosives indicated that there was acceptable performance; however, the method used did not include surrogates, resulting in only MS/MSD results for sample-specific performance. This did not result in qualification of the data.

Due to the interim measures activity during Phase II, no additional sampling was conducted at Site 15.

18.4.2 Data Quality Summary

The quality of the Phase I RI data was sufficient to provide an initial indication of risk to human health and the environment and to provide characterization data necessary to conduct the interim measures removal action.

The confirmation sample data quality was determined to be acceptable for use. Valid results were produced for 100 percent of the targeted sample analyses performed. No data were qualified for Site 15.

18.4.3 Background Screening

Due to the fact that a human health risk assessment was not required, screening of the site data against background was not performed. The data summary table presented in the following section does provide the corresponding background concentrations for metals to allow comparison with site-specific sample results.

18.4.4 Summary of Analytical Results

Table 18-1 provides a summary of the analytical results for metals in soil samples collected during the Phase I RI. Table 18-2 provides a summary of the confirmation sample results provided by SAIC (1997).

18.5 NATURE AND EXTENT OF CONTAMINATION

18.5.1 Soil

Results of the Phase I soil samples revealed that several metals were present at high concentrations in the surface soil around the concrete pad (Table 18-1). Lead values for the four soil samples ranged from 1,900 to 23,000 µg/g (10 to 1,210 times the background value, respectively). TCLP analysis revealed that three of the four samples had lead values that exceeded the RCRA limits for TCLP (5 mg/L). Other metals detected at concentrations exceeding their background values are antimony (two samples), silver (four samples), barium (four samples), cadmium (four samples), chromium (four samples), cobalt (one sample), cadmium (four samples), chromium (four samples), copper (four samples), manganese (four samples), nickel (four samples), tellurium (one sample), tin (four samples), vanadium (two samples), and zinc (four samples). The following metals exceeded USEPA Region 9 action level criteria: aluminum (three samples), antimony (two samples), arsenic (four samples), barium (two samples), cadmium (three samples), chromium (three samples), copper (four samples), lead (four samples), manganese (four samples), and zinc (four samples). Two of the samples also had detectable quantities of TPH; however, neither sample exceeded the Indiana state action level of 100 ppm for soil.

Results of the wipe sample show that both lead and zinc were detectable on the concrete surface, but neither metal was present at significant concentrations. There are no screening

criteria for metals wipe sample data. The TPH concentration was relatively high at 390 mg per square centimeter; this was anticipated because the wipe sample was collected from an area stained with a black tar-like substance (probably melted roofing materials). There are no action level criteria for TPH wipe sample data.

In January 1997, an interim measures removal action was initiated. The concrete pad was removed and contaminated soils surrounding the former pad were excavated and properly disposed of at an off-site facility. Confirmation samples collected following the soil removal indicate that the only metal exceeding USEPA Region 9 criteria was lead in one sample (S15006) at a concentration of 450 µg/g versus the criteria of 400 µg/g (Table 18-2). All other metals were found to be at acceptable levels. IDEM review of the confirmation data resulted in the determination that no additional soil removal is necessary at Site 15. All confirmation samples for Site 15 were collected from a depth from 0 to 1 foot on February 11, 1997 by SAIC. Details of the interim measures activities can be found in *Closure Report, Yellow Sulfur Area and Small Burn Area (Sites 14 and 15), Jefferson Proving Ground, Madison, Indiana* (Sverdrup,1997b) and in *Confirmation Sampling Report for Sites #7, 14, 15, 26, 28, and Borrow Area for Jefferson Proving Ground, Madison, Indiana* (SAIC, 1997).

18.6 HUMAN HEALTH RISK ASSESSMENT

Due to the completion of interim measures at Site 15, no human health risk assessment was required.

18.7 ECOLOGICAL RISK ASSESSMENT

It should be noted that an interim measure (i.e., removal of a concrete pad and excavation of contaminated soil) occurred at Site 18. These results have been evaluated in the ecological risk assessment to address the effectiveness of the interim measure to reduce ecological risks. The original ecological risk calculations are provided for informational purposes to support the need for the interim measure.

18.7.1 Ecological Site Description

The area surrounding Site 15 is grass covered; however, it was not regularly mowed or included in the open burn program (see Figure 18-1). There are woods on the south side of the intermittent drainage and numerous willows and other phreatophytes along the drainage. There are no trees on the north side of the drainage in the vicinity of the site. Around the burn area, the soil was black and ash covered, and no vegetation was noted. Vegetation in the surrounding areas was in good to excellent condition; species observed included honeysuckle, teasel, hop-clover, dewberry, red cedar, milkweed, greenbriar, mullein, chickweed, clover, and Virginia creeper. **Refer to Figure 5.3-13 for a map of habitat types at JPG. (EPA184)** The only wildlife observed was a dragonfly. Various bird calls were heard, but no other signs of wildlife were noted. **Refer to Table 18.7-a1 for a summary of Site 15 ecological habitat characteristics identified during site visits. (EPA184)**

18.7.2 Site 15 Investigations

For convenience to the reader, summary statistics, EPCs, risk driver HQs, total RME, and CT HIs are provided in this section. All intakes and other non risk-driving HQs are located in Appendix AA. **The COPCs for each medium were evaluated in the DERA are presented on the EPC tables in this section. Refer to Appendix AA for details pertaining to the specific data sets (e.g., sample numbers, depths, dates, etc.) used in the risk assessment for Site 15. (EPA179, EPA17)**

18.7.2.1 Phase I Activities. The Phase I summary statistics for soils at Site 15 are provided in Table 18.7-1. Table 18.7-2 provides the EPCs for Site 15.

18.7.2.2 Phase II Activities. Phase II data were not collected at this location.

18.7.2.3 Interim Measures and Phase III Activities. IM soil data for metals were collected at Site 15. Table 18.7-3 reports the summary statistics available for the IM sampling effort; Table 18.7-4 presents the EPCs. **IM confirmation samples were collected from an excavated area from surface to 1 foot in depth. (EPA18, ~~42~~)**

Phase III data were not collected at this location; however, the data collected at Site 14 were intended to represent Site 15 as well. Refer to Section 17.7 for the description of the Phase III sampling results at Site 14.

18.7.3 Exposure and Ecological Effects Profile

Birds and mammals may be exposed to COPCs by direct contact with or ingestion of soil. No surface water data were available at Site 15. To determine the estimated intakes of the COPCs, various key receptor species were selected to evaluate the impacts to area wildlife. The key receptors evaluated for Site 15 include mourning dove, chimney swift, American kestrel, wild turkey, white-footed mouse, eastern cottontail, red fox, little brown myotis, plants, and soil fauna.

The conceptual site model (CSM) for Site 15 provides an overview of the ecological receptors and exposure pathways evaluated in the ecological risk assessment. Refer to Figure 18.7-1a for a schematic of the CSM. Multiple terrestrial lines of evidence were evaluated for the ecological assessment conducted at Site 15. The lines of evidence were primarily hazard index (HI) calculations for a number of different receptors. Refer to Table 7.7-11a for a summary of the terrestrial ecosystem lines of evidence. (EPA180a,b)

The exposure pathways and receptors evaluated at this site are as follows:

- Terrestrial Ecosystem
  - All wildlife receptors—soil ingestion
  - All wildlife receptors—dietary ingestion
  - Plants—direct contact with soil

- Soil fauna—direct contact with soil

18.7.3.1 Selection of COPCs. Inorganic analytes from soil data collected during Phase I, IM confirmation sampling, and Phase III were compared to the JPG Phase II background data set (Section 5.3.2.1). Analytes that were not statistically elevated relative to background were removed from consideration as COPCs. The COPCs for Site 15 in the various media are presented in Tables 18.7-1 through 18.7-4.

Beryllium was not detected at Site 15 (Phase I). All other inorganic analytes were retained as COPCs. **Explosives were not detected in surface soil in the Phase I data.**

Neither cobalt nor molybdenum was detected in the IM confirmation soil samples. Aluminum, arsenic, beryllium, chromium, iron, manganese, lead, and selenium were removed as COPCs since their concentrations were not statistically elevated above background.

Neither cobalt nor thallium was detected in the Phase III data for the combined ecological study Site 14/15. Aluminum, arsenic, beryllium, iron, manganese, lead, vanadium, and zinc were removed as COPCs since their concentrations were not statistically elevated above background.

18.7.3.2 Comparison of Site Data to Reference Area Concentrations. See the description for Site 14 located in Section 17.7.3.2.

18.7.3.3 Earthworm Toxicity Test. See the ~~above~~ description for Site 14 (Section 17.7.3.3).

18.7.3.4 Phytotoxicity Test. See the ~~above~~ description for Site 14 (Section 17.7.3.4).

18.7.3.5 Soil Fauna Community Structure. See the ~~above~~ description for Site 14 (Section 17.7.3.5).

18.7.4 Risk Characterization

18.7.4.1 Risk Estimation. The HIs are summarized for each sampling event and receptor below. The HIs have been grouped by order of magnitude for discussion purposes. HIs based on RME and CT exposure parameters are presented. In addition, a ~~conservative~~ NOAEL-based TRV and a dose at which population-level effects may occur (LOAEL-based TRV) were used to establish the lower and upper bounds on toxicity, respectively.**(EPA 121)** These values define the risk boundaries. There are, thus, four sets of HI values for each location and sampling event (i.e., NOAEL-RME, NOAEL-CT, LOAEL-RME, and LOAEL-CT). The exposure intakes, HQs, and HIs are presented in Appendix AA. Figures 18.7-1 through 18.7-8 show the total NOAEL and LOAEL-based HI risks for both the RME and CT exposure scenarios by receptor. The reference area RME-NOAEL HIs were presented graphically only on the RME-NOAEL site graphs due to the low risks generally observed.

Site 15

Phase I RME NOAEL HIs
(See Figure 18.7-1)
Key Receptors with HI range 0-1: Mourning Dove, Wild Turkey, American Kestrel
HI Range 1.1-10: Chimney Swift, Red Fox,
HI Range 10.1-100: Little Brown Myotis, Eastern Cottontail
HI Range 100.1-1000: None
HI > 1000: White-footed Mouse, Plants, Soil Fauna

Phase I RME LOAEL HIs
(See Figure 18.7-2)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, Red Fox, Little Brown Myotis, American Kestrel
HI Range 1.1-10: Eastern Cottontail
HI Range 10.1-100: None
HI Range 100.1-1000: White-footed Mouse, Plants, Soil Fauna

Phase I CT NOAEL HIs
(See Figure 18.7-3)
Key Receptors with HI range 0-1: Mourning Dove, Wild Turkey, American Kestrel, Red Fox
HI Range 1.1-10: Chimney Swift
HI Range 10.1-100: Eastern Cottontail, Little Brown Myotis
HI Range 100.1-1000: None
HI > 1000: White-footed Mouse

Phase I CT LOAEL HIs
(See Figure 18.7-4)
Key Receptors with HI range 0-1: Wild Turkey, Red Fox, American Kestrel, Mourning Dove, Chimney Swift, Little Brown Myotis
HI Range 1.1-10: Eastern Cottontail
HI Range 10.1-100: None
HI Range 100.1-1000: White-footed Mouse

Site 15

IM RME NOAEL HIs
(See Figure 18.7-5)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Red Fox~~, Little Brown Myotis~~ **Soil Fauna, Plants**
HI Range 1.1-10: ~~Eastern Cottontail~~ **Little Brown Myotis**
HI Range 10.1-100: Eastern Cottontail, ~~Soil Fauna, Plants, White-footed Mouse~~
HI Range 100.1-1000: None
HI > 1000: ~~None~~ White-footed Mouse

IM RME LOAEL HIs
(See Figure 18.7-6)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Eastern Cottontail, Red Fox, Little Brown Myotis, Plants, Soil Fauna
HI Range 1.1-10: None
HI Range 10.1-100: White-footed Mouse
HI Range 100.1-1000: None

IM CT NOAEL HIs
(See Figure 18.7-7)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Red Fox, Eastern Cottontail, Little Brown Myotis
HI Range 1.1-10: None
HI Range 10.1-100: White-footed Mouse
HI Range 100.1-1000: None

IM CT LOAEL HIs
(See Figure 18.7-8)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Red Fox, Eastern Cottontail, Little Brown Myotis
HI Range 1.1-10: White-footed Mouse
HI Range 10.1-100: None
HI Range 100.1-1000: None

18.7.4.2 Risk Description. The Phase III data from Site 14 (Section 17.7) were also used to estimate risks at Site 15. Very few Phase III analytes were statistically elevated at Site 14 relative to the reference areas. Barium was statistically elevated at Site 14 relative to the soil concentrations observed in the reference areas. All other COPCs at Site 14 appeared to be within the expected ambient concentrations predicted by the data from the reference areas. The soils at Site 14 did not produce elevated levels of mortality in earthworms relative to that observed at the reference areas, nor was the soil fauna diversity or density obviously affected. Plant germination and biomass were not significantly different at Site 14 than at the reference areas.

Phase I risks for white-footed mouse, plants, and soil fauna are much higher than at the reference areas (Figure 18.7-1.) The IM confirmation sampling data (Figure 18.7-5) indicate all risks at Site 15 are less than the reference areas. The HIs for each reference area and the inherent JPG Phase II background risks can be found in Section 32.

The HIs for receptors at the reference areas can be used for comparison and determination of the relative, rather than the absolute, population-level risks at Site 15. The Phase I RME LOAEL-based HIs for Site 15, which indicate potential for population-level effects, were higher than the reference area HIs for white-footed mouse, plants, and soil fauna. The IM RME LOAEL-based HIs for Site 15 were similar to the reference areas. The IM RME LOAEL-based HIs (Figure 18.7-6) were much lower than HIs from the Phase I data for plants and soil fauna, but not for white-footed mouse (Appendix AA). The major risk to the mouse

for the IM data is due to estimated concentrations of selenium in diet; detection frequency for selenium was only 67 percent.

The HI results are in direct contrast with the results of the biometric studies at nearby Site 14, which measured a lack of population and individual level effects in earthworms and other soil invertebrates, and in plants. The results suggest that the NOAEL TRVs are overly conservative for this site, since ambient levels of inorganics in the reference areas produce high risk estimates. Few analytes at nearby Site 14 statistically exceed those at reference areas, and the biometric data failed to detect adverse effects in plants and soil fauna in direct contact with soils from Site 14. HIs for receptors other than white-footed mouse and plants are not higher than HIs at the reference areas. Consideration of all lines of evidence supports that contamination at Site 15 is not a likely threat to ecological health at JPG.

18.7.4.2.1 Risk Drivers/Summary of Lines of Evidence. Risk drivers associated with Site 15 are summarized in Tables 18.7-5 through 18.7-8. A COPC was categorized as a risk driver if it produced an HQ greater than or equal to 1 for any exposure pathway.

In addition, to provide an overall summary of the multiple lines of evidence that were evaluated for the Site, a summary table was developed. The lines of evidence were hazard index (HI) calculations for a number of different terrestrial receptors. Refer to Table 7.7-11a for a summary of the lines of evidence. An evaluation was made of which measurement endpoints were most sensitive in determining the potential for an ecological concern by ecosystem. (EPA180a,b)

Terrestrial Ecosystem

The most sensitive of the terrestrial measurement endpoints for Site 15 are white-footed mice, plants, and soil fauna. The reasonable maximum exposure (RME) no observed adverse effect level (NOAEL)-based hazard indices (HIs) for each of these receptors are as follows: 5974 (white-footed mice), 2127 (plants), and 1313 (soil fauna). The primary contributors of risk to white-footed mice are copper (RME NOAEL HQ of 3140), selenium (RME NOAEL HQ of 681), and zinc (RME NOAEL HQ of 447) from dietary ingestion. The primary contributors of risk to plants are zinc (RME NOAEL HQ of 657), copper (RME NOAEL HQ of 655), and aluminum (RME NOAEL HQ of 609) from direct contact with soil. The primary contributors of risk to soil fauna are copper (RME NOAEL HQ of 781) and zinc (RME NOAEL HQ of 329) from direct contact with soil. All these HQs were derived using Phase I data.

An interim measure was conducted at this site, and levels of contamination have been reduced. Based on Phase III data, **none of the metals listed as primary contributors to ecological risk are present at concentrations that exceed reference area concentrations. Thus, these metals (aluminum, copper, selenium, and zinc) would not be expected to contribute to ecological risk exceeding that in the reference areas. (EPA180a,b)**

18.7.4.3 Uncertainty Analysis. See the uncertainty analysis for Site 14 (Section 17.7.4.3). Because the biometric data were collected at Site 14, and not Site 15, application of these data

to evaluation of risks at Site 15 is more uncertain. In addition, Phase II data were not collected at Site 15.

18.7.5 Ecological Risk Assessment Summary

The conceptual site model (CSM) for Site 15 provides an overview of the ecological receptors and exposure pathways evaluated in the ecological risk assessment. Refer to Figure 18.7-1a for a schematic of the CSM. Site 15 will likely be used for industrial and agricultural purposes in the future. This future land use will alter the current CSM.

Multiple terrestrial lines of evidence were evaluated for the ecological assessment conducted at this site. The lines of evidence were primarily hazard index (HI) calculations for a number of different receptors. Refer to Table 7.7-11a for a summary of the terrestrial ecosystem lines of evidence. (EPA180a,b)

The following is an overall summary of the key results of the ecological risk assessment for Site 15. ~~The following summary is based on an initial review of the data. A full evaluation of whether or not the data meet all DQOs, and further statistical examination, will be made prior to finalizing these results for the next version of this report.~~ It should be noted again that soil toxicity tests and comparisons to Phase II background soils data were not performed for Site 15. However, the data collected at Site 14 were intended to represent Site 15 as well.

- Based on the ~~ecological effects~~ toxicity test data ~~at~~ for nearby Site 14, there are probably no adverse ecological effects at this site. This is anticipated to be the case at Site 15 too.

- Based on the analytical data, there are few COPCs statistically elevated above those at the reference areas at nearby Site 14. Barium and lead are the only analytes that are statistically elevated at Site 14 relative to the reference areas.

- Phase I HIs are within the same order of magnitude, or lower than, those observed at the reference areas for all receptors except white-footed mouse, plants, and soil fauna.

- IM HIs are lower than HIs from Phase I data for plants and soil fauna; IM HIs were higher than those at the reference areas only for the white-footed mouse. The driving factor in the HI for the mouse is a hypothetical selenium concentration in diet, which is highly uncertain. HIs indicated the potential for adverse population-level effects on white-footed mice, plants, and soil fauna. However, Phase III HIs for Site 14/15 were not higher than those at reference areas. Since Phase III data were collected after the IM data, adverse ecological effects above reference area levels would not be anticipated. Other lines of evidence ~~refute~~ are not consistent with the HI results, however. Effects on earthworm mortality ~~were not observed~~, ~~nor were effects on~~ soil fauna diversity, or plant reproduction and growth were not observed, at nearby Site 14.

- IM HIs are lower than those from Phase I indicating remedial actions were largely successful at this location. The Phase III HIs are lower than the IM HIs for most receptors. These results provide additional evidence of reduced ecological risk.

- Based on the multiple lines of evidence evaluated there is probably minimal ecological risk at this location.

As discussed in Section 5, rejected analytical data for antimony were not used *quantitatively* in this risk assessment. The absence of this data may underestimate risk to ecological receptors. (EPA99)

18.8 CONCLUSIONS AND RECOMMENDATIONS

Due to the removal of the contaminated concrete pad and contaminated soils at Site 15, no human health risk assessment was conducted. Results of the confirmation sampling at the site indicate that cleanup was complete and that no further action is necessary for this site.

~~The ecological risk assessment conducted for Site 14 (see Section 17.0) also included that area of Site 15. The results of this assessment indicate that there are no adverse effects on ecological receptors at this site.~~The results of the ecological assessment conducted at Site 15 and the nearby Site 14 (see Section 17) were used together to conclude that there is minimal ecological risk remaining at Site 15 after the IM was performed.

Based on the results of the confirmation sampling conducted for Site 15 and on the ecological risk assessment conducted at Sites 14 and 15, it appears that the interim measures have reduced potential risks to human health and the environment to acceptable levels. As a result, it is recommended that a No Further Action technical memorandum be prepared and that Site 15 be removed from the RI/FS process.

TABLES

TABLE 18-1

Analytical Results for Metals in Soil Samples
Site 15 – Burn Area South of New Incinerator
Jefferson Proving Ground
Madison, Indiana

SAMPLE ID: TEST TYPE: Analyte	BAS15SF001 TOTAL (µg/g)[a]	BAS15SF001 TCLP (µg/L)[b]	BAS15SF002 TOTAL (µg/g)	BAS15SF002 TCLP (µg/L)	BAS15SF003 TOTAL (µg/g)	BAS15SF003 TCLP (µg/L)	BAS15SF004 TOTAL (µg/g)	BAS15SF004 TCLP (µg/L)	Background TOTAL (µg/g)
Aluminum	21,400	NA[c]	10,800	NA	6,520	NA	31,100	NA	16,600
Antimony	LT 19.6[d]	NA	36.9	NA	211	NA	LT 19.6	NA	0.44
Arsenic	3.24	LT	4.86	LT	2.96	LT	4.77	LT	6.30
Barium	5,300	4,500	3,300	4,100	2,600	4,600	6,700	4,700	95.0
Beryllium	LT 0.427	NA	LT 0.427	NA	LT 0.427	NA	LT 0.427	NA	0.48
Boron	10.5	NA	LT 6.64	NA	12.6	NA	22.3	NA	0
Cadmium	1.96	20.0	3.86	52.0	5.83	47.0	5.95	58.0	0
Calcium	63,000	NA	21,000	NA	25,000	NA	13,000	NA	588
Chromium	32.2	LT	27.0	LT	36.0	LT	51.6	LT	18.0
Cobalt	3.95	NA	LT 2.50	NA	LT 2.50	NA	LT 2.50	NA	5.60
Copper	9,900	NA	11,000	NA	20,000	NA	75,000	NA	5.71
Iron	35,700	NA	10,100	NA	4,790	NA	12,500	NA	11,800
Lead	6,400	100,000	4,700	10,000	1,900	3,600	23,000	43,000	16.2
Magnesium	31,800	NA	93,000	NA	75,000	NA	18,400	NA	1,000
Manganese	367	NA	690	NA	544	NA	359	NA	718
Mercury	LT 0.05	1.50	LT 0.05	LT	LT 0.05	LT	LT 0.05	LT	0
Molybdenum	LT 14.3	NA	LT 14.3	NA	LT 14.3	NA	LT 14.3	NA	0
Nickel	19.1	NA	13.7	NA	11.6	NA	33.2	NA	6.31
Potassium	661	NA	LT 131	NA	328	NA	725	NA	2,360
Selenium	LT 0.45	LT	1.05	LT	2.18	LT	2.35	LT	1.21
Silver	0.287	LT	0.620	LT	0.720	LT	0.0541	0.0447	0
Sodium	172	NA	270	NA	251	NA	335	NA	377
Thallium	LT 34.3	NA	LT 34.3	NA	LT 34.3	NA	LT 34.3	NA	0
Tin	67.7	NA	79.2	NA	32.2	NA	146	NA	0
Vanadium	27.2	NA	12.7	NA	9.61	NA	41.9	NA	31.7
Zinc	4,700	NA	7,500	NA	5,500	NA	38,000	NA	23.9
TPHC	90.8	NA	11.2	NA	LT	NA	LT	NA	NA

General Note:

1. Samples were collected on 11/18/92. [EPA 18, 42]

Footnotes:

(a) Micrograms per gram.
(b) Toxicity Characteristic Leaching Procedure results in micrograms per liter.
(c) Not analyzed.
(d) Less than the reporting limit.

TABLE 18-2

Summary of Confirmation Sample Results
Site 15 – Burn Area South of New Incinerator
Jefferson Proving Ground
Madison, Indiana

SAMPLE ID: Analyte	S15001 (µg/g)[a]	S15002 (µg/g)	S15003 (µg/g)	S15003 Duplicate (µg/g)	S15004 (µg/g)	S15005 (µg/g)	S15006 (µg/g)	S15007 (µg/g)	S15008 (µg/g)	S15208 (µg/g)
Silver	1.20 U[b]	1.20 U	1.20 U	1.20 U	1.1 U	1.20 U	1.20 U	1.1 U	1.20 U	1.20 U
Aluminum	11000.00	6100.00	11000.00	12000.00	5500.00	7400.00	6000.00	4700.00	7700.00	12000.00
Arsenic	4.7 J[c]	3.2 J	4.5 J	5 J	1.1 J	5.5 J	0.6 UJ	2.9 J	4.4 J	5.1 J
Boron	10.00 U	10.00 U	10.00 U	10.00 U	10.00 U	4.4 B[d]	10.00 U	8.5 B	10.00 U	10.00 U
Barium	76.00	130.00	93.00	81.00	130.00	310.00	960.00	120.00	78.00	61.00
Beryllium	0.43 BJ	0.25 BJ	0.44 BJ	0.56 BJ	0.14 BJ	0.27 BJ	0.17 BJ	0.19 BJ	0.50 BJ	0.29 B
Calcium	1500 J	44000.00	3500.00	1800.00	79000.00	33000.00	24000.00	120,000	2100 J	1300 J
Cadmium	0.19 BJ	0.53 BJ	0.93 J	0.85 J	0.65 J	0.44 BJ	1.4 J	0.33 BJ	0.62 BJ	0.18 BJ
Cobalt	4.1 BU	2.7 BU	3.8 BU	3.7 BU	2.0 BU	3.3 BU	3.0 BU	2.0 BU	2.6 BU	2.8 BU
Chromium	11.00	11.00	15.00	23.00	8.00	12.00	9.00	6.90	10.00	12.00
Copper	7.1 J	16.00	93.00	23.00	15.00	23.00	410.00	9.1 J	11 J	7.1 J
Iron	10000 J	10000 J	25000 J	29000 J	7000 J	10000 J	7300 J	5600 J	19000 J	11000 J
Mercury	0.12 U	0.046 BJ	0.12 U	0.59 U	0.11 U	0.12 U	0.12 U	0.11 U	0.12 U	0.12 U
Potassium	290 BU	250 BU	330 BU	380 BU	170 BU	430 BU	210 BU	580U	170 BU	370 BU
Magnesium	1500.00	12000.00	3200.00	2600.00	39000.00	12000.00	11000.00	35000.00	2700.00	1800.00
Manganese	57 J	920 J	86 J	86 J	340 J	180 J	130 J	340 J	60 J	29 J
Molybdenum	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Sodium	75 BJ	63 BJ	110 BJ	110 BJ	76 BJ	59 BJ	50 BJ	130 BJ	190 BJ	170 BJ
Nickel	8.00	7.70	7.80	9.00	5.10	6.50	3.5 B	4.90	5.60	5.50
Lead	11 J	28 J	16 J	17 J	9.5 J	51 J	370 J	18 J	9.1 J	9.8 J
Selenium	0.62 UJ	0.59 UJ	0.62 UJ	0.62 UJ	11 J	0.29 BJ	0.52 BJ	0.26 BJ	0.26 BJ	0.21 BJ
Thallium	0.62 U	1.2 J	1 J	1.4 J	0.76 J	0.58 U	0.60 U	7.6 J	5.5 J	0.61 U
Vanadium	13 J	17 J	18 J	30 J	12 J	17 J	12 J	11 J	17 J	12 J
Zinc	19 J	32 J	95 J	43 J	100 J	41 J	380 J	34 J	23 J	18 J

Notes:
A complete description of data validation qualifiers is located in Appendix N.
Sample depths were from 0-1 foot; sampling date was 2/11/97. [EPA 18, 42]

Footnote:
(a) Micrograms per gram.
(b) U = metal analyzed but not detected.
(c) J = estimated concentration.
(d) B = value is detected between the method detection limit and the method reporting limit.

TABLE 18.7-a1

Site 15 Habitat Summary

Site 15 - Burn Area South of New Incinerator
Date: 4/17/93; 5/27/93
Acreage: 0.1
Soils mapping unit: NA
Vegetation mapping unit: Infrequently mowed grassland

General site conditions: Natural area with concrete pad
Slope: Level
Aspect: None
Drainages: 25feet to wetland drainage to south; drainage along north (15 feet)
Surface water/wetlands: Close proximity
Evidence of flood/fire: Burn area evidence
Description of surrounding area: Nature area near (25 feet) to wetland; infrequently mowed grassland

Soils
Surface layer texture: Typical
Surface color: Typical

Vegetation
Ground cover description: Infrequently mowed grassland
Species: Typical; around burn pad - soil is black and ash covered - no vegetation growing in these areas - probable contamination; pit - concrete adjacent to burn pad and filled with water; probably contaminated as well
Canopy cover: None
Species: NA
Successional status: Mid-successional grassland
Vegetation condition: good to excellent except around pad where there is no vegetation

Wildlife
Habitat type: Open grassland
Species observations: Frog; dragonfly over concrete pit
Sign Observations: Hear crow calls

Remarks: Likely environmental contamination of soil around burn pad; probable contamination of soil and water in concrete pit

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2440025.010102 MAD-1

TABLE 18.7-1

Summary Statistics for Analytes in Surface Soil
Site 15 - Burn Area South of New Incinerator
Jefferson Proving Ground
Madison,Indiana

Site	Analyte	Number of Detects	Number of Samples	Percent Detects	Minimum	Maximum	Average	Standard Deviation	UCL95 [(a)]	EPC µg/g [(b)]	Exceed Background (Bkg)?	Retain as COPC[(c)]?	Comment
15	Silver	4	4	100	0.29	1.40	0.76	0.47	1.31	1.31	Yes (Y)	Y	Not detected in Bkg.
15	Aluminum	4	4	100	6520	31100	17455	11040	30443	30443	Y	Y	
15	Arsenic	4	4	100	2.96	4.86	3.96	1.00	5.13	4.86	Y	Y	
15	Boron	0	4	0	NC[(d)]	NC	NC	NC	NC	NC	NA[(e)]	No (N)	Not a COPC
15	Barium	4	4	100	2600	6700	4475	1873	6679	6679	Y	Y	
15	Beryllium	0	4	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
15	Cadmium	4	4	100	1.96	5.95	4.40	1.89	6.62	5.95	Y	Y	
15	Cobalt	1	4	25	1.25	3.95	1.93	1.35	3.51	3.51	Y	Y	Not detected in Bkg.
15	Chromium	4	4	100	27.00	51.60	36.70	10.60	49.17	49.17	Y	Y	
15	Copper	4	4	100	9900	75000	28975	31015	65464	65464	Y	Y	
15	Iron	4	4	100	4790	35700	15773	13670	31855	31855	Y	Y	
15	Mercury	0	4	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
15	Manganese	4	4	100	359.0	690.0	490.0	158.3	676.3	676.3	Y	Y	
15	Molybdenum	0	4	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
15	Nickel	4	4	100	11.60	33.20	19.40	9.73	30.84	30.84	Y	Y	
15	Lead	4	4	100	1900	23000	9000	9516	20196	20196	Y	Y	
15	Antimony	2	2	100	36.90	211.0	124.0	123.1	673.6	211.0	Y	Y	
15	Selenium	3	3	100	1.05	2.35	1.86	0.71	3.05	2.35	Y	Y	
15	Tin	4	4	100	32.20	146.0	81.28	47.56	137.2	137.2	Y	Y	Not detected in Bkg.
15	Tellurium	1	4	25	7.45	34.20	14.14	13.38	29.87	29.87	Y	Y	Not detected in Bkg.
15	Thallium	0	4	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
15	Vanadium	4	4	100	9.61	41.90	22.85	14.83	40.30	40.30	Y	Y	
15	Zinc	4	4	100	4700.00	38000	13925	16093	32859	32859	Y	Y	
15	Total petroleum hydrocarbons	2	4	50	5.00	90.80	28.00	41.97	77.38	77.38	Y	Y	No bkg. data

Note:

1. Calcium, magnesium, sodium and potassium were not included in risk assessment as they are macronutrients.

Footnotes:

(a) Upper 95% confidence limit.

(b) Exposure point concentration, micrograms per gram, equivalent to parts per million.

(c) Contaminant of potential concern.

(d) Not calculated. Not a COPC.

(e) Not applicable or not evaluated.

TABLE 18.7-2

Summary of Contaminants of Potential Concern (COPC) Exposure Point Concentrations by Medium (Phase I)
Site 15 - Burn Area South of New Incinerator
Jefferson Proving Ground
Madison, Indiana

	Measured Concentrations in Abiotic Media				Estimated Concentrations in Biotic Media								
Analyte Name	Filtered Surface Water (µg/L) [(a)]	Sediment (mg/kg) [(b)]	Unfiltered Surface Water (mg/L) [(c)]	Soil (mg/kg)	Plant (mg/kg)	Invertebrate (mg/kg)	Mouse (mg/kg)	Swift (mg/kg)	Aquatic Plants (mg/kg)	Benthic Invertebrate (mg/kg)	Fish (mg/kg)	Frogs (mg/kg)
Aluminum				30443	1.22E+02	3.35E+02	8.37E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Antimony				211.0	5.55E+01	4.03E+01	4.85E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic				4.86	1.02E-01	5.49E-01	8.46E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Barium				6679	9.82E+02	2.40E+02	1.19E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium				5.95	2.38E+00	2.21E+01	2.97E-02	4.55E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium				49.17	5.90E-01	1.28E+00	9.59E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt				3.51	6.32E-02	1.23E-01	1.63E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper				65464	6.48E+03	5.76E+04	5.00E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Iron				31855	1.27E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead				20196	2.63E+03	1.41E+03	1.94E+00	1.05E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Manganese				676.3	2.50E+01	2.57E+01	7.78E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel				30.84	1.36E+00	1.54E+00	6.20E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Selenium				2.35	2.23E+01	1.84E+01	4.26E+00	2.43E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Silver				1.31	6.29E-02	1.57E-01	1.13E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tellurium				29.87	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tin				137.2	4.12E+00	0.00E+00	4.66E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total petroleum hydrocarbons				77.38	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Vanadium				40.30	1.21E-01	3.63E-01	5.03E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc				32859	1.81E+04	2.17E+04	1.33E+03	2.51E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Footnotes:
(a) Micrograms per liter, equivalent to parts per billion.
(b) Milligrams per kilograms, equivalent to parts per million.
(c) Milligrams per liter, equivalent to parts per million.

TABLE 18.7-3

Summary Statistics for Analytes in Surface Soil
IM Confirmation Sampling Data
Site 15 - Burn Area South of New Incinerator
Jefferson Proving Ground
Madison, Indiana

Site	Medium	Analyte Code	Analyte	Number of Detects	Number of Samples	Detection Frequency	Minimum	Maximum	Average	Standard Deviation	UCL95 (a)	EPC µg/g (b)	Exceed Background (Bkg)?	Retain as COPC(c)?	Comment
15	CSO	AG	Silver	0	9	0	NC[d]	NC	NC	NC	NC	NC	NA[e]	No (N)	Not a COPC
15	CSO	AL	Aluminum	9	9	100	4700	12000	7989	2794	9696	9695.99	N	N	
15	CSO	AS	Arsenic	8	9	89	0.30	5.50	3.55	1.83	4.67	4.67	N	N	
15	CSO	B	Boron	2	9	22	4.40	8.50	5.32	1.21	6.06	6.06	Yes (Y)	Y	Not detected in Bkg.
15	CSO	BA	Barium	9	9	100	61.0	960.0	216.9	288.5	393.1	393.1	Y	Y	
15	CSO	BE	Beryllium	9	9	100	0.14	0.50	0.30	0.14	0.39	0.39	N	N	
15	CSO	CD	Cadmium	9	9	100	0.18	1.40	0.58	0.38	0.81	0.81	Y	Y	
15	CSO	CO	Cobalt	0	9	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
15	CSO	CR	Chromium	9	9	100	6.90	19.00	10.99	3.48	13.11	13.11	N	N	
15	CSO	CU	Copper	9	9	100	7.10	410.0	61.8	131.5	142.2	142.2	Y	Y	
15	CSO	FE	Iron	9	9	100	5600	27000	11878	6846	16061	16061	N	N	
15	CSO	HG	Mercury	1	9	11	0.05	0.06	0.06	0.00	0.06	0.06	Y	Y	Not detected in Bkg.
15	CSO	MN	Manganese	9	9	100	29.00	920.0	238.0	281.11	409.8	409.8	N	N	
15	CSO	MO	Molybdenum	0	9	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
15	CSO	NI	Nickel	9	9	100	3.50	8.40	6.13	1.64	7.13	7.13	Y	Y	
15	CSO	PB	Lead	9	9	100	9.10	370.0	58.1	117.7	130.0	130.0	N	N	
15	CSO	SB	Antimony	no data	no data	no data	no data	no data	no data	no data	no data	no data	NA	NA	
15	CSO	SE	Selenium	6	9	67	0.21	11.00	1.50	3.57	3.67	3.67	Y	Y	
15	CSO	SN	Tin	no data	no data	no data	no data	no data	no data	no data	no data	no data	NA	NA	
15	CSO	TL	Thallium	5	9	56	0.29	7.60	1.94	2.69	3.58	3.58	Y	Y	
15	CSO	V	Vanadium	9	9	100	11.0	24.0	15.0	4.18	17.56	17.56	N	N	
15	CSO	ZN	Zinc	9	9	100	18.0	380.0	79.6	115.8	150.3	150.3	Y	Y	

General Note:

1. Calcium, magnesium, sodium and potassium were not included in risk assessment as they are macronutrients.

Footnotes:

(a) Upper 95% confidence limit.

(b) Exposure point concentration, micrograms per gram, equivalent to parts per million.

(c) Contaminant of potential concern.

(d) Not calculated. Not a COPC.

(e) Not applicable or not evaluated.

TABLE 18.7-4

Summary of Contaminants of Potential Concern (COPC) Exposure Point Concentrations by Medium
IM Confirmation Sampling Data
Site 15 - Burn Area South of New Incinerator
Jefferson Proving Ground
Madison, Indiana

	Measured Concentrations in Abiotic Media				Estimated Concentrations in Biotic Media								
Analyte Name	Filtered Surface Water (µg/L) [(a)]	Sediment (mg/kg) [(b)]	Unfiltered Surface Water (mg/L) [(c)]	Soil (mg/kg)	Plant (mg/kg)	Invertebrate (mg/kg)	Mouse (mg/kg)	Swift (mg/kg)	Aquatic Plants (mg/kg)	Benthic Invertebrate (mg/kg)	Fish (mg/kg)	Frogs (mg/kg)
Barium				393.1	5.78E+01	1.42E+01	7.01E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Boron				6.06	2.42E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium				0.81	3.26E-01	3.03E+00	4.07E-03	6.23E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper				142.2	1.41E+01	1.25E+02	1.09E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury				0.06	1.20E-04	8.64E-02	5.51E-02	1.12E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel				7.13	3.14E-01	3.57E-01	1.43E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Selenium				3.67	3.48E+01	2.88E+01	6.66E+00	3.79E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium				3.58	1.43E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc				150.3	8.27E+01	9.92E+01	6.11E+00	1.15E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Footnotes:

(a) Micrograms per liter, equivalent to parts per billion.

(b) Milligrams per kilograms, equivalent to parts per million.

(c) Milligrams per liter, equivalent to parts per million.

Table 18.7-5
Summary of Detailed Ecological Risk Assessment Reasonable Maximum Exposure (RME) Risk Drivers
Site 15 - Phase 1
Jefferson Proving Ground
Madison, Indiana

15	NOAEL[a]-Based HQs [b] Due to Soil Ingestion or Direct Contact - RME				NOAEL-Based HQs Due to Dietary Ingestion - RME			Total NOAEL-Based HQs Summed Across Pathways - RME				
Parameter	**White-footed Mouse**	**Eastern Cottontail**	**Plants**	**Soil Fauna**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**Plants**	**Soil Fauna**
Aluminum	23.13		608.86	12.18	8.50			31.62			608.86	12.18
Antimony	9.14		42.20		101.62			110.76	1.25		42.20	
Arsenic	4.21				13.82			18.03				
Barium	24.37		13.36		109.27	1.48		133.64	2.16		13.36	
Cadmium			1.98		31.21			31.52			1.98	
Chromium			9.83	122.93							9.83	122.93
Cobalt								1.22				
Copper	130.83	3.64	654.64	781.20	3137.97	5.36	8.37	3268.80	8.99	8.56	654.64	781.20
Iron	8.28			31.86				9.09				31.86
Lead	131.17	3.65	112.82	33.33	642.73	7.06		773.90	10.71		112.82	33.33
Manganese			1.35								1.35	
Nickel			1.23								1.23	
Selenium	1.61		2.35		681.38	6.29		682.98	6.34		2.35	
Tin	212.22	5.90			155.98	2.63		368.20	8.53			
Vanadium	62.82	1.75	20.15	2.02	18.47			81.29	1.82		20.15	2.02
Zinc	15.06		657.17	328.59	446.59	3.43		461.66	3.85		657.17	328.59
HI[c]_NOAEL	**622.8**	**14.94**	**2126**	**1312**	**5348**	**26.25**	**8.37**	**5973**	**43.65**	**8.56**	**2126**	**1312**

15	LOAEL[d]-Based HQs Due to Soil Ingestion - RME			LOAEL-Based HQs Due to Dietary Ingestion - RME	Total LOAEL-Based HQs Summed Across Pathways - RME		
Parameter	**White-footed Mouse**	**Plants**	**Soil Fauna**	**White-footed Mouse**	**White-footed Mouse**	**Plants**	**Soil Fauna**
Aluminum	11.73	41.70	10.87	4.31	16.04	41.70	10.87
Antimony	3.05			33.87	36.92		
Arsenic				1.09	1.42		
Copper		61.64	163.66			61.64	163.66
Iron	4.14				4.54		
Lead	3.09	40.88		15.12	18.21	40.88	
Selenium				45.43	45.53		
Tin	9.72			7.14	16.86		
Vanadium	20.94			6.16	27.10		
Zinc	2.51	86.70	38.03	74.43	76.94	86.70	38.03
HI_LOAEL	**55.17**	**230.9**	**212.6**	**187.6**	**243.6**	**230.9**	**212.6**

Footnotes:

(a) No Observed Adverse Effect Level

(b) Hazard Quotient

(c) Hazard Index

(d) Lowest Observed Adverse Effect Level

Table 18.7-6
Summary of Detailed Ecological Risk Assessment Central Tendency (CT) Risk Drivers
Site 15 - Phase 1
Jefferson Proving Ground
Madison, Indiana

15	NOAEL[a]-Based HQs[b] Due to Soil Ingestion - CT		NOAEL-Based HQs Due to Dietary Ingestion - CT			Total NOAEL-Based HQs Summed Across Pathways - CT		
Parameter	**White-footed Mouse**	**Eastern Cottontail**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**
Aluminum	9.65		3.55			13.20		
Antimony	3.81		42.42			46.24		
Arsenic	1.76		5.77			7.53		
Barium	10.17		45.62			55.79		
Cadmium			13.03			13.16		
Copper	54.62	1.48	1310.02	2.17	7.89	1364.64	3.65	8.07
Iron	3.46					3.79		
Lead	54.76	1.48	268.32	2.86		323.08	4.35	
Selenium			284.46	2.55		285.13	2.57	
Tin	88.59	2.39	65.12	1.07		153.71	3.46	
Vanadium	26.23		7.71			33.94		
Zinc	6.29		186.44	1.39		192.73	1.56	
HI[c]_NOAEL	**259.3**	**5.35**	**2232**	**10.05**	**7.89**	**2493**	**15.59**	**8.07**

15	LOAEL[d]-Based HQs Due to Soil Ingestion - CT	LOAEL-Based HQs Due to Dietary Ingestion - CT	Total LOAEL-Based HQs Summed Across Pathways - CT
Parameter	**White-footed Mouse**	**White-footed Mouse**	**White-footed Mouse**
Aluminum	4.90	1.80	6.69
Antimony	1.27	14.14	15.41
Iron	1.73		1.90
Lead	1.29	6.31	7.60
Selenium		18.96	19.01
Tin	4.06	2.98	7.04
Vanadium	8.74	2.57	11.31
Zinc	1.05	31.07	32.12
HI_LOAEL	**23.03**	**77.84**	**101.1**

Footnotes:
(a) No Observed Adverse Effect Level
(b) Hazard Quotient
(c) Hazard Index
(d) Lowest Observed Adverse Effect Level

Table 18.7-7
Summary of DERA RME Risk Drivers
Site 15 - Interim Measures Confirmation Sampling
Jefefrson Proving Ground
Madison, Indiana

15	NOAEL[a]-Based HQs[b] Due to Soil Ingestion or Direct Contact - RME			NOAEL-Based HQs Due to Dietary Ingestion - RME	Total NOAEL-Based HQs Summed Across Pathways - RME		
Parameter	White-footed Mouse	Plants	Soil Fauna	White-footed Mouse	White-footed Mouse	Plants	Soil Fauna
Barium	1.43			6.43	7.87		
Boron				3.63	3.67		
Chromium		2.62	32.79			2.62	32.79
Copper		1.42	1.70	6.81	7.10	1.42	1.70
Thallium					1.02		
Vanadium	27.37	8.78		8.05	35.41	8.78	
Zinc		3.01	1.50	2.04	2.11	3.01	1.50
HI[c]_NOAEL	**28.80**	**15.83**	**35.99**	**26.97**	**57.18**	**15.83**	**35.99**

15	LOAEL[d]-Based HQs Due to Soil Ingestion - RME	LOAEL-Based HQs Due to Dietary Ingestion - RME	Total LOAEL-Based HQs Summed Across Pathways - RME
Parameter	White-footed Mouse	White-footed Mouse	White-footed Mouse
Boron		1.82	1.83
Vanadium	9.12	2.68	11.80
HI_LOAEL	**9.12**	**4.50**	**13.64**

15	NOAEL-Based HQs Due to Soil Ingestion - CT	NOAEL-Based HQs Due to Dietary Ingestion - CT	Total NOAEL-Based HQs Summed Across Pathways - CT
Parameter	White-footed Mouse	White-footed Mouse	White-footed Mouse
Barium		2.69	3.28
Boron		1.52	1.53
Copper		2.85	2.96
Vanadium	11.42	3.36	14.78
HI_NOAEL	**11.42**	**10.40**	**22.56**

15	LOAEL-Based HQs Due to Soil Ingestion - CT	LOAEL-Based HQs Due to Dietary Ingestion - CT	Total LOAEL-Based HQs Summed Across Pathways - CT
Parameter	White-footed Mouse	White-footed Mouse	White-footed Mouse
Vanadium	3.81	1.12	4.93
HI_LOAEL	**3.81**	**1.12**	**4.93**

Footnotes:

(a) No Observed Adverse Effect Level

(b) Hazard Quotient

(c) Hazard Index

(d) Lowest Observed Adverse Effect Level

Table 18.7-8
Summary of Detailed Ecological Risk Assessment Central Tendency (CT) Risk Drivers
Site 15 - Interim Measures
Jefferson Proving Ground
Madison, Indiana

15	NOAEL[a]-Based HQs[b] Due to Soil Ingestion - CT	NOAEL-Based HQs Due to Dietary Ingestion - CT	Total NOAEL-Based HQs Summed Across Pathways - CT
Parameter	**White-footed Mouse**	**White-footed Mouse**	**White-footed Mouse**
Barium		2.69	3.28
Boron		1.52	1.53
Copper		2.85	2.96
Vanadium	11.42	3.36	14.78
HI[c]_NOAEL	**11.42**	**10.40**	**22.56**

15	LOAEL[d]-Based HQs Due to Soil Ingestion - CT	LOAEL-Based HQs Due to Dietary Ingestion - CT	Total LOAEL-Based HQs Summed Across Pathways - CT
Parameter	**White-footed Mouse**	**White-footed Mouse**	**White-footed Mouse**
Vanadium	3.81	1.12	4.93
HI_LOAEL	**3.81**	**1.12**	**4.93**

Footnotes:

(a) No Observed Adverse Effect Level

(b) Hazard Quotient

(c) Hazard Index

(d) Lowest Observed Adverse Effect Level

FIGURES

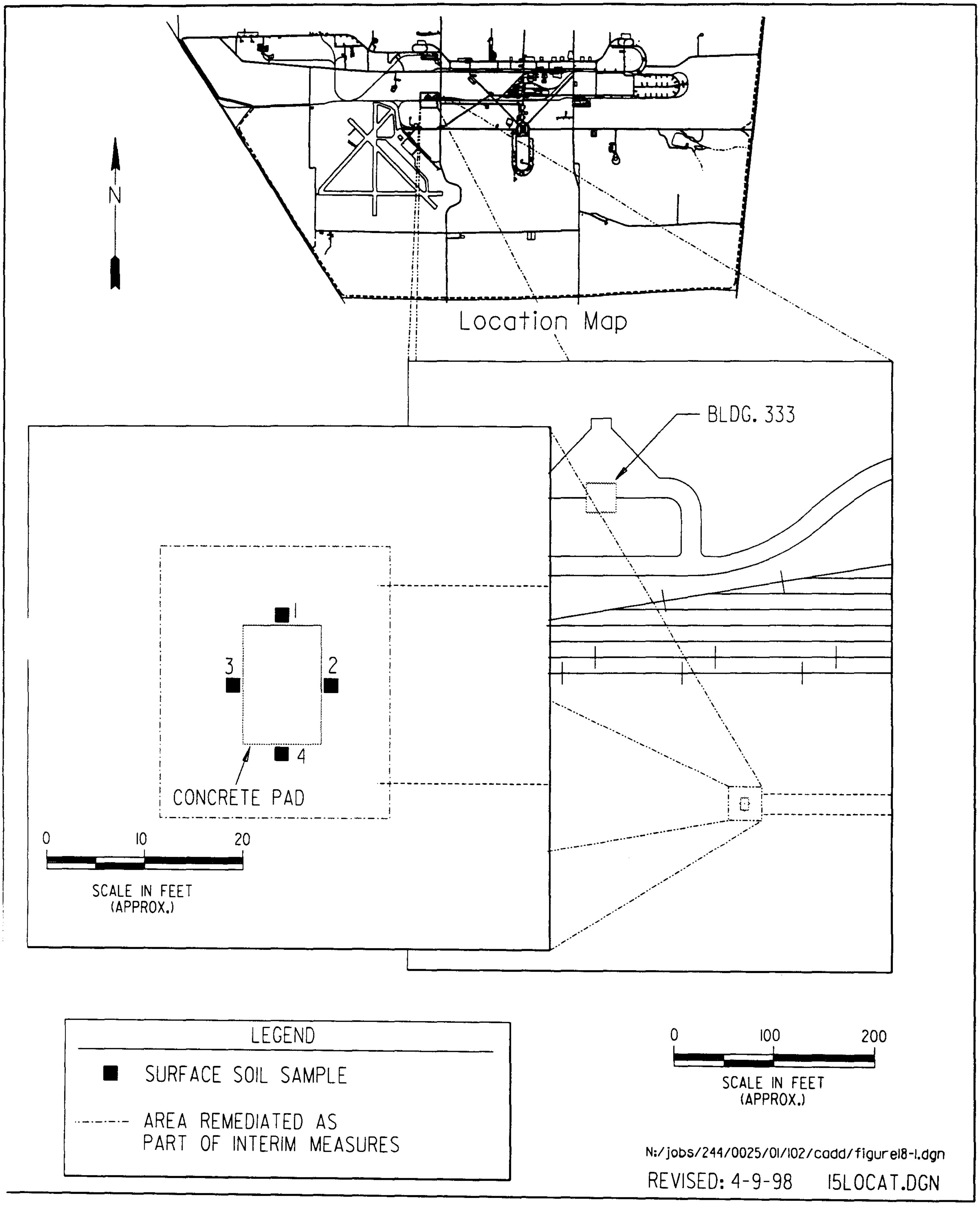


Figure 18-1. Phase I Sampling Locations at the Burn Area South of the New Incinerator (Site 15)

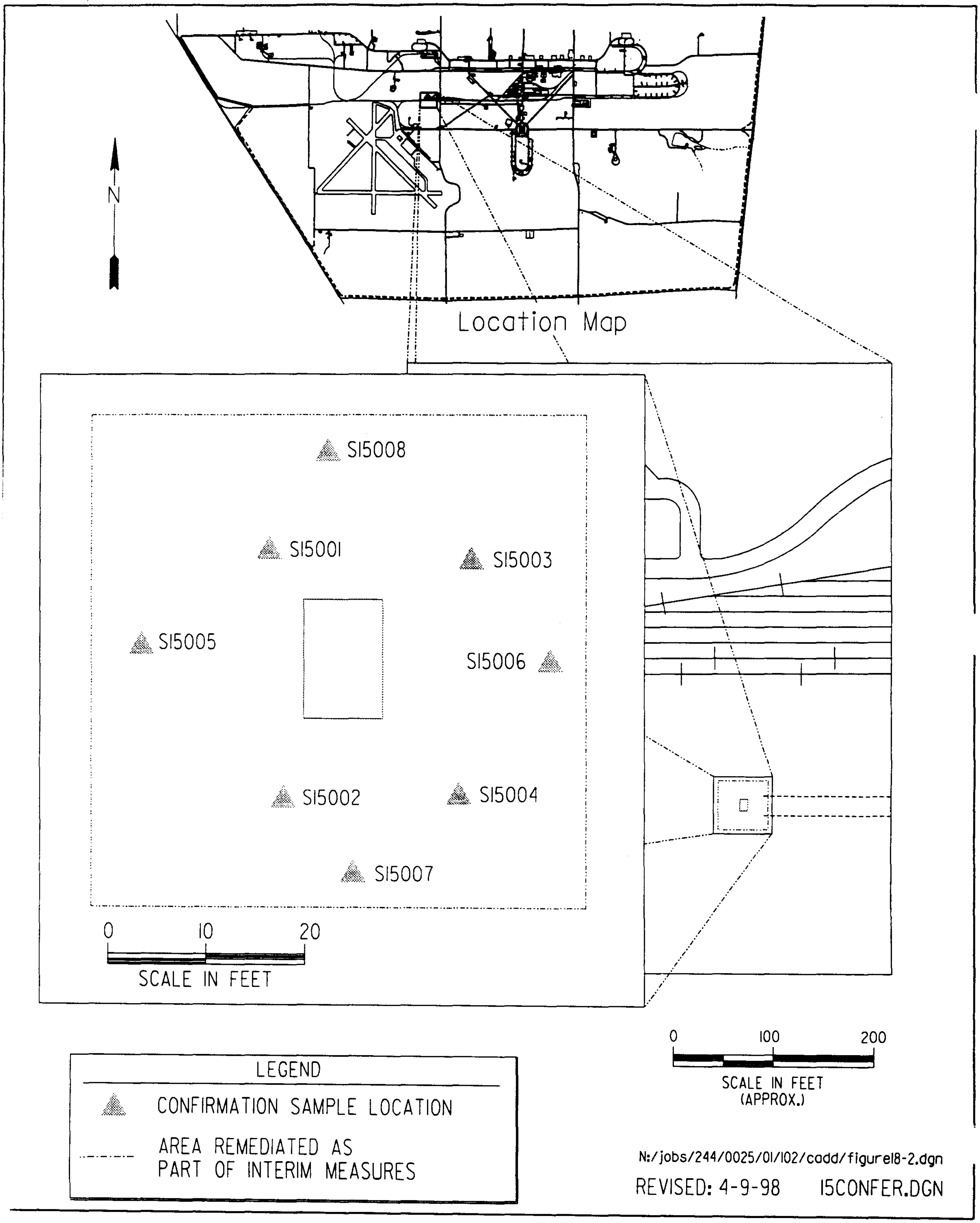
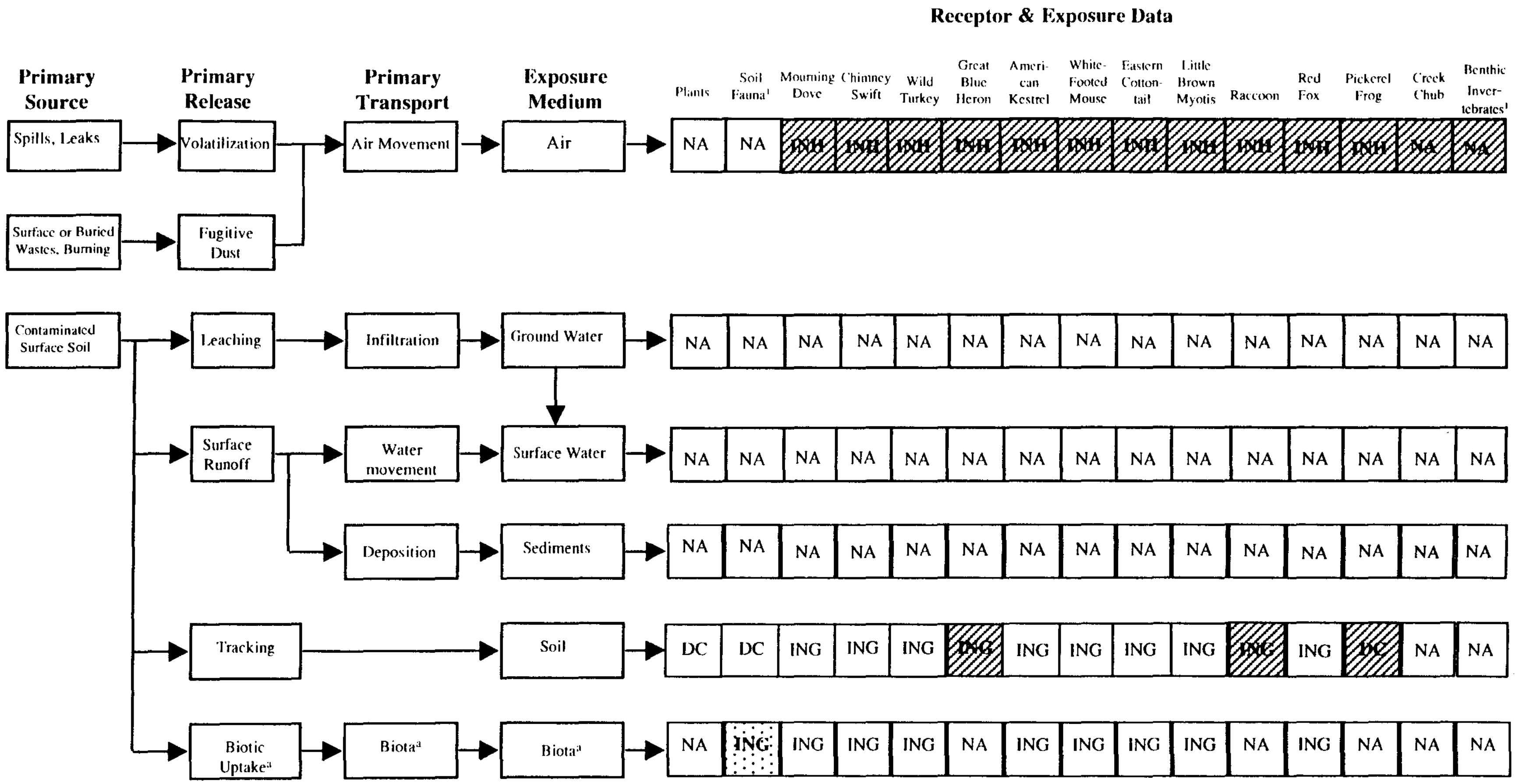


Figure 18-2. Confirmation Sample Location Map at the Burn Area South of the New Incinerator (Site 15)



Symbol	Meaning
(dotted box)	Pathway may be significant; not evaluated because toxicity criteria lacking
(hatched box)	Insignificant pathway; not quantitatively evaluated
NA	Not Applicable
ING	Ingestion
INH	Inhalation
DC	Direct Contact
1	Includes the terrestrial or aquatic crayfish
a	Refer to JPG Food Web (Figure 5.3-5)

Figure 18.7-1a
JPG Conceptual Site Model
Site 15

N:Jobs 244 0025 01 102 cadd figure18.7 1a.ppt

Figure 18.7-1 Total HIs - RME Risks Summed for All Pathways Based on NOAELs at Site 15 - Burn Area South of New Incinerator - Phase I

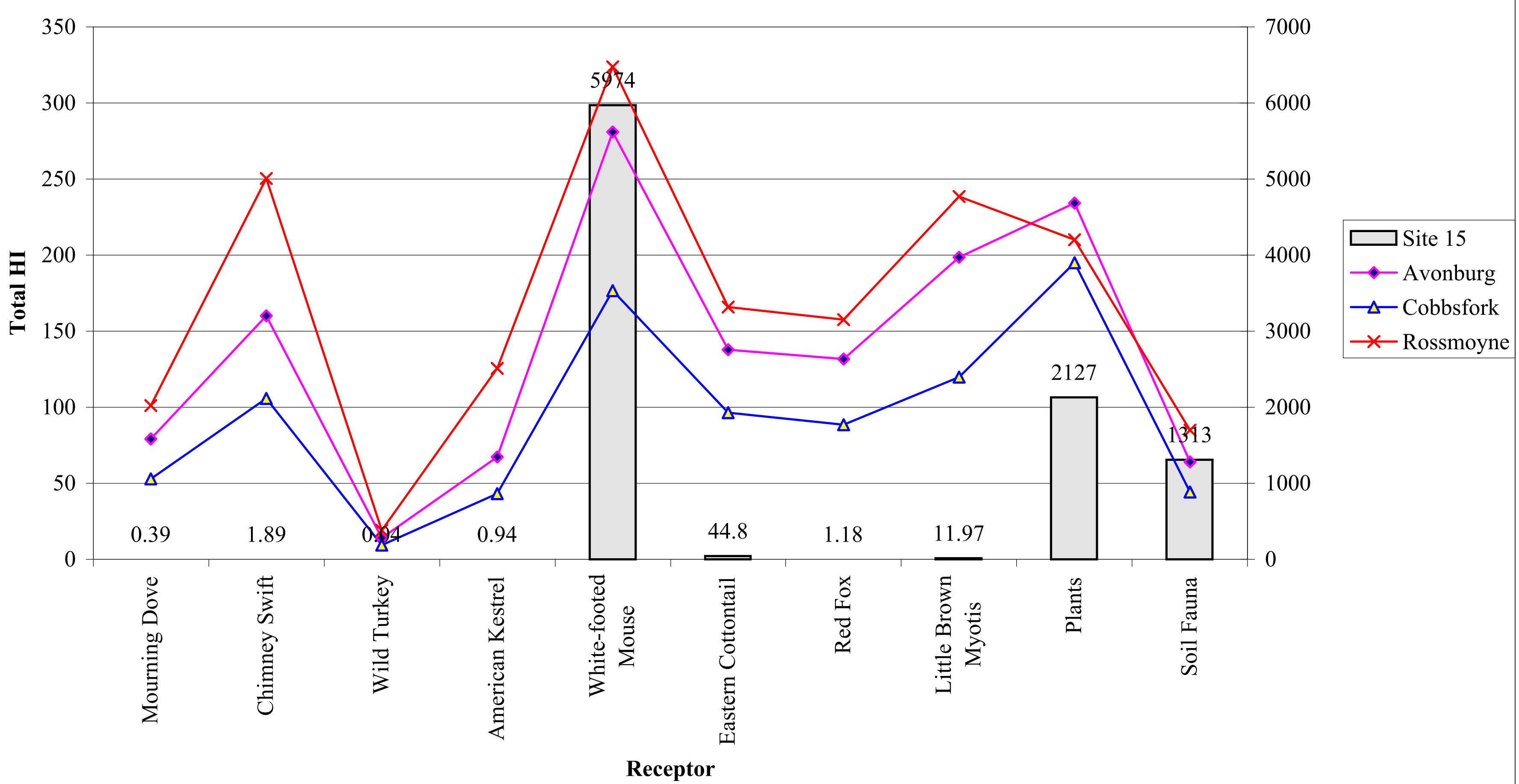


Figure 18.7-2 Total HIs - RME Risks Summed for All Pathways Based on LOAELs at Site 15 - Burn Area South of New Incinerator - Phase I

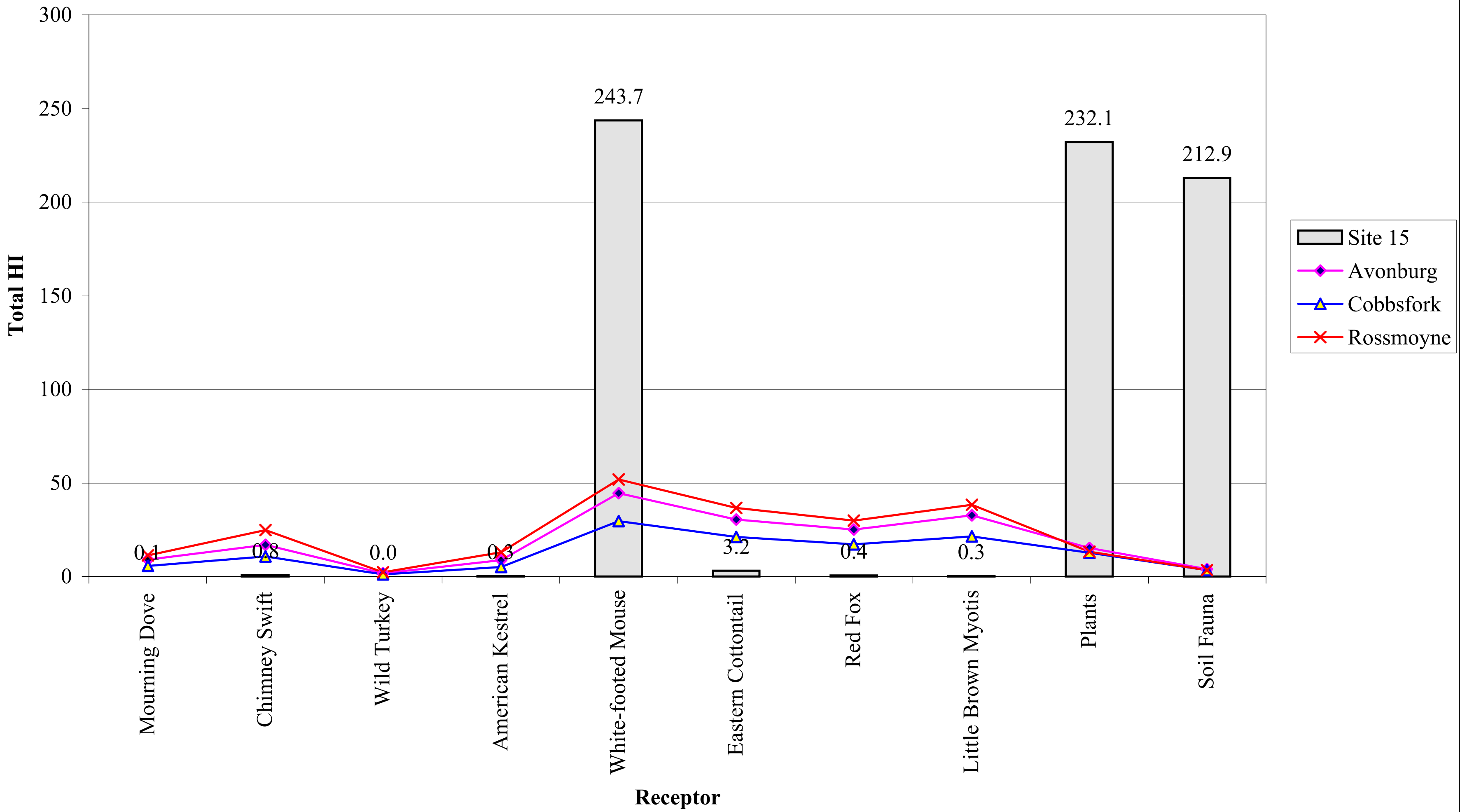


Figure 18.7-3 Total HIs - CT Risks Summed for All Pathways Based on NOAELs at Site 15 - Burn Area South of New Incinerator - Phase I

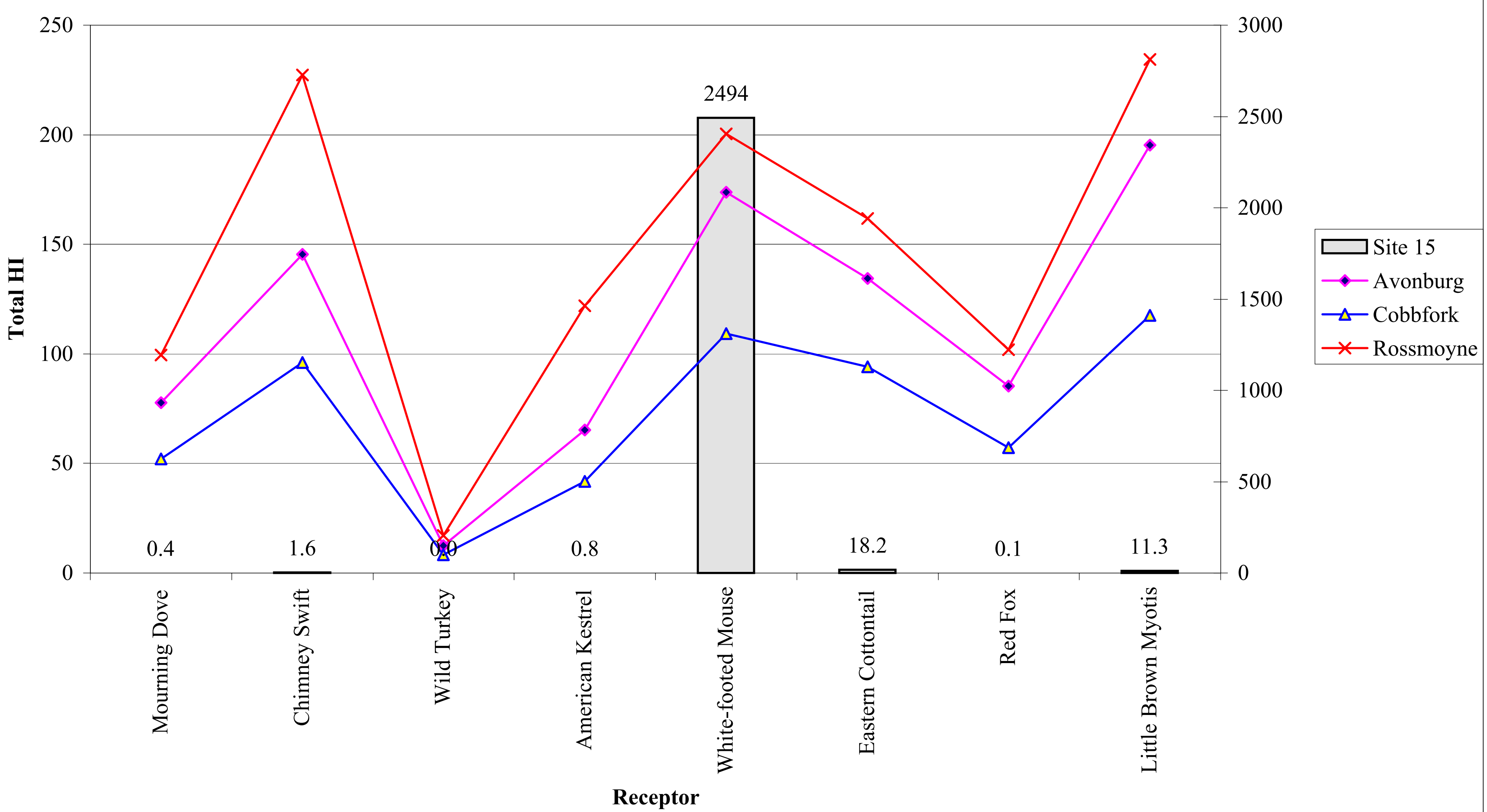
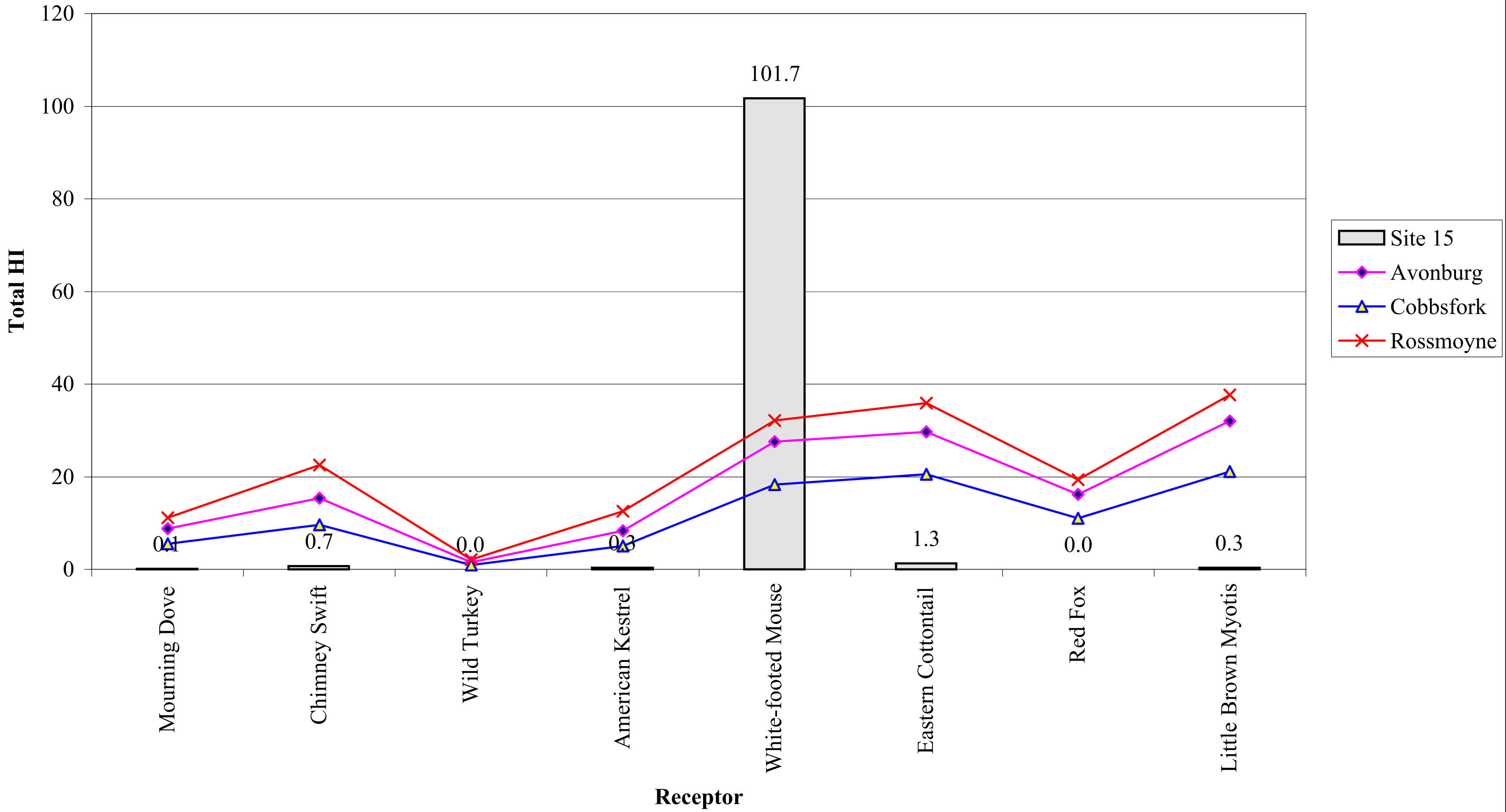
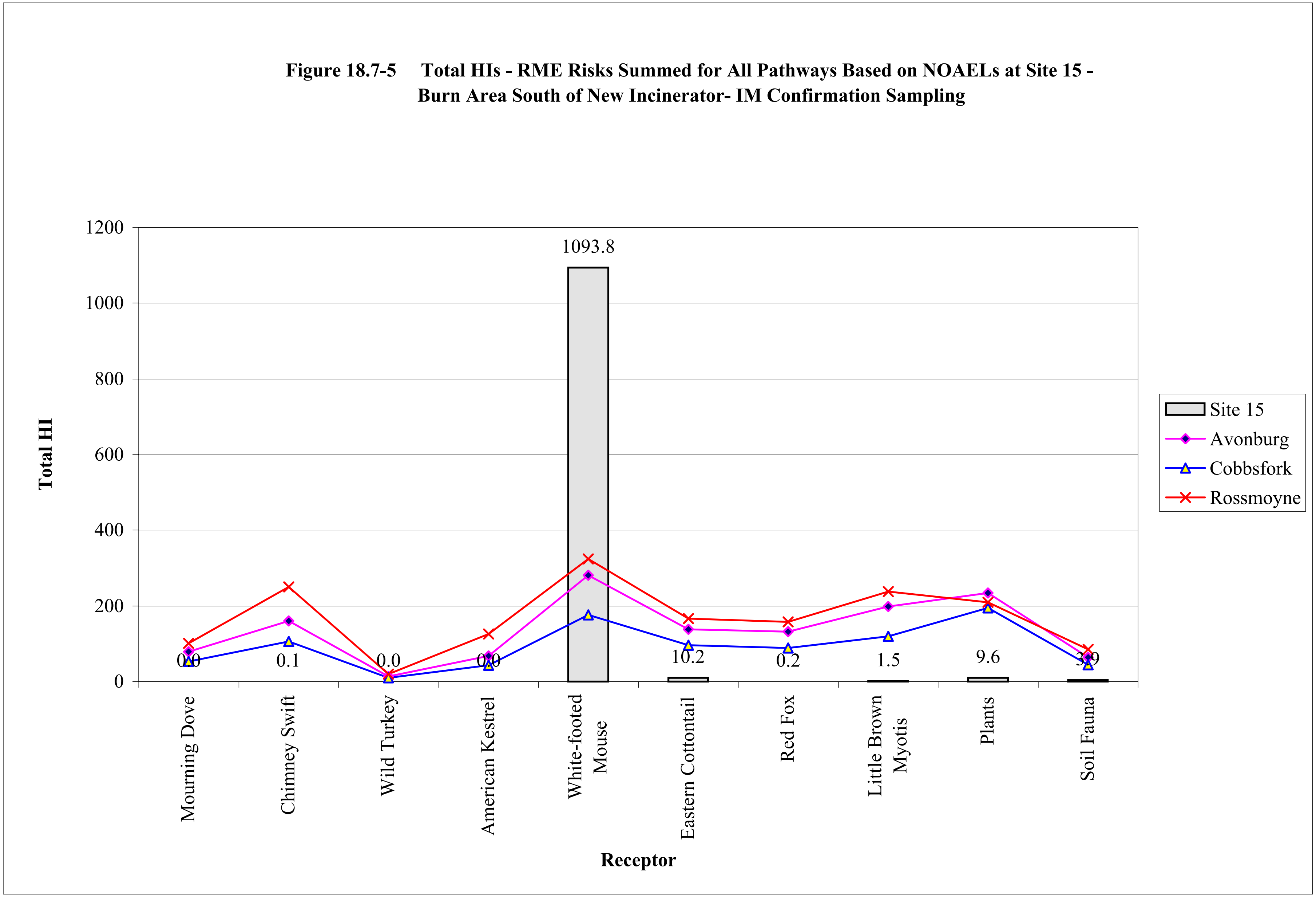


Figure 18.7-4 Total HIs - CT Risks Summed for All Pathways Based on LOAELs at Site 15 - Burn Area South of New Incinerator - Phase I

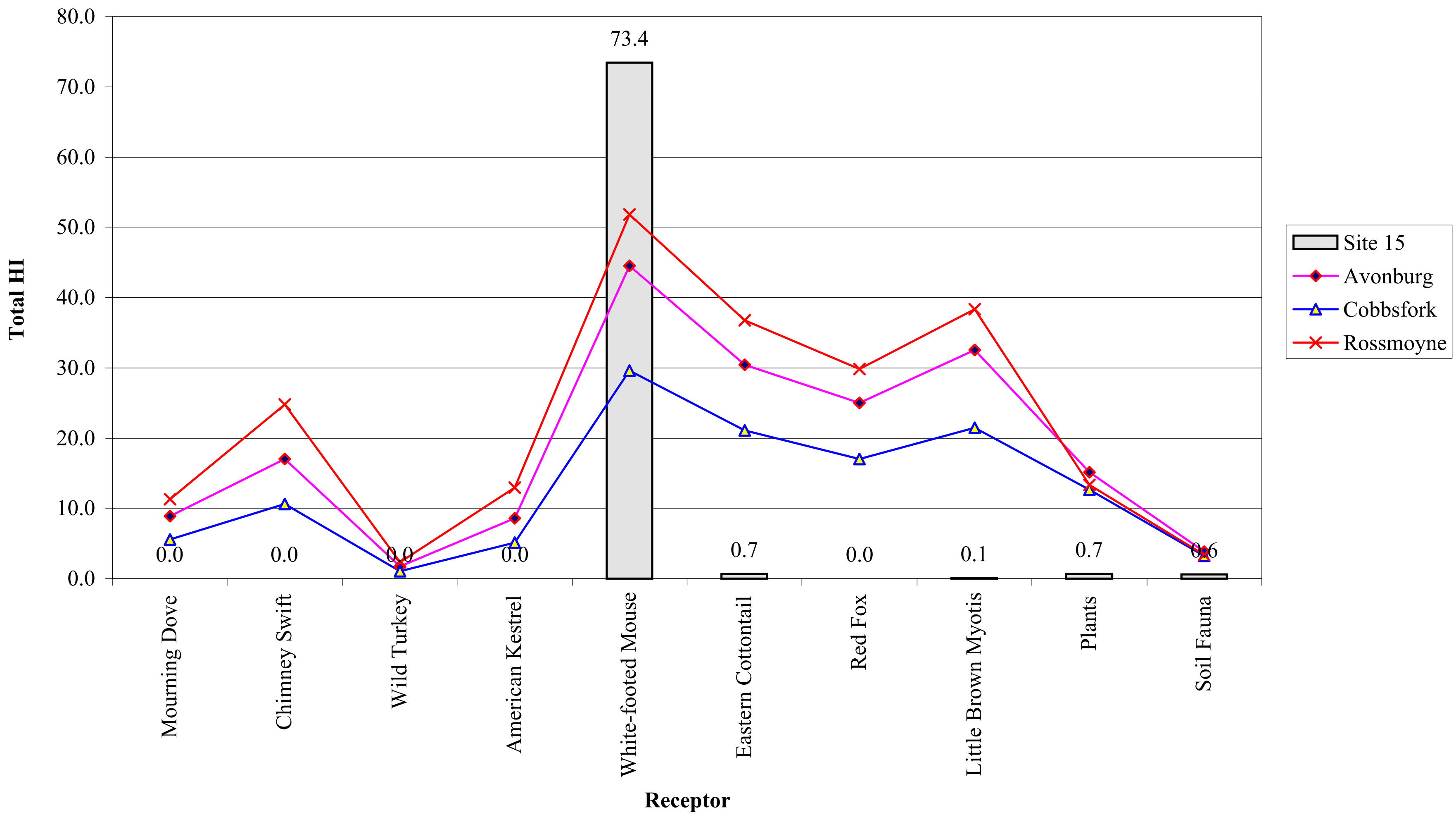


N:\jobs\244\0025\01\ET ECO Files\Jpg\Phase 1\Risk2\P1era_15MWH.xls Figure 18.7-4



N:\jobs\244\0025\01\ET ECO Files\Jpg\Im\Risk2\Eraim_15MWH.xls Figure 18.7-5

Figure 18.7-6 Total HIs - RME Risks Summed for All Pathways Based on LOAELs at Site 15 - Burn Area South of New Incinerator - IM Confirmation Sampling



N:\jobs\244\0025\01\ET ECO Files\Jpg\Im\Risk2\Eraim_15MWH.xls Figure 18.7-6

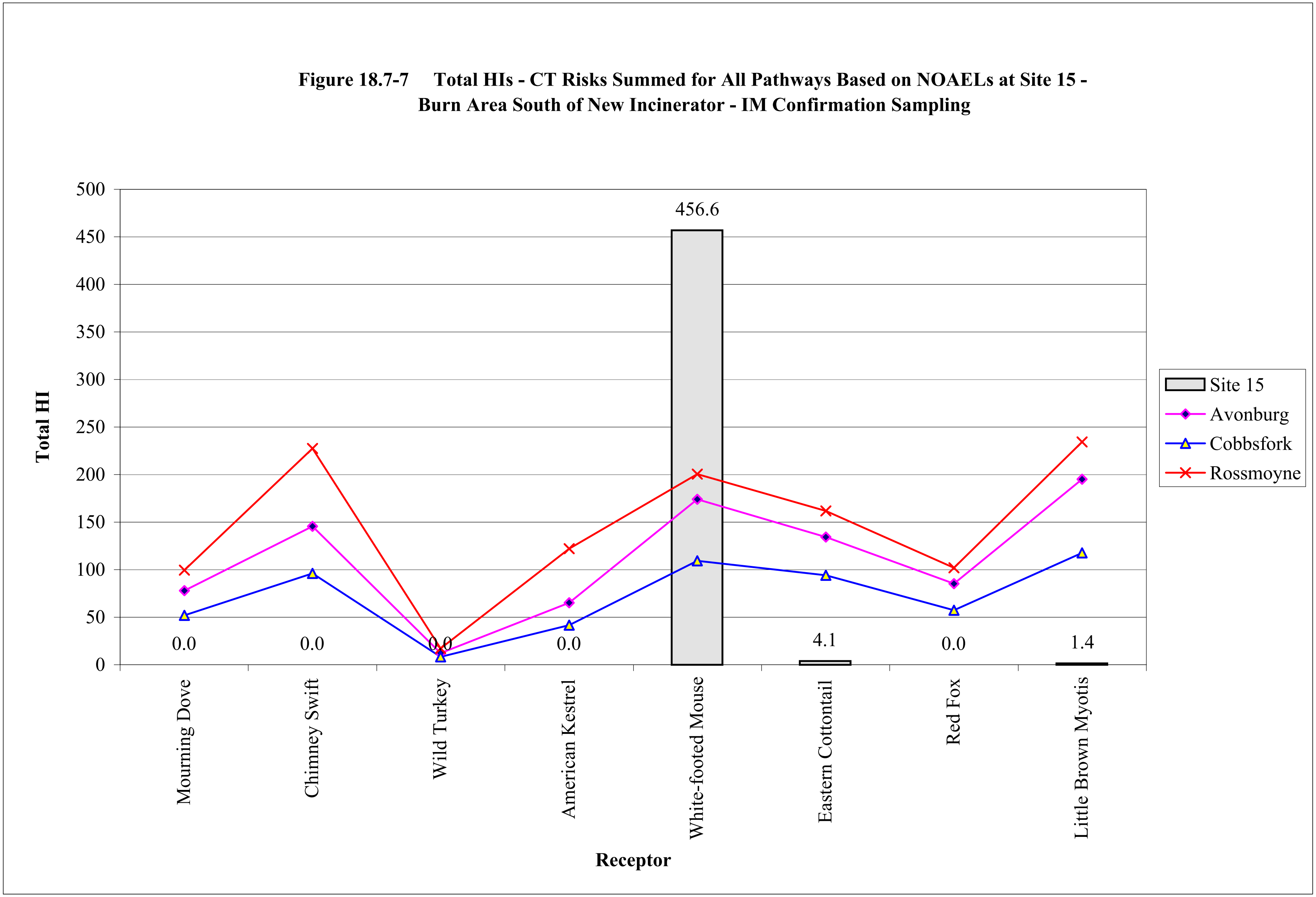
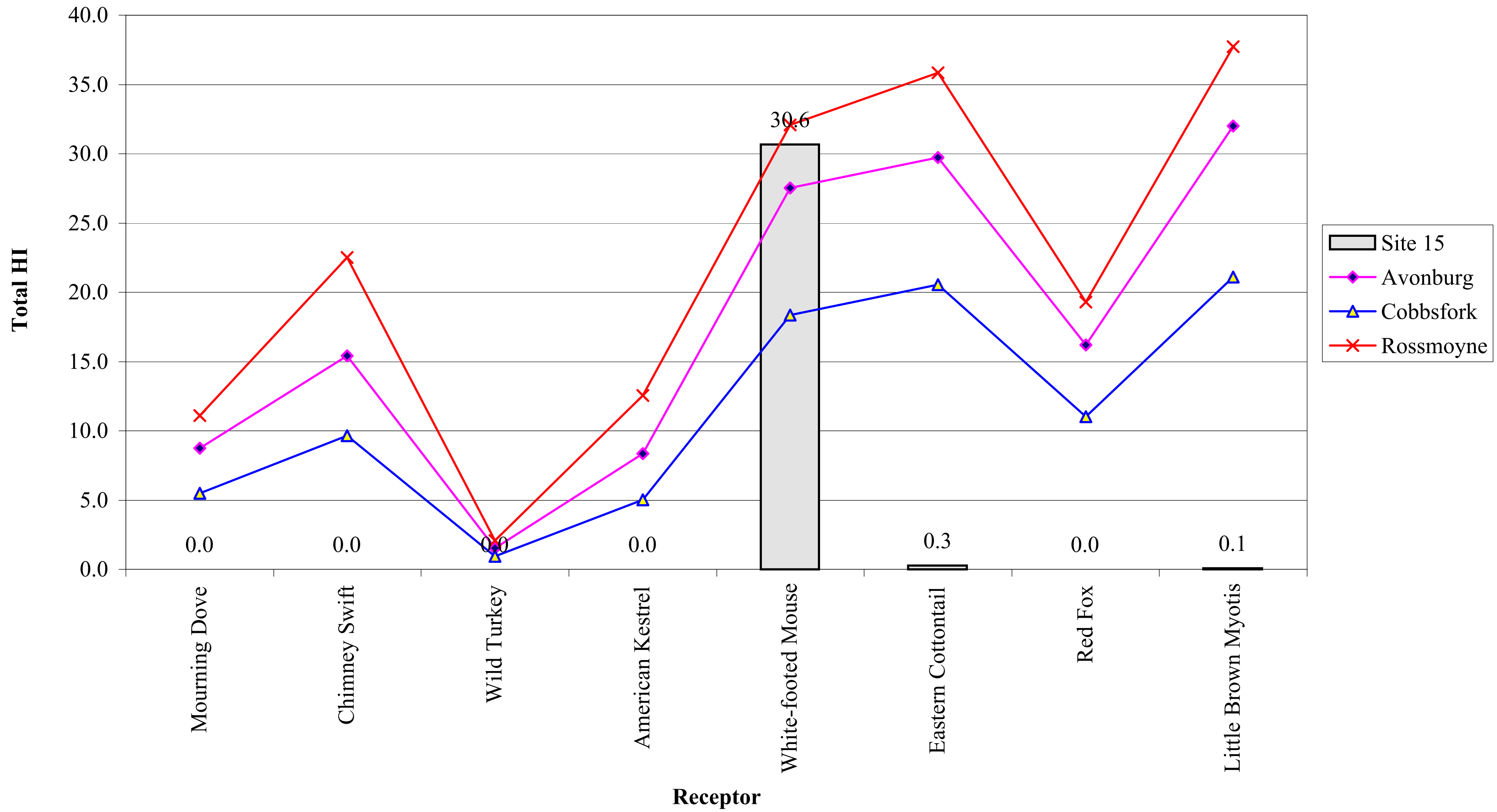


Figure 18.7-7 Total HIs - CT Risks Summed for All Pathways Based on NOAELs at Site 15 - Burn Area South of New Incinerator - IM Confirmation Sampling
Total HI
Receptor
500
450
400
350
300
250
200
150
100
50
0
456.6
0.0
0.0
0.0
0.0
4.1
0.0
1.4
Mourning Dove
Chimney Swift
Wild Turkey
American Kestrel
White-footed Mouse
Eastern Cottontail
Red Fox
Little Brown Myotis
Site 15
Avonburg
Cobbsfork
Rossmoyne

Figure 18.7-8 Total HIs - CT Risks Summed for All Pathways Based on LOAELs at Site 15 - Burn Area South of New Incinerator- IM Confirmation Sampling



19.0 BUILDING 204 TEMPORARY STORAGE AREA (SITES 21A AND 30)

19.1 SITE CHARACTERISTICS

Building 204 is located one block east of the intersection of Woodfill Road and Meridian Road (Figure 19-1). It is a single story brick building constructed of slab on grade. A variety of pesticides and herbicides have been stored inside of Building 204. A small metal shed southeast of Building 204 was used for mixing and rinsing pesticides and herbicides. Spills of these materials during loading, unloading, storage, or mixing may have resulted in a release of contaminants to environmental pathways. The facility was found to be in compliance with applicable regulations during the 1990 environmental audit (USEPA 1990). From observations made during this audit, it appeared that the chance of a major spill at this storage facility was small. Minor releases may have occurred in the past, however, as a result of poor handling practices.

The area around the building is relatively flat, and there is a small drainage swale on the north side of the building and a borrow ditch between the building and the railroad tracks on the south. There is a small area of lawn along the north side of the building; otherwise, the ground surface is either paved or bare of vegetation. Surface-water runoff on the north side of the building drains into the storm water sewer system and eventually discharges into Middle Fork Creek (Figure 2-1). Surface water from the south side of the building drains along the borrow ditch toward the west and eventually discharges into Middle Fork Creek.

The site soils belong to the Cobbsfork soil series. According to drilling logs from nearby wells, the soils are underlain by the Laurel Dolomite of Silurian age. The glacial till at the nearest monitoring well, MW93-10, is about 40 feet thick. MW93-10 is the upgradient well for the Red Lead Area (Site 7) and is located about 600 feet away.

During the Phase I RI, the site was being accessed by road- and ground-maintenance personnel who stored pesticides and herbicides inside Building 204. They periodically performed vegetation control activities for the installation and used the small metal shed southeast of Building 204 for mixing and rinsing. ~~All w~~Wash water was contained within a concrete berm inside the shed. Following facility closure in 1995, Building 204 is no longer used for pesticide storage.

19.2 PREVIOUS INVESTIGATIONS

No environmental sampling had been conducted at Building 204, and no releases had been reported at the site prior to the RI. Visual site inspections of Building 204 were performed for both the Environmental Audit (USEPA 1990) and the Base Closure and Realignment Environmental Impact Statement (USACE 1991). During these previous inspections, no evidence of a release that would harm either human health or the environment was found.

19.3 STUDY AREA INVESTIGATIONS

19.3.1 Phase I RI Field Activities

19.3.1.1 Surface Soils. To assess the potential for surface soil contamination, three surface-soil samples were collected from obvious surface-water drainage pathways outside of Building 204 during Phase I of the RI (Figure 19-1). These samples were analyzed for pesticides. Surface soil was expected to be the most contaminated medium at this site because of the possibility of accidental spills during handling and storage.

19.3.1.2 Subsurface Soils. ~~No s~~Subsurface soil samples were not collected during Phase I.

19.3.1.3 Wipe Samples. Three wipe samples were collected from the floor inside of the pesticide storage room on the north side of Building 204. The soil and wipe samples were analyzed for pesticides.

19.3.2 Phase II RI Field Activities

19.3.2.1 Surface Soils. Following pesticide detections observed during Phase I, additional samples were required during Phase II to further define the horizontal and vertical extent of contamination at this site. To assess horizontal extent, ~~13~~ additional surface soil samples were collected in the area south of Building 204 (Figure 19-1) and analyzed for PCB/pesticides.

19.3.2.2 Subsurface Soils. Subsurface soil samples were required during Phase II to determine the vertical extent of pesticide contamination at this site. To assess vertical extent, one soil boring (Figure 19-1) was drilled to a depth of 10 feet at the previous surface sample location that had the highest pesticide concentration; soil samples were collected at depths of 2, 5, and 10 feet for pesticide analysis.

19.4 DATA EVALUATION

19.4.1 Data Validation Results

Soil samples collected from Sites 21A and 30 during Phases I and II were analyzed for pesticides only.

19.4.1.1 Surrogate Spikes. No surrogate spikes were employed in the method during Phase I, therefore, it was advised that limited additional sampling and subsequent reanalysis using surrogate spikes be performed to assess potential matrix interference. During Phase II, surrogate spikes were performed and none of the data were rejected or qualified.

19.4.1.2 Rejected Results. None of the pesticide data were rejected during Phases I or II.

19.4.1.3 Evaluation of Non-Detected Values. A comparison was made between the USEPA Region 5 DQLs and the project CRLs for pesticides that were analyzed for but not detected in environmental media at this site, and no exceedances were found.

19.4.2 Data Quality Summary

In summary, the number of samples, the comprehensiveness of the parameter list, and the quality of the data are adequate to characterize the nature and magnitude of soil contamination at Sites 21A and 30 for the risk assessment.

19.4.3 Background Screening

Surface and subsurface soil samples collected at Sites 21A and 30 were not analyzed for inorganic constituents or for dioxins/furans. Therefore,~~ no~~ background screening was not performed.

19.4.4 Summary of Analytical Results

Table 19-1 provides a summary of analytical results for soil samples collected at Sites 21A and 30. The entire analytical database used for the human health risk assessment for Sites 21A and 30 consists of the 15 Phase I and Phase II surface soil samples, and the 3 Phase II subsurface soil samples. A comprehensive~~lete~~ listing ~~on all~~of the analytical results, including nondetected and below reporting limit analytes, is presented in Appendix N.

19.5 NATURE AND EXTENT OF CONTAMINATION

19.5.1 Soil

Results for the three soil samples collected outside of Building 204 during Phase I show that detectable amounts of DDT were found in samples 2 and 3 (Table 19-1 and Figure 19-2). Derivatives of DDT were also present. DDD was found in samples 2 and 3, and DDE was found in~~ all~~ the three samples. Phase II sample results show that 9 samples also contained detections of DDT and 12 samples contained DDE. Other pesticides detected were aldrin (3 samples), beta-endosulfan (1 sample), chlordane (1 sample), dibutylchlorendate (1 sample), dieldrin (14 samples), endrin (7 samples), heptachlor (2 samples), heptachlor epoxide (5 samples), and tetrachlorometaxylene (1 sample). Soil samples 2 and 13 (Figure 19-1) contained the greatest number of compounds detected, and Sample 2 contained the highest concentration of any single pesticide (dieldrin at 3.5 µg/g). The only pesticide detected at a concentration exceeding USEPA Region 9 criteria was dieldrin (two samples). One SVOC, fluoranthene, was detected in Sample 2 at a concentration well below USEPA Region 9 criteria.

The Phase I wipe sample results indicate that there is residual heptachlor epoxide and DDT on the floor inside the pesticide store room; however, these compounds were only detected in

one out of three samples and do not appear to be widespread. Bis(2-ethylhexyl)phthalate was detected in ~~all~~ the wipe samples; however, bis(2-ethylhexyl)phthalate is recognized by USEPA as a common laboratory contaminant. Concentrations detected in environmental samples at JPG are similar to those detected in method blank samples and are, therefore, qualified as a laboratory contaminant.

The main objective of the investigation was to determine if there is residual contamination related to possible unreported spills at the site. Soil samples provided data indicating that some soil contamination is present around the building. Wipe samples provided data indicating that no significant residual contamination related to unreported releases that may have occurred is known to remain~~s~~ inside ~~related to any unreported releases that may have occurred~~.

19.6 HUMAN HEALTH RISK ASSESSMENT

19.6.1 Selection of the Contaminants of Potential Concern at Sites 21A and 30

19.6.1.1 Surface Soil.

19.6.1.1.1 Data Grouping. The samples at these sites were collected within an area smaller than a residential lot. Therefore, ~~all~~ the samples were grouped together for the purposes of the risk assessment.

19.6.1.1.2 Frequency of Detection. Evaluation of frequency of detection was not undertaken at this site because of too few samples.

19.6.1.1.3 Nutrient Screening. Surface soil samples collected at Sites 21A and 30 were not analyzed for inorganic constituents. Therefore, no nutrient screening was performed.

19.6.1.1.4 Summary of Preliminary COPCs. Table 19-2 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95% UCL of the mean, and the exposure point concentration for each preliminary COPC in surface soil at Site 21A and 30.

19.6.1.1.5 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for each preliminary soil COPC was compared to the USEPA chemical-specific Region 9 residential soil PRG (Table 19-3). One-tenth of the PRG was used for noncarcinogens. As a result of the screening, dieldrin is the only chemical ***retained*** as a COPC in surface soil at Sites 21A and 30.

19.6.1.2 Surface/Subsurface Soil Combined.

19.6.1.2.1 Data Grouping. The combined surface/subsurface soils samples were grouped together for the purposes of the risk assessment.

19.6.1.2.2 Frequency of Detection. Evaluation of frequency of detection was not undertaken at this site because of too few samples.

19.6.1.2.3 Nutrient Screening. Surface/subsurface soil samples collected at Sites 21A and 30 were not analyzed for inorganic constituents. Therefore, no nutrient screening was performed.

19.6.1.2.4 Summary of Preliminary COPCs. Table 19-2 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95% UCL of the mean, and the exposure point concentration for each preliminary COPC in surface/ subsurface soil combined at Site 21A and 30.

19.6.1.2.5 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for each preliminary soil COPC was compared to the USEPA chemical-specific Region 9 residential soil PRG (Table 19-3). One-tenth of the PRG was used for noncarcinogens. As a result of the screening, dieldrin is the only chemical ***retained*** as a COPC in surface/ subsurface soil combined at Sites 21A and 30.

19.6.1.3 Air.

19.6.1.3.1 Summary of Preliminary COPCs. Ambient air concentrations to which future receptors at these sites might be exposed were estimated using air emission/dispersion modeling, as described in Appendix R. In the site-specific conceptual model, discussed below in Section 19.6.2.1, Sites 21A and 30 are evaluated under two future site-specific scenarios: as a residential site and as an industrial site.

In the future industrial land use scenario for the facility, ~~all~~ the sites were assumed to be industrial, except for the five sites designated agricultural sites. Each site with particulate-bound COPCs in surface soil (metals, SVOCs, and dioxins/furans) and/or volatile COPCs in surface/subsurface soil combined was assumed to contribute to the air concentrations at ~~all of~~ the sites. In the future residential scenario for the facility, ~~all~~ the sites were assumed to be residential except for the five sites designated agricultural. It was assumed that particulate and VOC emissions from the strictly residential sites would be negligible because the home sites would be covered with dense vegetation (lawns) and pavement. Therefore, under this residential scenario only the five agricultural sites contribute to the air concentrations at ~~all of~~ the sites. The list of preliminary air COPCs is therefore the same for every site for a given scenario, but the concentrations of the COPCs vary. Tables R-4 and R-6 in Appendix R present the estimated ambient air concentrations at Sites 21A and 30 under the future industrial and residential scenarios, respectively.

19.6.1.3.2 Region 9 Preliminary Remediation Goal Screening. The exposure point concentrations for each preliminary air COPC at Sites 21A and 30 in the future residential and future industrial scenarios were compared to chemical-specific USEPA Region 9 air PRGs (Table 19-4). One-tenth of the PRG was used for noncarcinogens. The exception was lead,

for which the full PRG was used. As a result of the screening, aluminum, silver, thallium, vanadium, and zinc are retained as COPCs in air for future on-site residents. For future on-site workers, aluminum, chromium, silver, thallium, vanadium, and zinc were retained.

19.6.2 Exposure Assessment

There are no people who **are known to** specifically work at or frequent Sites 21A and 30. There are, however, several types of individuals who could potentially be affected by the existing contamination at the facility. These are current trespassers to JPG, off-facility (nearby) rural residents, and future hunters. In each case, these individuals would most likely be impacted simultaneously by multiple sites rather than by single units. Because of this, these current and future receptor populations are addressed on a facility-wide, cumulative basis rather than by specific sites (see Sections 28 and 29).

Therefore, this site-specific exposure scenario only addresses future land use development. Sites 21A and 30 have two potential future land uses forwarded for evaluation:

- Residential
- Industrial

Residential Use. Under the future residential land use scenario, these sites are assumed to be developed for residential purposes, with the supposition that a family would build a house directly on/within this area of potential concern. Since there are subsurface soil COPCs at these sites, it was assumed that subsurface soil may or may not be excavated to a depth of 10 feet during the construction of homes. In the excavation scenario, subsurface soil was assumed to be mixed and dispersed with surface soil across the ground surface at each home-site.

With respect to a risk assessment analysis, resident populations were assumed to consist of both adults and toddlers. Each individual would be expected to come in contact with site contaminants via the following pathways at Sites 21A and 30:

- Inhalation of VOCs and fugitive particulates from soils
- Dermal contact with soil (surface or surface/subsurface combined) while gardening/playing outdoors
- Incidental ingestion of soil (surface or surface/subsurface combined) while gardening/playing outdoors
- Ingestion of fresh homegrown fruits and vegetables (grown in surface soil or surface/subsurface soil combined

On-site Worker. Industrial land use is considered to be a plausible future option for this site at JPG. On-site industrial workers (adult males and females) are assumed to be individuals who could be exposed directly to contaminated media through the following pathways at Sites 21A and 30:

- Inhalation of VOCs and fugitive particulates from soils
- Incidental ingestion/dermal contact with surface soil

19.6.2.2 Exposure Point Concentrations.

19.6.2.2.1 Air. The estimated ambient air concentrations of COPCs at these sites for the future on-site residents and the future on-site workers are presented in Table 19-4.

19.6.2.2.2 Soil. The concentrations of COPCs in surface soil and surface/subsurface soil combined at these sites are presented in Table 19-3.

19.6.2.2.3 Fruits, Vegetables and Crops. COPC concentrations in homegrown fruits and vegetables were estimated using the methods described in Section 5.1.5.2.8. Appendix U, Table U-12, documents the calculation of contaminant concentrations in fruits and vegetables at Sites 5 and 6.

19.6.2.3 Human Exposure Doses.

19.6.2.3.1 Inhalation of Contaminated Air. Inhalation of airborne contaminants (VOCs and particulates) is a potential route of exposure for future on-site residents (adults and children) and future on-site workers at these sites. The equation used for calculating human exposure doses of contaminants of potential concern due to inhalation of volatile and dust-bound contaminants is provided in Section 5.1.5.3.1, Table 5-**11**~~12~~. Table V-12, Appendix V, documents the calculation of human exposure doses at Sites 21A and 30 due to inhalation of contaminated air.

19.6.2.3.2 Incidental Ingestion of Contaminated On-site Soil. Mouthing behavior (toddlers) and incidental ingestion of soil with recreational or work-related activities may expose human receptors to contaminated soil at a site via the oral route of exposure. The equation used to calculate the human exposure dose due to incidental ingestion of contaminated soil is presented in Section 5.1.5.3.2, Table 5-**12**~~13~~. This pathway was assumed to be complete at Sites 21A and 30 for future on-site residents (adults and children) and future on-site workers. Table V-12, Appendix V, documents the calculation of human exposure doses due to incidental ingestion of soil at Sites 21A and 30.

19.6.2.3.3 Dermal Contact with Contaminated On-site Soil. The chemicals in contaminated soil also may be absorbed into a receptor's body through dermal contact. The equation used to calculate chemical doses due to dermal contact with contaminated soil is

presented in Section 5.1.5.3.3, Table 5-**13**~~14~~. This pathway is relevant for future on-site residents (adults and children) and future on-site workers at Sites 21A and 30. Table V-12, Appendix V, documents the calculation of human exposure doses due to dermal contact with soil at Sites 21A and 30.

19.6.2.3.4 Ingestion of Contaminated Fruits and Vegetables. Consumption of contaminated homegrown fruits and vegetables may be a source of chemical exposure for future on-site residents (adults and children). The equation used to calculate human exposure dose due to ingestion of contaminated fruits and vegetables is provided in Section 5.1.5.3.11, Table 5-**22**~~23~~. Table V-12, Appendix V, documents the calculation of human exposure doses due to ingestion of contaminated fruits and vegetables grown in soil at 21A and 30.

19.6.3 Risk Characterization

19.6.3.1 Chronic Health Hazards. The noncancer daily exposure doses calculated in the exposure assessment were used to calculate HQs for each of the COPCs possessing RfDs. Pathway-specific and overall HIs were then calculated for each receptor. The calculations of HQ and HI are described in Section 5.1.7.1. If an overall HI is calculated to be greater than 1.0 for a particular receptor, then the exposure pathway(s) primarily responsible for the result is identified as a "critical pathway(s)." For each critical pathway, those chemical contaminants responsible for the majority of the HI are listed as COCs. Table W-12, Appendix W, documents the calculation of the pathway- and chemical-specific HQs for the human receptors at Sites 21A and 30. The pathway-specific and overall HIs are summarized in Table 19-5.

19.6.3.1.1 Future On-Site Residents. If receptors are exposed COPCs in surface soil only, the overall HIs for the future on-site adult and toddler residents at Sites 21A and 30 are calculated to be **1.95**~~1.9~~ and **5.7**~~5.5~~, respectively. Both of these HIs exceed the USEPA's risk management criterion of 1.0. The critical exposure pathway for both receptors is ingestion of fruits/vegetables grown in surface soil at these sites. Dieldrin is the sole noncarcinogenic COC.

If subsurface soil is assumed to be mixed and dispersed with surface soil across the ground surface at the home-site, the overall HI for the future on-site adult is calculated to be **0.70**~~0.68~~, which is less than the USEPA's risk management criterion. The overall HI for the future toddler residents at Sites 21A and 30 is calculated to be 2.0, which exceeds the USEPA's risk management criterion. The critical exposure pathway is ingestion of homegrown fruits and vegetables, and dieldrin is the sole noncarcinogenic COC.

19.6.3.1.2 Future On-Site Workers. The overall HI for the future on-site worker at Sites 21A and 30 is calculated to be **0.05**~~0.02~~, which is less than USEPA's risk management criterion. Thus, no critical exposure pathways or chemicals of concern are identified for this receptor population. The existing contamination at Sites 21A and 30 would not present a chemical hazard to future on-site workers.

19.6.3.2 Excess Lifetime Cancer Risks. The cancer risks for each receptor were determined from the pathway-specific exposure doses and the route-specific SFs, as described in Section 5.1.7.2. To assess the simultaneous exposure of a receptor population to multiple carcinogens from multiple exposure routes, ~~all of~~ the cancer risks calculated for a receptor population were summed. Each overall receptor cancer risk was then compared to USEPA's target risk range (1.0E-06 to 1.0E-04). If the total cancer risk for a receptor from ~~all~~ **the** exposure pathways is less than 1.0E-04, then it is concluded that the site(s) does not pose a significant risk to that receptor. If the overall cancer risk exceeds the target risk range, ~~any~~ **a** chemical individually associated with a risk level greater than 1.0E-05 is identified as a COC. COCs represent the primary contributors to the potential cancer risk for the receptor-specific exposure pathway under evaluation. Table W-12, Appendix W, documents the calculation of the pathway-specific and chemical-specific cancer risks for the human receptors at Sites 21A and 30. The pathway-specific and overall cancer risks are summarized in Table 19-5.

19.6.3.2.1 Future On-Site Residents. If receptors are exposed COPCs in surface soil only, the overall cancer risks calculated for the future adults and toddlers living at Sites 21A and 30 are 6.5E-04 and 3.8E-04, respectively. Both of these cancer risks exceed the USEPA's target risk range of 1.0E-06 to 1.0E-04. The critical exposure pathways for both receptors are incidental ingestion of soil and ingestion of homegrown fruits and vegetables. Dieldrin is the sole carcinogenic COC.

If subsurface soil is assumed to be mixed and dispersed with surface soil across the ground surface at the home-site, the overall cancer risks calculated for the future adults and toddlers living at Sites 21A and 30 are 2.3E-04 and 1.4E-04, respectively. These cancer risks exceed the USEPA's target risk range of 1.0E-06 to 1.0E-04. The critical pathway for both receptors under this scenario is ingestion of homegrown fruits and vegetables and dieldrin is the sole carcinogenic COC.

19.6.3.2.2 Future On-Site Workers. The overall cancer risk calculated for the future workers at Sites 21A and 30 is **7.9**~~5.7~~E-06. Since this estimated cancer risk is within USEPA's target risk range of 1.0E-06 to 1.0E-04, no critical exposure pathways or chemicals of concern are identified for future workers.

19.6.3.3 Uncertainty/Sensitivity Analysis. The numerical risks/hazards that are calculated for Sites 21A and 30 represent *conditional* estimates of risk based on various simplifying assumptions concerning contaminant exposure and toxicity. These estimates of risk/hazard are derived using a series of conservative procedures that address contaminant concentrations at the site, their fate in the environment, how someone currently or in the future might be exposed to these contaminants, and the toxicity of each chemical toward humans. The uncertainty analysis specifies, when appropriate, the critical assumptions made for the site so that the site-specific results can be interpreted by risk managers in a proper context.

To assist the risk managers in this project, a qualitative uncertainty analysis has been performed. The primary goals of a qualitative uncertainty analysis are (1) to itemize the major

areas of uncertainty in the site-specific risk assessment and (2) to demonstrate that the assessment overall has been conservatively performed (i.e., that the potential risks/hazards at the site have not likely been underestimated, but may have been significantly overestimated).

The qualitative uncertainty analysis for this site is presented in Table 19-6. Based on this analysis, it can be concluded that this risk assessment is conservative. Some of the major uncertainties in this study that are most influential to the risks/hazards that were calculated include:

- Generic chemical uptake model (not chemical-specific) used to calculate fruit/vegetable concentrations

- Receptors' exposure frequency (350 days/year)

- Receptors' foodstuff ingestion rate (95th percentile of U.S. population)

There are a number of uncertainties associated with the fruit and vegetable ingestion pathway. A major source of uncertainty is attributable to uncertainty in soil-to-plant transfer factors. Many site-specific factors can affect the extent of uptake of chemicals into plants. Some of these factors include pH, the organic carbon content of the soil, and the presence of other chemicals. Site conditions may vary from those in studies used to derive the uptake factors used in the assessment. Some of the equations used to estimate plant uptake from soil utilize chemical-specific properties such as K_d and K_{ow}. For each chemical there may be a range of values for these parameters reported in the literature. Professional judgment was used to select the values used in the assessment. Another source of uncertainty for this pathway is the assumption that the intake rates for fruits and vegetables, which are based on data collected during a nationwide survey by Pao *et al*. (1982), would be representative of actual exposure conditions at this site. The percent of fruit and vegetable intake, which is homegrown produce, also cannot be known for a future population, and conservative estimates were used in the assessment based on national surveys. Because of these uncertainties, the HIs and cancer risks calculated for receptors ingesting fruits and vegetables grown at this site may be over- or underestimated by an order of magnitude.

19.7 ECOLOGICAL RISK ASSESSMENT

Based on protocols established in the PERA (Rust E&I 1997g), there were no apparent potential ecological risks determined for Sites 21A and 30. Due to the low concentrations of the organic contaminants detected, the comparison of the concentrations against levels for known toxic effects resulted in the determination that no apparent harmful effects are likely for ecological receptors at Sites 21A and 30. As a result, no further ecological risk analysis has been undertaken.

19.8 CONCLUSIONS AND RECOMMENDATIONS

Surface soil samples collected during Phase I at the Building 204 Temporary Storage Area (Sites 21A and 30) were found to contain pesticide contamination. Additional surface and subsurface samples were collected during Phase II to better define the vertical and horizontal extent of contamination. The Phase II results show that 9 samples contained detections of DDT and 12 samples contained DDE. Numerous other pesticides were detected in one or more samples at Building 204. Of these samples, only dieldrin was present at concentrations exceeding USEPA Region 9 risk-based criteria.

Phase I wipe samples from the interior of Building 204 indicate that there is residual heptachlor epoxide and DDT on the floor of the pesticide store room. However, these compounds were only detected in one sample and do not appear to be widespread.

The human health risk assessment evaluated risks associated with dieldrin in surface soils at Sites 21A and 30. Results for the future on-site worker show that there are no carcinogenic risks or chronic health hazards that exceed USEPA risk management criteria. For the hypothetical future on-site resident, both carcinogenic risk and chronic health hazard estimates exceed USEPA risk management criteria primarily due to the ingestion of dieldrin in homegrown produce. If the surface soil is mixed and dispersed with subsurface soil, these risks and hazards are below the criteria.

Since there are risks and hazards exceeding criteria, it is recommended that Sites 21A and 30 be carried forward to the FS. No additional remedial investigation activities appear to be ~~warranted~~necessary.

TABLES

TABLE 19-1

Analytical Results of Pesticides in Soil Samples
Site 21A – Building 204 Temporary Storage Area
Jefferson Proving Ground
Madison, Indiana

SAMPLE ID: Sample Date: Analyte	STA21SF001 11/18/92	STA21SF002 11/18/92	STA21SF003 11/18/92	STA21SF004 05/12/96	STA21SF005 05/12/96	STA21SF006 05/12/96	STA21SF007 05/12/96	STA21SF008 05/12/96	STA21SF009 05/12/96
Aldrin	LT[b] 0.0014	0.0159	LT 0.0014	LT 0.0017	LT 0.0017	LT 0.0017	LT 0.0017	LT 0.0017	LT 0.0017
Beta-Endosulfan	LT 0.0007	0.000918	LT 0.0007	LT 0.0033	LT 0.0033	LT 0.0033	LT 0.0033	LT 0.0033	LT 0.0033
Chlordane	LT 0.0684	LT 0.0684	LT 0.0684	LT 0.02	LT 0.02	LT 0.02	LT 0.02	LT 0.02	LT 0.02
DDT	LT 0.0035	0.0103	0.150	0.000626	LT 0.0033	LT 0.0033	LT 0.0033	LT 0.0033	0.00167
DDD	LT 0.0027	0.00327	0.00363	LT 0.0033	LT 0.0033	LT 0.0033	LT 0.0033	LT 0.0033	LT 0.0033
DDE	0.00307	0.00674	0.20	0.0000919	0.00124	0.000543	0.0033	0.00223	0.00169
Dieldrin	LT 0.0016	3.50	0.00641	LT 0.0033	LT 0.0033	LT 0.0033	LT 0.0033	0.0223	0.00218
Endrin	LT 0.0065	0.061	0.00882	LT 0.0033	LT 0.0033	LT 0.0033	LT 0.0033	LT 0.0033	LT 0.0033
Heptachlor	LT 0.0022	LT 0.0022	LT 0.0022	LT 0.0017	LT 0.0017	LT 0.0017	LT 0.0017	LT 0.0017	LT 0.0017
Heptachlor epoxide	LT 0.0013	LT 0.0013	LT 0.0013	LT 0.0017	LT 0.0017	LT 0.0017	LT 0.0017	LT 0.0017	0.000163

SAMPLE ID: Sample Date: Analyte	STA21SF010 05/12/96	STA21SF011 05/12/96	STA21SF012 05/12/96	STA21SF013 05/12/96	STA21SF014 05/12/96	STA21SF015 05/12/96
Aldrin	LT 0.0017	0.000627	0.000315	LT 0.0017	LT 0.0017	LT 0.0017
Beta-Endosulfan	LT 0.0033	LT 0.0033	LT 0.0033	LT 0.0033	LT 0.0033	LT 0.0033
Chlordane	3.24	LT 0.02	4.86	LT 0.02	2.96	LT 0.02
DDT	0.00164	0.00308	0.000438	0.00298	0.000553	0.00398
DDD	LT 0.0033	LT 0.0033	LT 0.0033	LT 0.0033	LT 0.0033	LT 0.0033
DDE	0.00104	0.000807	0.000249	0.00461	0.000387	0.00218
Dieldrin	0.028	0.101	0.0505	0.0164	0.000657	0.0148
Endrin	LT 0.0033	0.000893	0.000556	0.00313	0.00144	LT 0.0033
Heptachlor	LT 0.0017	LT 0.0017	LT 0.0017	0.00198	LT 0.0017	LT 0.0017
Heptachlor epoxide	LT 0.0017	0.0000797	LT 0.0017	0.00279	LT 0.0017	0.000506

General Note:

All samples taken at a depth of zero feet.

Footnotes:

(a) Micrograms per gram; all values are in µg/g.
(b) Less than the reporting limit.
(c) Not detected.

TABLE 19-2

Soil Exposure Point Concentrations of Preliminary Contaminants of Potential Concern
Site 21A – Storage Building 204 and Site 30 – Adjacent Shed
Jefferson Proving Ground
Madison, Indiana

Analyte	Frequency of Detection[a]	Range of Detected Values (µg/g)[b]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[c] (µg/g)
Surface Soil						
Aldrin	3/15	0.00032 - 0.0159	0.0014 - 0.0017	0.0018	0.0023	0.0023
beta-Endosulfan	1/15	0.00092	0.0007 - 0.0033	0.0014	0.0016	0.00092
Chlordane	1/15	0.299	0.02 - 0.068	0.034	0.0509	0.0509
DDD	2/15	0.0033 - 0.00363	0.0026 - 0.0033	0.0019	0.00213	0.00213
DDE	14/15	0.00025 - 0.20	0.0033	0.015	0.0318	0.0318
DDT	10/15	0.00044 - 0.15	0.0033 - 0.0035	0.012	0.023	0.023
Dieldrin	10/15	0.00066 - 3.5	0.0016 - 0.0033	0.249	2.8	2.8
Endrin	6/15	0.00056 - 0.061	0.0033 - 0.0065	0.0062	0.0097	0.0097
Heptachlor	1/15	0.00193	0.0017 - 0.0022	0.0009	0.0011	0.0011
Heptachlor epoxide	4/15	0.0001 - 0.00282	0.0013 - 0.0017	0.0008	0.0016	0.0016
Surface/Subsurface Soil Combined						
Aldrin	3/18	0.00032 - 0.0159	0.0014 - 0.0017	0.0016	0.0019	0.0019
beta-Endosulfan	1/18	0.00092	0.0007 - 0.0033	0.0015	0.0016	0.00092
Chlordane	1/18	0.299	0.02 - 0.068	0.03	0.0374	0.0374
DDD	2/18	0.0033 - 0.00363	0.0027 - 0.0033	0.0018	0.002	0.002
DDE	14/18	0.00025 - 0.20	0.0033	0.0129	0.0167	0.0167

TABLE 19-2

Soil Exposure Point Concentrations of Preliminary Contaminants of Potential Concern
Site 21A – Storage Building 204 and Site 30 – Adjacent Shed
Jefferson Proving Ground
Madison, Indiana

Analyte	Frequency of Detection[(a)]	Range of Detected Values (µg/g)[(b)]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[(c)] (µg/g)
Surface/Subsurface Soil Combined (cont'd)						
DDT	10/18	0.00044 - 0.15	0.0033 - 0.0035	0.011	0.0133	0.0133
Dieldrin	11/18	0.00051 - 3.5	0.0016 - 0.0033	0.208	1.0	1.0
Endrin	6/18	0.00056 - 0.061	0.0033 - 0.0065	0.005	0.007	0.007
Heptachlor	1/18	0.00193	0.0017 - 0.0022	0.001	0.001	0.001
Heptachlor epoxide	4/18	0.0001 - 0.00282	0.0013 - 0.0017	0.001	0.0014	0.0014

Footnotes:

(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Micrograms per gram.
(c) The 95% UCL (upper confidence limit of the mean) or the maximum detected value, whichever is lower (USEPA 1989b).

TABLE 19-3

Selection of Contaminants of Potential Concern (COPC) in Soil Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 21A – Storage Building 204 and Site 30 – Adjacent Shed
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Analyte	**Residential PRG (µg/g)[(a)]**	**Exposure Point Concentration (µg/g)**	**Retained as Soil COPC?**
Surface Soil			
Aldrin	0.026	0.0023	No
beta-Endosulfan	39.1[(b)]	0.00092	No
Chlordane	0.342	0.0509	No
DDD	1.85	0.00213	No
DDE	1.3	0.0318	No
DDT	1.3	0.023	No
Dieldrin	0.028	2.80	**YES**
Endrin	1.96	0.0097	No
Heptachlor	0.099	0.0011	No
Heptachlor epoxide	0.049	0.0016	No
Surface/Subsurface Soil Combined			
Aldrin	0.026	0.0019	No
beta-Endosulfan	39.1[(b)]	0.00092	No
Chlordane	0.342	0.0374	No
DDD	1.85	0.002	No
DDE	1.3	0.0167	No
DDT	1.3	0.0133	No
Dieldrin	0.028	1.0	**YES**
Endrin	1.96	0.007	No
Heptachlor	0.01	0.001	No
Heptachlor epoxide	0.049	0.0014	No

General Note**:**
PRGs were taken directly from the Region 9 PRG Table (USEPA 1998) except as noted in the footnotes. Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:
(a) Micrograms per gram.
(b) Value for endosulfan.

TABLE 19-4

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 21A – Storage Building 204 and Site 30 – Adjacent Shed
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Analyte	**Ambient Air PRG (μg/m^3)[(a)]**	**Exposure Point Conc. (μg/m^3)**	**Retained as Air COPC?**
Residential Scenario			
Aluminum	NA[(b)]	4.12E-03	**YES**
Arsenic	4.5E-04	1.36E-06	No
Barium	5.2E-02	2.43E-05	No
Beryllium	8.0E-04	1.07E-07	No
Cadmium	1.1E-03	4.73E-08	No
Chromium	2.3E-05	1.44E-05	No
Lead	1.5E+00[(c)]	3.51E-06	No
Manganese	5.1E-03	3.88E-04	No
Silver	NA	7.33E-06	**YES**
Thallium	NA	3.82E-06	**YES**
Vanadium	NA	6.64E-07	**YES**
Zinc	NA	2.42E-06	**YES**
Dioxins/Furans	4.5E-08	1.06E-13	No
Benzo(a)anthracene	9.2E-03	4.35E-09	No
Benzo(a)pyrene	9.2E-04	4.30E-08	No
Benzo(b)fluoranthene	9.2E-03	9.20E-08	No
DDE	2.0E-02	2.56E-09	No
Dibenz(a,h)anthracene	9.2E-04	5.12E-10	No
Dieldrin	4.2E-04	NA	No
Indeno(1,2,3-cd)pyrene	9.2E-03	2.60E-09	No
1,1-Dichloroethylene	3.8E-02	1.02E-09	No
Chlorobenzene	2.1E+00	1.22E-06	No

TABLE 19-4

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 21A – Storage Building 204 and Site 30 – Adjacent Shed
Jefferson Proving Ground
Madison, Indiana

Analyte	USEPA Region 9 PRG Screen		
	Ambient Air PRG ($\mu g/m^3$)[(a)]	Exposure Point Conc. ($\mu g/m^3$)	Retained as Air COPC?
Industrial Scenario			
Aluminum	NA	1.16E-02	**YES**
Arsenic	4.5E-04	6.48E-06	No
Barium	5.2E-02	6.14E-05	No
Beryllium	8.0E-04	2.80E-07	No
Cadmium	1.1E-03	8.15E-08	No
Chromium	2.3E-05	4.25E-05	**YES**
Lead	1.5E+00[(c)]	3.51E-06	No
Manganese	5.1E-03	7.14E-04	No
Silver	NA	7.33E-06	**YES**
Thallium	NA	3.82E-06	**YES**
Vanadium	NA	1.94E-06	**YES**
Zinc	NA	3.95E-05	**YES**
Dioxins/Furans	4.5E-08	1.39E-12	No
Benzo(a)anthracene	9.2E-03	4.35E-09	No
Benzo(a)pyrene	9.2E-04	4.81E-08	No
Benzo(b)fluoranthene	9.2E-03	9.20E-08	No
DDE	2.0E-02	2.56E-09	No
Dibenz(a,h)anthracene	9.2E-04	5.12E-10	No
Dieldrin	4.2E-04	2.05E-04	No
Indeno(1,2,3-cd)pyrene	9.2E-03	2.56E-09	No
1,1-Dichloroethylene	3.8E-02	1.02E-09	No
Chlorobenzene	2.1E+00	1.22E-06	No

General Note**:**
PRGs were taken directly from the Region 9 PRG Table (USEPA 1998). Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:
(a) Micrograms per cubic meter.
(b) Not applicable
(c) Federal ambient air quality criterion for lead.

TABLE 19-5

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 21A – Storage Building 204 and Site 30 – Adjacent Shed
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
Future On-site Resident Adult (surface soil only)				
Incidental ingestion of soil	2.63E-05	Dieldrin (100%)	0.0767	
Dermal contact with soil	NA[(a)]		0.0641	
Ingestion of homegrown fruits/vegetables	6.21E-04	Dieldrin (100%)	1.8115	Dieldrin (100%)
Inhalation of VOCs[(b)] and fugitive dusts	NA		0.0000	
Total	6.47E-04	Total	1.9523	
Future On-site Resident Child (surface soil only)				
Incidental ingestion of soil	4.91E-05	Dieldrin (100%)	0.7160	
Dermal contact with soil	NA		0.1846	
Ingestion of homegrown fruits/vegetables	3.30E-04	Dieldrin (100%)	4.8136	Dieldrin (100%)
Inhalation of VOCs and fugitive dusts	NA		0.0000	
Total	3.79E-04	Total	5.7142	
Future On-site Resident Adult (surface/subsurface soil combined)				
Incidental ingestion of soil	9.39E-06		0.0274	
Dermal contact with soil	NA		0.0229	
Ingestion of homegrown fruits/vegetables	2.22E-04	Dieldrin (100%)	0.6470	
Inhalation of VOCs and fugitive dusts	NA		NA	
Total	2.31E-04	Total	0.6973	

TABLE 19-5

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 21A – Storage Building 204 and Site 30 – Adjacent Shed
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern		Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
Future On-site Resident Child (surface/subsurface soil combined)					
Incidental ingestion of soil	1.75E-05			0.2557	
Dermal contact with soil	NA			0.0659	
Ingestion of homegrown fruits/vegetables	1.18E-04	Dieldrin (100%)		1.7192	Dieldrin (100%)
Inhalation of VOCs and fugitive dusts	NA			NA	
Total	1.36E-04		Total	2.0408	
Future On-site Worker (surface soil only)					
Incidental ingestion of soil	7.83E-06			0.0274	
Dermal contact with soil	NA			0.0273	
Inhalation of VOCs and fugitive dusts	4.14E-08			0.0001	
Total	7.87E-06		Total	0.0548	

Footnotes:
(a) Not applicable or not available.
(b) Volatile organic compounds.

RAB/PB
N:\Jobs\244\0025\01\wp\tbl\Table 19-5.doc

TABLE 19-6

Qualitative Uncertainty Analysis
Site 21A – Storage Building 204 and Site 30 – Adjacent Shed
Jefferson Proving Ground
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
A. Human Behavior				
Future receptors' exposure duration	30 years	Medium	Medium	National upper-bound time (90th percentile) at one residence
Future receptors' exposure frequency	350 days/year	Medium	Medium	High-end value
Future receptors' exposure time	24 hours/day	Low	High	Maximum possible value
Future receptors' food chain ingestion rates	NA[(a)]	Low	High	Nearly impossible for an average weight receptor to ingest daily the 95th percentile U.S. population consumption amounts
Exclusion of certain exposure pathways in the quantitative analysis	NA	Low	Low	Pathways eliminated are those that have low possibility of contributing risk to these receptors
B. Chemical Fate/Transport in the Environment				
Generic chemical uptake model used to calculate vegetable/fruit concentrations	NA	Low	High	Generic model based on chlorinated compounds only
Use of air dispersion modeling to predict air concentrations	NA	Low	High	Conservative assumptions and input parameters

TABLE 19-6

Qualitative Uncertainty Analysis
Site 21A – Storage Building 204 and Site 30 – Adjacent Shed
Jefferson Proving Ground
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
C. Chemical Toxicity				
Assumption that USEPA[(b)] reference doses truly represent toxicological thresholds	NA	Low	High	high degree of conservativeness utilized by USEPA in deriving RfDs[(c)] from toxicological literature
Assumption that USEPA carcinogenic slope factors truly represent dose-response phenomena	NA	Low-moderate	Moderate-high	Use of linear, multi-stage mathematical model to predict cancer incidence at low exposure levels is USEPA policy; not currently supported by scientific data
Assumption of risk/hazard additivity	NA	Moderate	Moderate	Summation of chemical-specific risks/hazards may over- or under-predict risks/hazards to receptors
Screening out of certain contaminants based on USEPA criteria	NA	Low	Low	Chemicals present in concentrations less than Region 9 criteria eliminated

Footnotes:
(a) Not applicable or not available.
(b) United States Environmental Protection Agency.
(c) Reference doses.

FIGURES

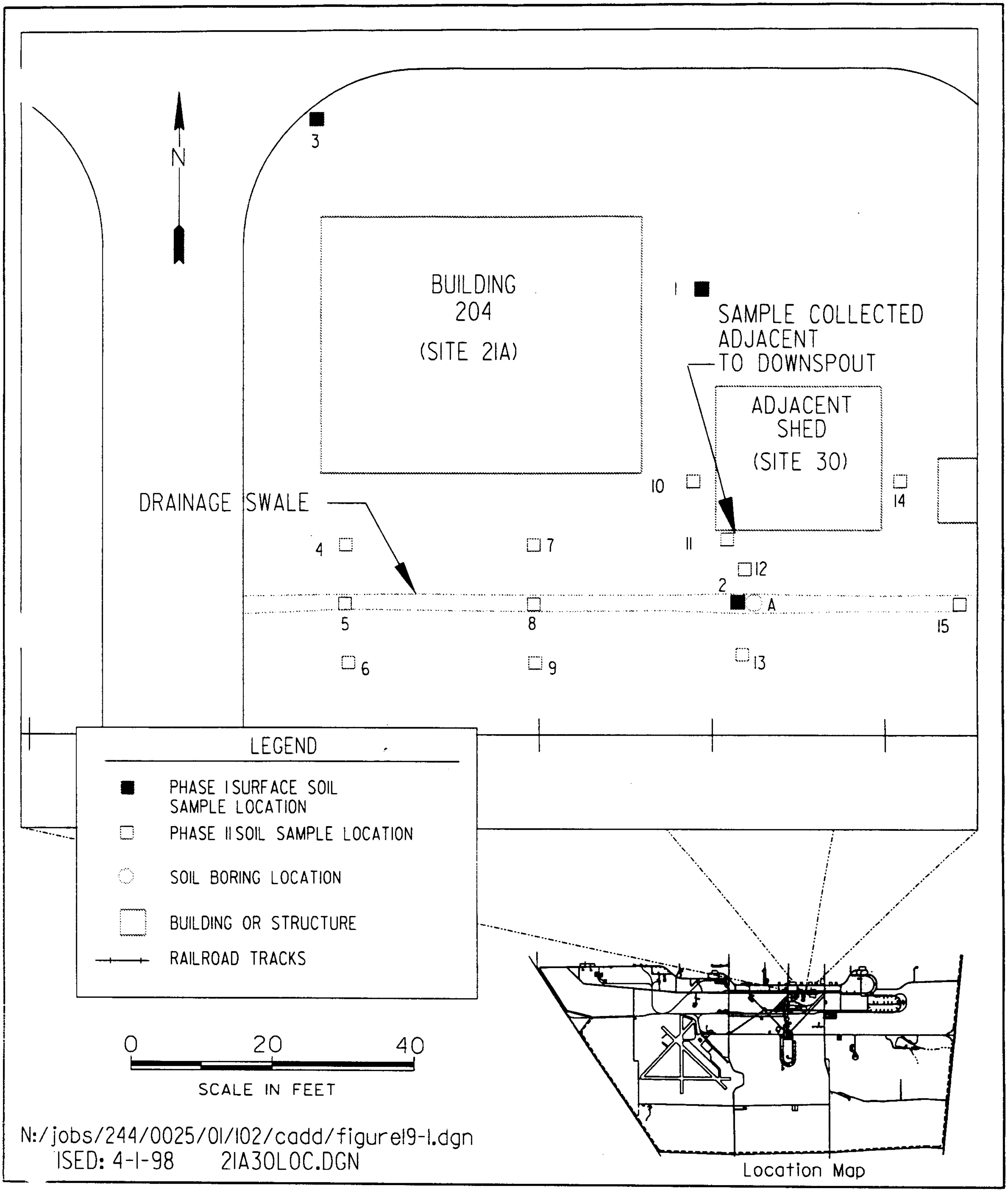


Figure 19-1. Sampling Locations for Building 204 Temporary Storage Area (Sites 21A and 30)

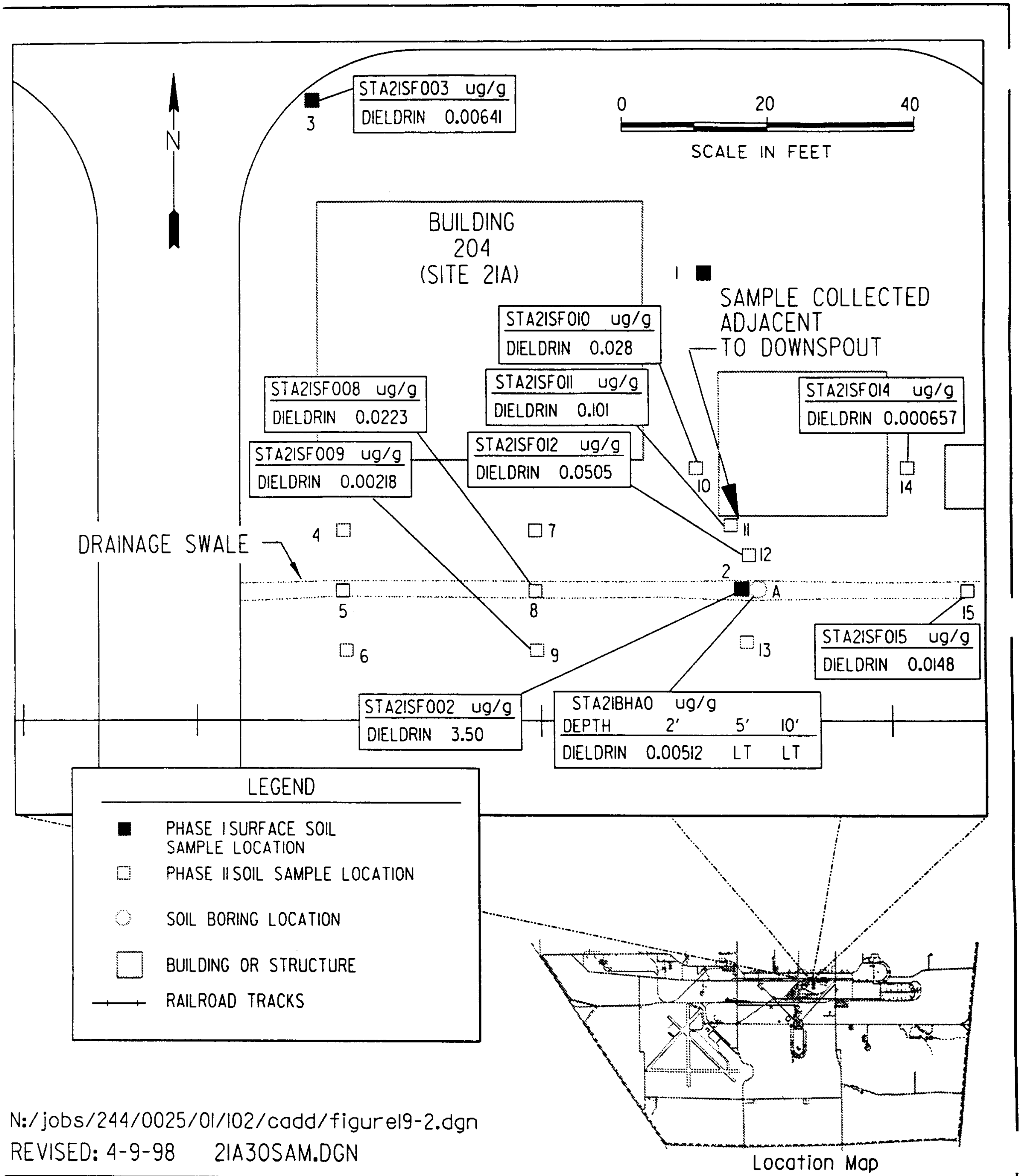


Figure 19-2. Summary of Contaminants Exceeding Background and Regulatory Risk-Based Concentrations at Building 204 Temporary Storage Area (Sites 21A and 30)

20.0 PAPERMILL ROAD DISPOSAL AREA (SITE 25)

20.1 SITE CHARACTERISTICS

The Papermill Road Disposal Area is located north of DRMO and east of Papermill Road (Figure 20-1). This site was first identified in the EPIC report (1986) as a possible disposal area used prior to 1949 until sometime before 1968. It was reportedly used for storage of surplus materials awaiting salvage or sale. Blackened ground surface, along with debris, mounded material, vehicles, and containers were noted in successive aerial photos studied for the EPIC report. During the Phase I RI, the site was no longer in use as a storage site. In the spring of 1997, the area was plowed and planted in corn. In some places, the blackened surfaces covered by a black, tar-like substance were avoided by farm personnel and the material remains at the surface. Other portions of the site were plowed resulting in the mixing of the gravel, cinders, and tarry materials to a depth of approximately 2 feet.

Following completion of the Phase I RI, Site 25 was included as an interim measures site. ~~As of January 1998, the planned removal action of near-surface contaminated soils had not been completed. Future plans call for~~ **Interim measures consisted of** the removal of contaminated soils **in a 200 by 200 ft area to a depth of 2 feet (IND 27, 39)** and backfilling with approved borrow material. ~~Pending completion of the removal action, a h~~**H**uman health and ecological risk assessment was conducted for Site 25 based on Phase I and Phase II sampling results.

The area is relatively flat with a slight slope toward the railroad tracks to the south. There is no obvious surface water pathway associated with the site; however, surface-water runoff appears to flow to the storm water drainage ditch alongside the railroad tracks and then west toward Papermill Road (Figure 2-1). As previously described, the site was planted in corn, whereas the areas surrounding Site 25 were planted in soybeans. During the ecological sampling conducted in September 1997, the corn crop was observed to be poor with stalks being on the order of 1 to 2 feet tall. The contaminated area was fenced by the Army to restrict access and to prevent further activities at the site until planned remedial action could be conducted.

The soils in this area belong to the Cobbsfork soil series. The glacial till is about 35 feet thick as determined from monitoring well boring logs for wells drilled at the nearby yellow sulfur disposal site. The bedrock beneath the glacial till is the Laurel Dolomite of Silurian age. The groundwater contour maps constructed for the Yellow Sulfur Disposal Area (Site 14) indicate an extremely flat horizontal groundwater gradient.

20.2 PREVIOUS INVESTIGATIONS

Prior to this investigation, no environmental sampling had been performed at this site. This site was first identified in the EPIC report (1986) as a possible disposal area used prior to 1949 until sometime before 1968. It was reportedly used for storage of surplus materials awaiting

salvage or sale. Blackened ground surface, along with debris, mounded material, vehicles, and containers were noted in successive aerial photos studied for the EPIC report. Visual site inspections were conducted by both Bonds et al. (1988) and A.T. Kearney, Inc. (1992). Files searches and JPG personnel interviews were completed along with these inspections. No information concerning the nature of potential contaminants at this site was available prior to the RI.

20.3 STUDY AREA INVESTIGATIONS

20.3.1 Phase I RI Field Activities

20.3.1.1 Surface Soils. No previous information existed concerning possible contaminant releases at this site. Given the past use of the site as a storage area for vehicles, containers, and equipment, contaminant releases may have included vehicle fluids, pesticides, and metals. The black tar-like substance appears to be road tar. Due to the unknown nature of potential contaminants at this site, surface- and subsurface-soil sampling and analysis were performed during Phase I.

During the Phase I RI, five surface soil samples were collected **(Figure 20-1)**. Three of these surface samples were collected from areas of surface staining and/or stressed vegetation and analyzed for total metals, PCBs, pesticides, and TPH. The two other samples were taken from the near surface in two of the three Phase I soil borings. These samples were analyzed for total metals, VOCs (sample PMR25BHA01 only), SVOCs, TPH, and explosives (sample PMR25BHA01 only).

20.3.1.2 Subsurface Soils. During Phase I, seven subsurface-soil samples were collected from three soil borings (borings A-C) drilled to the saturated zone or the water table. Subsurface samples were collected at approximate depths of 4 to 5 feet and 9 to 10 feet. The subsurface samples were analyzed for total metals, VOCs (one only), SVOCs (one only), TPH, PCBs, pesticides, and explosives (one only).

20.3.2 Phase II RI Field Activities

20.3.2.1 Surface Soils. Phase II sampling addressed the issue that beryllium and thallium data from Phase I were suspected of being biased high on the basis of data validation results. Eight additional random surface samples were selected on a 200-foot-square grid **(Figure 20-1)**. The Phase II samples were selected to confirm the presence or absence of these two metals and to define the extent of any other contamination that was found during Phase I. Two additional near surface samples were collected from two new soil borings on the grid. These samples were analyzed for SVOCs and metals. The soil boring samples were analyzed for SVOCs due to suspect sample results from Phase I.

20.3.2.2 Subsurface Soils. Two new soil borings (borings D and E) were drilled during Phase II sampling in order to address the suspect sample results for metals and SVOCs from

Phase I. These two boring locations were sampled at depths of 5 and 10 feet below surface for metals and SVOCs.

20.3.3 Interim Measures

Interim measures (IM) were conducted at Site 25 in late 1997 through 1998. Soil was excavated to a 2 foot depth in an area measuring approximately 200 ft by 200 ft. Confirmation sampling was performed (Table 20-3a). Sampling locations are on Figure 20-3.

20.4 DATA EVALUATION

20.4.1 Data Validation Results

All surface and subsurface soil samples from Site 25 were analyzed for metals during Phase I and Phase II. Selected Phases I/II samples were analyzed for explosives, VOCs, and SVOCs, and selected Phase I samples were analyzed for PCBs/pesticides. The analytical database utilized for the human health risk assessment consists of the five Phase I surface soil samples (except the SVOC, beryllium, and thallium results), the eight Phase II surface soil samples, the seven Phase I subsurface soil samples (except the SVOC, beryllium, and thallium results), and the four Phase II subsurface soil samples.

20.4.1.1 Blanks Assessment. When blank contamination exists, the investigative results must exceed the blank result by a factor of 5 (all compounds) or 10 (common laboratory contaminants such as acetone) in order to be considered positive. Several VOCs, SVOCs, and metals were detected in blanks associated with Site 25 samples. Based on comparisons to blanks, positive results were changed to nondetections ("U") if they met the above criteria. The associated sample quantitation limit became either the concentration detected in the sample, if the detected value was above the quantitation limit, or the quantitation limit, if detected results were less than the quantitation limit. Samples qualified as nondetected were not listed in the validation report during Phase I; however, Phase I soil results were listed in the database. Phase II samples were listed in both the validation report and the database.

During Phase I the following results were qualified as nondetected:

- Surface Soil
  - Arsenic—PMR25BHB01
  - Cobalt—PMR25BHB01
  - Silver—PMR25BHB01
  - Thallium—PMR25BHB01, PMR25SF001, and -SF003
  - Total Petroleum Hydrocarbons—PMR25SF002 and -SF003

During Phase II the following results were qualified as nondetected:

- Soil
  - Antimony—PMR25BHD04
  - Beryllium—PMR25BHE02, -E03; PMR25SF005
  - Boron—PMR25BHD01, -D02, -D03, -D04, -E01, -E02, -E03, -E04; PMR25SF004, -05, -08, -09, -11
  - Cadmium—PMR25BHD01, -D02; PMR25SF007
  - Copper—PMR25BHD01, -D02, -D03, -D04, -E01, -E02, -E03; PMR25SF006, -08, -11
  - Lead—PMR25BHD01, -D02, -D04; PMR25SF006, -07
  - Mercury—PMR25BHD01, -D02, -D03, -E02, -E03, -E04
  - Molybdenum—PMR25SF006
  - Vanadium—PMR25BHD01, -D02
  - Sodium—PMR25BHE02, -E03
  - Thallium—PMR25BHE03, -E04; PMR25SF005, -09, -10, -11
  - Di-n-butylphthalate—PMR25BHE02, -E03, -E04

20.4.1.2 Rejected Results. Results for antimony and several SVOCs, including all PCBs in soil, were rejected during Phase I. The rejected metals results were due to poor MS/MSD recoveries. Several parameters included in the SVOC list were rejected because of calibration problems. Due to these problems, all SVOC analyses were subjected to the Tier 2 validation. As a result of this validation, the Phase I SVOC results were not used for the risk assessment other than for providing qualitative information. In general, the following concerns were noted:

- All results for PCB compounds and toxaphene were rejected because they were not included in the calibration standard.

- 4-Nitrophenol was rejected in several samples because of poor response during calibration.

- Other low responses were noted for numerous SVOC compounds; however, qualifiers ~~were not~~**were not** assigned unless other calibration information was also unacceptable.

- Pesticides in soil had elevated CRLs (at least four were above the Region 5 DQL) because of calibration problems.

For Phase II data, the results for one SVOC compound (kepone) were rejected due to low response in the calibration in one or more analytical batch. Non-target (unknown) SVOC compounds were rejected in several analyses due to blank contamination. Analytes associated with rejected data were not included in the database used for the risk assessment.

The following list identifies rejected sample results. Results are <u>not</u> listed below if a reanalysis provided acceptable data for the same sample.

- Soil

  Phase I
  - Antimony—PMR25BHA01, -A02, -A03, -B01, -B02, -B03, -C01, -C02, -C03, PMR25SF001, -002, and -003
  - Atrazine—PMR25BHA01, -A02, -A03, -B01, -B02, -B03, -C01, -C02, -C03
  - Beta endosulfan—PMR25BHA01, -A02, -A03, -B01, -B02, -B03, -C01, -C02, -C03
  - Benzo(b)fluoranthene—PMR25BHB02, -B03, -C01, -C02, -C03
  - Benzo(g,h,i)perylene—PMR25BHB02, -B03, -C01, -C02, -C03
  - 4-Chloroaniline—PMR25BHA01, -A02, -A03, -B01, -B02, -B03, -C01, -C02, -C03
  - 4-Chlorophenylmethyl sulfoxide—PMR25BHB02, -B03, -C01, -C02, -C03
  - 2,4-Dinitrophenol—PMR25BHA01, -A02, -A03, -B01, -B02, -B03, -C01, -C02, -C03
    - 4,6-Dinitro-2-cresol—PMR25BHA01, -A02, -A03, -B01
  - Polychlorinated biphenyls (PCBs) (1016, 1221, 1232, 1242, 1248, 1254, 1260, and 1262)—PMR25BHA01, -A02, -A03, -B01, -B02, -B03, -C01, -C02, -C03
  - Toxaphene—PMR25BHA01, -A02, -A03, -B01, -B02, -B03, -C01, -C02, -C03

  Phase II
  - Kepone—PMR25BHD01, -D02, -D03, -D04, -E01, -E02, -E03, -E04
  - Unknown (UNK)535—PMR25BHE01
  - UNK536—PMR25BHD01, -D02, -D03, -D04, -E02, -E03, -E04
  - UNK537—PMR25BHD01, -D02
  - UNK538—PMR25BHD01, -D02, -D03, -D04

20.4.1.3 Evaluation of Non-Detected Values. A comparison was made between the USEPA Region 5 DQLs and the project CRLs for chemicals that were analyzed for but not detected in environmental media at this site. Exceedances for antimony and thallium were noted for surface water samples. No other exceedances were found.

20.4.2 Data Quality Summary

All antimony results from Phase I soil samples were rejected. However, there are sufficient valid antimony results from Phase ~~II to~~**II to** characterize antimony contamination at this site. Positive results were changed to nondetects ("U") for several metals analyzed during Phase I. Most of the detections in the affected samples were below quantitation limits, and the quantitation limits were below the Region 9 residential soil PRG. Therefore, blank contamination does not significantly impact the conclusions of the risk assessment. Phase II analytical results confirm the presence of low concentrations of PAHs in soils at this site.

In summary, the number of samples, the comprehensiveness of the parameter list, and the quality of the data are adequate to characterize the nature and magnitude of soil contamination at the exposure area addressed in the risk assessment.

20.4.3 Background Screening

20.4.3.1 Surface Soil. Due to the small size of this site, all samples were grouped together for the background comparison. The background screening protocol is described in Section 5.1.4.5.2. The results of the background screening procedure for surface soil at Site 25 are presented in Table 20-1. There were sufficient surface soil samples analyzed for inorganic constituents to apply the t-test and the Mann-Whitney test where appropriate. The site samples were compared to the background for the Cobbsfork soil series. As shown in **Table** 20-1 antimony, boron, cadmium, chromium, cobalt, copper, manganese, mercury, molybdenum, nickel, silver, thallium, tin, vanadium, and zinc are above background in surface soil. These metals, therefore, are carried forward through the COPC selection process.

20.4.3.2 Subsurface Soil. There were sufficient subsurface soil samples analyzed for inorganic constituents to apply the t-test and Mann-Whitney test where appropriate (**Table** 20-1). The following analytes were determined to be above background in subsurface soil at this site: aluminum, barium, beryllium, boron, chromium, cobalt, copper, manganese, mercury, molybdenum, nickel, selenium, silver, thallium, tin, and zinc. These metals were carried forward through the COPC selection process.

20.4.4 Summary of Analytical Results

The summary of analytical results for metals in soil samples from Site 25 is presented in Table 20-2. A complete listing on all analytical results, including nondetected and below reporting limit analytes, is presented in Appendix N.

20.5 NATURE AND EXTENT OF CONTAMINATION

20.5.1 Soil

Analysis of the soil samples collected from the surface and subsurface during Phase I revealed some spotty detections of a variety of organic contaminants (Table 20-3). The near surface soil sample from borehole A contained detectable DDD and DDE at concentrations above the reporting limit; however, the compounds were not detected in the soil samples collected deeper in the borehole or in any other samples collected at the site. In addition, the pesticide results were determined to be suspect due to calibration problems resulting in elevated CRLs. Other organic contaminants detected in Phase I soil samples at Site 25 include TPH detected at 30 μg/g in the surface sample collected from location 1 and two PAHs detected in the near surface sample collected from borehole C. Both of the PAHs, fluoranthene and pyrene, were present at concentrations well below USEPA Region 9 criteria for these compounds.

Phase II samples were found to contain low concentrations of the SVOCs anthracene, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[g,h,i]perylene, benzo[k]fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, fluoranthene, indeno[1,2,3-

c,d]pyrene, phenanthrene, and pyrene. These SVOCs are consistent with the tar-like substance observed at the surface throughout much of the site. The only SVOCs that exceeded USEPA Region 9 criteria, however, were benzo[a]pyrene (two samples) and benzo[b]fluoranthene (one sample).

The following metals were detected above their background values: antimony (3 samples), arsenic (7 samples), barium (9 samples), beryllium (13 samples), boron (10 samples), cadmium (5 samples), chromium (9 samples), cobalt (10 samples), copper (15 samples), lead (7 samples), manganese (7 samples), mercury (2 samples), molybdenum (13 samples), nickel (23 samples), selenium (3 samples), silver (10 samples), thallium (11 samples), tin (11 samples), vanadium (5 samples), and zinc (17 samples). Antimony, boron, cadmium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, silver, vanadium, and zinc detections are all below the USEPA Region 9 criteria.

Aluminum (ranging from 1,410 to 57,000 µg/g), arsenic (2.6 to 47 µg/g), barium (4.8 to 339 µg/g), beryllium (0.292 to 8.84 µg/g), chromium (7.75 to 112 µg/g), manganese (43.5 to 1,340 µg/g), and thallium (6.11 to 75 µg/g) exceed USEPA Region 9 criteria for surface/subsurface soils combined. **The distribution of contaminants detected in soils is presented in Figure 20-1a.** The highest concentrations of thallium and beryllium were detected in the near surface sample in borehole A and in surface soil sample 2. In addition to thallium and beryllium, these two samples also contained the highest concentrations of aluminum (50,000 and 57,000 µg/g, respectively), boron (111 and 109µg/g, respectively), chromium (112 and 120µg/g, respectively), cobalt (18.6 and 22.4 µg/g, respectively), and vanadium (81.8 and 95.0 µg/g). The highest arsenic concentrations were present in the near surface sample of borehole D (25.9µg/g) and surface soil sample 1 (47µg/g). The source of these elevated metals is unknown. The primary use of thallium was as a pesticide and rodenticide, until it was banned in most countries in the mid-1970s. It was mainly produced from flue dusts associated with smelting of sulphate ores of lead and zinc, and from coal-fired power-plant stacks. The source of the elevated beryllium is also not clear. Beryllium has been used to manufacture non-sparking tool alloys for the explosives industry and also in the manufacture of glass, ceramics, fluorescent tubes, and TV tubes. It should be noted that background soil concentrations of arsenic and beryllium also exceed USEPA Region 9 criteria, indicating that naturally high background concentrations exist for these two metals at JPG.

An interim measures removal action was performed at this site, removing soils to a 2 ft depth in an area 200 ft x 200 ft (Figure 20-3). Confirmation samples (Table 20-3a) indicate that residual soils met PRGs.

20.6 HUMAN HEALTH RISK ASSESSMENT

It should be noted that an interim measure (i.e., excavation of contaminated soil) occurred at Site 25. The results of the human health risk assessment have not been updated based on these results. Rather, the original risk calculations are provided for informational purposes to support the need for this interim measure.

20.6.1 Selection of the Contaminants of Potential Concern

20.6.1.1 Surface Soil.

20.6.1.1.1 Data Grouping. As described ~~above~~ **previously in the data evaluation subsection 20.4**, all surface soil samples were grouped together for the purposes of the risk assessment COPC selection process. **All acceptable analytical data were used in the risk assessment. (EPA17)**

20.6.1.1.2 Frequency of Detection. Evaluation of frequency of detection was not undertaken at this site because of too few samples.

20.6.1.1.3 Nutrient Screening. With the exception of iron, the maximum value of each of the nutrients detected in surface soil at this site was less than the corresponding nutrient screening value: calcium (maximum 280,000 µg/g; screening value 1,000,000 µg/g), iron (maximum 160,000 µg/g; screening value 70,000 µg/g), magnesium (maximum 50,500 µg/g; screening value 1,000,000 µg/g), potassium (maximum 8,640 µg/g; screening value 150,000 µg/g), and sodium (maximum 1,360 µg/g; screening value 1,000,000 µg/g). Therefore, all nutrients except iron were eliminated as COPCs in surface soil at Site 25.

20.6.1.1.4 Summary of Preliminary COPCs. Table 20-4 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95% UCL of the mean, and the exposure point concentration for each preliminary COPC in surface soil at Site 25. Preliminary COPCs are chemicals detected above background (or above nutrient screening values) in over 5 percent of the samples.

20.6.1.1.5 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for each preliminary soil COPC was compared to the chemical-specific **USEPA** Region 9 residential soil PRG (Table 20-5). One-tenth of the PRG was used for most noncarcinogens. The exception was organic compounds with PRGs based on saturation limits; the full PRG was used for these chemicals. As a result of the screening chromium, manganese, thallium, benzo(a)pyrene, and benzo(b)fluoranthene were ***retained*** as COPCs in surface soil at Site 25 (Figure 20-2).

20.6.1.2 Surface/Subsurface Soil Combined.

20.6.1.2.1 Data Grouping. All surface/subsurface soil samples were grouped together for the purposes of the risk assessment COPC selection process **as discussed in the data evaluation subsection 20.4**. **All acceptable analytical data were used in the risk assessment. (EPA17)**

20.6.1.2.2 Frequency of Detection. No chemical was detected in fewer than 5 percent of surface/subsurface samples combined.

20.6.1.2.3 Nutrient Screening. With the exception of iron, the maximum value of each of the nutrients detected in surface/subsurface soil combined at this site was less than the corresponding nutrient screening value: calcium (maximum 280,000 µg/g; screening value 1,000,000 µg/g), iron (maximum 160,000 µg/g; screening value 70,000 µg/g), magnesium (maximum 50,500 µg/g; screening value 1,000,000 µg/g), potassium (maximum 8,640 µg/g; screening value 150,000 µg/g), and sodium (maximum 1,360 µg/g; screening value 1,000,000 µg/g). Therefore, all nutrients except iron were eliminated as COPCs in surface soil at Site 25.

20.6.1.2.4 Summary of Preliminary COPCs. Table 20-4 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95% UCL of the mean, and the exposure point concentration for each preliminary COPC in surface/ subsurface soil combined at Site 25. Preliminary COPCs are chemicals detected above background in either surface or subsurface soil (or above nutrient screening values) in over 5 percent of the samples.

20.6.1.2.5 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for each preliminary soil COPC was compared to the chemical-specific **USEPA** Region 9 residential soil PRG (Table 20-5). One-tenth of the PRG was used for most noncarcinogens. The exceptions were lead and organic compounds with PRGs based on saturation limits; the full PRG was used for these chemicals. As a result of the screening, aluminum, beryllium, chromium, manganese, thallium, and benzo(a)pyrene were ***retained*** as COPCs in surface/subsurface soil combined at Site 25.

20.6.1.3 Air.

20.6.1.3.1 Summary of Preliminary COPCs. Ambient air concentrations to which future receptors at this site might be exposed were estimated using air emission/dispersion modeling, as described in Appendix R. In the site-specific conceptual model, discussed below in Section 20.6.2.1, Site 25 is evaluated under two future site-specific scenarios: a future residential/ agricultural site and leased agricultural land.

For determining ambient air concentrations in the future residential scenario for the facility, all sites were assumed to be residential except for the five sites designated agricultural. It was assumed that particulate emissions from the strictly residential sites would be negligible because the home sites would be covered with dense vegetation (lawns) and pavement. Therefore, under the residential scenario only the agricultural sites contribute to the air concentrations at all of the sites. The list of preliminary air COPCs is therefore the same for every site, although the concentrations vary. Table R-6 in Appendix R presents the estimated ambient air concentrations at Site 25 under the future residential land use scenario.

Under the leased agricultural land use scenario, the consumers of livestock products from animals fed crops grown at this site are assumed to live far enough distant from the site that

their exposure to site-related air contaminants would be negligible. The air pathway was therefore not evaluated for these future off-site receptors.

20.6.1.3.2 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for each preliminary air COPC at Site 25 in the future residential scenario was compared to the chemical-specific **USEPA** Region 9 air PRG (Table 20-6). One-tenth of the PRG was used for noncarcinogens. The exception was lead, for which the full PRG was used. As a result of the screening, aluminum, chromium, manganese, thallium, silver, vanadium, and zinc are retained as air COPCs for future residents at Site 25.

20.6.2 Exposure Assessment

20.6.2.1 Site Conceptual Model. There are no **known** people who specifically work at Site 25, with the exception of agricultural workers. This land use scenario for this site is evaluated as a potential future land use, as described below. Several other types of individuals could also potentially be affected by the existing contamination at the facility. These are current trespassers to JPG, off-facility (nearby) rural residents, and future hunters. In each case, these individuals would most likely be impacted simultaneously by multiple sites rather than by single units. Because of this, these other current receptor populations are addressed on a facility-wide, cumulative basis rather than by specific sites (see Sections 28 and 29). Therefore, this site-specific conceptual model only addresses future land use development. Site 25 has two potential future land uses forwarded for evaluation:

- Agricultural
- Residential

Agricultural Use. Under this future land use scenario, Site 25 is assumed to be leased to a nearby farmer for the purpose of cultivating cash crops. The most likely receptor population would therefore consist of individuals residing in nearby communities who consume beef and milk products obtained from cattle fed crops harvested at JPG.

Residential Use. Under the future residential land use scenario, this site was assumed to be developed as homesteads, with the supposition that a family would build a house directly on or within this area of potential concern. Since Site 25 is a residential/agricultural site, it was assumed that these receptors could raise beef and dairy cattle on their property. With respect to a risk assessment analysis, resident populations were assumed to consist of both adults and toddlers. Each individual would be expected to come in contact with site contaminants through the following pathways at Site 25:

- Inhalation of VOCs and fugitive particulates from soils
- Dermal contact with soil (surface or surface/subsurface combined) while gardening/playing outdoors

- Incidental ingestion of soil (surface or surface/subsurface combined) while gardening/playing outdoors

- Ingestion of fresh homegrown fruits and vegetables (grown in surface soil or surface/subsurface soil combined)

- Ingestion of home-produced beef

- Ingestion of home-produced milk

20.6.2.2 Exposure Point Concentrations.

20.6.2.2.1 Air. The estimated ambient air concentrations of COPCs at this site for the future on-site resident are presented in Table 20-6.

20.6.2.2.2 Soil. The concentrations of COPCs in surface soil and surface/subsurface soil combined at this site are presented in Table 20-5.

20.6.2.2.3 Fruits, Vegetables, and Crops. COPC concentrations in homegrown fruits and vegetables and crops (corn) grown for livestock consumption were estimated using the methods described in Section 5.1.5.2.8. Appendix U, Table U-13, documents the calculation of contaminant concentrations in fruits, vegetables, and crops at Site 25.

20.6.2.2.4 Beef and Milk. COPC concentrations in beef and milk were estimated using the methods described in Sections 5.1.5.2.9 and 5.1.5.2.10, respectively. Table U-13, Appendix U, documents the calculation of contaminant concentrations in beef and milk at Site 25.

20.6.2.3 Human Exposure Doses.

20.6.2.3.1 Inhalation of Contaminated Air. Inhalation of airborne contaminants (VOCs and particulates) is a potential route of exposure for future on-site residents (adults and children) at this site. The equation used for calculating human exposure doses of contaminants of potential concern due to inhalation of volatile and dust-bound contaminants is provided in Section 5.1.5.3.1, Table 5-**11**~~12~~. Table V-13, Appendix V, documents the calculation of human exposure doses due to inhalation of contaminated air.

20.6.2.3.2 Incidental Ingestion of Contaminated On-site Soil. Mouthing behavior (toddlers) and incidental ingestion of soil with recreational or work-related activities may expose human receptors to contaminated soil at a site via the oral route of exposure. The equation used to calculate the human exposure dose due to incidental ingestion of contaminated soil is presented in Section 5.1.5.3.2, Table 5-**12**~~13~~. This pathway was assumed to be complete at Site 25 for future on-site residents (adults and children). Table V-13, Appendix V, documents the calculation of human exposure doses due to incidental ingestion of soil at Site 25.

20.6.2.3.3 Dermal Contact with Contaminated On-site Soil. The chemicals in contaminated soil also may be absorbed into a receptor's body through dermal contact. The equation used to calculate chemical doses due to dermal contact with contaminated soil is presented in Section 5.1.5.3.3, Table 5-**13**~~14~~. This pathway is relevant for future on-site residents (adults and children) at Site 25. Table V-13, Appendix V, documents the calculation of human exposure doses due to dermal contact with soil at Site 25.

20.6.2.3.4 Ingestion of Contaminated Fruits and Vegetables. Consumption of contaminated homegrown fruits and vegetables may be a source of chemical exposure for future on-site residents (adults and children). The equation used to calculate human exposure doses due to ingestion of contaminated fruits and vegetables is provided in Section 5.1.5.3.11, Table 5-**22**~~23~~. Table V-13, Appendix V, documents the calculation of human exposure doses due to ingestion of contaminated fruits and vegetables grown in surface soil at Site 25.

20.6.2.3.5 Ingestion of Contaminated Beef and Milk. Ingestion of contaminated beef and milk may be significant pathways of chemical exposure for future on-site residents and future off-site residents (adults and children) who consume these products from cattle fed corn (silage) harvested from fields at Site 25. The equation used to calculate human exposure doses due to ingestion of contaminated beef is provided in Section 5.1.5.3.12, Table 5-**23**~~24~~. The equation used to calculated human exposure doses due to ingestion of contaminated milk is provided in Section 5.1.5.3.13, Table 5-**24**~~25~~. Table V-13, Appendix V, documents the calculation of the human exposure doses due to ingestion of contaminated beef and milk from cattle fed corn (silage) grown in fields at Site 25.

20.6.3 Risk Characterization

20.6.3.1 Chronic Health Hazards. The noncancer daily exposure doses calculated in the exposure assessment were used to calculate HQs for each of the COPCs possessing RfDs. Pathway-specific and overall HIs were then calculated for each receptor. The calculations of HQ and HI are described in Section 5.1.7.1. If an overall HI is calculated to be greater than 1.0 for a particular receptor, then the exposure pathway(s) primarily responsible for the result is identified as a "critical pathway(s)." For each critical pathway, those chemical contaminants responsible for the majority of the HI are listed as COCs. Table W-13, Appendix W, documents the calculation of the pathway- and chemical-specific HQs for the human receptors at Site 25. The pathway-specific and overall HIs are summarized in Table 20-7.

20.6.3.1.1 Future On-Site Residents. If receptors are exposed to COPCs in surface soil only, the overall HIs for the future on-site adult and toddler residents at Site 25 are calculated to be 1.7 and **8.7**~~8.5~~, respectively. Both of these HIs exceed the USEPA's risk management criterion of 1.0. For the adult resident, no single pathway or chemical-specific multi-pathway HI exceeds 1.0. The critical exposure pathways for the toddler receptors are incidental ingestion of soil, for which thallium is the sole noncarcingenic COC, and inhalation of fugitive dusts, for which manganese is the only COC.

If subsurface soil is assumed to be mixed and dispersed with surface soil across the ground surface at the home-site, the overall HIs for the future on-site adult and toddler residents at Site 25 are calculated to be 1.6 and **7.6**~~7.8~~, respectively. Both of these HIs exceed the USEPA's risk management criterion of 1.0. For the adult resident, no single pathway or chemical-specific multi-pathway HI exceeds 1.0. The critical exposure pathways for the toddler receptors are incidental ingestion of soil, for which thallium is the sole noncarcingenic COC, and inhalation of fugitive dusts from surface soil, for which manganese is the only COC.

Because the hazards for the inhalation of air pathway reflect combined modeled fugitive dust and/or VOC contributions from all sites, the data were reviewed to determine the contribution of soil at Site 25 to the chemical-specific HQs calculated for the noncarcinogenic hazards for this pathway. Manganese in Site 25 soils is responsible for essentially all of the air pathway HQ for this chemical at this site.

Thallium and manganese are present naturally in soils at the facility. The relative contributions of background soil concentrations of these noncarcinogenic soil COCs to the hazards at this site were estimated by comparing the average soil background concentrations of these chemicals (in Cobbsfork soils) to the average concentration in site soils. This analysis shows that background concentrations of thallium and manganese contribute approximately 10 percent and 43 percent, respectively, to the total surface soil concentrations of these two chemicals in soils at this site, and approximately 9 percent and 44 percent, respectively, to the total surface/subsurface soil combined concentrations.

Background concentrations of thallium and manganese at Site 25 would contribute approximately 10 percent and 30 percent, respectively, to the total hazards estimated for surface soil at this site, and approximately 9 percent and 37 percent, respectively, to the total hazards estimated for the excavation scenario.

20.6.3.1.2 Future Off-Site Consumers of Beef and Milk. The overall HIs for the future off-site adult and toddler consumers of beef and milk produced at Site 25 are calculated to be **0.15**~~0.18~~ and **0.42**~~0.50~~, respectively. Both of these HIs are less than USEPA's risk management criterion. Thus, no critical exposure pathways or chemicals of concern are identified for these receptors. The existing contamination at Site 25 would not present a chemical hazard to future off-site consumers of beef and milk from cattle fed corn (silage) grown in fields at this site.

20.6.3.2 Excess Lifetime Cancer Risks. The cancer risks for each receptor were determined from the pathway-specific exposure doses and the route-specific SFs, as described in Section 5.1.7.2. To assess the simultaneous exposure of a receptor population to multiple carcinogens from multiple exposure routes, all of the cancer risks calculated for a receptor population were summed. Each overall receptor cancer risk was then compared to USEPA's target risk range (1.0E-06 to 1.0E-04). If the total cancer risk for a receptor from all exposure pathways is less than 1.0E-04, then it is concluded that the site(s) does not pose a significant risk to that receptor. If the overall cancer risk exceeds the target risk range, any chemical individually associated with a risk level greater than 1.0E-05 is identified as a COC. COCs represent the

primary contributors to the potential cancer risk for the receptor-specific exposure pathway under evaluation.

Table W-13, Appendix W, documents the calculation of the pathway- and chemical-specific cancer risks for the human receptors at Site 25. The pathway-specific and overall cancer risks are summarized in Table 20-7~~5~~.

20.6.3.2.1 Future On-Site Residents. The overall cancer risks calculated for the future adults and toddlers living at Site 25 are calculated to be **7.8E-05**~~7.7E-05~~ and **5.8E-05**~~5.7E-05~~, respectively. These cancer risks are within the USEPA's target risk range of 1.0E-06 to 1.0E-04. Therefore, no critical exposure pathways or carcinogenic COCs are identified for these receptors.

If subsurface soil is assumed to be mixed with surface soil across the ground surface at the home-site, the overall cancer risks calculated for the future adults and toddlers living at Site 25 are calculated to be 7.6E-05 and 5.7E-05, respectively. These cancer risks are within the USEPA's target risk range of 1.0E-06 and 1.0E-04. Therefore, no critical exposure pathways or carcinogenic COCs are identified for these receptors. (EPA3d)

20.6.3.2.2 Future Off-Site Consumers of Beef and Milk. The overall cancer risks calculated for the future off-site adults and children consuming beef and milk from cattle fed corn (silage) grown at this site are 1.8E-05 and 1.3E-05, respectively. These cancer risks are within the USEPA's target risk range of 1.0E-06 to 1.0E-04. Therefore, no critical exposure pathways or carcinogenic COCs are identified for these receptor populations.

20.6.3.3 Uncertainty/Sensitivity Analysis. The numerical risks/hazards that are calculated for Site 25 represent *conditional* estimates of risk based on various simplifying assumptions concerning contaminant exposure and toxicity. These estimates of risk/hazard are derived using a series of ~~conservative~~ procedures that address contaminant concentrations at the site, their fate in the environment, how someone currently or in the future might be exposed to these contaminants, and the toxicity of each chemical toward humans~~.~~ **.(~~[~~EPA 121)~~0]~~** The uncertainty analysis specifies, when appropriate, the critical assumptions made for the site so that the site-specific results can be interpreted by risk managers in a proper context.

To assist the risk managers in this project, a qualitative uncertainty analysis has been performed. The primary goals of a qualitative uncertainty analysis are (1) to itemize the major areas of uncertainty in the site-specific risk assessment and (2) to demonstrate that the assessment overall has been conservatively performed (i.e., that the potential risks/hazards at the site have not likely been underestimated, but may have been significantly overestimated).

The qualitative uncertainty analysis for this site is presented in Table 20-8. Based on this analysis, it can be concluded that this risk assessment is conservative. Some of the major uncertainties in this study that are most influential to the risks/hazards that were calculated include:

- Receptors' exposure time (24 hours/day) and exposure frequency (350 days/year)
- Receptors' exposure duration (30 years)
- Air dispersion modeling of exposure point concentrations
- Use of high-end values as receptors' soil ingestion rates

20.7 ECOLOGICAL RISK ASSESSMENT

It should be noted that an interim measure (i.e., excavation of contaminated soil) occurred at Site 25. These results have been evaluated in the ecological risk assessment to address the effectiveness of the interim measure to reduce ecological risks. The original ecological risk calculations are provided for informational purposes to support the need for the interim measure.

20.7.1 Ecological Site Description

Site 25 has been fenced and is now surrounded by plowed fields planted in corn and/or soybeans. Pea-gravel is present in some areas, and what appear to be black chunks of asphalt, clinkers, and gravel are present throughout most of the site. The area is weedy with grasses, sedges, rushes, clover milkweed, dewberry, hop-clover, and chickweed sparsely distributed across the site. The condition of vegetation is generally poor, particularly in the area with the black material. **Refer to Figure 5.3-13 for a map of habitat types at JPG. (EPA184)** No wildlife were observed, but a few deer tracks and crayfish burrows were noted in the surrounding area. **Refer to Table 20.7-a1 for a summary of Site 25 ecological habitat characteristics identified during site visits. (EPA184)** -Figure 20.7-1 provides a summary of ecological sampling locations (Phase III) at Site 25.

20.7.2 Site 25 Investigations

For convenience to the reader, summary statistics, EPCs, risk driver HQs, total RME, and CT HIs are provided in this section. All intakes and other non risk-driving HQs are located in Appendix AA**. The COPCs for each medium that were evaluated in the DERA are presented on the EPC tables in this section. Refer to Appendix AA for details pertaining to the specific data sets (e.g., sample numbers, depths, dates, etc.) used in the risk assessment for Site 25. (EPA 179)**

20.7.2.1 Phase I Activities. The Phase I summary statistics for Site 25 are provided in Table 20.7-1. Table 20.7-2 provides the EPCs for Site 25.

20.7.2.2 Phase II Activities. The Phase II summary statistics for Site 25 are provided in Table 20.7-3. Table 20.7-4 provides the EPCs for Site 25.

20.7.2.3 Phase III Activities. The Phase III summary statistics for Site 25 are provided in Table 20.7-5. Table 20.7-6 provides the EPCs for Site 25.

20.7.2.4 Interim Measures. **Interim measures (IM) were conducted at Site 25 in late 1997 and completed in 1998. Confirmation sampling consisted of 24 surface soil samples collected from a 2-foot-deep excavated area measuring approximately 200 by 200 feet (Figure 20-3). All samples were analyzed for Target Analyte List (TAL) metals, SVOCs, and VOCs. The only detects included metals and two detects of toluene, which likely represent laboratory contamination. The IM summary statistics for Site 25 are provided in Table 20.7-7. Table 20.7-8 provides the EPCs for Site 25 (IND 27,39).**

20.7.3 Exposure and Ecological Effects Profile

Birds and mammals may be exposed to COPCs by direct contact with or ingestion of soil. No surface water data were available at Site 25. To determine the estimated intakes of the COPCs, various key receptor species were selected to evaluate the impacts to area wildlife. The key receptors evaluated for Site 25 include mourning dove, chimney swift, American kestrel, wild turkey, white-footed mouse, eastern cottontail, red fox, little brown myotis, plants, and soil fauna.

The conceptual site model (CSM) for Site 25 provides an overview of the ecological receptors and exposure pathways evaluated in the ecological risk assessment. Refer to Figure 20.7-1a for a schematic of the CSM. Multiple terrestrial lines of evidence were evaluated for the ecological assessment conducted at Site 25. The lines of evidence were primarily hazard index (HI) calculations for a number of different receptors, but for the terrestrial ecosystem toxicity testing was also conducted. Refer to Table 7.7-11a for a summary of the terrestrial ecosystem lines of evidence. (EPA180a,b)

The exposure pathways and receptors evaluated at this site are as follows:

- Terrestrial Ecosystem
  - All wildlife receptors—soil ingestion
  - All wildlife receptors—dietary ingestion
  - Plants—direct contact with soil
  - Soil fauna—direct contact with soil

20.7.3.1 Selection of COPCs. Inorganic analytes from soil data collected during Phases I, II, III, and IM confirmation sampling were compared to the JPG Phase II background data set (Section 5.3.2.1). Analytes that were not statistically elevated relative to background were removed from consideration as COPCs. **The COPCs for Site 25 in the various media are presented in Tables 20.7-1 through 20.7-8.**

Aluminum, arsenic, manganese, selenium, and vanadium were removed as COPCs at Site 25 in Phase I since their soil concentrations were not statistically elevated above background. **There were no explosives detected in surface soil in the Phase I data.**

Metals and SVOCs were analyzed in surface soil in Phase II. Aluminum, barium, beryllium, chromium, manganese, lead, selenium, and vanadium were removed as COPCs for Site 25 Phase II since their soil concentrations were not statistically elevated above the JPG Phase II background.

Aluminum, arsenic, barium, beryllium, chromium, iron, manganese, lead, and vanadium were removed as COPCs for Eco Site 25 Phase III since their soil concentrations were not statistically elevated above the JPG Phase II background. Neither molybdenum nor thallium was detected in soil at this ecological study site for Phase III.

For the IM confirmation sampling results, only boron and cobalt remained as COPCs when compared to the JPG Phase II background data set.

20.7.3.2 Comparison of Site Data to Reference Area Concentrations. No COPCs were significantly elevated at Site 25 relative to the Phase III reference areas.

20.7.3.3 Earthworm Toxicity Test. **Earthworm mortality at Site 25 ranged from 0 to 10 percent. Refer to Table 8.7-12a for results of the earthworm toxicity testing. (EPA191)** The null hypothesis is that "the number of dead earthworms is similar among all locations". The χ^2 test statistic was 49.25 with a degree of freedom of 40, which resulted in a p value of 0.1498. Since this p-value exceeds 0.1, the hypothesis that row and columns are independent cannot be rejected. Therefore, the site location may bear no relation to earthworm mortality when this test is used.

ANOVA on the arcsine-transformed data provides a different interpretation. The p-value for ANOVA is 0.0016, indicating a significant difference between the mean mortality from one location to another at the 95 percent confidence level. A 95 percent LSD test indicated that mortality was not significantly different at Site 25 than at the Avonburg, Cobbsfork, or Rossmoyne reference areas. The statistical analysis therefore indicates that earthworm mortality is not likely to be significantly affected by existing site conditions at Site 25.

20.7.3.4 Phytotoxicity Test. The phytotoxicity early seedling growth test resulted in data for percent germination and biomass. The results are summarized in Appendix Z. There was little variability in germination rates. The germination data were neither normal nor log-normal. The biomass data on a wet-weight basis were lognormal. Germination at Site 25 ranged from 92 to 100 percent.

ANOVA of the germination data resulted in a p-value of 0.1480, which is greater than 0.05, indicating that location does not have a statistically significant effect on germination at the 95 percent confidence level. ANOVA of the biomass data resulted in a p-value of 0.0037, indicating site location has a significant effect on wet weight biomass at the 95 percent confidence level. The lowest biomass observed in the study was the biomass for the Cobbsfork reference area. An LSD multiple range test revealed that the biomass was

significantly higher at Site 25 than at Avonburg or Cobbsfork reference areas, but that biomass was not significantly different from that observed at the Rossmoyne reference area.

The percent germination and the biomass data indicate that existing site conditions at Site 25 will not significantly decrease plant growth or reproduction relative to effects observed in controls. Instead, Site 25 is more productive than two of the reference areas.

20.7.3.5 Soil Fauna Community Structure. The number of individuals per sample (density) was log-normal. The number of species was neither normal nor log-normal. Diversity ranged from 0 to 97 percent at the reference areas, indicating that this parameter is so inherently variable at JPG that it possibly cannot be used to identify contaminant-related effects. The number of individuals was not significantly different by location when the log transformed data were analyzed by ANOVA. The number of invertebrate species was not statistically significantly different at the 95 percent confidence level when analyzed by the Kruskal-Wallis test. There does not appear to be any affect of site location on soil invertebrates.~~, although community similarity will be examined in a later version.~~

20.7.4 Risk Characterization

20.7.4.1 Risk Estimation. The HIs are summarized for each sampling event and receptor below. The HIs have been grouped by order of magnitude for discussion purposes. HIs based on RME and CT exposure parameters are presented. In addition, a conservative NOAEL-based TRV and a dose at which population-level effects may occur (LOAEL-based TRV) were used to establish the lower and upper bounds on toxicity, respectively. These values define the risk boundaries. There are thus four sets of HI values for each location and sampling event (NOAEL-RME, NOAEL-CT, LOAEL-RME, and LOAEL-CT). The exposure intakes, HQs, and HIs are presented in Appendix AA. **Figures 20.7-2 through 20.7-17** show the total NOAEL and LOAEL-based HI risks for both the RME and CT exposure scenarios by receptor **(Figure 5.3-5)**.

Site 25

Phase I RME NOAEL HIs
(See Figure 20.7-2)
Key Receptors with HI range 0-1: Mourning Dove, Wild Turkey, Red Fox, Chimney Swift, American Kestrel, Little Brown Myotis
HI Range 1.1-10: None
HI Range 10.1-100: Eastern Cottontail, Plants
HI Range 100.1-1000: White-footed Mouse, Soil Fauna

Phase I RME LOAEL HIs
(See Figure 20.7-3)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Red Fox, Soil Fauna, Little Brown Myotis
HI Range 1.1-10: Plants, Eastern Cottontail

HI Range 10.1-100: White-footed Mouse
HI Range 100.1-1000: None

Phase I CT NOAEL HIs
(See Figure 20.7- 4)
Key Receptors with HI range 0-1: Mourning Dove, Wild Turkey, American Kestrel, Red Fox, Chimney Swift, Little Brown Myotis
HI Range 1.1-10: Eastern Cottontail
HI Range 10.1-100: White-footed Mouse
HI Range 100.1-1000: None

Phase I CT LOAEL HIs
(See Figure 20.7-5)
Key Receptors with HI range 0-1: Wild Turkey, Red Fox, American Kestrel, Mourning Dove, Chimney Swift, Little Brown Myotis
HI Range 1.1-10: Eastern Cottontail
HI Range 10.1-100: White-footed Mouse
HI Range 100.1-1000: None

Site 25

Phase II RME NOAEL HIs
(See Figure 20.7-6)
Key Receptors with HI range 0-1: Mourning Dove, Wild Turkey, Red Fox, Chimney Swift, American Kestrel**, Little Brown Myotis**
HI Range 1.1-10: ~~Little Brown Myotis,~~ Plants**, Eastern Cottontail, Soil Fauna**
HI Range 10.1-100: White-footed Mouse~~, Eastern Cottontail, Soil Fauna~~
HI Range 100.1-1000: None

Phase II RME LOAEL HIs
(See Figure 20.7-7)
Key Receptors with HI range 0-1: Mourning Dove, Wild Turkey, Red Fox, Chimney Swift, Little Brown Myotis, Soil Fauna, American Kestrel**, Plants, Eastern Cottontail**
HI Range 1.1-10: ~~Plants, Eastern Cottontail~~**White-footed Mouse**
HI Range 10.1-100: ~~White-footed Mouse~~**None**
HI Range 100.1-1000: None

Phase II CT NOAEL HIs
(See Figure 20.7-8)
Key Receptors with HI range 0-1: Wild Turkey, Red Fox, American Kestrel, Mourning Dove, Chimney Swift**, Little Brown Myotis**
HI Range 1.1-10: ~~Little Brown Myotis,~~ Eastern Cottontail
HI Range 10.1-100: White-footed Mouse
HI Range 100.1-1000: None

Phase II CT LOAEL HIs
(See Figure 20.7-9)
Key Receptors with HI range 0-1: Wild Turkey, Red Fox, American Kestrel, Mourning Dove, Chimney Swift, Little Brown Myotis, Eastern Cottontail
HI Range 1.1-10: White-footed Mouse
HI Range 10.1-100: None
HI Range 100.1-1000: None

Site 25

Phase III RME NOAEL HIs
(See Figure 20.7-10)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, Red Fox, American Kestrel, Soil Fauna
HI Range 1.1-10: Little Brown Myotis, Plants, Eastern Cottontail
HI Range 10.1-100: None
HI Range 100.1-1000: White-footed Mouse

Phase III RME LOAEL HIs
(See Figure 20.7-11)
Key Receptors with HI range 0-1: Mourning Dove, Wild Turkey, American Kestrel, Red Fox, Chimney Swift, Little Brown Myotis, Plants, Soil Fauna
HI Range 1.1-10: Eastern Cottontail
HI Range 10.1-100: White-footed Mouse
HI Range 100.1-1000: None

Phase III CT NOAEL HIs
(See Figure 20.7-12)
Key Receptors with HI range 0-1: Wild Turkey, American Kestrel, Mourning Dove, Chimney Swift, Red Fox
HI Range 1.1-10: Little Brown Myotis, Eastern Cottontail
HI Range 10.1-100: White-footed Mouse
HI Range 100.1-1000: None

Phase III CT LOAEL HIs
(See Figure 20.7-13)
Key Receptors with HI range 0-1: Wild Turkey, Red Fox, American Kestrel, Mourning Dove, Chimney Swift, Little Brown Myotis, Eastern Cottontail
HI Range 1.1-10: White-footed Mouse
HI Range 10.1-100: None
HI Range 100.1-1000: None

Site 25

Interim Measures RME NOAEL HIs
(See Figure 20.7-14)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Red Fox, Little Brown Myotis, Plants, Soil Fauna
HI Range 1.1-10: Eastern Cottontail
HI Range 10.1-100: White-footed Mouse
HI Range 100.1-1000: None

Interim Measures RME LOAEL HIs
(See Figure 20.7-15)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Red Fox, Little Brown Myotis, Plants, Soil Fauna
HI Range 1.1-10: Eastern Cottontail
HI Range 10.1-100: White-footed Mouse
HI Range 100.1-1000: None

Interim Measures CT NOAEL HIs
(See Figure 20.7-16)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Red Fox, Little Brown Myotis
HI Range 1.1-10: Eastern Cottontail
HI Range 10.1-100: White-footed Mouse
HI Range 100.1-1000: None

Interim Measures CT LOAEL HIs
(See Figure 20.7-17)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Red Fox, Little Brown Myotis
HI Range 1.1-10: Eastern Cottontail
HI Range 10.1-100: White-footed Mouse
HI Range 100.1-1000: None

20.7.4.2 Risk Description. All COPCs at Site 25 were within the expected ambient concentrations predicted by the data from the reference areas. The soils at Site 25 did not produce elevated levels of mortality in earthworms relative to that observed at the reference areas, nor was the soil fauna diversity or density affected. Plant germination and biomass were not significantly different at Site 25 than at the reference areas.

The Phase I RME NOAEL-based HIs for soil fauna were higher than at the reference areas (Figure 20.7-2). The Phase II RME NOAEL-based HIs are highest for the white-footed mouse, eastern cottontail, plants, and soil fauna (Figure 20.7-6). The Phase II and III (Figure 20.7-10) **and IM (Figure 20.7-14)** RME NOAEL-based HIs at Site 25 were lower than the

HIs at the reference areas. The HIs for each reference area and the inherent JPG Phase II background risks can be found in Section 32.

HIs greater than 1 based on the LOAEL indicate a potential for population-level effects since the LOAEL is an adverse effect level. The Phase I RME LOAEL-based HIs for Site 25 were similar to the reference area HIs. The Phase II RME LOAEL-based HIs for Site 25 were similar to the reference area HIs except for white-footed mouse. The Phase III RME LOAEL-based HIs for Site 25 were within the same order of magnitude as those at the reference areas for all receptors. **The IM RME LOAEL-based HIs for Site 25 were lower than those at the reference areas for all receptors.** These somewhat conflicting data indicate a weak potential for adverse population-level effects for soil fauna and white-footed mouse.

The HI results are in direct contrast with the results of the biometric studies, which measured a lack of population and individual level effects in earthworms and other soil invertebrates, and in plants. The results suggest that the NOAEL TRVs are overly conservative for this site, since ambient levels of inorganics in the reference areas produce high risk estimates, yet only one analyte statistically exceeds measured concentrations at the reference areas. HIs for receptors other than white-footed mouse and soil fauna are not higher than HIs at the reference areas. Consideration of all lines of evidence supports the conclusion that contamination at Site 25 is not a likely threat to ecological health at JPG.

20.7.4.2.1 Risk Drivers/Summary of Lines of Evidence. Risk drivers associated with Site 25 are summarized in **Tables 20.7-9 through 20-7-14.** A COPC was categorized as a risk driver if it produced an HQ greater than or equal to 1 for any exposure pathway.

In addition, to provide an overall summary of the multiple lines of evidence that were evaluated for the Site, a summary table was developed. The lines of evidence were primarily hazard index (HI) calculations for a number of different receptors, but for the terrestrial ecosystem, toxicity testing was also conducted for Site 25. Refer to Table 7.7-11a for a summary of the lines of evidence. A number of measurement endpoints were assessed for the terrestrial ecosystem. An evaluation was made of which measurement endpoints were most sensitive in determining the potential for an ecological concern to the terrestrial ecosystem. (EPA180a,b)

The most sensitive of the terrestrial measurement endpoints for Site 25 are soil fauna and white-footed mice. The reasonable maximum exposure (RME) no observed adverse effect level (NOAEL)-based hazard indices (HIs) for each of these receptors are as follows: 362 (soil fauna) and 117 (white-footed mice). The primary contributors of risk to soil fauna are chromium (RME NOAEL HQ of 246) and iron (RME NOAEL HQ of 115) from direct contact with soil. The primary contributors of risk to white-footed mice are boron (RME NOAEL HQ of 55) through dietary ingestion and iron (RME NOAEL HQ of 30) from direct contact with soil. All HQs were derived using Phase I data.

None of the metals listed as primary contributors to ecological risk based on the Phase I data are present at concentrations that exceed reference area concentrations. Thus,

these metals (aluminum, copper, selenium, and zinc) would not be expected to contribute to ecological risk exceeding that in the reference areas. In addition, since an interim measure was taken at this site, levels of contamination have been further reduced. For these reasons, residual contamination at Site 25 would not be expected to pose an ecological concern. (EPA180a,b)

As additional lines of evidence, earthworm and plant toxicity tests were performed at Site 25. The soils at Site 25 did not produce elevated levels of mortality in earthworms relative to that observed at the reference areas, nor was the soil fauna diversity or density affected. Plant germination and biomass were not significantly different at Site 25 than at the reference areas.

20.7.4.3 Uncertainty Analysis. The collection of Phase I, II, III, and IM confirmation sampling data at Site 25 helps to reduce the uncertainty associated with the risk assessment results for this location. In addition to metals, SVOCs were analyzed in the Phase II soil data. The number of samples and analyses for soils at Site 25 should provide adequate coverage and reduce overall uncertainty.

Uncertainty in the exposure estimates is due primarily to:

- Variability in the exposure parameters, which produce a natural distribution of the variables in the intake equations for each of the receptors;
- Exposure parameters derived from literature and not measured on site;
- Uncertainty in the dietary ingestion pathway, which utilized BAFs to predict dietary concentrations;
- Variation in the concentrations of COPCs in the environment;
- Uncertainty as to whether the most conservative pathways have been addressed and evaluated.

The predicted effect of each of these sources of uncertainty on the risk assessment is as follows:

Variability in the exposure parameters—Because both the average and RME scenarios were quantitatively addressed, this source of uncertainty is expected to have no overall effect on the risk assessment results.

Exposure parameters derived from literature—Because so many ecological receptors were quantitatively considered in the ecological risk assessment, this source of uncertainty is expected to have no overall effect on the risk assessment.

Uncertainty in the dietary ingestion pathway—The use of literature-based BAFs or BCFs is expected to overestimate as opposed to underestimate concentrations in the dietary pathway. This is because under laboratory conditions, animals are chronically exposed on a daily basis and supposedly reach steady state. In the wild, as animals move in and out of contaminated areas, metabolism and excretion are expected to reduce the body burden. Use of field-based BAFs from TEAD is not expected to overestimate or underestimate risk for these analytes, since these data were measured in conjunction with co-located soil samples.

Variation in the concentrations of COPCs in the environment—This uncertainty is not expected to bias the risk assessment towards underestimation of risk since maximum or UCL95 concentrations were used in all exposure scenarios to estimate the EPCs.

Uncertainty as to whether the most conservative pathways have been addressed—The receptors were carefully considered by the DSG, and typically have high exposure rates due to their life-histories (i.e., ground-feeding or burrowing). Therefore, this source of uncertainty is not expected to impact the risk assessment.

Uncertainty in the ecological analysis is less than the uncertainty in the exposure estimates, because these data were gathered as part of a site-specific, controlled field study. There were sufficient samples collected at each site (n=5) to identify within and between site variability. The data identify the potential for adverse effects to species that form the basis of the JPG food web, that is, the plants and soil fauna. The data indicate a potential for phytotoxicity at Grid 2.

20.7.5 Ecological Risk Assessment Summary

The conceptual site model (CSM) for Site 25 provides an overview of the ecological receptors and exposure pathways evaluated in the ecological risk assessment. Refer to Figure 20.7-1a for a schematic of the CSM. Site 25 will likely be used for industrial purposes in the future. This future land use will alter the current CSM.

Multiple terrestrial lines of evidence were evaluated for the ecological assessment conducted at this site. The lines of evidence were primarily hazard quotient (HQ) calculations for a number of different receptors, but also included soil toxicity tests. Refer to Table 7.7-11a for a summary of the terrestrial ecosystem lines of evidence. (EPA180a,b)

The following is an overall summary of the key results of the ecological risk assessment for Site 25. It should be noted that an interim measure occurred at Site 25 that has reduced levels of contamination at the site. This summary provides results based first on pre-IM investigation data, and then a summary of the IM results.~~The following summary is based on an initial review of the data. A full evaluation of whether or not the data meet all DQOs, and further statistical examination, will be made prior to finalizing these results for the next version of this report.~~

Pre-IM Results

- Based on the ecological effects data, there are no ecological effects at this site.
- No metals at Site 25 were statistically elevated above the reference areas based on the Phase III data.
- Phase I HIs are within the same order of magnitude, or lower, than those observed at the reference areas for all receptors except soil fauna.
- Phase II HIs are within the same order of magnitude, or lower, than those observed at the reference areas for all receptors except white-footed mouse and soil fauna.
- Phase III HIs are within the same order of magnitude as those observed at the reference areas for all receptors.
- The magnitude of the HIs for soil fauna and white-footed mouse suggests potential population level effects since RME LOAEL-based HIs exceed RME LOAEL-based HIs at reference areas. Other lines of evidence refute the HI results, however. Effects on earthworm mortality**,** ~~were not observed nor were effects on~~ soil fauna diversity**,** or plant reproduction and growth **were not observed**.
- Consideration of ~~all~~ **each of the** lines of evidence supports a conclusion of no significant ecological risk at this site.

IM Results

- **IM HIs are below those observed at the reference areas for all receptors. The residual levels of contamination present after the interim measure are not anticipated to pose an ecological concern.**

20.8 CONCLUSIONS AND RECOMMENDATIONS

The results of surface and subsurface soil samples collected during Phase I at the Papermill Road Disposal Area (Site 25) show that SVOC, TPH, pesticide, and metals contaminants are present. Additional soil samples were collected during Phase II to confirm the previous results for SVOCs. The Phase II samples were found to contain low concentrations of numerous SVOCs that are consistent with the tar-like substance observed on the ground surface. However, only benzo[a]pyrene and benzo[b]fluoranthene were found to exceed USEPA Region 9 PRGs. Benzo[a]pyrene was retained as a COPC for the human health risk assessment.

Numerous metals were also detected in the soil samples collected at Site 25 in concentrations exceeding their respective background concentrations. Of these metals, aluminum, barium,

beryllium, chromium, manganese, and thallium were found to exceed USEPA Region 9 PRGs and were retained as COPCs for the human health risk assessment.

The results of the human health risk assessment indicate that chronic health hazard estimates exceed the USEPA HI goal of 1.0 for future on-site residents. Although both the adult and child residents had HIs that exceeded 1.0, no single pathway or chemical-specific multi-pathway exceeds this criteria. The critical pathways for the child resident appear to be ingestion of thallium in soil and inhalation of manganese in fugitive dusts. For the future off-site consumers of beef and milk, the estimated HIs are below the goal of 1.0, indicating that the existing contamination at Site 25 would not present a chemical hazard to these future off-site consumers.

The cancer risks for the future on-site residents were within the USEPA target range of 1E-04 to 1E-06. The overall cancer risks calculated for the future off-site consumers of beef and milk also show that the risks are within the target range.

Based on the ecological effects data for Site 25, it appears there are no adverse ecological effects for this site. Using Phase I RI data, the HIs are within the same order of magnitude as those of the reference areas. Phase II and the supplemental data (Phase III) collected in September 1997 also resulted in HIs consistent with those observed at the reference areas. Effects on earthworm mortality or on soil fauna diversity were not observed at this site. Plant reproduction and growth was also not effected. Based on all lines of evidence, it was concluded that there is no significant ecological risk at Site 25.

An interim remedial action consisting of removal of a 200-by-200-foot area of contamination to a depth of 2 feet was completed and a technical memorandum was submitted in October 1998. This removal action will reduce or eliminate the future risks to human health that were identified for the residential scenario. (IN27) Therefore, it is recommended that ~~of the proposed interim measures,~~ a No Further Action technical memorandum be prepared and Site 25 be removed from the RI/FS.

This site will not be carried forward to the FS.

TABLES

TABLE 20-1

Background Screening of Inorganic Chemicals Detected in Soil
Site 25 – Papermill Road Disposal Area
Jefferson Proving Ground
Madison, Indiana

Analyte	Location	Frequency of Detection[a]	Maximum Detected Value (mg/kg)	Avg. Conc. (mg/kg)	Median Conc. (mg/kg)	Background Threshold (mg/kg)	Data Distribution	Test Performed	p value	Site > Bkgd?
Surface Soil										
Aluminum	Site	17/17	57,000	14,689	5,880		Lognormal	t test	0.25[b]	No
	Background	**10/10**	**10,900**	**7,673**	**7,845**	**11,000**	**Lognormal**			
Antimony	Site	3/12	1.33	0.62	0.5		Neither	Mann-Whitney	<0.001	**YES**
	Background	**9/10**	**0.42**	**0.38**	**0.37**	**0.49**	**Lognormal**			
Arsenic	Site	16/17	47.0	9.8	4.85		Lognormal	Mann-Whitney	0.065	No
	Background	**10/10**	**9.46**	**4.8**	**3.9**	**9.26**	**Neither**			
Barium	Site	17/17	339	97.6	55.7		Lognormal	t test	0.27[c]	No
	Background	**10/10**	**74.1**	**49.8**	**45.7**	**84.5**	**Lognormal**			
Beryllium	Site	10/12	3.02	0.79	0.31		Neither	NA[d]	NA	No
	Background	**10/10**	**0.45**	**0.32**	**0.32**	**0.52**	**Neither**			
Boron	Site	9/17	111	30.7	9.4		Neither	NA	NA	**YES**
	Background	**0/10**	**NA**	**NA**	**NA**	**NA**	**NA**			
Cadmium	Site	5/17	0.87	0.49	0.5		Normal	NA	NA	**YES**
	Background	**0/10**	**NA**	**NA**	**NA**	**NA**	**NA**			
Chromium (total)	Site	17/17	120	37.5	23.4		Lognormal	t test	0.002	**YES**
	Background	**10/10**	**15.5**	**9.7**	**9.9**	**15.1**	**Lognormal**			
Cobalt	Site	16/17	22.4	6.0	2.9		Lognormal	t test	0.003	**YES**
	Background	**10/10**	**3.6**	**1.9**	**1.9**	**3.5**	**Lognormal**			
Copper	Site	11/17	93.7	16.8	10.3		Lognormal	Mann-Whitney	0.001	**YES**
	Background	**7/10**	**4.96**	**3.5**	**4.1**	**5.64**	**Normal**			

TABLE 20-1

Background Screening of Inorganic Chemicals Detected in Soil
Site 25 – Papermill Road Disposal Area
Jefferson Proving Ground
Madison, Indiana

Analyte	Location	Frequency of Detection[(a)]	Maximum Detected Value (mg/kg)	Avg. Conc. (mg/kg)	Median Conc. (mg/kg)	Background Threshold (mg/kg)	Data Distribution	Test Performed	p value	Site > Bkgd?
Surface Soil (cont'd)										
Lead	Site	14/17	121	21.9	9.9		Lognormal	NA[(d)]	NA	No
	Background	**10/10**	**14.6**	**13.6**	**13.6**	**14.9**	**Normal**			
Manganese	Site	17/17	95.5	268	268		Lognormal	t test	<0.001	**YES**
	Background	**10/10**	**344**	**115**	**85.9**	**302**	**Lognormal**			
Mercury	Site	1/17	0.042	NA[x]	NA		NA	NA	NA	**YES**
	Background	**0/10**	**NA**	**NA**	**NA**	**NA**	**NA**			
Molybdenum	Site	9/17	4.5	NA[x]	NA		NA	NA	NA	**YES**
	Background	**0/10**	**NA**	**NA**	**NA**	**NA**	**NA**			
Nickel	Site	17/17	62.9	17.6	8.3		Lognormal	Extreme value	NA	**YES**
	Background	**1/10**	**2.30**	**2.0**	**2.0**	**2.23**	**Neither**			
Selenium	Site	2/17	22.6	1.8	0.25		Neither	NA[(d)]	NA	No
	Background	**5/10**	**0.66**	**0.40**	**0.30**	**0.74**	Neither			
Silver	Site	6/17	0.53	0.36	0.5		Neither	NA	NA	**YES**
	Background	**0/10**	**NA**	**NA**	**NA**	**NA**	**NA**			
Thallium	Site	6/12	27.4	5.5	1.0		Neither	Extreme value	NA	**YES**
	Background	**1/10**	**0.43**	**NA**	**NA**	**0.43**[(e)]	**NA**			
Tin	Site	8/17	14.5	5.9	5.0		Neither	NA	NA	**YES**
	Background	**0/10**	**NA**	**NA**	**NA**	**NA**	**NA**			
Vanadium	Site	16/17	95	29.7	24.6		Lognormal	t test	<0.001	**YES**
	Background	**10/10**	**27.6**	**19.8**	**19.2**	**27.0**	**Lognormal**			

TABLE 20-1

Background Screening of Inorganic Chemicals Detected in Soil
Site 25 – Papermill Road Disposal Area
Jefferson Proving Ground
Madison, Indiana

Analyte	Location	Frequency of Detection[(a)]	Maximum Detected Value (mg/kg)	Avg. Conc. (mg/kg)	Median Conc. (mg/kg)	Background Threshold (mg/kg)	Data Distribution	Test Performed	p value	Site > Bkgd?
Surface Soil (cont'd)										
Zinc	Site	17/17	82.7	36.8	29		Lognormal	Mann-Whitney	0.002	**YES**
	Background	**10/10**	**18.5**	**14.7**	**14.7**	**19.5**	**Normal**			
Subsurface Soil										
Aluminum	Site	11/11	20,500	12,900	13,000		Lognormal	t test	<0.001	**YES**
	Background	**10/10**	**10,900**	**7,673**	**7,845**	**11,000**	**Lognormal**			
Arsenic	Site	7/11	18.9	6.9	5.4		Normal	Mann-Whitney	0.39	No
	Background	**10/10**	**9.46**	**4.8**	**3.9**	**9.26**	**Neither**			
Barium	Site	11/11	179	97.2	90.3		Normal	Mann-Whitney	0.001	**YES**
	Background	**10/10**	**74.1**	**49.8**	**45.7**	**84.5**	**Lognormal**			
Beryllium	Site	3/4	1.3	0.9	1.0		Normal	t test	<0.001	**YES**
	Background	**10/10**	**0.45**	**0.32**	**0.32**	**0.52**	**Normal**			
Boron	Site	2/11	9.2	5.1	3.3		Neither	NA	NA	**YES**
	Background	**0/10**	**NA**	**NA**	**NA**	**NA**	**NA**			
Chromium (total)	Site	11/11	22.8	15.7	14.5		Lognormal	t test	<0.001	**YES**
	Background	**10/10**	**15.5**	**9.7**	**9.9**	**15.1**	**Lognormal**			
Cobalt	Site	7/11	19.4	5.5	4.7		Lognormal	t test	0.03	**YES**
	Background	**10/10**	**3.6**	**1.9**	**1.9**	**3.5**	**Lognormal**			
Copper	Site	8/11	21.9	9.9	9.7		Lognormal	Mann-Whitney	<0.001	**YES**
	Background	**7/10**	**4.96**	**3.5**	**4.1**	**5.64**	**Normal**			

TABLE 20-1

Background Screening of Inorganic Chemicals Detected in Soil
Site 25 – Papermill Road Disposal Area
Jefferson Proving Ground
Madison, Indiana

Analyte	Location	Frequency of Detection[a]	Maximum Detected Value (mg/kg)	Avg. Conc. (mg/kg)	Median Conc. (mg/kg)	Background Threshold (mg/kg)	Data Distribution	Test Performed	p value	Site > Bkgd?
Subsurface Soil (cont'd)										
Lead	Site	10/11	15.4	9.6	9.3		Normal	NA[e]	NA	No
	Background	**10/10**	**14.6**	**13.6**	**13.6**	**14.9**	**Normal**			
Manganese	Site	11/11	1,340	252	190		Lognormal	t test	0.03	**YES**
	Background	**10/10**	**344**	**115**	**85.9**	**302**	**Lognormal**			
Mercury	Site	2/11	0.07	0.04	0.03		Neither	NA	NA	**YES**
	Background	**0/10**	**NA**	**NA**	**NA**	**NA**	**NA**			
Molybdenum	Site	2/11	0.67	NA[f]	NA[f]		NA	NA	NA	**YES**
	Background	**0/10**	**NA**	**NA**	**NA**	**NA**	**NA**			
Nickel	Site	11/11	23.1	13.4	13.4		Normal	Extreme value	NA	**YES**
	Background	**1/10**	**2.30**	**2.0**	**2.0**	**2.23**	**Neither**			
Selenium	Site	1/11	14.0	1.5	0.22		Neither	Extreme value	NA	**YES**
	Background	**5/10**	**0.66**	**0.40**	**0.30**	**0.74**	Neither			
Silver	Site	6/11	0.45	0.18	0.04		Normal	NA	NA	**YES**
	Background	**0/10**	**NA**	**NA**	**NA**	**NA**	**NA**			
Thallium	Site	2/4	28.2	5.2	0.83		Neither	Extreme value	NA	**YES**
	Background	**1/10**	**0.43**	**NA**	**NA**	**0.43[e]**	**NA**			
Tin	Site	1/11	2.85	NA[f]	NA[f]		Neither	NA	NA	**YES**
	Background	**0/10**	**NA**	**NA**	**NA**	**NA**	**NA**			

TABLE 20-1

Background Screening of Inorganic Chemicals Detected in Soil
Site 25 – Papermill Road Disposal Area
Jefferson Proving Ground
Madison, Indiana

Analyte	Location	Frequency of Detection[(a)]	Maximum Detected Value (mg/kg)	Avg. Conc. (mg/kg)	Median Conc. (mg/kg)	Background Threshold (mg/kg)	Data Distribution	Test Performed	p value	Site > Bkgd?
Subsurface Soil (cont'd)										
Vanadium	Site	11/11	28.1	21.9	20.3		Lognormal	t test	0.12[(g)]	No
	Background	**10/10**	**27.6**	**19.8**	**19.2**	**27.0**	**Lognormal**			
Zinc	Site	11/11	59.6	33.2	31.5		Lognormal	Mann-Whitney	<0.001	**YES**
	Background	**10/10**	**18.5**	**14.7**	**14.7**	**19.5**	**Normal**			

General Notes:

Concentrations are in milligrams per kilogram, mg/kg.
NA = Not applicable.

Footnotes:

(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) The 95% confidence interval for the difference between the means of the aluminum log-transformed values is -0.37 to 0.72.
(c) The 95% confidence interval for the difference between the means of the barium log-transformed values is -0.44 to 0.81.
(d) The Mann-Whitney test was not performed because the site median value is less than the background median value.
(e) The t test was not performed because the site average concentration is less than the background average concentration.
(f) Values not recorded because of high detection limits for nondetections.
(g) The 95% confidence interval for the difference between the means of the vanadium log-transformed data is -0.07 to 0.27.

FIGURES

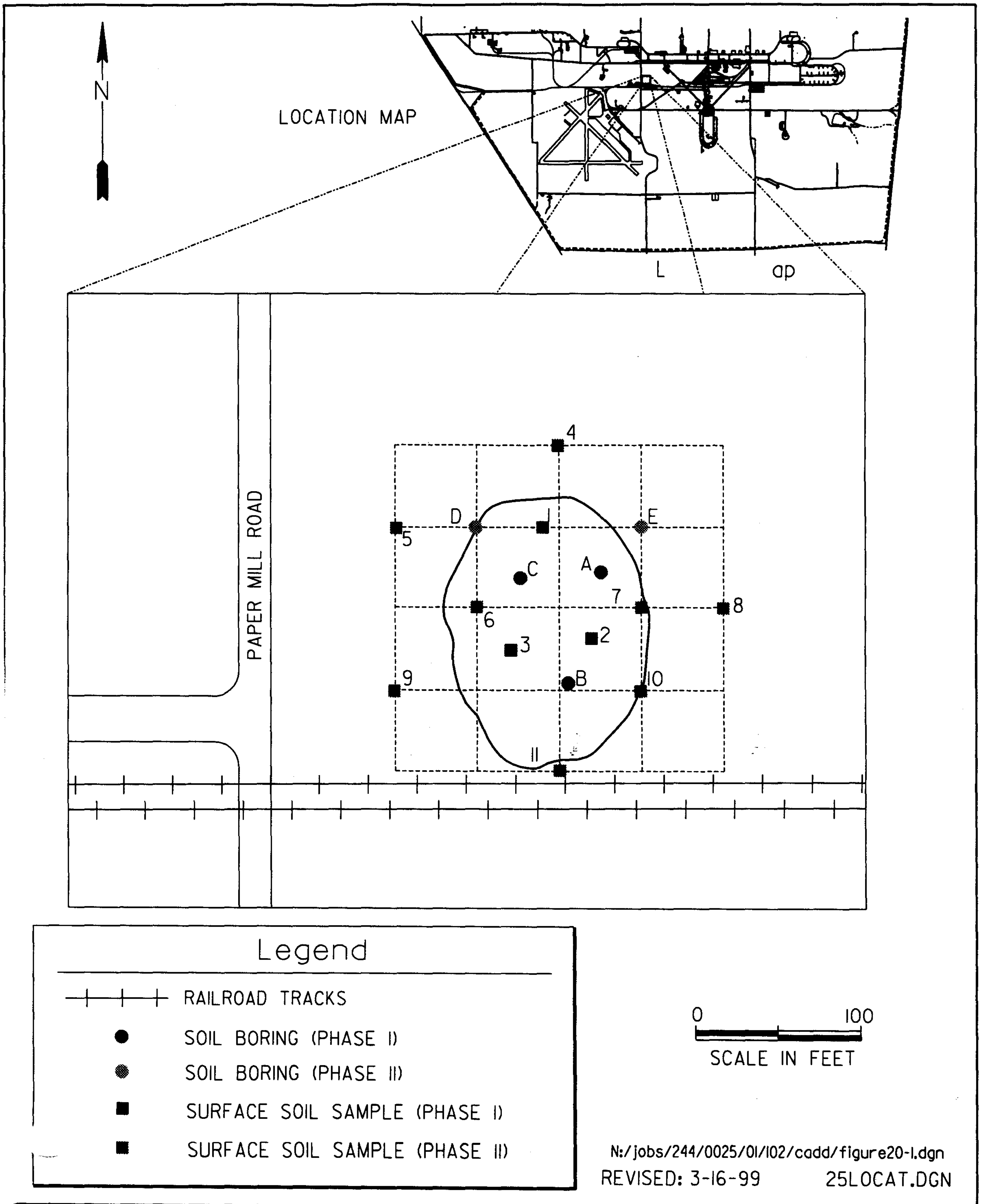


Figure 20-1. Sampling Locations, Papermill Road Disposal Area (Site 25)

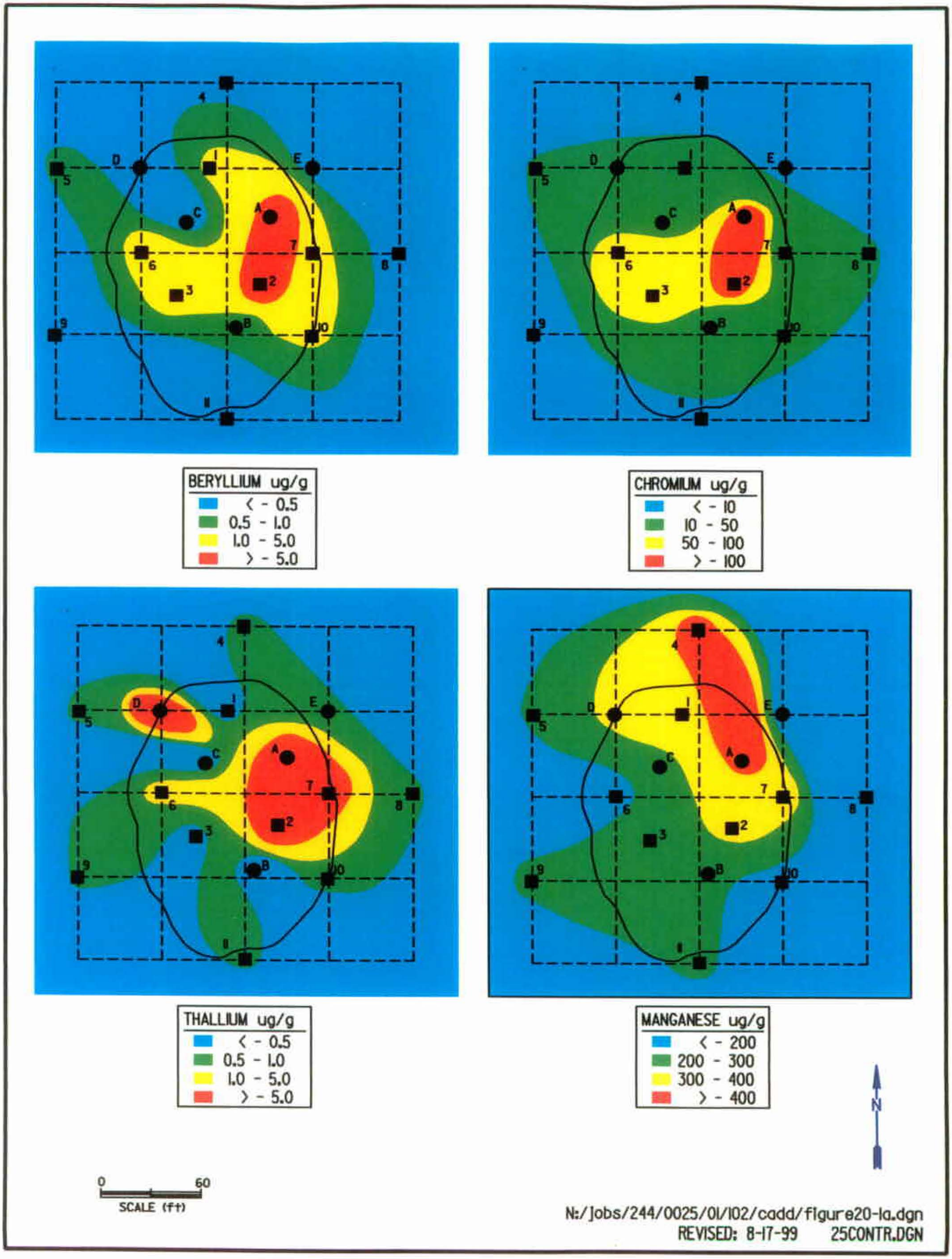


Figure 20-1a. Contaminant Distribution Maps for Surface Soils at Papermill Road Disposal AREA (Site 25)

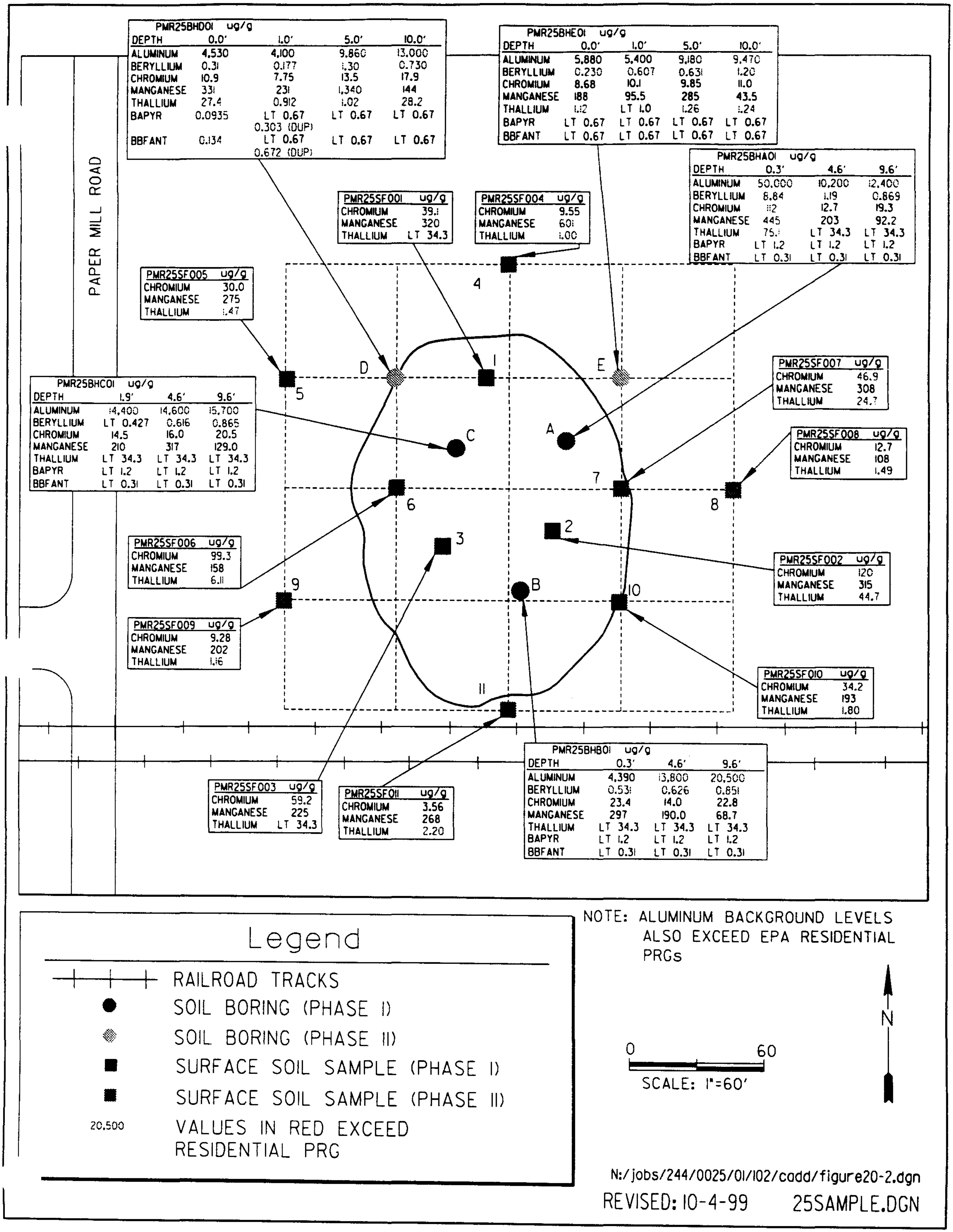


Figure 20-2. Summary of Contaminants Exceeding Background and Regulatory Risk-Based Concentrations, Papermill Road Disposal Area (Site 25)

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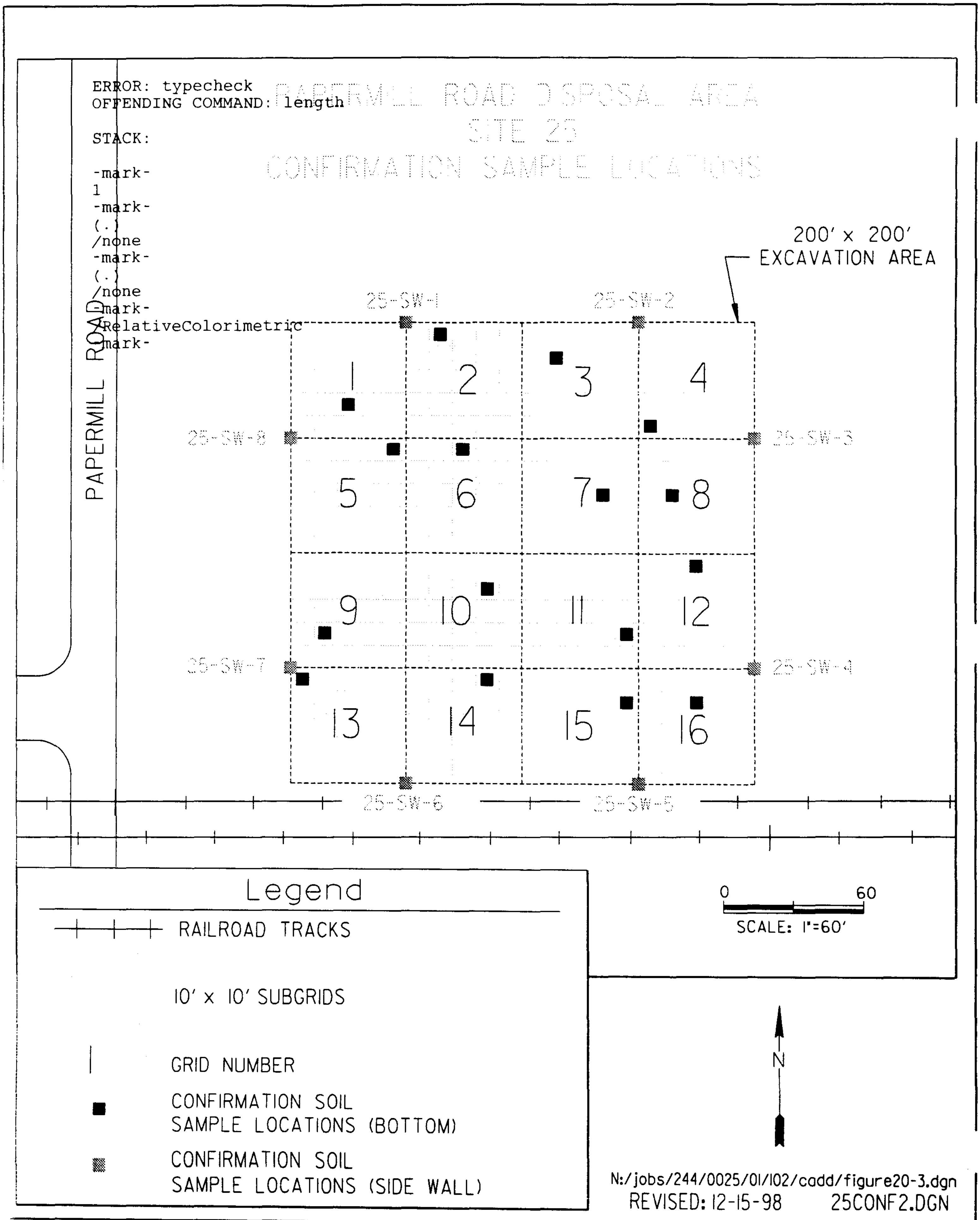


Figure 20-3. Interim Measures Confirmation Sample Locations Papermill Road Disposal Area (Site 25)

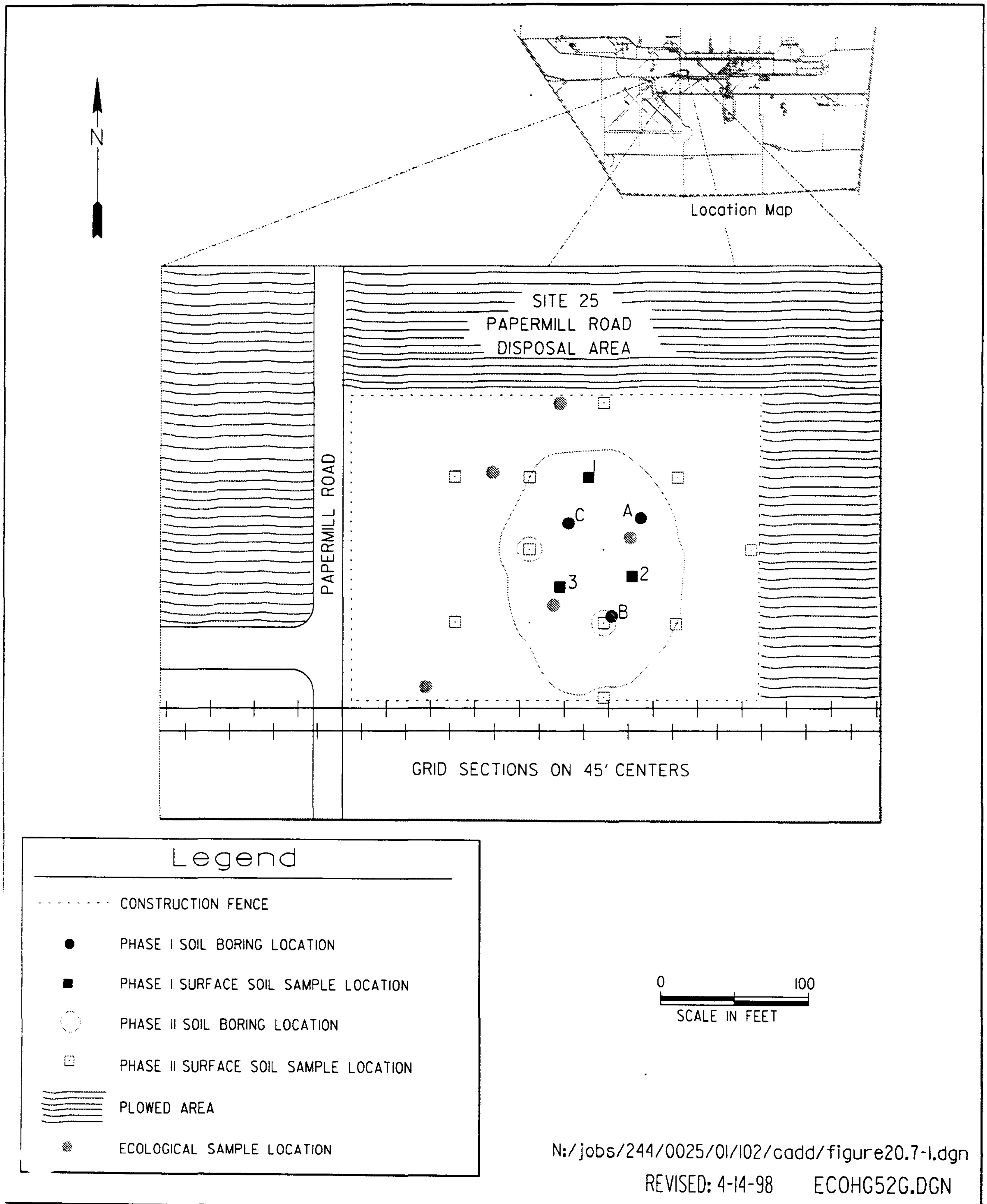
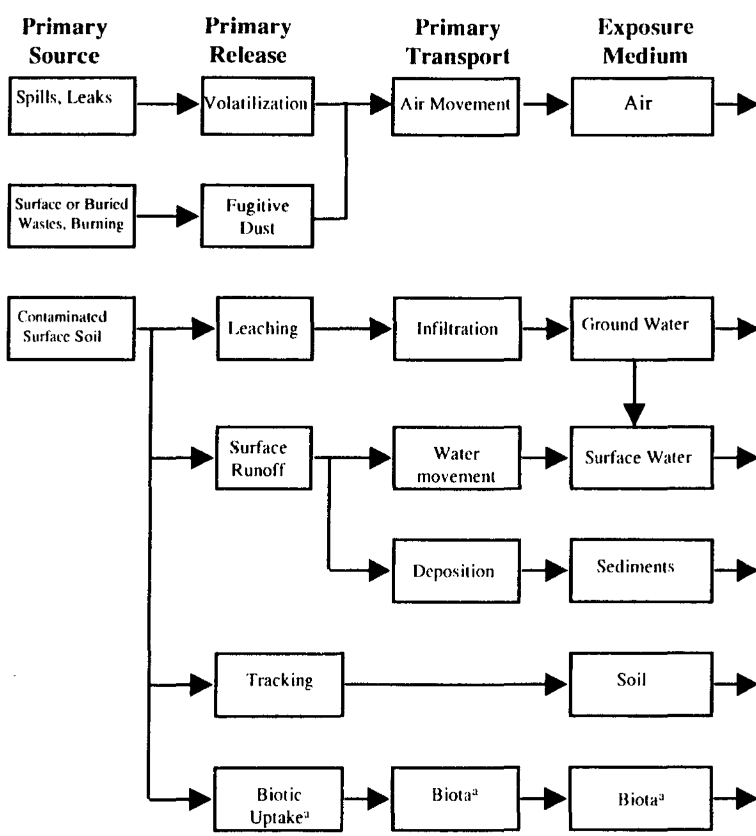


Figure 20.7-1. Ecological Sampling Locations Papermill Road Disposal Area (Site 25)



Receptor & Exposure Data

Exposure Medium	Plants	Soil Fauna[1]	Mourning Dove	Chimney Swift	Wild Turkey	Great Blue Heron	American Kestrel	White-Footed Mouse	Eastern Cottontail	Little Brown Myotis	Raccoon	Red Fox	Pickerel Frog	Creek Chub	Benthic Invertebrates[1]
Air	NA	NA	INH	INH	INH	INH	INH	INH	INH	INH	INH	INH	INH	NA	NA
Ground Water	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Surface Water	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sediments	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Soil	DC	DC	ING	ING	ING	ING	ING	ING	ING	ING	ING	ING	DC	NA	NA
Biota[a]	NA	ING	ING	ING	ING	NA	ING	ING	ING	ING	NA	ING	NA	NA	NA

(dotted box) Pathway may be significant; not evaluated because toxicity criteria lacking

(hatched box) Insignificant pathway; not quantitatively evaluated

NA Not Applicable

ING Ingestion

INH Inhalation

DC Direct Contact

1 Includes the terrestrial or aquatic crayfish

a Refer to JPG Food Web (Figure 5.3-5)

Figure 20.7-1a
JPG Conceptual Site Model
Site 25

N:Jobs 244 0025 01 102 cadd figure20.7-1a.ppt

Figure 20.7-2 Total HIs - RME Risks Summed for All Pathways Based on NOAELs at Site 25 - Papermill Road Disposal Area - Phase I

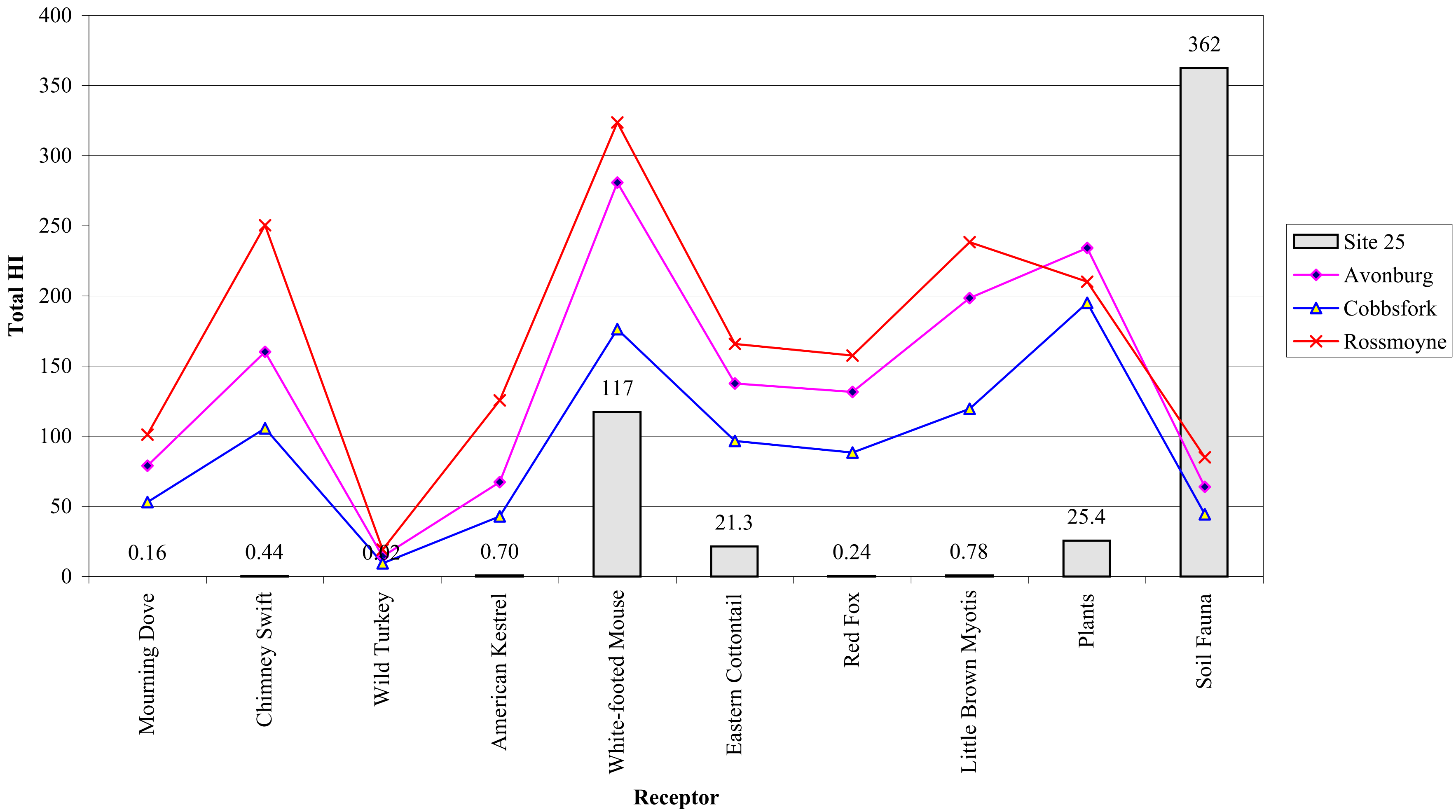
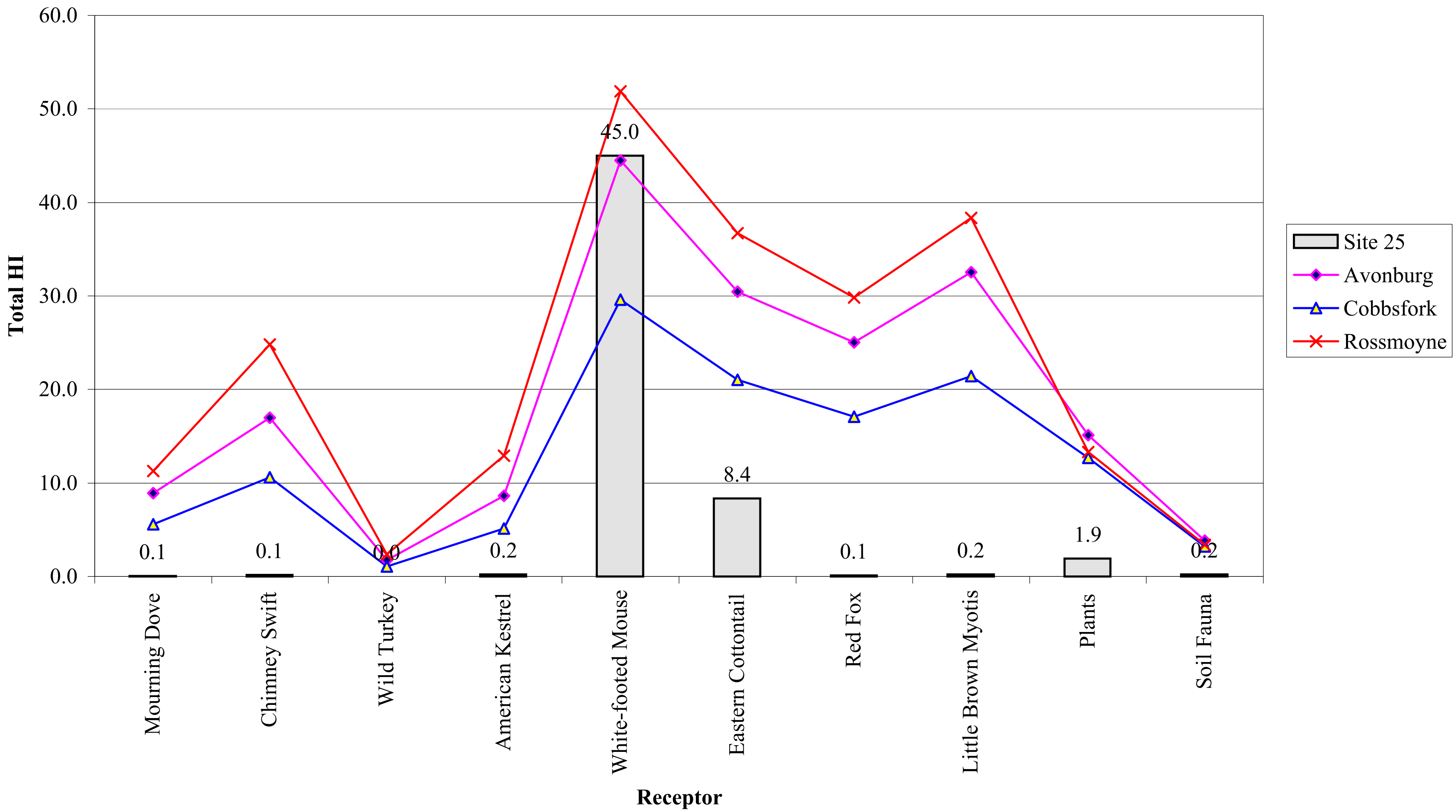
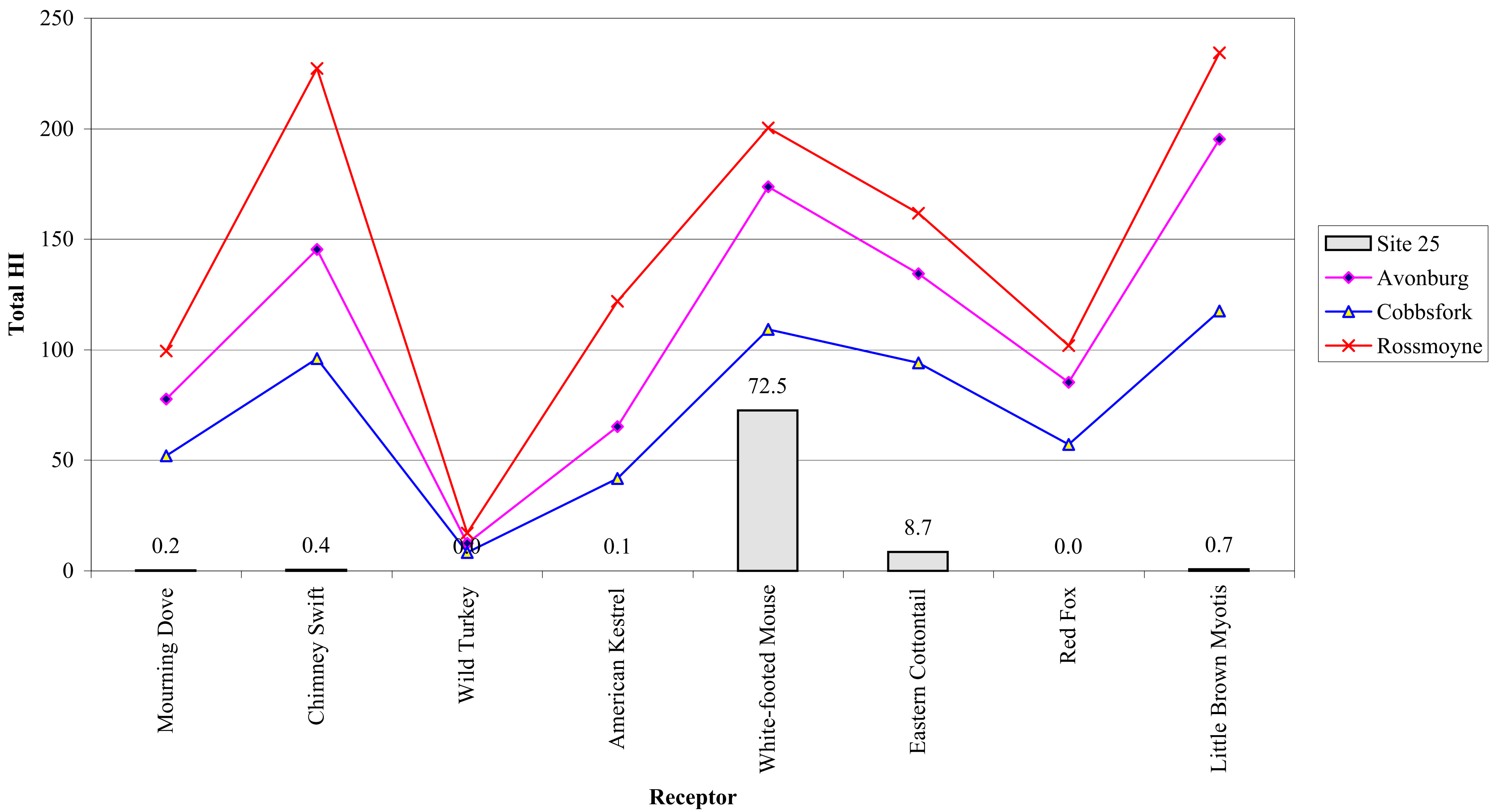


Figure 20.7-3 Total HIs - RME Risks Summed for All Pathways Based on LOAELs at Site 25 - Papermill Road Disposal Area - Phase I



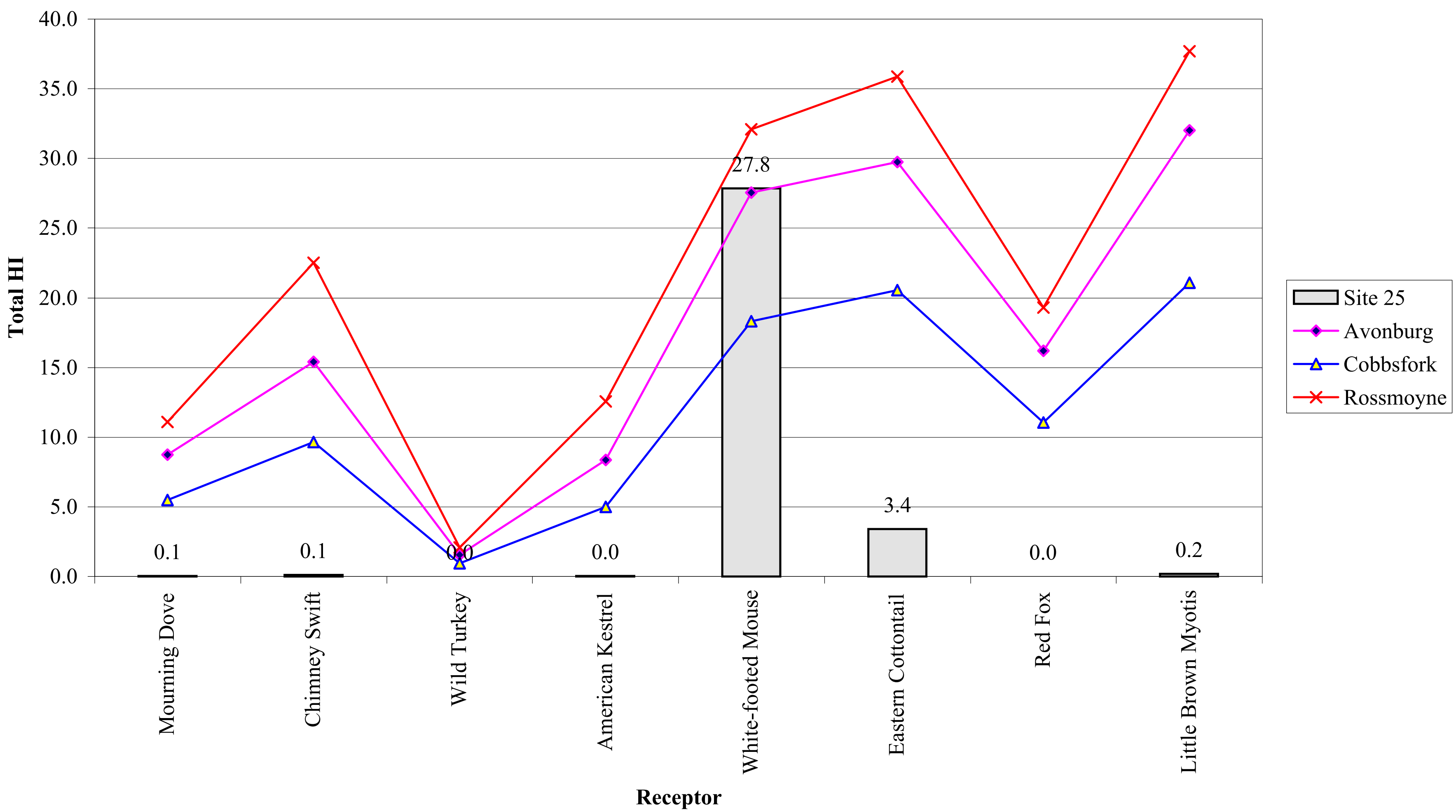
N:\jobs\244\0025\01\ET ECO Files\JPG\Phase1\Risk2\P1era_25MWH.xls Figure 20.7-3

Figure 20.7-4 Total HIs - CT Risks Summed for All Pathways Based on NOAELs at Site 25 - Papermill Road Disposal Area - Phase I



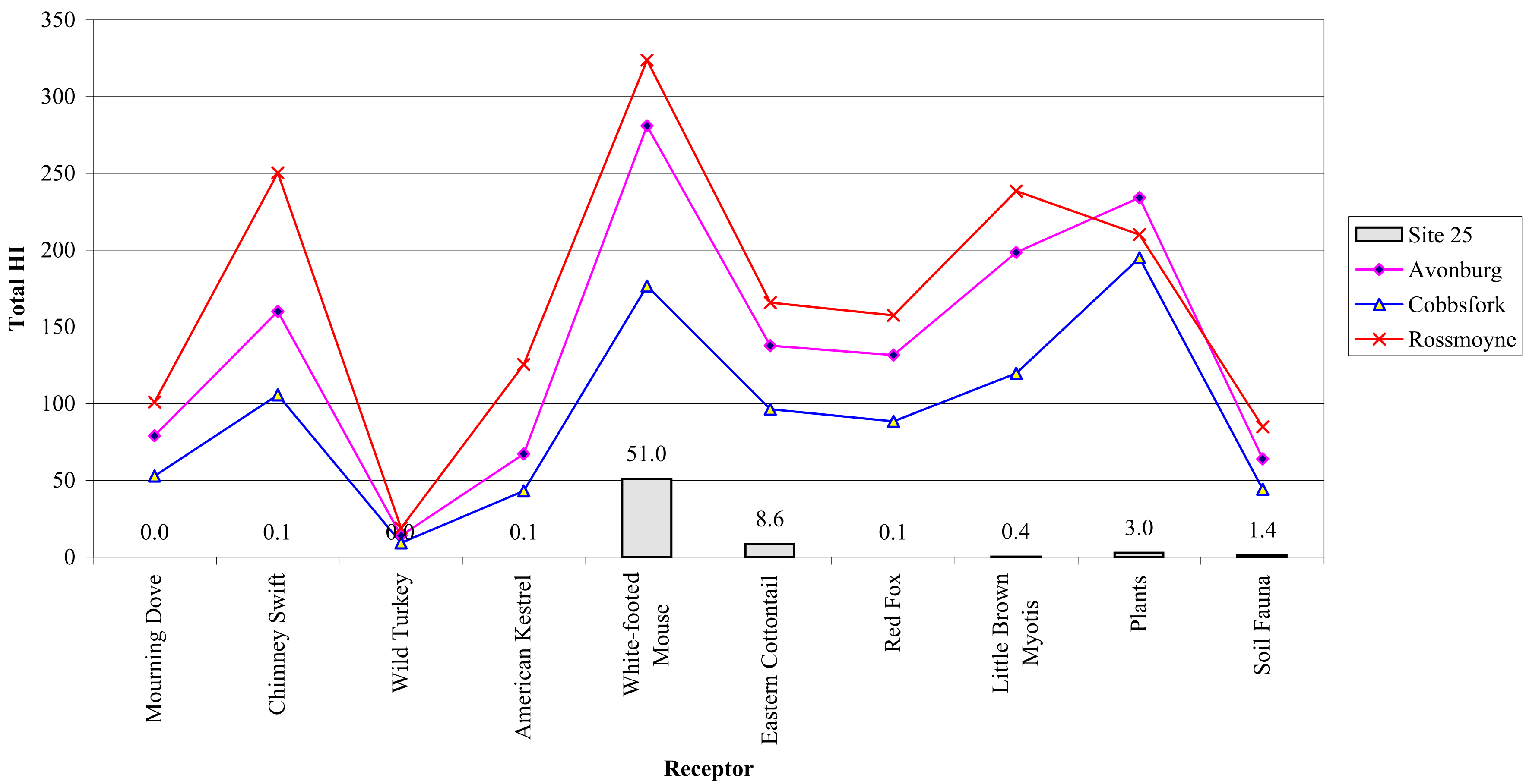
N:\jobs\244\0025\01\ET ECO Files\JPG\Phase1\Risk2\P1era_25MWH.xls Figure 20.7-4

Figure 20.7-5 Total HIs - CT Risks Summed for All Pathways Based on LOAELs at Site 25 - Papermill Road Disposal Area - Phase I

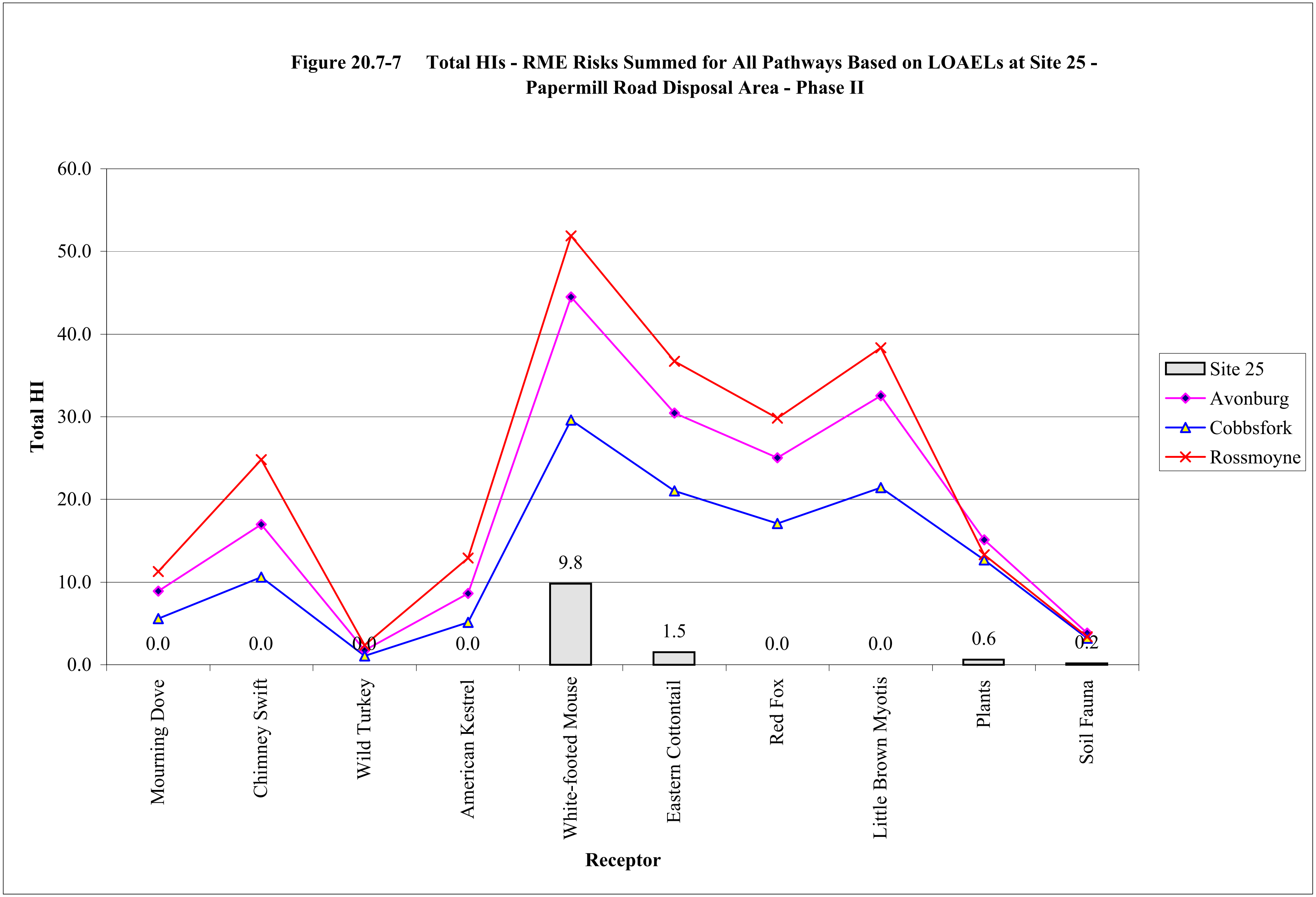


N:\jobs\244\0025\01\ET ECO Files\JPG\Phase1\Risk2\P1era_25MWH.xls Figure 20.7-5

Figure 20.7-6 Total HIs - RME Risks Summed for All Pathways Based on NOAELs at Site 25 - Papermill Road Disposal Area - Phase II

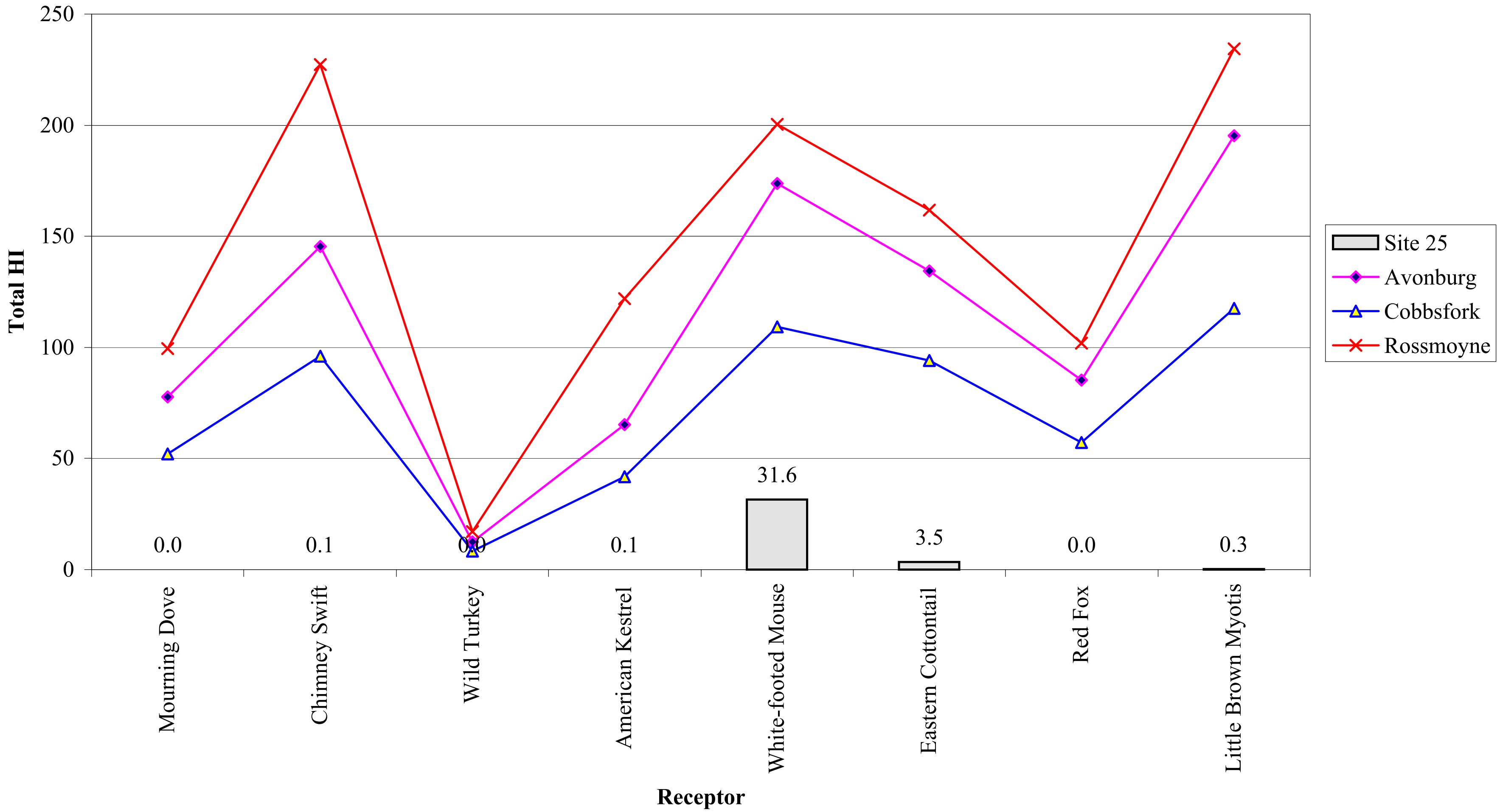


N:\jobs\244\0025\01\ET ECO Files\JPG\Phase2\Risk2\P2era_25MWH.xls Figure 20.7-6

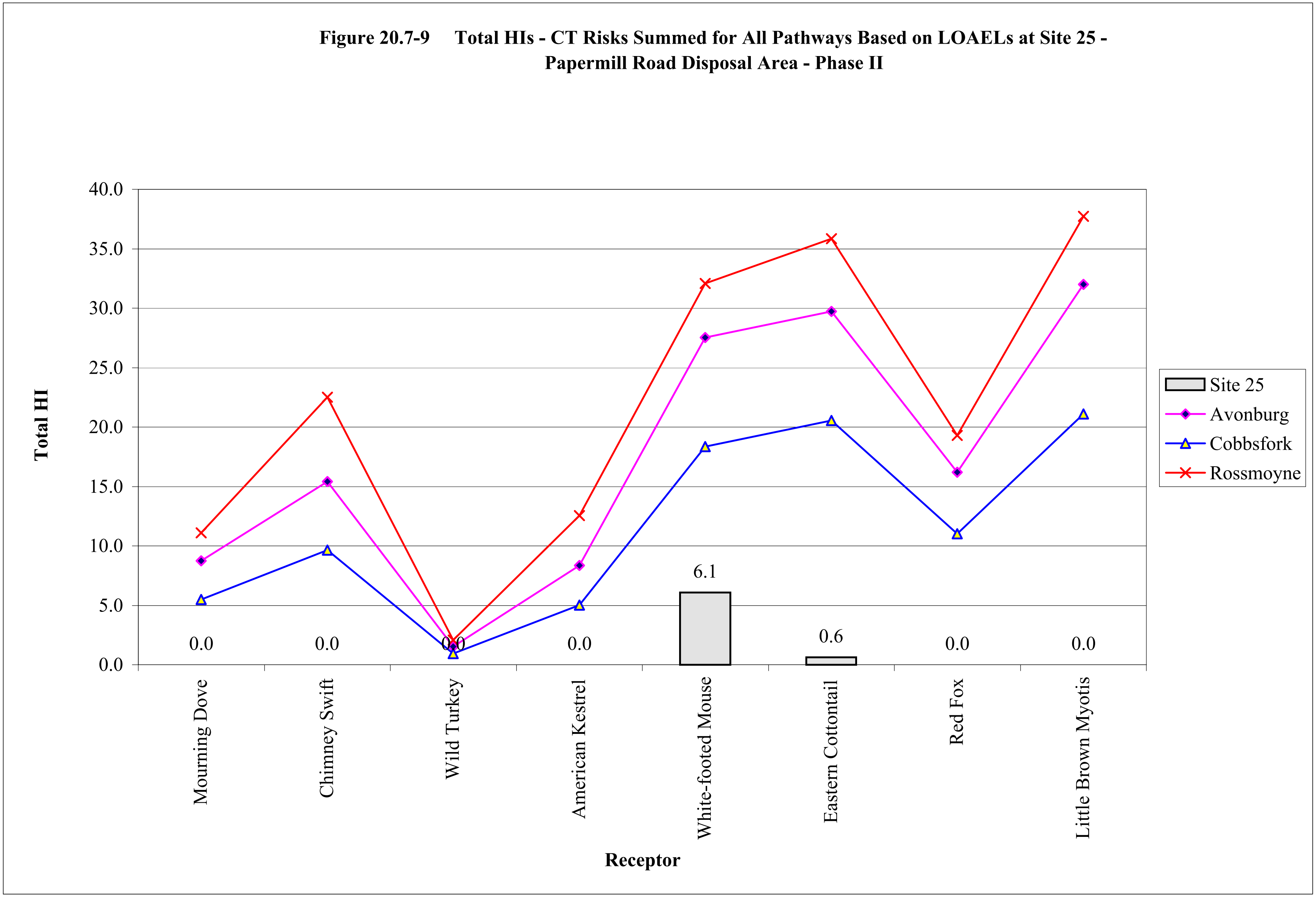


N:\jobs\244\0025\01\ET ECO Files\JPG\Phase2\Risk2\P2era_25MWH.xls Figure 20.7-7

Figure 20.7-8 Total HIs - CT Risks Summed for All Pathways Based on NOAELs at Site 25 - Papermill Road Disposal Area - Phase II



N:\jobs\244\0025\01\ET ECO Files\JPG\Phase2\Risk2\P2era_25MWH.xls Figure 20.7-8



N:\jobs\244\0025\01\ET ECO Files\JPG\Phase2\Risk2\P2era_25MWH.xls Figure 20.7-9

Figure 20.7-10 Total HIs-RME Risks Summed for All Pathways Based on NOAELs at Eco Site 25 - Phase III

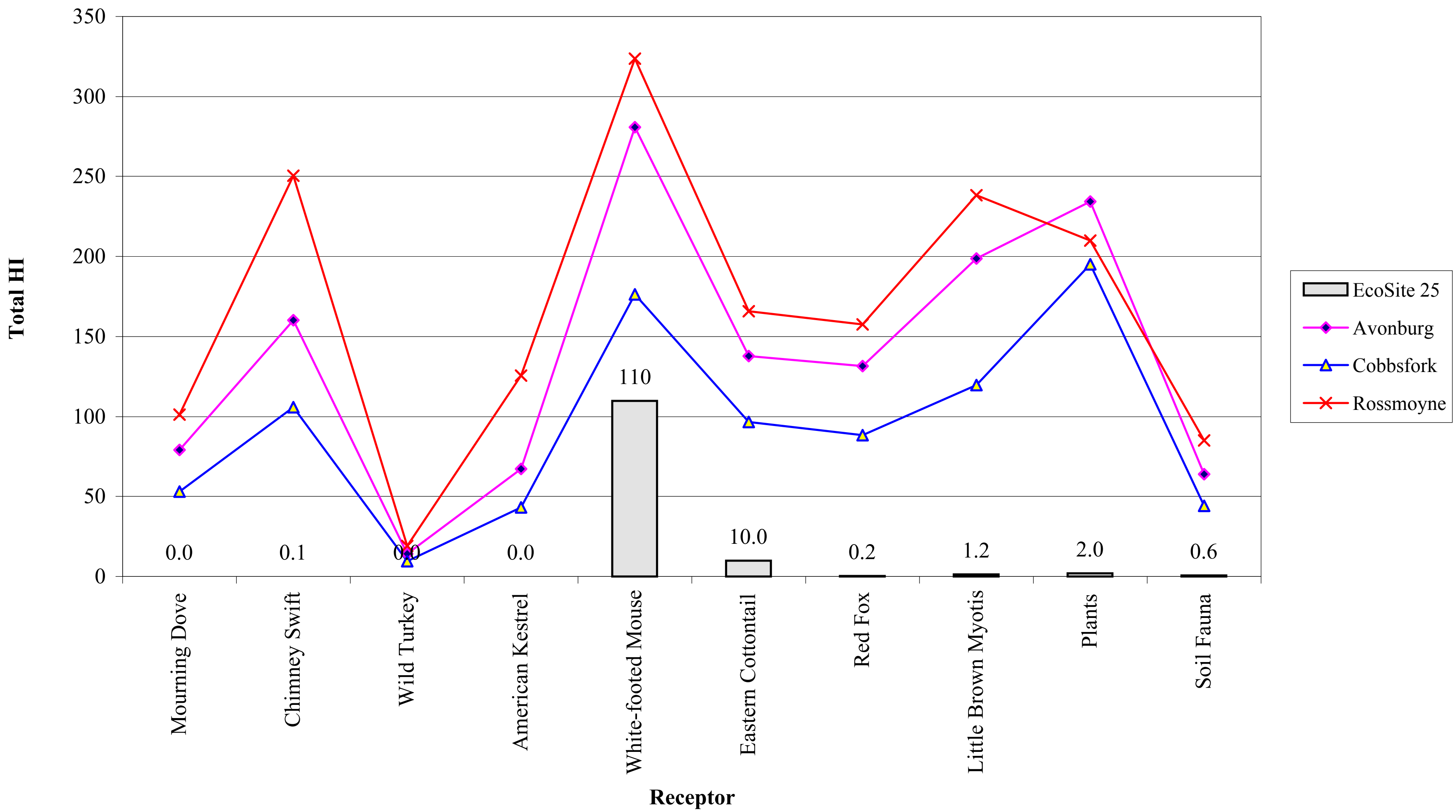
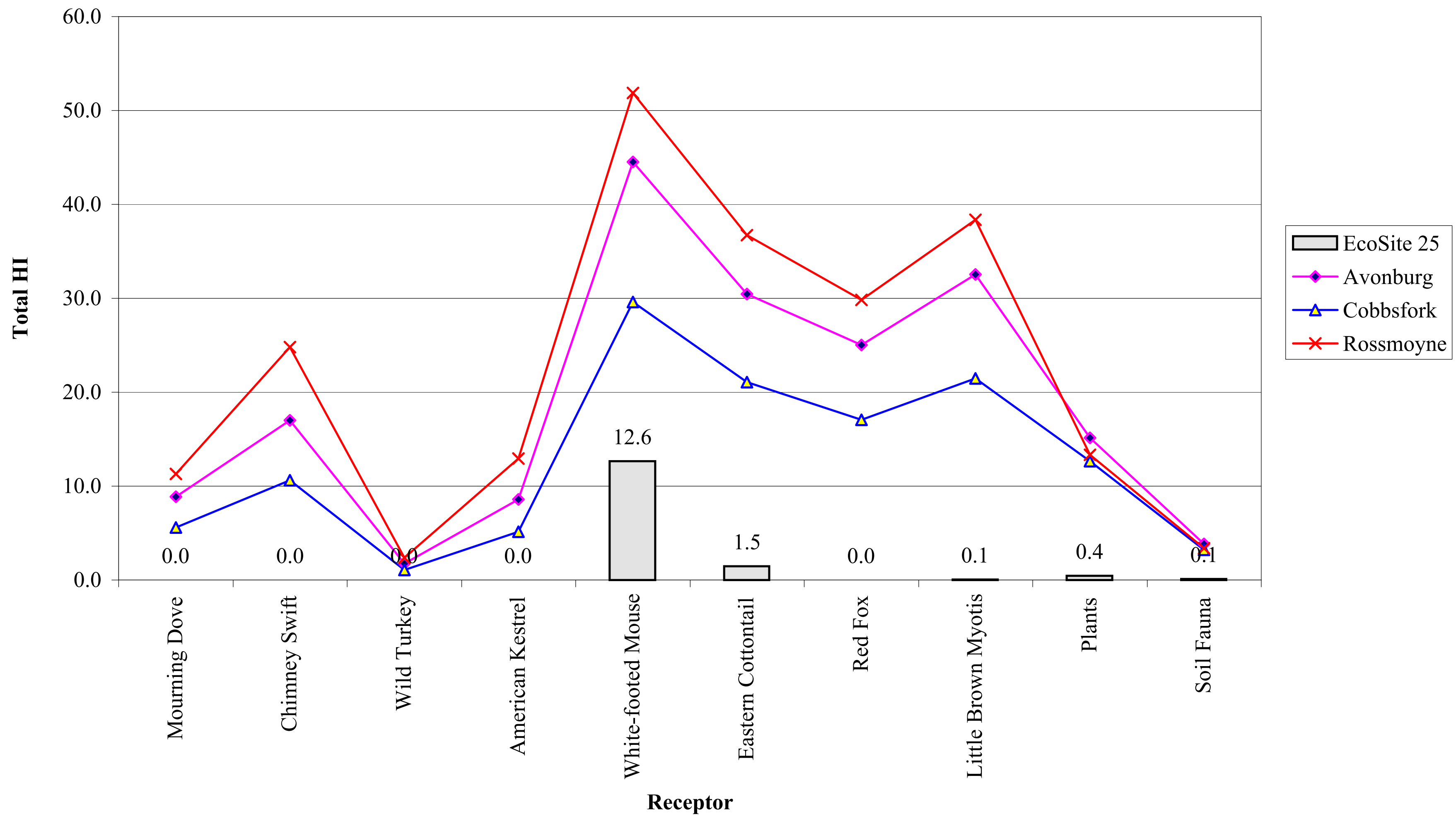
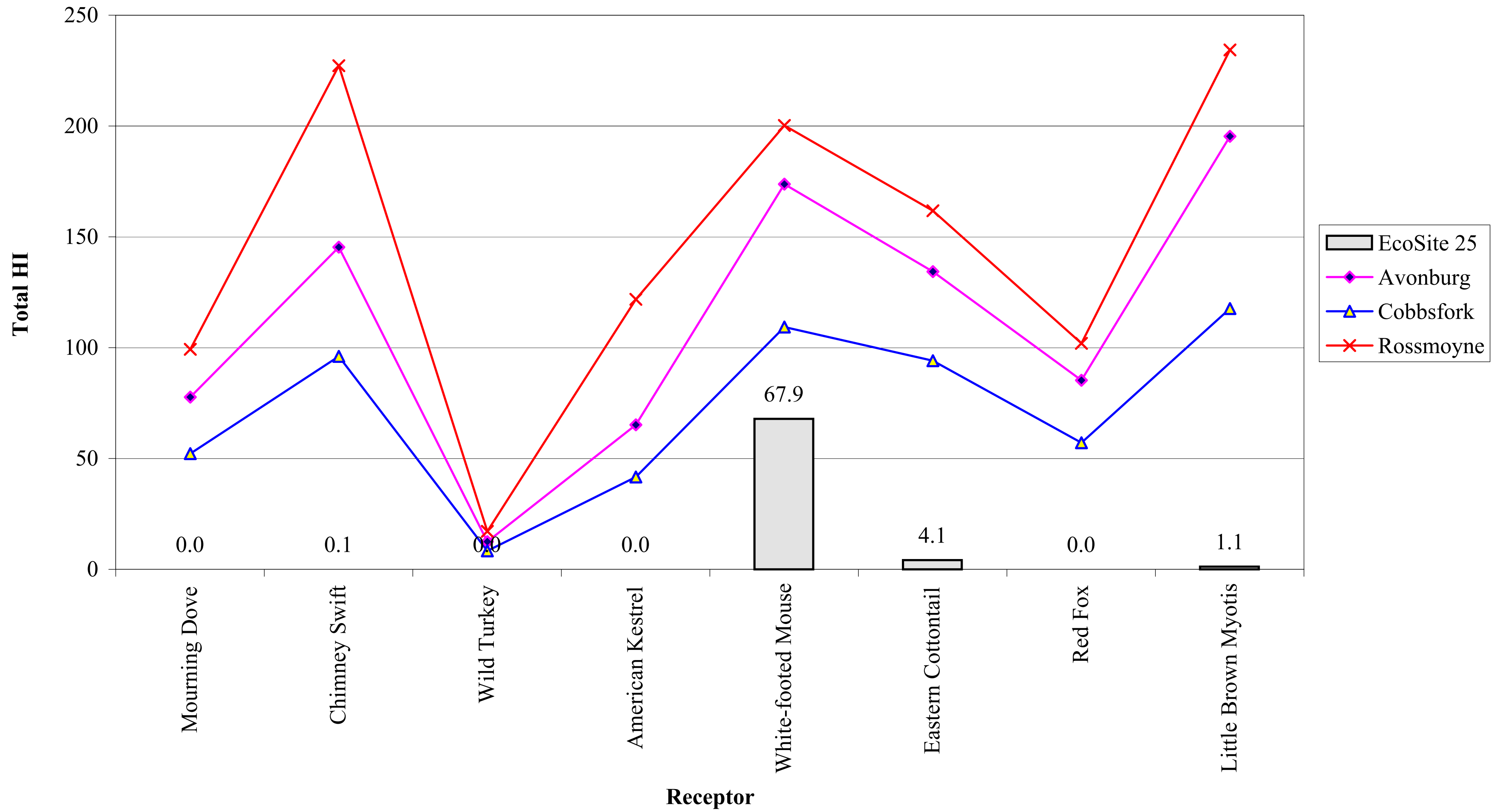


Figure 20.7-11 Total HIs-RME Risks Summed for All Pathways Based on LOAELs at Eco Site 25 - Phase III



N:\jobs\244\0025\01\ET ECO Files\JPG\Phase3\Risk2\P3era_25MWH.xls Figure 20.7-11

Figure 20.7-12 Total HIs-CT Risks Summed for All Pathways Based on NOAELs at Eco Site 25 - Phase III



N:\jobs\244\0025\01\ET ECO Files\JPG\Phase3\Risk2\P3era_25MWH.xls Figure 20.7-12

Figure 20.7-13 Total HIs-CT Risks Summed for All Pathways Based on LOAELs at Eco Site 25 - Phase III

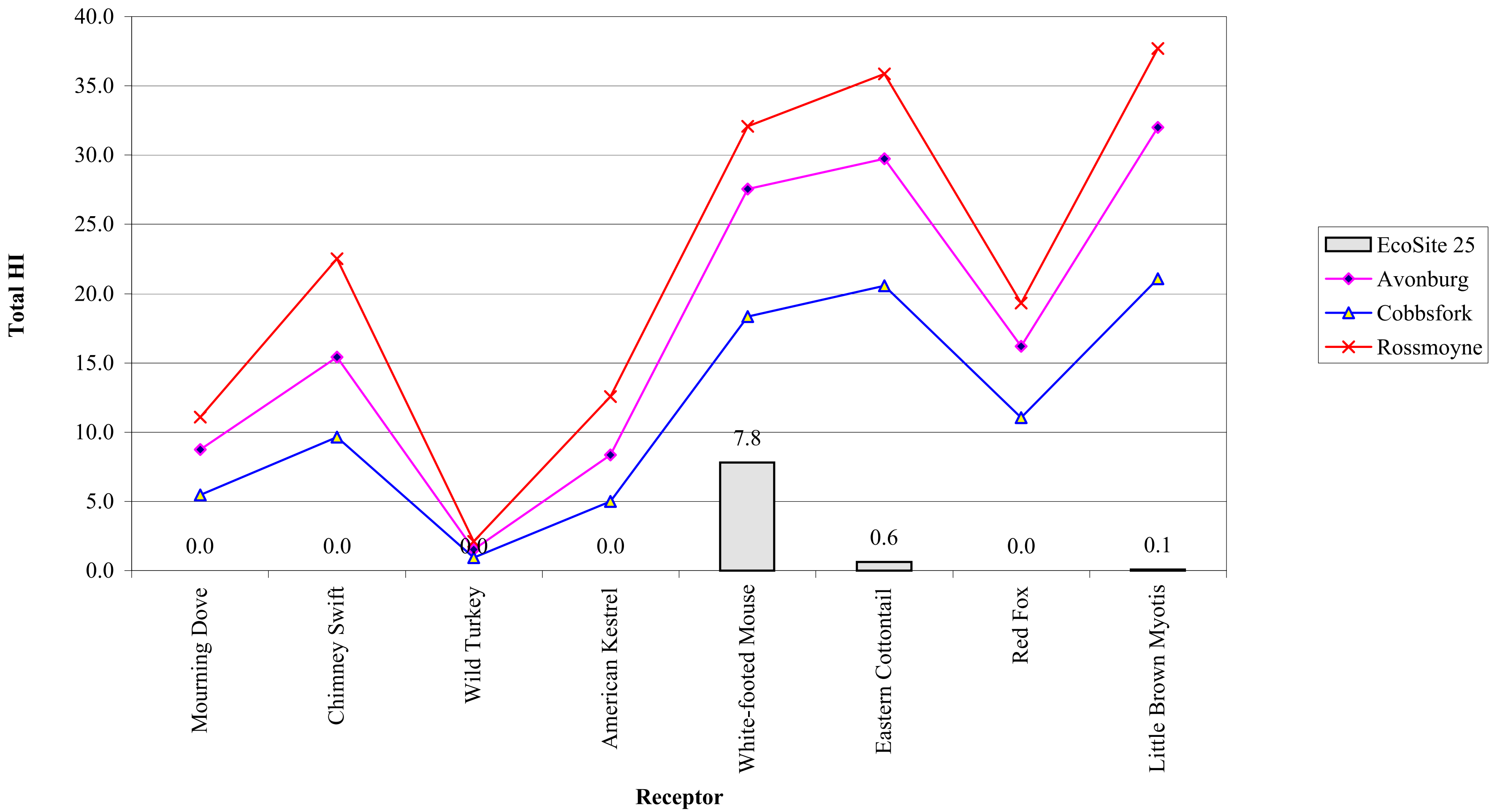


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Figure 20.7-14 Total HIs - RME Risks Summed for All Pathways Based on NOAELs at Site 25 - Papermill Road Disposal Area- IM Confirmation Sampling

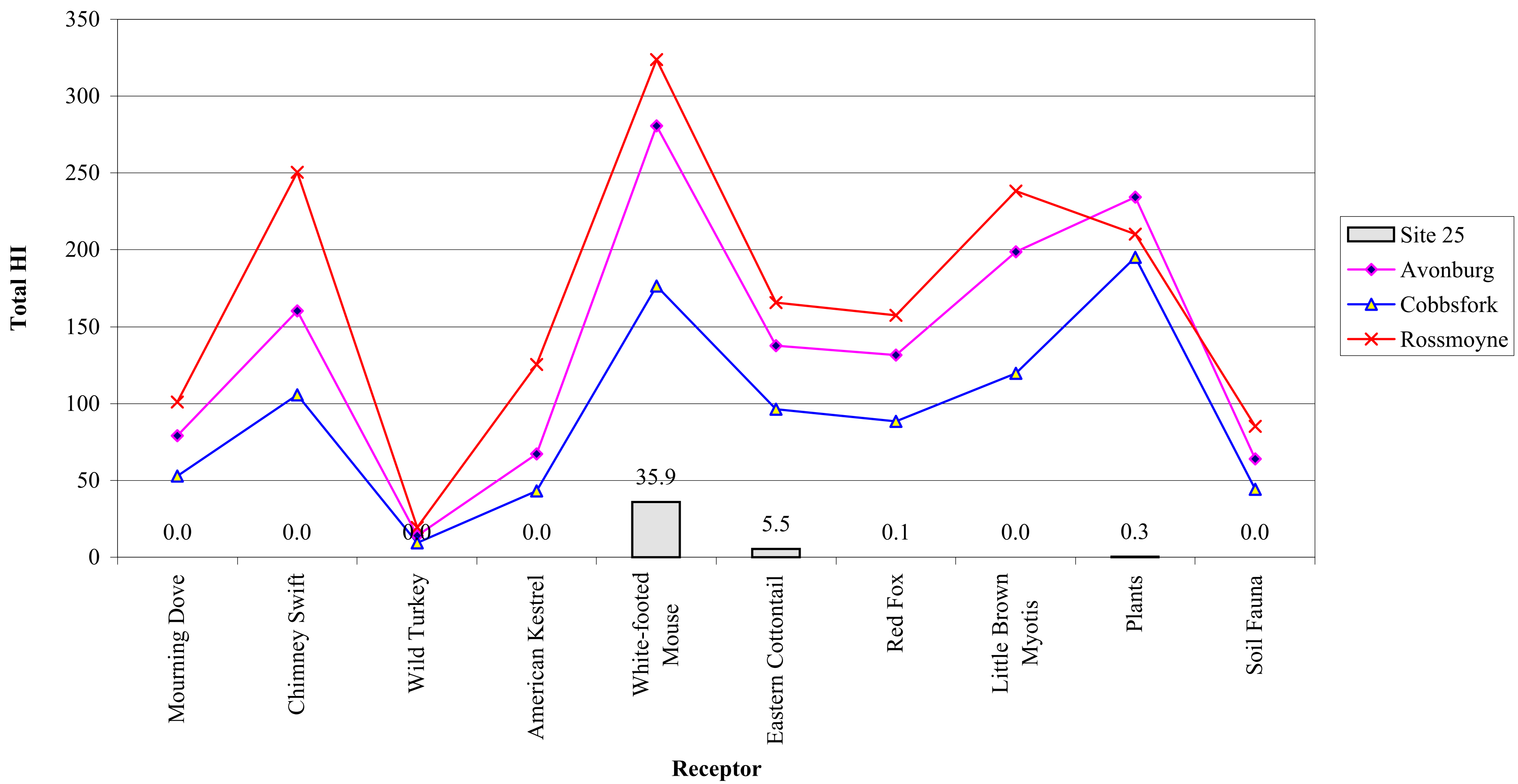

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Figure 20.7-15 Total HIs - RME Risks Summed for All Pathways Based on LOAELs at Site 25 - Papermill Road Disposal Area - IM Confirmation Sampling

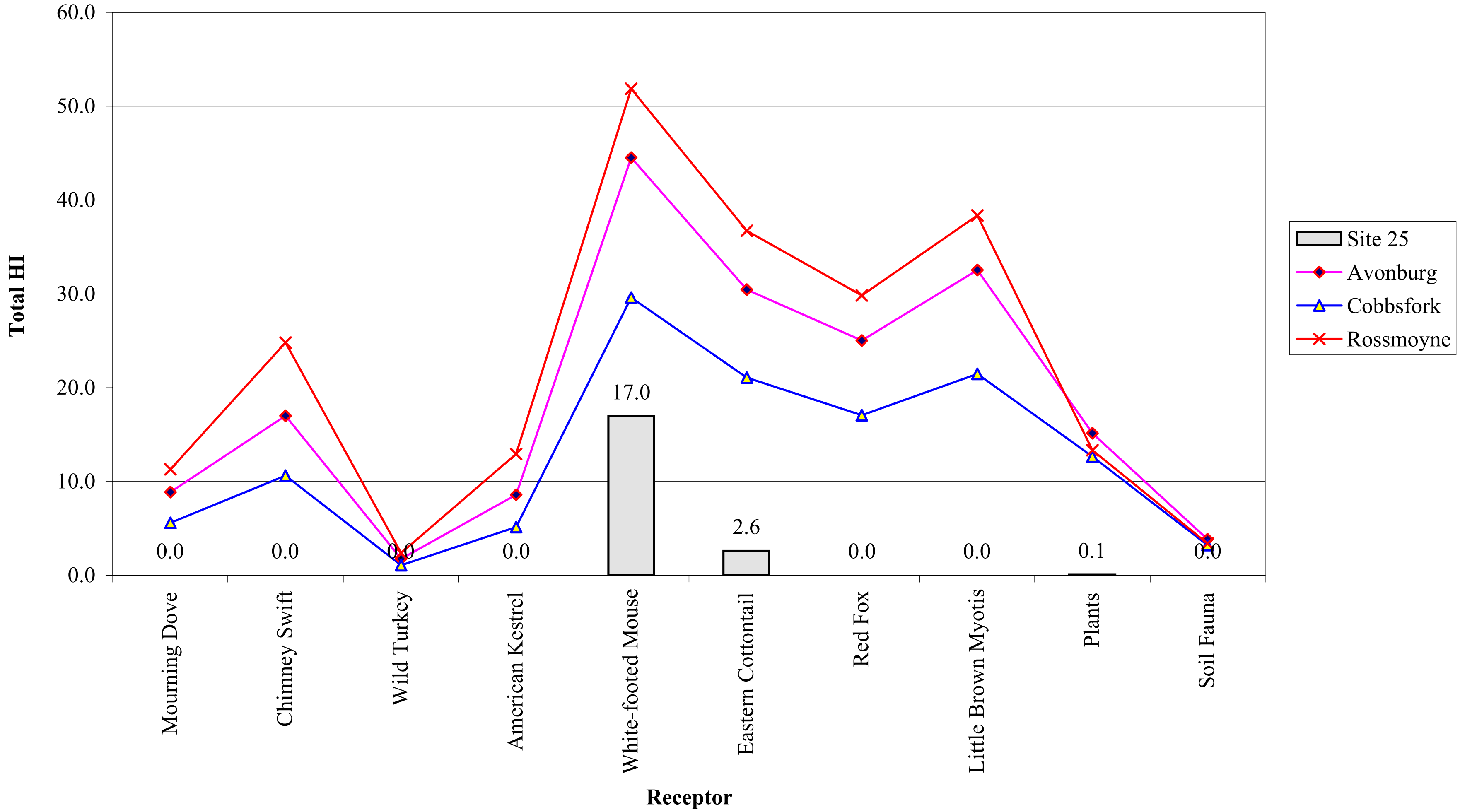

Figure 20.7-16 Total HIs - CT Risks Summed for All Pathways Based on NOAELs at Site 25 - Papermill Road Disposal Area - IM Confirmation Sampling

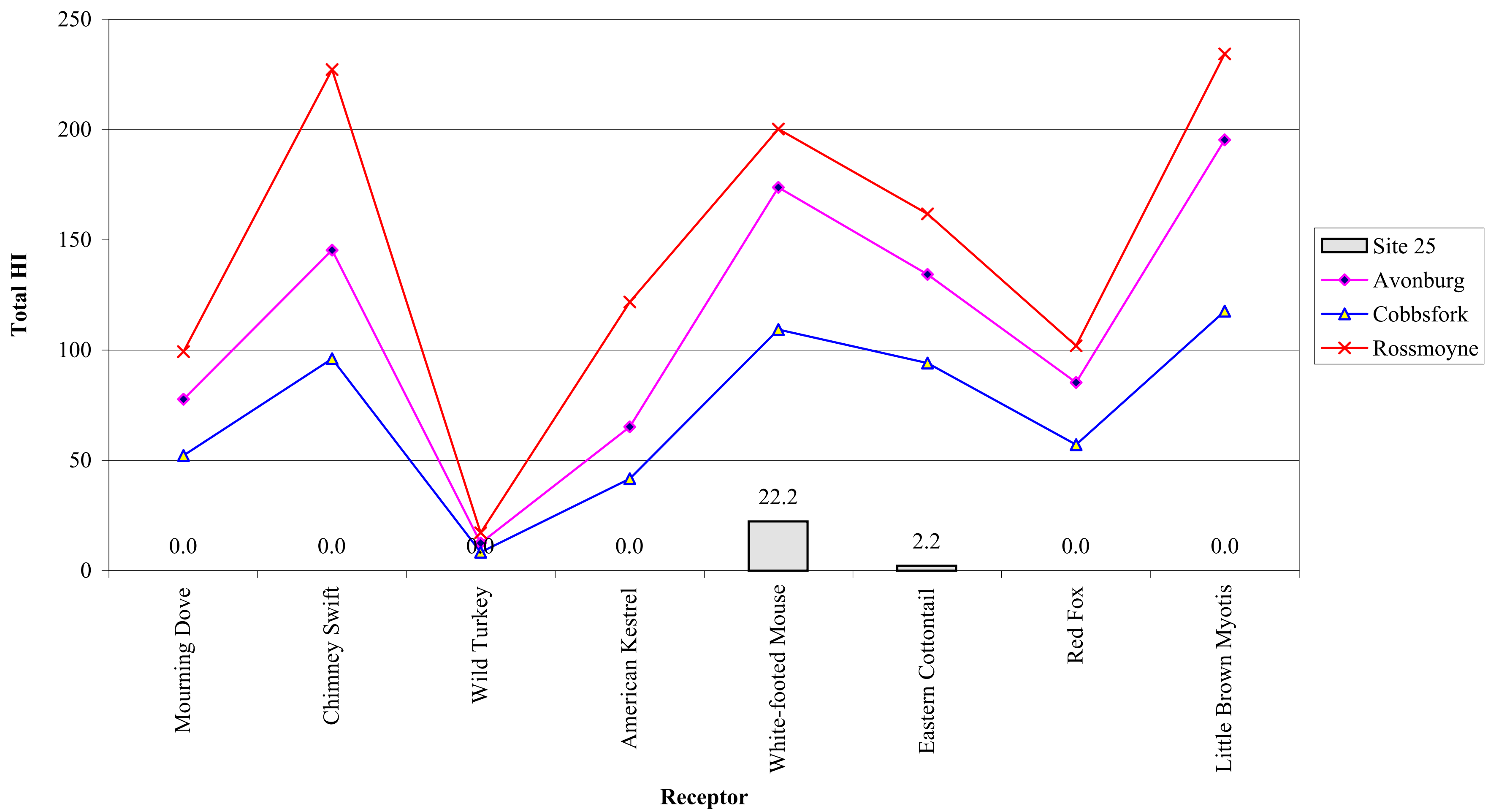

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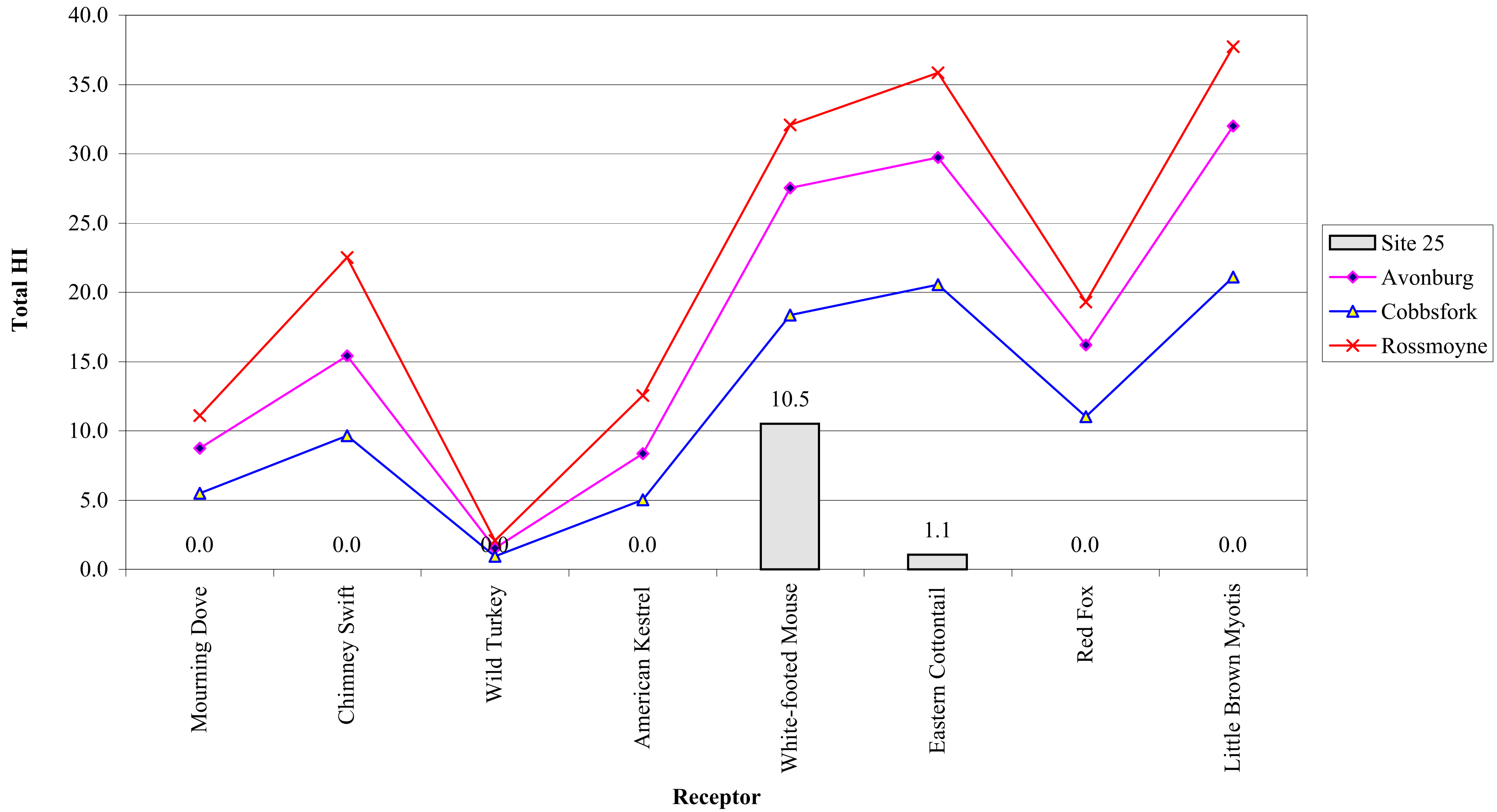
Figure 20.7-17 Total HIs - CT Risks Summed for All Pathways Based on LOAELs at Site 25 - Papermill Road Disposal Area - IM Confirmation Sampling



N:\jobs\244\0025\01\ET ECO Files\JPG\Im\Risk2\Eraim_25MWH.xls Figure 20.7-17

21.0 DRMO STORAGE AREA AND POSSIBLE DISPOSAL SITES SOUTH OF DRMO (SITE 26)

21.1 SITE CHARACTERISTICS

The DRMO storage area sites are located at the northeastern corner of Paper Mill Road and Infantry Road, adjacent to Building 189 (Figure 21-1). The storage area is surrounded by a 6-foot-high chain-link fence and at the time of the Phase I RI was being used to store scrap metal and scrap equipment from JPG prior to being sold to off-site vendors. The fenced area used for storage of lead-acid batteries and transformers consists of a flat, gravel-covered open area approximately 100 feet wide and 550 feet long. A small area in the northwestern part of the fenced area was used to store spent lead-acid vehicle batteries. The batteries were brought to the unit from the Building 186 Spent Lead-Acid Battery Storage and stored prior to off-site reclamation. The batteries were placed on wooden pallets, which rested directly on the recently laid gravel. At the time of the visual site inspection, there were approximately 50 batteries on 5 pallets (Kearney 1992). The tops of the batteries were covered with plastic and a layer of cardboard. Facility representatives stated that the batteries were normally stored 3 to 4 months before being shipped off-site for recycling.

According to facility personnel, the southeastern corner of the fenced area was used prior to 1980 for the storage of used oil and transformers containing less than 50 ppm of PCBs. The material was reportedly stored on pallets that rested on the gravel surface (Kearney 1992).

The two disposal sites **south of the DRMO Storage Area** were located about 200 and 300 feet south of the southeastern corner of the DRMO fenced storage area (Figure 21-1). The two areas consisted of bare ground located south of Infantry Road that were identified by installation personnel during the RI and were subsequently included as part of Site 26. There was no **known** information available on possible prior use of these sites. The only indication that the areas may have been used for disposal was the bare ground surface and a small amount of scattered glass and metal debris at each site.

Surface-water runoff from the graveled storage area flows to the storm water drainage ditches alongside the railroad tracks and along Infantry Road, then west toward Papermill Road where they flow south into a small natural drainage. Runoff from the area south of Infantry Road flows south into the same unnamed natural tributary to Middle Fork Creek (Figure 2-1). The fenced part of the site is gravel covered, but the surrounding area is currently under cultivation (corn and soybeans). For the two **disposal** sites located south of the DRMO yard, crops were planted to within a few feet of each of the two small contaminated areas.

The soils in this area belong to the Cobbsfork soil series. The glacial till is about 35 feet thick as determined from monitoring well boring logs for wells drilled at the nearby Yellow Sulfur Disposal Area (Site 14). The bedrock beneath the glacial till is presumed to be the Laurel Dolomite of Silurian age. The groundwater contour maps constructed for the Yellow Sulfur Disposal Area indicate an extremely flat horizontal groundwater gradient.

In January and February 1997 ~~A~~an interim removal action was conducted at **the Disposal sites south of the DRMO.** ~~Site 26 in January and February 1997 where a~~ **A** 40-foot-by-40-foot-by-1-foot-deep area was excavated in the bare ground ~~area~~ **of the disposal site** south of the DRMO yard and the soil was disposed ~~of~~ at an off-site facility, Heritage Environmental Services, Inc. (Heritage) Indianapolis, Indiana. Five post-excavation hand auger samples were analyzed for total lead and **the** five contained concentrations less than 10 ppm. On the basis of these results and confirmation sample results from SAIC, the excavation was backfilled with soil obtained from an on-site borrow pit. IDEM, after reviewing the confirmation sample results, indicated that ~~no~~ further soil removal is **not** necessary at Site 26. Farming activities, including plowing, planting, cultivating, and harvesting of crops, currently continue at this site.

In addition, in April 1998 soils were excavated from an area within the fenced DRMO Storage Area. Confirmation samples were analyzed for lead.

21.2 PREVIOUS INVESTIGATIONS

The DRMO storage area was first identified as a possible site in the EPIC report (1986). It is an open storage area used prior to 1949 until the time of the RI. Mounded materials, ground stains, debris, and piles of crates were identified in a succession of aerial photos. A visual site inspection, JPG personnel interviews, and file searches were conducted by A.T. Kearney (1992) in order to begin site characterization. No ground staining was noted during the visual site inspection for the Kearney (1992) report. No other previous investigations were performed prior to the RI. Two bare ground areas located south of Infantry Road were identified by installation personnel during the RI and were included as part of the site. There is no **known** information on possible prior use. The only indication that the areas may have been used for disposal was the bare ground surface and a small amount of scattered glass and metal debris observed at each site during the RI.

21.3 STUDY AREA INVESTIGATIONS

21.3.1 Phase I RI Field Activities

21.3.1.1 Surface Soils. Three near-surface soil samples were collected from -the lead-acid-battery storage area and analyzed for lead. Three near-surface soil samples were collected from the southeastern corner of the storage area (formerly, the transformer storage area) and analyzed for TPH and PCBs. Three near-surface soil samples **(i.e., depths from 0 to 6 inches (EPA56)**) were collected from the two spots of bare ground south of DRMO (two samples from the larger area and one sample from the smaller area). These samples were analyzed for metals, TPH, SVOCs, and PCB/pesticides. **Table 21-1 summarizes the analytical results for inorganic analytes and comparison to background.**

21.3.2 Phase II RI Field Activities

21.3.2.1 Surface Soils. ~~No s~~Surface soil samples were **not** collected during Phase II of the RI due to the fact that the site was slated for interim remedial action.

21.3.2.2 Subsurface Soils. ~~No s~~Subsurface soil samples were **not** collected during Phase II of the RI.

~~**21.3.2.3 Interim Measures Confirmation Samples.**~~

21.3.3 Interim Measures Confirmation Samples

Following excavation of contaminated soils ~~at Site 26~~ in January and February 1997, nine soil samples were collected **from the disposal site (south of the DRMO Storage Area)** and analyzed for metals to confirm that the metals exceeding USEPA Region 9 criteria had been removed (Figure 21-2 and Table 21-2). ~~All~~ **The confirmation samples were collected from 0 to 1 foot on February 13, 1997 by SAIC. (EPA56, 18). Following excavation of soils at Site 26 in April 1998, five samples were collected and analyzed for lead to confirm lead soils had been removed (Figure 21-3 and Table 21-2).**

21.4 DATA EVALUATION

21.4.1 Data Validation Results

The majority of the Phase I data for this site were acceptable for use. ~~All m~~Metals, explosives, and PCB data were usable except for antimony in soils and occasional iron and aluminum in soil that exceed the linear range of the calibration. A few SVOCs suffered from calibration problems, but only two pesticide CRLs were elevated above USEPA Region 5 DQLs.

21.4.2 Data Quality Summary

Phase I provided data of sufficient quality to conduct a human health risk assessment. However, as a result of the interim measures conducted at the site, no additional assessment was determined to be necessary.

The overall quality of the interim measures confirmation sample data was determined to meet the established objectives at Site 26. Data were qualified as usable but estimated when necessary. There were no rejected data in the confirmation sample data set.

21.4.3 Background Screening

~~No b~~Background screening was **not** conducted ~~since~~ **because** development of COPCs was not required. Background comparisons, however, can be made by review of the data summary tables in the following section. A column of background values for metals data is provided.

21.4.4 Summary of Analytical Results

Table 21-1 provides a summary of Phase I analytical results for metals in soils at the DRMO Storage Area and Possible **Disposal** Sites South of DRMO (Site 26). Table 21-2 provides a summary of the confirmation sample results from SAIC (1997). Table 21-3 provides a summary of organic contaminants detected in soil samples from Site 26. For the Phase I RI data collected by Rust E&I, a complete listing of the analytical results can be found in Appendix N.

21.5 NATURE AND EXTENT OF CONTAMINATION

21.5.1 Soil

Soil samples 1 through 3 were collected from the lead-acid battery storage area. Lead values for the three soil samples ranged from 130 to 330 µg/g (8 times and 22 times its background value, respectively), indicating that lead contamination has resulted from the storage of batteries (Table 21-1). These levels, however, are below the USEPA Region 9 criteria of 400 µg/g. Samples 4 through 6 were collected from the former transformer storage area. Evaluation of the sample data revealed that none of the samples contained **detectable** PCBs and that TPH was detected in only one sample (Sample 6) at less than the state action level of 100 µg/g. These results indicate that no significant contamination has resulted from the past transformer storage.

Soil samples 7 through 9 were collected from the bare spots south of the fenced area. Sample 9 was resampled for SVOCs because the di-n-butylphthalate detection was reported by DataChem as greater than the upper detection limit of 6.2 µg/g. The resampled result of 4.9 µg/g is reported as sample 10. Samples 7 through 9 ~~all~~ had detectable concentrations of TPH (Table 21-3). None of the TPH concentrations exceeded the state action level of 100 µg/g. Di-n-butylphthalate was detected at low concentrations in ~~all~~ **the** three of the soil samples collected from the two spots of bare ground south of the DRMO far below the USEPA Region 9 criteria.

A number of metals were detected in the soil samples collected from the bare spots at concentrations that exceeded their background screening criteria: antimony (two samples), arsenic (one sample), barium (two samples),chromium (three samples), cobalt (two samples), copper (three samples), lead (three samples), mercury (three samples) nickel (three samples), selenium (two samples), silver (three samples), tin (two samples), vanadium (three samples), and zinc (three samples). Of these, aluminum (7,900 to 11,900), antimony (41.6 and 92.3 µg/g), arsenic (9.29 and 17.3 µg/g), copper (12,000 and 7,800µg/g), and lead (40,000 and 23,000µg/g) were the primary contaminants detected at concentrations exceeding the USEPA Region 9 criteria **(Figure 21-1)**. The area of high metals concentrations was roughly defined by the ground surface that was devoid of vegetation.

An interim removal action was conducted in January and February 1997 at the bare ground area ~~of Site 26~~**south of the DRMO Storage Area**. An area approximately 40 feet by 40 feet was excavated to a depth of 1 foot.

Excavated soils were stockpiled and later disposed ~~of~~ as hazardous waste at Heritage Environmental Services, Inc. in Indianapolis, Indiana, due to confirmed lead contamination exceeding hazardous waste criteria. Confirmation samples collected from the bottom of the excavation by SAIC show that ~~all~~ **the** metals are now at acceptable levels (Table 21-**2**~~1~~) and that cleanup is complete. Details of the interim measures performed at Site 26 can be found in *Closure Report, Jefferson Proving Ground, Site 26 - DRMO Storage Area, Madison, Indiana* (TolTest, Inc. 1997a) and *Confirmatory Sampling Report (Sites #7,14,15,26,28, and Borrow Area), Jefferson Proving Ground, Madison, Indiana* (SAIC 1997).

In addition, in April 1998, soils were excavated at the DRMO Storage Area (Figure 21-3). Confirmation sampling (locations shown in Figure 21-3) indicated residual soil analytical results met PRGs (Table 21-2).

Based on the analytical results from confirmation sampling following excavation, residual metals concentrations were at or near background concentrations. If antimony contamination were present, removal of the affected soils would have also effectively removed the antimony. (EPA101)

21.6~~7~~ ECOLOGICAL RISK ASSESSMENT

Site 26 is approximately 0.2 acre including both the small, isolated area in the middle of the plowed field and the fenced area formerly used as a staging area. The isolated area in the field had been inadvertently plowed and subsequently was remediated as part of the interim measures program and then backfilled with clean soils in 1997.

Utilizing protocol established in the PERA, (Rust E&I 1997b) it was determined that barium, copper, lead, and zinc are contaminants of concern for potential ecological receptors at Site 26. However, it was determined in the analysis leading to the September 1997 Technical Memorandum (Rust E&I 1997f) that no further ecological action is ~~warranted~~**necessary**. Since the fenced area is mostly paved or consists of crushed gravel/asphalt, the potential exposure pathways for ecological receptors are essentially ~~nonexistent~~**absent**. Additionally, the isolated area in the field is very small (less than 500 square feet); the immediately surrounding area has been significantly altered as a result of agricultural practices; and cleanup of contaminants has been completed.

21.7~~8~~ CONCLUSIONS AND RECOMMENDATIONS

Phase I soil sample results show that two bare ground locations **(Disposal sites south of the DRMO)** contained a number of metals that exceeded their respective background

concentrations. Included were lead concentrations of 40,000 µg/g and 23,000 µg/g, which exceeded the cleanup goal of 400 µg/g by up to 100 times.

As a result of the discovery of high concentrations of metals in soils, an interim measures was conducted for the bare ground areas **south of the DRMO Storage Area** that consisted of excavation and off-site disposal of contaminated soils followed by backfill with gravel. Confirmation sample results show that ~~all~~ **the** contaminants exceeding USEPA Region 9 PRGs have been removed.

In addition, soils in an area within the fenced DRMO Storage Area were excavated in April 1998. Confirmation samples indicated residual soils met PRGs.

Due to the adequate removal of contaminated soils, it is recommended that no further investigation under the RI is required. Additionally, it is recommended that a No Further Action technical memorandum be prepared and submitted for this site. This site will not be carried forward to the FS.

TABLES

TABLE 21-1

Summary of Phase I Analytical Results for Soil Samples
Site 26 - DRMO Storage Area and Disposal Sites South of DRMO
Jefferson Proving Ground
Madison, Indiana

Sample ID Analyte	DRM26SF001 (µg/g)[a]	DRM26SF002 (µg/g)	DRM26SF003 (µg/g)	DRM26SF007 (µg/g)	DRM26SF008 (µg/g)	DRM26SF009 (µg/g)	Background (µg/g)
Aluminum	NA[b]	NA	NA	9,020	9,380	11,900	11,000
Antimony	NA	NA	NA	41.6	92.3	LT[c] 1.00	0.49
Arsenic	NA	NA	NA	9.29	17.3	LT 2.50	9.26
Barium	NA	NA	NA	1,800	1,200	49.6	84.5
Beryllium	NA	NA	NA	LT 0.427	LT 0.427	LT 0.427	0.52
Boron	NA	NA	NA	LT 6.64	LT 6.64	LT 6.64	0
Cadmium	NA	NA	NA	LT 1.20	LT 1.20	LT 1.20	0
Calcium	NA	NA	NA	10,700	6,950	641	750
Chromium	NA	NA	NA	18.6	18.0	17.5	15.1
Cobalt	NA	NA	NA	3.72	LT 2.50	3.86	3.50
Copper	NA	NA	NA	12,000	7,800	959	5.64
Iron	NA	NA	NA	13,700	9,610	24,600	14,800
Lead	330	130	250	40,000	23,000	24.0	14.9
Magnesium	NA	NA	NA	3,340	2,080	772	7,000
Manganese	NA	NA	NA	582	258	287	302
Mercury	NA	NA	NA	0.865	0.947	0.754	0
Molybdenum	NA	NA	NA	LT 14.3	LT 14.3	LT 14.3	0
Nickel	NA	NA	NA	44.1	15.8	4.39	2.23
Potassium	NA	NA	NA	471	537	708	681
Selenium	NA	NA	NA	1.06	1.86	LT 0.45	0.74
Silver	NA	NA	NA	1.60	0.95	0.0194	0
Sodium	NA	NA	NA	180	109	71.3	50.5
Thallium	NA	NA	NA	LT 34.3	LT 34.3	LT 34.3	0.43
Tin	NA	NA	NA	92.0	89.4	LT 7.43	0
Vanadium	NA	NA	NA	30.0	28.8	31.8	27.0
Zinc	NA	NA	NA	8,100	6,300	80.5	19.5

General Note:
1. Samples were collected on 5/18/93 at a depth of 0 feet. (EPA 18)

Footnotes:
(a) Micrograms per gram.
(b) Not analyzed.
(c) Less than the reporting limit.

TABLE 21-2

Summary of Analytical Results for Interim Measures Confirmation Samples
Site 26 - DRMO Storage Area and Disposal Sites South of DRMO
Jefferson Proving Ground
Madison, Indiana

Sample I.D. **Analyte**	**S26001** **(mg/kg)[a]**	**S26002** **(mg/kg)**	**S26003** **(mg/kg)**	**S26004** **(mg/kg)**	**S26005** **(mg/kg)**	**S26006** **(mg/kg)**	**S26206** **(mg/kg)**	**S26007** **(mg/kg)**
Silver	1.2 UJ[b]	1.2 UJ	1.3 UJ	1.2 UJ	1.3 UJ	1.3 UJ	1.2 UJ	1.2 UJ
Aluminum	9700.00	6300.00	9700.00	7900.00	7100.00	8000.00	6500.00	10000.00
Arsenic	3.2 J[c]	4.4 J	9.5 J	4.4 J	5.5 J	2.8 J	4.4 J	2.7 J
Boron	10 U[d]	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Barium	48.00	48.00	46.00	38.00	37.00	48.00	32.00	49.00
Beryllium	0.24 BJ[e]	0.33 BJ	0.19 BJ	0.19 BJ	0.17 BJ	0.28 BJ	0.17 BJ	0.23 BJ
Calcium	510 BJ	680 J	3500.00	580 BJ	330 BU	500 BJ	350 BU	460 BJ
Cadmium	0.11 BJ	0.24 BJ	0.088 BJ	0.61 U	0.65 U	0.12 BJ	0.61 U	0.62 U
Cobalt	1.3 BJ	2.3 BJ	1.3 BJ	1.9 BJ	1.6 BJ	1.8 BJ	1.2 BJ	1.4 BJ
Chromium	12.00	10.00	13.00	9.90	8.20	1.00	8.70	12.00
Copper	13 J	57 J	5.5 J	4.3 J	3.7 J	4.7 J	2.3 BJ	4.1 J
Iron	8600.00	12000.00	7800.00	7700.00	6500.00	11000.00	6000.00	8200.00
Mercury	0.037 BJ	0.042 BJ	0.13 U	0.051 BJ	0.13 U	0.044 BJ	0.035 BJ	0.037 BJ
Potassium	460 BUJ	250 BJ	340 BJ	290 BJ	210 BJ	350 BJ	230 BJ	460 BJ
Magnesium	590 BJ	450 BJ	1900J	470 BJ	420 BJ	480 BJ	400 BJ	580 BJ
Manganese	87 J	180 J	160 J	56 J	60 J	71 J	39 U	67 J
Molybdenum	10 U	10 U	10 U	10 U	1.5 BU	10 U	10 U	10 U
Sodium	50 BJ	39 BJ	46 BJ	28 BJ	28 BJ	32 BJ	25 BJ	56 BJ
Nickel	4.0 BJ	3.4 BJ	2.8 BJ	2.2 BJ	3.0 BJ	2.8 BJ	2.1 BJ	3.5 BJ
Lead	51 J	31 J	13 J	7.4 J	8.1 J	7.8 J	7.1 J	8.3 J
Selenium	0.62 UJ	0.30 BJ	0.87 UJ	0.28 BUJ	0.25 BUJ	0.64 UJ	0.21 BUJ	0.62 UJ
Thallium	7.3 J	0.62 U	11 J	7.7 J	12 J	7.6 J	7.6 J	8.00
Vanadium	19 J	23 J	20 J	18 J	14 J	24 J	17 J	20 J
Zinc	23 J	48 J	18 J	13 J	15 J	15 J	12 J	17 J

TABLE 21-2

Summary of Analytical Results for Interim Measures Confirmation Samples
Site 26 - DRMO Storage Area and Disposal Sites South of DRMO
Jefferson Proving Ground
Madison, Indiana

Sample I.D. Analyte	S26008 (mg/kg)	S26009 (mg/kg)	26-BS (mg/kg)	26-SW-N (mg/kg)	26-SW-W (mg/kg)	26-SW-S (mg/kg)	26-SW-E (mg/kg)
Silver	1.3 UJ	1.2 UJ	NA[(f)]	NA	NA	NA	NA
Aluminum	6000.00	7800.00	NA[(f)]	NA	NA	NA	NA
Arsenic	2.1 J	17 J	NA[(f)]	NA	NA	NA	NA
Boron	10 U	10 U	NA[(f)]	NA	NA	NA	NA
Barium	36.00	42.00	NA[(f)]	NA	NA	NA	NA
Beryllium	0.26 BJ	0.25 BJ	NA[(f)]	NA	NA	NA	NA
Calcium	340 BU	580 BU	NA[(f)]	NA	NA	NA	NA
Cadmium	0.078 BJ	0.16 BJ	NA[(f)]	NA	NA	NA	NA
Cobalt	1.4 BJ	3.5 BJ	NA[(f)]	NA	NA	NA	NA
Chromium	9.00	10.00	NA[(f)]	NA	NA	NA	NA
Copper	2.7 BJ	2.7 BJ	NA[(f)]	NA	NA	NA	NA
Iron	8900.00	12000.00	NA[(f)]	NA	NA	NA	NA
Mercury	0.13 U	0.12 U	NA[(f)]	NA	NA	NA	NA
Potassium	210 BJ	120 BJ	NA[(f)]	NA	NA	NA	NA
Magnesium	360 BJ	440 BJ	NA[(f)]	NA	NA	NA	NA
Manganese	120 J	200 J	NA[(f)]	NA	NA	NA	NA
Molybdenum	10 U	10 U	NA[(f)]	NA	NA	NA	NA
Sodium	25 BJ	150 BJ	NA[(f)]	NA	NA	NA	NA
Nickel	4.6 BJ	1.4 BJ	NA[(f)]	NA	NA	NA	NA
Lead	6.3 J	74 J	22.3	3.35	17.6	9.44	8.95
Selenium	0.66 UJ	0.77 UJ	NA	NA	NA	NA	NA
Thallium	18.00	0.61 U	NA	NA	NA	NA	NA
Vanadium	20 J	25 J	NA	NA	NA	NA	NA
Zinc	12 J	15 J	NA	NA	NA	NA	NA

General Note:

1. A summary of data qualifiers may be found in Appendix N. Samples S26001-S26009 were taken from 0-1 foot depths. Remaining samples were done in April 1998. (EPA18)

Footnotes:

(a) Micrograms per kilogram.
(b) Not detected, estimated quantitation limit.
(c) Estimated value.
(d) Not detected.
(e) Estimated value is between the method detection limit and reporting limit.
(f) Not analyzed.

TABLE 21-3

Analytical Results for Organic Contaminants Detected in Soil Samples
Site 26 - DRMO Storage Area and Disposal Sites South of the DRMO
Jefferson Proving Ground
Madison, Indiana

Sample ID	Contaminant	Concentration (µg/g)[a]	Date Sampled
DRM26SF006	Total Petroleum Hydrocarbons	20.0	11/19/92
DRM26SF007	Total Petroleum Hydrocarbons	53.0	05/18/93
	Di-n-butyl phthalate	4.00	
DRM26SF008	Total Petroleum Hydrocarbons	56.0	05/18/93
	Di-n-butyl phthalate	3.90	
DRM26SF009	Total Petroleum Hydrocarbons	18.0	05/18/93
	Di-n-butyl phthalate	6.20	
DRM26SF010 (resample of DRM26SF009)	Di-n-butyl phthalate	4.90	01/28/94

General Note:
1. All samples collected at a depth of zero feet. (EPA 18)

Footnotes:
(a) Micrograms per gram.

N:\Jobs\244\0025\01\wp\tbl\Table 21-3.doc

FIGURES

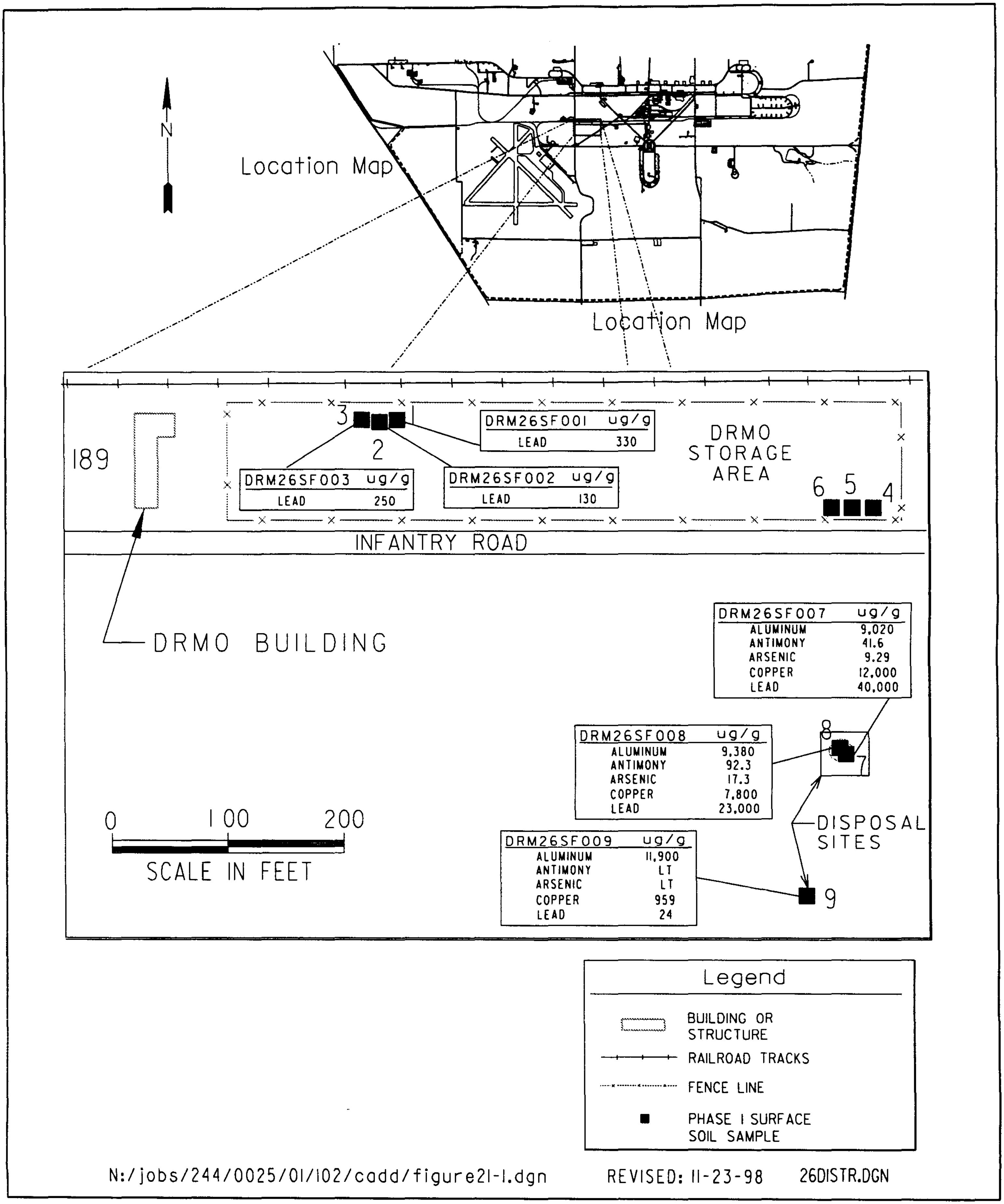


Figure 21-1. Sampling Locations and Results Exceeding PRGs for DRMO Storage Area and Disposal Sites South of DRMO (Site 26)

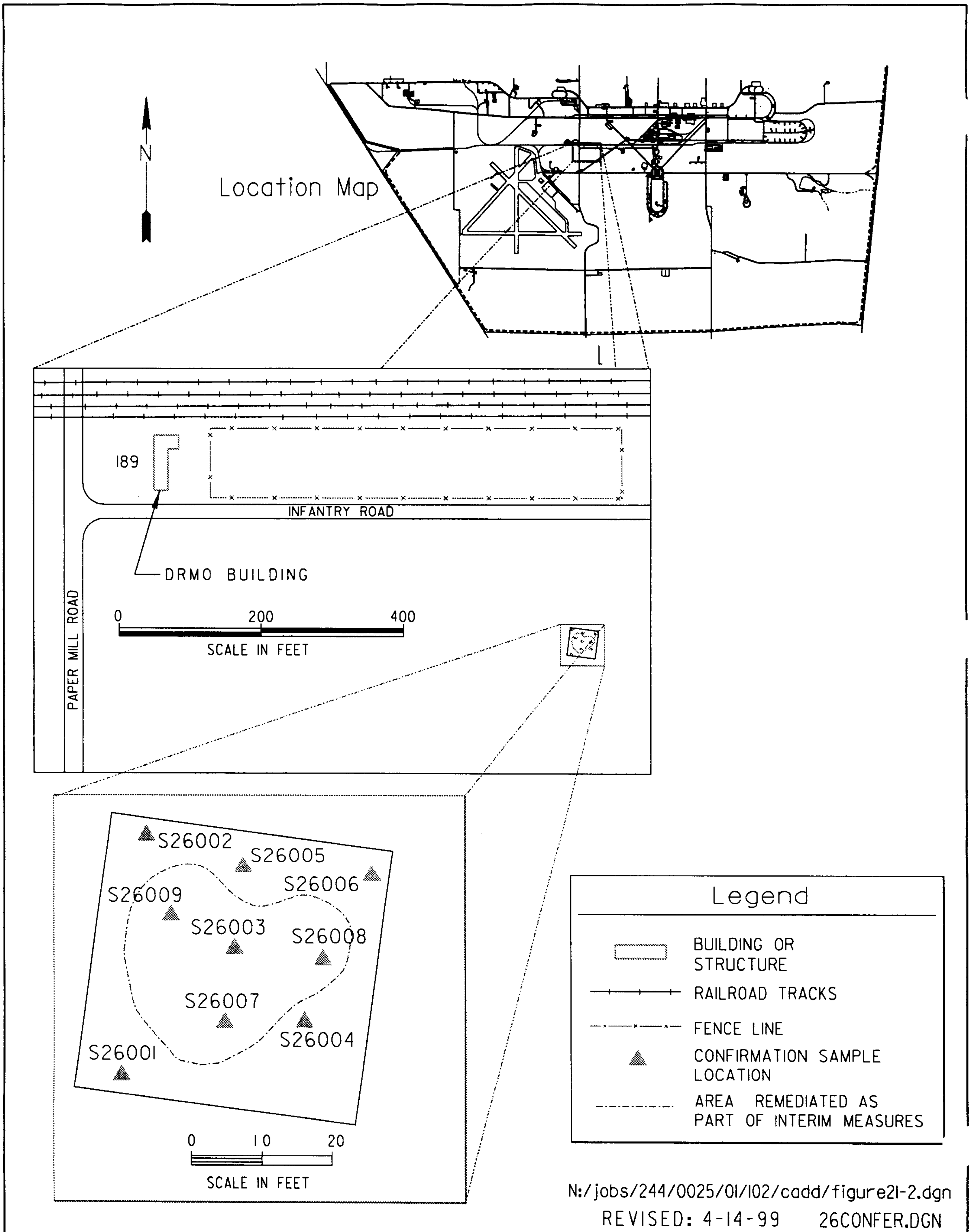


Figure 21-2. Confirmation Sample Locations for Disposal Sites South of DRMO (Site 26)

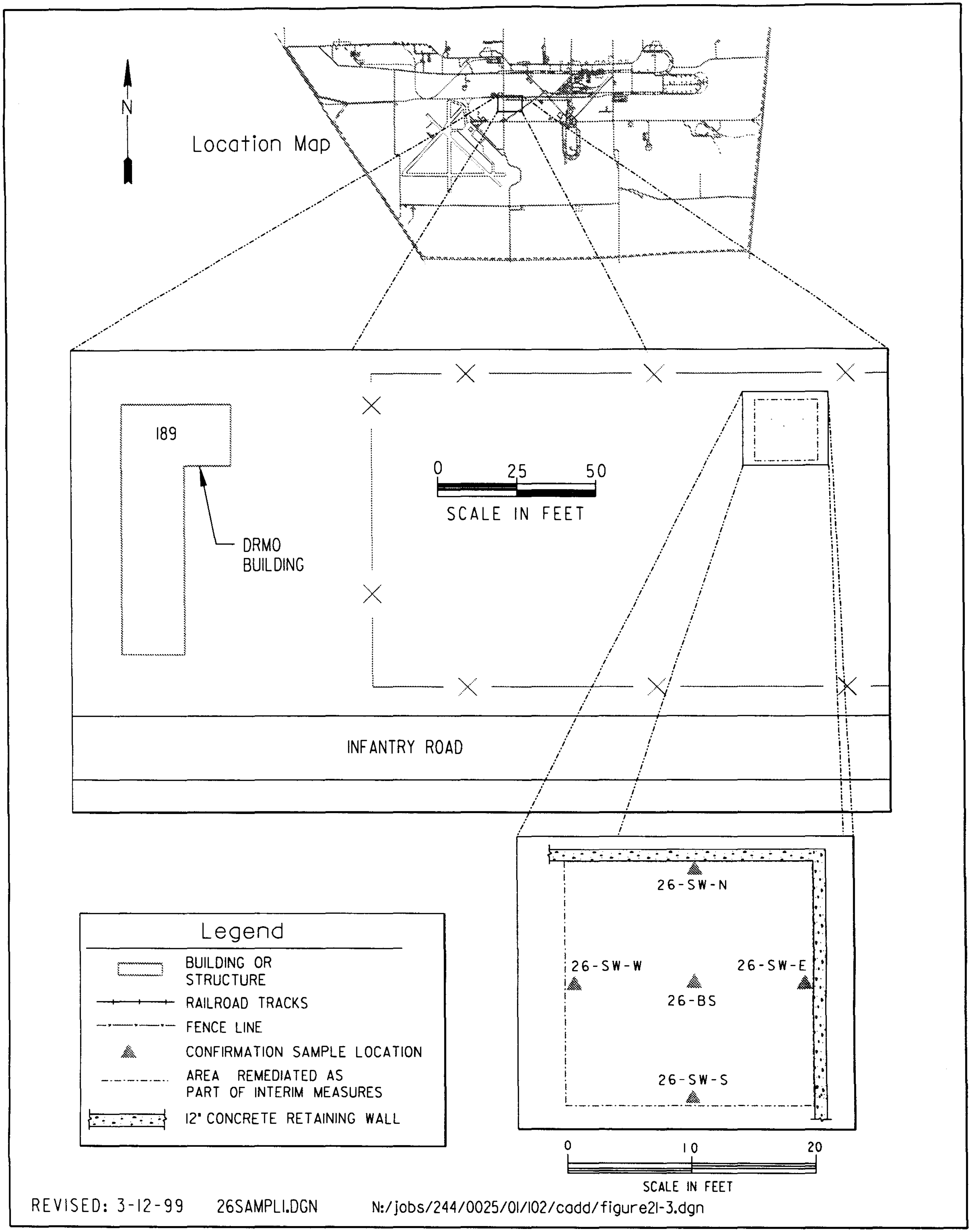


Figure 21-3. Confirmation Sample Locations for DRMO Storage Area (Site 26)

22.0 GATOR Z OPEN BURN AREA (SITE 28), GATOR Z MINE SCRAP DISPOSAL AREA (SITE 29), AND GATOR Z MINE TEST AREA (SITE 39)

22.1 SITE CHARACTERISTICS

The Gator Z Open Burn Area, Gator Z Scrap Disposal Area, and Gator Z Mine Test Area are all located in the southeastern portion of the facility (Figure 22-1). These sites can be accessed by traveling west on Mine Field Road from the intersection of Mine Field and East Perimeter Roads. The area is relatively flat with a slight slope to the southwest. Surface water drainage is directed via ditches along the roadways to the south into a tributary of Harberts Creek, which borders the mine test area on the south (**see Figure 22.7-1**). The area around the mine test pits is covered with grass and gravel and is bordered by woods on the east, south, and west. Mine Field Road borders the test area on the north. The open burn site and the mine scrap disposal site are located north of Mine Field Road in an area that is slowly being reforested by natural succession. Thus, there are grasses, shrubs, and trees in these areas. Only the mine test area was regularly mowed at the time of the Phase I RI. The other two sites were inoperative at the time of the RI. There are currently no activities at the three sites. An interim removal action was conducted at Sites 28 and 29 in January and February 1997, and Site 28 was backfilled with clean soil. The Site 29 excavation was left open to restore the aquatic habitat that was present prior to the removal action and to allow the completion of additional UXO surveying.

The sites are located in an area with soils belonging to the Cobbsfork series. The depth to bedrock is unknown, but is probably between 15 and 30 feet based on information from background monitoring wells installed at the intersection of East Perimeter Road and Mine Field Road. According to geologic mapping of the subsurface bedrock, the glacial till is underlain by the Louisville Limestone of Silurian age (Figure 2-3).

22.1.1 Gator Z Open Burn Area (Site 28)

This former open burn area (Site 28) is located in the southeastern portion of the facility about 600 feet north of Mine Field Road along an unnamed gravel road, which leads north of the mine test area (Figure 22-1). The burn area is flat, open, and non-vegetated. During Phase I of the RI, the ground was stained black and was reportedly used from 1985 until the early 1990's to burn scrap Styrofoam□ and plywood used as damping and packing material at the Gator Z Mine Test Area. As a result, it was suspected that live detonators and blasting caps could be imbedded in the scrap. The packing material was taken to the open burn area and burned directly on the ground surface. Burning was conducted several times per month. There is also scrap metal at the area. After each burn, the ashes were collected and stored in drums. TCLP analysis was performed on the ash to determine the appropriate disposal. The open burning was conducted under a variance to air pollution regulations granted by IDEM. The facility began burning the scrap at the new incinerator (Building 333) upon approval of an application submitted to IDEM in March of 1991 (Kearney 1992). The only release control

at the site was the removal of the ash after burning had been conducted. The wastes and residues potentially contained explosive residues and heavy metals.

In January and February 1997, an interim measures removal action was conducted in the former burning area with the removal of approximately 17 cubic yards of ash and gravel and 64 cubic yards of contaminated soil from beneath the ash and gravel. The resulting excavation was approximately 70 by 140 feet in size and 1 foot in depth (Figure 22-2). Following receipt of confirmation sample results, the excavation was backfilled with clean soils. **During the interim removal action, the excavated soils were temporarily stockpiled on the ground surface pending off-site disposal. Following off-site disposal, confirmation samples were collected in 1999 from soils below the area where the stockpiled soils had been located. The confirmation samples were analyzed for metals. The confirmation sample results showed that leaching from the temporary stockpile had not occurred. (IN28)**

22.1.2 Gator Z Mine Scrap Disposal Area (Site 29)

The mine scrap disposal area (Site 29) is located about 250 feet north of the Gator Z Mine Open Burn Area (Figure 22-1). During the Phase I RI, there was an open water-filled pit, approximately 12 feet wide, 25 feet long, and 5 feet deep. The pit was used to dispose of the steel components of "bouncing betty" mines after they had been tested at the mine test area. The material in the pit was believed to be primarily the residual steel components. The area was reportedly last used in 1970, but the exact period of operation is unknown. The pit did not have a surface-water outlet. The pit reportedly dried up periodically, revealing many pieces of steel scrap embedded in the bottom. There was a mound of dirt approximately 70 feet west of the pit that most likely represented the soil that was originally excavated from the open pit.

In January and February 1997, an interim measures removal action was conducted at Site 29. Soil and metal debris was removed from the floor of the pond, and the resulting excavation was left open to restore the aquatic environment that was present prior to the removal action. Confirmation sample locations are presented in Figure 22-2.

22.1.3 Gator Z Mine Test Area (Site 39)

The mine test site (Site 39) is located west of the East Perimeter Road between Mine Field Road and a tributary to Harberts Creek (Figure 22-3). It encompasses approximately 220,000 square yards. There are 26 mine test-pits placed in two long east-west rows that are parallel to Mine Field Road. Each pit consisted of a steel box, open to the soil on the bottom and fitted with a removable top. Concrete walls surrounded the steel boxes. These steel boxes were used to test the performance of explosive mines. The two pits at the east end of the area were the ones used most frequently. While in operation, the debris was cleaned from the pits after each use. The boxes were designed so that precipitation entering them were routed from the box via drain pipes in the bottom that emptied into drainage swales that lead to Harberts Creek. As a result, it was believed that the pits and drainage swales may have been contaminated with residual explosives and metals such as lithium, vanadium, arsenic, and mercury, all of which are commonly associated with pyrotechnics and explosives.

At the time of the Phase I RI, the facility was in the process of removing all of the metal boxes from the pits for eventual sale of the scrap metal. Currently, many of these boxes are still lying on the ground surface adjacent to the pits. The area is fenced and is no longer used.

22.2 PREVIOUS INVESTIGATIONS

Water and sediment samples were collected from Harberts Creek by Rust E&I personnel (formerly SEC Donohue) in January of 1992 (SEC Donohue 1992)) and by USAEHA personnel in July of 1992. Silver was detected in the water and sediment of Harberts Creek during both sampling efforts. The potential sources of the silver were identified as the wastewater treatment plant discharge, runoff from sludge application areas, and the Gator Z Mine Test Area.

Facility personnel have sampled the residual ash at the burn area and soil from within the test pits. Analytical results of the samples were reviewed and revealed that the ash samples had a pH of greater than 10. The cadmium concentration ~~of 41.5~~**of 41.5** µg/g exceeded the USEPA Region 9 criteria for soils of 38 µg/g. The lead concentration of 1,562 µg/g exceeded the USEPA lead cleanup level of 400 µg/g. There were also anomalous (above background criteria) concentrations of silver, arsenic, and chromium in the ash samples. The soil-sample results for a sample collected by facilities personnel from mine test pit #4 contained anomalous silver at 19.9 µg/g, but the silver concentration did not exceed the USEPA Region 9 criteria of 380 µg/g.

22.3 STUDY AREA INVESTIGATIONS

22.3.1 Phase I RI Field Activities

22.3.1.1 Gator Z Open Burn Area (Site 28).

22.3.1.1.1 Surface Soils. Because there was a high potential for release of contaminants to the soil from the burning conducted at the burn site, information was collected to identify possible near-surface soil contamination. Phase I investigation activities at the Open Burn Area included three near-surface soil samples taken from areas considered most likely to be contaminated. These samples were analyzed for explosives and total metals. During Phase I, one ash sample was also collected and analyzed for TCLP metals, total metals, and explosives. This sample was also collected to determine the appropriate disposal for the ash at this site.

22.3.1.1.2 Interim Action Program. The Gator Z Open Burn Area (Site 28) was included in the voluntary interim action program being conducted by USACE. The interim measures for the Gator Z Open Burn Area included the removal of debris and ash and the addition of 12 inches of soil beneath the debris and ash over a 75-by-125-foot area. Ten confirmatory

samples **(Figure 22-2)** were taken from the bottom and sidewalls of the excavation, and analyzed for total metals.

22.3.1.2 Gator Z Mine Scrap Disposal Area (Site 29).

22.3.1.2.1 Geophysical Survey. There were no data on the nature and extent of contamination at the mine scrap disposal pit. Even though the pit containing scrap had not been used since 1970, it was considered possible that the pit water and sediment might be contaminated with explosives and possibly metals. It was also considered possible that other pits, which are now covered with soil, might exist in the area. Thus, both magnetometer and EM-31 terrain conductivity geophysical surveys were performed over the 1-acre surrounding the disposal pit in order to identify other potential disposal areas**. Anomalies, correspond to metal within the pond, to the dirt pile northwest of the pond, and to a metal box west of the pond. No other trenches or pits were indicated by the survey.**

22.3.1.2.2 Surface Water and Sediment. During Phase I efforts at the Mine Scrap Disposal Pit, three surface-water and sediment samples were collected from the open pit and were analyzed for explosives and total metals to assess residual contamination in the pit.

22.3.1.3 Gator Z Mine Test Site (Site 39). During the Phase I RI, six surface soil samples were collected and analyzed for explosives and total metals. Three of the samples were collected from three test pits that had been most frequently used. The remaining three samples were collected from the drainage swales draining the test pit areas in order to determine if contaminants are being transported from the testing area to the surface water drainages.

22.3.2 Phase II RI Field Activities

22.3.2.1 Gator Z Open Burn Area (Site 28).

22.3.2.1.1 Surface Soils. Due to the interim remedial action activities at the open burn area, no Phase II RI sampling was conducted. Interim removal action was completed at Site 28 in February 1997.

22.3.2.1.2 Subsurface Soils. No Phase II RI sampling was conducted due to the interim measures conducted at the site.

22.3.2.1.3 Interim Measures Confirmation Samples. In February 1997, following removal of contaminated ash, gravel, and soil from the burning area, a total of 10 confirmation samples were collected for metals analysis (see Figure 22-2).

22.3.2.2 Gator Z Mine Scrap Disposal Area (Site 29).

22.3.2.2.1 Surface Water and Sediment. No surface water or sediment samples were collected during Phase II of the RI.

22.3.2.2.2 Interim Measures Confirmation Samples. Two sediment samples and one surface water sample were collected in February 1997 for metals and explosives analysis following removal of approximately 12 cubic yards of soil and debris (see Figure 22-2).

22.3.2.3 Gator Z Mine Test Area (Site 39).

22.3.2.3.1 Surface Soils. Two biased Phase II samples were collected at this site due to recommendations from the site data validation summary. As recommended, these samples were only analyzed for explosives.

22.3.2.3.2 Subsurface Soils. As part of the ecological risk assessment studies, five additional soil samples were collected for metals analysis. The samples were taken from auger cores collected from the surface to a depth of 2 feet. The results from these samples are discussed in the ecological risk assessment for the Gator Z Mine Test Area but were not used in the human health risk assessment.

22.4 DATA EVALUATION

22.4.1 Data Validation Results for Site 39

Surface soil samples were collected and analyzed from Site 39 for metals and explosives during Phase I, and for explosives only during Phase II.

22.4.1.1 Blank Assessment. When blank contamination exists, the investigative results must exceed the blank result by a factor of 5 (all metal compounds) in order to be considered positive. Three metals were detected in blanks associated with Site 39 samples. Based on comparisons to blanks, specific positive results were qualified as nondetects ("U"). The associated sample quantitation limit became either the concentration detected in the sample, if the detected value was above the quantitation limit, or the quantitation limit, if detected results were less than the quantitation limit. During Phase I, the following results were qualified as nondetected:

- Boron—GZM39SF002, -F003, -F005, -F006, and -F006,D
- Cobalt—GZM39SF002
- Sodium—GZM39SF001, -F002, -F003, and -F004

22.4.1.2 Surrogate Spikes. No surrogate spikes were employed in the method during Phase I; therefore, it was advised that limited additional sampling and subsequent reanalysis using surrogate spikes be performed to assess potential matrix interference. During Phase II, surrogate spikes were performed and none of the data were rejected or qualified.

22.4.1.3 Rejected Results. The antimony results from Phase I were rejected due to low LCS/MS recoveries for the following samples:

- GZM39SF001, -F002, -F003, -F004, -F005, -F006, and -F006,D

22.4.1.4 Evaluation of Non-Detected Values. A comparison was made between the USEPA Region 5 DQLs and the project CRLs for chemicals that were analyzed for but not detected in environmental media at this site. Beryllium and thallium exceedances were noted for soil samples. No other exceedances were found.

22.4.2 Data Quality Summary

All soil antimony results from Phase I soil samples were rejected, and no Phase II soil samples were analyzed for this metal. Therefore, antimony contamination in soil at this site has not been characterized. Positive results were changed to nondetects ("U") for several metals analyzed during Phase I. In particular, soil boron results were affected by blank contamination. All of the boron detections in the affected samples were below quantitation limits, and the quantitation limits were below the Region 9 residential soil PRG. Therefore, blank contamination does not significantly impact the conclusions of the risk assessment.

In summary, the number of samples, the comprehensiveness of the parameter list (with the exception of antimony), and the quality of the data are adequate to characterize the nature and magnitude of soil contamination at the exposure area addressed in the risk assessment. **Uncertainty involving the presence of antimony at Site 39 is~~will be~~ discussed further in the uncertainty section of the human risk assessment for the site. (EPA102)**

22.4.3 Background Screening for Site 39

22.4.3.1 Surface Soil. **None of the surface soil samples collected appear to represent a "hot spot." (EPA57)** Therefore, the samples were grouped for the purposes of background screening. The background screening protocol is described in Section 5.1.4.5.2. The results of the background screening procedure for surface soil at Site 39 are presented in Table 22-1. There were sufficient samples analyzed for inorganic constituents (six) to apply the t-test and the Mann-Whitney test where appropriate. The site samples were compared to the background for the Cobbsfork soil series. As shown in Table 22-1, aluminum, arsenic, boron, chromium, cobalt, copper, lead, manganese, mercury, nickel, silver, vanadium, and zinc are above background. These metals, therefore, are carried forward to the COPC selection process.

22.4.3.2 Other Environmental Media. No other environmental media at Site 39 are considered to be potentially impacted by the previous activities at the Gator Z Mine Test Area.

22.5 NATURE AND EXTENT OF CONTAMINATION

22.5.1 Gator Z Mine Open Burn Area (Site 28)

22.5.1.1 Ash and Soils. Analysis of surface-soil samples collected during Phase I at the burn area showed that both the ash and surface soils were contaminated with metals (Table 22-2). Analysis of the three surface-soil samples revealed that the following metals were present in above-background concentrations: barium (one sample), boron (one sample), cadmium (three samples), chromium (two samples), copper (three samples), lead (three samples), manganese (two samples, nickel (three samples), silver (three samples), tin (two samples), and zinc (three samples). None of the metals, however, exceeded USEPA Region 9 criteria.

The ash sample from Phase I contained numerous metals in above-background concentrations, including antimony, arsenic, barium, boron, cadmium, chromium, cobalt, copper, lead, manganese, nickel, silver, tellurium, thallium, tin, vanadium, and zinc. Antimony (58.5 µg/g), arsenic (26.7 µg/g), chromium (4,100 µg/g), copper (32,000 µg/g), nickel (2,360 µg/g), lead (2,000 µg/g), thallium (106 µg/g), and zinc (52,000 µg/g) were found to exceed USEPA Region 9 cleanup criteria. TCLP analysis of the ash sample revealed that no metals exceeded the RCRA TCLP criteria.

22.5.1.2 Interim Measures Confirmation Samples. In January 1997, interim action began at Site 28 with the excavation, removal, and disposal of contaminated materials at on off-site facility. The removal action was completed in February **of 1997**, and confirmation sampling shows that residual metals contamination is below USEPA Region 9 action levels with the exception of arsenic and beryllium (Table 22-3). The results for these two metals, however, are consistent with background concentrations for JPG and indicate naturally occurring elevated levels. Based on the confirmation sampling results **from soils taken from 0 to 1 foot in depth**, interim remedial action has adequately reduced potential exposure risks to human and environment receptors and no further action is required (TolTest 1997b).

22.5.2 Gator Z Mine Scrap Disposal Area (Site 29)

22.5.2.1 Soil. Both magnetometer and EM-31 geophysical surveys were performed around the mine scrap disposal site during Phase I. The surveys did not show any significant anomalies believed to be associated with large amounts of buried scrap. There did appear to be some buried metal in the soil mound about 70 feet northwest of the open pit, but it did not appear to be extensive.

22.5.2.2 Sediment. Analysis of the sediment and water samples collected at the mine scrap disposal pit during the RI showed that cadmium is present in the pond sediments at concentrations that do not exceed USEPA Region 9 action level criteria (Table 22-4). The only metals that were detected in the pond sediments above their background screening criteria were silver (sample 1) and cadmium (all three samples).

22.5.2.3 Surface Water. Analysis of the pond water revealed detectable concentrations of the explosive 1,3,5- trinitrobenzene in all three samples (Table 22-4). Cadmium and zinc were the only metals detected above the background values established for groundwaters. Cadmium concentrations in all three samples exceeded the MCL of 0.005 mg/L. None of the chemicals detected in the water samples exceeded the USEPA Region 9 action level criteria.

22.5.2.4 Interim Measures Confirmation Samples. In January 1997, an interim measures removal action was conducted at Site 29 with the removal of debris and sediment from the pond. The removal action was completed in February 1997, and confirmation samples **consisting of 2 sediment and 1 surface water** were collected and submitted for metals **and explosives. Refer to Table 22-3 for the interim measures confirmation sampling results for Site 29.**

Results indicate that all metals are below USEPA Region 9 cleanup criteria. Following excavation, the pond was left open to promote the re-establishment of the aquatic environment that existed prior to remedial action (TolTest 1997c).

22.5.3 Gator Z Mine Test Area (Site 39)

22.5.3.1 Soil. Analysis of the six surface-soil samples collected inside the mine test pits and along the drainage swales near the test pits showed no detectable explosives compounds (Table 22-5). Analysis for metals revealed that the following metals are present at concentrations exceeding their background screening value: arsenic (one sample), barium (two samples), chromium (three samples), cobalt (four samples), copper (four samples), lead (five samples), manganese (three samples), mercury (one sample), nickel (six samples), silver (six samples), vanadium (three samples), and zinc (five samples). Of the metals, aluminum, arsenic, chromium, and manganese were present at concentrations exceeding USEPA Region 9 action level criteria. Lead was found in four of the surface-soil samples at above-background concentrations, ranging from 20.7 µg/g to 74.0 µg/g. These concentrations, however, are well below the USEPA criteria of 400µg/g.

Most of the metals concentrations that exceeded background occurred in samples from the mine test pits. Of the samples collected from the drainage swales, all but one of the six metals concentrations that exceeded its background value occurred in Sample 5. These results indicate that most of the metals contamination remains within the mine test pits and that contamination resulting from transport by surface water is limited. The absence of any detectable explosives contamination is further evidence that the mine tests pits are not a significant source of contamination.

22.6 HUMAN HEALTH RISK ASSESSMENT

It should be noted that an interim measure (i.e., excavation of contaminated soil) occurred at Sites 28 and 29. For this reason a human health risk assessment was not

considered necessary at these sites. A human health risk assessment was performed for Site 39 where no interim measures have been performed.

22.6.1 Gator Z Mine Test Area (Site 39)

22.6.1.1 Selection of the Contaminants of Potential Concern at Site 39 - Surface Soil.

22.6.1.1.1 Data Grouping. The surface soil samples at this site were collected up to 1,000 feet apart, but there did not appear to be any hot spots of contamination. Therefore, the samples were grouped for the purposes of background screening**. The analytical data used in the human health risk assessment are identified in the data evaluation discussion of this section (22.4). All acceptable analytical data were used in the risk assessment. (EPA17)**

2.6.1.1.2 Frequency of Detection. Evaluation of frequency of detection was not undertaken at this site because of too few samples.

22.6.1.1.3 Nutrient Screening. The maximum value of each of the nutrients detected in surface soil at this site was less than the corresponding nutrient screening value: calcium (maximum 13,800 µg/g; screening value 1,000,000 µg/g), iron (maximum 22,800 µg/g; screening value 70,000 µg/g), magnesium (maximum 3,710 µg/g; screening value 1,000,000 µg/g), potassium (maximum 799 µg/g; screening value 150,000 µg/g), and sodium (maximum 96.3 µg/g; screening value 1,000,000 µg/g). Therefore, all nutrients were eliminated as COPCs in surface soil at Site 39.

22.6.1.1.4 Summary of Preliminary COPCs. Table 22-6 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95% UCL of the mean, and the exposure point concentration for each preliminary COPC in surface soil at Site 39 **(Figure 22-4).**~~(Figure 22-6).~~

22.6.1.1.5 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for each preliminary soil COPC was compared to the chemical-specific **USEPA** Region 9 residential soil PRG (Table 22-7). One-tenth of the PRG was used for most noncarcinogens. The exception was lead, for which the full PRG was used. As a result of the screening, aluminum, arsenic, chromium, and manganese were ***retained*** as COPCs in surface soil at Site 39 **(Figure 22-4).**~~(Figure 22-6).~~ No organic chemicals were detected.

22.6.1.2 Air.

22.6.1.2.1 Summary of Preliminary COPCs. Ambient air concentrations to which future receptors at this site might be exposed were estimated using air emission/dispersion modeling, as described in Appendix R. In the site-specific conceptual model, discussed below in Section 22.6.2.1, Site 39 is evaluated under two future site-specific scenarios: a residential site and ~~-~~an industrial site.

In the future industrial land use scenario for the facility, all sites were assumed to be industrial, except for the five sites designated agricultural. Each site with particulate-bound COPCs in surface soil (metals, SVOCs, and dioxins/furans) and/or volatile COPCs in surface/subsurface soil combined was assumed to contribute to the air concentrations at all of the sites. In the future residential scenario for the facility, all sites were assumed to be residential except for the five sites designated agricultural. It was assumed that particulate and VOC emissions from the strictly residential sites would be negligible because the home sites would be covered with dense vegetation (lawns) and pavement. Therefore, under the residential scenario, only the five agricultural sites contribute to the air concentrations at all of the sites. The list of preliminary air COPCs is therefore the same for every site for a given scenario, but the concentrations of the COPCs vary. Tables R-4 and R-6 in Appendix R present the estimated ambient air concentrations at Site 39 under the future industrial and residential scenarios, respectively.

22.6.1.2.2 Region 9 Preliminary Remediation Goal Screening. The exposure point concentrations for each preliminary air COPC at Site 39 in the future residential scenario and the future industrial scenario were compared to chemical-specific **USEPA** Region 9 air PRGs (Table 22-8). One-tenth of the PRG was used for noncarcinogens. The exception was lead, for which the full PRG was used. As a result of the screening, aluminum, silver, thallium, vanadium, and zinc are retained as COPCs in air for future on-site residents. For future on-site workers, aluminum, arsenic, chromium, manganese, silver, thallium, vanadium, and zinc were retained as COPCs.

22.6.1.3 Exposure Assessment.

22.6.1.3.1 Site Conceptual Model. No people specifically work at or frequent Site 39. There are, however, several types of individuals who could potentially be affected by the existing contamination at the facility. These are current trespassers to JPG, off-facility (nearby) rural residents, and future hunters. In each case, these individuals would most likely be impacted simultaneously by multiple sites rather than by single units. Because of this, these current and future receptor populations are addressed on a facility-wide, cumulative basis rather than by specific sites (see Sections 28 and 29).

Therefore, this site-specific exposure scenario only addresses future land use development. Site 39 has two potential future land uses forwarded for evaluation:

- Residential
- Industrial

Residential Use. Under the future residential land use scenario, this site is assumed to be developed for residential purposes, with the supposition that a family would build a house directly on or within this area of potential concern.

With respect to a risk assessment analysis, resident populations are assumed to consist of both adults and toddlers. Each individual would be expected to come in contact with site contaminants in the following pathways at Site 39:

- Inhalation of VOCs
- Inhalation/ingestion of airborne fugitive particulates
- Dermal contact with soil while gardening/playing outdoors
- Incidental ingestion of soil while gardening/playing outdoors
- Ingestion of fresh homegrown fruits and vegetables

On-site Worker. Industrial land use is considered to be a plausible future option for this site at JPG. On-site industrial workers (adult males and females) are assumed to be individuals who could be exposed directly to contaminated media through the following pathways at Site 39:

- Inhalation of VOCs
- Inhalation/ingestion of airborne fugitive particulates from surface soils
- Incidental inhalation/dermal contact with soil

22.6.1.3.2 Exposure Point Concentrations.

Air. The estimated ambient air concentrations of COPCs at this site for the future on-site residents and the future on-site workers are presented in Table 22-8.

Soil. The concentrations of COPCs in surface soil at this site are presented in Table 22-5. No subsurface samples were collected at Site 39.

Fruits, Vegetables, and Crops. COPC concentrations in homegrown fruits and vegetables were estimated using the methods described in Section 5.1.5.2.8. Appendix U, Table U-18, documents the calculation of contaminant concentrations in fruits and vegetables at Site 39.

22.6.1.3.3 Human Exposure Doses.

Inhalation of Contaminated Air. Inhalation of airborne contaminants (VOCs and particulates) is a potential route of exposure for future on-site residents (adults and children) and future on-site workers at this site. The equation used for calculating human exposure doses of contaminants of potential concern due to inhalation of volatile and dust-bound contaminants is provided in Section 5.1.5.3.1, Table 5-12. Table V-18, Appendix V,

documents the calculation of human exposure doses at Site 39 due to inhalation of contaminated air.

Incidental Ingestion of Contaminated On-site Soil. Mouthing behavior (toddlers) and incidental ingestion of soil with recreational or work-related activities may expose human receptors to contaminated soil at a site via the oral route of exposure. The equation used to calculate the human exposure dose due to incidental ingestion of contaminated soil is presented in Section 5.1.5.3.2, Table 5-13. This pathway was assumed to be complete at Site 39 for future on-site residents (adults and children) and future on-site workers. Table V-18, Appendix V, documents the calculation of human exposure doses due to incidental ingestion of soil at Site 39.

Dermal Contact with Contaminated On-site Soil. The chemicals in contaminated soil also may be absorbed into a receptor's body through dermal contact. The equation which was used to calculate chemical doses due to dermal contact with contaminated soil is presented in Section 5.1.5.3.3, Table 5-14. This pathway is relevant for future on-site residents (adults and children) and future on-site workers at Site 39. Table V-18, Appendix V, documents the calculation of human exposure doses due to dermal contact with soil at Site 39.

Ingestion of Contaminated Fruits and Vegetables. Consumption of contaminated homegrown fruits and vegetables may be a source of chemical exposure for future on-site residents (adults and children). The equation used to calculate human exposure dose due to ingestion of contaminated fruits and vegetables is provided in Section 5.1.5.3.11, Table 5-23. Details of the derivation of these values are provided in Table V-18, Appendix V, documents the calculation of human exposure doses due to ingestion of contaminated fruits and vegetables grown in surface soil at Site 39.

22.6.1.4 Risk Characterization.

22.6.1.4.1 Chronic Health Hazards. The noncancer daily exposure doses calculated in the exposure assessment were used to calculate HQs for each of the COPCs possessing RfDs. Pathway-specific and overall HIs were then calculated for each receptor. The calculations of HQs and HIs are described in Section 5.1.7.1. If an overall HI is calculated to be greater than 1.0 for a particular receptor, then the exposure pathway(s) primarily responsible for the result is identified as a "critical pathway(s)." For each critical pathway, those chemical contaminants responsible for the majority of the HI are listed as COCs. Table W-18, Appendix W, documents the calculation of the pathway- and chemical-specific HQs for the human receptors at Site 39. The pathway-specific and overall HIs are summarized in Table 22-9.

Future On-Site Residents. The overall HI for the future on-site adult resident at Site 39 is calculated to be **0.30**~~0.40~~. This HI is less than USEPA's risk management criterion. Thus, no critical exposure pathways or chemicals of concern are identified for the on-site adult residents. The overall HI for the future on-site child resident is calculated to be **1.36**~~1.68~~. This HI exceeds the USEPA's risk management criterion of 1.0. The primary pathway of concern

is incidental ingestion of soil, and the chemical primarily responsible for the hazard is arsenic. However, neither the incidental ingestion pathway nor the total arsenic HI exceeds 1.0.

Future On-Site Workers. The overall HI for the future on-site worker at Site 39 is calculated to be **0.68**~~0.59~~, which is less than USEPA's risk management criterion. Thus, no critical exposure pathways or chemicals of concern are identified for this receptor population. The existing contamination at Site 39 would not present a chemical hazard to future on-site workers.

22.6.1.4.2 ***Excess Lifetime Cancer Risks***. The cancer risks for each receptor were determined from the pathway-specific exposure doses and the route-specific SFs, as described in Section 5.1.5.1.2. To assess the simultaneous exposure of a receptor population to multiple carcinogens from multiple exposure routes, all of the cancer risks calculated for a receptor population were summed. Each overall receptor cancer risk was then compared to USEPA's target risk range (1.0E-06 to 1.0E-04). If the total cancer risk for a receptor from all exposure pathways is less than 1.0E-04, then it is concluded that the site(s) does not pose a significant risk to that receptor. If the overall cancer risk exceeds the target risk range, any chemical individually associated with a risk level greater than 1.0E-05 is identified as a COC. COCs represent the primary contributors to the potential cancer risk for the receptor-specific exposure pathway under evaluation. Table W-18 (Appendix W) documents the calculation of the pathway- and chemical-specific cancer risks for the human receptors at Site 39. The pathway-specific and overall cancer risks are summarized in Table 22-9.

Future On-Site Residents. The overall cancer risks calculated for the future adults and toddlers living at Site 39 are both 2.9E-05. Since these cancer risks are within USEPA's target risk range of 1.0E-06 to 1.0E-04, no critical exposure pathways or chemicals of concern are identified for these receptors.

Future On-Site Workers. The overall cancer risk calculated for the future workers at Site 39 is **1.9E-05** ~~1.5E-05~~. Since this estimated cancer risk is within USEPA's target risk range of 1.0E-06 to 1.0E-04, no critical exposure pathways or chemicals of concern are identified for future workers.

22.6.1.4.3 ***Uncertainty/Sensitivity Analysis***. The numerical risks/hazards calculated for Site 39 represent *conditional* estimates of risk based on various simplifying assumptions concerning contaminant exposure and toxicity. These estimates of risk/hazard are derived using a series of conservative procedures that address contaminant concentrations at the site, their fate in the environment, how someone currently or in the future might be exposed to these contaminants, and the toxicity of each chemical toward humans. The purpose of the uncertainty analysis specifies, when appropriate, the critical assumptions made for the site so that the site-specific results can be interpreted by risk managers in a proper context.

To assist the risk managers in this project, a qualitative uncertainty analysis has been performed. The primary goals of a qualitative uncertainty analysis are (1) to itemize the major areas of uncertainty in the site-specific risk assessment and (2) to demonstrate that the

assessment overall has been conservatively performed (i.e., that the potential risks/hazards at the site have not likely been underestimated, but may have been significantly overestimated).

The qualitative uncertainty analysis for this site is presented in Table 22-10. Based on this analysis, it can be concluded that this risk assessment is conservative. Some of the major uncertainties in this study that are most influential to the risks/hazards that were calculated include:

- Assumptions regarding receptors' exposure time (24 hours/day) and exposure frequency (350 days/year)
- Assumptions regarding receptors' food-chain ingestion rates (95th percentile of U.S. population)
- Maximum soil concentrations used

In addition, Phase I antimony results obtained by USATHAMA-certified methods were acceptable under USATHAMA QA/QC guidelines, but were later rejected in accordance with EPA CLP guidelines (see Section 5 for additional discussion of this matter). The rejected data were not used *quantitatively* in the risk assessment for this site. Therefore, the lack of results may underestimate risk to human health and ecological receptors. (EPA102)

22.7 ECOLOGICAL RISK ASSESSMENT

22.7.1 Ecological Site Description

The Gator Z Mine Test Area (Site 39) (Figure 22.7-1) and the associated Open Burn Area (Site 28) and Mine Scrap Disposal Area (Site 29) (see Figure 22-1) are located in the southeastern portion of the facility along Mine Field Road. In general, the area is relatively flat with a slight slope to the southwest. Surface water drainage is directed via ditches along the roadways to the south into a tributary of Harberts Creek, which borders the mine test area on the south. The area around the mine test pits is covered with grass and gravel, and is bordered by flatwoods on the east, south, and west. Mine Field Road borders the test area on the north. The Open Burn Area and the Mine Scrap Disposal Area are located north of Mine Field Road, which are slowly being reforested by natural succession.

The Mine Test Area (Site 39) is now fenced. It encompasses approximately 220,000 square yards. The former Open Burn Area (Site 28) is located about 600 feet north of Mine Field Road along an unnamed gravel road, which leads north of the mine test area. The burn area is flat, open, and non-vegetated. As part of the interim measures remediation, approximately 80 cubic yards of soil were removed from this area and replaced with clean fill. The Mine Scrap Disposal Area (Site 29) is located about 250 feet north of the former Open Burn Area. There is an open water-filled pit, approximately 12 feet wide, 25 feet long, and 5 feet deep.

The pit reportedly has dried up periodically, revealing many pieces of scrap embedded in the bottom. In early 1997, as an interim measure, the pond was drained and approximately 12 cubic yards of sediment containing the metal fragments were removed. The pit has been left to be redeveloped as a pond.

In January and February 1997, an interim measures removal action was conducted in the former burning area (Site 28) with the removal of approximately 17 cubic yards of ash and gravel and 64 cubic yards of contaminated soil from beneath the ash and gravel. The resulting excavation was approximately 70 by 140 feet in size and 1 foot in depth (Figure 22-2).

Following receipt of confirmation sample results, the excavation was backfilled with clean soils.

The sites are located in an area that has soils belonging to the Cobbsfork series. The soil is probably between 15 and 30 feet thick and is underlain by Louisville Limestone of Silurian age. Soil samples collected during the Phase III sampling event indicated all soils in Site 39 were Cobbsfork or possibly a fill material (Appendix BB). Vegetation observed at and near these sites included various grasses, sedges and rushes, aster, yarrow, hop-clover, grape, red maple, willow, multiflora rose, dogbane, clover, sycamore, milkweed, plantain, pepper grass, and sweetgum. **Refer to Figure 5.3-13 for a map of habitat types at JPG. (EPA184)** Birds and wildlife observed in the area included frogs, box turtles, grackles, killdeer, and dragonflies. Crayfish holes, mole hills, and deer tracks were also noted. **Refer to Table 22.7-a1 for a summary of Site 28, 29, and 39 ecological habitat characteristics identified during site visits. (EPA184)**

22.7.2 Sites 28, 29, and 39 Investigations

For convenience to the reader, summary statistics, EPCs, risk driver HQs, total RME, and CT HIs are provided in this section. All intakes and other non risk-driving HQs are located in Appendix AA. **The COPCs for each medium were evaluated in the DERA are presented on the EPC tables in this section. Refer to Appendix AA for details pertaining to the specific data sets (e.g., sample numbers, depths, dates, etc.) used in the risk assessment for Sites 28, 29, and 39. (EPA179)**

22.7.2.1 Phase I Activities. The Phase I summary statistics for Site 28 are provided in Table 22.7-1. Table 22.7-2 provides the EPCs for Site 28. The Phase I data for Site 29 are for filtered and unfiltered surface water and for sediments. The Phase I summary statistics for Site 29 are provided in Table 22.7-3. Table 22.7-4 provides the EPCs for Site 29. The Phase I summary statistics for Site 39 are provided in Table 22.7-5. Table 22.7-6 provides the EPCs for Site 39.

22.7.2.2 Phase II Activities. Phase II sampling activities were limited to two surface soil samples at Site 39 for explosives; however, there were no detects in this data set.

22.7.2.3 Interim Measures and Phase III Activities. IM data were collected at Sites 28 and 29. The IM summary statistics for Sites 28 are provided in Table 22.7-7. **Table 22.7-8 provides the EPCs for Site 28 while Tables 22.7-9a, 22.7-9b, and 22.7-10 provide the summary statistics and EPCs for Site 29. IM confirmation soil samples for Site 28 were collected from an excavated area from surface to 1 foot in depth.**

Phase III data were collected only at Site 39. **The Phase III summary statistics for Site 39 are provided in Table 22.7-11. Table 22.7-12 provides the EPCs for Site 39.** The Phase III data collected at Site 39 were intended to be representative of Sites 28 and 29 as well (Rust E&I 1997f).

22.7.3 Exposure and Ecological Effects Profile

Fish, amphibians, reptiles, aquatic invertebrates, aquatic macrophytes, birds, and mammals may all be exposed to COPCs at Site 29 (Phase I data only), either by direct contact with or ingestion of the surface water and/or sediments and soil. Birds and mammals may be exposed to COPCs in soil at Sites 28, 29, and 39. To determine the estimated intakes of the COPCs, various key receptor species were selected to evaluate the impacts to area wildlife. The key aquatic receptors evaluated for Site 29 (Phase I) included creek chub, Pickerel frog, crayfish, great blue heron, and raccoon; key terrestrial receptors evaluated at Sites 28, 29, and 39 included mourning dove, chimney swift, American kestrel, wild turkey, white-footed mouse, eastern cottontail, red fox, little brown myotis, plants, and soil fauna.

The conceptual site models (CSMs) for Sites 28, 29, and 39 provide an overview of the ecological receptors and exposure pathways evaluated in the ecological risk assessment. Refer to Figures 22.7-1a, 22.7-1b, and 22.7-1c for schematics of the CSMs. Multiple lines of evidence were evaluated for the ecological assessment conducted at Sites 28, 29, and 39. Aquatic lines of evidence were evaluated for Site 29. Terrestrial lines of evidence were evaluated for all three sites. The lines of evidence were primarily hazard index (HI) calculations for a number of different receptors, but for the terrestrial ecosystem, toxicity testing was also conducted at Site 39. Refer to Table 7.7-11a for a summary of the terrestrial and aquatic ecosystem lines of evidence. (EPA180a,b)

The exposure pathways and receptors evaluated at this site are as follows:

- Aquatic Ecosystem (**Site 29** Phase I data only)
  - Great blue heron—surface water and sediment ingestion, and dietary ingestion of fish, crayfish, and aquatic plants
  - Raccoon—surface water and sediment ingestion, and dietary ingestion of fish, crayfish, and aquatic plants
  - Creek chub, pickerel frog, crayfish—direct contact with surface water and sediment
  - Aquatic invertebrates—direct contact with surface water and sediment

- Terrestrial Ecosystem (Phase I, II, IM and III)

(all receptors except raccoon, great blue heron, creek chub, pickerel frog, crayfish)

- All wildlife receptors—soil ingestion
- All wildlife receptors—surface water ingestion
- All wildlife receptors—dietary ingestion
- Plants—direct contact with soil
- Soil fauna—direct contact with soil

Note: TRVs for aquatic plants were unavailable from the literature; it was assumed that risks to other aquatic life would be representative of aquatic plants.

22.7.3.1 Selection of COPCs. Inorganic analytes from soil data collected during Phases I and III and from IM confirmation sampling were compared to the JPG Phase II background data set (Section 5.3.2.1). Analytes not statistically elevated relative to background were removed from consideration as COPCs.

The COPCs for Sites 28, 29, and 39 in the various media are presented in Tables 22.7-1 through 22.7-10.

Neither beryllium nor selenium was detected in soil at Site 28 (Phase I). All other inorganic analytes were retained as COPCs. Selenium was also not detected at Site 39 (Phase I). Aluminum, arsenic, barium, manganese, and vanadium were removed as COPCs at Site 39 (Phase I) since their soil concentrations were not statistically elevated above background. All analytes in sediment and surface water at Site 29 (Phase I) were retained as COPCs due to the limited amount of data. **Explosives were not detected in surface soils at Sites 28 and 39, nor were explosives detected in the sediment at Site 29 in the Phase I data. There were three detects of 1,3,5-trinitrobenzene in three surface water samples at Site 29 in the Phase I data.**

Neither selenium nor molybdenum were detected in soil at Site 28 (Interim Measures (IM) confirmation sampling). Barium, iron, and manganese were removed as COPCs at Site 28 (IM) since their soil concentrations were not statistically elevated above background.

No analytes were removed from the IM Site 29 data set for surface water and sediment. All analytes were retained as COPCs since the amount of surface water and sediment data representative of background was so limited.

Thallium was not detected at Site 39 (Eco Phase III). Aluminum, barium, beryllium, manganese, lead, antimony, and selenium were removed as COPCs since their soil concentrations were not statistically elevated above background.

22.7.3.2 Comparison of Site Data to Reference Area Concentrations. The Phase III COPCs were not statistically significantly higher than those observed at the reference areas. **The results of a comparison of site ~~data~~ to reference contaminant concentration data are presented in Appendix AA, "stats" worksheet. (EPA214)**

22.7.3.3 Earthworm Toxicity Test. **Earthworm mortality at Site 39 ranged from 10 to 35 percent. Only one of the five samples yielded earthworm mortality of 35 percent. The other four samples yielded earthworm mortality of 10 to 15 percent. Refer to Table 8.7-12a for results of the earthworm toxicity testing. (EPA191)** Earthworm mortality at Site 29 exceeded 15 percent. The null hypothesis is "the number of dead earthworms is similar among all locations". The χ^2 test statistic was 49.25 with a degrees of freedom of 40, which resulted in a p value of 0.1498. Since this p-value exceeds 0.1, the hypothesis that row and columns are independent cannot be rejected. Therefore, the site location may bear no relation to earthworm mortality when this test is used.

ANOVA on the arcsine-transformed data provides a different interpretation. The p-value for ANOVA is 0.0016, indicating a significant difference between the mean mortality from one location to another at the 95% confidence level. A 95% LSD indicated that mortality was significantly higher at Site 39 than at Avonburg or Cobbsfork reference area, but overlapped (was not significantly higher) that observed at the Rossmoyne reference area. The statistical analysis therefore indicates that earthworm mortality is not likely to be significantly affected by existing conditions at Site 39.

22.7.3.4 Phytotoxicity Test. The phytotoxicity early seedling growth test resulted in data for percent germination and biomass. The results are summarized in Appendix Z. There was little variability in germination rates. The germination data were neither normal nor log-normal. The biomass data on a wet-weight basis were lognormal. The percent germination ranged from 92 to 100 percent at Site 39.

ANOVA of the germination data resulted in a p-value of 0.1480, which is greater than 0.05, indicating that location does not have a statistically significant effect on germination at the 95% confidence level. ANOVA of the biomass data resulted in a p-value of 0.0037, indicating site location has a significant effect on wet weight biomass at the 95% confidence level. The lowest biomass observed in the study was the biomass for the Cobbsfork reference area. An LSD multiple range test revealed that biomass was significantly higher than biomass at the Cobbsfork reference area, but that biomass overlapped that of the remaining two reference areas.

The germination and biomass data indicate that existing site conditions at JPG will not significantly decrease plant growth or reproduction relative to effects observed in controls. Instead, Site 39 appears more productive than one of the reference areas.

22.7.3.5 Soil Fauna Community Structure. The number of individuals per sample (density) was log-normal. The number of species was neither normal nor log-normal. Diversity ranged from 0 to 97 percent at the reference areas, indicating that this parameter is so inherently variable at JPG that it possibly may not be useful to identify contaminant-related effects. The number of individuals was not significantly different by location when the log transformed data were analyzed by ANOVA. The number of invertebrate species was not statistically significantly different at the 95% confidence level when analyzed by the Kruskal-Wallis test.

There does not appear to be any affect of site location on soil invertebrates., although community similarity will be examined in a later version of this report.

22.7.4 Risk Characterization

22.7.4.1 Risk Estimation. The HIs are summarized for each sampling event and receptor below. The HIs have been grouped by order of magnitude for discussion purposes. HIs based on RME and CT exposure parameters are presented. In addition, a conservative NOAEL-based TRV and a dose at which population-level effects may occur (LOAEL-based TRV) were used to establish the lower and upper bounds on toxicity, respectively. These values define the risk boundaries. There are, thus, four sets of HI values for each location and sampling event (NOAEL-RME, NOAEL-CT, LOAEL-RME, and LOAEL-CT). The exposure intakes, HQs, and HIs are presented in Appendix AA. **Figures 22.7-2 through 22.7-25** show the total NOAEL and LOAEL-based HI risks for both the RME and CT exposure scenarios by receptor.

<u>Site 28</u>

Phase I RME NOAEL HIs
(See Figure 22.7-2)
<u>Key Receptors with HI range 0-1</u>: Wild Turkey
<u>HI Range 1.1-10</u>: Mourning Dove, Chimney Swift, Red Fox, American Kestrel
<u>HI Range 10.1-100</u>: Little Brown Myotis
<u>HI Range 100.1-1000</u>: Eastern Cottontail
<u>HI > 1000</u>: White-footed Mouse, Plants, Soil Fauna

Phase I RME LOAEL HIs
(See Figure 22.7-3)
<u>Key Receptors with HI range 0-1</u>: Mourning Dove, Wild Turkey, Red Fox, American Kestrel
<u>HI Range 1.1-10</u>: Chimney Swift, Little Brown Myotis
<u>HI Range 10.1-100</u>: Eastern Cottontail
<u>HI Range 100.1-1000</u>: White-footed Mouse, Plants, Soil Fauna

Phase I CT NOAEL HIs
(See Figure 22.7-4)
<u>Key Receptors with HI range 0-1</u>: Wild Turkey, Red Fox
<u>HI Range 1.1-10</u>: Mourning Dove, American Kestrel
<u>HI Range 10.1-100</u>: Chimney Swift, Little Brown Myotis
<u>HI Range 100.1-1000</u>: Eastern Cottontail
<u>HI > 1000</u>: White-footed Mouse

Phase I CT LOAEL HIs
(See Figure 22.7-5)
<u>Key Receptors with HI range 0-1</u>: Wild Turkey, Red Fox, Mourning Dove
<u>HI Range 1.1-10</u>: American Kestrel, Little Brown Myotis, Chimney Swift
<u>HI Range 10.1-100</u>: Eastern Cottontail

HI Range 100.1-1000: White-footed Mouse
HI > 1000: None

Site 29

Phase I RME NOAEL HIs
(See Figure 22.7-6)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, White-footed Mouse, Eastern Cottontail, Red Fox, Little Brown Myotis, Raccoon
HI Range 1.1-10: Great Blue Heron
HI Range 10.1-100: Benthic Invertebrates, Creek Chub, Pickerel Frog
HI Range 100.1-1000: None

Phase I RME LOAEL HIs
(See Figure 22.7-7)
Key Receptors with HI range 0-1: Great Blue Heron, Raccoon, Mourning Dove, Wild Turkey, Chimney Swift, American Kestrel, Little Brown Myotis, Red Fox, Eastern Cottontail, White-footed Mouse
HI Range 1.1-10: Benthic Invertebrates, Creek Chub, Pickerel Frog
HI Range 10.1-100: None
HI Range 100.1-1000: None

Phase I CT NOAEL HIs
(See Figure 22.7-8)
Key Receptors with HI range 0-1: Raccoon, Wild Turkey, Red Fox, Mourning Dove, American Kestrel, Chimney Swift, Little Brown Myotis, White-footed Mouse, Eastern Cottontail
HI Range 1.1-10: ~~None~~ **Great Blue Heron**
HI Range 10.1-100: ~~Great Blue Heron,~~ Benthic Invertebrates, Creek Chub, Pickerel Frog
HI Range 100.1-1000: None

Phase I CT LOAEL HIs
(See Figure 22.7-9)
Key Receptors with HI range 0-1: Raccoon, Wild Turkey, Red Fox, American Kestrel, Mourning Dove, Chimney Swift, Little Brown Myotis, White-footed Mouse, Eastern Cottontail**, Great Blue Heron**
HI Range 1.1-10: ~~Great Blue Heron,~~ Benthic Invertebrates, Creek Chub, Pickerel Frog
HI Range 10.1-100: None
HI Range 100.1-1000: None

Site 39

Phase I RME NOAEL HIs
(See Figure 22.7-10)
Key Receptors with HI range 0-1: Mourning Dove, Wild Turkey, Red Fox

HI Range 1.1-10: Little Brown Myotis, American Kestrel, Chimney Swift
HI Range 10.1-100: White-footed Mouse, Eastern Cottontail, Plants
HI Range 100.1-1000: Soil Fauna

Phase I RME LOAEL HIs
(See Figure 22.7-11)
Key Receptors with HI range 0-1: Mourning Dove, Wild Turkey, Chimney Swift, Little Brown Myotis, Red Fox, Soil Fauna
HI Range 1.1-10: American Kestrel, White-footed Mouse, Eastern Cottontail, Plants
HI Range 10.1-100: None
HI Range 100.1-1000: None

Phase I CT NOAEL HIs
(See Figure 22.7-12)
Key Receptors with HI range 0-1: Wild Turkey, Red Fox, Mourning Dove, American Kestrel
HI Range 1.1-10: Little Brown Myotis, Chimney Swift
HI Range 10.1-100: White-footed Mouse, Eastern Cottontail
HI Range 100.1-1000: None

Phase I CT LOAEL HIs
(See Figure 22.7-13)
Key Receptors with HI range 0-1: Mourning Dove, American Kestrel, Wild Turkey, Red Fox, Little Brown Myotis, Chimney Swift
HI Range 1.1-10: Eastern Cottontail, White-footed Mouse
HI Range 10.1-100: None
HI Range 100.1-1000: None

Site 28

IM RME NOAEL HIs
(See Figure 22.7-14)
Key Receptors with HI range 0-1: Mourning Dove, Wild Turkey, Red Fox, American Kestrel
HI Range 1.1-10: Chimney Swift, Eastern Cottontail, Little Brown Myotis
HI Range 10.1-100: ~~None~~ **Plants**
HI Range 100.1-1000: White-footed Mouse, ~~Plants,~~ Soil Fauna

IM RME LOAEL HIs
(See Figure 22.7-15)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, Little Brown Myotis, American Kestrel, Eastern Cottontail, Red Fox
HI Range 1.1-10: Soil Fauna
HI Range 10.1-100: White-footed Mouse, Plants
HI Range 100.1-1000: None

IM CT NOAEL HIs
(See Figure 22.7-16)
Key Receptors with HI range 0-1: Mourning Dove, Wild Turkey, Red Fox**, Eastern Cottontail**
HI Range 1.1-10: Chimney Swift, American Kestrel, ~~Eastern Cottontail,~~ Little Brown Myotis
HI Range 10.1-100: None
HI Range 100.1-1000: White-footed Mouse

IM CT LOAEL HIs
(See Figure 22.7-17)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Eastern Cottontail, Red Fox, Little Brown Myotis
HI Range 1.1-10: White-footed Mouse
HI Range 10.1-100: None
HI Range 100.1-1000: None

Site 29

IM RME NOAEL HIs
(See Figure 22.7-18)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, White-footed Mouse, Eastern Cottontail, Red Fox, Little Brown Myotis, Great Blue Heron, Raccoon
HI Range 1.1-10: Benthic Invertebrates, Creek Chub, Pickerel Frog
HI Range 10.1-100: None
HI Range 100.1-1000: None

IM RME LOAEL HIs
(**See Figure 22.7**-19)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, White-footed Mouse, Eastern Cottontail, Red Fox, Little Brown Myotis, Great Blue Heron, Raccoon
HI Range 1.1-10: Benthic Invertebrates, Creek Chub, Pickerel Frog
HI Range 10.1-100: None
HI Range 100.1-1000: None

IM CT NOAEL HIs
(**See Figure 22.7**-20)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, White-footed Mouse, Eastern Cottontail, Red Fox, Little Brown Myotis, Raccoon
HI Range 1.1-10: Great Blue Heron, Benthic Invertebrates, Creek Chub, Pickerel Frog
HI Range 10.1-100: None
HI Range 100.1-1000: None

IM CT LOAEL HIs
(See Figure 22.7-21)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, White-footed Mouse, Eastern Cottontail, Red Fox, Little Brown Myotis, Great Blue Heron, Raccoon
HI Range 1.1-10: Benthic Invertebrates, Creek Chub, Pickerel Frog
HI Range 10.1-100: None
HI Range 100.1-1000: None

Site 39 (also 28 and 29)

Phase III RME NOAEL HIs
(See Figure 22.7-22)
Key Receptors with HI range 0-1: Wild Turkey
HI Range 1.1-10: Mourning Dove, Red Fox
HI Range 10.1-100: Chimney Swift, American Kestrel, Little Brown Myotis, Plants
HI Range 100.1-1000: White-footed Mouse, Eastern Cottontail, Soil Fauna

Phase III RME LOAEL HIs
(See Figure 22.7-23)
Key Receptors with HI range 0-1: Mourning Dove, Wild Turkey, Soil Fauna
HI Range 1.1-10: Chimney Swift, American Kestrel, Red Fox, Plants
HI Range 10.1-100: Eastern Cottontail, Little Brown Myotis, White-footed Mouse
HI Range 100.1-1000: None

Phase III CT NOAEL HIs
(See Figure 22.7-24)
Key Receptors with HI range 0-1: Red Fox, Wild Turkey
HI Range 1.1-10: American Kestrel, Mourning Dove
HI Range 10.1-100: Chimney Swift, Little Brown Myotis
HI Range 100.1-1000: White-footed Mouse, Eastern Cottontail

Phase III CT LOAEL HIs
(See Figure 22.7-25)
Key Receptors with HI range 0-1: Wild Turkey, Red Fox, American Kestrel, Mourning Dove
HI Range 1.1-10: Chimney Swift
HI Range 10.1-100: Little Brown Myotis, White-footed Mouse, Eastern Cottontail
HI Range 100.1-1000: None

22.7.4.2 Risk Description. **Following discussion and concurrence with regulators, it was agreed that** ~~The~~ Phase III data collected at Site 39 ~~were intended~~ **would** ~~to~~ be representative of Sites 28 and 29 as well~~.~~**, especially since both Sites 28 and 29 were extremely small in size and did not constitute significant ecological habitat. Site 39 was selected because it comprised 16 acres,** ~~and~~ **some of which haves some ecological habitat. (EPA215)**

It should also be noted again that interim measures have occurred at Sites 28 and 29, while at Site 39 no interim measure has been performed. Therefore, although the results of~~for~~ earlier phases of data are evaluated for Sites 28 and 29, the interim measures data is probably the most applicable data set on which to base conclusions of ecological risk for these two sites.

All COPCs at Site 39 based on the Phase III data were within the expected ambient concentrations predicted by the data from the reference areas.

The soils at Site 39 did not produce elevated levels of mortality in earthworms relative to that observed at the reference areas, nor was the soil fauna diversity or density affected. Plant germination and biomass were not significantly different at Site 39 than at the reference areas.

Phase I RME NOAEL-based HIs at Site 28 were much higher than those at the reference areas only for white-footed mouse plants and soil fauna (Figure 22.7-2). Total HIs for eastern cottontail were also elevated above the reference areas. The HIs for each reference area and the inherent JPG Phase II background risks can be found in Section 32.

Phase I RME NOAEL-based HIs at Site 29 (Figure 22.7-6) are highest for aquatic life that might occur in the pond, but indicate the pond is not likely to be a potential threat to most species of terrestrial wildlife or birds utilizing it for feeding or drinking. The basis of the risk estimates for aquatic life were the chronic AWQC and conservative sediment criteria. There were no soil data for Site 29 Phase I only surface water and sediment.

Phase I RME NOAEL-based HIs at Site 39 exceed the HIs observed at the reference areas only for soil fauna (Figure 22.7-10).

The IM RME NOAEL-based HIs at Site 28 were higher than those at the reference areas for soil fauna (Figure 22.7-14). The IM HIs are much lower than HIs observed for the Phase I sampling.

The Phase III RME NOAEL-based HIs were higher than those at the reference areas for soil fauna. HIs for other receptors were similar to or lower than those at the reference areas for Sites 28/29/39 (Figure 22.7-18).

The Phase I RME LOAEL-based HIs for Site 28 were similar to the reference area RME LOAEL-based HIs except for white-footed mouse, plants, and soil fauna. The Phase I RME LOAEL-based HIs for Site 29 indicated potential risks only to aquatic life; the basis of these risk estimates are the acute AWQC. The Phase I and III RME LOAEL-based HIs for Site 39 were similar to those at the reference areas for all receptors, indicating no elevated population-level risks. The IM RME LOAEL-based HIs for Site 28 were similar to those at the reference areas. The HI results indicate that Sites 28, 29, and 39 were a potential ecological risk in the past, but that interim activities have reduced the risk to that inherently expected in the environment. The HI results are supported by the results of the biometric studies, which measured a lack of population and individual level effects in earthworms and other soil

invertebrates, and in plants. The results suggest that the NOAEL TRVs are overly conservative for this site, since ambient levels of inorganics in the reference areas produce high risk estimates, yet no COPC statistically exceeded measured concentrations at the reference areas based on Phase III data. Consideration of all lines of evidence support the conclusion that contamination at Sites 28, 29, and 39 is not a likely threat to ecological health at JPG.

22.7.4.2.1 Risk Drivers/Summary of Lines of Evidence. Risk drivers associated with Sites 28, 29, and 39 are summarized in Tables 22.7-13~~11~~ through 22.7-22~~20~~. A COPC was categorized as a risk driver if it produced an HQ greater than or equal to 1 for any exposure pathway.

In addition, to provide an overall summary of the multiple lines of evidence that were evaluated for the Sites, a summary table was developed. The lines of evidence were primarily hazard index (HI) calculations for a number of different receptors, but for the terrestrial ecosystem, toxicity testing was also conducted (Site 39 only). Refer to Table 7.7-11a for a summary of the lines of evidence. A number of measurement endpoints were assessed for both aquatic (Site 29 only) and terrestrial ecosystems. An evaluation was made of which measurement endpoints were most sensitive in determining the potential for an ecological concern by terrestrial or aquatic ecosystem. (EPA180a,b)

It should be noted that based on the IM data collected at Site 28 the only HI exceeding reference area HIs was for soil fauna (HI = 168). This HI was within the sure order of magnitude as the reference HI for soil fauna.

Terrestrial Ecosystem

The most sensitive of the terrestrial measurement endpoints for Site 28 are soil fauna, white-footed mice, and plants. The highest reasonable maximum exposure (RME) no observed adverse effect level (NOAEL)-based hazard indices (HIs) for each of these receptors at Site 28 are 9570 (soil fauna), 6421 (white-footed mice), and 2318 (plants). The primary contributors of risk to soil fauna are chromium (RME NOAEL HQ of 8600) and zinc (RME NOAEL HQ of 436) from direct contact with soil. The primary contributors of risk to white-footed mice are tin (RME NOAEL HQs of 1990 and 1460) through direct contact with soil and dietary ingestion, respectively and copper (RME NOAEL HQ of 1290) through dietary ingestion. The primary contributors of risk to plants are zinc (RME NOAEL HQ of 873) and chromium (RME NOAEL HQ of 688) from direct contact with soil. All of these Site 28 HQs were derived using Phase I data.

It should be noted that, based on the IM data collected at Site 28, the only HI exceeding reference area HIs is for soil fauna (HI = 168). This HI is within the same order of magnitude as the reference HI for soil fauna.

The terrestrial endpoints for Site 29 were associated with HIs less than one.

The most sensitive of the terrestrial measurement endpoints for Site 39 are white-footed mice, soil fauna, and eastern cottontail. The highest reasonable maximum exposure (RME) no observed adverse effect level (NOAEL)-based hazard indices (HIs) for each of these receptors at Site 39 are 174 (white-footed mice), 140 (soil fauna), and 111 (eastern cottontail). The primary contributors of risk to white-footed mice are vanadium (RME NOAEL HQ of 73) through direct contact with soil and arsenic (RME NOAEL HQ of 46) through dietary ingestion. These HQs were derived using Phase III data. The primary contributor of risk to soil fauna is chromium (RME NOAEL HQ of 112) through direct contact with soil. This HQ was derived using Phase I data. The primary contributor of risk to eastern cottontail is vanadium (RME NOAEL HQ of 75) through direct contact with soil. This HQ was derived using Phase III data.

Based on Phase III data, none of the metals listed as primary contributors to ecological risk are present at concentrations that exceed reference area concentrations. Thus, these metals would not be expected to contribute to ecological risk exceeding that in the reference areas. (EPA180a,b)

Aquatic Ecosystem (Site 29 Only)

The most sensitive of the aquatic measurement endpoints are benthic invertebrates, creek chub, and pickerel frog. The maximum RME NOAEL HQ for these receptors is 15. The primary contributor of risk to these aquatic receptors is cadmium (RME NOAEL HQ of 14) through direct contact with sediment. This HQ was derived using Phase I data. (EPA180a,b)

22.7.4.3 Uncertainty Analysis. In general, collection of Phase I, II, and III data at Sites 28, 29, and 39 helps to reduce the uncertainty associated with the risk assessment results for these locations; however, the Phase II data for Site 39 were limited to only two samples for explosives, which somewhat increases the uncertainty at that location. In addition, no soil data were available for Site 29, only surface water and sediment. Because the biometric data were collected at Site 39 and not Sites 28 and 29, application of these data to evaluation of risks at Sites 28 and 29 is more uncertain.

Uncertainty in the exposure estimates is due primarily to:

- Variability in the exposure parameters, which produce a natural distribution of the variables in the intake equations for each of the receptors;
- Exposure parameters derived from literature and not measured on site;
- Uncertainty in the dietary ingestion pathway, which utilized BAFs to predict dietary concentrations;

- Variation in the concentrations of COPCs in the environment;
- Uncertainty as to whether the most conservative pathways have been addressed and evaluated.

The predicted effect of each of these sources of uncertainty on the risk assessment is as follows:

Variability in the exposure parameters—Because both the average and RME scenarios were quantitatively addressed, this source of uncertainty is expected to have no overall effect on the risk assessment results.

Exposure parameters derived from literature—Because so many ecological receptors were quantitatively considered in the ecological risk assessment, this source of uncertainty is expected to have no overall effect on the risk assessment.

Uncertainty in the dietary ingestion pathway—The use of literature-based BAFs or BCFs is expected to overestimate, as opposed to underestimate, concentrations in the dietary pathway. This is because under laboratory conditions, animals are chronically exposed on a daily basis and supposedly reach steady state. In the wild, as animals move in and out of contaminated areas, metabolism and excretion are expected to reduce the body burden. Use of field-based BAFs from TEAD is not expected to overestimate or underestimate risk for these analytes, since these data were measured in conjunction with co-located soil samples.

Variation in the concentrations of COPCs in the environment—This uncertainty is not expected to bias the risk assessment towards underestimation of risk since maximum or UCL95 concentrations were used in all exposure scenarios to estimate the EPCs.

Uncertainty as to whether the most conservative pathways have been addressed—The receptors were considered carefully by the DSG, and typically have high exposure rates due to their life-histories (i.e., ground-feeding or burrowing). Therefore, this source of uncertainty is not expected to impact the risk assessment.

Uncertainty in the ecological analysis is less than the uncertainty in the exposure estimates, because these data were gathered as part of a site-specific, controlled field study. There were sufficient samples collected at each site (n=5) to identify within and between site variability. The data identify the potential for adverse effects to species that form the basis of the JPG food web, that is, the plants and soil fauna.

22.7.5 Ecological Risk Assessment Summary

The conceptual site models (CSMs) for Sites 28, 29, and 39 provide an overview of the ecological receptors and exposure pathways evaluated in the ecological risk assessment. Refer to Figures 22.7-1a, 22.7-1b, and 22.7-1c for schematics of the CSMs. These sites will

likely remain undeveloped in the future. This future land use will not alter the current CSMs.

Multiple lines of evidence were evaluated for the ecological assessment conducted at these sites. For all three sites, terrestrial lines of evidence were evaluated. Aquatic lines of evidence were evaluated for Site 29. The lines of evidence were primarily hazard index (HI) calculations for a number of different receptors, but for the terrestrial ecosystem, toxicity testing was also conducted for Site 39. Refer to Table 7.7-11a for a summary of the terrestrial and aquatic ecosystem lines of evidence. (EPA180a,b)

The following is an overall summary of the key results of the ecological risk assessment for Sites 28, 29 and 39. It should be noted again that toxicity tests performed for Site 39 w~~h~~ere considered to be applicable for Sites 28 and 29 too. Also, interim measures were performed at Sites 28 and 29, but not Site 39. The interim measures data collected at sites 28 and 29 probably represents the better data set upon which to evaluate potential ecological risk for these sites.~~The following summary is based on an initial review of the data. A full evaluation of whether or not the data meet all DQOs, and further statistical examination, will be made prior to finalizing these results for the next version of this report.~~

- Based on the **toxicity test** ~~ecological effects~~ data **for Site 39**, there are no **apparent** ecological effects at ~~this site~~**Sites 28, 29, and 39**.

- Phase I data **at Site 28** indicated a greater potential for risk than did IM or Phase III data**, indicating the IM activities reduced the level of potential risk at this site**. ~~Interim measures at Site 28 have therefore been successful in alleviating unacceptable ecological risk.~~

- ~~The lack of additional surface water and sediment sampling at Site 29 to confirm the success of the removal actions was identified as a data gap.~~

- Soil fauna were identified by the RME NOAEL HIs as being the receptor group most potentially at risk due to site-related activities **at Sites 28 and 39**; however, lack of effects on earthworms and on the soil fauna community were observed in the Phase III sampling.

- Sites 28, 29, and 39 do not appear to present an ecological risk to terrestrial birds and wildlife. Site 29 was a threat to aquatic life; however, sediment removal actions occurred within the pond **as an interim measurement**, which should have reduced the risk levels.

22.8 CONCLUSIONS AND RECOMMENDATIONS

Phase I results for surface soil and ash samples at the Gator Z Mine Open Burn Area (Site 28) indicate that numerous metal contaminants were present at levels exceeding their respective background concentrations. Several samples also contained metals exceeding USEPA Region 9 PRGs.

Due to the elevated metals detected in the soils and ash of Site 28, interim measures activities were initiated in the fall of 1996 and confirmation sampling was completed in February 1997. The interim measures consisted of the excavation and off-site disposal of contaminated soils and ash. A review of the confirmation results for Site 28 indicates that the remedial action has adequately removed contaminants to levels below their respective USEPA Region 9 PRGs.

As a result of the interim measures conducted at Site 28, it is concluded that no further investigation is warranted. It is recommended that a No Further Action technical memorandum be prepared for this site and that the site be removed from the FS process.

Phase I and Phase II sediment and surface water results for the Gator Z Mine Scrap Disposal Area **(Site 29)** indicated that the pond sediments contain metals exceeding USEPA Region 9 cleanup criteria, whereas the water contained no contaminants exceeding criteria.

On the basis of the Phase I results, an interim measures effort was conducted that included the removal of debris and sediment from the pond. The removal action was completed in January 1997 and confirmation samples collected indicate that all **residual** metals are below USEPA Region 9 PRGs.

Due to the cleanup of the pond and the reestablishment of the aquatic environment that existed in the pond prior to the removal action, it is concluded that no further investigation of Site 29 is ~~warranted~~ **needed** under the RI. **UXO clearance was performed and residual soil testing indicated soils met PRGs. Refer to the *Draft Technical Memorandum UXO Soil Testing for the NE and SE Parcels*, February 2002. (IN29)** It is recommended that a No Further Action technical memorandum be prepared and that the site not be carried forward to the FS.

Surface soils from the Gator Z Mine Test Area (Site 39) were found to be contaminated by metals during the Phase I RI. Of the metals present, aluminum, arsenic, chromium, and manganese exceeded USEPA Region 9 PRGs and were retained as COPCs for the human health risk assessment.

Results of the human health risk assessment for Site 39 indicate that risks and hazards to future on-site residents and future on-site workers are at acceptable levels when compared to the USEPA risk range and hazard goal, respectively.

~~Results of the~~ **An** ecological risk assessment conducted at Site 39 indicate**s** that there are no adverse ecological effects at this site. Also, interim measures at Site 28 appear to have been successful in alleviating any ecological risk. ~~Due to the lack of available confirmation samples for Site 29, the potential for ecological risk was not completely evaluated.~~ Overall, it appears

that Sites 28, 29, and 39 do not pose an unacceptable ecological risk. From Phase I data, it appeared that there may have been a risk to aquatic life at Site 29. However, with the removal of debris and sediment, these risks have likely been significantly reduced.

As a result of the human health and ecological risk assessments, it is concluded that no further investigation of Site 39 is ~~warranted~~**needed.** It is recommended that a No Further Action technical memorandum be prepared and that the site not be carried forward to the FS.

TABLES

TABLE 22-1
Background Screening of Inorganic Chemicals Detected in Soil
Site 39 -Gator Z Mine Test Area
Jefferson Proving Ground
Madison, Indiana

Chemical	Location	Frequency of Detection[(a)]	Maximum Detected Value (µg/g)[(b)]	Avg. Conc. (µg/g)	Median Conc. (µg/g)	Background (Bkg.) Threshold[(c)] (µg/g)	Data Distribution	Test Performed	p value	Site > Bkgd?
Surface Soil										
Aluminum	Site	6/6	16,500	10,023	8,462		Lognormal	t test	0.045	**YES**
	Background	**10/10**	**10,900**	**7,673**	**7,845**	**11,000**	**Lognormal**			
Arsenic	Site	6/6	12.7	6.9	6.0		Lognormal	Mann-Whitney	0.041	**YES**
	Background	**10/10**	**9.46**	**4.8**	**3.9**	**9.26**	**Neither**			
Barium	Site	6/6	91.7	62.0	54.0		Lognormal	t test	0.09[(d)]	No
	Background	**10/10**	**74.1**	**49.8**	**45.7**	**84.5**	**Lognormal**			
Boron	Site	2/6	10.4	5.7	3.3		Neither	---	---	**YES**
	Background	**0/10**	**---**[(e)]	**---**	**---**	**---**	**---**			
Chromium (total)	Site	6/6	64.8	27.1	17.2		Lognormal	t test	0.02	**YES**
	Background	**10/10**	**15.5**	**9.7**	**9.9**	**15.1**	**Lognormal**			
Cobalt	Site	5/6	7.68	4.4	4.2		Normal	Mann-Whitney	0.01	**YES**
	Background	**10/10**	**3.6**	**1.9**	**1.9**	**3.5**	**Lognormal**			
Copper	Site	6/6	30.8	13.7	8.2		Lognormal	Mann-Whitney	<0.001	**YES**
	Background	**7/10**	**4.96**	**3.5**	**4.1**	**5.64**	**Normal**			
Lead	Site	6/6	74.0	36.7	25.9		Lognormal	Mann-Whitney	0.008	**YES**
	Background	**10/10**	**14.6**	**13.6**	**13.6**	**14.9**	**Normal**			
Manganese	Site	6/6	669.5	328	285		Lognormal	t test	0.002	**YES**
	Background	**10/10**	**344**	**115**	**85.9**	**302**	**Lognormal**			

TABLE 22-1
Background Screening of Inorganic Chemicals Detected in Soil
Site 39 -Gator Z Mine Test Area
Jefferson Proving Ground
Madison, Indiana

Chemical	Location	Frequency of Detection[a]	Maximum Detected Value (µg/g)[b]	Avg. Conc. (µg/g)	Median Conc. (µg/g)	Background (Bkg.) Threshold[c] (µg/g)	Data Distribution	Test Performed	p value	Site > Bkgd?
Mercury	Site	1/6	0.88	0.17	0.025		Neither	---	---	**YES**
	Background	**0/10**	**---**	**---**	**---**	**---**	**---**			
Nickel	Site	6/6	45.9	19.5	12.0		Lognormal	Extreme value	---	**YES**
	Background	**1/10**	**2.30**	**2.0**	**2.0**	**2.23**	**Neither**			
Silver	Site	6/6	2.4	0.48	0.046		Normal	---	---	**YES**
	Background	**0/10**	**---**	**---**	**---**	**---**	**---**			
Vanadium	Site	6/6	31.8	25.7	26.1		Normal	Mann-Whitney	0.017	**YES**
	Background	**10/10**	**27.6**	**19.8**	**19.2**	**27.0**	**Lognormal**			
Zinc	Site	6/6	214	80	48.9		Lognormal	Mann-Whitney	<0.001	**YES**
	Background	**10/10**	**18.5**	**14.7**	**14.7**	**19.5**	**Normal**			

Footnotes:

(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Micrograms per gram.
(c) Average concentration plus two times the standard deviation. Values presented rounded up to the number of decimals in the values reported by the laboratory.
(d) The 95% confidence interval for the difference between the means of the logtransformed data is: -0.13 to 0.62.
(e) Not applicable.

TABLE 22-2

Summary of Phase I Analytical Results for Surface Soil
Site 28 - Gator Z Open Burn Area
Jefferson Proving Ground
Madison, Indiana

Sample ID Analyte	GZO28SF001 (µg/g)[a]	GZO28SF002 (µg/g)	GZO28SF003 (µg/g)	Background (µg/g)
Aluminum	8,760	3,380	9,140	11,000
Antimony	LT[b] 19.6 R[c]	LT 19.6 R	LT 19.6 R	0.49
Arsenic	LT 2.50	3.94	LT 2.50	9.26
Barium	52.3	158	67.5	84.5
Beryllium	LT 0.427	LT 0.427	LT 0.427	0.52
Boron	LT 6.64	LT 6.64	LT 6.64	0
Cadmium	8.18	35.3	4.61	0
Calcium	53,500	210,000	15,600	750
Chromium	20.2	9.70	15.7	15.1
Cobalt	LT 2.50	LT 2.50	3.43	3.50
Copper	1,800	169	35.7	5.64
Iron	10,500	12,200	14,500	14,800
Lead	36.0	59.0	21.3	14.9
Magnesium	8,940	45,800	3,480	7,000
Manganese	272	538	344	302
Mercury	LT 0.05	LT 0.05	LT 0.05	0
Molybdenum	LT 14.3	LT 14.3	LT 14.3	0
Nickel	17.0	11.2	7.53	2.23
Potassium	583	230	573	681
Selenium	LT 0.45	LT 0.45	LT 0.45	0.74
Silver	0.0761	0.0379	0.0957	0
Sodium	442	242	259	50.5
Thallium	LT 34.3	LT 34.3	LT 34.3	0.43
Tin	10.0	15.3	LT 7.43	0
Vanadium	16.9	6.71	18.1	27.0
Zinc	307	613	104	19.5

General Note:

All samples were collected at a depth of zero feet on 11/21/92.

Footnotes:

(a) Micrograms per gram.
(b) Less than the reporting limit.
(c) Rejected.

TABLE 22-3

Summary of Analytical Results for Confirmation Samples
Site 28 - Gator Z Open Burn Area and Site 29 - Gator Z Mine Scrap Disposal Area
Jefferson Proving Ground
Madison, Indiana

Analyte	S28001 (mg/kg)[a]	S28201 (mg/kg)	S28002 (mg/kg)	S28003 (mg/kg)	S28004 (mg/kg)	S28005 (mg/kg)	S28006 (mg/kg)
Silver	1.2 U[b]	1.2 U	1.1 U	1.2 U	1.1 U	1.1 U	1.2 U
Aluminum	6000.00	4200.00	4600.00	5400.00	3700.00	4400.00	6100.00
Arsenic	3.1 J[c]	4.20	3.50	4.00	2.10	2.10	3.30
Boron	20 U	8.8 BU	17 U	5.0 BU	22 U	29 U	4.7 BU
Barium	53.00	49.00	50.00	75.00	23.00	21.00	59.00
Beryllium	0.41 BJ[d]	0.25 BU	0.30 BU	0.20 BJ	0.25 BU	0.33 BU	0.28 BJ
Calcium	120000 J	150000 J	160000 J	76000 J	210000 J	250000 J	21000 J
Cadmium	35.00	41.00	14.00	87.00	6.20	1.90	34.00
Cobalt	2.2 BJ	1.4 BJ	2.4 BJ	2.3 BJ	1.5 BJ	3.3 BJ	1.4 BJ
Chromium	45 J	19 J	31 J	14 J	14 J	180 J	13 J
Copper	210.00	220.00	230.00	190.00	64.00	1700.00	79.00
Iron	13000.00	8200.00	8100.00	11000.00	5700.00	7900.00	11000.00
Mercury	0.12 U	0.12 U	0.11 U	0.12 U	0.11 U	0.11 U	0.12 U
Potassium	1100 J	580 BJ	1000 J	280 BJ	1300 J	2000 J	330 BJ
Magnesium	33000.00	37000.00	23000.00	18000.00	32000.00	23000.00	4600.00
Manganese	270.00	280.00	250.00	290.00	230.00	190.00	180.00
Molybdenum	10 U	1.4 BU	10 U	10 U	10 U	1.3 BU	10 U
Sodium	230 BJ	200 BJ	300 BJ	150 BJ	230 BJ	180 BJ	57 BJ
Nickel	25.00	15.00	25.00	15.00	7.20	84.00	8.20
Lead	57 J	66 J	55 J	110 J	16 J	6.9 J	41 J
Selenium	0.60 UJ	0.60 UJ	0.21 BUJ	0.18 BUJ	0.54 UJ	0.54 UJ	0.68 UJ
Thallium	9.3 J	0.60 U	0.55 U	0.59 U	0.54 U	0.58 J	0.59 U
Vanadium	14.00	11.00	11.00	12.00	7.90	10.00	16.00
Zinc	670.00	730.00	450.00	1400.00	210.00	130.00	800.00

TABLE 22-3

Summary of Analytical Results for Confirmation Samples
Site 28 - Gator Z Open Burn Area and Site 29 - Gator Z Mine Scrap Disposal Area
Jefferson Proving Ground
Madison, Indiana

Analyte	S28007 (mg/kg)	S28008 (mg/kg)	S28009 (mg/kg)	S28010 (mg/kg)	29-S-N (mg/kg)	S29-S-S (mg/kg)	29-1 (mg/L)
Silver	1.2 U	1.4 U	1.2 U	1.1 U	1.0 U	1.0 U	0.01 U
Aluminum	6400.00	6600.00	3000.00	5000.00	NA (e)	NA	NA
Arsenic	1.80	2.30	4.80	3.00	9.0 U	9.0 U	0.075 U
Boron	8.3 BU	4.4 BU	18 U	6.0 BU	NA	NA	NA
Barium	43.00	53.00	29.00	55.00	32	36	0.053
Beryllium	0.23 BJ	0.31 BJ	0.23 BJ	0.26 BJ	NA	NA	NA
Calcium	70000 J	13000 J	180000 J	79000 J	NA	NA	NA
Cadmium	4.70	1.80	5.90	33.00	2.0	8.0	0.005 U
Cobalt	1.6 BJ	1.3 BJ	1.6 BJ	1.6 BJ	NA	NA	NA
Chromium	10 J	7.7 J	9.7 J	15 J	5.0	4.0	0.010 U
Copper	56.00	8.70	31.00	140.00	NA	NA	NA
Iron	5300.00	5800.00	7700.00	8900.00	NA	NA	NA
Mercury	0.12 U	0.14 U	0.12 U	0.11 U	0.01	0.02	0.0001 U
Potassium	670 J	270 BJ	780 J	340 BJ	NA	NA	NA
Magnesium	17000.00	1400.00	35000.00	18000.00	NA	NA	NA
Manganese	230.00	97.00	260.00	260.00	NA	NA	NA
Molybdenum	10 U	10 U	10 U	10 U	NA	NA	NA
Sodium	170 BJ	100 BJ	160 BJ	84 BJ	NA	NA	NA
Nickel	5.60	4.6 B	5.10	9.40	NA	NA	NA
Lead	16 J	7.5 J	33 J	33 J	9.0 U	9.0 U	0.05 U
Selenium	0.18 BUJ	0.34 BUJ	0.30 BUJ	0.24 BUJ	9.0 U	9.0 U	0.05 U
Thallium	16 U	0.68 U	1 J	0.56 U	NA	NA	NA
Vanadium	11.00	14.00	7.60	12.00	NA	NA	NA
Zinc	130.00	44.00	170.00	730.00	NA	NA	NA

TABLE 22-3

Summary of Analytical Results for Confirmation Samples
Site 28 - Gator Z Open Burn Area and Site 29 - Gator Z Mine Scrap Disposal Area
Jefferson Proving Ground
Madison, Indiana

General Notes:

1. A summary of data qualifiers may be found in Appendix N.
2. All samples collected at a depth of 0 to 1 foot on 2/11/97. Sediments 29-S-N, and 29-S-S and surface water 29-1 which were collected on 1/23/97 as part of the interim measures confirmation sampling.
3. Explosives were collected and analyzed by method 8330 for sediment samples 29-S-N and 29-S-S and surface water sample 29-1 but were not detected and are not included on this table.

Footnotes:

(a) Milligrams per kilogram.
(b) U = Value is not detected.
(c) J = Value is estimated.
(d) B = Value is detected between the method detection limit and the reporting limit.
(e) Not analyzed.

TABLE 22-4

Summary of Phase I Analytical Results for Sediment and Surface Water
Site 29 - Gator Z Mine Scrap Disposal Area
Jefferson Proving Ground
Madison, Indiana

Sample ID Analyte	GZS29SD001 (µg/g)[a]	GZS29SD002 (µg/g)	GZS29SD003 (µg/g)	GZS29SW001 (µg/L)[b]	GZS29SW002 (µg/L)	GZS29SW003 (µg/L)
Aluminum	11,100	8,020	8,800	2,090	1,640	1,830
Antimony	LT[c] 19.6 R[d]	LT 19.6 R	LT 19.6 R	LT 60.0	LT 60.0	LT 60.0
Arsenic	LT 2.50	LT 2.50	LT 2.50	LT 2.35	LT 2.35	LT 2.35
Barium	59.7	42.4	58.6	49.6	45.8	42.2
Beryllium	LT 0.427	LT 0.427	LT 0.427	LT 1.12	LT 1.12	LT 1.12
Boron	LT 6.64	LT 6.64	LT 6.64	LT 230	LT 230	LT 230
Cadmium	17.0	10.3	5.47	15.9	13.0	13.8
Calcium	1,480	724	801	14,300	12,700	11,800
Chromium	11.8	9.30	11.3	LT 16.8	LT 16.8	LT 16.8
Cobalt	LT 2.50	LT 2.50	LT 2.50	LT 25.0	LT 25.0	LT 25.0
Copper	11.3	5.85	5.27	LT 18.8	LT 18.8	LT 18.8
Iron	9,570	12,700	10,700	7,590	7,600	7,560
Lead	17.1	10.7	14.2	LT 4.47	LT 4.47	LT 4.47
Magnesium	794	539	596	4,250	3,890	3,680
Manganese	101	59.7	101	704	632	615
Mercury	LT 0.05	LT 0.05	LT 0.05	LT 0.10	LT 0.10	LT 0.10
Molybdenum	LT 14.3	LT 14.3	LT 14.3	LT 52.7	LT 52.7	LT 52.7
Nickel	5.68	5.56	LT 2.74	LT 32.1	LT 32.1	LT 32.1
Potassium	407	243	372	2,310	2,390	2,720
Selenium	LT 0.45	LT 0.45	LT 0.45	LT 2.53	LT 2.53	LT 2.53
Silver	0.0783	0.0461	0.0480	LT 0.33	LT 0.33	LT 0.33
Sodium	LT 38.7	LT 38.7	LT 38.7	1,540	1,480	1,440
Thallium	LT 34.3	LT 34.3	LT 34.3	LT 125	LT 125	LT 125
Tin	LT 7.43	LT 7.43	LT 7.43	LT 59.9	LT 59.9	LT 59.9
Vanadium	17.4	21.2	20.2	LT 27.6	LT 27.6	LT 27.6
Zinc	54.7	37.7	27.2	45.7	45.0	41.6
1,3,5-Trinitrobenzene	LT 2.11	LT 2.11	LT 2.11	1.24	1.17	1.28

Note:
Surface water and sediment samples were collected on 11/21/92.

Footnotes:
(a) Micrograms per gram.
(b) Micrograms per liter.
(c) Value is less than the reporting limit.
(d) Value is unusable (rejected).

TABLE 22-5

Summary of Phase I Analytical Results for Soil
Site 39 - Gator Z Mine Test Area
Jefferson Proving Ground
Madison, Indiana

Sample ID Analyte	GZM39SF001 (µg/g)[(a)]	GZM39SF002 (µg/g)	GZM39SF003 (µg/g)	GZM39SF004 (µg/g)	GZM39SF005 (µg/g)	GZM39SF006 (µg/g)	Background (µg/g)
Aluminum	8,370	6,670	8,340	11,700	16,500	9,490	11,000
Antimony	LT[(b)] 19.6 R[(c)]	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	LT 19.6 R	0.49
Arsenic	3.88	4.47	8.46	7.37	12.7	4.69	9.26
Barium	44.6	50.0	57.3	50.8	91.7	99.6	84.5
Beryllium	LT 0.427	LT 0.427	LT 0.427	LT 0.427	LT 0.427	LT 0.427	0.52
Boron	10.4	LT 6.64	LT 6.64	10.3	LT 6.64	LT 6.64	0
Cadmium	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	LT 1.20	0
Calcium	13,800	574	7,670	1,570	2,470	1,820	750
Chromium	64.8	9.14	40.6	14.6	19.8	13.3	15.1
Cobalt	3.47	LT 2.50	3.95	4.37	7.68	6.53	3.50
Copper	30.8	4.51	25.2	6.33	9.97	6.23	5.64
Iron	14,200	10,700	22,400	19,700	22,800	16,800	14,800
Lead	74.0	27.0	61.0	12.8	20.7	17.6	14.9
Magnesium	2,400	566	3,710	1,070	2,160	1,030	7,000
Manganese	319	251	225	165	338	728	302
Mercury	LT 0.05	0.881	LT 0.05	LT 0.05	LT 0.05	LT 0.05	0
Molybdenum	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	LT 14.3	0
Nickel	45.9	3.97	36.7	6.62	15.0	11.1	2.23
Potassium	396	233	329	516	799	512	681
Selenium	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	LT 0.45	0.74
Silver	2.40	0.0523	0.314	0.0371	0.0404	0.0365	0
Sodium	LT 38.7	LT 38.7	LT 38.7	LT 38.7	94.7	115	50.5
Thallium	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	LT 34.3	0.43
Tin	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	LT 7.43	0
Vanadium	22.7	18.4	25.0	29.1	31.8	26.2	27.0
Zinc	116	18.0	214	49.2	48.5	41.7	19.5

General Note:

All samples were collected at a depth of zero feet on 11/21/92.

Footnotes:

(a) Micrograms per gram.
(b) Value is less than the reporting limit.
(c) Value is unusable (rejected).

TABLE 22-6
Soil Exposure Point Concentrations of Contaminants of Potential Concern
Site 39 - Gator Z Mine Test Area
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[(a)]	Range of Detected Values (µg/g)[(b)]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[(c)] (µg/g)
Surface Soil						
Aluminum	6/6	6,670 - 16,500	NA[(d)]	10,023	14,264	14,264
Arsenic	6/6	3.88 - 12.7	NA	6.93	12.0	12.0
Boron	2/6	10.3 - 10.4	6.64	5.7	8.7	8.7
Chromium	6/6	9.1 - 64.8	NA	27.1	88.0	64.8
Cobalt	5/6	3.47 - 7.68	2.50	4.4	6.2	6.2
Copper	6/6	4.5 - 30.8	NA	13.7	56.9	30.8
Lead	6/6	12.8 - 74.0	NA	36.7	98.2	74.0
Manganese	6/6	165 - 669.5	NA	328	581	581
Mercury	1/6	0.881	0.050	0.168	5.97	0.881
Nickel	6/6	3.97 - 45.9	NA	19.5	128	45.9
Silver	6/6	0.037 - 2.40	NA	0.48	86.3	2.40
Vanadium	6/6	18.4 -31.8	NA	25.7	29.6	29.6
Zinc	6/6	18.0 - 214	NA	80.1	379	214

Footnotes:

(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Micrograms per gram.
(c) The 95% UCL (upper confidence limit of the mean) or the maximum detected value, whichever is lower (USEPA 1989b).
(d) Not applicable.

TABLE 22-7

Selection of Contaminants of Potential Concern (COPC) in Soil Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 39 - Gator Z Mine Test Area
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Residential PRG (µg/g)[(a)]**	**Exposure Point Conc. (µg/g)**	**Retained as Soil COPC?**
Surface Soil			
Aluminum	7,667	14,264	**YES**
Arsenic	0.38	12.0	**YES**
Boron	586	8.7	No
Chromium	30.1[(b)]	64.8	**YES**
Cobalt	456	6.2	No
Copper	285	30.8	No
Lead	400[(c)]	74.0	No
Manganese	318	581	**YES**
Mercury	2.3[(d)]	0.881	No
Nickel	153	45.9	No
Silver	38.3	2.4	No
Vanadium	53.7	29.6	No
Zinc	2,300	214	No

General Note:

PRGs were taken directly from the Region 9 PRG Table (USEPA 1998c). Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:
(a) Micrograms per gram.
(b) Value for chromium VI.
(c) Value for lead is full PRG.
(d) Value for mercuric chloride.

TABLE 22-8
Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 39 - Gator Z Mine Test Area
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Ambient Air PRG (µg/m^3)[a]**	**Exposure Point Conc. (µg/m^3)**	**Retained as Air COPC?**
Residential Scenario			
Aluminum	NA[b]	1.73E-03	**YES**
Arsenic	4.5E-04	6.84E-07	No
Barium	5.2E-02	7.25E-06	No
Beryllium	8.0E-04	5.35E-08	No
Cadmium	1.1E-03	1.41E-08	No
Chromium	2.3E-05	3.86E-06	No
Lead	1.5E+00[c]	1.05E-06	No
Manganese	5.1E-03	1.45E-04	No
Silver	NA	3.73E-06	**YES**
Thallium	NA	8.81E-07	**YES**
Vanadium	NA	3.38E-07	**YES**
Zinc	NA	7.21E-07	**YES**
Dioxins/Furans	4.5E-08	3.51E-14	No
Benzo(a)anthracene	9.2E-03	1.30E-09	No
Benzo(a)pyrene	9.2E-04	8.73E-09	No
Benzo(b)fluoranthene	9.2E-03	1.84E-08	No
DDE	2.0E-02	7.63E-10	No
Dibenz(a,h)anthracene	9.2E-04	1.53E-10	No
Dieldrin	4.2E-04	NA	No
Indeno(1,2,3-cd)pyrene	9.2E-03	7.60E-10	No
1,1-Dichloroethylene	3.8E-02	5.97E-10	No
Chlorobenzene	2.1E+00	4.42E-07	No

TABLE 22-8
Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 39 - Gator Z Mine Test Area
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Ambient Air PRG (μg/m³)[a]**	**Exposure Point Conc. (μg/m³)**	**Retained as Air COPC?**
Industrial Scenario			
Aluminum	NA	3.25E+00	**YES**
Arsenic	4.5E-04	2.74E-03	**YES**
Barium	5.2E-02	7.73E-06	No
Beryllium	8.0E-04	9.74E-08	No
Cadmium	1.1E-03	2.65E-08	No
Chromium	2.3E-05	1.48E-02	**YES**
Lead	1.5E+00[c]	1.05E-06	No
Manganese	5.1E-03	1.33E-01	**YES**
Silver	NA	3.73E-06	**YES**
Thallium	NA	8.81E-07	**YES**
Vanadium	NA	5.97E-07	**YES**
Zinc	NA	1.42E-05	**YES**
Dioxins/Furans	4.5E-08	6.10E-13	No
Benzo(a)anthracene	9.2E-03	1.30E-09	No
Benzo(a)pyrene	9.2E-04	8.78E-09	No
Benzo(b)fluoranthene	9.2E-03	1.84E-08	No
DDE	2.0E-02	7.63E-10	No
Dibenz(a,h)anthracene	9.2E-04	1.53E-10	No
Dieldrin	4.2E-04	2.46E-09	No
Indeno(1,2,3-cd)pyrene	9.2E-03	7.63E-10	No
1,1-Dichloroethylene	3.8E-02	5.97E-10	No
Chlorobenzene	2.1E+00	4.42E-07	No

Note:

PRGs were taken directly from the Region 9 PRG Table (USEPA 1998). Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:

(a) Micrograms per cubic meter.
(b) Not available or not applicable.
(c) Federal ambient air quality criterion for lead.

TABLE 22-9

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 39 - Gator Z Mine Test Area
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
	Future On-site Resident Adult			
Incidental ingestion of soil	1.06E-05		0.0901	
Dermal contact with soil	2.65E-06		0.0167	
Ingestion of homegrown fruits/vegetables	1.59E-05		0.1954	
Inhalation of VOCs[a] and fugitive dusts	NA[b]		NA	
Total	2.92E-05		0.3022	
	Future On-site Resident Child			
Incidental ingestion of soil	1.97E-05		0.8406	
Dermal contact with soil	1.53E-06		0.0480	
Ingestion of homegrown fruits/vegetables	7.69E-06		0.4696	
Inhalation of VOCs and fugitive dusts	NA		NA	
Total	2.89E-05		1.3582	

PZ

TABLE 22-9

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 39 - Gator Z Mine Test Area
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
		Future On-site Worker		
Incidental ingestion of soil	3.15E-06		0.0322	
Dermal contact with soil	9.40E-07		0.0071	
Inhalation of VOCs and fugitive dusts	1.44E-05		0.6379	
Total	1.85E-05		0.6772	

Footnotes:
(a) Volatile organic compounds.
(b) Not available or not applicable.

PZ/PB
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TABLE 22-10
Qualitative Uncertainty Analysis
Site 39 – Gator Z Mine Test Area
Jefferson Proving Ground
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
A. Human Behavior				
Future receptors' exposure duration	30 years	Medium	Medium	National upper-bound time (90th percentile) at one residence
Future receptors' exposure frequency	350 days/year	Medium	Medium	High-end value
Future receptors' exposure time	24 hours/day	Low	High	Maximum possible value
Future receptors' soil ingestion rates	200 mg/day (child) 100 mg/day (adult)	Low	High	Soil consumption rates are high-end values obtained from published distribution data
Exclusion of certain exposure pathways in the quantitative analysis	NA[a]	Low	Low	Pathways eliminated are those that have low possibility of contributing risk to these receptors
B. Chemical Fate/Transport in the Environment				
Use of air dispersion modeling to predict air concentrations	NA	Low	High	Conservative assumptions and input parameters
C. Chemical Toxicity				
Assumption that USEPA[b] reference doses truly represent toxicological thresholds	Mn inhalation RfD[c] (1.5E-05)	Low	Medium	IRIS[d] value; high degree of conservativeness utilized by USEPA in deriving RfDs from toxicological literature

TABLE 22-10
Qualitative Uncertainty Analysis
Site 39 – Gator Z Mine Test Area
Jefferson Proving Ground
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
Assumption that USEPA carcinogenic slope factors truly represent dose-response phenomena	NA	Low-moderate	Moderate-high	Use of linearized, multi-stage mathematical model to predict cancer incidence at low exposure levels is USEPA policy; not currently supported by scientific data
Assumption of risk/hazard additivity	NA	Moderate	Moderate	Summation of chemical-specific risks/hazards may over- or under-predict risks/hazards to receptors
Screening out of certain contaminants based on USEPA criteria	NA	Low	Low	Chemicals present in concentrations less than Region 9 criteria eliminated

Footnotes:
- (a) Not available or not applicable
- (b) U.S. Environmental Protection Agency
- (c) Reference dose.
- (d) Integrated Risk Information System.

TABLE 22.7-a1

Sites 28, 29 and 39 Habitat Summary

Site 28 - Gator Z Burn
Date: 4/19/93; 6/14/93
Acreage: 0.5
Soils mapping unit: NA
Vegetation mapping unit: Open, infrequently mowed/burned grassland

General site conditions: NA
Slope: Flat
Aspect: None
Drainages: Slight ditch around burn area; drainage to west
Surface water/wetlands: Standing water around burn site
Evidence of flood/fire: None
Description of surrounding area: Site surrounded by early succession (30-40 yrs) flatwoods in close proximity

Soils
Surface layer texture: Typical
Surface color: Typical

Vegetation
Ground cover description: Open, infrequently mowed or burned grassland
Species: Quite marshy, grasses with sedges
Canopy cover: Typical flatwoods adjacent
Species: NA
Successional status: Maintained versus mowed infrequently
Vegetation condition: NA

Wildlife
Habitat type: Open grassland surrounded by flatwoods
Species observations: Crows
Sign Observations: Lots; numerous deer tracks; the area/soil adjacent to the site (gravel) is heavily tracked by deer and they probably use the soil as a lick; the standing water is cloudy, whitish (not clear or muddy like nearby area); obviously the water quality is different here, and something exists in the soil that attracts deer

Remarks: The soil adjacent to the burn area is probably contaminated and utilized by the deer and is thus probably a pathway

Sites 28, 29 and 39 Habitat Summary

Site 29 - Z Mine Scrap Disposal
Date: 4/19/93; 6/14/93
Acreage: 0.1
Soils mapping unit: NA
Vegetation mapping unit: Infrequently mowed/burned grassland

General site conditions: Pond (small) surrounded by woods
Slope: Flat
Aspect: None
Drainages: Slight roadside to the south and west
Surface water/wetlands: the scrap disposal site is a pond with water at this time
Evidence of flood/fire: Infrequently burned
Description of surrounding area: the area is within the woods with only a small amount of maintained grass along road; dirt mounds are located along the east side of the “pond”; these mounds are partially revegetated

Soils
Surface layer texture: Typical
Surface color: Typical

Vegetation
Ground cover description: Infrequently mowed versus maintained grass and flatwoods
Species: Typical
Canopy cover: Typical
Species: NA
Successional status: Maintained grass; early/mid-successional flatwoods
Vegetation condition: Moderate around pit

Wildlife
Habitat type: Flatwoods
Species observations: None
Sign Observations: Few deer tracks

Remarks: Depending on whether the pit has water contamination or not, and if deere utilize this as a source for drinking water, a pathway may exist; likewise, true for any amphibians, etc; possible pathway

Sites 28, 29 and 39 Habitat Summary

Site 39 - Gator Z Mine Test Area
Date: 4/19/93; 6/14/93
Acreage: 10
Soils mapping unit: NA
Vegetation mapping unit: Infrequently mowed grassland or regularly mowed

General site conditions: Open area with concrete pits
Slope: Flat
Aspect: None
Drainages: West and south to Harbert's Creek
Surface water/wetlands: Wetland along tributary to Harbert's Creek
Evidence of flood/fire: Burned
Description of surrounding area: Large open area surrounded by flatwoods; Harbert's Creek tributary along west boundary

Soils
Surface layer texture: Typical
Surface color: Typical

Vegetation
Ground cover description: Infrequently burned grassland
Species: Typical
Canopy cover: Typical flatwoods surround site
Species: Immature flatwoods
Successional status: Site is early to mid-successional grassland
Vegetation condition: Good to poor

Wildlife
Habitat type: Open grassland
Species observations: None (no walk around)
Sign Observations: None

Remarks: Pits at south end of site are more disturbed, and evidence of probably sprayed vegetation; as one moves to west end of site, vegetation becomes less weedy and in better condition; some contamination likely, and pathways towards the east end of site

Table 22.7-1
Summary Statistics for Phase I Analytes in Surface Soil
Site 28 - Gator Z Open Burn Area
Jefferson Proving Ground
Madison, Indiana

Site	Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Standard Deviation	UCL95 [(a)]	EPC µg/g [(b)]	Exceed Background (Bkg)?	Retain as COPC[(c)]?	Comment
28	Silver	4	4	100	0.04	20.00	5.05	9.97	16.78	16.78	Yes (Y)	Y	Not detected in Bkg.
28	Aluminum	4	4	100	3380	14600	8711	4628	14156	14156	Y	Y	
28	Arsenic	2	4	50	1.25	26.70	8.29	12.34	22.81	22.81	Y	Y	
28	Boron	2	4	50	3.32	286.0	74.76	140.8	240.5	240.5	Y	Y	
28	Beryllium	0	4	0	NC[(d)]	NC	NC	NC	NC	NC	NA[(e)]	No (N)	Not a COPC
28	Barium	4	4	100	52.45	220.0	124.5	78.91	217.3	217.3	Y	Y	
28	Cadmium	4	4	100	4.61	35.80	20.79	17.08	40.89	35.80	Y	Y	
28	Cobalt	2	4	50	1.25	51.00	14.23	24.53	43.10	43.10	Y	Y	
28	Chromium	4	4	100	9.70	4100	1035	2043	3439	3439	Y	Y	
28	Copper	4	4	100	35.70	32000	8290	15812	26893	26893	Y	Y	
28	Iron	4	4	100	10235	230000	66734	108858	194805	194805	Y	Y	
28	Mercury	0	4	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
28	Manganese	4	4	100	235.0	2700	954	1171	2331	2331	Y	Y	
28	Molybdenum	1	4	25	7.15	70.80	23.06	31.83	60.50	60.50	Y	Y	
28	Nickel	4	4	100	7.53	2360	597.8	1175	1980	1980	Y	Y	
28	Lead	4	4	100	21.30	2000	526.5	982.5	1682	1682	Y	Y	
28	Antimony	1	1	100	58.50	58.50	58.50	NA	NA	58.50	Y	Y	
28	Selenium	0	4	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
28	Tin	3	4	75	3.72	1530	389.0	760.7	1284	1284	Y	Y	
28	Tellurium	1	4	25	7.45	27.60	12.49	10.08	24.34	24.34	Y	Y	
28	Thallium	1	4	25	17.15	106.0	39.36	44.43	91.63	91.63	Y	Y	
28	Vanadium	4	4	100	6.71	177.0	55.08	81.47	150.9	150.9	Y	Y	
28	Zinc	4	4	100	104.0	52000	13250	25834	43644	43644	Y	Y	

General Note;

1. Calcium, magnesium, sodium and potassium were not included in risk assessment as they are macronutrients.

Footnotes:

(a) Upper 95% confidence limit.

(b) Exposure point concentration, micrograms per gram, equivalent to parts per million.

(c) Contaminant of potential concern.

(d) Not calculated. Not a COPC.

(e) Not applicable or not evaluated.

Table 22.7-2
Summary of Contaminants of Potential Concern (COPC) Exposure Point Concentrations by Medium (Phase I)
Site 28 - Gator Z Open Burn Area
Jefferson Proving Ground
Madison, Indiana

	Measured Concentrations in Abiotic Media				Estimated Concentrations in Biotic Media							
Analyte Name	Filtered Surface Water (µg/L) [(a)]	Sediment (mg/kg) [(b)]	Unfiltered Surface Water (mg/L) [(c)]	Soil (mg/kg)	Plant (mg/kg)	Invertebrate (mg/kg)	Mouse (mg/kg)	Swift (mg/kg)	Aquatic Plants (mg/kg)	Benthic Invertebrate (mg/kg)	Fish (mg/kg)	Frogs (mg/kg)
Aluminum				14156	5.66E+01	1.56E+02	3.89E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Antimony				58.50	1.54E+01	1.12E+01	1.34E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic				22.81	4.79E-01	2.58E+00	3.97E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Barium				217.3	3.19E+01	7.82E+00	3.88E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Boron				240.5	9.62E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium				35.80	1.43E+01	1.33E+02	1.79E-01	2.74E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium				3439	4.13E+01	8.94E+01	6.71E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt				43.10	7.76E-01	1.51E+00	2.00E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper				26893	2.66E+03	2.37E+04	2.06E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Iron				194805	7.79E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead				1682	2.19E+02	1.18E+02	1.62E-01	8.78E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Manganese				2331	8.63E+01	8.86E+01	2.68E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Molybdenum				61.00	1.53E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel				1980	8.71E+01	9.90E+01	3.98E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Silver				16.78	8.05E-01	2.01E+00	1.45E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tellurium				24.34	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium				91.63	3.67E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tin				1284	3.85E+01	0.00E+00	4.36E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Vanadium				150.9	4.53E-01	1.36E+00	1.88E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc				43644	2.40E+04	2.88E+04	1.77E+03	3.33E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Footnotes:

(a) Micrograms per liter, equivalent to parts per billion.

(b) Milligrams per kilogram, equivalent to parts per million.

(c) Milligrams per liter, equivalent to parts per million.

Table 22.7-3
Summary Statistics for Analytes in Surface Water & Sediments (Phase I)
Site 29 - Gator Z Mine Scrap Disposal Area
Jefferson Proving Ground
Madison, Indiana

Site	Medium	Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Standard Deviation	UCL95 [(a)]	EPC µg/L [(b)]
Filtered Surface Water											
29	CSW [(c)]	Aluminum	1	3	33	56.00	216.0	109.3	92.38	265.1	216.0
29	CSW	Barium	3	3	100	23.80	30.50	27.63	3.45	33.45	30.50
29	CSW	Cadmium	3	3	100	7.55	15.20	10.14	4.38	17.53	15.20
29	CSW	Iron	3	3	100	616.0	1390	1000	387.0	1652	1390
29	CSW	Manganese	3	3	100	434.0	533.0	493.3	52.35	581.6	533.0
29	CSW	Zinc	3	3	100	29.30	54.20	39.63	12.98	61.51	54.20
Unfiltered Surface Water											**µg/L**
29	CSW	Aluminum	3	3	100	1640	2090	1853	225.9	2234	2090
29	CSW	Barium	3	3	100	42.20	49.60	45.87	3.70	52.11	49.60
29	CSW	Cadmium	3	3	100	13.00	15.90	14.23	1.50	16.76	15.90
29	CSW	Iron	3	3	100	7560	7600	7583	20.82	7618	7600
29	CSW	Manganese	3	3	100	615.0	704.0	650.3	47.25	730.0	704.0
29	CSW	Zinc	3	3	100	41.60	45.70	44.10	2.19	47.80	45.70
29	CSW	1,3,5-Trinitrobenzene	3	3	100	1.17	1.28	1.23	0.06	1.32	1.28
Sediment											**µg/g [(d)]**
29	CSE [(e)]	Silver	3	3	100	0.05	0.08	0.06	0.02	0.09	0.08
29	CSE	Aluminum	3	3	100	8020	11100	9307	1601	12006	11100
29	CSE	Barium	3	3	100	42.40	59.70	53.57	9.69	69.90	59.70
29	CSE	Cadmium	3	3	100	5.47	17.00	10.92	5.79	20.68	17.00
29	CSE	Chromium	3	3	100	9.30	11.80	10.80	1.32	13.03	11.80
29	CSE	Copper	3	3	100	5.27	11.30	7.47	3.33	13.08	11.30
29	CSE	Iron	3	3	100	9570	12700	10990	1585	13662	12700
29	CSE	Manganese	3	3	100	59.70	101.0	87.23	23.84	127.4	101.0
29	CSE	Nickel	2	3	67	1.37	5.68	4.20	2.45	8.34	5.68
29	CSE	Lead	3	3	100	10.70	17.10	14.00	3.20	19.40	17.10
29	CSE	Vanadium	3	3	100	17.40	21.20	19.60	1.97	22.92	21.20
29	CSE	Zinc	3	3	100	27.20	54.70	39.87	13.88	63.26	54.70

Footnotes:

(a) Upper 95% confidence limit.

(b) Exposure point concentration, micrograms per liter, equivalent to parts per billion.

© Surface water.

(d) Micrograms per gram, equivalent to parts per million.

(e) Sediment.

Table 22.7-4
Summary of Contaminants of Potential Cocern (COPC) Exposure Point Concentrations by Medium (Phase I)
Site 29 - Gator Z Mine Scrap Disposal Area
Jefferson Proving Ground
Madison, Indiana

	Measured Concentrations in Abiotic Media				Estimated Concentrations in Biotic Media							
Analyte Name	**Filtered Surface Water (µg/L) [(a)]**	**Sediment (mg/kg) [(b)]**	**Unfiltered Surface Water (mg/L) [(c)]**	**Soil (mg/kg)**	**Plant (mg/kg)**	**Invertebrate (mg/kg)**	**Mouse (mg/kg)**	**Swift (mg/kg)**	**Aquatic Plants (mg/kg)**	**Benthic Invertebrate (mg/kg)**	**Fish (mg/kg)**	**Frogs (mg/kg)**
Aluminum	216.0	11100	2.09		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Barium	30.50	59.70	0.05		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium	15.20	17.00	0.02		0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.13E+00	1.76E+00	1.27E-01	1.27E-01
Chromium		11.80			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper		11.30			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Iron	1390	12700	7.60		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead		17.10			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Manganese	533.00	101.0	0.70		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel		5.68			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Silver		0.08			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,3,5-Trinitrobenzene			0.001		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Vanadium		21.20			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc	54.20	54.70	0.05		0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.55E+02	8.68E+01	1.29E+01	1.29E+01

Footnotes:

(a) Micrograms per liter, equivalent to parts per billion.

(b) Milligrams per kilogram, equivalent to parts per million.

© Milligrams per liter, equivalent to parts per million.

Table 22.7-5
Summary Statistics Analytes in Surface Soil (Phase I)
Site 39 - Gator Z Mine Test Area
Jefrferson Proving Ground
Madison, Indiana

Site	Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Standard Deviation	UCL95 [a]	EPC µg/g [b]	Exceed Background (Bkg)?	Retain as COPC[c]?	Comment
39	Silver	6	6	100	0.04	2.40	0.48	0.95	1.26	1.26	Yes (Y)	Y	Not detected in Bkg.
39	Aluminum	6	6	100	6670	16500	10023	3570	12959	12959	No (N)	N	
39	Arsenic	6	6	100	3.88	12.70	6.93	3.35	9.69	9.69	N	N	
39	Boron	2	6	33	3.32	10.40	5.66	3.63	8.65	8.65	Y	Y	Not detected in Bkg.
39	Barium	6	6	100	44.60	91.70	62.02	18.56	77.29	77.29	N	N	
39	Beryllium	0	6	0	NC[d]	NC	NC	NC	NC	NC	NA[e]	N	Not a COPC
39	Cadmium	0	6	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
39	Cobalt	5	6	83	1.25	7.68	4.39	2.15	6.16	6.16	Y	Y	
39	Chromium	6	6	100	9.14	64.80	27.12	21.51	44.81	44.81	Y	Y	
39	Copper	6	6	100	4.51	30.80	13.75	11.33	23.07	23.07	Y	Y	
39	Iron	6	6	100	10700	22800	17958	4754	21869	21869	Y	Y	
39	Mercury	1	6	17	0.03	0.88	0.17	0.35	0.46	0.46	Y	Y	Not detected in Bkg.
39	Manganese	6	6	100	165.0	669.5	327.9	178.8	475.0	475.0	N	N	
39	Molybdenum	0	6	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
39	Nickel	6	6	100	3.97	45.90	19.54	17.49	33.93	33.93	Y	Y	
39	Lead	6	6	100	12.80	74.00	36.72	24.68	57.02	57.02	Y	Y	
39	Selenium	0	6	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
39	Tin	0	6	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
39	Tellurium	0	6	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
39	Thallium	0	6	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
39	Vanadium	6	6	100	18.40	31.80	25.71	4.77	29.64	29.64	N	N	
39	Zinc	6	6	100	18.00	214.0	80.13	73.56	140.6	140.6	Y	Y	

General Note:

1. Calcium, magnesium, sodium and potassium were not included in risk assessment as they are macronutrients.

Footnotes:

(a) Upper 95% confidence limit.

(b) Exposure point concentration, micrograms per gram, equivalent to parts per million.

(c) Contaminant of potential concern.

(d) Not calculated. Not a COPC.

(e) Not applicable or not evaluated.

Table 22.7-5
Summary Statistics Analytes in Surface Soil (Phase I)
Site 39 - Gator Z Mine Test Area
Jefrferson Proving Ground
Madison, Indiana

Site	Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Standard Deviation	UCL95 [(a)]	EPC µg/g [(b)]	Exceed Background (Bkg)?	Retain as COPC[(c)]?	Comment
39	Silver	6	6	100	0.04	2.40	0.48	0.95	1.26	1.26	Yes (Y)	Y	Not detected in Bkg.
39	Aluminum	6	6	100	6670	16500	10023	3570	12959	12959	No (N)	N	
39	Arsenic	6	6	100	3.88	12.70	6.93	3.35	9.69	9.69	N	N	
39	Boron	2	6	33	3.32	10.40	5.66	3.63	8.65	8.65	Y	Y	Not detected in Bkg.
39	Barium	6	6	100	44.60	91.70	62.02	18.56	77.29	77.29	N	N	
39	Beryllium	0	6	0	NC[(d)]	NC	NC	NC	NC	NC	NA[(e)]	N	Not a COPC
39	Cadmium	0	6	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
39	Cobalt	5	6	83	1.25	7.68	4.39	2.15	6.16	6.16	Y	Y	
39	Chromium	6	6	100	9.14	64.80	27.12	21.51	44.81	44.81	Y	Y	
39	Copper	6	6	100	4.51	30.80	13.75	11.33	23.07	23.07	Y	Y	
39	Iron	6	6	100	10700	22800	17958	4754	21869	21869	Y	Y	
39	Mercury	1	6	17	0.03	0.88	0.17	0.35	0.46	0.46	Y	Y	Not detected in Bkg.
39	Manganese	6	6	100	165.0	669.5	327.9	178.8	475.0	475.0	N	N	
39	Molybdenum	0	6	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
39	Nickel	6	6	100	3.97	45.90	19.54	17.49	33.93	33.93	Y	Y	
39	Lead	6	6	100	12.80	74.00	36.72	24.68	57.02	57.02	Y	Y	
39	Selenium	0	6	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
39	Tin	0	6	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
39	Tellurium	0	6	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
39	Thallium	0	6	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
39	Vanadium	6	6	100	18.40	31.80	25.71	4.77	29.64	29.64	N	N	
39	Zinc	6	6	100	18.00	214.0	80.13	73.56	140.6	140.6	Y	Y	

General Note:

1. Calcium, magnesium, sodium and potassium were not included in risk assessment as they are macronutrients.

Footnotes:

(a) Upper 95% confidence limit.

(b) Exposure point concentration, micrograms per gram, equivalent to parts per million.

(c) Contaminant of potential concern.

(d) Not calculated. Not a COPC.

(e) Not applicable or not evaluated.

Table 22.7-6
Summary of Contaminants of Potential Concern (COPC) Exposure Point Concentrations by Medium (Phase I)
Site 39 - Gator Z Mine Test Area
Jefferson Proving Ground
Madison, Indiana

	Measured Concentrations in Abiotic Media				Estimated Concentrations in Biotic Media							
Analyte Name	Filtered Surface Water (µg/L) [(a)]	Sediment (mg/kg) [(b)]	Unfiltered Surface Water (mg/L) [(c)]	Soil (mg/kg)	Plant (mg/kg)	Invertebrate (mg/kg)	Mouse (mg/kg)	Swift (mg/kg)	Aquatic Plants (mg/kg)	Benthic Invertebrate (mg/kg)	Fish (mg/kg)	Frogs (mg/kg)
Boron				8.65	3.46E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium				44.81	5.38E-01	1.17E+00	8.74E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt				6.16	1.11E-01	2.16E-01	2.86E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper				23.07	2.28E+00	2.03E+01	1.76E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Iron				21869	8.75E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead				57.02	7.41E+00	3.99E+00	5.47E-03	2.98E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury				0.46	9.20E-04	6.62E-01	4.23E-01	8.62E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel				33.93	1.49E+00	1.70E+00	6.82E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Silver				1.26	6.05E-02	1.51E-01	1.09E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc				140.6	7.74E+01	9.28E+01	5.71E+00	1.07E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Footnotes:

(a) Micrograms per liter, equivalent to parts per billion.

(b) Milligrams per kilogram, equivalent to parts per million.

(c) Milligrams per liter, equivalent to parts per million.

Table 22.7-7
Summary Statistics for Analytes in Surface Soil
Interim Measures Confirmation Sampling Data
Site 28 - Gator Z Open Burn Area
Jefferson Proving Ground
Madison, Indiana

Site	Medium	Analyte Code	Analyte	Number of Detects	Number of Samples	Detection Frequency	Minimum	Maximum	Average	Standard Deviation	UCL95 [a]	EPC µg/g [b]	Exceed Background (Bkg)?	Retain as COPC[c]?	Comment
28	CSO	AG	Silver	0	11	0	NC[d]	NC	NC	NC	NC	NC	NA[e]	No (N)	Not a COPC
28	CSO	AL	Aluminum	11	11	100	3000	6600	5018.2	1166.9	5650.1	5650.1	N	N	
28	CSO	AS	Arsenic	11	11	100	1.8	4.8	3.0	0.9	3.5	3.5	N	N	
28	CSO	B	Boron	0	11	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
28	CSO	BA	Barium	11	11	100	21	74	46.3	16.1	55.0	55.0	N	N	
28	CSO	BE	Beryllium	7	11	64	0.125	0.41	0.2	0.1	0.3	0.3	N	N	
28	CSO	CD	Cadmium	11	11	100	1.8	80	23.4	24.1	36.5	36.5	Y	Y	
28	CSO	CO	Cobalt	11	11	100	1.3	3.3	1.9	0.6	2.2	2.2	N	N	
28	CSO	CR	Chromium	11	11	100	7.7	180	32.7	50.1	59.8	59.8	Y	Y	
28	CSO	CU	Copper	11	11	100	8.7	1700	266.2	482.3	527.4	527.4	Y	Y	
28	CSO	FE	Iron	11	11	100	5300	13500	8645	2794	10158	10158	N	N	
28	CSO	HG	Mercury	0	11	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
28	CSO	MN	Manganese	11	11	100	97	320	233.4	60.1	265.9	265.9	N	N	
28	CSO	MO	Molybdenum	0	11	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
28	CSO	NI	Nickel	11	11	100	4.6	84	18.6	22.9	31.0	31.0	Y	Y	
28	CSO	PB	Lead	11	11	100	6.9	110	40.1	30.8	56.8	56.8	Y	Y	
28	CSO	SB	Antimony	no data	no data	no data	no data	no data	no data	no data	no data	no data	NA	NA	
28	CSO	SE	Selenium	0	11	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
28	CSO	SN	Tin	no data	no data	no data	no data	no data	no data	no data	no data	no data	NA	NA	
28	CSO	TL	Thallium	3	11	27	0.27	9.3	1.9	3.4	3.7	3.7	Y	Y	
28	CSO	V	Vanadium	11	11	100	7.6	16	11.5	2.5	12.8	12.8	Y	Y	
28	CSO	ZN	Zinc	11	11	100	44	1450	501.3	424.8	731.3	731.3	Y	Y	

General Note:

1. Calcium, magnesium, sodium and potassium were not included in risk assessment as they are macronutrients.

Footnotes:

(a) Upper 95% confidence limit.

(b) Exposure point concentration, micrograms per gram, equivalent to parts per million.

(c) Contaminant of potential concern.

(d) Not calculated. Not a COPC.

(e) Not applicable or not evaluated.

Table 22.7-8
Summary of Contaminant of Potential Concern (COPC) Exposure Point Concentrations by Medium
Interim Measures Confirmation Sampling Data
Site 28 - Gator Z Open Burn Area
Jefferson Proving Ground
Madison, Indiana

	Measured Concentrations in Abiotic Media				Estimated Concentrations in Biotic Media							
Analyte Name	Filtered Surface Water (µg/L) [(a)]	Sediment (mg/kg) [(b)]	Unfiltered Surface Water (mg/L) [(c)]	Soil (mg/kg)	Plant (mg/kg)	Invertebrate (mg/kg)	Mouse (mg/kg)	Swift (mg/kg)	Aquatic Plants (mg/kg)	Benthic Invertebrate (mg/kg)	Fish (mg/kg)	Frogs (mg/kg)
Cadmium				36.47	1.46E+01	1.36E+02	1.82E-01	2.79E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium				59.82	7.18E-01	1.56E+00	1.17E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper				527.4	5.22E+01	4.64E+02	4.03E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead				56.81	7.39E+00	3.98E+00	5.45E-03	2.97E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel				31.01	1.36E+00	1.55E+00	6.23E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium				3.72	1.49E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Vanadium				12.83	3.85E-02	1.15E-01	1.60E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc				731.3	4.02E+02	4.83E+02	2.97E+01	5.59E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Footnotes:

(a) Micrograms per liter, equivalent to parts per billion.

(b) Milligrams per kilogram, equivalent to parts per million.

(c) Milligrams per liter, equivalent to parts per million.

Table 22.7-9a
Summary of Statistics For Analytes in Sediment
Interim Measures Confirmation Sampling Data
Site 29 - Gator Z Mine Scrap Disposal Area
Jefferson Proving Ground
Madison, Indiana

Site	Medium	Analyte Code	Analyte	Number of Detects	Number of Samples	Detection Frequency	Minimum	Maximum	Average	Standard Deviation	UCL95 [(a)]	EPC µg/g [(b)]
29	CSE [(c)]	BA	Barium	2	2	100	32.0	36.0	34.0	2.83	NA	36.0
29	CSE	CD	Cadmium	2	2	100	2.00	8.00	5.00	4.24	NA	8.00
29	CSE	CR	Chromium	2	2	100	4.00	5.00	4.50	0.71	NA	5.00
29	CSE	HG	Mercury	2	2	100	0.010	0.020	0.015	0.007	NA	0.020

Footnotes:

(a) Upper 95% confidence limit.

(b) Exposure point concentration, micrograms per gram, equivalent to parts per million.

(c) Sediment

Table 22.7-9b
Summary Statistics for Analytes in Surface Water
Interim Measures Confirmation Sampling Data
Site 29 - Gator Z Mine Scrap Disposal Area
Jefferson Proving Ground
Madison, Indiana

Site	Medium	Analyte Code	Analyte	Number of Detects	Number of Samples	Detection Frequency	Minimum	Maximum	Average	Standard Deviation	UCL95	EPC µg/ml [(a)]
29	CSW [(b)]	BA	Barium	1	1	100	0.053	0.053	NA [(c)]	NA	NA	0.053
29	CSW	OG	Oil and grease	1	1	100	0.86	0.86	NA	NA	NA	0.86
29	CSW	TPH	Total petroleum hydrocarbons	1	1	100	0.57	0.57	NA	NA	NA	0.57

Footnotes:

(a) Exposure point concentration, micrograms per milliter, equivalent to parts per million.

(b) Surface water.

(c) Not analyzed.

Table 22.7-10
Summary of Contaminants of Potential Concern Exposure Point Concentrations by Medium
Interim Measures Confirmation Sampling Data
Site 29 - Gator Z Mine Scrap Disposal Area
Jefferson Proving Ground
Madison, Indiana

	Measured Concentrations in Abiotic Media				Estimated Concentrations in Biotic Media							
Analyte Name	Filtered Surface Water (µg/L) [a]	Sediment (mg/kg) [b]	Unfiltered Surface Water (mg/L) [c]	Soil (mg/kg)	Plant (mg/kg)	Invertebrate (mg/kg)	Mouse (mg/kg)	Swift (mg/kg)	Aquatic Plants (mg/kg)	Benthic Invertebrate (mg/kg)	Fish (mg/kg)	Frogs (mg/kg)
Barium	53.0	36.0	0.053		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium		8.00			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium		5.00			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury		0.02			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total petroleum hydrocarbons	570		0.57		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Footnotes:

(a) Micrograms per liter, equivalent to parts per billion.

(b) Milligrams per kilograms, equivalent to parts per million.

(c) Milligram per liter, equivalent to parts per million.

Table 22.7-11
Summary Statistics for Analytes in Surface Soil (Phase III)
Site 39 (& 28, 29) - Gator Z Mine Areas
Jefferson Proving Ground
Madison, Indiana

Site	Medium	Analyte Code	Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Standard Deviation	UCL95 (a)	EPC µg/g (b)	Exceed Background (Bkg)?	Retain as COPC(c)?	Comment
39	CSO	AG	Silver	0	5	0	NC(d)	NC	NC	NC	NC	NC	NA(e)	No (N)	Not a COPC
39	CSO	AL	Aluminum	5	5	100	7390	11200	9632	1497	11059	11059	N	N	
39	CSO	AS	Arsenic	5	5	100	4.90	20.10	10.33	6.09	16.13	16.13	Yes (Y)	Y	
39	CSO	B	Boron	0	5	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
39	CSO	BA	Barium	5	5	100	33.45	52.40	44.21	6.88	50.77	50.77	N	N	
39	CSO	BE	Beryllium	5	5	100	0.32	0.82	0.46	0.21	0.65	0.65	N	N	
39	CSO	CD	Cadmium	5	5	100	0.09	0.37	0.17	0.11	0.28	0.28	Y	Y	
39	CSO	CO	Cobalt	1	5	20	1.59	7.75	3.25	2.57	5.70	5.70	Y	Y	
39	CSO	CR	Chromium	5	5	100	10.90	28.60	18.41	7.07	25.15	25.15	Y	Y	
39	CSO	CU	Copper	5	5	100	4.55	11.60	7.41	3.04	10.31	10.31	Y	Y	
39	CSO	CYN	Cyanide	0	5	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
39	CSO	FE	Iron	5	5	100	12100	44200	24600	13476	37448	37448	Y	Y	
39	CSO	HG	Mercury	0	5	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
39	CSO	MN	Manganese	5	5	100	147.5	402.0	292.7	93.30	381.7	381.7	N	N	
39	CSO	MO	Molybdenum	3	5	60	1.64	6.94	4.49	1.94	6.34	6.34	Y	Y	
39	CSO	NI	Nickel	5	5	100	2.74	7.23	5.32	1.77	7.01	7.01	Y	Y	
39	CSO	PB	Lead	5	5	100	12.40	20.00	15.00	3.06	17.91	17.91	N	N	
39	CSO	SB	Antimony	3	5	60	0.25	0.50	0.34	0.10	0.44	0.44	N	N	
39	CSO	SE	Selenium	4	5	80	0.25	0.77	0.49	0.20	0.68	0.68	N	N	
39	CSO	SN	Tin	0	5	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
39	CSO	TL	Thallium	0	5	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
39	CSO	V	Vanadium	5	5	100	21.70	49.80	34.83	12.66	46.90	46.90	Y	Y	
39	CSO	ZN	Zinc	5	5	100	16.70	33.30	24.46	7.38	31.49	31.49	Y	Y	

General Note:

1. Calcium, magnesium, sodium and potassium were not included in risk assessment as they are macronutrients.

Footnotes:

(a) Upper 95% confidence limit.

(b) Exposure point concentration, micrograms per gram, equivalent to parts per million.

(c) Contaminant of potential concern.

(d) Not calculated. Not a COPC.

(e) Not applicable or not evaluated.

Table 22.7-12
Summary of COPC Exposure Point Concentrations by Medium (Phase III)
Site 39 (& 28, 29) - Gator Z Mine Areas
Jefferson Proving Ground
Madison, Indiana

	Measured Concentrations in Abiotic Media				Estimated Concentrations in Biotic Media							
Analyte Name	Filtered Surface Water (µg/L) [(a)]	Sediment (mg/kg) [(b)]	Unfiltered Surface Water (mg/L) [(c)]	Soil (mg/kg)	Plant (mg/kg)	Invertebrate (mg/kg)	Mouse (mg/kg)	Swift (mg/kg)	Aquatic Plants (mg/kg)	Benthic Invertebrate (mg/kg)	Fish (mg/kg)	Frogs (mg/kg)
Arsenic				16.13	3.39E-01	1.82E+00	2.81E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium				0.28	1.12E-01	1.04E+00	1.40E-03	2.14E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium				25.15	3.02E-01	6.54E-01	4.90E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt				5.70	1.03E-01	2.00E-01	2.65E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper				10.31	1.02E+00	9.07E+00	7.88E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Iron				37448	1.50E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Molybdenum				6.34	1.59E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel				7.01	3.08E-01	3.51E-01	1.41E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Vanadium				46.90	1.41E-01	4.22E-01	5.85E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc				31.49	1.73E+01	2.08E+01	1.28E+00	2.41E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Footnotes:

(a) Micrograms per liter, equivalent to parts per billion.

(b) Milligrams per kilogram, equivalent to parts per million.

(c) Milligrams per liter, equivalent to parts per million.

Table 22.7-13
Summary of Detailed Ecological Risk Assessment Reasonable Maximum Exposure (RME) Risk Drivers (Phase I)
Site 28 - Gator Z Open Burn Area
Jefferson Proving Ground
Madison, Indiana

28	NOAEL[a]-Based HQs[b] Due to Soil Ingestion or Direct Contact - RME							NOAEL-Based HQs Due to Dietary Ingestion - RME				Total NOAEL-Based HQs Summed Across Pathways - RME							
Parameter	American Kestrel	White-footed Mouse	Eastern Cottontail	Red Fox	Little Brown Myotis	Plants	Soil Fauna	Chimney Swift	White-footed Mouse	Eastern Cottontail	Little Brown Myotis	Chimney Swift	American Kestrel	White-footed Mouse	Eastern Cottontail	Red Fox	Little Brown Myotis	Plants	Soil Fauna
Aluminum		10.75				283.12	5.66		3.95					14.71				283.12	5.66
Antimony		2.53				11.70			28.18					30.71				11.70	
Arsenic		19.75	1.10			2.28			64.85					84.60	1.44			2.28	
Barium									3.56					4.35					
Boron		1.47							144.05	4.86				145.52	4.94				
Cadmium		1.86				11.93	3.98	1.34	187.77		1.01	1.38		189.63			1.01	11.93	3.98
Chromium		22.34				687.81	8597.60		20.80					43.13				687.81	8597.60
Cobalt		6.53				2.16			8.48					15.01				2.16	
Copper		53.74	2.99			268.93	320.92		1289.08	4.40	6.87			1342.83	7.39		7.03	268.93	320.92
Iron		50.61	2.81				194.81		4.96					55.57	2.98				194.81
Lead		10.93				9.40	2.78		53.54	1.18				64.47	1.78			9.40	2.78
Manganese						4.66												4.66	
Molybdenum		5.28							32.36					37.64					
Nickel						79.20			2.25					3.23				79.20	
Silver						8.39												8.39	
Thallium		23.81	1.32						2.33					26.14	1.40				
Tin		1985.52	110.42	1.21	5.89				1459.36	49.27				3444.88	159.68	2.14	5.89		
Vanadium	1.25	235.25	13.08			75.46	7.55		69.16				1.26	304.42	13.67		1.01	75.46	7.55
Zinc		20.01	1.11			872.88	436.44	1.43	593.18	9.10	1.92	1.69		613.19	10.22		1.98	872.88	436.44
HI[c]_NOAEL	**1.25**	**2450**	**132.8**	**1.21**	**5.89**	**2318**	**9570**	**2.78**	**3968**	**68.81**	**9.80**	**3.07**	**1.26**	**6420**	**203.5**	**2.14**	**16.92**	**2318**	**9570**

Table 22.7-13
Summary of Detailed Ecological Risk Assessment Reasonable Maximum Exposure (RME) Risk Drivers (Phase I)
Site 28 - Gator Z Open Burn Area
Jefferson Proving Ground
Madison, Indiana

28	LOAEL[d]-Based HQs Due to Soil Ingestion - RME				LOAEL-Based HQs Due to Dietary Ingestion - RME		Total LOAEL-Based HQs Summed Across Pathways - RME			
Parameter	**White-footed Mouse**	**Eastern Cottontail**	**Plants**	**Soil Fauna**	**White-footed Mouse**	**Eastern Cottontail**	**White-footed Mouse**	**Eastern Cottontail**	**Plants**	**Soil Fauna**
Aluminum	5.45		19.39	5.06	2.00		7.46		19.39	5.06
Antimony					9.39		10.24			
Arsenic	1.56				5.12		6.68			
Boron					72.02	2.43	72.76	2.47		
Cadmium				1.79						1.79
Chromium			17.20						17.20	
Copper			25.32	67.23					25.32	67.23
Iron	25.31	1.41			2.48		27.79	1.49		
Lead			3.41		1.26		1.52		3.41	
Molybdenum	1.06				6.47		7.53			
Nickel			39.60				1.08		39.60	
Tin	90.94	5.06			66.84	2.26	157.78	7.31		
Vanadium	78.42	4.36			23.05		101.47	4.56		
Zinc	3.33		115.16	50.51	98.86	1.52	102.20	1.70	115.16	50.51
HI_LOAEL	**206.1**	**10.83**	**220.1**	**124.6**	**287.5**	**6.21**	**496.5**	**17.54**	**220.1**	**124.6**

Footnotes:
(a) No Observed Adverse Effect Level
(b) Hazard Quotient
(c) Hazard Index
(d) Lowest Observed Adverse Effect Level

Table 22.7-14
Summary of Detailed Ecological Risk Assessment Central Tendency (CT) Risk Drivers (Phase I)
Site 28 - Gator Z Open Burn Area
Jefferson Proving Ground
Madison, Indiana

28	NOAEL[a]-Based HQs[b] Due to Soil Ingestion - CT				NOAEL-Based HQs Due to Dietary Ingestion - CT						Total NOAEL-Based HQs Summed Across Pathways - CT				
Parameter	Chimney Swift	White-footed Mouse	Eastern Cottontail	Little Brown Myotis	Chimney Swift	American Kestrel	White-footed Mouse	Eastern Cottontail	Little Brown Myotis	Mourning Dove	Chimney Swift	American Kestrel	White-footed Mouse	Eastern Cottontail	Little Brown Myotis
Aluminum		6.66					2.45						9.10		
Antimony		1.57					17.44						19.01		
Arsenic		12.23	1.11				40.14						52.36	1.46	
Barium							2.20						2.69		
Boron							89.16	4.93					90.07	5.02	
Cadmium		1.15			2.83	1.66	116.22		2.37		2.92	1.69	117.37		2.38
Chromium		13.82					12.87				1.08		26.70		
Cobalt		4.04					5.25						9.29		
Copper		33.26	3.03		1.21		797.86	4.46	16.21		1.37		831.13	7.50	16.58
Iron		31.32	2.85				3.07						34.39	3.02	
Lead		6.76					33.14	1.19					39.90	1.81	
Molybdenum		3.27					20.03						23.30		
Nickel							1.39						2.00		
Thallium		14.73	1.34				1.44						16.18	1.42	
Tin		1228.91	112.00	13.89			903.25	49.97					2132.17	161.97	13.89
Vanadium	1.54	145.61	13.27	1.65			42.81				1.65		188.42	13.86	2.37
Zinc		12.38	1.13		3.02	1.83	367.14	9.23	4.53	1.18	3.55	1.96	379.53	10.36	4.67
HI[c]_NOAEL	**1.54**	**1516**	**134.7**	**15.53**	**7.07**	**3.50**	**2456**	**69.80**	**23.11**	**1.18**	**10.58**	**3.65**	**3974**	**206.4**	**39.89**

28	LOAEL[d]-Based HQs Due to Soil Ingestion - CT		LOAEL-Based HQs Due to Dietary Ingestion - CT		Total LOAEL-Based HQs Summed Across Pathways - CT		
Parameter	White-footed Mouse	Eastern Cottontail	White-footed Mouse	Eastern Cottontail	Chimney Swift	White-footed Mouse	Eastern Cottontail
Aluminum	3.37		1.24			4.62	
Antimony			5.81			6.34	
Arsenic			3.17			4.13	
Boron			44.58	2.47		45.03	2.51
Copper					1.04		
Iron	15.66	1.43	1.53			17.20	1.51
Molybdenum			4.01			4.66	
Tin	56.29	5.13	41.37	2.29		97.66	7.42
Vanadium	48.54	4.42	14.27			62.81	4.62
Zinc	2.06		61.19	1.54		63.25	1.73
HI_LOAEL	**125.9**	**10.98**	**177.2**	**6.29**	**1.04**	**305.7**	**17.79**

Footnotes:

(a) No Observed Adverse Effect Level

(b) Hazard Quotient

(c) Hazard Index

(d) Lowest Observed Adverse Effect Level

Table 22.7-15
Summary of Detailed Ecological Risk Assessment Reasonable Maximum Exposure (RME) Risk Drivers (Phase I)
Site 29 - Gator Z Mine Scrap Disposal Area
Jefferson Proving Ground
Madison, Indiana

29	NOAEL[a]-Based HQs[b] Due to Sediment Ingestion or Direct Contact - RME				NOAEL-Based HQs Due to Dietary Ingestion - RME	Total NOAEL-Based HQs Summed Across Pathways - RME			
Parameter	Great Blue Heron	Benthic Invertebrate	Creek Chub	Pickerel Frog	Great Blue Heron	Great Blue Heron	Benthic Invertebrate	Creek Chub	Pickerel Frog
Cadmium		14.17	14.17	14.17	1.01	2.00	14.18	14.18	14.18
Vanadium	4.98					4.98			
HI[c]_NOAEL	**4.98**	**14.17**	**14.17**	**14.17**	**1.01**	**6.98**	**14.18**	**14.18**	**14.18**

29	LOAEL[d]-Based HQs Due to Sediment Ingestion or Direct Contact - RME			Total LOAEL-Based HQs Summed Across Pathways - RME		
Parameter	Benthic Invertebrate	Creek Chub	Pickerel Frog	Benthic Invertebrate	Creek Chub	Pickerel Frog
Cadmium	2.13	2.13	2.13	2.13	2.13	2.13
HI_LOAEL	**2.13**	**2.13**	**2.13**	**2.13**	**2.13**	**2.13**

Footnotes:

(a) No Observed Adverse Effect Level

(b) Hazard Quotient

(c) Hazard Index

(d) Lowest Observed Adverse Effect Level

Table 22.7-16
Summary of Detailed Ecological Risk Assessment Central Tendency (CT) Risk Drivers (Phase I)
Site 29 - Gator Z Mine Scrap Disposal Area
Jefferson Proving Ground
Madison, Indiana

29	NOAEL[(a)]-Based HQs[(b)] Due to Sediment Ingestion or Direct Contact - CT				NOAEL-Based HQs Due to Dietary Ingestion - CT	Total NOAEL-Based HQs Summed Across Pathways - CT			
Parameter	**Great Blue Heron**	**Benthic Invertebrate**	**Creek Chub**	**Pickerel Frog**	**Great Blue Heron**	**Great Blue Heron**	**Benthic Invertebrate**	**Creek Chub**	**Pickerel Frog**
Cadmium	2.14	14.17	14.17	14.17	2.23	4.41	14.18	14.18	14.18
Vanadium	11.03					11.03			
HI[(c)]_NOAEL	**13.17**	**14.17**	**14.17**	**14.17**	**2.23**	**15.43**	**14.18**	**14.18**	**14.18**

29	LOAEL[(d)]-Based HQs Due to Sediment Ingestion or Direct Contact - CT			Total LOAEL-Based HQs Summed Across Pathways - CT		
Parameter	**Benthic Invertebrate**	**Creek Chub**	**Pickerel Frog**	**Benthic Invertebrate**	**Creek Chub**	**Pickerel Frog**
Cadmium	2.13	2.13	2.13	2.13	2.13	2.13
HI_LOAEL	**2.13**	**2.13**	**2.13**	**2.13**	**2.13**	**2.13**

Footnotes:
(a) No Observed Adverse Effect Level
(b) Hazard Quotient
(c) Hazard Index
(d) Lowest Observed Adverse Effect Level

Table 22.7-17
Summary of Detailed Ecological Risk Assessment Reasonable Maximum Exposure (RME) Risk Drivers (Phase I)
Site 39 - Gator Z Mine Test Area
Jefferson Proving Ground
Madison, Indiana

39	NOAEL[a]-Based HQs[b] Due to Soil Ingestion or Direct Contact - RME						NOAEL-Based HQs Due to Dietary Ingestion - RME		Total NOAEL-Based HQs Summed Across Pathways - RME					
Parameter	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**Plants**	**Soil Fauna**	**White-footed Mouse**	**Eastern Cottontail**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**Plants**	**Soil Fauna**
Boron							5.18	3.24		5.23	3.30			
Chromium					8.96	112.03							8.96	112.03
Cobalt							1.21			2.15	1.22			
Copper							1.11			1.15				
Iron	1.20	5.68	5.86	1.35		21.87			1.20	6.24	6.20	1.35		21.87
Lead							1.81			2.19	1.12			
Mercury					1.53	4.60							1.53	4.60
Nickel					1.36								1.36	
Zinc					2.81	1.41	1.91			1.98			2.81	1.41
HI[c]_NOAEL	**1.20**	**5.68**	**5.86**	**1.35**	**14.67**	**139.90**	**11.23**	**3.24**	**1.20**	**18.93**	**11.84**	**1.35**	**14.67**	**139.90**

39	LOAEL[d]-Based HQs Due to Soil Ingestion - RME		LOAEL-Based HQs Due to Dietary Ingestion - RME		Total LOAEL-Based HQs Summed Across Pathways - RME	
Parameter	**White-footed Mouse**	**Eastern Cottontail**	**White-footed Mouse**	**Eastern Cottontail**	**White-footed Mouse**	**Eastern Cottontail**
Boron			2.59	1.62	2.62	1.65
Iron	2.84	2.93			3.12	3.10
HI_LOAEL	**2.84**	**2.93**	**2.59**	**1.62**	**5.74**	**4.75**

Footnotes:

(a) No Observed Adverse Effect Level

(b) Hazard Quotient

(c) Hazard Index

(d) Lowest Observed Adverse Effect Level

Table 22.7-18
Summary of Detailed Ecological Risk Assessment Central Tendency (CT) Risk Drivers (Phase I)
Site 39 - Gator Z Mine Test Area
Jefferson Proving Ground
Madison, Indiana

39	NOAEL[a]-Based HQs[b] Due to Soil Ingestion - CT			NOAEL-Based HQs Due to Dietary Ingestion - CT		Total NOAEL-Based HQs Summed Across Pathways - CT		
Parameter	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**White-footed Mouse**	**Eastern Cottontail**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**
Boron				3.21	3.17	3.24	3.22	
Cobalt						1.33	1.19	
Iron	3.52	5.72	1.27			3.86	6.06	1.27
Lead				1.12		1.35	1.09	
Zinc				1.18		1.22		
HI[c]_NOAEL	**3.52**	**5.72**	**1.27**	**5.51**	**3.17**	**11.00**	**11.56**	**1.27**

39	LOAEL[d]-Based HQs Due to Soil Ingestion - CT		LOAEL-Based HQs Due to Dietary Ingestion - CT		Total LOAEL-Based HQs Summed Across Pathways - CT	
Parameter	**White-footed Mouse**	**Eastern Cottontail**	**White-footed Mouse**	**Eastern Cottontail**	**White-footed Mouse**	**Eastern Cottontail**
Boron			1.60	1.58	1.62	1.61
Iron	1.76	2.86			1.93	3.03
HI_LOAEL	**1.76**	**2.86**	**1.60**	**1.58**	**3.55**	**4.64**

Footnotes:
(a) No Observed Adverse Effect Level
(b) Hazard Quotient
(c) Hazard Index
(d) Lowest Observed Adverse Effect Level

Table 22.7-19
Summary of Detailed Ecological Risk Assessment Reasonable Maximum Exposure (RME) Risk Drivers
Interim Measures Confirmation Sampling
Site 28 - Gator Z Open Burn Area
Jefferson Proving Ground
Madison, Indiana

28	NOAEL[(a)]-Based HQs[(b)] Due to Soil Ingestion or Direct Contact - RME				NOAEL-Based HQs Due to Dietary Ingestion - RME			Total NOAEL-Based HQs Summed Across Pathways - RME					
Parameter	**White-footed Mouse**	**Eastern Cottontail**	**Plants**	**Soil Fauna**	**Chimney Swift**	**White-footed Mouse**	**Little Brown Myotis**	**Chimney Swift**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**Plants**	**Soil Fauna**
Aluminum	4.29		113.00	2.26		1.58			5.87			113.00	2.26
Arsenic	3.04					9.97			13.01				
Cadmium	1.90		12.16	4.05	1.37	191.30	1.02	1.41	193.20		1.03	12.16	4.05
Chromium			11.96	149.56								11.96	149.56
Copper	1.05		5.27	6.29		25.28			26.33			5.27	6.29
Lead						1.81			2.18				
Nickel			1.24									1.24	
Thallium									1.06				
Vanadium	19.99	1.11	6.41			5.88			25.87	1.16		6.41	
Zinc			14.63	7.31		9.94			10.27			14.63	7.31
HI[(c)]_NOAEL	**30.27**	**1.11**	**164.7**	**169.5**	**1.37**	**245.8**	**1.02**	**1.41**	**277.8**	**1.16**	**1.03**	**164.7**	**169.5**

28	LOAEL[(d)]-Based HQs Due to Soil Ingestion - RME			LOAEL-Based HQs Due to Dietary Ingestion - RME	Total LOAEL-Based HQs Summed Across Pathways - RME		
Parameter	**White-footed Mouse**	**Plants**	**Soil Fauna**	**White-footed Mouse**	**White-footed Mouse**	**Plants**	**Soil Fauna**
Aluminum	2.18	7.74	2.02		2.98	7.74	2.02
Arsenic					1.03		
Cadmium			1.82				1.82
Copper			1.32				1.32
Vanadium	6.66			1.96	8.62		
Zinc		1.93		1.66	1.71	1.93	
HI_LOAEL	**8.84**	**9.67**	**5.16**	**3.62**	**14.34**	**9.67**	**5.16**

Footnotes:

(a) No Observed Adverse Effect Level

(b) Hazard Quotient

(c) Hazard Index

(d) Lowest Observed Adverse Effect Level

Table 22.7-20
Summary of Detailed Ecological Risk Assessment Central Tendency (CT) Risk Drivers
Interim Measures Confirmation Sampling
Site 28 - Gator Z Open Burn Area
Jefferson Proving Ground
Madison, Indiana

28	NOAEL[a]-Based HQs[b] Due to Soil Ingestion - CT		NOAEL-Based HQs Due to Dietary Ingestion - CT				Total NOAEL-Based HQs Summed Across Pathways - CT				
Parameter	**White-footed Mouse**	**Eastern Cottontail**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Little Brown Myotis**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**
Aluminum	2.66								3.63		
Arsenic	1.88				6.17				8.05		
Cadmium	1.17		2.88	1.70	118.40	2.42	2.97	1.72	119.58		2.43
Copper					15.65				16.30		
Lead					1.12				1.35		
Vanadium	12.37	1.13			3.64				16.01	1.18	
Zinc					6.15				6.36		
HI[c]_NOAEL	**18.08**	**1.13**	**2.88**	**1.70**	**151.1**	**2.42**	**2.97**	**1.72**	**171.3**	**1.18**	**2.43**

28	LOAEL[d]-Based HQs Due to Soil Ingestion - CT	LOAEL-Based HQs Due to Dietary Ingestion - CT	Total LOAEL-Based HQs Summed Across Pathways - CT
Parameter	**White-footed Mouse**	**White-footed Mouse**	**White-footed Mouse**
Aluminum	1.35		1.84
Vanadium	4.12	1.21	5.34
Zinc		1.03	1.06
HI_LOAEL	**5.47**	**2.24**	**8.24**

Footnotes:

(a) No Observed Adverse Effect Level

(b) Hazard Quotient

(c) Hazard Index

(d) Lowest Observed Adverse Effect Level

Table 22.7-20a
Summary of Detailed Ecological Risk Assessment Reasonable Maximum Exposure (RME) Risk Driver
Interim Measures Confirmation Sampling
Site 29 - Gator Z Mine Scrap Disposal Area
Jefferson Proving Ground
Madison, Indiana

29	NOAEL[a]-Based HQs[b] Due to Sediment Ingestion or Direct Contact - RME			Total NOAEL-Based HQs Summed Across Pathways - RME		
Parameter	**Benthic Invertebrate**	**Creek Chub**	**Pickerel Frog**	**Benthic Invertebrate**	**Creek Chub**	**Pickerel Frog**
Cadmium	7	7	7	7	7	7
HI[c]_NOAEL	**7**	**7**	**7**	**7**	**7**	**7**

29	LOAEL[d]-Based HQs Due to Sediment Ingestion or Direct Contact RME			Total LOAEL-Based HQs Summed Across Pathways - RME		
Parameter	**Benthic Invertebrate**	**Creek Chub**	**Pickerel Frog**	**Benthic Invertebrate**	**Creek Chub**	**Pickerel Frog**
Cadmium	1	1	1	1	1	1
HI_LOAEL	**1**	**1**	**1**	**1**	**1**	**1**

Footnotes:

(a) No Observed Adverse Effect Level

(b) Hazard Quotient

(c) Hazard Index

(d) Lowest Observed Adverse Effect Level

Table 22.7-20b

Summary of Detailed Ecological Risk Assessment Central Tendency (CT) Risk Drivers

Interim Measures Confirmation Sampling

Site 29 - Gator Z Mine Scrap Disposal Area

Jefferson Proving Ground

Madison, Indiana

29	NOAEL[(a)]-Based HQs[(b)] Due to Sediment Ingestion or Direct Contact - CT			Total NOAEL-Based HQs Summed Across Pathways - CT		
Parameter	**Benthic Invertebrate**	**Creek Chub**	**Pickerel Frog**	**Benthic Invertebrate**	**Creek Chub**	**Pickerel Frog**
Cadmium	7	7	7	7	7	7
HI[(c)]_NOAEL	**7**	**7**	**7**	**7**	**7**	**7**

29	LOAEL[(d)]-Based HQs Due to Sediment Ingestion or Direct Contact - CT			Total LOAEL-Based HQs Summed Across Pathways - CT		
Parameter	**Benthic Invertebrate**	**Creek Chub**	**Pickerel Frog**	**Benthic Invertebrate**	**Creek Chub**	**Pickerel Frog**
Cadmium	1.0	1.0	1.0	1.0	1.0	1.0
HI_LOAEL	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**

Footnotes:

(a) No Observed Adverse Effect Level

(b) Hazard Quotient

(c) Hazard Index

(d) Lowest Observed Adverse Effect Level

Table 22.7-21
Summary of Detailed Ecological Risk Assessment Reasonable Maximum Exposure (RME) Risk Drivers (Phase III)
Site 39 (& 28, 29) - Gator Z Mine Areas
Jefferson Proving Ground
Madison, Indiana

39	NOAEL[a]-Based HQs[b] Due to Soil Ingestion or Direct Contact - RME									NOAEL-Based HQs Due to Dietary Ingestion - RME				
Parameter	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**	**Plants**	**Soil Fauna**	**Chimney Swift**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**
Arsenic				13.97	14.40		3.31	1.61			45.86	4.50	1.00	18.35
Cadmium											1.47			
Chromium								5.03	62.88					
Cobalt											1.12			
Iron		1.20	2.05	9.73	10.03		2.31		37.45					
Molybdenum											3.36	1.26		
Vanadium	6.07	18.11	31.02	73.11	75.34	3.56	17.35	23.45	2.35	1.40	21.49	3.36		7.65
HI[c]_NOAEL	**6.07**	**19.30**	**33.07**	**96.81**	**99.77**	**3.56**	**22.97**	**30.09**	**102.7**	**1.40**	**73.31**	**9.12**	**1.00**	**26.01**

39	Total NOAEL-Based HQs Summed Across Pathways - RME								
Parameter	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**	**Plants**	**Soil Fauna**
Arsenic				59.83	18.89	1.68	21.67	1.61	
Cadmium				1.48					
Chromium								5.03	62.88
Cobalt				1.99	1.13				
Iron		1.20	2.05	10.68	10.62		2.31		37.45
Molybdenum				3.91	1.60				
Vanadium	6.23	19.51	31.35	94.60	78.71	4.04	25.00	23.45	2.35
HI_NOAEL	**6.23**	**20.71**	**33.40**	**172.5**	**111.0**	**5.72**	**48.98**	**30.09**	**102.7**

39	LOAEL[d]-Based HQs Due to Soil Ingestion - RME						LOAEL-Based HQs Due to Dietary Ingestion - RME			Total LOAEL-Based HQs Summed Across Pathways - RME					
Parameter	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**
Arsenic			1.10	1.14			3.62		1.45			4.72	1.49		1.71
Iron		1.03	4.86	5.01		1.15					1.03	5.34	5.31		1.15
Vanadium	1.21	2.07	24.37	25.11	1.19	5.78	7.16	1.12	2.55	1.30	2.09	31.53	26.24	1.35	8.33
HI_LOAEL	**1.21**	**3.09**	**30.34**	**31.26**	**1.19**	**6.94**	**10.78**	**1.12**	**4.00**	**1.30**	**3.12**	**41.60**	**33.04**	**1.35**	**11.20**

Footnotes:

(a) No Observed Adverse Effect Level

(b) Hazard Quotient

(c) Hazard Index

(d) Lowest Observed Adverse Effect Level

Table 22.7-22
Summary of Detailed Ecological Risk Assessment Central Tendency (CT) Risk Drivers (Phase III)
Site 39 (& 28, 29) - Gator Z Mine Areas
Jefferson Proving Ground
Madison, Indiana

39	NOAEL[(a)]-Based HQs[(b)] Due to Soil Ingestion - CT						NOAEL-Based HQs Due to Dietary Ingestion - CT				Total NOAEL-Based HQs Summed Across Pathways - CT					
Parameter	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**Chimney Swift**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**
Arsenic				8.65	14.06	3.13		28.38	4.39	17.31				37.03	18.45	20.44
Cobalt														1.23	1.10	
Iron		1.01		6.02	9.79	2.18						1.01		6.61	10.37	2.18
Molybdenum								2.08	1.23					2.42	1.56	
Vanadium	5.93	15.27	3.71	45.25	73.57	16.36	1.18	13.30	3.28	7.22	6.08	16.45	4.41	58.55	76.85	23.58
HI[(c)]_NOAEL	**5.93**	**16.28**	**3.71**	**59.92**	**97.42**	**21.67**	**1.18**	**43.77**	**8.91**	**24.53**	**6.08**	**17.46**	**4.41**	**105.8**	**108.3**	**46.19**

39	LOAEL[(d)]-Based HQs Due to Soil Ingestion - CT				LOAEL-Based HQs Due to Dietary Ingestion - CT			Total LOAEL-Based HQs Summed Across Pathways - CT			
Parameter	**Chimney Swift**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**	**Chimney Swift**	**White-footed Mouse**	**Eastern Cottontail**	**Little Brown Myotis**
Arsenic			1.11		2.24		1.37		2.92	1.46	1.61
Iron		3.01	4.90	1.09					3.31	5.19	1.09
Vanadium	1.02	15.08	24.52	5.45	4.43	1.09	2.41	1.10	19.52	25.62	7.86
HI_LOAEL	**1.02**	**18.09**	**30.53**	**6.54**	**6.68**	**1.09**	**3.77**	**1.10**	**25.75**	**32.26**	**10.56**

Footnotes:
(a) No Observed Adverse Effect Level
(b) Hazard Quotient
(c) Hazard Index
(d) Lowest Observed Adverse Effect Level

FIGURES

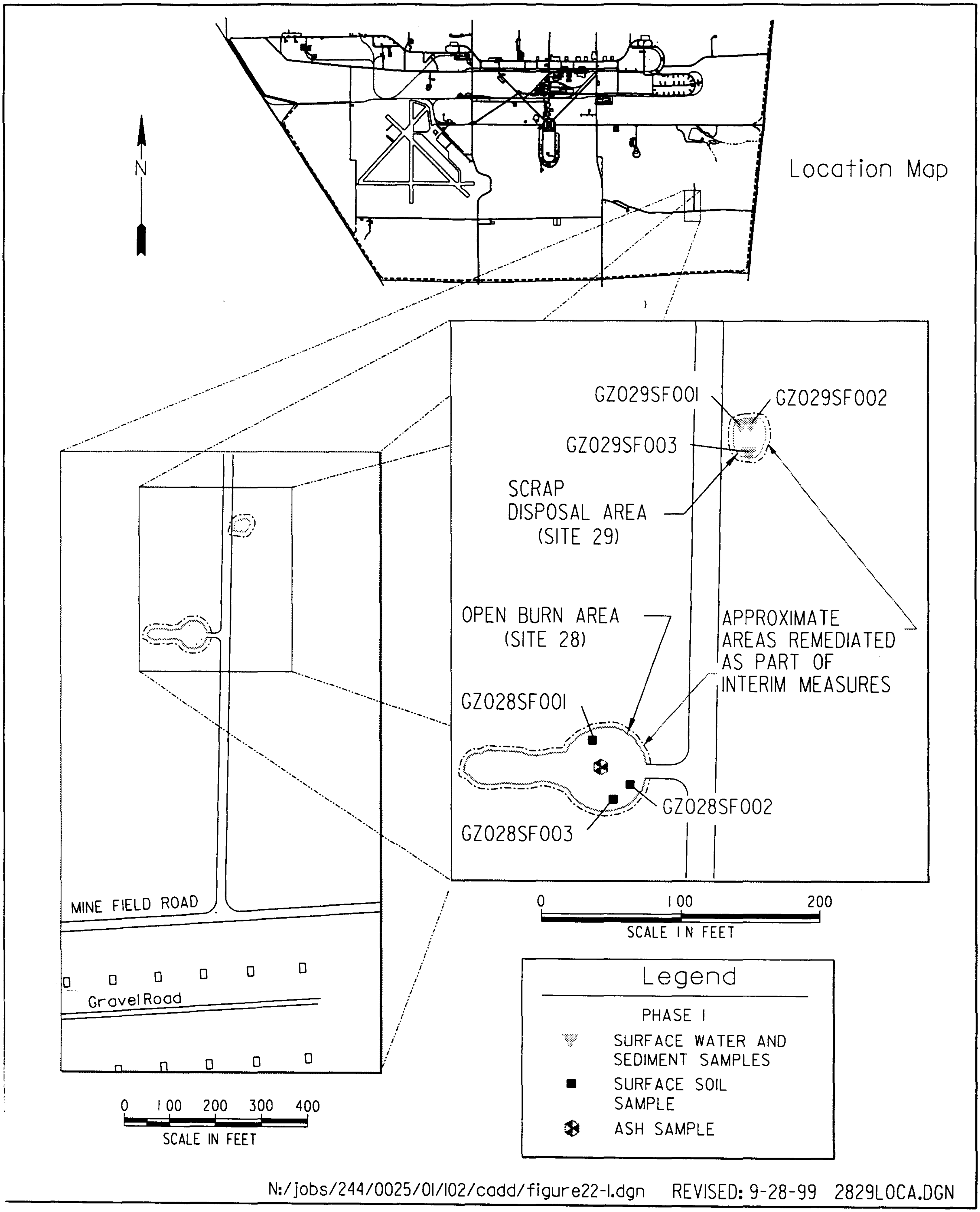


Figure 22-1. Sampling Locations at Gator Z Open Burn Area (Site 28) and Gator Z Mine Scrap Disposal Area (Site 29)

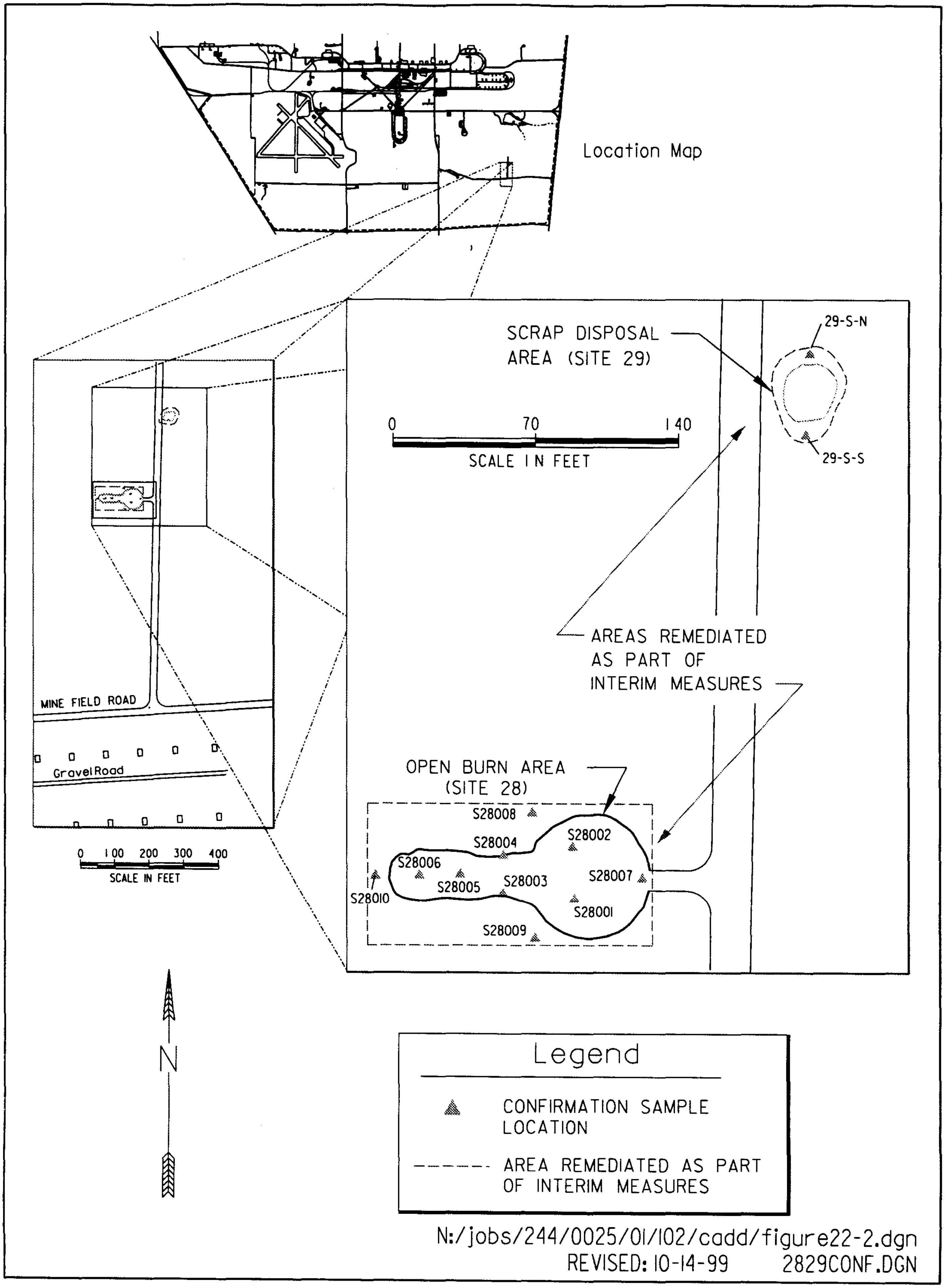


Figure 22-2. Confirmation Sample Locations and Excavation Outline Gator Z Open Burn Area (Site 28) and Gator Z Mine Sweep Disposal Area (Site 29)

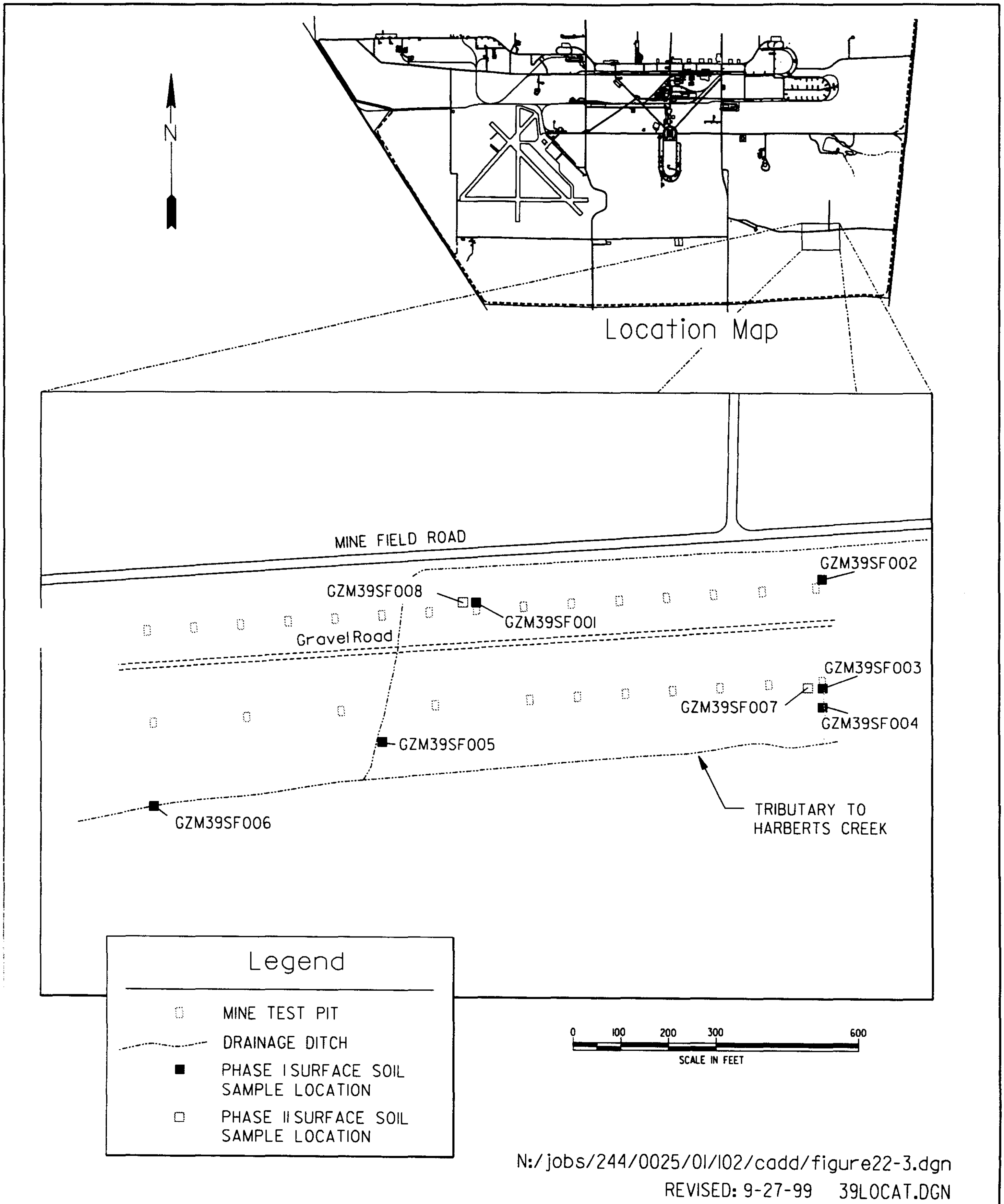


Figure 22-3. Sampling Locations at Gator Z Mine Test Area (Site 39)

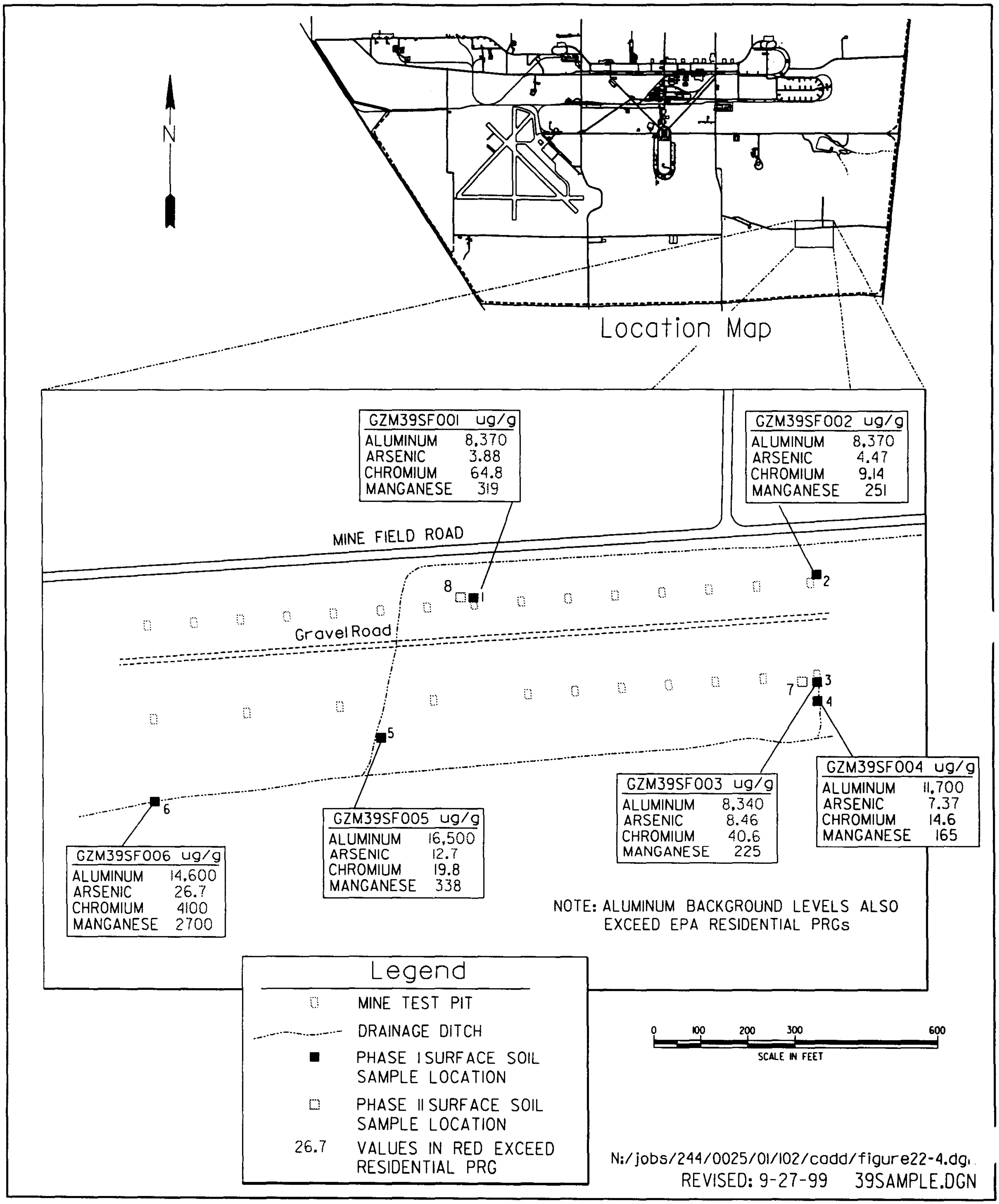


Figure 22-4. Summary of Samples Exceeding Background and Regulatory Risk-Based Concentrations at Gator Z Mine Test Area (Site 39)

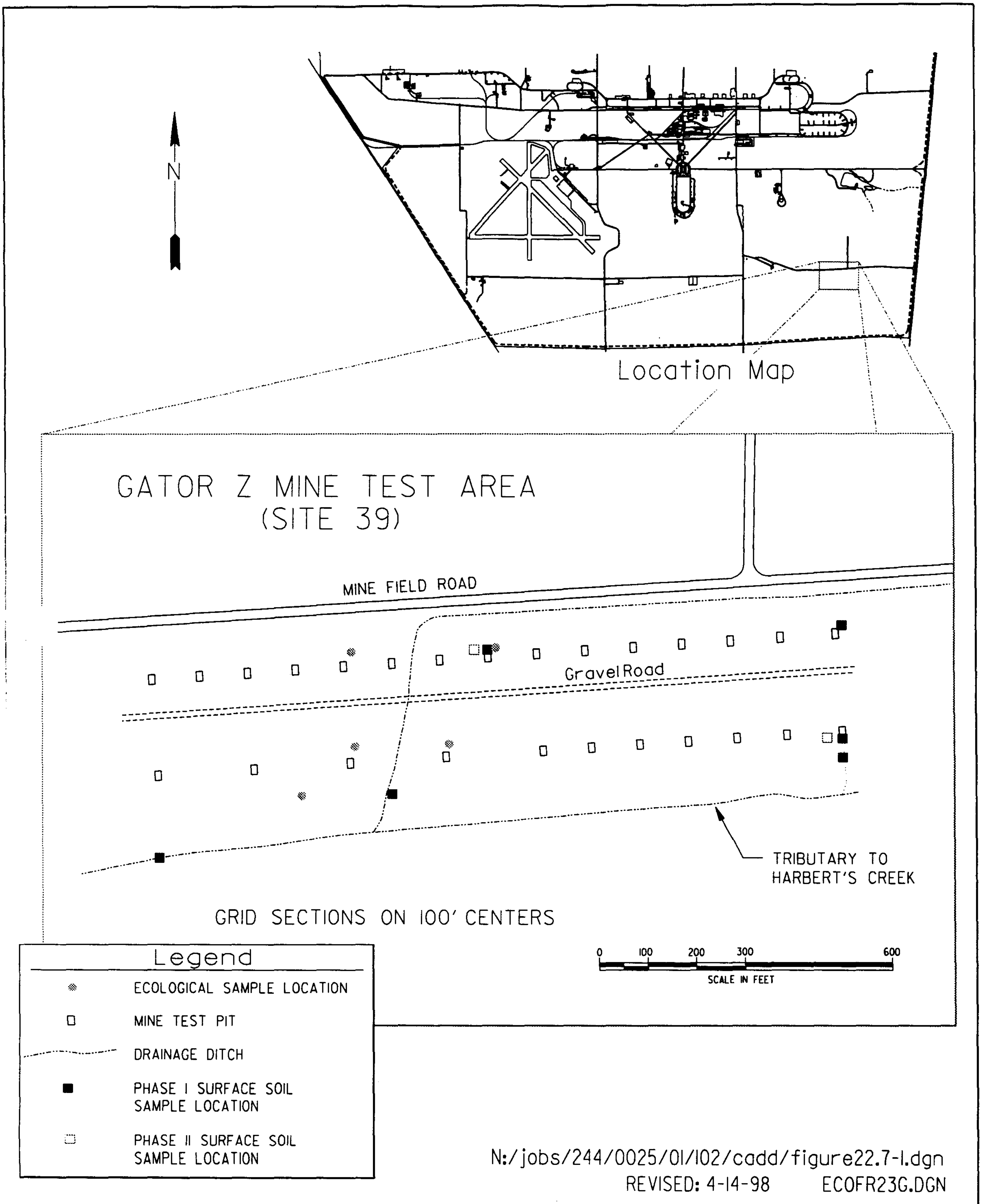


Figure 22.7-1. Gator Z Mine Test Area (Site 39)

Receptor & Exposure Data

Primary Source	Primary Release	Primary Transport	Exposure Medium	Plants	Soil Fauna[1]	Mourning Dove	Chimney Swift	Wild Turkey	Great Blue Heron	American Kestrel	White-Footed Mouse	Eastern Cotton-tail	Little Brown Myotis	Raccoon	Red Fox	Pickerel Frog	Creek Chub	Benthic Inver-tebrates[1]
Spills, Leaks / Surface or Buried Wastes, Burning	Volatilization / Fugitive Dust	Air Movement	Air	NA	NA	INH	INH	INH	INH	INH	INH	INH	INH	INH	INH	INH	NA	NA
Contaminated Surface Soil	Leaching	Infiltration	Ground Water	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Contaminated Surface Soil	Surface Runoff	Water movement	Surface Water	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Contaminated Surface Soil	Surface Runoff	Deposition	Sediments	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Contaminated Surface Soil	Tracking		Soil	DC	DC	ING	ING	ING	ING	ING	ING	ING	ING	ING	ING	DC	NA	NA
Contaminated Surface Soil	Biotic Uptake[a]	Biota[a]	Biota[a]	NA	ING	ING	ING	ING	NA	ING	ING	ING	ING	NA	ING	NA	NA	NA

Dotted box: Pathway may be significant; not evaluated because toxicity criteria lacking

Hatched box: Insignificant pathway; not quantitatively evaluated

NA Not Applicable

ING Ingestion

INH Inhalation

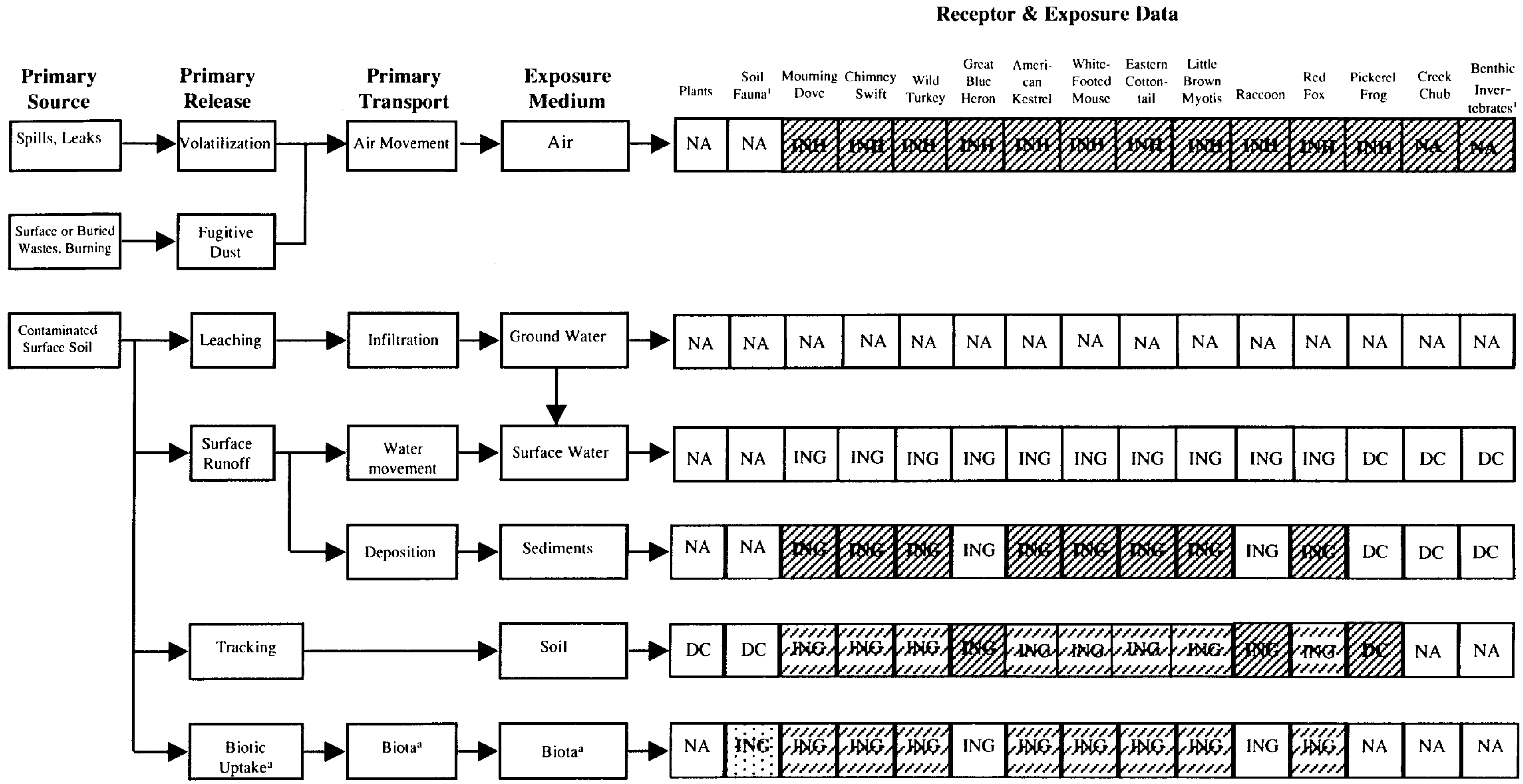
DC Direct Contact

[1] Includes the terrestrial or aquatic crayfish

[a] Refer to JPG Food Web

Figure 22.7-1a
JPG Conceptual Site Model
Site 28

N:Jobs\244\0025\01\102\cadd\figure22.7-1a.ppt

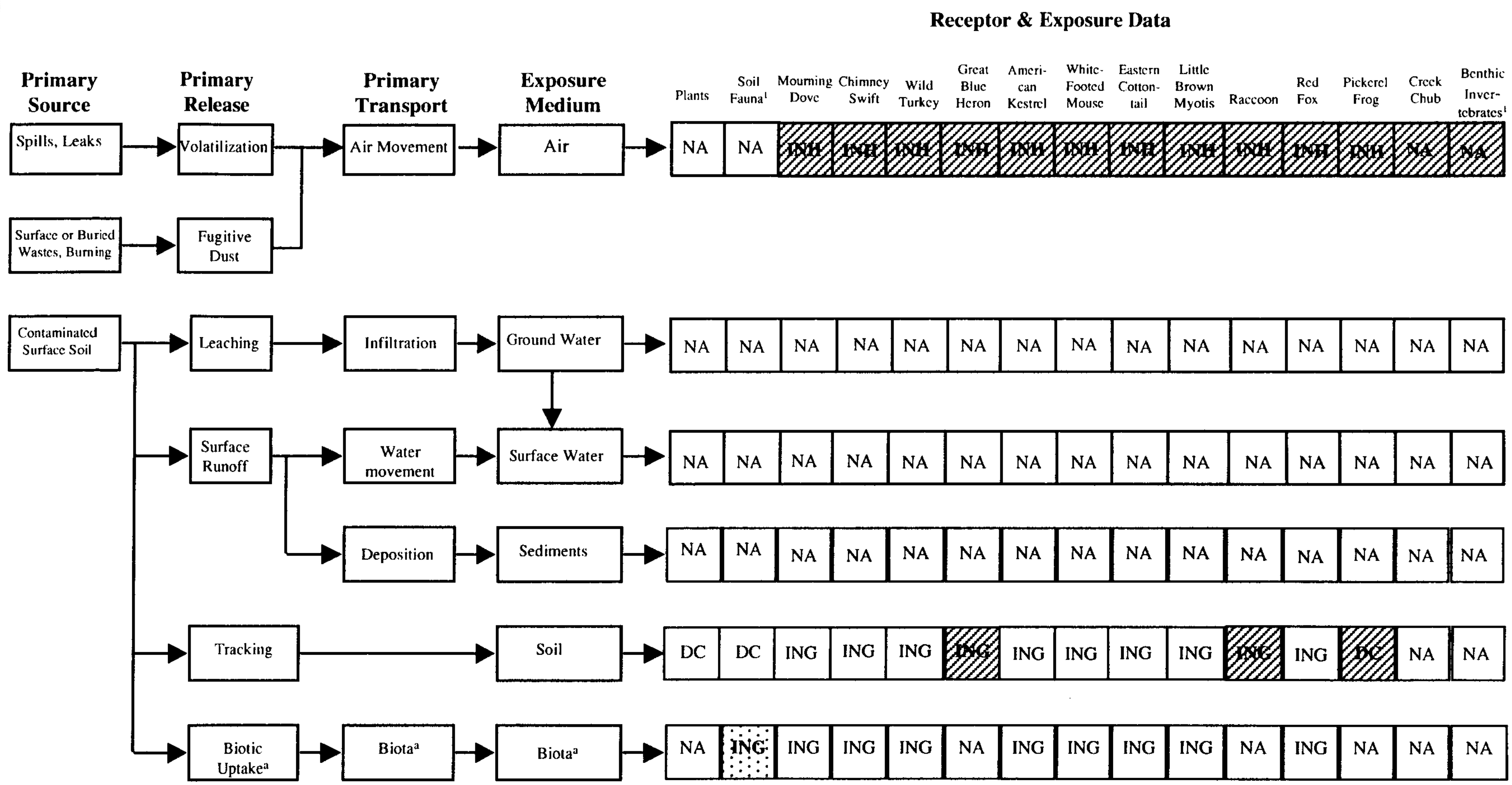


Symbol	Meaning
(dotted)	Pathway may be significant; not evaluated because toxicity criteria lacking
(cross-hatched)	Pathway may be significant; not evaluated because analyte concentrations in medium (soil) lacking
(hatched)	Insignificant pathway; not quantitatively evaluated

NA	Not Applicable
ING	Ingestion
INH	Inhalation
DC	Direct Contact
1	Includes the terrestrial or aquatic crayfish
a	Refer to JPG Food Web

Figure 22.7-1b
JPG Conceptual Site Model
Site 29

N:Jobs 244 0025 01 102 cadd figure22.7-1b.ppt



Pathway may be significant; not evaluated because toxicity criteria lacking

Insignificant pathway; not quantitatively evaluated

NA Not Applicable

ING Ingestion

INH Inhalation

DC Direct Contact

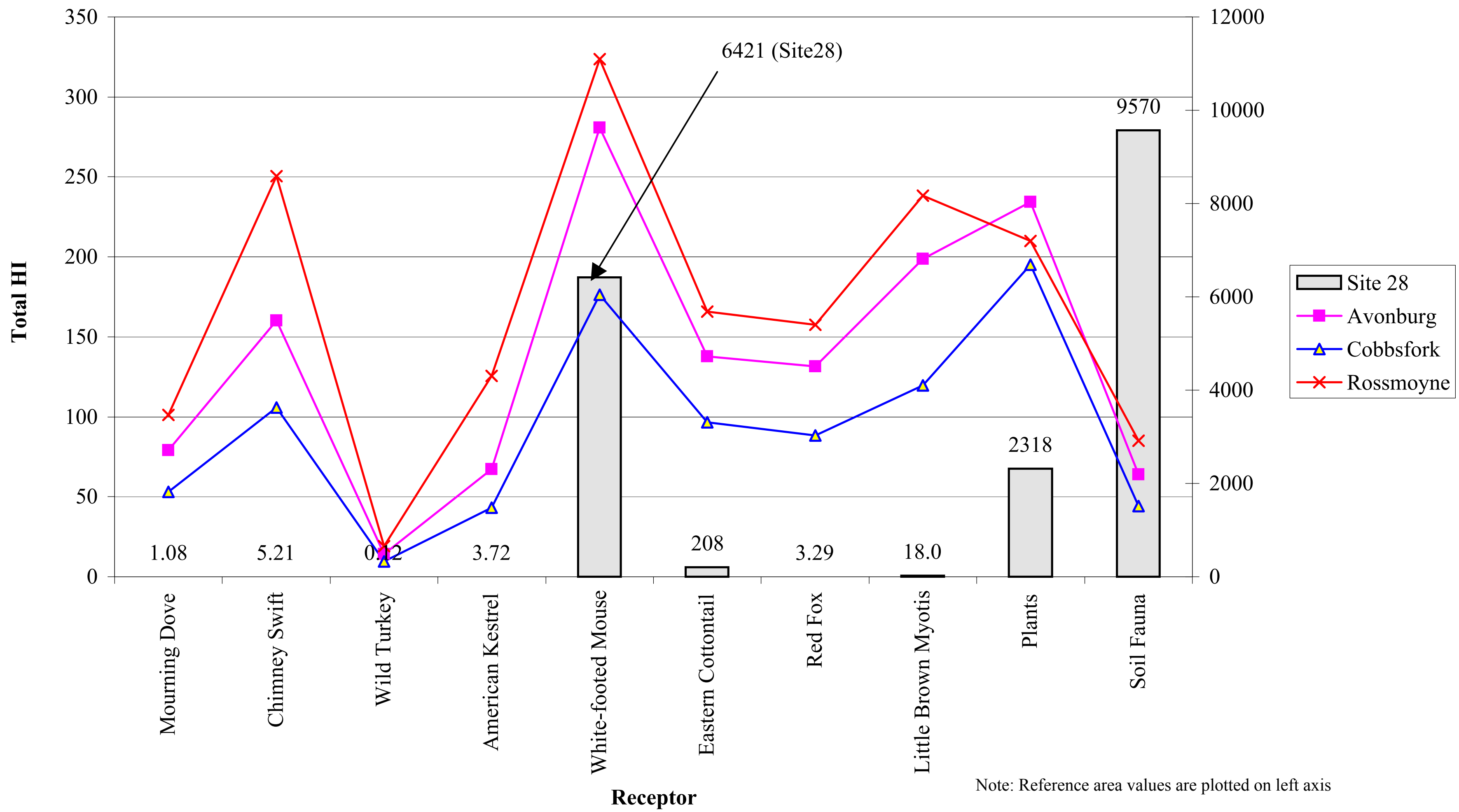
1 Includes the terrestrial or aquatic crayfish

a Refer to JPG Food Web

Figure 22.7-1c
JPG Conceptual Site Model
Site 39

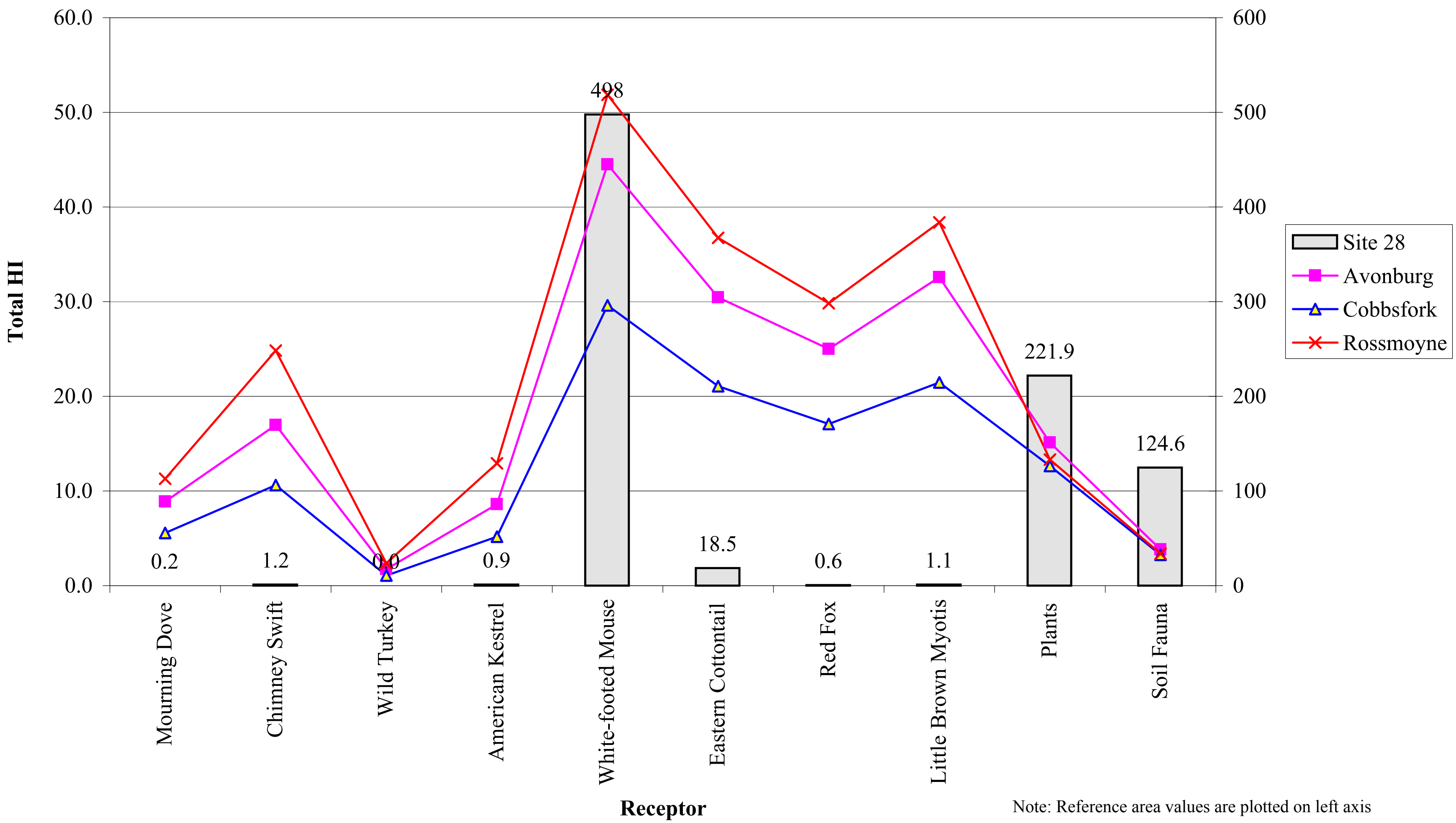
N:Jobs\244\0025\01\102 cadd figure22.7-1c.ppt

Figure 22.7-2 Total HIs - RME Risks Summed for All Pathways Based on NOAELs at Site 28 - Gator Z Open Burn Area - Phase I



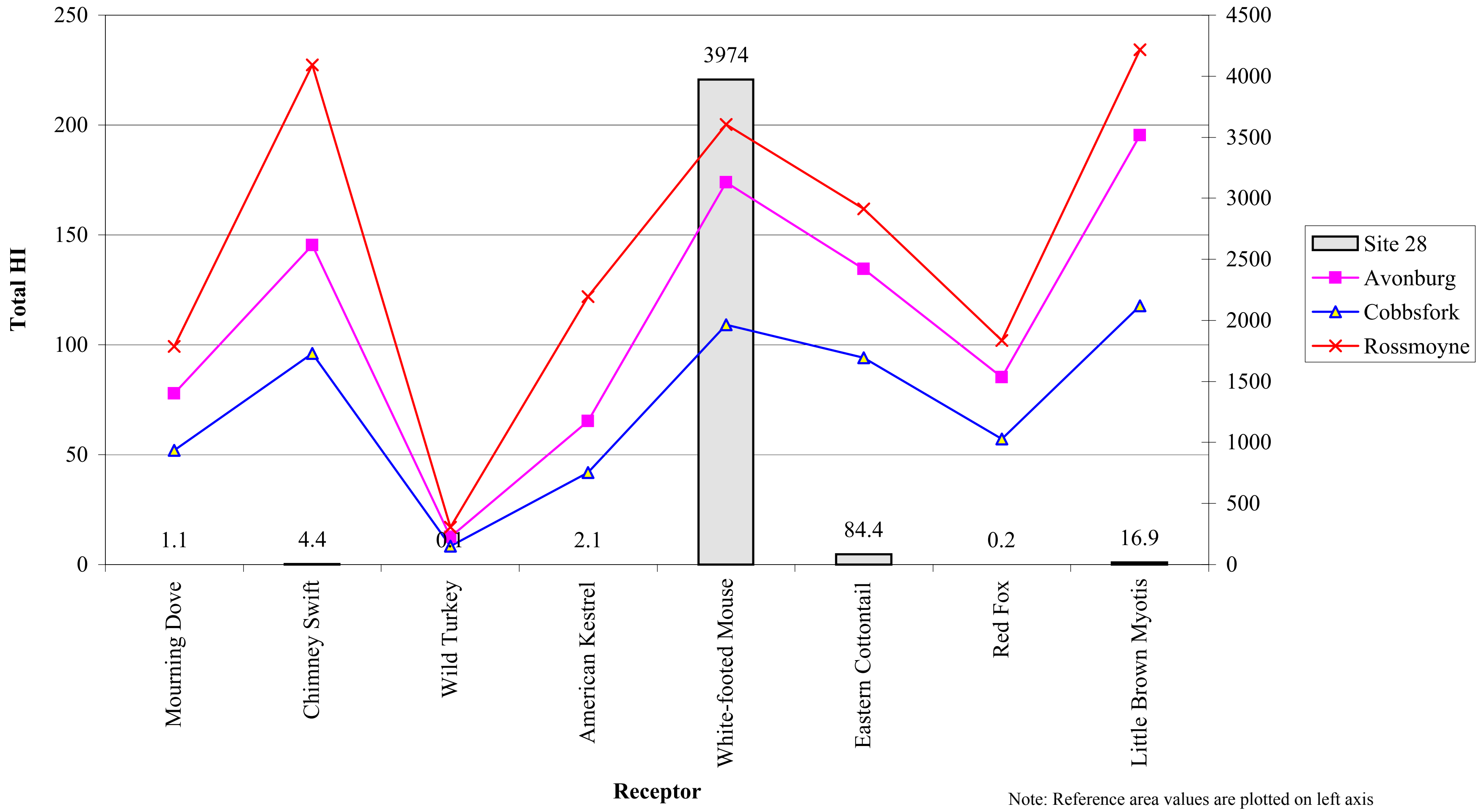
N:\jobs\244\0025\01\ET ECO Files\JPG\Phase1\Risk2\P1era_28MWH.xls Figure 22.7-2

Figure 22.7-3 Total HIs - RME Risks Summed for All Pathways Based on LOAELs at Site 28 - Gator Z Open Burn Area - Phase I



N:\jobs\244\0025\01\ET ECO Files\JPG\Phase1\Risk2\P1era_28MWH.xls Figure 22.7-3

Figure 22.7-4 Total HIs - CT Risks Summed for All Pathways Based on NOAELs at Site 28 - Gator Z Open Burn Area - Phase I



Note: Reference area values are plotted on left axis

N:\jobs\244\0025\01\ET ECO Files\JPG\Phase1\Risk2\P1era_28MWH.xls Figure 22.7-4

Figure 22.7-5 Total HIs - CT Risks Summed for All Pathways Based on LOAELs at Site 28 - Gator Z Open Burn Area - Phase I

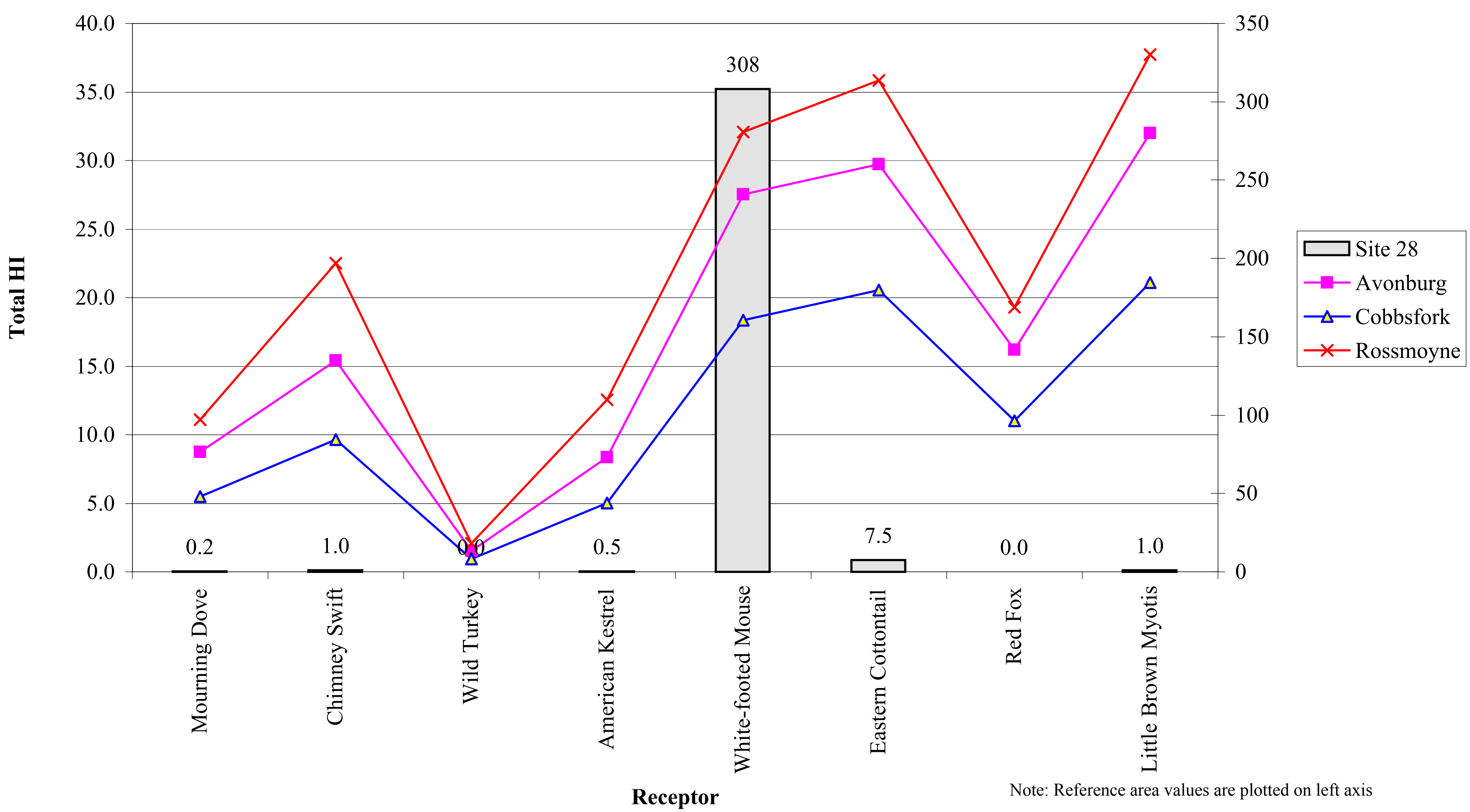
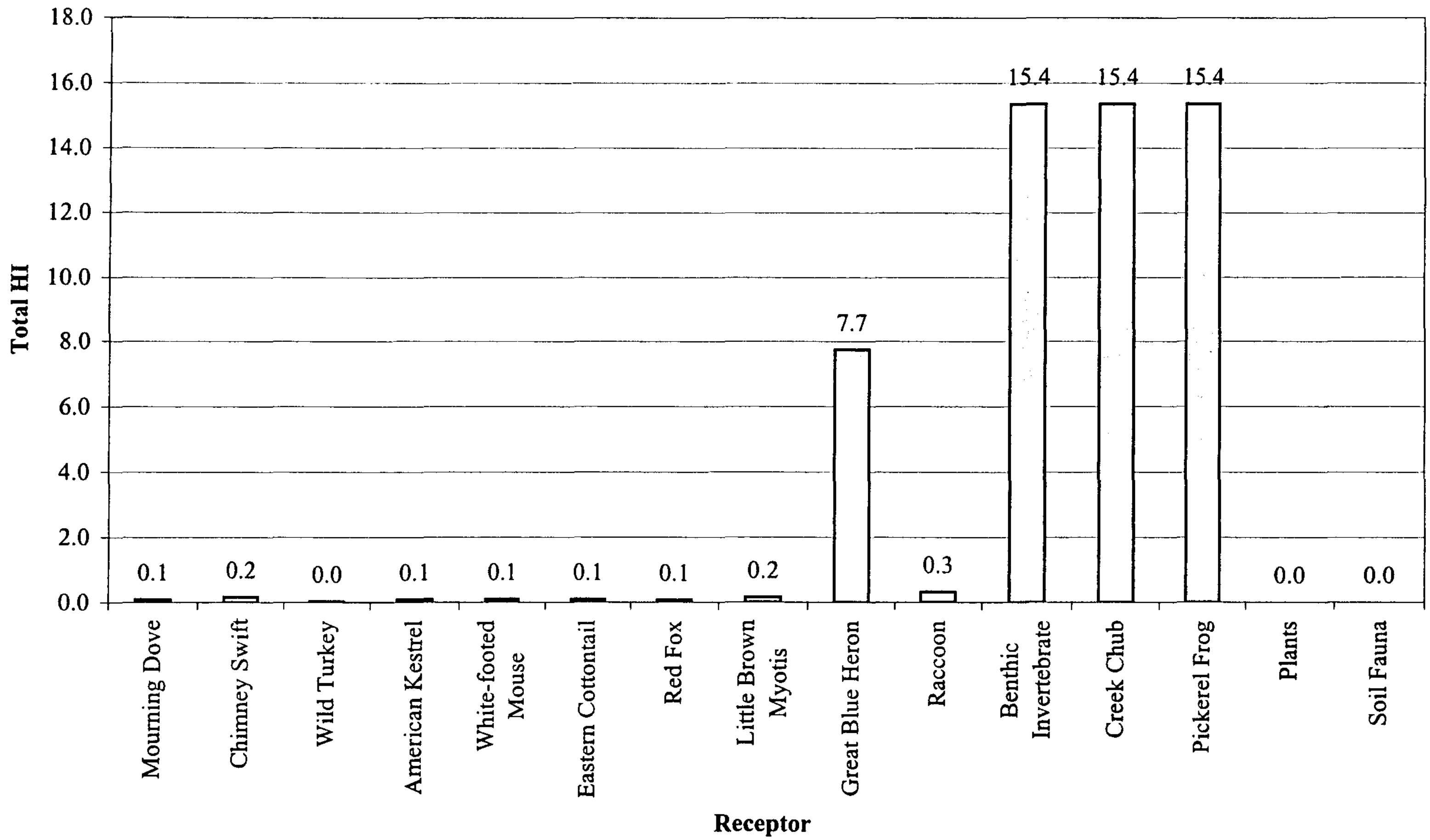


Figure 22.7-6 Total HIs - RME Risks Summed for All Pathways Based on NOAELs at Site 29 - Gator Z Mine Scrap Disposal Area - Phase I



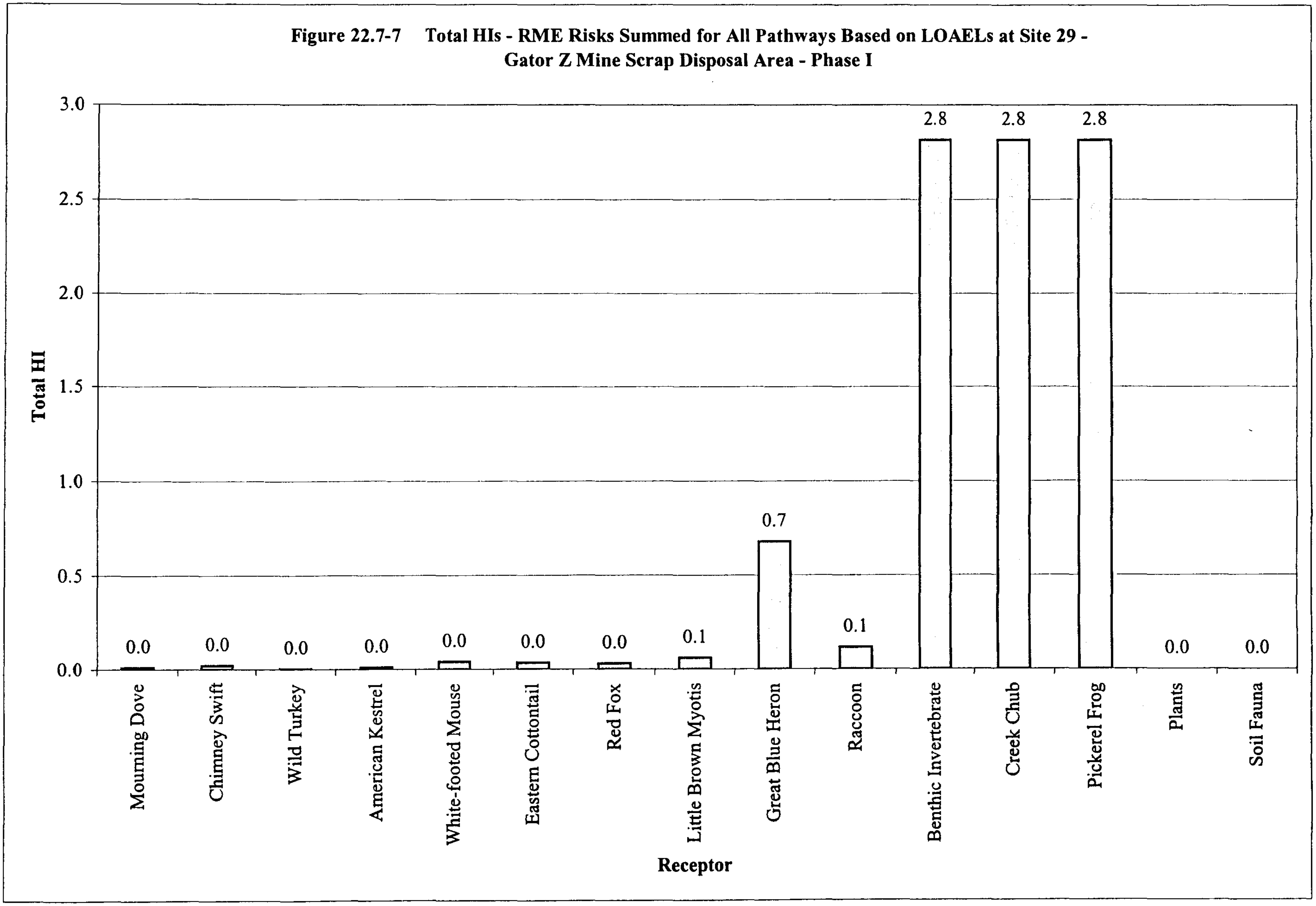


Figure 22.7-7 Total HIs - RME Risks Summed for All Pathways Based on LOAELs at Site 29 - Gator Z Mine Scrap Disposal Area - Phase I
Total HI
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0
0.0
0.0
0.0
0.0
0.0
0.0
0.1
0.7
0.1
2.8
2.8
2.8
0.0
0.0
Mourning Dove
Chimney Swift
Wild Turkey
American Kestrel
White-footed Mouse
Eastern Cottontail
Red Fox
Little Brown Myotis
Great Blue Heron
Raccoon
Benthic Invertebrate
Creek Chub
Pickerel Frog
Plants
Soil Fauna
Receptor

Figure 22.7-8 Total HIs - CT Risks Summed for All Pathways Based on NOAELs at Site 29 - Gator Z Mine Scrap Disposal Area - Phase I

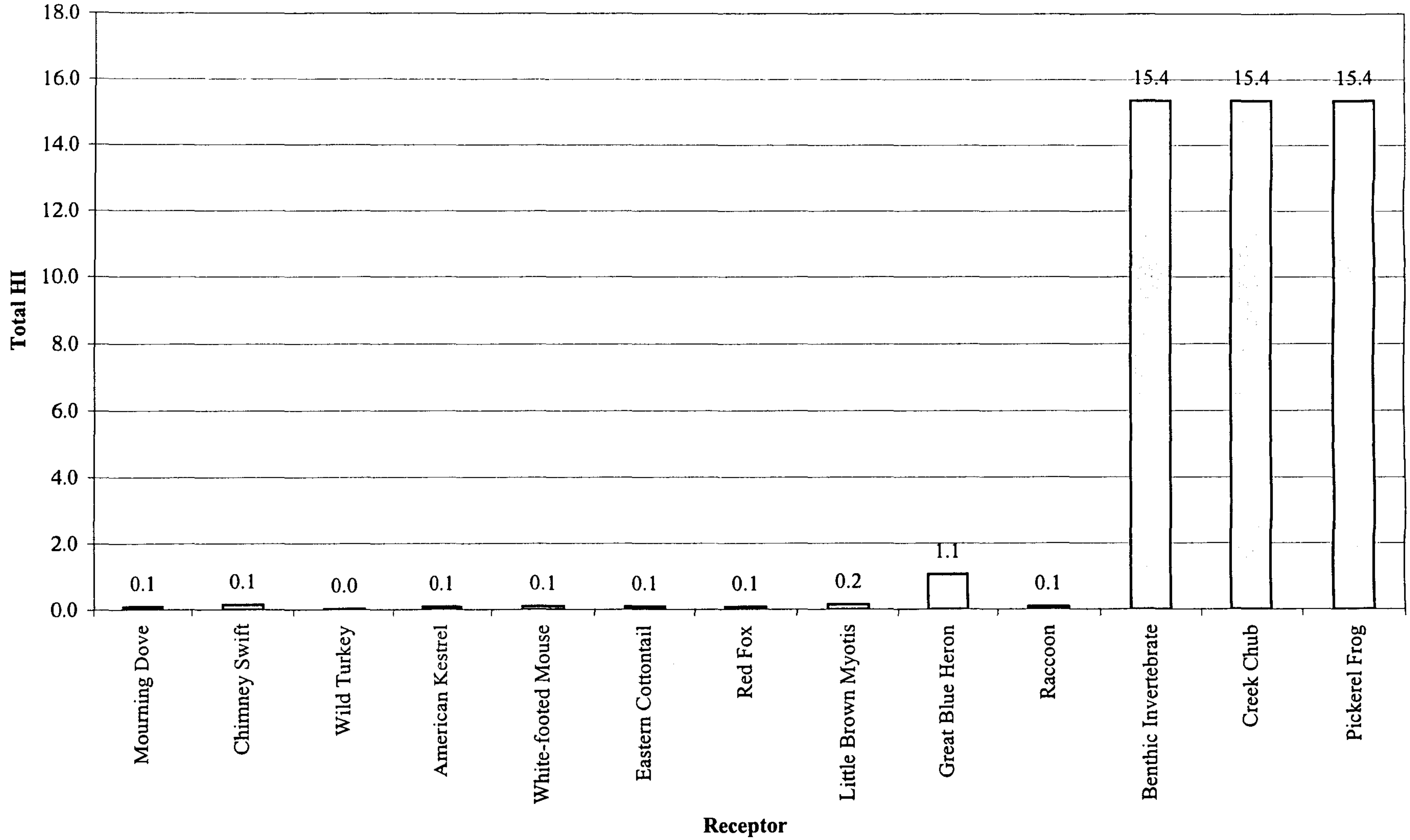
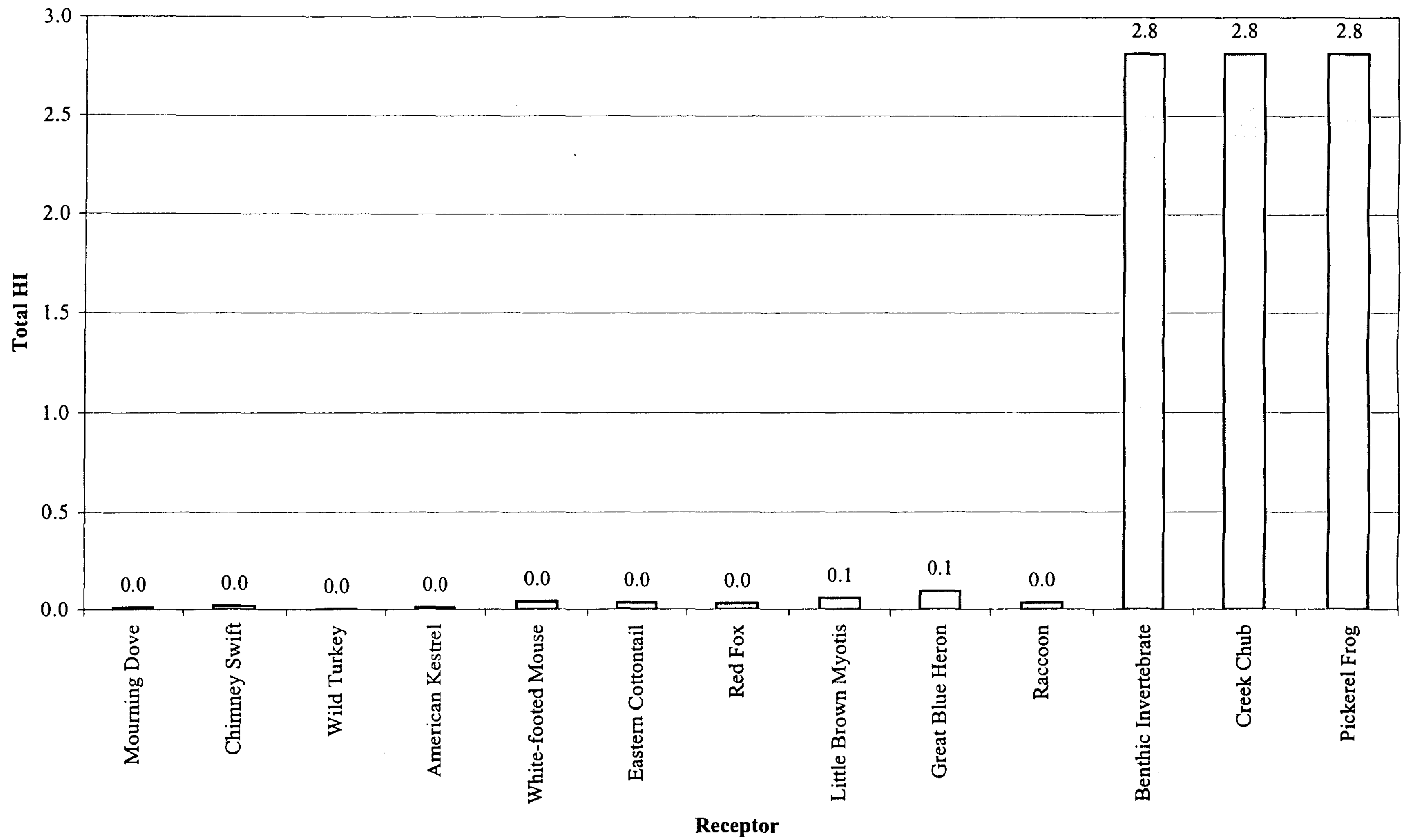
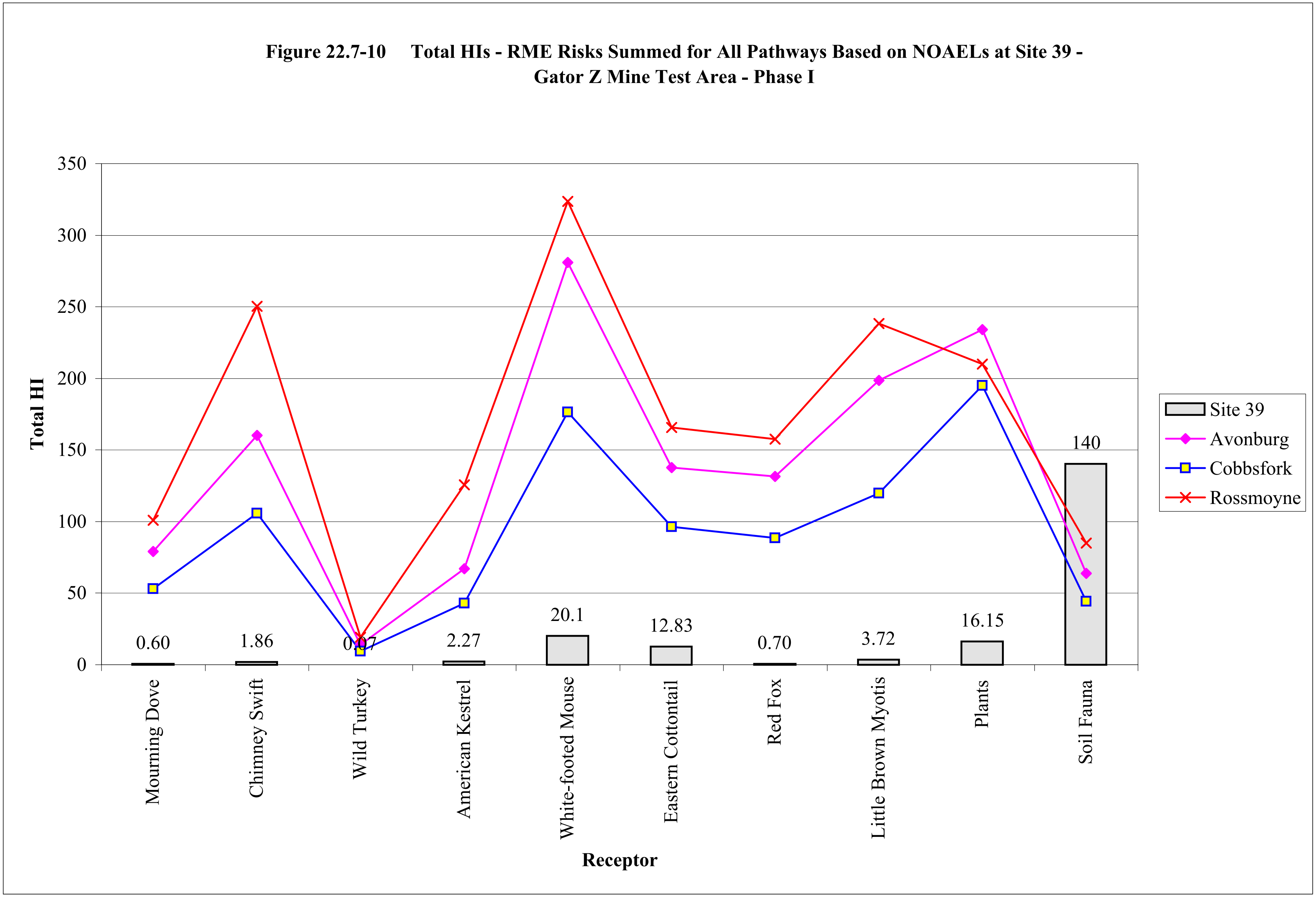


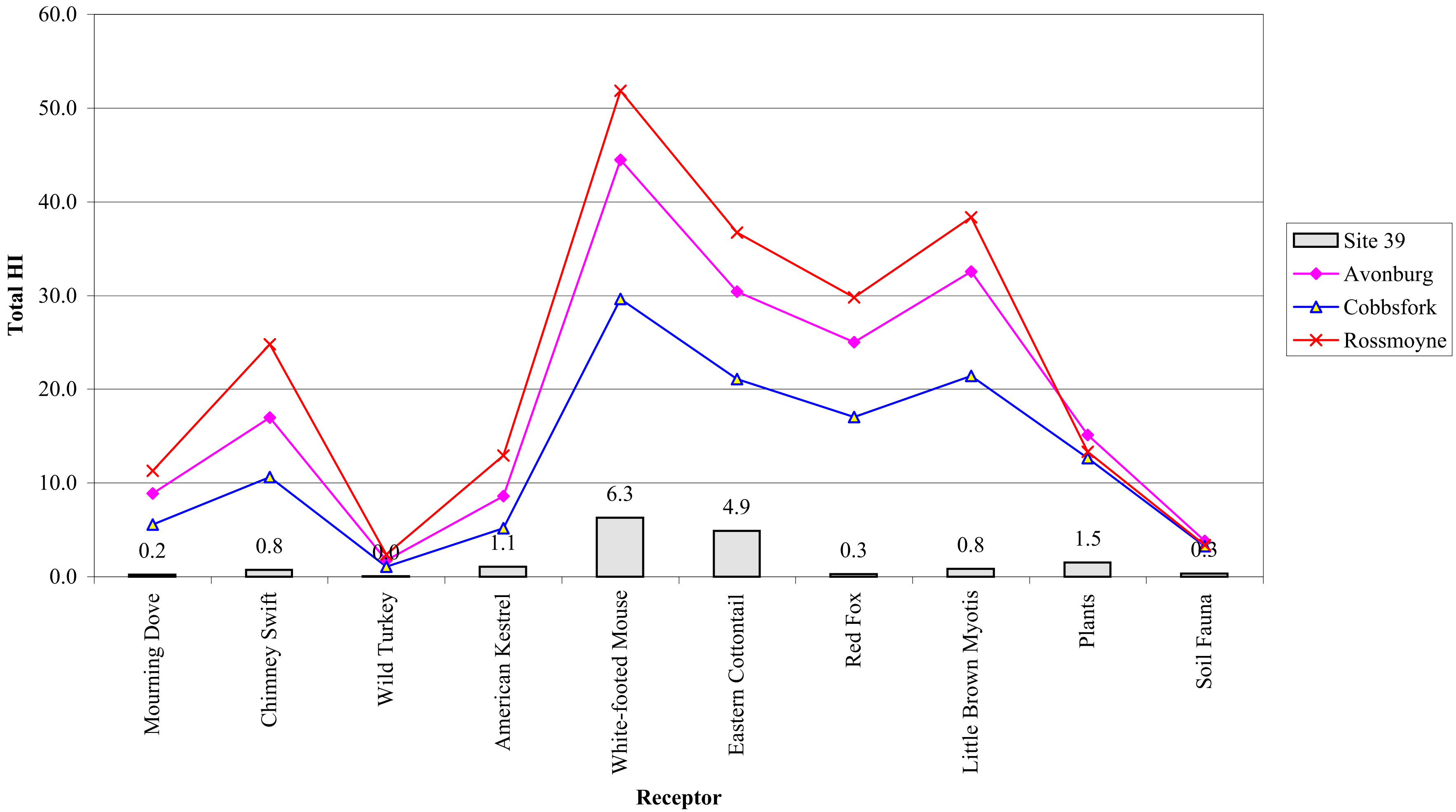
Figure 22.7-9 Total HIs - CT Risks Summed for All Pathways Based on LOAELs at Site 29 - Gator Z Mine Scrap Disposal Area - Phase I





N:\jobs\244\0025\01\ET ECO Files\JPG\Phase1\Risk2\P1era_39MWH.xls Figure 22.7-10

Figure 22.7-11 Total HIs - RME Risks Summed for All Pathways Based on LOAELs at Site 39 - Gator Z Mine Test Area - Phase I



N:\jobs\244\0025\01\ET ECO Files\JPG\Phase1\Risk2\P1era_39MWH.xls Figure 22.7-11

Figure 22.7-12 Total HIs - CT Risks Summed for All Pathways Based on NOAELs at Site 39 - Gator Z Mine Test Area - Phase I

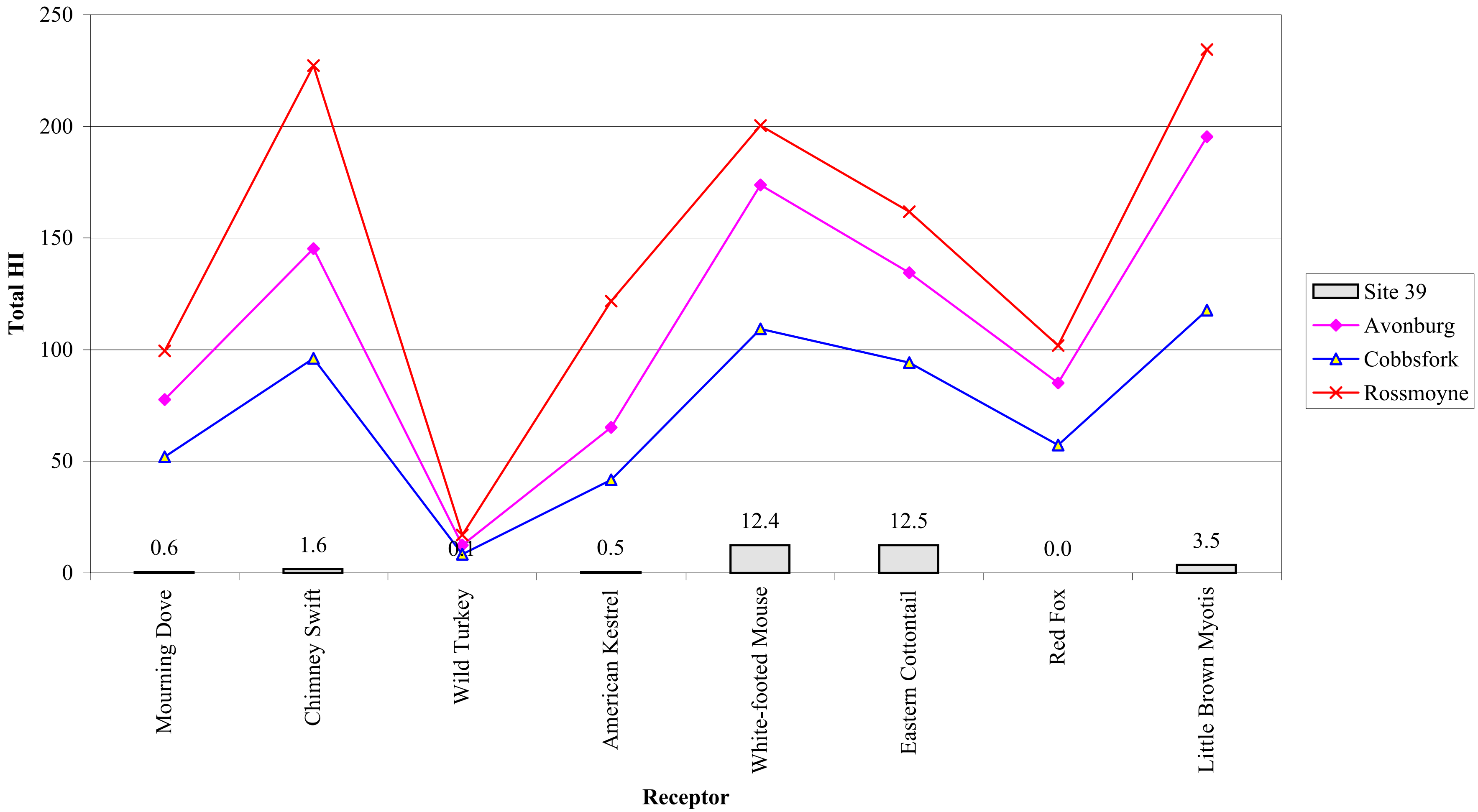
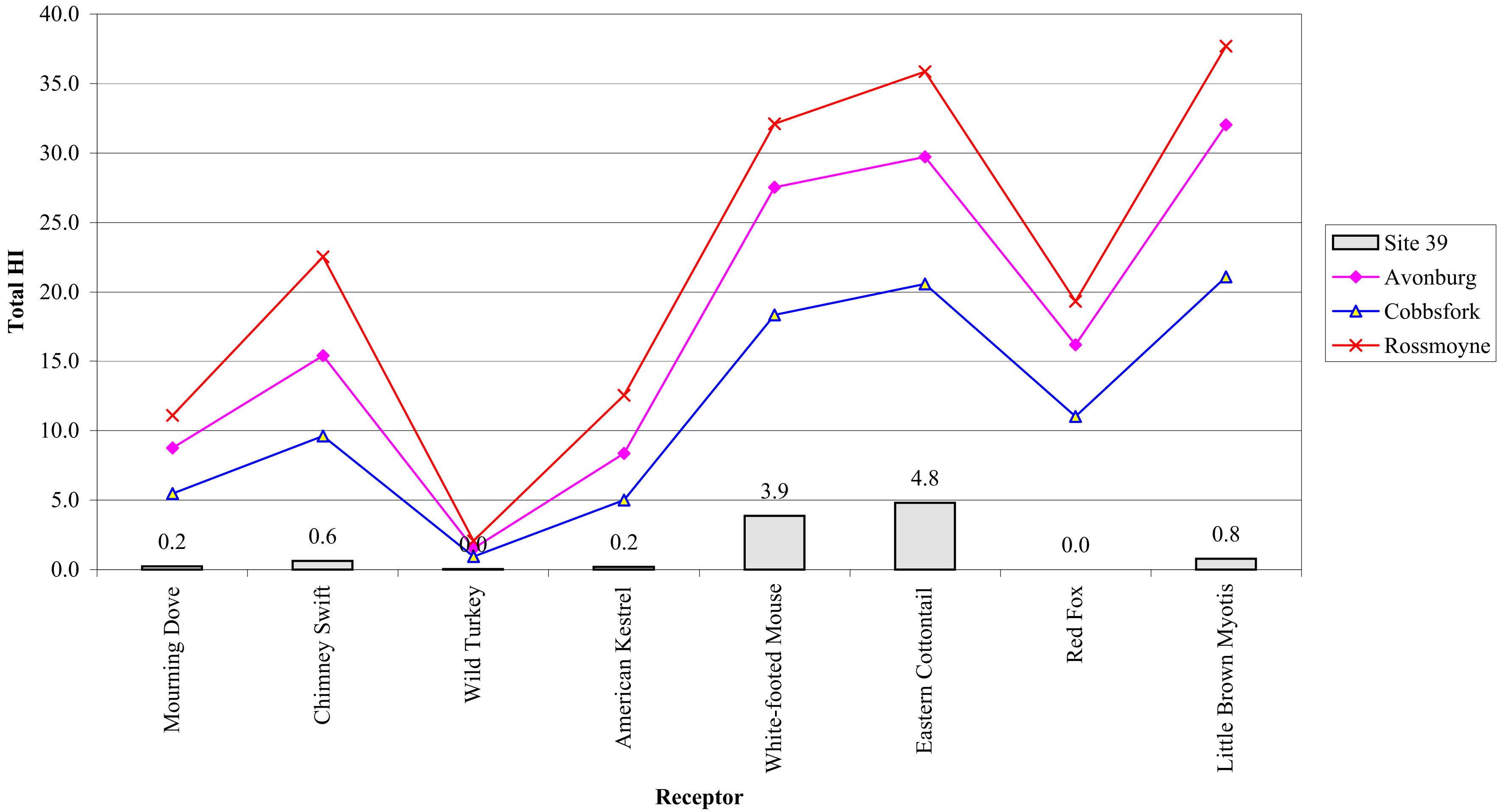
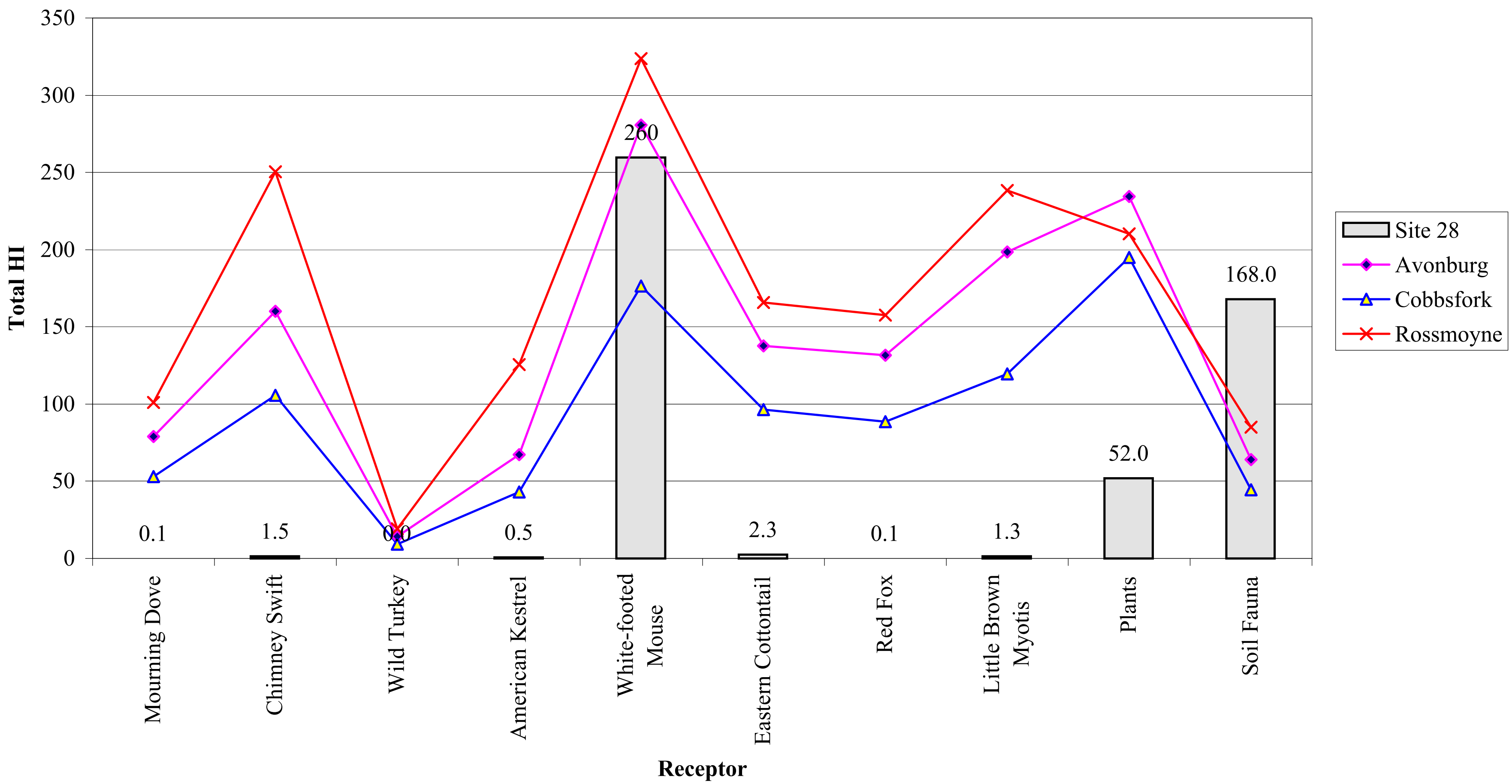


Figure 22.7-13 Total HIs - CT Risks Summed for All Pathways Based on LOAELs at Site 39 - Gator Z Mine Test Area - Phase I



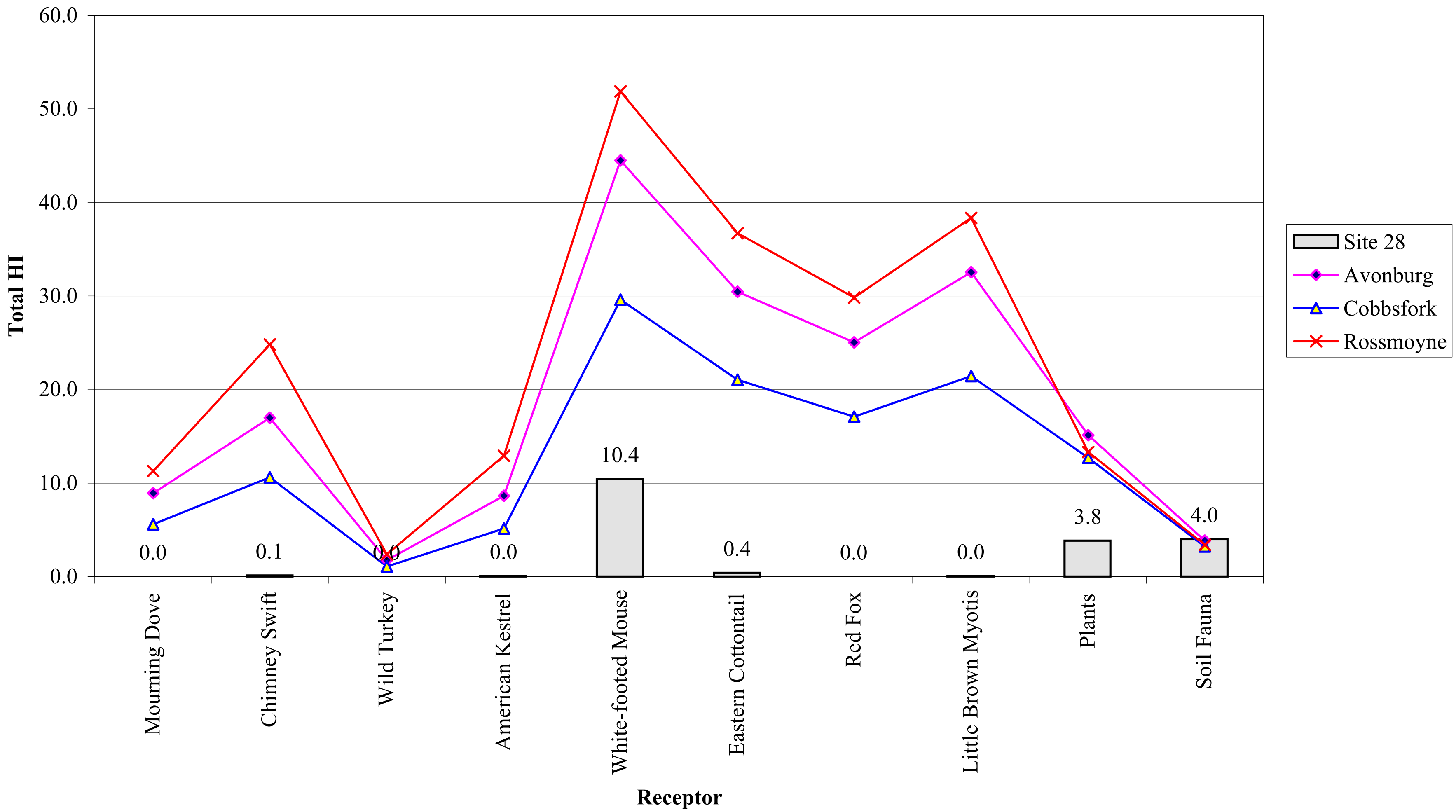
N:\jobs\244\0025\01\ET ECO Files\JPG\Phase1\Risk2\P1era_39MWH.xls Figure 22.7-13

Figure 22.7-14 Total HIs - RME Risks Summed for All Pathways Based on NOAELs at Site 28 - Gator Z Open Burn Area - IM Confirmation Sampling



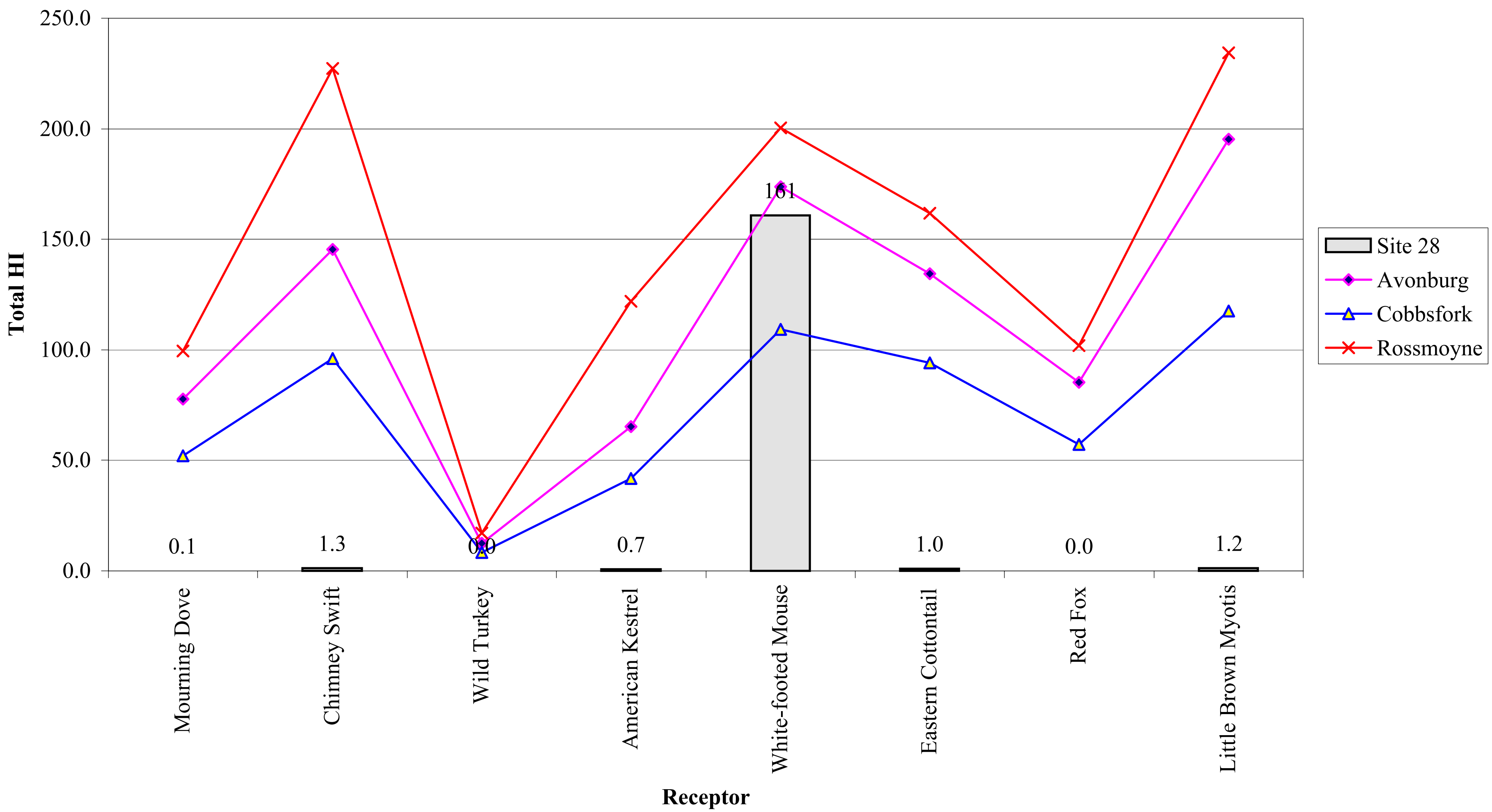
N:\jobs\244\0025\01\ET ECO Files\JPG\Im\Risk2\Eraim_28MWH.xls Figure 22.7-14

Figure 22.7-15 Total HIs - RME Risks Summed for All Pathways Based on LOAELs at Site 28 - Gator Z Open Burn Area - IM Confirmation Sampling



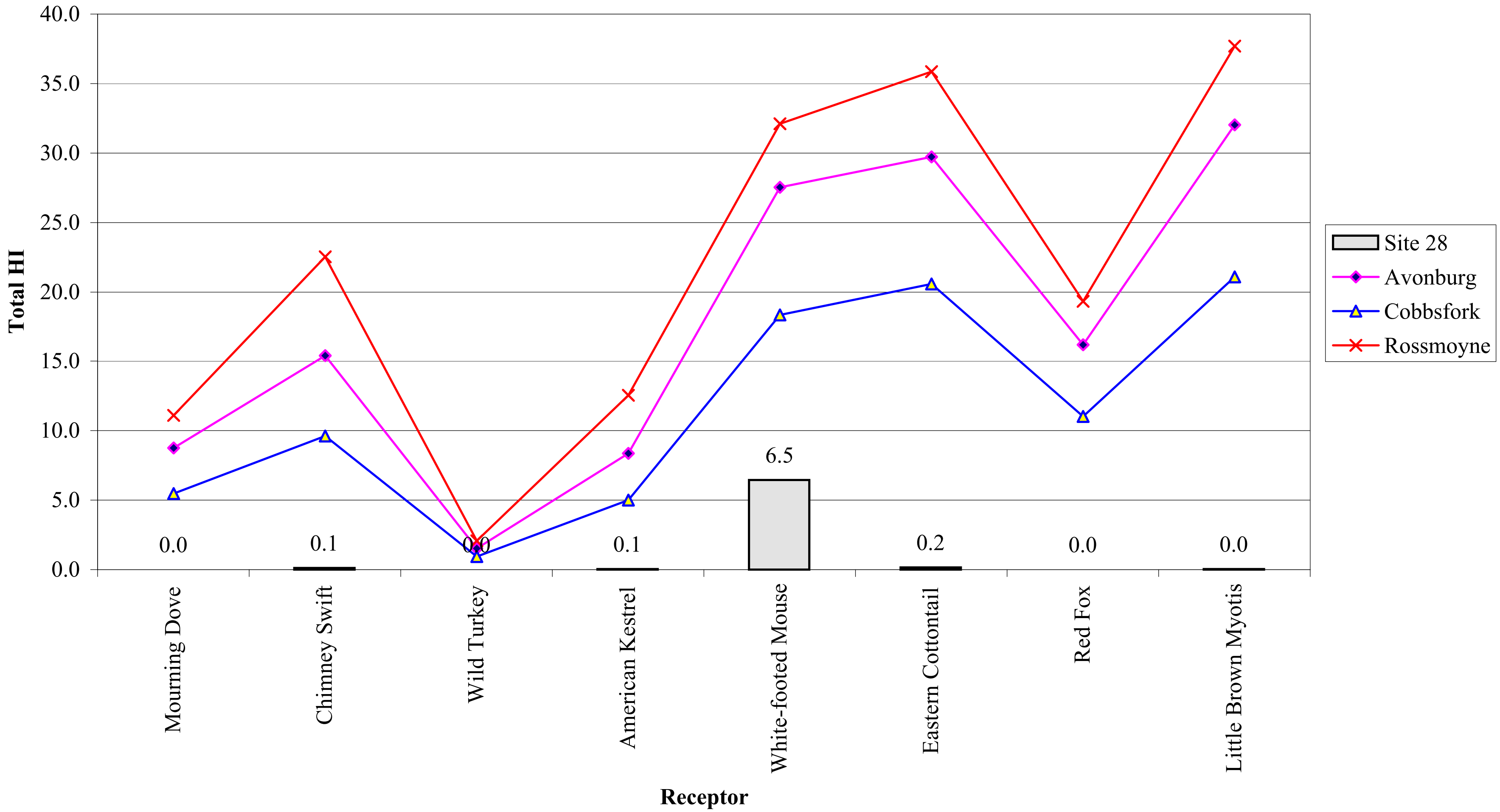
N:\jobs\244\0025\01\ET ECO Files\JPG\Im\Risk2\Eraim_28MWH.xls Figure 22.7-15

Figure 22.7-16 Total HIs - CT Risks Summed for All Pathways Based on NOAELs at Site 28 - Gator Z Open Burn Area- IM Confirmation Sampling



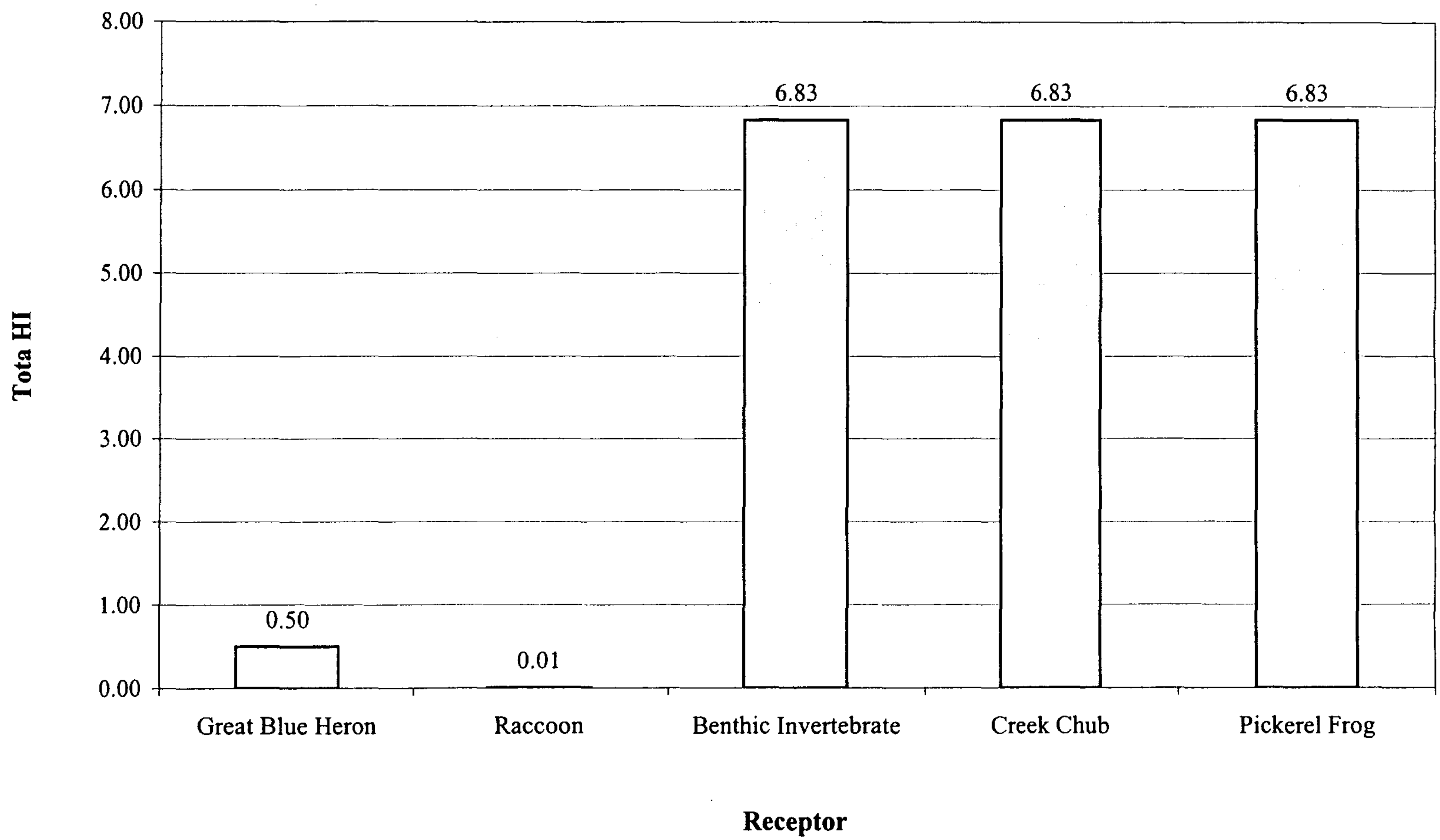
N:\jobs\244\0025\01\ET ECO Files\JPG\Im\Risk2\Eraim_28MWH.xls Figure 22.7-16

Figure 22.7-17 Total HIs - CT Risks Summed for All Pathways Based on LOAELs at Site 28 - Gator Z Open Burn Area - IM Confirmation Sampling



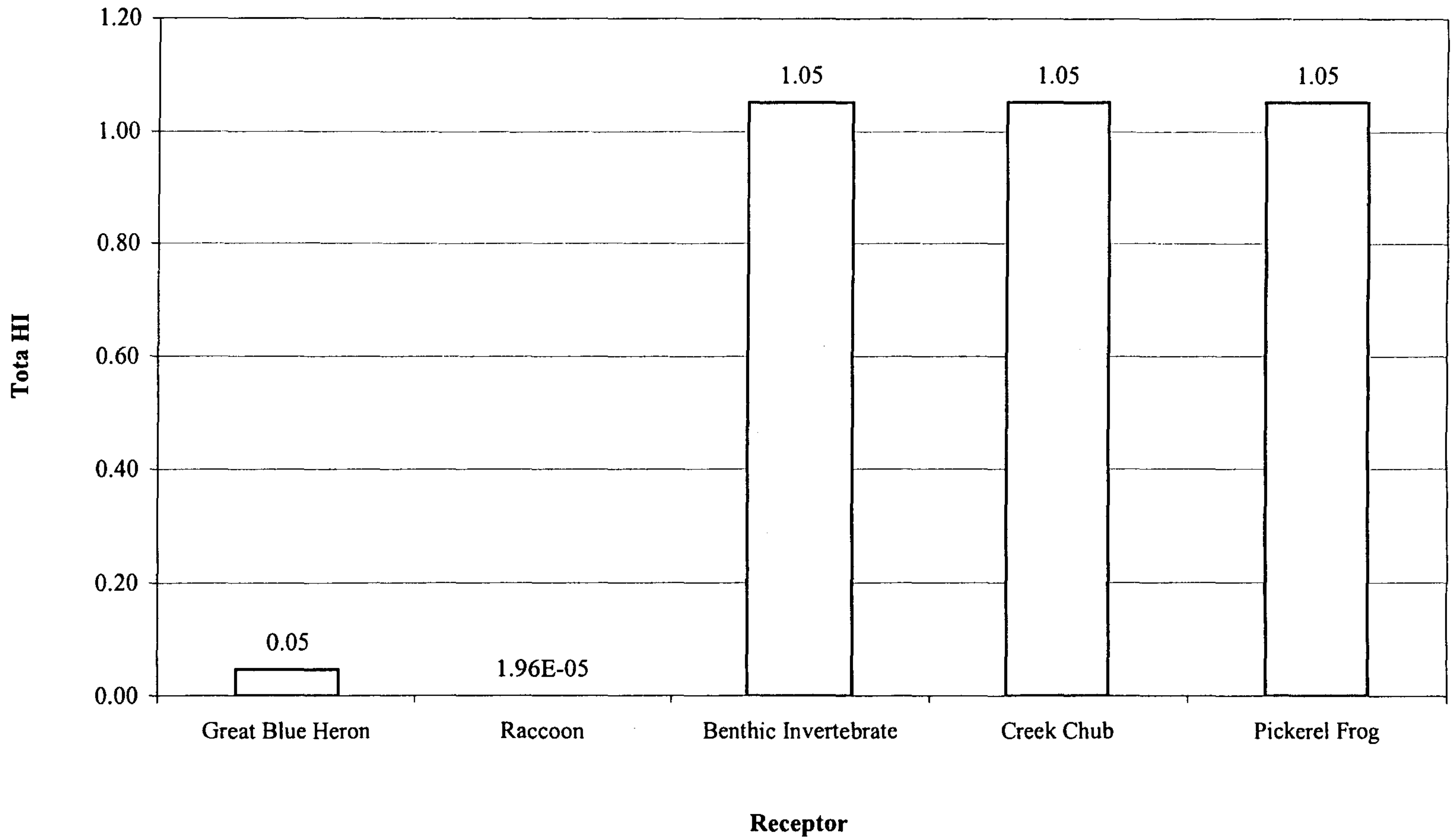
N:\jobs\244\0025\01\ET ECO Files\JPG\Im\Risk2\Eraim_28MWH.xls Figure 22.7-17

Figure 22.7-18 Total HIs - RME Risks Summed for All Pathways Based on NOAELs at Site 29 - Gator Z Scrap Disposal Area- IM Confirmation Sampling



N:\jobs\244\0025\01\ET ECO Files\JPG\Im\Risk2\Eraim_29MWH.xls Figure 22.7-18

Figure 22.7-19 Total HIs - RME Risks Summed for All Pathways Based on LOAELs at Site 29 - Gator Z Scrap Disposal Area- IM Confirmation Sampling



N:\jobs\244\0025\01\ET ECO Files\JPG\Im\Risk2\Eraim_29MWH.xls Figure 22.7-19

Figure 22.7-20 Total HIs - CT Risks Summed for All Pathways Based on NOAELs at Site 29 - Gator Z Scrap Disposal Area- IM Confirmation Sampling

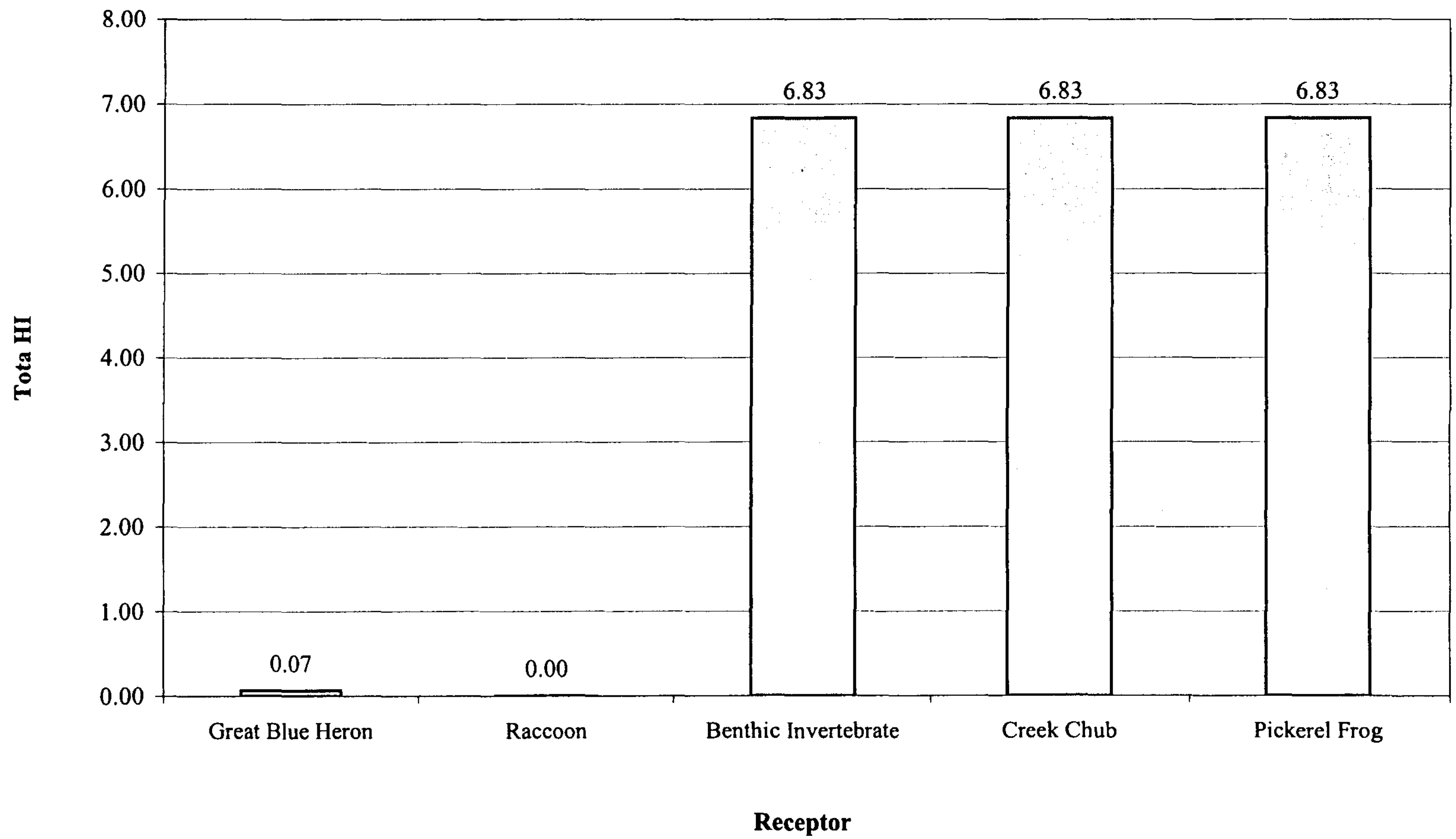


Figure 22.7-21 Total HIs - CT Risks Summed for All Pathways Based on LOAELs at Site 29 - Gator Z Scrap Disposal Area- IM Confirmation Sampling

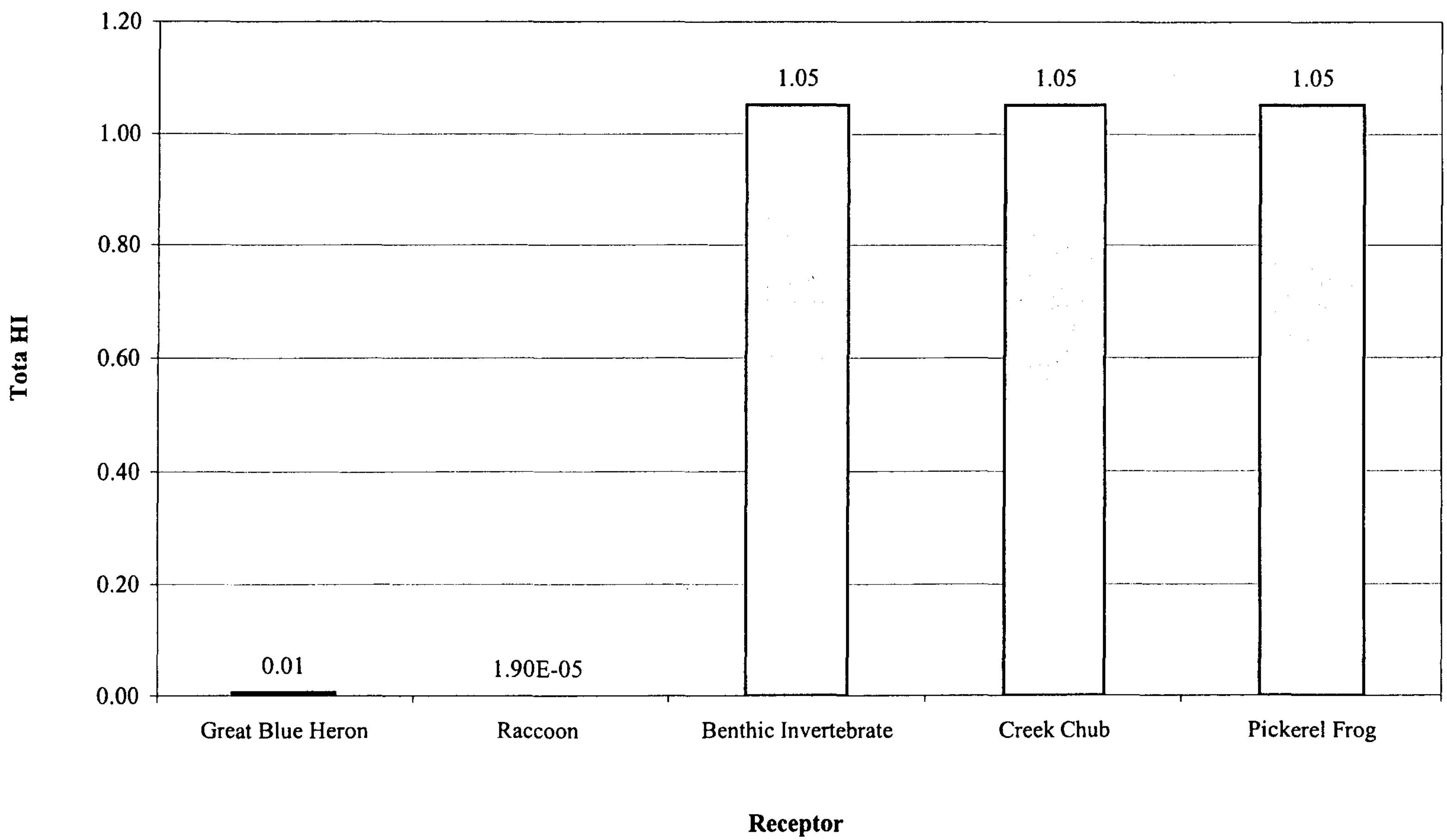
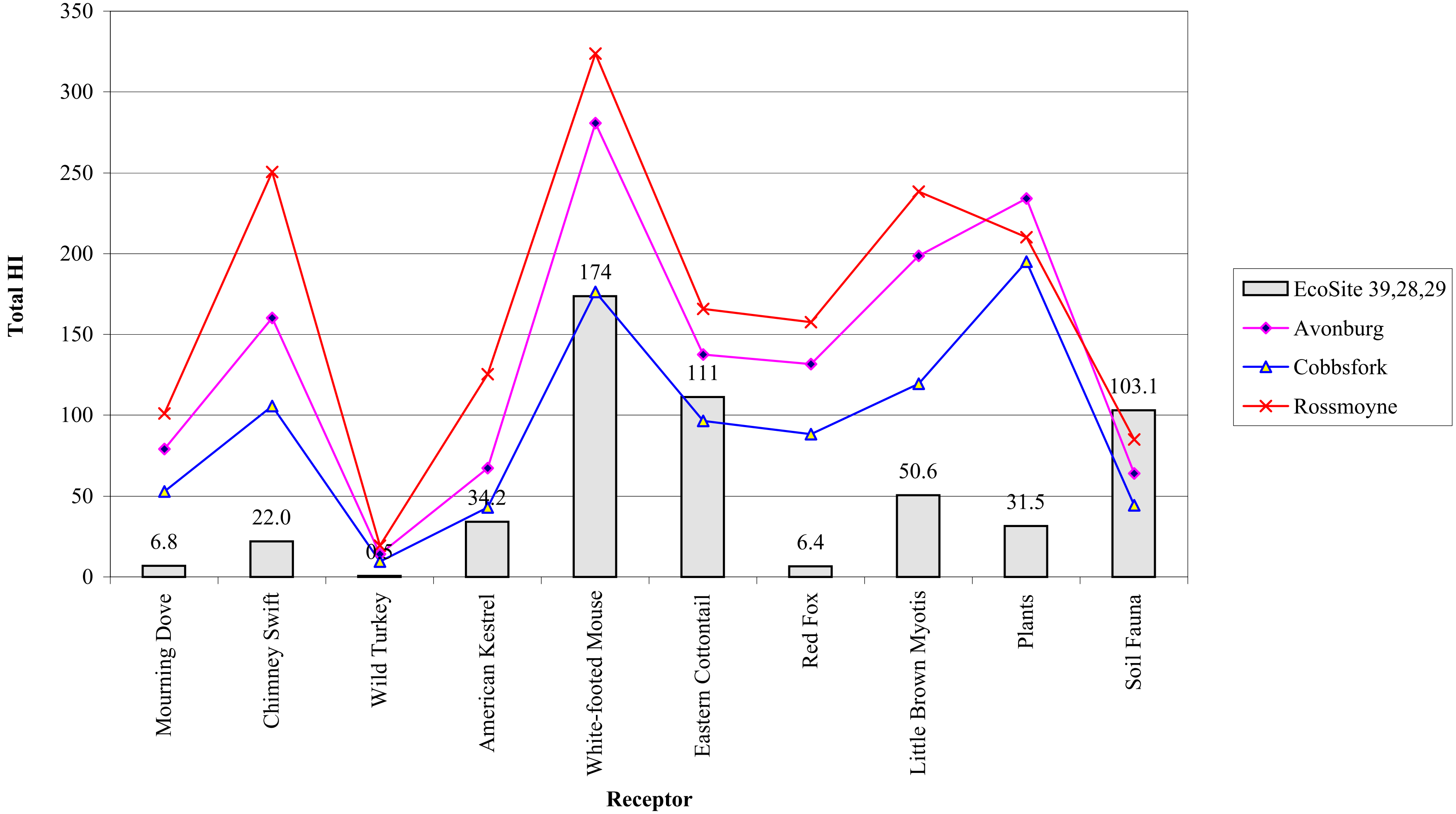
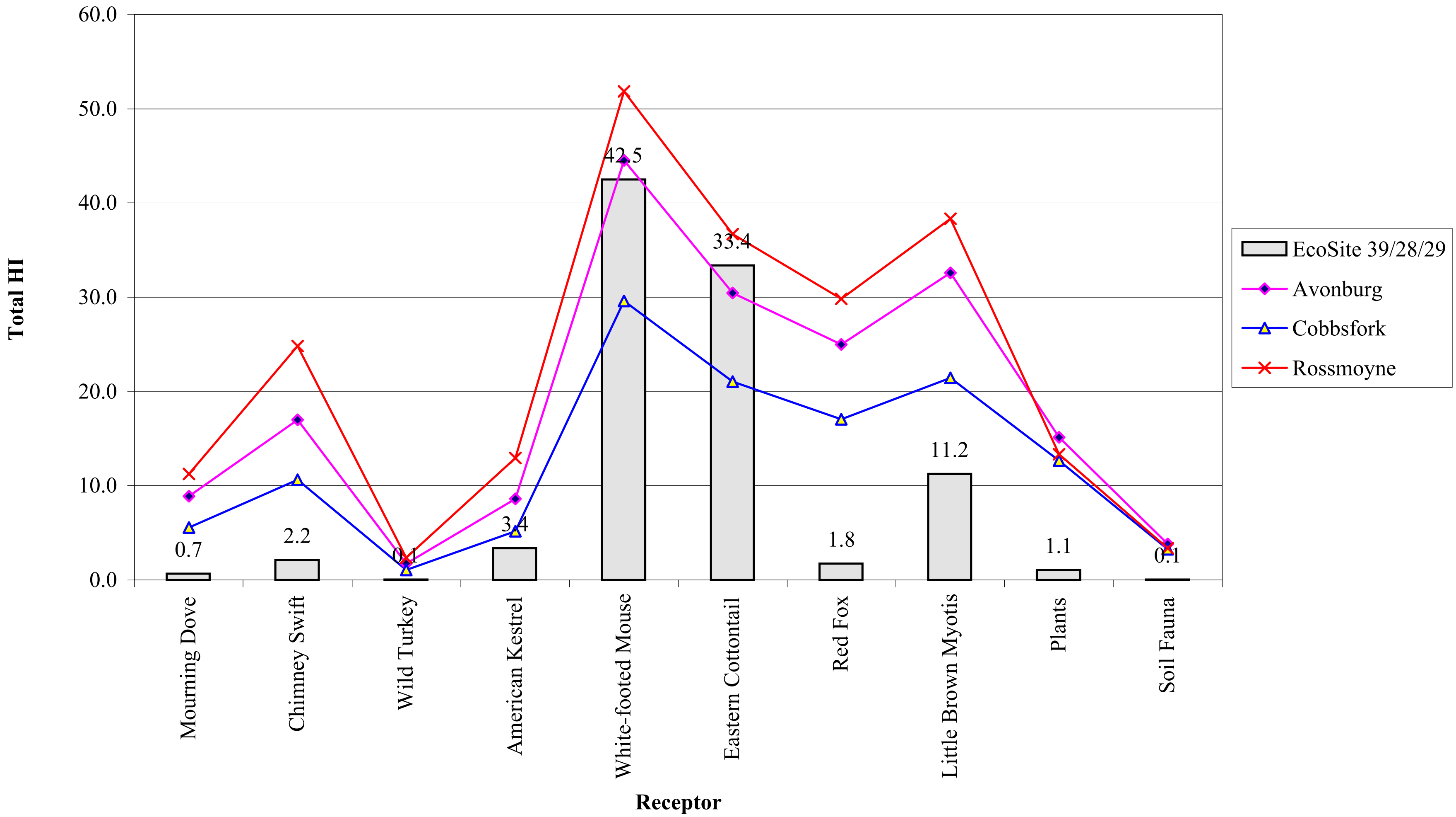


Figure 22.7-22 Total HIs-RME Risks Summed for All Pathways Based on NOAELs at Eco Site 39 (&28, 29) - Phase III

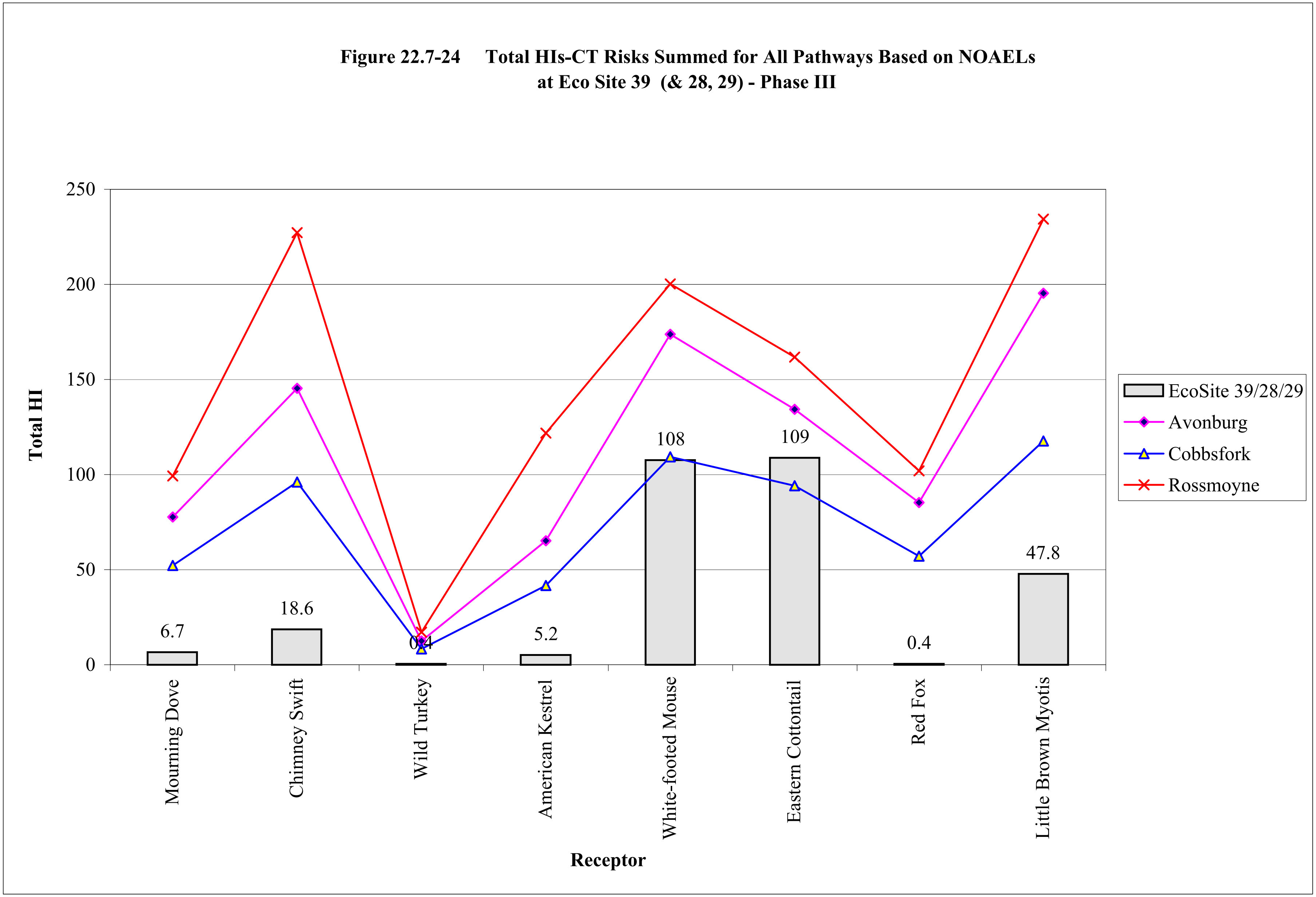


N:\jobs\244\0025\01\ET ECO Files\JPG\Phase3\Risk2\P3era_39MWH.xls Figure 22.7-22

Figure 22.7-23 Total HIs-RME Risks Summed for All Pathways Based on LOAELs at Eco Site 39 (& 28, 29) - Phase III



N:\jobs\244\0025\01\ET ECO Files\JPG\Phase3\Risk2\P3era_39MWH.xls Figure 22.7-23



N:\jobs\244\0025\01\ET ECO Files\JPG\Phase3\Risk2\P3era_39MWH.xls Figure 22.7-24

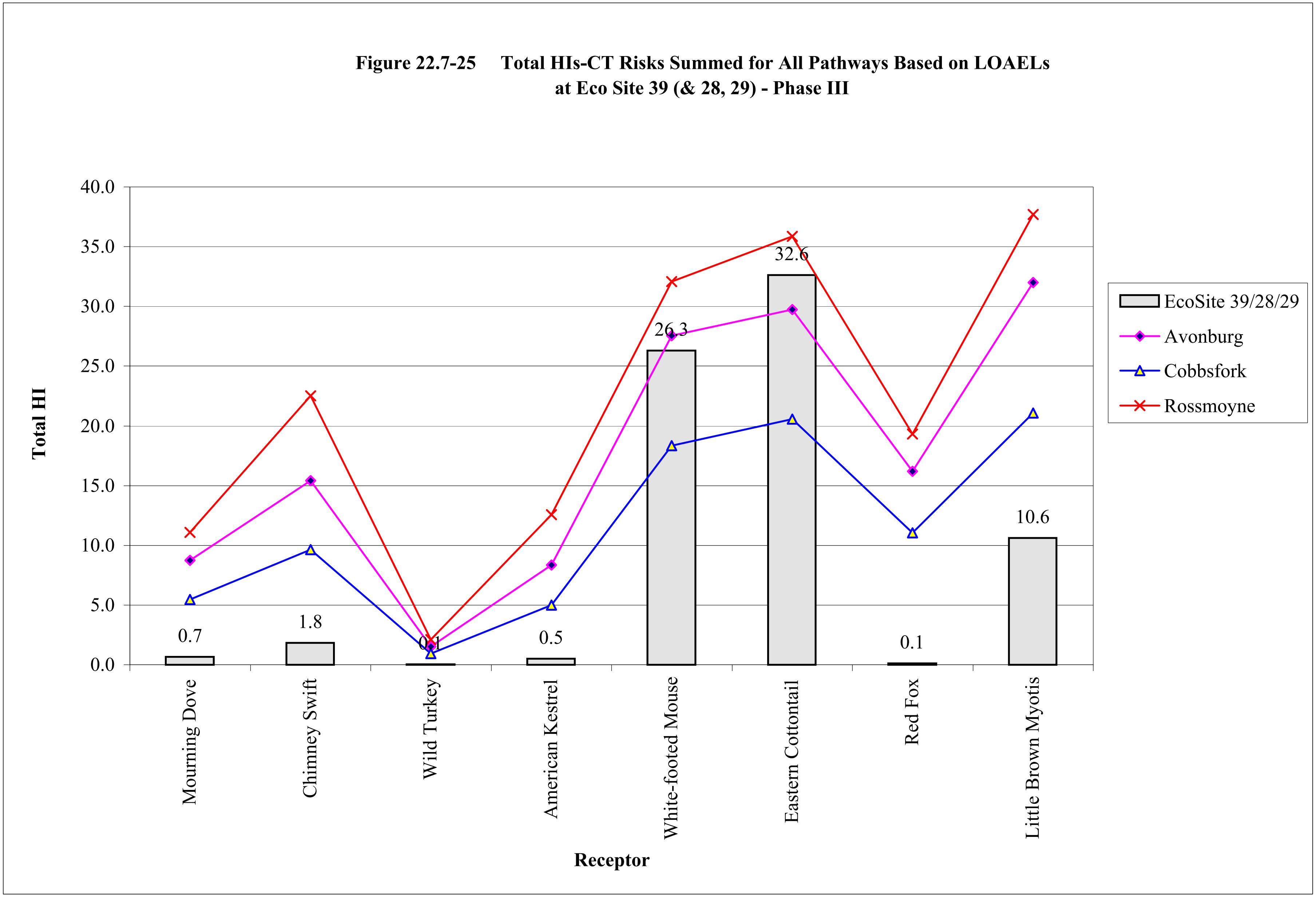


Figure 22.7-25 Total HIs-CT Risks Summed for All Pathways Based on LOAELs
at Eco Site 39 (& 28, 29) - Phase III
Total HI
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0.7
1.8
0.1
0.5
26.3
32.6
0.1
10.6
Mourning Dove
Chimney Swift
Wild Turkey
American Kestrel
White-footed Mouse
Eastern Cottontail
Red Fox
Little Brown Myotis
Receptor
EcoSite 39/28/29
Avonburg
Cobbsfork
Rossmoyne

23.0 BUILDING 227 FORMER STORAGE PAD (SITE 31)

23.1 SITE CHARACTERISTICS

Building 227 is located just south of Woodfill Road and east of Artillery Road (Figure 23-1). The building was historically used as a heavy gun maintenance and repair shop. There is an open shed (Shed 11) **Figure 23-1** east of Building 227, adjacent to a 30-foot-by-50-foot concrete pad **(EPA58)**. The shed and the pad were used to store stoddard solvent, waste oil, paint wastes, and lubricants. Possible spills of stored materials during loading, unloading, or storage could have resulted in release of contaminants to environmental pathways. From observations made during three site visits, the chance of a major spill having occurred appears to be slight; however, there was a dark stained area, approximately 3 square feet in area, located at the northeastern corner of the concrete pad that was suspected to represent a contaminant release.

The area around the building is covered with either grass, asphalt, or concrete. Surface-water runoff drains either into the ditch along the south side of Woodfill Road where it enters the storm water sewer or into the ditch between the building and the railroad tracks to the south where it eventually discharges into a tributary of Middle Fork Creek (Figure 2-1).

The site is located in an area with soils belonging to the Cobbsfork series. The depth to bedrock is unknown, but is probably between 35 and 40 feet based on information from wells drilled at Building 279 and Building 211 to the east of the site. According to geologic mapping of the subsurface bedrock, the glacial till is underlain by the Laurel Dolomite of Silurian age. Regional groundwater potentiometric mapping shows that the shallow bedrock groundwater is generally flowing to the west-southwest (Figure 2-15).

Building 227 is currently shown as being leased to Rotary Lift/Dover Corporation. At the time of the Phase II RI, however, the building was unoccupied. When in operation as a gun shop, equipment was parked on the concrete pad and gun barrels were cleaned in the tank stand adjacent to the pad. **Site personnel placed waste solvents and oils in waste drums that when full, were picked up by the DRMO contractor for off-site disposal. Minor spillage reportedly occurred during handling of the drums (USEPA 1990)**. **These spills were cleaned as they occurred by wiping or picking up the stained materials. Laboratory data was collected by DRMO to support the spill cleanup results. (EPA59)**

23.2 PREVIOUS INVESTIGATIONS

The concrete pad and storage shed are located next to Building 227. This site is listed in the *Enhanced PA Report* (Ebasco 1990a) as SWMU 30. This previous investigation included visual site inspections, records searches, and JPG personnel interviews. No sample data had been collected for this site prior to the RI. There is no evidence or record of a major spill

having occurred at this site; however, the stained area at the northeastern corner of the concrete pad indicates that some surface-soil contamination was likely.

23.3 STUDY AREA INVESTIGATIONS

23.3.1 Phase I RI Field Activities

23.3.1.1 Soil. Due to the presence of the stained area at the northeastern corner of the concrete pad, soil sampling was conducted as part of the Phase I RI.

Three soil borings were drilled near the northeastern corner of the concrete pad (Figure 23-1). One surface sample was collected at each borehole. The sampling intervals were from 0.9 to 1.4 feet or from 0.2 to 0.7 feet bgs. The samples were analyzed for TPH and total metals.

A total of 10 subsurface samples were collected from the 3 soil borings to evaluate the vertical extent of the contamination associated with the stained area. These samples were analyzed for TPH (USEPA method 418.1) and total metals. Monitoring wells were not installed in this area because metals and TPH concentrations detected in the Phase I subsurface soils were below regulatory criteria.

Field screening with a PID using headspace methods was performed for ~~all~~ samples collected. B~~ and b~~ased on the screening results, analysis for VOCs was determined to be unnecessary. (EPA60)

23.3.2 Phase II RI Field Activities

Because it was concluded that this site was adequately characterized on the basis of the Phase I field work, no further investigation was recommended as part of Phase II.

23.4 DATA EVALUATION

23.4.1 Data Validation Results

23.4.1.1 Blank Assessment. When blank contamination exists, the investigative results must exceed the blank result by a factor of 5 (all compounds) or 10 (common laboratory contaminants such as phthalates) in order to be considered positive. Several metals and TPH were detected in blanks associated with Site 31 samples. Based on comparisons to blanks, positive results were qualified as nondetects (“U”) when appropriate. When this change was made, the associated sample quantitation limit became either the concentration detected in the sample, if the detected value was above the quantitation limit, or the quantitation limit, if detected results were less than the quantitation limit. During Phase I the following results were qualified nondetected:

- Beryllium—FSP31BHA01, -C01, -C02.
- Boron—FSP31BHA01, -A02, -A03, -B02, -B03, -B05, -C01, -C02Copper—FSP31BHA01, -A02
- Mercury—FSP31BHA02, -A03, -A04, -B02, -B03, -B04, -B05, -C02, -C03, -C04
- Nickel—FSP31BHC02
- Silver—FSP31BHA03, -B04, -B05 and duplicate, and -C03
- Sodium—FSP31BHA01, -A02
- Total petroleum hydrocarbons (TPH)—FSP31BHA01, -A02, -A03, -A04, -B02, -B03, -B04, -B05, -B05 and duplicate, -C03, and -C04

23.4.1.2 Rejected Results. ~~All~~ **The** antimony soil results were rejected in this data set due to low LCS/MS recoveries. The sample identifications were:

- Antimony—FSP31BHA01, -A02, -A03, -A04, -B01, -B02, -B03, -B04, -B05, -C01, -C02, -C03, and -C04.

23.4.1.3 Evaluation of Non-Detected Values. A comparison was made between the USEPA Region 5 DQLs and the project CRLs for chemicals that were analyzed for but not detected in environmental media at this site. Thallium exceedances were noted for soil samples. No other exceedances were found.

23.4.2 Data Quality Summary

~~All~~ **The** antimony results from Phase I soil samples were rejected. Therefore, antimony contamination in soil at this site has not been characterized. Positive results were changed to nondetects ("U") for several metals analyzed during Phase I. In particular, soil mercury, boron, silver, and TPH results were affected by blank contamination. The detections in the affected samples were below quantitation limits, and the quantitation limits were below Region 9 PRGs, where available. Therefore, blank contamination does not significantly impact the conclusions of the risk assessment.

In summary, the number of samples, the comprehensiveness of the parameter list (with the exception of antimony), and the quality of the data are adequate to characterize the nature and magnitude of soil contamination at the exposure area addressed in the risk assessment. **Uncertainty involving the presence of antimony will be discussed further in the uncertainty section of the human risk assessment for the site. (EPA103)**

23.4.3 Background Screening

23.4.3.1 Surface Soil. Because of the close proximity of the borings installed at this site (within approximately 10 feet of each other), the three surface soil samples were grouped together for the purposes of background screening. The background screening protocol is described in Section 5.1.4.5.2. The results of the background screening procedure for surface soil at Site 31 are shown in Table 23-1. The maximum detected concentration of each inorganic was compared to the calculated background threshold value for the appropriate soil series, in this case the Cobbsfork soil series. As shown in the table, the maximum concentrations of arsenic, barium, beryllium, boron, chromium, cobalt, copper, lead, manganese, nickel, silver, and zinc exceeded their respective background threshold values. These inorganics are therefore considered potential contaminants and are carried through to the COPC selection process.

23.4.3.2 Subsurface Soil. The results of the background screening for subsurface soil at Site 31 are presented in Table 23-2. Because there were six subsurface soil samples, the t-test and Mann-Whitney test were utilized, where appropriate. As shown in Table 23-2, aluminum, barium, beryllium, boron, chromium, cobalt, copper, manganese, nickel, silver, vanadium, and zinc are above background in subsurface soil and are carried through to the COPC selection process.

23.4.4 Summary of Analytical Results

Table 23-3 provides a summary of analytical results for surface and subsurface soil samples collected at Site 31. The complete analytical database utilized for the human health risk assessment for Site 31 consists of the three Phase I surface soil samples and six Phase I subsurface soil samples. Four Phase I subsurface soil samples collected at depths greater than 10 feet are shown in Table 23-3 but are not included in the risk assessment database.

23.5 NATURE AND EXTENT OF CONTAMINATION

23.5.1 Soil

Analysis of the 13 soil samples collected from the 3 soil borings revealed that TPH was present at the surface (81.2 µg/g) and at 4.5 feet (46.9 µg/g) in borehole C (Table 23-1). TPH was not detected in the two deeper samples in borehole C. The only other TPH detection was in the surface sample from borehole B (11.9 µg/g). ~~All of t~~**T**he detected TPH concentrations were less than the action level of 100 µg/g. The presence of TPH in only the two shallowest samples of one borehole indicates the TPH contamination is of limited lateral and vertical extent.

Analysis of the soil samples for metals revealed that the following metals were detected at above-background concentrations: arsenic (2 samples), barium (9 samples), beryllium (10 samples), boron (6 samples), chromium (8 samples), cobalt (10 samples), copper (10 samples),

lead (4 samples), manganese (10 samples), nickel (12 samples), silver (9 samples), vanadium (7 samples), and zinc (12 samples). Aluminum, arsenic, barium, beryllium, and manganese are the metals at this site that exceed the USEPA Region 9 risk-based concentration criteria. It should be noted that arsenic and beryllium both exceed USEPA Region 9 criteria in the background samples, indicating that these metals have naturally high levels in JPG soils. Metals contamination that resulted from facility operations would likely be most concentrated near the surface. However, all but one of the beryllium detections were in samples collected from a depth greater than 4 feet. This distribution of beryllium is better explained by natural variations in soil types. Furthermore, the IDEM Tier II cleanup goal for beryllium in subsurface soils of 118.6 µg/g is much higher than the highest beryllium detection at this site (IDEM 1993). The highest arsenic detection at this site (12.4 µg/g) was in the near-surface sample in borehole B. The IDEM Tier II cleanup goal for arsenic in surface soils, however, is 81 µg/g, and the IDEM maximum background stream and lake sediment concentration for arsenic is 29 µg/g (IDEM 305b Report 1989). Also, the only other arsenic detections above the arsenic background value were in the 10-foot and 15-foot samples in borehole C. This distribution of arsenic is better explained as naturally occurring variations in soil types rather than a result of contamination by facility operations.

In summary, there is some minor TPH in the soil, but it is below the action level for cleanup. The maximum lead concentration measured at the site, 150 µg/g, is less than the USEPA lead cleanup level of 400 µg/g. The beryllium and arsenic detections at this site are only slightly above the background soil screening concentrations and are significantly less than the IDEM Tier II cleanup goals for these metals. Of the metals exceeding USEPA risk management criteria, only manganese had an influence on the potential human health risks. Therefore, the contamination at this site does not appear to be significant in terms of risks to human health and the environment.

23.6 HUMAN HEALTH RISK ASSESSMENT

23.6.1 Selection of the Contaminants of Potential Concern at Site 31

23.6.1.1 Surface Soil.

23.6.1.1.1 Frequency of Detection. Evaluation of frequency of detection was not undertaken at this site because of too few samples.

23.6.1.1.2 Nutrient Screening. The maximum value of each of the nutrients detected in surface soil at this site was less than the corresponding nutrient screening value: calcium (maximum 220,000 µg/g; screening value 1,000,000 µg/g), iron (maximum 11,500 µg/g; screening value 70,000 µg/g), magnesium (maximum 28,200 µg/g; screening value 1,000,000 µg/g), potassium (maximum 544 µg/g; screening value 150,000 µg/g), and sodium (maximum 258 µg/g; screening value 1,000,000 µg/g). Therefore, ~~all~~ nutrients were eliminated as COPCs in surface soil.

23.6.1.1.3 Summary of Preliminary COPCs. Table 23-4 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95% UCL of the mean, and the exposure point concentration for each preliminary COPC in surface soil at Site 31. Soil preliminary COPCs are chemicals detected above background (and/or above the nutrient screening value) at a frequency of greater than 5 percent in soil samples.

23.6.1.1.4 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for each preliminary soil COPC was compared to the chemical-specific Region 9 residential soil PRG (Table 23-5). One-tenth of the PRG was used for ~~all~~ **the** noncarcinogens except lead, for which the full PRG was used. As a result of the screening arsenic, barium, beryllium, and manganese are retained as COPCs in surface soil at Site 31.

23.6.1.2 Surface/Subsurface Soil Combined.

23.6.1.2.1 Frequency of Detection. Evaluation of frequency of detection was not undertaken at this site because of too few samples.

23.6.1.2.2 Nutrient Screening. The maximum value of each of the nutrients detected in surface/subsurface combined soil at this site was less than the corresponding nutrient screening value: calcium (maximum 220,000 µg/g; screening value 1,000,000 µg/g), iron (maximum 53,500 µg/g; screening value 70,000 µg/g), magnesium (maximum 28,200 µg/g; screening value 1,000,000 µg/g), potassium (maximum 1,380 µg/g; screening value 150,000 µg/g), and sodium (maximum 256 µg/g; screening value 1,000,000 µg/g). Therefore, ~~all~~ nutrients were eliminated as COPCs in surface/subsurface soil combined.

23.6.1.2.3 Summary of Preliminary COPCs. Table 23-4 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95% UCL of the mean, and the exposure point concentration for each preliminary COPC in surface/ subsurface soil combined at Site 31. Soil preliminary COPCs are chemicals that have been detected above background (and/or above the nutrient screening value) at a frequency of greater than 5 percent in soil samples. ~~Any i~~**I**norganic constituent**s** determined to be above background in either or both surface and subsurface soil was considered to be a preliminary COPC in surface/subsurface soil combined.

23.6.1.2.4 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for each preliminary soil COPC was compared to the chemical-specific Region 9 residential soil PRG (Table 23-5). One-tenth of the PRG was used for noncarcinogens except for lead, for which the full PRG was used. As a result of the screening, aluminum, arsenic, beryllium, and manganese are retained as COPCs in surface/subsurface soil combined at Site 31 (Figure 23-2).

23.6.1.3 Air.

23.6.1.3.1 Summary of Preliminary COPCs. Ambient air concentrations to which future receptors at this site might be exposed were estimated using air emission/dispersion modeling,

as described in Appendix R. In the site-specific conceptual model, discussed below in Section 23.6.2.1, Site 31 is evaluated under two future site-specific scenarios: as a residential site and an industrial site.

In the future industrial land use scenario for the facility, ~~all~~ **the** sites were assumed to be industrial, except for the five sites designated agricultural sites. Each site with particulate-bound COPCs in surface soil (metals, SVOCs, and dioxins/furans) and/or volatile COPCs in surface/subsurface soil combined was assumed to contribute to the air concentrations at ~~all of~~ the sites. In the future residential scenario for the facility, ~~all~~ **the** sites were assumed to be residential except for the five sites designated agricultural. It was assumed that particulate and VOC emissions from the strictly residential sites would be negligible because the home sites would be covered with dense vegetation (lawns) and pavement. Therefore, under the residential scenario only the five agricultural sites contribute to the air concentrations at ~~all of~~ the sites. The list of preliminary air COPCs is therefore the same for every site for a given scenario, but the concentrations of the COPCs vary. Tables R-4 and R-6 in Appendix R present the estimated ambient air concentrations at Site 31 under the future industrial and residential scenarios, respectively.

23.6.1.3.2 Region 9 Preliminary Remediation Goal Screening. The exposure point concentrations for each preliminary air COPC at Site 31 in the future residential scenario and the future industrial scenario were compared to chemical-specific Region 9 air PRGs (Table 23-6). One-tenth of the PRG was used for noncarcinogens. The exception was lead, for which the full PRG was used. As a result of the screening, aluminum, silver, thallium, vanadium, and zinc are retained as COPCs in air for future on-site residents. For future on-site workers, aluminum, chromium, manganese, silver, thallium, vanadium, and zinc were retained as COPCs.

23.6.2 Exposure Assessment

23.6.2.1 Site Conceptual Model. Current information shows that Building 227 is leased to Rotary Lift/Dover Corporation. However, at the time of the Phase II RI, the building remained unoccupied. As a result, potential risks were assessed for potential future land use scenarios. There are several types of individuals who could potentially be affected by the existing contamination at the facility. These are current trespassers to JPG and off-facility (nearby) rural residents and future hunters. In each case, these individuals would most likely be impacted simultaneously by multiple sites rather than by single units. Because of this, these current receptor populations are addressed on a facility-wide, cumulative basis rather than by specific sites (Sections 28 and 29).

Therefore, this site-specific exposure scenario only addresses future land use development. Site 31 has two potential future land uses forwarded for evaluation:

- Residential
- Industrial

Residential Use. Under the future residential land use scenario, this site is assumed to be developed for residential purposes, with the supposition that a family would build a house directly on/within this area of potential concern. Since there are subsurface soil COPCs at these sites, it was assumed that subsurface soil may or may not be excavated to a depth of 10 feet during the construction of homes. In the excavation scenario, subsurface soil was assumed to be mixed and dispersed with surface soil across the ground surface at each home-site.

With respect to a risk assessment analysis, resident populations were assumed to consist of both adults and toddlers. Each individual would be expected to come in contact with site contaminants via the following pathways at Site 31:

- Inhalation of VOCs and fugitive particulates from soils
- Dermal contact with soil (surface or surface/subsurface combined) while gardening/playing outdoors
- Incidental ingestion of soil (surface or surface/subsurface combined) while gardening/playing outdoors
- Ingestion of fresh homegrown fruits and vegetables (grown in surface soil or surface/subsurface soil combined)

On-site Worker. Industrial land use is considered to be a plausible future option for this site at JPG. On-site industrial workers (adult males and females) are assumed to be individuals who could be exposed directly to contaminated media through the following pathways at Site 31:

- Inhalation of VOCs and fugitive particulates from soils
- Incidental ingestion/dermal contact with soil

23.6.2.2 Exposure Point Concentrations.

23.6.2.2.1 Air. The estimated ambient air concentrations of COPCs at this site for the future on-site residents and the future on-site workers are presented in Table 23-6.

23.6.2.2.2 Soil. The concentrations of COPCs in surface and surface/subsurface soil combined at this site are presented in Table 23-5.

23.6.2.2.3 Fruits, Vegetables, and Crops. COPC concentrations in homegrown fruits and vegetables were estimated using the methods described in Section 5.1.5.2.8. Appendix U, Table U-14, documents the calculation of contaminant concentrations in fruits and vegetables at Site 31.

23.6.2.3 Human Exposure Doses.

23.6.2.3.1 Inhalation of Contaminated Air. Inhalation of airborne contaminants (VOCs and particulates) is a potential route of exposure for future on-site residents (adults and children) and future on-site workers at this site. The equation used for calculating human exposure doses of contaminants of potential concern due to inhalation of volatile and dust-bound contaminants is provided in Section 5.1.5.3.1, Table ~~5-12~~**5-11**. Table V-14, Appendix V, documents the calculation of human exposure doses at Site 31 due to inhalation of contaminated air.

23.6.2.3.2 Incidental Ingestion of Contaminated On-site Soil. Mouthing behavior (toddlers) and incidental ingestion of soil with recreational or work-related activities may expose human receptors to contaminated soil at a site via the oral route of exposure. The equation used to calculate the human exposure dose due to incidental ingestion of contaminated soil is presented in Section 5.1.5.3.2, Table ~~5-13~~**5-12**. This pathway was assumed to be complete at Site 31 for future on-site residents (adults and children) and future on-site workers. Table V-14, Appendix V, documents the calculation of human exposure doses due to incidental ingestion of soil at Site 31.

23.6.2.3.3 Dermal Contact with Contaminated On-site Soil. The chemicals in contaminated soil also may be absorbed into a receptor's body through dermal contact. The equation used to calculate chemical doses due to dermal contact with contaminated soil is presented in Section 5.1.5.3.3, Table ~~5-14~~**5-13**. This pathway is relevant for future on-site residents (adults and children) and future on-site workers at Site 31. Table V-14, Appendix V, documents the calculation of human exposure doses due to dermal contact with soil at Site 31.

23.6.2.3.4 Ingestion of Contaminated Fruits and Vegetables. Consumption of contaminated homegrown fruits and vegetables may be a source of chemical exposure for future on-site residents (adults and children). The equation used to calculate human exposure dose due to ingestion of contaminated fruits and vegetables is provided in Section 5.1.5.3.11, Table ~~5-23~~**5-22**. Table V-14, Appendix V, documents the calculation of human exposure doses due to ingestion of contaminated fruits and vegetables grown in surface soil at Site 31.

23.6.3 Risk Characterization

23.6.3.1 Chronic Health Hazards. The noncancer daily exposure doses calculated in the exposure assessment were used to calculate HQs for each of the COPCs possessing RfDs. Pathway-specific and overall HIs were then calculated for each receptor. The calculations of HQ and HI are described in Section 5.1.7.1. If an overall HI is calculated to be greater than 1.0 for a particular receptor, then the exposure pathway(s) primarily responsible for the result is identified as a “critical pathway(s).” For each critical pathway, those chemical contaminants responsible for the majority of the HI are listed as COCs. Table W-14, Appendix W,

documents the calculation of the pathway- and chemical-specific HQs for the human receptors at Site 31. The pathway-specific and overall HIs are summarized in Table 23-7.

23.6.3.1.1 Future On-Site Residents. If receptors are exposed to COPCs in surface soil only, the overall HI for the future on-site adult residents at Site 31 is calculated to be **0.4**~~0.56~~, which is less than the USEPA's risk management criterion. The overall HI for the future on-site toddler resident is calculated to be **1.5**~~2.0~~. This HI exceeds the risk management criterion of 1.0, however, no single chemical has a total HI that exceeds 1.0. **For this reasons, and the conservatism associated with this scenario, non-cancer health effects would not be anticipated in future residents. (EPA175)** The highest chemical-specific total HI is **0.80**~~0.90~~ for **arsenic**~~manganese~~. The highest pathway-specific HI is **0.8**~~1.1~~ for ingestion of **surface soil.**~~homegrown fruits/vegetables.~~

If subsurface soil is assumed to be mixed and dispersed with surface soil across the ground surface at the home-site, the overall HI for the future on-site adult is calculated to be 0.45, which is less than the USEPA's risk management criterion. The overall HI for the future toddler residents at Site 31 is calculated to be **1.12**~~1.7~~, which~~ exceeds~~ **is basically equivalent to** the USEPA's risk management criterion. ~~However,~~ **In addition,** no pathway-specific or total chemical-specific HI exceeds 1.0.

23.6.3.1.2 Future On-Site Workers. The overall HI for the future on-site worker at Site 31 is calculated to be **0.14**~~0.11~~, which is less than USEPA's risk management criterion. Thus, no critical exposure pathways or chemicals of concern are identified for this receptor population. The existing contamination at Site 31 would not present a chemical hazard to future on-site workers.

23.6.3.2 Excess Lifetime Cancer Risks. The cancer risks for each receptor were determined from the pathway-specific exposure doses and the route-specific SFs, as described in Section 5.1.7.2. To assess the simultaneous exposure of a receptor population to multiple carcinogens from multiple exposure routes, ~~all of~~ the cancer risks calculated for a receptor population were summed. Each overall receptor cancer risk was then compared to USEPA's target risk range (1.0E-06 to 1.0E-04). If the total cancer risk for a receptor from ~~all~~ **the** exposure pathways is less than 1.0E-04, then it is concluded that the site(s) does not pose a significant risk to that receptor. If the overall cancer risk exceeds the target risk range, ~~any~~ **a** chemical individually associated with a risk level greater than 1.0E-05 is identified as a COC. COCs represent the primary contributors to the potential cancer risk for the receptor-specific exposure pathway under evaluation. Table W-14, Appendix W, documents the calculation of the pathway- and chemical-specific cancer risks for the human receptors at Site 31. The pathway-specific and overall cancer risks are summarized in Table 23-7.

23.6.3.2.1 Future On-Site Residents. If receptors are exposed to COPCs in surface soil only, the overall cancer risks calculated for the future adults and toddlers living at Site 31 are **both** ~~3.2~~**3.0**E-05~~. and 3.3E-05, respectively.~~ Since these cancer risks are within USEPA's target

risk range of 1.0E-06 to 1.0E-04, no critical exposure pathways or chemicals of concern are identified for these receptors if they are exposed to surface soil only.

If subsurface soil is assumed to be mixed and dispersed with surface soil across the ground surface at the home-site, the overall cancer risks calculated for the future adults and toddlers living at Site 31 are **both 3.0E-05**~~3.3E-05 and 3.4E-05, respectively~~. Since these cancer risks are within USEPA's target risk range of 1.0E-06 to 1.0E-04, no critical exposure pathways or chemicals of concern are identified for -these receptors if they are exposed to a mixture of surface and subsurface soil.

23.6.3.2.2 Future On-Site Workers. The overall cancer risk calculated for the future workers at Site 31 is **4.3**~~3.4~~E-06. Since this estimated cancer risk is within USEPA's target risk range of 1.0E-06 to 1.0E-04, no critical exposure pathways or chemicals of concern are identified for future workers.

23.6.3.3 Uncertainty/Sensitivity Analysis. The numerical risks/hazards that are calculated for Site 31 represent *conditional* estimates of risk based on various simplifying assumptions concerning contaminant exposure and toxicity. These estimates of risk/hazard are derived using a series of conservative procedures that address contaminant concentrations at the site, their fate in the environment, how someone currently or in the future might be exposed to these contaminants, and the toxicity of each chemical toward humans. The uncertainty analysis specifies, when appropriate, the critical assumptions made for the site so that the site-specific results can be interpreted by risk managers in a proper context.

To assist the risk managers in this project, a qualitative uncertainty analysis has been performed. The primary goals of a qualitative uncertainty analysis are (1) to itemize the major areas of uncertainty in the site-specific risk assessment and (2) to demonstrate that the assessment overall has been conservatively performed (i.e., that the potential risks/hazards at the site have not likely been underestimated, but may have been significantly overestimated).

The qualitative uncertainty analysis for this site is presented in Table 23-8. Based on this analysis, it can be concluded that this risk assessment is conservative. Some of the major uncertainties in this study that are most influential to the risks/hazards that were calculated include:

- Assumptions regarding receptors' exposure time (24 hours/day) and exposure frequency (350 days/year)

- Assumptions regarding receptors' food-chain ingestion rates (95th percentile of U.S. population)

- Maximum soil concentrations used

It should be noted that Phase I antimony results obtained by USATHAMA-certified methods were acceptable under USATHAMA QA/QC guidelines, but were later rejected

in accordance with EPA CLP guidelines for data review. The rejected data were not used *quantitatively* in the risk assessment of this site. The lack of these results for antimony may underestimate risk to human health and ecological receptors. (EPA103)

23.7 ECOLOGICAL RISK ASSESSMENT

Utilizing protocol established in the PERA (Rust E&I 1997g), it was determined that the only COC at this site is barium, which was detected at a maximum concentration of 742 mg/kg in the site soils. This concentration was determined to be potentially harmful to site fauna. The site is surrounded by a frequently mowed lawn consisting of typical lawn grasses such as fescue, rye, and bluegrass. Since barium does not bioaccumulate and the impacted area is small (less than 150 square feet), no further ecological investigation was undertaken for this site.

23.8 CONCLUSIONS AND RECOMMENDATIONS

Soil boring samples from the Building 227 Former Storage Pad (Site 31) were found to contain TPH in concentrations below the action level of 100 µg/g. These TPH detections were present in the near-surface soil only and the contamination appears to be of limited lateral and vertical extent. Additionally, several metals were present at levels exceeding their respective background concentrations. When screened against USEPA Region 9 PRGs, aluminum, arsenic, beryllium, and manganese were retained as COPCs for Site 31.

Human health risk assessment results for Site 31 indicate that there are no risks or hazards that exceed USEPA risk management criteria for the future on-site worker **and resident**. **(EPA175)** ~~For the future resident scenario, the HI for the child resident exceeds 1.0 primarily due to ingestion of manganese in homegrown produce.~~ No ecological risk was identified for Site 31.

~~Although the HI for the future child resident was found to exceed the goal of 1.0, no other risks or hazards exceeding USEPA risk management criteria were identified. Manganese in soil was the major contributor to the HIs for the future resident. Elevated manganese is present throughout the area south of the Firing Line. and may represent background conditions.~~ ~~**However, no individual contaminants resulted in an unacceptable hazard as the cumulative risks were overestimated for reasons stated in Section 26.6.3.**~~ **(IN30)** Therefore, it is recommended that a No Further Action technical memorandum be prepared for Site 31 and the site be removed from the RI/FS.

TABLES

TABLE 23-1

Background Screening of Inorganic Chemicals Detected in Surface Soil
Site 31 - Building 227 Former Storage Pad
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[(a)]	Maximum Detected Value (µg/g)[(b)]	Soil Series Background Screening Value[(c)] (µg/g)	Exceeds Soil Series Background?
Aluminum	3/3	9,250	11,000	No
Arsenic	3/3	12.4	9.26	**YES**
Barium	3/3	742	84.5	**YES**
Beryllium	1/3	0.575	0.52	**YES**
Boron	1/3	14.9	NA[(d)]	**YES**
Chromium	3/3	20.4	15.1	**YES**
Cobalt	2/3	4.2	3.5	**YES**
Copper	2/3	29.7	5.64	**YES**
Lead	3/3	150	14.9	**YES**
Manganese	3/3	1,000	302	**YES**
Nickel	3/3	8.78	2.3	**YES**
Silver	3/3	0.074	NA	**YES**
Vanadium	3/3	19.5	27.0	No
Zinc	3/3	137	19.5	**YES**

Footnotes:
(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Micrograms per gram.
(c) See Section 5.1.2.4.2 for an explanation of how the soil-series-specific background screening values were calculated.
(d) Not applicable.

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TABLE 23-2

Background Screening of Inorganic Chemicals Detected in Subsurface Soil
Site 31 - Building 227 Former Storage Pad
Jefferson Proving Ground
Madison, Indiana

Chemical	Location	Frequency of Detection[a]	Maximum Detected Value (mg/kg)[b]	Average Conc. (mg/kg)	Median Conc. (mg/kg)	Background (Bkg.) Threshold (mg/kg)	Data Distribution	Test Performed	p value	Site > Bkgd?
Subsurface Soil										
Aluminum	Site	6/6	16,300	12,849	12,850		Lognormal	t test	<0.001	**YES**
	Background	**10/10**	**10,900**	**7,673**	**7,845**	**11,000**	**Lognormal**			
Arsenic	Site	3/6	11.4	4.1	2.5		Lognormal	---[c]	---	No
	Background	**10/10**	**9.46**	**4.8**	**3.9**	**9.26**	**Neither**			
Barium	Site	6/6	206	137	128.5		Lognormal	t test	<0.001	**YES**
	Background	**10/10**	**74.1**	**49.8**	**45.7**	**84.5**	**Lognormal**			
Beryllium	Site	5/6	0.983	0.714	0.792		Normal	Mann-Whitney	0.01	**YES**
	Background	**10/10**	**0.45**	**0.32**	**0.32**	**0.52**	**Neither**			
Boron	Site	1/6	15.4	5.3	3.3		Neither	---	---	**YES**
	Background	**0/10**	**---**[d]	**---**	**---**	**---**	**---**			
Chromium (total)	Site	6/6	20.2	15.4	15.1		Lognormal	t test	0.003	**YES**
	Background	**10/10**	**15.5**	**9.7**	**9.9**	**15.1**	**Lognormal**			
Cobalt	Site	6/6	18.7	9.1	8.2		Lognormal	t test	<0.001	**YES**
	Background	**10/10**	**3.6**	**1.9**	**1.9**	**3.5**	**Lognormal**			
Copper	Site	5/6	18.3	8.7	7.8		Lognormal	Mann-Whitney	0.02	**YES**
	Background	**7/10**	**4.96**	**3.5**	**4.1**	**5.64**	**Normal**			
Lead	Site	6/6	15.0	11.5	12.2		Normal	---[e]	---	No
	Background	**10/10**	**14.6**	**13.6**	**13.6**	**14.9**	**Normal**			

TABLE 23-2

Background Screening of Inorganic Chemicals Detected in Subsurface Soil
Site 31 - Building 227 Former Storage Pad
Jefferson Proving Ground
Madison, Indiana

Chemical	Location	Frequency of Detection[a]	Maximum Detected Value (mg/kg)[b]	Average Conc (mg/kg)	Median Conc (mg/kg)	Background (Bkg.) Threshold (mg/kg)	Data Distribution	Test Performed	p value	Site > Bkgd?
Manganese	Site	6/6	1,180	605	554		Normal	Mann-Whitney	0.004	**YES**
	Background	**10/10**	**344**	**115**	**85.9**	**302**	**Lognormal**			
Nickel	Site	5/6	42.5	14.9	9.1		Lognormal	Extreme value	---	**YES**
	Background	**1/10**	**2.30**	**2.0**	**2.0**	**2.23**	**Neither**			
Silver	Site	4/6	0.032	0.019	0.021		Normal	---	---	**YES**
	Background	**0/10**	**---**	**---**	**---**	**---**	**---**			
Vanadium	Site	6/6	49.8	30.0	29.7		Lognormal	t test	0.02	**YES**
	Background	**10/10**	**27.6**	**19.8**	**19.2**	**27.0**	**Lognormal**			
Zinc	Site	6/6	76.6	42.4	36.9		Lognormal	Mann-Whitney	<0.001	**YES**
	Background	**10/10**	**18.5**	**14.7**	**14.7**	**19.5**	**Normal**			

Footnotes:

(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Milligrams per kilogram.
(c) The Mann-Whitney test was not performed because the site median concentration is less than the background median concentration.
(d) Not applicable.
(e) The t test was not performed because the site average concentration is less than the background average concentration.

TABLE 23-3

Summary of Analytical Results for Metals in Soil Boring Samples
Site 31 - Building 227 Former Storage Pad
Jefferson Proving Ground
Madison, Indiana

Sample ID Depth (ft.) Analyte	FSP31BHA01 0.9-1.4 (µg/g)[(a)]	FSP31BHA02 4.3-4.8 (µg/g)	FSP31BHA03 9.3-9.8 (µg/g)	FSP31BHA04 14.3-14.8 (µg/g)	FSP31BHB01 0.9-1.4 (µg/g)	FSP31BHB02 4.3-4.8 (µg/g)	FSP31BHB03 9.3-9.8 (µg/g)	Background (µg/g)
Aluminum	9,250	9,070	16,300	19,100	6,540	10,500	15,100	11,000
Arsenic	7.92	6.14	LT 2.50	3.62	12.4	3.82	LT 2.50	9.26
Barium	56.7	119	192	379	36.9	138	98.9	84.5
Beryllium	LT[(b)] 0.427	0.836	0.983	0.821	0.575	0.657	0.748	0.520
Boron	LT 6.64	LT 6.64	LT 6.64	8.29	14.9	LT 6.64	LT 6.64	0
Calcium	1,730	1,460	2,970	23,400	220,000	1,580	2,060	750
Chromium	9.86	10.5	20.2	23.7	10.6	14.6	15.5	15.1
Cobalt	3.62	7.73	8.58	11.5	LT 2.50	9.21	6.89	3.50
Copper	LT 2.84	LT 2.84	9.54	13.6	7.98	4.79	9.52	5.64
Iron	11,500	13,600	16,500	21,800	7,910	27,400	25,000	14,800
Lead	14.8	15.0	8.13	18.2	28.0	12.5	13.3	14.9
Magnesium	795	731	2,120	8,460	28,200	1,090	1,470	700
Manganese	55.9	486	621	1,500	1,000	912	331	302
Mercury	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	0
Nickel	4.35	7.66	16.0	19.8	3.84	8.78	9.34	2.23
Potassium	461	332	771	1,590	506	477	381	681
Silver	0.0353	0.0288	LT 0.0124	0.0294	0.0368	0.0204	0.0216	0
Sodium	LT 38.7	LT 38.7	197	175	158	53.1	111	50.5
Vanadium	19.5	29.0	13.9	35.9	11.9	49.8	30.4	27.0
Zinc	16.8	28.9	46.8	61.2	31.9	32.0	29.5	19.5

TABLE 23-3

Summary of Analytical Results for Metals in Soil Boring Samples
Site 31 - Building 227 Former Storage Pad
Jefferson Proving Ground
Madison, Indiana

Sample ID Depth Analyte	FSP31BHB04 14.3-14.8	FSP31BHB05 19.2-19.7	FSP31BHC01 0.2-0.7	FSP31BHC02 4.5-5.0	FSP31BHC03 9.5-10.0	FSP31BHC04 14.2-14.7	Background (µg/g)
Aluminum	18,900	8,900	8,950	10,600	15,600	15,800	11,000
Arsenic	6.41	5.00	2.95	LT 2.50	11.4	9.17	9.26
Barium	237	51.7	742	67.0	206	143	84.5
Beryllium	0.654	0.697	LT 0.427	LT 0.427	0.844	0.804	0.52
Boron	55.3	LT 6.64	LT 6.64	LT 6.64	15.4	13.9	0
Calcium	63,000	52,100	89,000	3,940	3,120	56,700	750
Chromium	23.2	16.4	20.4	11.5	19.9	21.4	15.1
Cobalt	10.6	7.50	4.20	3.36	18.7	10.9	3.50
Copper	18.8	13.1	29.7	6.07	18.3	37.6	5.64
Iron	18,400	20,700	10,500	9,290	53,500	24,100	14,800
Lead	13.3	11.9	150	8.13	11.9	9.25	14.9
Magnesium	17,300	13,200	23,100	1,690	2,930	15,600	700
Manganese	791	204	482	101	1,180	688	302
Mercury	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	LT 0.05	0
Nickel	19.4	13.6	8.78	LT 2.74	42.5	22.1	2.23
Potassium	2,170	685	544	426	1,380	1,810	681
Silver	LT 0.0124	LT 0.0124	0.074	0.0317	LT 0.0124	0.0157	0
Sodium	252	132	112	73.2	256	193	50.5
Vanadium	35.2	26.2	19.0	22.0	34.5	33.4	27.0
Zinc	58.0	37.7	137	41.8	76.6	71.5	19.5

General Notes:

1. All samples were collected on 11/19/92. (EPA 18)
2. Antimony results were rejected due to quality control deficiencies.

Footnotes:

(a) Micrograms per gram.
(b) Less than the reporting limit.

TABLE 23-4

Soil Exposure Point Concentrations of Contaminants of Potential Concern
Site 31 - Building 227 Former Storage Pad
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/g)[b]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[c] (µg/g)
Surface Soil						
Arsenic	3/3	2.95 - 12.4	NA[d]	7.8	1,953	12.4
Barium	3/3	36.9 - 742	NA	279	5.1E+13	742
Beryllium	1/3	0.575	0.427	0.334	8.2	0.575
Boron	1/3	14.9	6.64	7.2	10,636	14.9
Chromium	3/3	9.86 - 20.4	NA	13.6	61.2	20.4
Cobalt	2/3	3.62 - 4.20	2.50	3.0	236	4.2
Copper	2/3	7.98 - 29.7	NA	13.0	1.4E+11	29.7
Lead	3/3	14.8 - 150	NA	64.3	4.4E+7	150
Manganese	3/3	55.9 - 1,000	NA	513	9.8E+11	1,000
Nickel	3/3	3.84 - 8.78	NA	5.6	45.1	8.78
Silver	3/3	0.035 - 0.074	NA	0.049	0.34	0.074
Zinc	3/3	16.8 - 137	NA	61.9	3.8E+6	137
Surface/Subsurface Soil Combined						
Aluminum	9/9	6,540 - 16,300	NA	11,350	14,366	14,366
Arsenic	6/9	2.95 - 12.4	2.50	5.5	17.4	12.4
Barium	9/9	36.9 - 742	NA	173	464	464

TABLE 23-4

Soil Exposure Point Concentrations of Contaminants of Potential Concern
Site 31 - Building 227 Former Storage Pad
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[(a)]	Range of Detected Values (µg/g)[(b)]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[(c)] (µg/g)
Surface/Subsurface Soil Combined (cont'd)						
Beryllium	6/9	0.58 - 0.98	0.427	0.59	0.77	0.77
Boron	2/9	14.9 - 15.4	6.64	5.9	9.2	9.2
Chromium	9/9	9.86 - 20.4	NA	14.8	18.4	18.4
Cobalt	8/9	3.36 - 18.7	2.50	7.2	16.2	16.2
Copper	7/9	4.79 - 29.7	2.84	10.3	39.0	29.7
Lead	9/9	8.13 - 150	NA	24.0	66.1	66.1
Manganese	9/9	55.9 - 1,180	NA	574	818	818
Nickel	8/9	3.84 - 42.5	2.74	11.3	35.9	35.9
Silver	7/9	0.02 - 0.074	0.012	0.03	0.076	0.074
Vanadium	9/9	11.9 - 49.8	NA	25.5	37.2	37.2
Zinc	9/9	16.8 - 137	NA	48.0	86.5	86.5

Footnotes:
(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Micrograms per gram.
(c) The 95% UCL (upper confidence limit of the mean) or the maximum detected value, whichever is lower (USEPA 1989b).
(d) Not applicable.

TABLE 23-5

Selection of Contaminants of Potential Concern (COPC) in Soil Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 31 - Building 227 Former Storage Pad
Jefferson Proving Grounds
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Residential PRG (µg/g)[a]**	**Exposure Point Conc. (µg/g)**	**Retained as Soil COPC?**
Surface Soil			
Arsenic	0.38	12.4	**YES**
Barium	527	742	**YES**
Beryllium	0.143	0.575	**YES**
Boron	586	14.9	No
Chromium	30.1[b]	20.4	No
Cobalt	456	4.2	No
Copper	285	29.7	No
Lead	400[c]	150	No
Manganese	318	1,000	**YES**
Nickel	153	8.78	No
Silver	38.3	0.074	No
Zinc	2,300	137	No
Surface/Subsurface Soil Combined			
Aluminum	7,667	14,366	**YES**
Arsenic	0.38	12.4	**YES**
Barium	527	464	No
Beryllium	0.143	0.77	**YES**
Boron	586	9.2	No
Chromium	30.1[b]	18.4	No
Cobalt	456	16.2	No
Copper	285	29.7	No
Lead	400[c]	66.1	No

TABLE 23-5

Soil Exposure Point Concentrations of Contaminants of Potential Concern (COPC) Based United States Environmental Protection Agency (USEPA) Region 9 Preliminary Remediation Goals (PRGs) Site 31 - Building 227 Former Storage Pad Jefferson Proving Ground Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Residential PRG (µg/g)[(a)]**	**Exposure Point Conc. (µg/g)**	**Retained as Soil COPC?**
Manganese	318	818	**YES**
Surface/Subsurface Soil Combined (cont'd)			
Nickel	153	35.9	No
Silver	38.3	0.074	No
Vanadium	53.7	37.2	No
Zinc	2,300	86.5	No

General Note:

1. PRGs were taken directly from the Region 9 PRG Table (USEPA 1998) except as noted in the footnotes. Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnote:

(a) Micrograms per gram.
(b) Value for chromium VI.
(c) Value for lead is full PRG.

TABLE 23-6

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 31 - Building 227 Former Storage Pad
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Ambient Air PRG (µg/m^3)[(a)]**	**Exposure Point Conc. (µg/m^3)**	**Retained as Air COPC?**
Residential Scenario			
Aluminum	NA[(b)]	2.89E-03	**YES**
Arsenic	4.5E-04	9.20E-07	No
Barium	5.2E-02	1.80E-05	No
Beryllium	8.0E-04	7.21E-08	No
Cadmium	1.1E-03	3.51E-08	No
Chromium	2.3E-05	1.41E-05	No
Lead	1.5E+00[(c)]	2.60E-06	No
Manganese	5.1E-03	2.92E-04	No
Silver	NA	4.94E-06	**YES**
Thallium	NA	3.94E-06	**YES**
Vanadium	NA	4.47E-07	**YES**
Zinc	NA	1.79E-06	**YES**
Dioxins/Furans	4.5E-08	7.73E-14	No
Benzo(a)anthracene	9.2E-03	3.22E-09	No
Benzo(a)pyrene	9.2E-04	4.53E-08	No
Benzo(b)fluoranthene	9.2E-03	9.78E-08	No
DDE	2.0E-02	1.90E-09	No
Dibenz(a,h)anthracene	9.2E-04	3.79E-10	No
Dieldrin	4.2E-04	NA	No
Indeno(1,2,3-cd)pyrene	9.2E-03	1.90E-09	No
1,1-Dichloroethylene	3.8E-02	9.82E-10	No
Chlorobenzene	2.1E+00	7.82E-07	No

TABLE 23-6

Selection of Contaminants of Potential Concern (COPC) in Air Based on United States Environmental Protection Agency (USEPA) Region 9 Preliminary Remediation Goals (PRGs)
Site 31 - Building 227 Former Storage Pad
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	Ambient Air PRG ($\mu g/m^3$)[(a)]	Exposure Point Conc. ($\mu g/m^3$)	Retained as Air COPC?
Industrial Scenario			
Aluminum	NA	1.80E-02	**YES**
Arsenic	4.5E-04	2.96E-04	No
Barium	5.2E-02	1.69E-02	No
Beryllium	8.0E-04	1.33E-05	No
Cadmium	1.1E-03	5.71E-08	No
Chromium	2.3E-05	8.13E-05	**YES**
Lead	1.5E+00[(c)]	2.60E-06	No
Manganese	5.1E-03	2.37E-02	**YES**
Silver	NA	4.94E-06	**YES**
Thallium	NA	3.94E-06	**YES**
Vanadium	NA	9.06E-07	**YES**
Zinc	NA	2.57E-05	**YES**
Dioxins/Furans	4.5E-08	9.62E-13	No
Benzo(a)anthracene	9.2E-03	3.22E-09	No
Benzo(a)pyrene	9.2E-04	4.53E-08	No
Benzo(b)fluoranthene	9.2E-03	9.78E-08	No
DDE	2.0E-02	1.90E-09	No
Dibenz(a,h)anthracene	9.2E-04	3.79E-10	No
Dieldrin	4.2E-04	4.08E-09	No
Indeno(1,2,3-cd)pyrene	9.2E-03	1.90E-09	No
1,1-Dichloroethylene	3.8E-02	9.82E-10	No
Chlorobenzene	2.1E+00	7.82E-07	No

General Note:

PRGs were taken directly from the Region 9 PRG Table (USEPA 1998). Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:

(a) Micrograms per cubic meter.
(b) Not available or not applicable.
(c) Federal ambient air quality criterion for lead.

TABLE 23-7

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 31 - Building 227 Former Storage Pad
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
Future On-site Resident Adult (surface soil only)				
Incidental ingestion of soil	1.09E-05		0.0813	
Dermal contact with soil	2.74E-06		0.0162	
Ingestion of homegrown fruits/vegetables	1.64E-05		0.3015	
Inhalation of VOCs[a] and fugitive dusts	NA[b]		NA	
Total	3.0E-05		0.3990	
Future On-site Resident Child (surface soil only)				
Incidental ingestion of soil	2.04E-05		0.7590	
Dermal contact with soil	1.58E-06		0.0468	
Ingestion of homegrown fruits/vegetables	7.95E-06		0.7149	
Inhalation of VOCs and fugitive dusts	NA		NA	
Total	2.99E-05		1.5207	
Future On-site Resident Adult (surface/subsurface soil combined)				
Incidental ingestion of soil	1.09E-05		0.0652	
Dermal contact with soil	2.74E-06		0.0149	
Ingestion of homegrown fruits/vegetables	1.64E-05		0.2098	

TABLE 23-7

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 31 - Building 227 Former Storage Pad
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
Inhalation of VOCs and fugitive dusts	NA		NA	
Total	3.0E-05		0.2899	
Future On-site Resident Child (surface/subsurface soil combined)				
Incidental ingestion of soil	2.04E-05		0.6081	
Dermal contact with soil	1.58E-06		0.0429	
Ingestion of homegrown fruits/vegetables	7.95E-06		0.4985	
Inhalation of VOCs and fugitive dusts	NA		NA	
Total	2.99E-05		1.1495	
Future On-site Worker (surface soil only)				
Incidental ingestion of soil	3.25E-06		0.0290	
Dermal contact with soil	9.71E-07		0.0069	
Inhalation of VOCs and fugitive dusts	7.92E-08		0.1079	
Total	4.3E-06		0.1438	

Footnotes:
(a) Volatile organic compounds.
(b) Not applicable or not available.

TABLE 23-8

Qualitative Uncertainty Analysis
Site 31 - Building 227 Former Storage Pad
Jefferson Proving Ground
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
A. Human Behavior				
Future receptors' exposure duration	30 years	Medium	Medium	National upper-bound time (90th percentile) at one residence
Future receptors' exposure frequency	350 days/year	Medium	Medium	High-end value
Future receptors' exposure time	24 hours/day	Low	High	Maximum possible value
Future receptors' foodchain ingestion rates	NA[a]	Low	High	Nearly impossible for an average weight receptor to ingest daily the 95th percentile U.S. population consumption amounts
Exclusion of certain exposure pathways in the quantitative analysis	NA	Low	Low	Pathways eliminated are those that have low possibility of contributing risk to these receptors
B. Chemical Fate/Transport in the Environment				
Calculation of exposure point concentration of COC[b]/foodchain modeling	NA	Low	High	Conservative assumptions and input parameters
Use of air dispersion modeling to predict air concentrations	NA	Low	High	Conservative assumptions and input parameters

TABLE 23-8

Qualitative Uncertainty Analysis
Site 31 - Building 227 Former Storage Pad
Jefferson Proving Ground
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
C. Chemical Toxicity				
Assumption that USEPA[c] reference doses truly represent toxicological thresholds	NA	Low	High	High degree of conservativeness utilized by USEPA in deriving RfDs[d] from toxicological literature
Assumption that USEPA carcinogenic slope factors truly represent dose-response phenomena	NA	Low-moderate	Moderate-high	Use of linearized, multi-stage mathematical model to predict cancer incidence at low exposure levels is USEPA policy; not currently supported by scientific data
Assumption of risk/hazard additivity	NA	Moderate	Moderate	Summation of chemical-specific risks/hazards may over- or under-predict risks/hazards to receptors
Screening out of certain contaminants based on USEPA criteria	NA	Low	Low	Chemicals present in concentrations less than Region 9 criteria eliminated

Footnotes:
(a) Not applicable or not available.
(b) Contaminant of concern.
(c) United States Environmental Protection Agency.
(d) Reference doses.

FIGURES

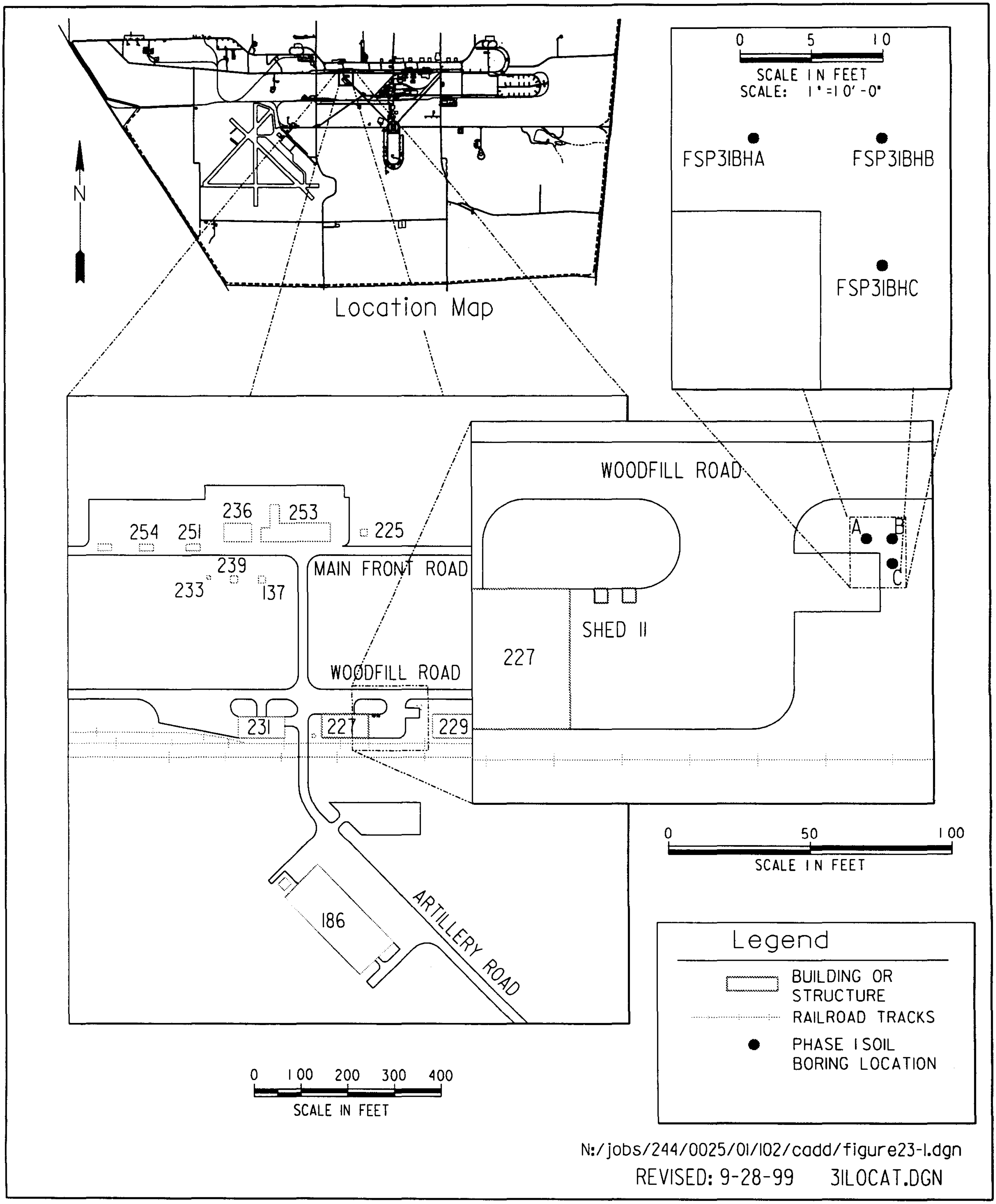
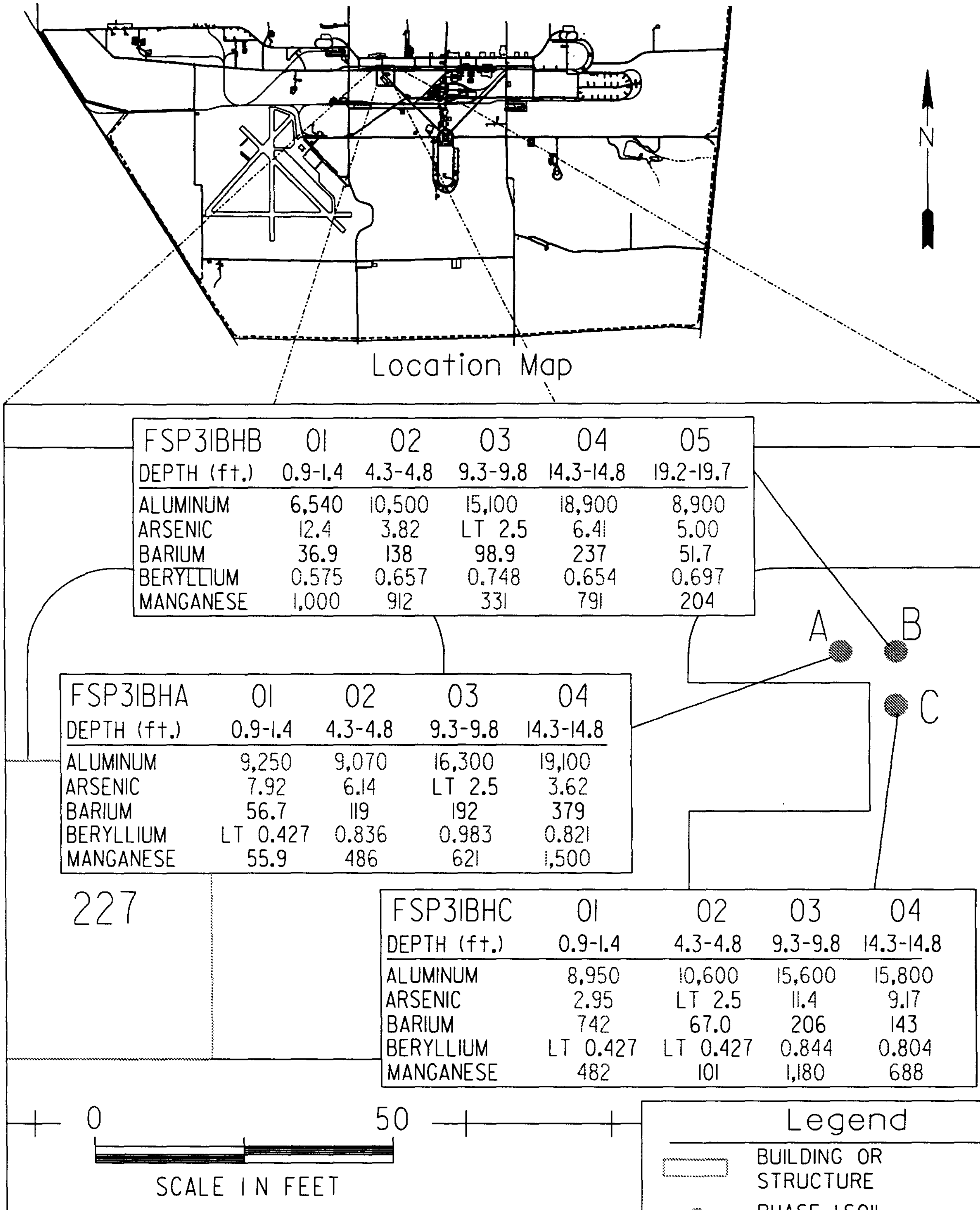


Figure 23-1. Sampling Locations at Building 227 Former Storage Pad (Site 31)



FSP3IBHB	01	02	03	04	05
DEPTH (ft.)	0.9-1.4	4.3-4.8	9.3-9.8	14.3-14.8	19.2-19.7
ALUMINUM	6,540	10,500	15,100	18,900	8,900
ARSENIC	12.4	3.82	LT 2.5	6.41	5.00
BARIUM	36.9	138	98.9	237	51.7
BERYLLIUM	0.575	0.657	0.748	0.654	0.697
MANGANESE	1,000	912	331	791	204

FSP3IBHA	01	02	03	04
DEPTH (ft.)	0.9-1.4	4.3-4.8	9.3-9.8	14.3-14.8
ALUMINUM	9,250	9,070	16,300	19,100
ARSENIC	7.92	6.14	LT 2.5	3.62
BARIUM	56.7	119	192	379
BERYLLIUM	LT 0.427	0.836	0.983	0.821
MANGANESE	55.9	486	621	1,500

FSP3IBHC	01	02	03	04
DEPTH (ft.)	0.9-1.4	4.3-4.8	9.3-9.8	14.3-14.8
ALUMINUM	8,950	10,600	15,600	15,800
ARSENIC	2.95	LT 2.5	11.4	9.17
BARIUM	742	67.0	206	143
BERYLLIUM	LT 0.427	LT 0.427	0.844	0.804
MANGANESE	482	101	1,180	688

Legend

- BUILDING OR STRUCTURE
- PHASE I SOIL BORING LOCATION
- 482 VALUES IN RED EXCEED RESIDENTIAL PRG

NOTE: ALUMINUM BACKGROUND LEVELS ALSO EXCEED EPA RESIDENTIAL PRGs

ALL VALUES IN ug/g

N:/jobs/244/0025/01/102/cadd/figure23-2.dgr.

REVISED: 10-14-99 31SAMPLE.DGN

Figure 23-2. Summary of Contaminants Exceeding Background and Regulatory Risk-Based Concentrations at Building 227 Former Storage Pads (Site 31)

24.0 BUILDING 333 NEW INCINERATOR (SITE 33)

Since submittal of the Draft RI (August 1998), a soil removal action was performed at Site 33. Approximately 30.11 tons of soil were excavated and removed from the site during remedial removal action performed in 2000. Confirmation sampling was performed to assess the removal action. Residual dioxin contamination exceeded the PRGs in some of the confirmation samples. Of those, only one exceeded background. However, a risk calculation for that level was performed, which indicated that exceedance was below the USEPA's target risk range. Therefore, no additional excavation was warranted. The excavation site was backfilled with clean fill material and the site was seeded. A detailed description of the construction activities and sample results are contained in the *Draft Final Construction Completion Report, Remedial Removal Actions, Sites 12A, 12B, 12C, and 33 (Montgomery Watson, February 2002* (New Work).

24.1 SITE CHARACTERISTICS

The Building 333 incinerator is located about 500 feet west of Papermill Road between Woodfill Road and the airfield (Figure 24-1). The incinerator, which was in operation from 1978 to 1995, was used to burn primarily paper and paper products. The incinerator is a fuel-oil-fired single-chamber unit with an afterburner. In 1988-89, polyurethane foam used as inert filler and wastes containing iron oxide were also incinerated. The resulting ash was characterized ~~and properly disposed of~~**for proper disposal**. The test burn of these materials was unsuccessful and the practice was discontinued. Ash from the incinerator was previously placed in fiber drums and taken to the Gate 19 Landfill; however, with the closure of landfill **off-site disposal of** the ash ~~was disposed of off site~~ **was done** until closure in 1995. Potential contaminants in the ash from the incinerator are primarily heavy metals.

There are railroad tracks to the south of the incinerator building and woods around the north and west sides. The east side opens out to a large field currently under cultivation (soybeans). Prior to being cultivated, the field was a grassy area that was occasionally included in the open burning program at JPG. There is a small tributary to Middle Fork Creek located just south of the railroad tracks; surface-water runoff from the site discharges into this tributary (Figure 2-1).

The site is located in an area with soils belonging to the Cobbsfork series. The depth to bedrock is unknown but is probably between 35 and 40 feet based on information from wells drilled at the Yellow Sulfur Disposal Area (Site 14) located to the south of the site. According to geologic mapping of the subsurface bedrock, the glacial till is underlain by the Laurel Dolomite of Silurian age. The groundwater contour maps constructed for the Yellow Sulfur Disposal Area indicate an extremely flat horizontal groundwater gradient.

There are currently no activities at the site with the exception of farming of the adjacent field. There are plans to lease the incinerator once it is determined that no further remedial action activities are required.

24.2 PREVIOUS INVESTIGATIONS

Prior to the RI, this site was inspected and the records were searched in the *Enhanced PA Report* (Ebasco 1990a), which lists the site as SWMU 11. This study revealed that the ash from the new incinerator was routinely sampled and analyzed for total cyanide, total sulfide, ignitability, pH, and EP toxicity metals. The existing conditions and proposed sampling activities were summarized in the *Master Environmental Plan* (Ebasco 1990b).

24.3 STUDY AREA INVESTIGATION

24.3.1 Phase I RI Field Activities

A review of the historical data from routine ash sampling was conducted in order to evaluate the types of contaminants that might have been released from the site. Wind direction data were also collected to determine if ash fall had contaminated soil downwind of the incinerator. As part of the Phase I RI, one ash sample was collected and analyzed for TCLP metals. In addition, two near-surface soil samples **(i.e., with depths from 0 to 6 inches) (EPA61)** were collected—one downwind from each of the two prevailing wind directions—and analyzed for metals. After completion of the ~~F~~**f**inal *Draft RI Report* (Rust E&I 1994), the presence or absence of dioxin contamination in surface soils downwind of the building was identified as a data gap.

24.3.2 Phase II RI Field Activities

During Phase II of the RI, two additional surface soil samples were collected from the previous locations and analyzed for dioxins.

24.4 DATA EVALUATION

24.4.1 Data Validation Results

Surface soil samples were collected and analyzed from Site 33 for metals during Phase I and for dioxins during Phase II to address a data gap. No water samples or subsurface soil samples were collected during Phases I or II.

During Phase II, a Tier 1 review was performed for the dioxin results. This review showed that ~~all~~ **the** electronic data results were incorrectly reported by the laboratory because they

were corrected twice for percent moisture values. The error was corrected for this assessment, and the resulting database was determined to be valid.

24.4.1.1 Blank Assessment. When blank contamination exists, the investigative results must exceed the blank result by a factor of 5 (all compounds) or 10 (common laboratory contaminants such as phthalates) in order to be considered positive. Sample results associated with blank contamination were changed to nondetects ("U") if the above criteria were met. No blank contamination occurred for Phase I samples. During Phase II, three compounds (2,3,7,8 TCDF, 1,2,3,4,6,7,8 HpCDD, and OCDD) were detected in the method blank. The associated sample results were not qualified since they were greater than the action level (5 times the blank concentrations).

24.4.1.2 Rejected Results. ~~All~~ **The** antimony soil results were rejected due to low LCS/MS recoveries. The sample identifications were:

- NIN33SF001 and NIN33SF002

The confirmation soil sampling and analysis performed during the soil removal action in 2000 indicated that residual soils met PRGs. Therefore, antimony was successfully removed as well. (EPA104)

None of the dioxin data were rejected during Phase II.

24.4.1.3 Evaluation of Non-Detected Values. A comparison was made between the USEPA Region 5 DQLs and the project CRLs for chemicals that were analyzed for but not detected in environmental media at this site. Thallium and beryllium exceedances were noted for soil samples. No other exceedances were found.

24.4.2 Data Quality Summary

The quality of the data (with the exception of antimony in soil) is adequate to characterize the nature of soil contamination at Site 33. Since ~~all~~ **the** antimony results were rejected, potential antimony contamination ~~has~~ **was** not ~~been~~ characterized at this site. **However, the confirmation soil sampling during the soils removal action indicated residual soils met PRGs and therefore antimony was successfully removed.**

24.4.3 Background Screening

Concentrations of several of the potential COPCs in the two surface soil samples collected at Site 33 are somewhat higher in sample NIN33SF004, which was collected south of Building 333. This is particularly true in the case of dioxins/furans. Further, the samples were collected almost 300 feet apart. However, it was decided that the two samples should be combined for the purposes of background comparisons and COPC selection. This was based on a review that determined that the same chemicals would be above background and above screening level PRGs in both samples.

The background screening protocol is described in Section 5.1.4.5.2. The results of the background screening procedure for Site 33 are shown in Table 24-1. Since the site sample area had two samples that were analyzed for inorganics, the maximum detected concentration of each constituent was compared to the calculated background threshold value for the appropriate soil series, in this case the Cobbsfork soil series. As shown in the table, with the exception of arsenic, the maximum concentration of every inorganic detected in surface soil at this site exceeded background.

Because chlorinated dioxins and furans are frequently encountered in the environment as anthropogenic background, site dioxins/furans were compared to background dioxins/furans to determine if the congeners detected in soil at this site are more likely related to site activities than they are to anthropogenic background. This comparison was performed in two ways.

First, the profiles of the dioxins/furans (i.e., the relative magnitudes of the masses between the congener groups) within the individual samples collected at the site were compared to the profiles of the congeners within the five background samples (BKG51SF036, -37, -38, -39, and -40). In general, the lower chlorinated congeners degrade quickly in the environment, leaving behind the higher chlorinated congeners, which can persist for hundreds of years (Bumb *et al.* 1980; Nestrick *et al.* 1986; Smith *et al.* 1983). Thus, dioxin/furan profiles weighted heavily toward the heavier congeners are indicative of anthropogenic sources rather than more recently deposited site sources. For comparison purposes, bar graphs, which are presented in Figure 24-2, were constructed using *total* concentrations of each of the various congeners within a sample. The graphs are presented only to illustrate the overall pattern of the congener distribution within the samples, not to compare total dioxins/furan concentrations among the samples. The figure shows that the congener pattern in sample NIN33SF003 is similar to that of the background samples. The pattern in sample NIN33SF004, however, shows a higher proportion of the lower chlorinated congeners.

For the second type of comparison, the concentrations of each of the congeners were converted into 2,3,7,8-TCDD equivalent concentrations using USEPA-recommended TEFs, as described in Section 5.1.6.3.1. The 2,3,7,8-TCDD-equivalent concentrations were then summed to derive a total 2,3,7,8-TCDD-equivalent concentration for each sample. Since there were only two site samples that were analyzed for dioxins/furans, the maximum site 2,3,7,8-TCDD-equivalent concentration was compared to the background 2,3,7,8-TCDD-equivalent threshold concentration, calculated as described in Section 5.1.4.5.2. The maximum site concentration is greater than the background threshold. The sample with the maximum concentration (NIN33SF004) is also the sample that has a congener pattern less typical of background. The conclusion is that the dioxins/furans present in this sample are more likely due to a site source than background. It should be noted that the 2,3,7,8-TCDD-equivalent concentration in the other sample, NIN33SF003, does not exceed background, and the congener pattern in this sample is consistent with anthropogenic background.

24.4.4 Summary of Analytical Results

Table 24-2 presents the analytical results for soil samples collected for inorganics during Phase I and dioxins/furans during Phase II field investigations. This table includes those analytes detected in at least one sample. A complete set of data including "less than" and "non-detect" results is presented in Appendix N.

Confirmation soil sample results from the soil removal action in 2000 are contained in the *Draft Final Construction Completion Report, Remedial Removal Actions, Sites 12A, 12B, 12C, and 33 (Montgomery Watson, February 2002* (New Work).

24.5 NATURE AND EXTENT OF CONTAMINATION

24.5.1 Soil

The results for the two Phase I soil samples collected in the prevailing downwind directions revealed that barium (both samples), chromium (one sample), cobalt (both samples), copper (both samples), lead (both samples), manganese (both samples), nickel (both samples), silver (both samples), vanadium (one sample), and zinc (both samples) concentrations at levels exceeding their background screening values; however, these concentrations did not exceed corresponding USEPA Region 9 action level criteria for these same metals. Two exceptions are aluminum and manganese that were found to exceed USEPA Region 9 PRGs. These may be a result of naturally occurring elevated concentrations in JPG soils. The greatest lead concentration (40 μg/g) is twice its background value, but less than the USEPA cleanup level of 400 μg/g.

As stated previously, approximately 30.11 tons of soil were excavated and removed from the site during a remedial removal action performed in 2000. A detailed description of the construction activities and sample results is contained in the *Draft Final Construction Completion Report, Remedial Removal Actions, Sites 12A, 12B, 12C, and 33 (Montgomery Watson, February 2002* (New Work).

24.5.2 Ash

While in operation, ash from the incinerator was monitored through analysis of RCRA characteristics, including total sulfide, ignitability, pH, and TCLP metals. The results of this waste-characterization program were reviewed by Rust E&I, and it appears that the ash was being appropriately handled. The ash sample collected during the RI was analyzed for TCLP metals. The leachable lead concentration exceeded the RCRA limits for TCLP (5 mg/L) (see Table 24-1). ~~All~~ **The** other leachable metals concentrations were less than the RCRA limits for TCLP.

In summary, the ash from the incinerator was appropriately handled and therefore was not a source of contamination to environmental pathways at this site. Phase I soil sample results support this conclusion.

24.6 HUMAN HEALTH RISK ASSESSMENT

As noted at the beginning of this Section, since submittal of the Draft RI (August 1998), a soil removal action was performed at Site 33. Confirmation sampling was performed to assess the effectiveness of the removal action. Residual dioxin contamination exceeded the PRGs in some of the confirmation samples, but only one exceeded background. However, a risk calculation for that level was performed, which indicated that exceedance of background was below the USEPA's target risk range. Therefore, no additional excavation was warranted. The excavation site was backfilled with clean fill material and the site was seeded. A detailed description of the construction activities, sample results, and risk calculation are contained in the *Draft Final Construction Completion Report, Remedial Removal Actions, Sites 12A, 12B, 12C, and 33 (Montgomery Watson, February 2002* (New Work). Because remediation has already been completed at Site 33, and have met the USEPA's target risk range, the risk estimates for Site 33 provided in the Draft RI have not been updated. Rather the original draft risk calculations are provided for informational purposes to document, in part, why remedial action was considered warranted at this site.

24.6.1 Selection of the Contaminants of Potential Concern - Surface Soil

24.6.1.1 Data Grouping

24.6.1.1.1 Frequency of Detection. Evaluation of frequency of detection was not undertaken at this site because of too few samples.

24.6.1.1.2 Nutrient Screening. The maximum value of each of the nutrients detected in soil at this site was less than the corresponding nutrient screening value: calcium (maximum 59,700 µg/g; screening value 1,000,000 µg/g), iron (maximum 21,500 µg/g; screening value 70,000 µg/g), magnesium (maximum 11,200 µg/g; screening value 1,000,000 µg/g), potassium (maximum 1,440 µg/g; screening value 150,000 µg/g), and sodium (maximum 109 µg/g; screening value 1,000,000 µg/g). Therefore, ~~all~~ **the** nutrients were eliminated as COPCs in surface soil at Site 33.

24.6.1.1.3 Summary of Preliminary COPCs. Table 24-3 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95% UCL of the mean, and the exposure point concentration for each preliminary COPC in soil at Site 33. Preliminary COPCs are chemicals that have been detected above background in more than 5 percent of the samples.

24.6.1.1.4 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for each preliminary soil COPC was compared to the chemical-specific Region 9 residential soil PRG (Figure 24-3 and Table 24-4). One-tenth of the PRG was used for noncarcinogens. The exception was lead, for which the full PRG was used. As a result of the

screening, aluminum, manganese, and dioxins/furans are ***retained*** as COPCs in surface soil at Site 33.

24.6.1.2 Air.

24.6.1.2.1 Summary of Preliminary COPCs. Ambient air concentrations to which future receptors at this site might be exposed were estimated using air emission/dispersion modeling, as described in Appendix R. In the site-specific conceptual model, discussed below in Section 24.6.2.1, Site 33 is evaluated under two future site-specific scenarios: as a residential site and as an industrial site.

In the future industrial land use scenario for the facility, ~~all~~ **the** sites were assumed to be industrial, except for the five sites designated agricultural sites. Each site with particulate-bound COPCs in surface soil (metals, SVOCs, and dioxins/furans) and/or volatile COPCs in surface/subsurface soil combined was assumed to contribute to the air concentrations at ~~all of~~ the sites. In the future residential scenario for the facility, ~~all~~ **the** sites were assumed to be residential except for the five sites designated agricultural. It was assumed that particulate and VOC emissions from the strictly residential sites would be negligible because the home sites would be covered with dense vegetation (lawns) and pavement. Therefore, under the residential scenario only the five agricultural sites contribute to the air concentrations at ~~all of~~ the sites. The list of preliminary air COPCs is therefore the same for every site for a given scenario, but the concentrations of the COPCs vary. Tables R-4 and R-6 in Appendix R present the estimated ambient air concentrations at Site 33 under the future industrial and residential scenarios, respectively.

24.6.1.2.2 Region 9 Preliminary Remediation Goal Screening. The exposure point concentrations for each preliminary air COPC in the future residential scenario and the future industrial scenario were compared to chemical-specific Region 9 air PRGs (Table 24-5).

One-tenth of the PRG was used for noncarcinogens. The exception was lead, for which the full PRG was used. As a result of the screening, aluminum, silver, thallium, vanadium, and zinc are retained as COPCs in air for future on-site residents. For future on-site workers, aluminum, chromium, manganese, silver, thallium, vanadium, and zinc were retained as COPCs.

24.6.2 Exposure Assessment

24.6.2.1 Site Conceptual Model. There are currently no people who **are known to** specifically work at or frequent Site 33. There are, however, several types of individuals who could potentially be affected by the existing contamination at the facility. These are current trespassers to JPG and off-facility (nearby) rural residents and future hunters. In each case, these individuals would most likely be impacted simultaneously by multiple sites rather than by single units. Because of this, these current receptor populations are addressed on a facility-wide, cumulative basis rather than by specific sites (Sections 28 and 29).

Therefore, this site-specific exposure scenario only addresses future land use development. Site 33 has two potential future land uses forwarded for evaluation:

- Residential
- Industrial

Residential Use. Under the future residential land use scenario, this site is assumed to be developed for residential purposes with the supposition that a family would build a house directly on or within this area of potential concern.

With respect to a risk assessment analysis, resident populations are assumed to consist of both adults and toddlers. Each individual would be expected to come in contact with site contaminants in the following pathways at Site 33:

- Inhalation/ingestion of airborne fugitive particulates
- Dermal contact with soil while gardening/playing outdoors
- Incidental ingestion of soil while gardening/playing outdoors
- Ingestion of fresh homegrown fruits and vegetables

On-site Worker. Industrial land use is considered to be a plausible future option for this site at JPG. On-site industrial workers (adult males and females) are assumed to be individuals who could be exposed directly to contaminated media through the following pathways at Site 33:

- Inhalation/ingestion of airborne fugitive particulates from surface soils
- Incidental inhalation/dermal contact with soil

24.6.2.2 Exposure Point Concentrations.

24.6.2.2.1 Air. The estimated ambient air concentrations of COPCs at this site for the future on-site residents and the future on-site workers are presented in Table 24-5.

24.6.2.2.2 Soil. The concentrations of COPCs in surface soil at this site are presented in Table 24-4. No subsurface samples were collected at Site 33.

24.6.2.2.3 Fruits, Vegetables, and Crops. COPC concentrations in homegrown fruits and vegetables were estimated using the methods described in Section 5.1.5.2.8. Appendix U, Table U-15, documents the calculation of contaminant concentrations in fruits and vegetables at Site 33.

24.6.2.3 Human Exposure Doses.

24.6.2.3.1 Inhalation of Contaminated Air. Inhalation of airborne contaminants (VOCs and particulates) is a potential route of exposure for future on-site residents (adults and children) and future on-site workers at this site. The equation used for calculating human exposure doses of contaminants of potential concern due to inhalation of volatile and dust-bound contaminants is provided in Section 5.1.5.3.1, Table ~~5-12~~**5-11**. Table V-15, Appendix V, documents the calculation of human exposure doses at Site 33 due to inhalation of contaminated air.

24.6.2.3.2 Incidental Ingestion of Contaminated On-site Soil. Mouthing behavior (toddlers) and incidental ingestion of soil with recreational or work-related activities may expose human receptors to contaminated soil at a site via the oral route of exposure. The equation used to calculate the human exposure dose due to incidental ingestion of contaminated soil is presented in Section 5.1.5.3.2, Table ~~5-13~~**5-12**. This pathway was assumed to be complete at Site 33 for future on-site residents (adults and children) and future on-site workers. Table V-15, Appendix V, documents the calculation of human exposure doses due to incidental ingestion of soil at Site 33.

24.6.2.3.3 Dermal Contact with Contaminated On-site Soil. The chemicals in contaminated soil also may be absorbed into a receptor's body through dermal contact. The equation that was used to calculate chemical doses due to dermal contact with contaminated soil is presented in Section 5.1.5.3.3, Table ~~5-14~~**5-13**. This pathway is relevant for future on-site residents (adults and children) and future on-site workers at Site 33. Table V-15, Appendix V, documents the calculation of human exposure doses due to dermal contact with soil at Site 33.

24.6.2.3.4 Ingestion of Contaminated Fruits and Vegetables. Consumption of contaminated homegrown fruits and vegetables may be a source of chemical exposure for future on-site residents (adults and children). The equation used to calculate the human exposure dose due to ingestion of contaminated fruits and vegetables is provided in Section 5.1.5.3.11, Table ~~5-23~~**5-22**. Table V-15, Appendix V, documents the calculation of human exposure doses due to ingestion of contaminated fruits and vegetables grown in surface soil at Site 33.

24.6.3 Risk Characterization

24.6.3.1 Chronic Health Hazards. The noncancer daily exposure doses calculated in the exposure assessment were used to calculate HQs for each of the COPCs possessing RfDs. Pathway-specific and overall HIs were then calculated for each receptor. The calculations of HQs and HIs are described in Section 5.1.7.1. If an overall HI is calculated to be greater than 1.0 for a particular receptor, then the exposure pathway(s) primarily responsible for the result is identified as a "critical pathway(s)." For each critical pathway, those chemical contaminants responsible for the majority of the HI are listed as COCs. Table W-15, Appendix W,

documents the calculation of the pathway- and chemical-specific HQs for the human receptors at Site 33. The pathway-specific and overall HIs are summarized in Table 24-6.

24.6.3.1.1 ***Future On-Site Residents***. The overall HIs for the future on-site adult and toddler residents at Site 33 are calculated to be 0.26 and 0.91, respectively. Both of these HIs are less than USEPA's risk management criterion. Thus, no critical exposure pathways or COCs are identified for these receptors. The existing contamination at Site 33 would not present a chemical hazard to future on-site resident adults or toddlers.

24.6.3.1.2 Future On-Site Workers. The overall HI for the future on-site worker at Site 33 is calculated to be 0.37, which is less than USEPA's risk management criterion. Thus, no critical exposure pathways or chemicals of concern are identified for this receptor population. The existing contamination at Site 33 would not present a chemical hazard to future on-site workers.

24.6.3.2 Excess Lifetime Cancer Risks. The cancer risks for each receptor were determined from the pathway-specific exposure doses and the route-specific SFs, as described in Section 5.1.7.2. To assess the simultaneous exposure of a receptor population to multiple carcinogens from multiple exposure routes, ~~all of~~ the cancer risks calculated for a receptor population were summed. Each overall receptor cancer risk was then compared to USEPA's target risk range (1.0E-06 to 1.0E-04). If the total cancer risk for a receptor from ~~all~~ **the** exposure pathways is less than 1.0E-04, then it is concluded that the site(s) does not pose a significant risk to that receptor. If the overall cancer risk exceeds the target risk range, ~~any~~ **a** chemical individually associated with a risk level greater than 1.0E-05 is identified as a COC. COCs represent the primary contributors to the potential cancer risk for the receptor-specific exposure pathway under evaluation. Table W-15 (Appendix W) documents the calculation of the pathway- and chemical-specific cancer risks for the human receptors at Site 33. The pathway-specific and overall cancer risks are summarized in Table 24-6.

24.6.3.2.1 Future On-Site Residents. The overall cancer risks calculated for the future adults and toddlers living at Site 33 are 3.2E-05 and 2.8E-05, respectively. Since both of these cancer risks are within USEPA's target risk range of 1.0E-06 to 1.0E-04, no critical exposure pathways or chemicals of concern are identified for these receptors.

24.6.3.2.2 Future On-Site Workers. The overall cancer risk calculated for the future workers at Site 33 is 2.6E-06. Since this estimated cancer risk is within USEPA's target risk range of 1.0E-06 to 1.0E-04, no critical exposure pathways or chemicals of concern are identified for future workers.

24.6.3.3 Uncertainty/Sensitivity Analysis. The numerical risks/hazards calculated for Site 33 represent *conditional* estimates of risk based on various simplifying assumptions concerning contaminant exposure and toxicity. These estimates of risk/hazard are derived using a series of conservative procedures that address contaminant concentrations at the site, their fate in the environment, how someone currently or in the future might be exposed to these contaminants, and the toxicity of each chemical toward humans. The uncertainty

analysis specifies, when appropriate, the critical assumptions made for the site so that the site-specific results can be interpreted by risk managers in a proper context.

To assist the risk managers in this project, a qualitative uncertainty analysis has been performed. The primary goals of a qualitative uncertainty analysis are (1) to itemize the major areas of uncertainty in the site-specific risk assessment and (2) to demonstrate that the assessment overall has been conservatively performed (i.e., that the potential risks/hazards at the site have not likely been underestimated, but may have been significantly overestimated). The qualitative uncertainty analysis for this site is presented in Table 24-7. Based on this analysis, it can be concluded that this risk assessment is conservative. Some of the major uncertainties in this study that are most influential to the risks/hazards that were calculated include:

- Assumptions regarding receptors' exposure time (24 hours/day) and exposure frequency (350 days/year)

- Assumptions regarding receptors' foodchain ingestion rates (95th percentile of U.S. population)

- Maximum soil concentrations used

24.7 ECOLOGICAL RISK ASSESSMENT

Based on protocols established in the PERA (Rust E&I 1997g), there were no potential ecological risks determined for Site 33. Silver, lead, and zinc were identified as potential COPCs for this site. The contaminant levels detected in surface soils, however, did not exceed the contaminant toxicity screening criteria established in the PERA. As a result, no further ecological risk analysis has been undertaken.

24.8 CONCLUSIONS AND RECOMMENDATIONS

The results of Phase I and Phase II RI sampling at the New Incinerator (Site 33) show that several metals and dioxins/furans exceed their respective background concentrations in soils at Site 33. When the RI data were screened against USEPA Region 9 PRGs for residential risk, aluminum, manganese, and dioxins/furans were retained as COPCs for potential human exposure to soils. The assessment of risk for future land use scenarios shows that estimated risks are within or below USEPA's target risk range of 1.0E-06 to 1.0E-04 for carcinogenic risk and are below the HI goal for chronic health hazards. The assessment of ecological risk shows that the contaminants present at Site 33 pose little risk to ecological receptors.

On the basis of the human health and ecological risk assessment results for the New Incinerator (Site 33), no additional investigations at the site are ~~warranted~~ **needed** and no further action is recommended. **In addition, confirmation soil sampling performed during**

the soil removal action (Summer 2000) indicated only one dioxin sample exceeded background levels and a risk calculation performed for that value was below the USEPA's target risk range. (Draft Final Construction Completion Report, February 2002).

As a result, a Technical Memorandum for No Further Action will be prepared and the site will not be carried through the FS process.

TABLES

TABLE 24-1

Background Screening of Inorganic Chemicals Detected in Soil
Site 33 - Building 333 New Incinerator
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Maximum Detected Value (µg/g)[b]	Soil Series Background Screening Value[c] (µg/g)	Exceeds Soil Series Background?
Surface Soil				
Aluminum	2/2	21,600	11,000	**YES**
Arsenic	2/2	5.02	9.26	No
Barium	2/2	131	84.5	**YES**
Calcium	2/2	59,700	750	**YES**
Chromium	2/2	19.8	15.1	**YES**
Cobalt	2/2	6.72	3.5	**YES**
Copper	2/2	31.5	5.64	**YES**
Lead	2/2	40	14.9	**YES**
Manganese	2/2	678	302	**YES**
Nickel	2/2	12.2	2.3	**YES**
Silver	2/2	0.68	ND	**YES**
Vanadium	2/2	34	27.0	**YES**
Zinc	2/2	212	19.5	**YES**
Dioxins/Furans	2/2	8.99E-05	2.03E-05[d]	**YES**

Footnotes:

(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Micrograms per gram.
(c) See Section 5.1.4.5.2 for an explanation of how the soil-series-specific background screening values were calculated.
(d) The dioxin background is unrelated to the soil series; see Section 24.4.3 of text.

TABLE 24-2

Summary of Analytical Results for Soil Samples
Site 33 – Building 333 New Incinerator
Jefferson Proving Ground
Madison, Indiana

Sample ID Analyte	NIN33SF001 (µg/g)[a]	NIN33SF002 (µg/g)	NIN33SF003 (µg/g)	NIN33SF004 (µg/g)
Aluminum	13,900	21,600	NA[b]	NA
Arsenic	5.02	4.57	NA	NA
Barium	95.7	131	NA	NA
Calcium	59,700	8,320	NA	NA
Chromium	14.1	19.8	NA	NA
Cobalt	4.59	6.72	NA	NA
Copper	31.5	25.9	NA	NA
Iron	16,000	21,500	NA	NA
Lead	40.0	30.0	NA	NA
Magnesium	11,200	3,070	NA	NA
Manganese	344	678	NA	NA
Nickel	9.71	12.2	NA	NA
Potassium	866	1,440	NA	NA
Silver	0.312	0.680	NA	NA
Sodium	109	77.9	NA	NA
Vanadium	24.8	34.0	NA	NA
Zinc	212	60.0	NA	NA
2,3,4,6,7,8-Hexachlorodibenzofuran	NA	NA	LT [c]0.00000044	0.00002480
2,3,4,7,8-Pentachlorodibenzofuran	NA	NA	0.00000102	0.00002690
1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	NA	NA	0.00004240	0.00012300
1,2,3,4,6,7,8-Heptachlorodibenzofuran	NA	NA	0.00000361	0.00112000
1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin	NA	NA	0.00000195	0.00001020
1,2,3,6,7,8-Hexachlorodibenzofuran	NA	NA	0.00000056	0.00007410
1,2,3,4,7,8,9-Heptachlorodibenzofuran	NA	NA	LT 0.00000026	0.00003230
1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin	NA	NA	0.00000300	0.00000950
1,2,3,7,8,9-Hexachlorodibenzofuran	NA	NA	LT 0.00000044	0.00000920
1,2,3,4,7,8-Hexachlorodibenzo-*p*-dioxin	NA	NA	0.00000081	0.00000361
1,2,3,4,7,8-Hexachlorodibenzofuran	NA	NA	0.00000157	0.00025700
1,2,3,7,8-Pentachlorodibenzo-*p*-dioxin	NA	NA	0.00000101	0.00000538
1,2,3,7,8-Pentachlorodibenzofuran	NA	NA	0.00000071	0.00003870
Octachlorodibenzodioxin	NA	NA	0.00447000	0.00354000
Octachlorodibenzofuran	NA	NA	LT 0.00000571	0.00174000
2,3,7,8-Tetrachlorodibenzodioxin	NA	NA	LT 0.00000021	0.00001150
2,3,7,8-Tetrachlorodibenzofuran	NA	NA	LT 0.00000260	0.00003420

General Note:
1. Samples collected for metals on 3/24/93 at depth of zero feet; samples collected for dioxins/furans on 5/13/96 at zero foot depth (EPA 18).
2. Antimony results are unusable due to quality control deficiencies.

Footnotes:
(a) Micrograms per gram.
(b) Not analyzed.
(c) Less than the reporting limit.

TABLE 24-3

Soil Exposure Point Concentrations of Contaminants of Potential Concern
Site 33 - Building 333 New Incinerator
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[(a)]	Range of Detected Values (µg/g)[(b)]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[(c)] (µg/g)
Surface Soil						
Aluminum	2/2	13,900 - 21,600	NA[(d)]	17,750	NC[(e)]	21,600
Barium	2/2	95.7 - 131	NA	113.4	NC	131
Chromium	2/2	14.1 - 19.8	NA	17.0	NC	19.8
Cobalt	2/2	4.59 - 6.72	NA	5.7	NC	6.72
Copper	2/2	25.9 - 31.5	NA	28.7	NC	31.5
Lead	2/2	30.0 - 40.0	NA	35.0	NC	40.0
Manganese	2/2	344 - 678	NA	511	NC	678
Nickel	2/2	9.71 - 12.2	NA	11.0	NC	12.2
Silver	2/2	0.312 - 0.68	NA	0.50	NC	0.68
Vanadium	2/2	24.8 - 34.0	NA	29.4	NC	34.0
Zinc	2/2	60 - 212	NA	136	NC	212
Dioxins/furans	2/2	6.79E-06 - 8.99E-05	NA	4.83E-05	NC	8.99E-05

Footnotes:
(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Micrograms per gram.
(c) The 95% UCL (upper confidence limit of the mean) or the maximum detected value, whichever is lower (USEPA 1989b).
(d) Not applicable.
(d) Not calculated due to insufficient data.

TABLE 24-4

Selection of Contaminants of Potential Concern (COPC) in Soil Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 33 - Building 333 New Incinerator
Jefferson Proving Ground
Madison, Indiana

Chemical	USEPA Region 9 PRG Screen		
	Residential PRG (µg/g)[a]	Exposure Point Conc. (µg/g)	Retained as Soil COPC?
Surface Soil			
Aluminum	7,667	21,600	**YES**
Barium	527	131	No
Chromium	30.0	19.8	No
Cobalt	457	6.72	No
Copper	285	31.5	No
Lead	400	40	No
Manganese	318	678	**YES**
Nickel	150	12.2	No
Silver	38.3	0.68	No
Vanadium	53.7	34.0	No
Zinc	2,300	212	No
Dioxins/furans	3.77E-06	8.99E-05	**YES**

General Note:

1. PRGs were taken directly from the Region 9 PRG Table (USEPA 1996c). Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnote:

(a) Micrograms per gram.

TABLE 24-5

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 33 - Building 333 New Incinerator
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Ambient Air PRG (µg/m^3)[a]**	**Exposure Point Conc. (µg/m^3)**	**Retained as Air COPC?**
Residential Scenario			
Aluminum	NA[b]	8.92E-03	**YES**
Arsenic	4.5E-04	4.22E-06	No
Barium	5.2E-02	1.98E-05	No
Beryllium	8.0E-04	3.29E-07	No
Cadmium	1.1E-03	3.86E-08	No
Chromium	2.3E-05	1.32E-05	No
Lead	1.5E+00[c]	2.86E-06	No
Manganese	5.1E-03	6.69E-04	No
Silver	NA	2.33E-05	**YES**
Thallium	NA	2.15E-06	**YES**
Vanadium	NA	2.11E-06	**YES**
Zinc	NA	1.97E-06	**YES**
Dioxins/Furans	4.5E-08	1.19E-13	No
Benzo(a)anthracene	9.2E-03	3.54E-09	No
Benzo(a)pyrene	9.2E-04	1.20E-08	No
Benzo(b)fluoranthene	9.2E-03	2.39E-08	No
DDE	2.0E-02	2.08E-09	No
Dibenz(a,h)anthracene	9.2E-04	4.17E-10	No
Dieldrin	4.2E-04	NA	No
Indeno(1,2,3-cd)pyrene	9.2E-03	2.10E-09	No
1,1-Dichloroethylene	3.8E-02	4.71E-09	No
Chlorobenzene	2.1E+00	7.11E-06	No
Industrial Scenario			
Aluminum	NA	2.54E+00	**YES**
Arsenic	4.5E-04	7.21E-06	No
Barium	5.2E-02	2.13E-05	No

TABLE 24-5

Selection of Contaminants of Potential Concern in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 33 - Building 333 New Incinerator
Jefferson Proving Ground
Madison, Indiana

Chemical	USEPA Region 9 PRG Screen		
	Ambient Air PRG (µg/m^3)[a]	**Exposure Point Conc. (µg/m^3)**	**Retained as Air COPC?**
Industrial Scenario			
Beryllium	8.0E-04	1.07E-06	No
Cadmium	1.1E-03	2.38E-07	No
Chromium	2.3E-05	3.24E-05	**YES**
Lead	1.5E+00[c]	2.86E-06	No
Manganese	5.1E-03	8.01E-02	**YES**
Silver	NA	2.33E-05	**YES**
Thallium	NA	2.15E-06	**YES**
Vanadium	NA	6.21E-06	**YES**
Zinc	NA	2.19E-04	**YES**
Dioxins/Furans	4.5E-08	1.05E-08	No
Benzo(a)anthracene	9.2E-03	3.54E-09	No
Benzo(a)pyrene	9.2E-04	1.22E-08	No
Benzo(b)fluoranthene	9.2E-03	2.39E-08	No
DDE	2.0E-02	2.08E-09	No
Dibenz(a,h)anthracene	9.2E-04	4.17E-10	No
Dieldrin	4.2E-04	7.38E-09	No
Indeno(1,2,3-cd)pyrene	9.2E-03	2.08E-09	No
1,1-Dichloroethylene	3.8E-02	4.71E-09	No
Chlorobenzene	2.1E+00	7.11E-06	No

General Note:

1. PRGs were taken directly from the Region 9 PRG Table (USEPA 1996c). Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:

(a) Micrograms per cubic meter.
(b) Not available or not applicable.
(c) Federal ambient air quality criterion for lead.

TABLE 24-6

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 33 - Building 333 New Incinerator
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
		Future On-site Resident Adult		
Incidental ingestion of soil	7.92E-06		0.0429	
Dermal contact with soil	3.31E-06		0.0036	
Ingestion of homegrown fruits/vegetables	2.09E-05		0.2108	
Inhalation of VOCs[(a)] and fugitive dusts	NA[(b)]		0.0013	
Total	3.21E-05		0.2586	
		Future On-site Resident Child		
Incidental ingestion of soil	1.48E-05		0.4000	
Dermal contact with soil	1.90E-06		0.0103	
Ingestion of homegrown fruits/vegetables	1.15E-05		0.4953	
Inhalation of VOCs and fugitive dusts	NA		0.0047	
Total	2.82E-05		0.9103	

TABLE 24-6

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 33 - Building 333 New Incinerator
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
		Future On-site Worker		
Incidental ingestion of soil	1.70E-06		0.0110	
Dermal contact with soil	8.45E-07		0.0011	
Inhalation of VOCs and fugitive dusts	2.22E-08		0.3525	
Total	2.57E-06		0.3646	

Footnotes:

(a) Volatile organic compounds.
(b) Not applicable or not available.

TABLE 24-7

Qualitative Uncertainty Analysis
Site 33 - Building 333 New Incinerator
Jefferson Proving Ground
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
A. Human Behavior				
Future receptors' exposure duration	30 years	Medium	Medium	National upper-bound time (90th percentile) at one residence
Future receptors' exposure frequency	350 days/year	Medium	Medium	High-end value
Future receptors' exposure time	24 hours/day	Low	High	Maximum possible value
Future receptors' foodchain ingestion rates	NA[a]	Low	High	Nearly impossible for an average weight receptor to ingest daily the 95th percentile U.S. population consumption amounts
Exclusion of certain exposure pathways in the quantitative analysis	NA	Low	Low	Pathways eliminated are those that have low possibility of contributing risk to these receptors
B. Chemical Fate/Transport in the Environment				
Calculation of exposure point concentration of COC[b]/foodchain modeling	NA	Low	High	Conservative assumptions and input parameters
Use of air dispersion modeling to predict air concentrations	NA	Low	High	Conservative assumptions and input parameters

TABLE 24-7

Qualitative Uncertainty Analysis
Site 33 - Building 333 New Incinerator
Jefferson Proving Ground
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Overestimation	Comments
C. Chemical Toxicity				
Assumption that USEPA[c] reference doses truly represent toxicological thresholds	NA	Low	High	High degree of conservativeness utilized by USEPA in deriving RfDs[d] from toxicological literature
Assumption that USEPA carcinogenic slope factors truly represent dose-response phenomena	NA	Low-moderate	Moderate-high	Use of linearized, multi-stage mathematical model to predict cancer incidence at low exposure levels is USEPA policy; not currently supported by scientific data
Assumption of risk/hazard additivity	NA	Moderate	Moderate	Summation of chemical-specific risks/hazards may over- or under-predict risks/hazards to receptors
Screening out of certain contaminants based on USEPA criteria	NA	Low	Low	Chemicals present in concentrations less than Region 9 criteria eliminated

Footnotes:
(a) Not applicable or not available.
(b) Contaminant of concern.
(c) United States Environmental Protection Agency.
(d) Reference doses.

FIGURES

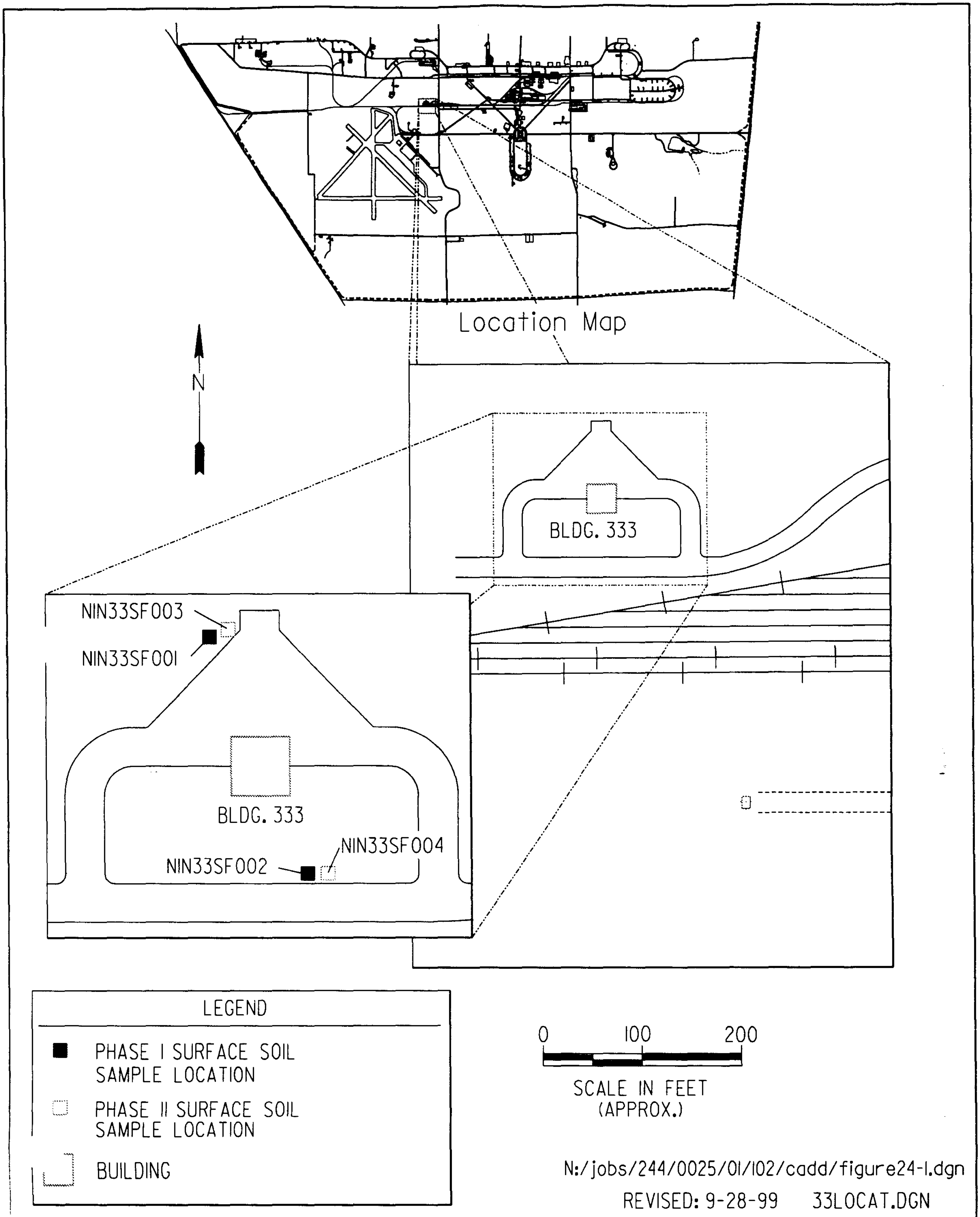
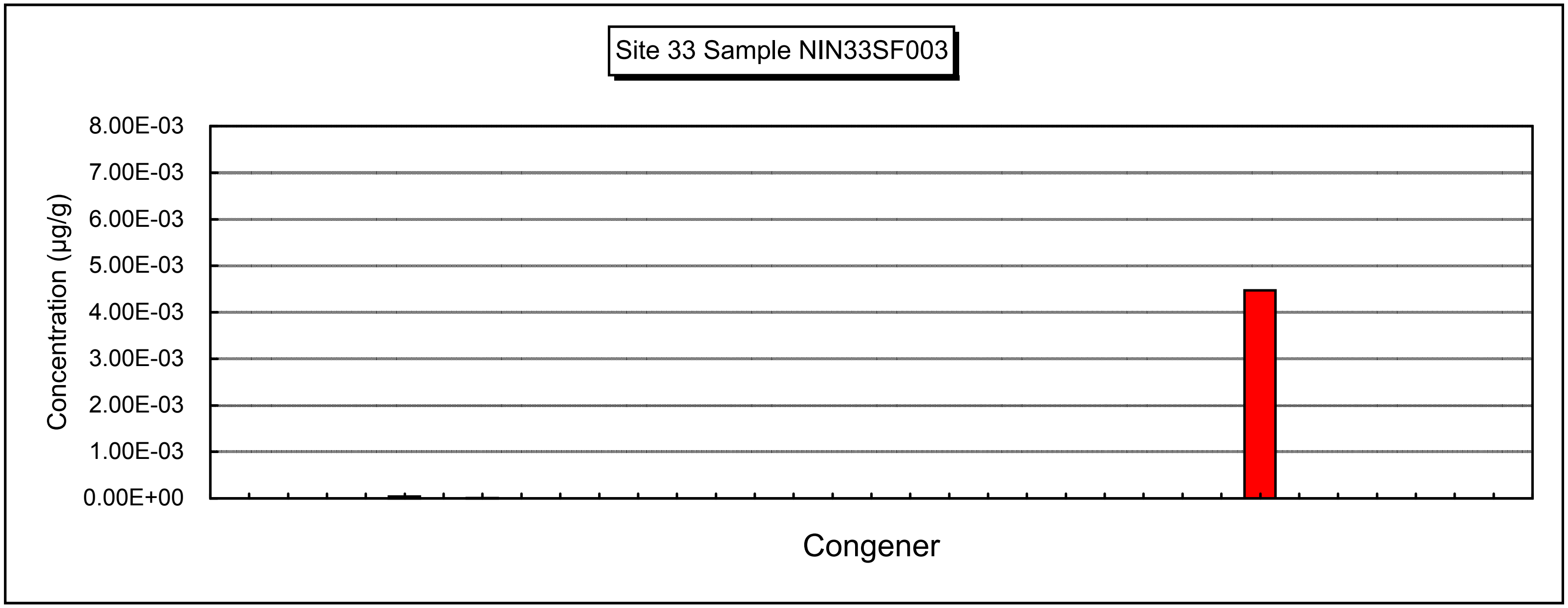


Figure 24-1. Phase I and Phase II Sampling Locations at the Building 333 New Incinerator (Site 33)



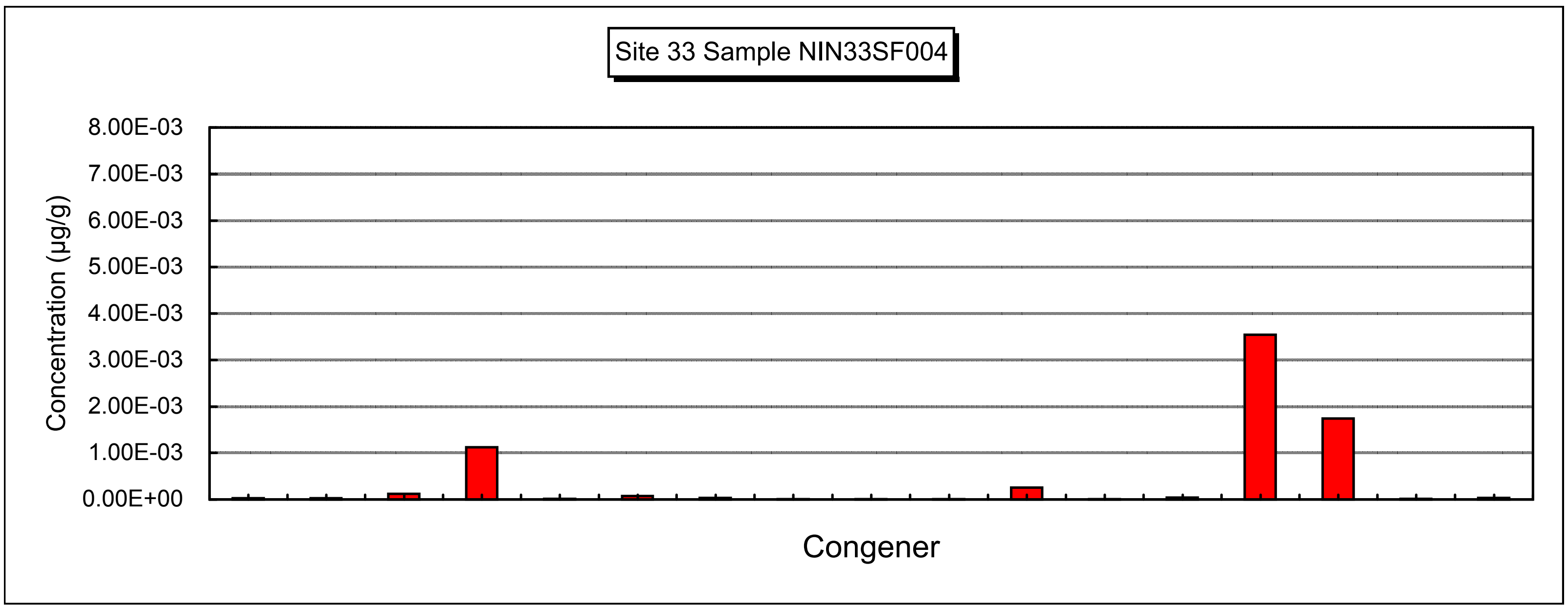


Figure 24-2. Distribution of Dioxin/Furan Congeners,
Building 333 New Incinerator (Site 33)

n/j/244/0025/01/wp/figures/Fig24-2.xls

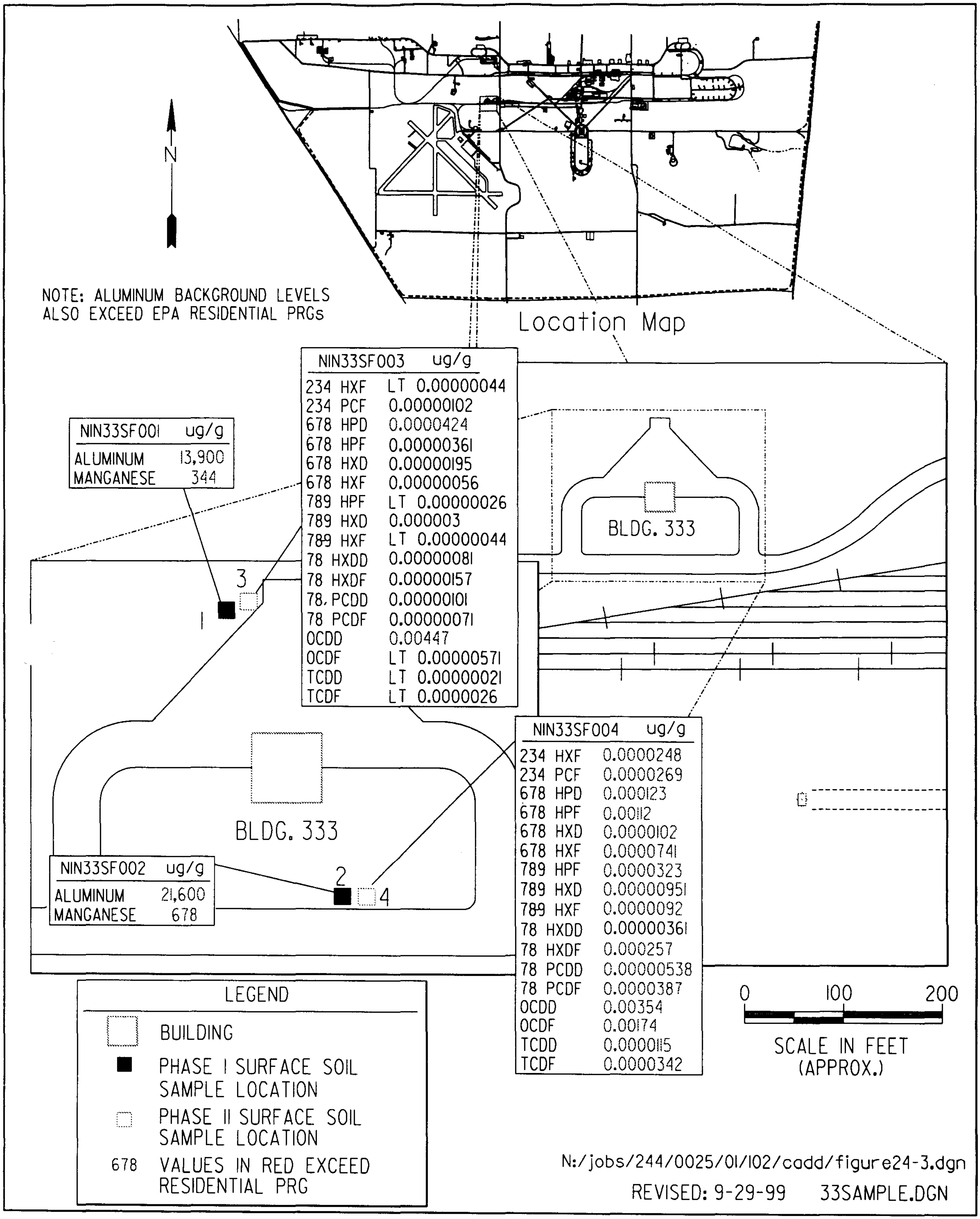


Figure 24-3. Summary of Contaminants Exceeding Background and Regulatory Risk-Based Concentrations at Building 333 New Incinerator (Site 33)

25.0 BUILDING 136 SANDBLASTING AREA (SITE 34)

25.1 SITE CHARACTERISTICS

Building 136 is located on the northern side of Niblo Road just across the street from the former facility fire department (Figure 25-1). The sandblasting area is located west of Building 136. The unit began operating in the 1940s and was active until 1995. It consists of an approximately 20-by-20-foot area on a 6-inch-thick asphalt pad that was used for sandblasting operations. Vehicles and other equipment were sandblasted there prior to being painted inside Building 136. In the past, red primer containing lead was used as a base coat on the vehicles and equipment. More recently, green primer without lead was used. Waste sand was routinely analyzed for hazardous constituents prior to disposal. The amount of sand expended was not known by facility personnel at the time of the RI. There were no release controls observed at the site during the Phase I RI.

The area around Building 136 is flat, and surface-water runoff is directed to the north into a drainage swale along the railroad tracks. This drainage swale is connected to Middle Fork Creek via the storm water runoff system (Figure 2-1). The surface around the building is either grass, asphalt, or concrete covered. During the RI, the grass was mowed regularly.

The site is located in an area with soils belonging to the Cobbsfork series. The depth to bedrock is unknown, but is probably between 18 and 25 feet based on information from wells drilled at Building 118 gas station (Site 37) located to the east of the sandblasting area. According to geologic mapping of the subsurface bedrock, the glacial till is underlain by the Laurel Dolomite of Silurian age. Groundwater potentiometric mapping at the gas station shows that the shallow glacial till groundwater is generally flowing to the northeast; however, the regional bedrock groundwater flow is toward the west-southwest (Figure 2-15).

Prior to 1995, human activities at the site consisted of frequent access by personnel performing sandblasting activities outside Building 136 and painting inside it. No one was in the building on an 8-hour-a-day basis. Shortly after completion of the RI sampling, facility personnel removed the loose sand and the used sand from the site and disposed of it off site. Currently, the facility is abandoned and nobody is known to access the site on a regular basis.

25.2 PREVIOUS INVESTIGATIONS

Prior to the RI, A.T. Kearney (1992) performed an investigation at this site. The study included a visual site inspection, records searches, and JPG personnel interviews. At the time of the visual site inspection, there was freshly applied gravel that covered about half of the pad and sand that was mixed with paint particles on the soils surrounding the unit. The sand/paint mixture extended to approximately 2 yards beyond the perimeter of the asphalt (Kearney 1992). The sand from the site was analyzed for hazardous constituents prior to disposal. No

environmental sampling to define the extent of the possible contamination, however, had occurred at the site prior to this RI.

25.3 STUDY AREA INVESTIGATION

25.3.1 Phase I RI Field Activities

There is the potential that lead-based paints could have contaminated the surface soil around the pad. Information on the extent of this possible contamination was collected in order to evaluate the potential for leaching to the groundwater or transport to surface water. Information on the background metals in the unused sandblasting material and the added contaminants in the used sand was also collected.

Three near-surface soil samples **(i.e., with depths from 0 to 6 inches) (EPA62)** were collected during Phase I from locations around the perimeter of the outdoor sandblasting area and analyzed for total metals. Two sand samples were also collected. One composite sample was collected from used sand stored in drums outside the building and analyzed for total metals, and the other sample was collected from unused sand and was analyzed for total metals to provide data on background metals concentrations.

25.3.2 Phase II RI Field Activities

No Phase II field investigation activities were conducted at this site.

25.4 DATA EVALUATION

Surface soil and sand pile samples were collected and analyzed for Site 34 during Phase I only. No Phase I water samples or Phase II samples were collected.

25.4.1 Data Validation Results

When blank contamination exists, the investigative results must exceed the blank result by a factor of 5 (all compounds) or 10 (common laboratory contaminants such as phthalates) in order to be considered positive. Positive results were changed to nondetects ("U") when the concentrations were less than the 5/10x values. In these cases, the associated sample quantitation limit became either the concentration in the sample, if the detected value was above the quantitation limit, or the quantitation limit, if detected results were less than the quantitation limit. The following samples and analytes were qualified as nondetected during Phase I.

- Surface Soil
  - Cobalt, copper, and silver in SBA34SF003
  - Selenium in SBA34SF001 and -F003

- Sand
  - Barium, boron, calcium, chromium, copper, lead, magnesium, nickel, silver, and zinc in SBA34SN001

25.4.1.1 Evaluation of Non-Detected Values. A comparison was made between the USEPA Region 5 DQLs and the project CRLs for chemicals that were analyzed for but not detected in environmental media at this site. Arsenic exceedances were noted for sand samples. Beryllium and thallium exceedances were noted for soil samples. No other exceedances were found.

25.4.2 Data Quality Summary

~~All~~ **The following** antimony soil results were rejected due to low LCS/MS recoveries. **The potential effect of rejecting the antimony results will be discussed further in the uncertainty section of the human risk assessment for the site. (EPA105)** The sample identifications were:

- Soil
  - SBA34SF001, -F002, and -F003

- Sand
  - SBA34SN001 and -N002

25.4.3 Analytical Results

The summary of analytical results for metals in soil and sand samples from Site 34 is presented in Table 25-1. **(EPA176)** A com**prehensive**~~plete~~ listing of ~~all~~ **the** analytical results, including nondetected and below reporting limit analytes, is presented in Appendix N.

25.5 NATURE AND EXTENT OF CONTAMINATION

25.5.1 Soil

Samples results reveal that the following metals were present in the surface soil around the pad at concentrations exceeding their screening criteria for background soils (Table 25-1): barium (one sample), boron (three samples), chromium (two samples), cobalt (two samples), copper (two samples), lead (three samples), manganese (three samples), nickel (three samples), silver (two samples), and zinc (three samples). Lead values for the three soil samples ranged from 21.0 to 330.0 µg/g, which are ~~all~~ below the USEPA criteria of 400µg/g. The rest of the metals detected were just above their screening criteria and below the USEPA Region 9 criteria with the exception of aluminum and manganese. However, background samples at JPG also contained these metals exceeding the criteria. The elevated aluminum and manganese may be related to site activities or may represent natural variations in background concentrations.

25.5.2 Sand

Analysis of the unused sand (Sample 1) showed only aluminum and iron as detectable metals. The used sand analysis (Sample 2) revealed a number of other detectable metals; however, the only metal that exceeded its background soil screening criteria was lead **(Table 25-1). (EPA176)**. The lead value was three times its criterion for background soils. These results indicate that lead contamination resulted from the sandblasting practices. Lead was detected in the used sand sample and was detected at concentrations above its background value in ~~all~~ **the** three surface-soil samples. However, the lead concentrations in ~~all~~ these samples are less than the USEPA cleanup level of 400 µg/g.

25.6 HUMAN HEALTH RISK ASSESSMENT

25.6.1 Selection of the Contaminants of Potential Concern at Site 34

25.6.1.1 Surface Soil.

25.6.1.1.1 Frequency of Detection. Evaluation of frequency of detection was not undertaken at this site because of too few samples.

25.6.1.1.2 Nutrient Screening. The maximum value of each of the nutrients detected in soil at this site was less than the corresponding nutrient screening value: calcium (maximum 59,700 µg/g; screening value 1,000,000 µg/g), iron (maximum 21,500 µg/g; screening value 70,000 µg/g), magnesium (maximum 11,200 µg/g; screening value 1,000,000 µg/g), potassium (maximum 1,440 µg/g; screening value 150,000 µg/g), and sodium (maximum 109 µg/g; screening value 1,000,000 µg/g). Therefore, ~~all~~ **the** nutrients were eliminated as COPCs in surface soil at Site ~~33~~**34**.

25.6.1.1.3 Summary of Preliminary COPCs. Table 25-2 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95% UCL of the mean, and the exposure point concentration for each preliminary COPC in soil at Site ~~33~~**34**. Preliminary COPCs are chemicals that have been detected above background and in more than 5 percent of the samples.

25.6.1.1.4 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for each preliminary soil COPC was compared to the chemical-specific Region 9 residential soil PRG (Table 25-3). One-tenth of the PRG was used for noncarcinogens. The exception was lead, for which the full PRG was used. As a result of the screening, aluminum and manganese are ***retained*** as COPCs in surface soil at Site 34 (Figure 25-2).

25.6.1.2 Sand.

25.6.1.2.1 Frequency of Detection. Evaluation of frequency of detection was not undertaken at this site because of too few samples.

25.6.1.2.2 Nutrient Screening. The maximum value of each of the nutrients detected in sand at this site was less than the corresponding nutrient screening value: calcium (maximum 1,100 µg/g; screening value 1,000,000 µg/g), iron (maximum 6,950 µg/g; screening value 70,000 µg/g), and magnesium (maximum 223 µg/g; screening value 1,000,000 µg/g). Therefore, ~~all~~ **the** nutrients were eliminated as COPCs in sand at Site 34.

25.6.1.2.3 Summary of Preliminary COPCs. Table 25-2 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95% UCL of the mean, and the exposure point concentration for each preliminary COPC in sand at Site 34.

25.6.1.2.4 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for each preliminary sand COPC was compared to the chemical-specific Region 9 residential soil PRG (Table 25-3). One-tenth of the PRG was used for noncarcinogens, with the exception of lead, for which the full PRG was used. As a result of the screening, there are no COPCs in sand at Site 34.

25.6.1.3 Air.

25.6.1.3.1 Summary of Preliminary COPCs. Ambient air concentrations to which future receptors at this site might be exposed were estimated using air emission/dispersion modeling, as described in Appendix R. In the site-specific conceptual model, discussed below in Section 25.6.2.1, Site 34 is evaluated under two future site-specific scenarios: as a residential site and as an industrial site.

In the future industrial land use scenario for the facility, ~~all~~ **the** sites were assumed to be industrial, except for the five sites designated agricultural. Each site with particulate-bound COPCs in surface soil (metals, SVOCs, and dioxins/furans) and/or volatile COPCs in surface/subsurface soil combined was assumed to contribute to the air concentrations at ~~all of~~ the sites. In the future residential scenario for the facility, ~~all~~ **the** sites were assumed to be residential except for the five sites designated agricultural. It was assumed that particulate and VOC emissions from the strictly residential sites would be negligible because the home sites would be covered with dense vegetation (lawns) and pavement. Therefore, under the residential scenario, only the five agricultural sites contribute to the air concentrations at ~~all of~~ the sites. The list of preliminary air COPCs is therefore the same for every site for a given scenario, but the concentrations of the COPCs vary. Tables R-4 and R-6 in Appendix R present the estimated ambient air concentrations at Site 34 under the future industrial and residential scenarios, respectively.

25.6.1.3.2 Region 9 Preliminary Remediation Goal Screening. The exposure point concentrations for each preliminary air COPC at Site 34 in the future residential scenario and

the future industrial scenario were compared to chemical-specific Region 9 air PRGs (Table 25-4). One-tenth of the PRG was used for noncarcinogens. The exception was lead, for which the full PRG was used. As a result of the screening, aluminum, silver, thallium, vanadium, and zinc were retained as COPCs in air for future on-site residents. For future on-site workers, aluminum, chromium, manganese, silver, thallium, vanadium, and zinc were retained.

25.6.2 Exposure Assessment

25.6.2.1 Site Conceptual Model. No people **are known to** specifically work at or frequent Site 34. There are, however, several types of individuals who could potentially be affected by the existing contamination at the facility. These are current trespassers to JPG and off-facility (nearby) rural residents and future hunters. In each case, these individuals would most likely be impacted simultaneously by multiple sites rather than by single units. Because of this, these current receptor populations are addressed on a facility-wide, cumulative basis rather than by specific sites (see Sections 28 and 29).

Therefore, this site-specific exposure scenario only addresses future land use development. Site 33 has two potential future land uses forwarded for evaluation:

- Residential
- Industrial

Residential Use. Under the future residential land use scenario, this site is assumed to be developed for residential purposes, with the supposition that a family would build a house directly on or within this area of potential concern.

With respect to a risk assessment analysis, resident populations are assumed to consist of both adults and toddlers. Each individual would be expected to come in contact with site contaminants in the following pathways at Site 34:

- Inhalation/ingestion of airborne fugitive particulates
- Dermal contact with soil while gardening/playing outdoors
- Incidental ingestion of soil while gardening/playing outdoors
- Ingestion of fresh homegrown fruits and vegetables

On-site Worker. Industrial land use is considered to be a plausible future option for this site at JPG. On-site industrial workers (adult males and females) are assumed to be individuals who could be exposed directly to contaminated media through the following pathways at Site 34:

- Inhalation/ingestion of airborne fugitive particulates from surface soils

- Incidental inhalation/dermal contact with soil

25.6.2.2 Exposure Point Concentrations.

25.6.2.2.1 Air. The estimated ambient air concentrations of COPCs at this site for the future on-site residents and the future on-site workers are presented in Table 25-4.

25.6.2.2.2 Soil. The concentrations of COPCs in surface soil at this site are presented in Table 25-3. No subsurface samples were collected at Site 34.

25.6.2.2.3 Fruits, Vegetables, and Crops. COPC concentrations in homegrown fruits and vegetables were estimated using the methods described in Section 5.1.5.2.8. Appendix U, Table U-16, documents the calculation of contaminant concentrations in fruits and vegetables at Site 34.

25.6.2.3 Human Exposure Doses.

25.6.2.3.1 Inhalation of Contaminated Air. Inhalation of airborne contaminants (VOCs and particulates) is a potential route of exposure for future on-site residents (adults and children) and future on-site workers at this site. The equation used for calculating human exposure doses of COPCs due to inhalation of volatile and dust-bound contaminants is provided in Section 5.1.5.3.1, Table ~~5-12~~**5-11**. Table V-16, Appendix V, documents the calculation of human exposure doses at Site 34 due to inhalation of contaminated air.

25.6.2.3.2 Incidental Ingestion of Contaminated On-site Soil. Mouthing behavior (toddlers) and incidental ingestion of soil with recreational or work-related activities may expose human receptors to contaminated soil at a site via the oral route of exposure. The equation used to calculate the human exposure dose due to incidental ingestion of contaminated soil is presented in Section 5.1.5.3.2, Table ~~5-13~~**5-12**. This pathway was assumed to be complete at Site 34 for future on-site residents (adults and children) and future on-site workers. Table V-16, Appendix V, documents the calculation of human exposure doses due to incidental ingestion of soil at Site 34.

25.6.2.3.3 Dermal Contact with Contaminated On-site Soil. The chemicals in contaminated soil also may be absorbed into a receptor's body through dermal contact. The equation which was used to calculate chemical doses due to dermal contact with contaminated soil is presented in Section 5.1.5.3.3, Table ~~5-14~~**5-13**. This pathway is relevant for future on-site residents (adults and children) and future on-site workers at Site 34. Table V-16, Appendix V, documents the calculation of human exposure doses due to dermal contact with soil at Site 34.

25.6.2.3.4 Ingestion of Contaminated Fruits and Vegetables. Consumption of contaminated homegrown fruits and vegetables may be a source of chemical exposure for future on-site residents (adults and children). The equation used to calculate human exposure

dose due to ingestion of contaminated fruits and vegetables is provided in Section 5.1.5.3.11, Table ~~5-23~~**5-22**. Table V-16, Appendix V, documents the calculation of human exposure doses due to ingestion of contaminated fruits and vegetables grown in surface soil at Site 34.

25.6.3 Risk Characterization

25.6.3.1 Chronic Health Hazards. The noncancer daily exposure doses calculated in the exposure assessment were used to calculate HQs for each of the COPCs possessing RfDs. Pathway-specific and overall ~~-~~HIs were then calculated for each receptor. The calculations of HQ and HI are described in Section 5.1.7.1. If an overall HI is calculated to be greater than 1.0 for a particular receptor, then the exposure pathway(s) primarily responsible for the result is identified as a "critical pathway(s)." For each critical pathway, those chemical contaminants responsible for the majority of the HI are listed as COCs. Table W-16, Appendix W, documents the calculation of the pathway- and chemical-specific HQs for the human receptors at Site 34. The pathway-specific and overall HIs are summarized in Table 25-5.

25.6.3.1.1 Future On-Site Residents. The overall HIs for the future on-site adult and toddler residents at Site 34 are calculated to be **0.08**~~0.18~~ and **0.21**~~0.61~~, respectively. Both of these HIs are less than USEPA's risk management criterion. Thus, no critical exposure pathways or COCs are identified for these receptors. The existing contamination at Site 34 would not present a chemical hazard to future on-site resident adults or toddlers.

25.6.3.1.2 Future On-Site Workers. The overall HI for the future on-site worker at Site 34 is calculated to be 0.18, which is less than USEPA's risk management criterion. Thus, no critical exposure pathways or COCs are identified for this receptor population. The existing contamination at Site 34 would not present a chemical hazard to future on-site workers.

25.6.3.2 Excess Lifetime Cancer Risks. The cancer risks for each receptor were determined from the pathway-specific exposure doses and the route-specific SFs, as described in Section 5.1.7.2. To assess the simultaneous exposure of a receptor population to multiple carcinogens from multiple exposure routes, ~~all of~~ the cancer risks calculated for a receptor population were summed. Each overall receptor cancer risk was then compared to USEPA's target risk range (1.0E-06 to 1.0E-04). If the total cancer risk for a receptor from ~~all~~ **the** exposure pathways is less than 1.0E-04, it is concluded that the site(s) does not pose a significant risk to that receptor. If the overall cancer risk exceeds the target risk range, ~~any~~ **a** chemical individually associated with a risk level greater than 1.0E-05 is identified as a COC. COCs represent the primary contributors to the potential cancer risk for the receptor-specific exposure pathway under evaluation. Table W-16 (Appendix W) documents the calculation of the pathway-specific and chemical-specific cancer risks for the human receptors at Site 34. The pathway-specific and overall cancer risks are summarized in Table 25-5.

25.6.3.2.1 Future On-Site Residents. There were no carcinogenic COPCs in soil or air for the future on-site residents.

25.6.3.2.2 Future On-Site Workers. The overall cancer risk calculated for the future workers at Site 34 is **3.66**~~2.58~~E-08. Since this estimated cancer risk is below USEPA's target risk range of 1.0E-06 to 1.0E-04, no critical exposure pathways or chemicals of concern are identified for future workers.

25.6.3.3 Uncertainty/Sensitivity Analysis. The numerical risks/hazards calculated for Site 34 represent *conditional* estimates of risk based on various simplifying assumptions concerning contaminant exposure and toxicity. These estimates of risk/hazard are derived using a series of conservative procedures that address contaminant concentrations at the site, their fate in the environment, how someone currently or in the future might be exposed to these contaminants, and the toxicity of each chemical toward humans. The uncertainty analysis specifies, when appropriate, the critical assumptions made for the site so that the site-specific results can be interpreted by risk managers in a proper context.

To assist the risk managers in this project, a qualitative uncertainty analysis has been performed. The primary goals of a qualitative uncertainty analysis are (1) to itemize the major areas of uncertainty in the site-specific risk assessment and (2) to demonstrate that the assessment overall has been conservatively performed (i.e., that the potential risks/hazards at the site have not likely been underestimated, but may have been significantly overestimated).

The qualitative uncertainty analysis for this site is presented in Table 25-6. Based on this analysis, it can be concluded that this risk assessment is conservative. Some of the major uncertainties in this study that are most influential to the risks/hazards that were calculated include:

- Assumptions regarding receptors' exposure time (24 hours/day) and exposure frequency (350 days/year)

- Assumptions regarding receptors' food-chain ingestion rates (95th percentile of U.S. population)

- Maximum soil concentrations used

It should be noted that Phase I antimony results obtained by USATHAMA-certified methods were acceptable under USATHAMA QA/QC guidelines, but were later rejected in accordance with USEPA CLP guidelines for data review. The rejected data were not used *quantitatively* in the risk assessment of this site. The lack of these results for antimony may underestimate risk to human health and ecological receptors. (EPA105)

25.7 ECOLOGICAL RISK ASSESSMENT

Utilizing protocol established in the PERA (Rust E&I 1997g), it was determined that the only COC at Site 34 is lead, which was detected at a maximum concentration of 330 mg/kg in the site soils. This concentration was determined to be potentially harmful to site fauna; however,

the next highest detection of lead in the site soils was 62 mg/kg. Building 136 is surrounded by pavement and frequently mowed grass. Since there is only one COC and the impacted area is small (estimated to be less than 0.1 acre), no further ecological investigation was undertaken for this site.

25.8 CONCLUSIONS AND RECOMMENDATIONS

Surface soil samples collected during Phase I around the perimeter of the pad at the Building 136 Sandblasting Area (Site 34) were found to contain several metals exceeding their respective background concentrations. Only aluminum and manganese were found to exceed USEPA Region 9 PRGs and then retained as COPCs for the human health risk assessment.

Results of the human health risk assessment show that no risks exceeding USEPA criteria are present at Site 34. ~~Results of the preliminary ecological risk assessment (Rust E&I 1994) for Site 34 indicated that none of the contaminants exceed ecological toxicity criteria. Therefore,~~ **For the rationale described above under Section 25.7,** no additional ecological assessment was required.

On the basis of the human health and ecological risk assessments, it is concluded that no further investigation is ~~warranted~~ **needed**. It is recommended that a No Further Action technical memorandum be prepared and the site be removed from the FS.

TABLES

TABLE 25-1

Summary of Phase II Analytical Results for Surface Soils and Sand
Site 34 - Building 136 Sandblasting Area
Jefferson Proving Ground
Madison, Indiana

Sample ID Analyte	SBA34SF001 (µg/g)[a]	SBA34SF002 (µg/g)	SBA34SF003 (µg/g)	SBA34SN001 (µg/g)	SBA34SN002 (µg/g)	Background (µg/g)
Aluminum	8,720	14,000	931	27.2	71.7	11,000
Arsenic	4.67	5.30	3.14	LT 2.5	LT 25	9.26
Barium	153	79.6	18.7	LT 3.29	15.4	84.5
Boron	13.7	12.5	13.1	LT 6.64	8.44	0
Calcium	73,000	15,800	160,000	LT 25.3	1,100	750
Chromium	18.6	24.0	9.38	LT 1.04	20.1	15.1
Cobalt	8.19	5.44	LT[b] 2.50	LT 2.50	LT 2.50	3.50
Copper	17.4	7.28	2.84	LT 2.84	8.13	5.64
Iron	15,300	16,200	12,700	84.4	6,950	14,800
Lead	330	62.0	21.0	LT 0.467	63.0	14.9
Magnesium	33,100	6,030	63,000	LT 10.1	223	7,000

TABLE 25-1

Summary of Phase II Analytical Results for Surface Soils and Sand
Site 34 - Building 136 Sandblasting Area
Jefferson Proving Ground
Madison, Indiana

Sample ID Analyte	SBA34SF001 (µg/g)[(a)]	SBA34SF002 (µg/g)	SBA34SF003 (µg/g)	SBA34SN001 (µg/g)	SBA34SN002 (µg/g)	Background (µg/g)
Manganese	461	317	371	LT 9.87	49.5	302
Nickel	11.2	7.1	3.92	LT 2.74	5.35	2.23
Potassium	691	820	327	LT 131	LT 131	681
Selenium	LT 0.45	0.56	LT 0.45	LT 0.449	LT 0.449	0.74
Silver	0.0327	0.0385	LT 0.0124	LT 0.0124	0.0127	0
Sodium	121	72.6	179	LT 38.7	LT 38.7	50.5
Vanadium	18.5	26.9	2.41	LT 1.41	LT 1.41	27.0
Zinc	112	70.0	20.7	LT 2.34	27.6	19.5

General Note:
1. All samples were collected at a depth of 0 feet on 11/19/92 (EPA18).
2. Antimony results are qualified unusable due to quality control deficiencies.

Footnotes:
(a) Micrograms per gram.
(b) Less than the reporting limit.

TABLE 25-2

Soil/Sand Exposure Point Concentrations of Contaminants of Potential Concern
Site 34 - Building 136 Sandblasting Area
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/g)[b]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[c] (µg/g)
Surface Soil						
Aluminum	3/3	931 - 14,000	NA[d]	7,884	7.2E+12	14,000
Barium	3/3	18.7 - 153	NA	83.8	5.5E+6	153
Boron	3/3	12.5 - 13.7	NA	13.1	14.3	13.7
Chromium	3/3	9.38 - 24.0	NA	17.3	169	24.0
Cobalt	2/3	5.44 - 8.19	2.50	4.9	57,000	8.19
Copper	2/3	7.28 - 17.4	2.84	8.7	5.5E+7	17.4
Lead	3/3	21.0 - 330	NA	138	1.24E+10	330
Manganese	3/3	317 - 461	NA	383	597	461
Nickel	3/3	3.92 - 11.2	NA	7.4	142	11.2
Silver	2/3	0.033 - 0.039	0.012	0.026	865	0.039
Zinc	3/3	20.7 - 112	NA	67.6	1.10E+5	112
Sand						
Aluminum	2/2	27.2 - 71.7	NA	49.5	NC[e]	71.7
Barium	½	15.4	3.29	8.5	NC	15.4
Boron	½	8.44	6.64	5.88	NC	8.44

TABLE 25-2

Soil/Sand Exposure Point Concentrations of Contaminants of Potential Concern
Site 34 - Building 136 Sandblasting Area
Jefferson Proving Ground
Madison, Indiana

Chemical	Frequency of Detection[(a)]	Range of Detected Values (µg/g)[(b)]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[(c)] (µg/g)
Chromium	½	20.1	1.04	10.3	NC	20.1
Copper	½	8.13	2.84	4.78	NC	8.13
Lead	½	63.0	0.467	31.6	NC	63.0
Manganese	½	49.5	9.87	27.2	NC	49.5
Nickel	½	5.35	2.74	3.36	NC	5.35
Silver	½	0.013	0.012	0.009	NC	0.013
Zinc	½	27.6	2.34	14.4	NC	27.6

Footnotes:

(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Micrograms per gram.
(c) The 95% UCL (upper confidence limit of the mean) or the maximum detected value, whichever is lower (USEPA 1989b).
(d) Not applicable.
(e) Not calculated due to insufficient data.

TABLE 25-3

Selection of Contaminants of Potential Concern (COPC) in Soil/Sand Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 34 - Building 136 Sandblasting Area
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screening Data		
Chemical	**Residential PRG (μg/g)[a]**	**Exposure Point Conc. (μg/g)**	**Retained as Soil COPC?**
Surface Soil			
Aluminum	7,667	14,000	**YES**
Barium	527	153	No
Boron	586	13.7	No
Chromium	30.0	24.0	No
Cobalt	457	8.19	No
Copper	285	17.4	No
Lead	400[b]	330	No
Manganese	318	461	**YES**
Nickel	150	11.2	No
Silver	38.3	0.039	No
Zinc	2,300	112	No
Sand			
Aluminum	7,667	71.7	No
Barium	527	15.4	No
Boron	586	8.44	No
Chromium	30.0	20.1	No
Copper	285	8.13	No
Lead	400[b]	63.0	No
Manganese	318	49.5	No
Nickel	150	5.35	No
Silver	38.3	0.013	No
Zinc	2,300	27.6	No

Note:

PRGs were taken directly from the Region 9 PRG Table (USEPA 1996c) except as noted in the footnotes. Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:

(a) Micrograms per gram.
(b) Value for lead is the full PRG.

TABLE 25-4

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 34 - Building 136 Sandblasting Area
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Ambient Air PRG (µg/m^3)[(a)]**	**Exposure Point Conc. (µg/m^3)**	**Retained as Air COPC?**
Residential Scenario			
Aluminum	NA[(b)]	7.35E-03	**YES**
Arsenic	4.5E-04	1.78E-06	No
Barium	5.2E-02	5.99E-05	No
Beryllium	8.0E-04	1.41E-07	No
Cadmium	1.1E-03	1.17E-07	No
Chromium	2.3E-05	1.11E-05	No
Lead	1.5E+00[(c)]	8.64E-06	No
Manganese	5.1E-03	6.82E-04	No
Silver	NA	9.34E-06	**YES**
Thallium	NA	2.65E-06	**YES**
Vanadium	NA	8.46E-07	**YES**
Zinc	NA	5.96E-06	**YES**
Dioxins/Furans	4.5E-08	2.41E-13	No
Benzo(a)anthracene	9.2E-03	1.07E-08	No
Benzo(a)pyrene	9.2E-04	3.21E-08	No
Benzo(b)fluoranthene	9.2E-03	6.28E-08	No
DDE	2.0E-02	6.31E-09	No
Dibenz(a,h)anthracene	9.2E-04	1.26E-09	No
Dieldrin	4.2E-04	NA	No
Indeno(1,2,3-cd)pyrene	9.2E-03	6.30E-09	No
1,1-Dichloroethylene	3.8E-02	1.21E-09	No
Chlorobenzene	2.1E+00	1.59E-06	No

TABLE 25-4

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs) Site 34 - Building 136 Sandblasting Area Jefferson Proving Ground Madison, Indiana

	USEPA Region 9 PRG Screen		
Chemical	**Ambient Air PRG (µg/m^3)[a]**	**Exposure Point Conc. (µg/m^3)**	**Retained as Air COPC?**
Industrial Scenario			
Aluminum	NA	1.20E+00	**YES**
Arsenic	4.5E-04	6.56E-06	No
Barium	5.2E-02	7.81E-05	No
Beryllium	8.0E-04	3.80E-07	No
Cadmium	1.1E-03	1.61E-07	No
Chromium	2.3E-05	3.76E-05	**YES**
Lead	1.5E+00[c]	8.64E-06	No
Manganese	5.1E-03	3.99E-02	**YES**
Silver	NA	9.34E-06	**YES**
Thallium	NA	2.65E-06	**YES**
Vanadium	NA	2.04E-06	**YES**
Zinc	NA	5.46E-05	**YES**
Dioxins/Furans	4.5E-08	2.58E-12	No
Benzo(a)anthracene	9.2E-03	1.07E-08	No
Benzo(a)pyrene	9.2E-04	3.46E-08	No
Benzo(b)fluoranthene	9.2E-03	6.28E-08	No
DDE	2.0E-02	6.31E-09	No
Dibenz(a,h)anthracene	9.2E-04	1.26E-09	No
Dieldrin	4.2E-04	5.49E-08	No
Indeno(1,2,3-cd)pyrene	9.2E-03	6.31E-09	No
1,1-Dichloroethylene	3.8E-02	1.21E-09	No
Chlorobenzene	2.1E+00	1.59E-06	No

General Note:

1. PRGs were taken directly from the Region 9 PRG Table (USEPA 1996c). Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:

(a) Micrograms per cubic meter.
(b) Not available or not applicable.
(c) Federal ambient air quality criterion for lead.

TABLE 25-5

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 34 – Building 136 Sandblasting Area
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
	Future On-site Resident Adult			
Incidental ingestion of soil	NA[a]		0.0045	
Dermal contact with soil	NA		0.0004	
Ingestion of homegrown fruits/vegetables	NA		0.0701	
Inhalation of VOCs[b] and fugitive dusts	NA		NA	
Total	NA		0.0750	
	Future On-site Resident Child			
Incidental ingestion of soil	NA		0.0421	
Dermal contact with soil	NA		0.0011	
Ingestion of homegrown fruits/vegetables	NA		0.1645	
Inhalation of VOCs and fugitive dusts	NA		NA	
Total	NA		0.2077	

TABLE 25-5

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 34 – Building 136 Sandblasting Area
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
		Future On-site Worker		
Incidental ingestion of soil	NA		0.0016	
Dermal contact with soil	NA		0.0002	
Inhalation of VOCs and fugitive dusts	3.66E-08		0.1814	
Total	3.66E-08		0.1832	

Footnotes:
(a) Not available or not applicable.
(b) Volatile organic compounds.

RAB/PB
N:\Jobs\244\0025\01\wp\tbl\96_Table 25-5_Phase 2 RI.doc

TABLE 25-6

Qualitative Uncertainty Analysis
Site 34 - Building 136 Sandblasting Area
Jefferson Proving Grounds
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
A. Human Behavior				
Future receptors' exposure duration	30 years	Medium	Medium	National upper-bound time (90th percentile) at one residence
Future receptors' exposure frequency	350 days/year	Medium	Medium	High-end value
Future receptors' exposure time	24 hours/day	Low	High	Maximum possible value
Future receptors' food-chain ingestion rates	NA[a]	Low	High	Nearly impossible for an average weight receptor to ingest daily the 95th percentile U.S. population consumption amounts
Exclusion of certain exposure pathways in the quantitative analysis	NA	Low	Low	Pathways eliminated are those that have low possibility of contributing risk to these receptors
B. Chemical Fate/Transport in the Environment				
Calculation of exposure point concentration of COC[b]/food-chain modeling	NA	Low	High	Conservative assumptions and input parameters
Use of air dispersion modeling to predict air concentrations	NA	Low	High	Conservative assumptions and input parameters

TABLE 25-6

Qualitative Uncertainty Analysis
Site 34 - Building 136 Sandblasting Area
Jefferson Proving Grounds
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
C. Chemical Toxicity				
Assumption that USEPA[c] reference doses truly represent toxicological thresholds	NA	Low	High	High degree of conservativeness utilized by USEPA in deriving RfDs[d] from toxicological literature
Assumption that USEPA carcinogenic slope factors truly represent dose-response phenomena	NA	Low-moderate	Moderate-high	Use of linearized, multi-stage mathematical model to predict cancer incidence at low exposure levels is USEPA policy; not currently supported by scientific data
Assumption of risk/hazard additivity	NA	Moderate	Moderate	Summation of chemical-specific risks/hazards may over- or under-predict risks/hazards to receptors
Screening out of certain contaminants based on USEPA criteria	NA	Low	Low	Chemicals present in concentrations less than Region 9 criteria eliminated

Footnotes:

(a) Not available or not applicable.
(b) Contaminant of concern.
(c) United States Environmental Protection Agency.
(d) Reference doses.

FIGURES

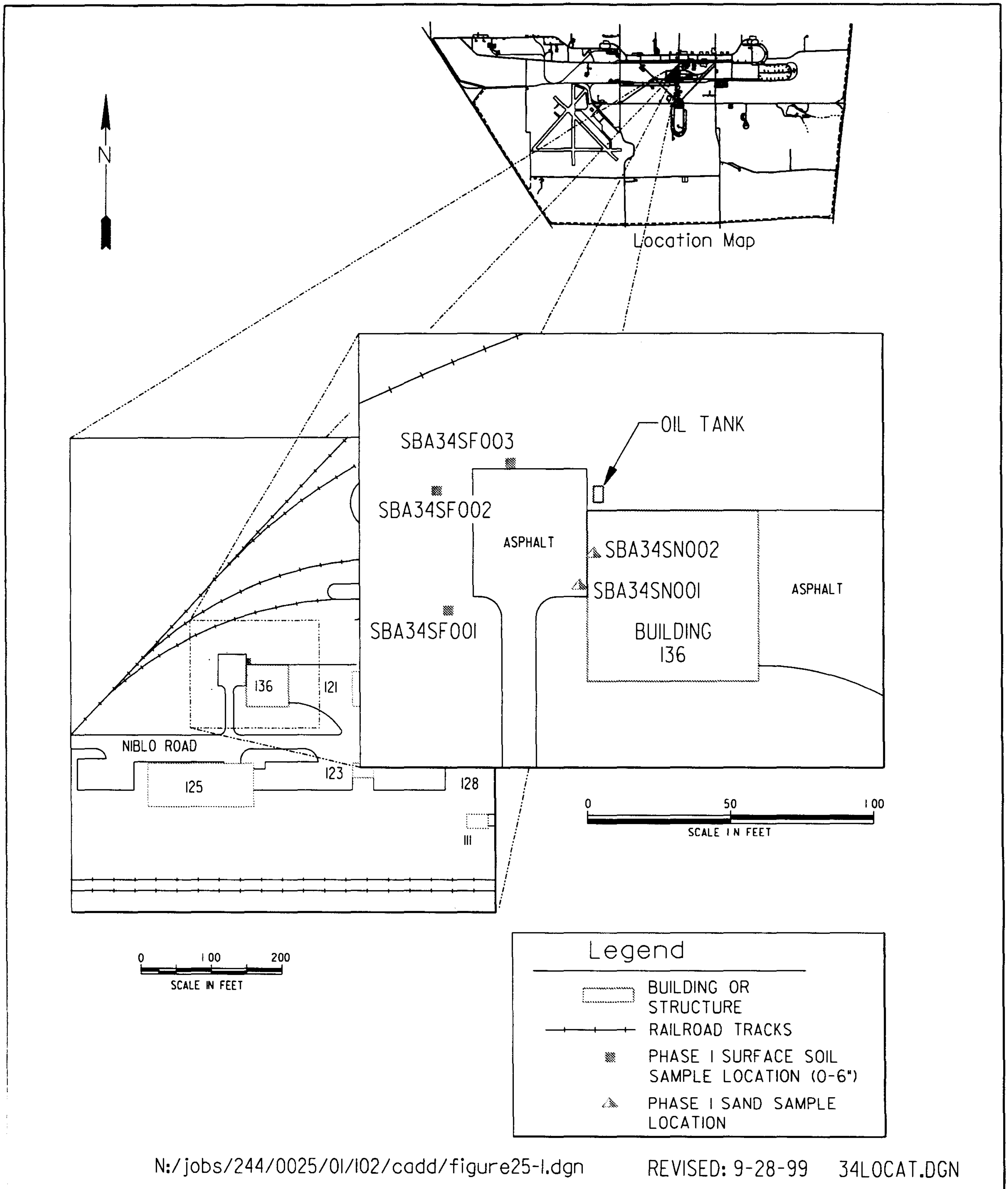


Figure 25-1. Sampling Locations at Building 136 Sandblasting Area (Site 34)

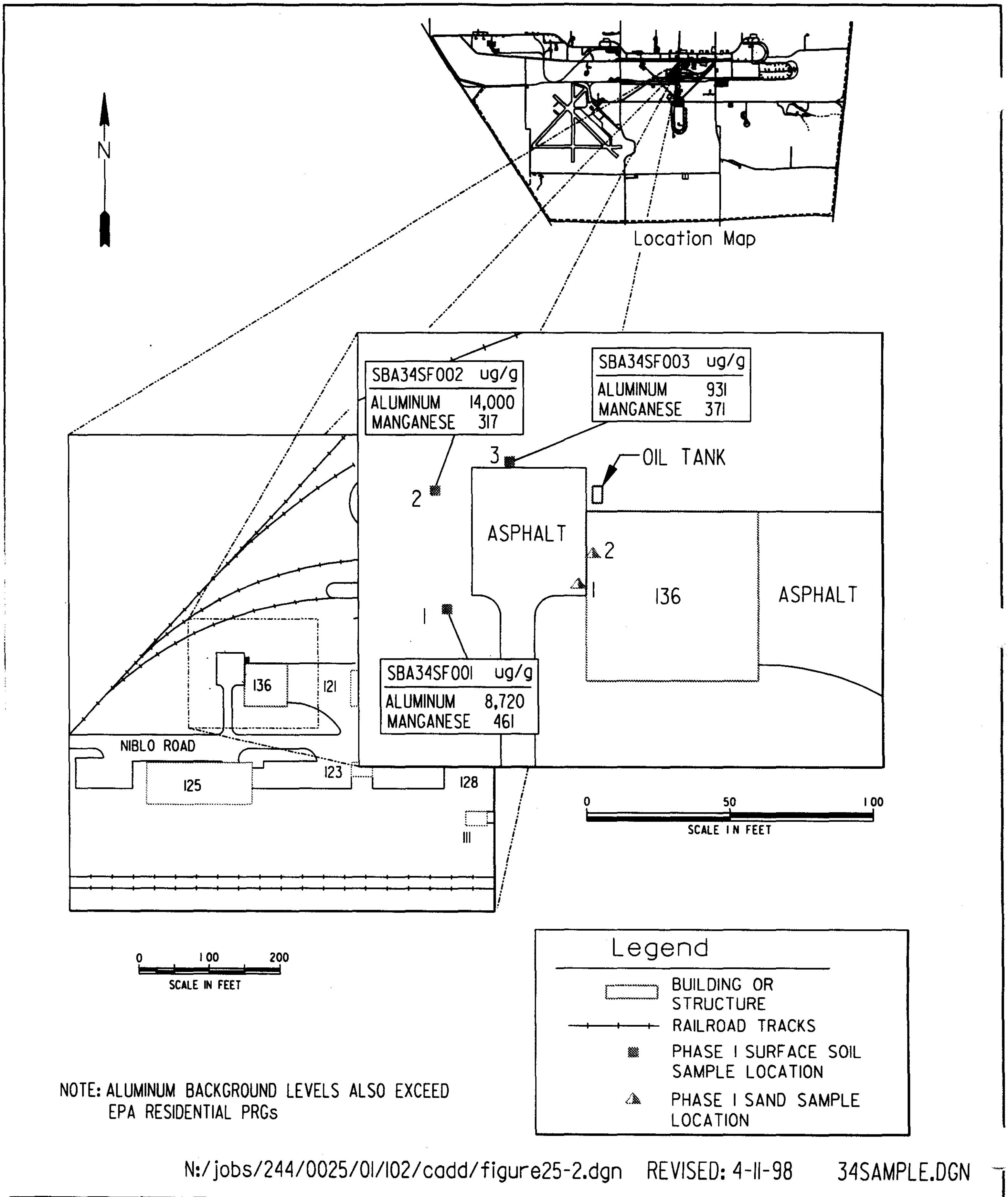


Figure 25-2. Summary of Contaminants Exceeding Background and Regulatory Risk-Based Concentrations, Building 136 Sandblasting Area (Site 34)

26.0 NORTHWEST-SOUTHEAST RUNWAY FLARE TEST AREA (SITE 38)

26.1 SITE CHARACTERISTICS

The flare test area (Site 38) is located along the south side of the northwest-southeast runway at the airfield (Figure 26-1). The area is rectangularly shaped and is approximately 150 feet wide and several hundred feet long. It is located about midway along the runway. This site was still being used for flare testing at the time of the Phase I RI as evidenced by the burned appearance of the ground surface and the presence of some recently launched flares. The area was reportedly cleared of UXO by facilities EO personnel after each testing period. However, it was believed that potential UXO may exist in the area. Residual contamination from flare components was also a potential concern. Most flares contain magnesium, white phosphorus, sulfur, and either potassium or sodium nitrate. White phosphorus is poisonous when ingested and ignitable at ambient temperatures. The other constituents present little or no hazard. The flare test area is coincident with an area identified on a 1945 facilities map as a mine/mortar test area.

The area is very flat, and ~~all~~ surface water drainage is directed via an underground storm water sewer system to Harberts Creek, about ½ mile south of the airfield (Figure 2-1). The ground surface at the test area is covered with clinkers (coal ash) reportedly brought in from the nearby coal-fired power plant at Madison. The remainder of the surrounding ground surface is covered with either grass or the concrete runway. There are no trees or shrubs in the vicinity of the site.

The site is located in an area that has soils belonging to the Cobbsfork soil series. The depth to bedrock is probably about 30 feet as determined from three monitoring wells installed nearby at the Fire Training Area (Site 13). Based on geologic information compiled from monitoring well cores, the glacial till is probably underlain by the Jeffersonville Limestone of Devonian age. The regional bedrock groundwater gradient is toward the west-southwest (Figure 2-15).

26.2 PREVIOUS INVESTIGATIONS

No environmental samples were collected from Site 38 prior to the Phase I RI. The site was included in the RI based on visual observations of the burned ground surface and on the presence of spent flare components.

26.3 STUDY AREA INVESTIGATION

26.3.1 Phase I RI Field Activities

A records search and an interview with J. Bowling of the JPG Range Support Branch (Bowling 1992) were conducted to determine the type of flares and mortars tested and the frequency of flare testing. An evaluation of hazard potential based on the identified contaminants of concern was performed. Magnetometer and EM-31 terrain conductivity geophysical surveys were conducted at the site to determine the existence of buried metal (possible unexploded flares or mortars). The results of this survey, summarized in Appendix C, **show no significant accumulation of buried metal that might represent unexploded flares or mortars. The only indications of metal found by the surveys were confirmed to be related to surface infrastructure such as lighting, manholes for the storm sewer, etc.** A composite surface soil sample was collected and analyzed for metals and explosives to determine if ~~any~~ contamination was present.

26.3.2 Phase II RI Field Activities

Because ~~it was concluded~~**agreement was reached with USEPA and IDEM during the planning of Phase II field investigations throughout JPG that Site 38** ~~that this site~~ was adequately characterized on the basis of the Phase I field work, no further investigation was recommended as part of Phase II **(EPA 63)**. Soil borings and wells were not installed in this area because no explosive compounds were detected, and because the metals concentrations detected in the Phase I surface soil sample were below regulatory criteria. Additionally, the potential UXO areas are being evaluated under a separate Army program **(EPA11, EPA63)**, and as a result Phase II RI activities were deemed to be unnecessary.

26.4 DATA EVALUATION

26.4.1 Data Validation Results

No blank contamination was reported. ~~All~~ **The** data, except for antimony, were deemed acceptable for use. The antimony result for sample FTA38SF001 was rejected due to low LCS/MS recoveries.

26.4.1.1 Evaluation of Non-Detected Values. A comparison was made between the USEPA Region 5 DQLs and the project CRLs for chemicals that were analyzed for but not detected in environmental media at this site. Thallium exceedances were noted for soil samples. No other exceedances were found.

26.4.2 Data Quality Summary

With the exception of antimony, ~~all~~ **the** Phase I results were determined to be acceptable for use. **The potential effect of rejecting the antimony results will be discussed further in the uncertainty section of the human risk assessment for the site. (EPA105)**

26.4.3 Background Screening

The background screening protocol is described in Section 5.1.4.5.2. The results of the background screening procedure for Site 38 are shown in Table 26-1. The concentration of each inorganic constituent detected in the single site sample were compared to the background threshold for the appropriate soil series, in this case the Cobbsfork soil series. As shown in Table 26-1, beryllium, boron, cobalt, copper, nickel, and silver are above background in the surface soil sample collected at this site.

26.4.4 Summary of Analytical Results

Table 26-2 summarizes the analytical results for the soil sample collected at Site 38. A comp**re**he**nsive**~~lete~~ listing of ~~all~~**the** analytical results, including nondetected and below reporting limit analytes, is presented in Appendix N.

26.5 NATURE AND EXTENT OF CONTAMINATION

A records search and an interview (Bowling 1992) revealed that green-, red-, and white-star flares have been tested at the site. No records of mortar testing were found, and there was no confirmation from facilities personnel concerning mortar testing at the site. Flare testing has been conducted on an irregular basis, approximately once per month. The flares contain a primer at the base, a rocket propellant, and an illumination assembly. When the flares are fired, the rocket motor burns out at about 200 feet and a black powder expelling charge expels and ignites the 5-star illumination assembly. Burning time is 6 to 10 seconds with burnout usually occurring from 250 to 300 feet above ground. The primer charge, the propellant, and the expelling charge consist of black powder. The illuminator is composed of salts of either sodium, barium/copper, or strontium, producing flares of white, green, and red, respectively.

The geophysical survey results are presented in Appendix C. The results show no significant accumulation of buried metal that might represent unexploded flares or mortars. The only indications of metal found by the surveys were confirmed to be related to surface infrastructure such as lighting, manholes for the storm sewer, etc.

26.5.1 Soil

The soil sample collected at the site was analyzed for metals and explosives. The analytical results for this sample are presented in Table 26-2. Beryllium, boron, cobalt, copper, iron, nickel, and silver were detected at levels exceeding their corresponding background values.

~~No e~~**E**xplosive compounds were **not** detected in the sample. Only beryllium was found to exceed the USEPA Region 9 criteria. However, background concentrations of beryllium at JPG also exceed the Region 9 criteria.

In summary, the objectives of the proposed activities were to identify the type and frequency of flare and mortar testing and to determine the COCs. A file search and interviews provided information on the flare constituents. Analytical testing of a composite soil sample provided information on the presence of possible residual metals contamination at the site. There was no confirmation that mortars had been tested at the site. The results of the geophysical survey indicate no ~~cause for concern about buried~~**significant subsurface anomalies were identified that could be interpreted as** UXO at the site. Because no anomalous metals or explosives related to flare test components were noted in the soil-sample results, no additional site investigation is recommended.

26.6 HUMAN HEALTH RISK ASSESSMENT

26.6.1 Selection of the Contaminants of Potential Concern at Site 38

26.6.1.1 Surface Soil.

26.6.1.1.1 Frequency of Detection. Evaluation of frequency of detection was not undertaken at this site because of too few samples.

26.6.1.1.2 Nutrient Screening. The maximum value of each of the nutrients detected in the soil sample collected at this site was less than the corresponding nutrient screening value: calcium (maximum 5,820 µg/g; screening value 1,000,000 µg/g), iron (maximum 20,800 µg/g; screening value 70,000 µg/g), magnesium (maximum 1,230 µg/g; screening value 1,000,000 µg/g), potassium (maximum 501 µg/g; screening value 150,000 µg/g), and sodium (maximum 94.5 µg/g; screening value 1,000,000 µg/g). Therefore, ~~all~~ **the** nutrients were eliminated as COPCs in surface soil at this site.

26.6.1.1.3 Summary of Preliminary COPCs. Table 26-3 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95% UCL of the mean, and the exposure point concentration for each preliminary COPC in soil at Site ~~27~~**38**. No explosives were detected.

26.6.1.1.4 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for each preliminary soil COPC was compared to the chemical-specific Region 9 residential soil PRG (Table 26-4). One-tenth of the PRG was used for noncarcinogens. As a result of the screening, beryllium is the only COPC for surface soil at Site 38.

26.6.1.2 Air.

26.6.1.2.1 Summary of Preliminary COPCs. Ambient air concentrations to which future receptors at this site might be exposed were estimated using air emission/dispersion modeling, as described in Appendix R. In the site-specific conceptual model discussed below in Section 26.6.2.1, Site 38 is evaluated under two future site-specific scenarios: as a residential site and as an industrial site.

In the future industrial land use scenario for the facility, ~~all~~ **the** sites were assumed to be industrial, except for the five sites designated agricultural sites. Each site with particulate-bound COPCs in surface soil (metals, SVOCs, and dioxins/furans) and/or volatile COPCs in surface/subsurface soil combined was assumed to contribute to the air concentrations at ~~all of~~ the sites. In the future residential scenario for the facility, ~~all~~ **the** sites were assumed to be residential except for the five sites designated residential/agricultural. It was assumed that particulate and VOC emissions from the strictly residential sites would be negligible because the home sites would be covered with dense vegetation (lawns) and pavement. Therefore, under the residential scenario only the five residential/agricultural sites contribute to the air concentrations at ~~all of~~ the sites. The list of preliminary air COPCs is therefore the same for every site for a given scenario, but the concentrations of the COPCs vary. Tables R-4 and R-6 in Appendix R present the estimated ambient air concentrations at Site 38 under the future industrial and residential scenarios, respectively.

26.6.1.2.2 Region 9 Preliminary Remediation Goal Screening. The exposure point concentrations for each preliminary air COPC at Site 38 in the future residential scenario and the future industrial scenario were compared to chemical-specific Region 9 air PRGs (Table 26-5). One-tenth of the PRG was used for noncarcinogens. The exception was lead, for which the full PRG was used. As a result of the screening, aluminum, silver, thallium, vanadium, and zinc are retained as COPCs in air for future on-site residents. For future on-site workers, aluminum, chromium, silver, thallium, vanadium, and zinc were retained.

26.6.2 Exposure Assessment

26.6.2.1 Site Conceptual Model. No people **are known to** specifically work at or frequent Site 38. There are, however, several types of individuals who could potentially be affected by the existing contamination at the facility. These are current trespassers to JPG and off-facility (nearby) rural residents and future hunters. In each case, these individuals would most likely be impacted simultaneously by multiple sites rather than by single units. Because of this, these current receptor populations are addressed on a facility-wide, cumulative basis rather than by specific sites (see Sections 28 and 29).

Therefore, this site-specific exposure scenario only addresses future land use development. Site 38 has two potential future land uses forwarded for evaluation:

- Residential

- Industrial

26.6.2.1.1 Residential Use. Under the future residential land use scenario, this site is assumed to be developed for residential purposes, with the supposition that a family would build a house directly on or within this area of potential concern.

With respect to a risk assessment analysis, resident populations are assumed to consist of both adults and toddlers. Each individual would be expected to come in contact with site contaminants in the following pathways at Site 38:

- Inhalation/ingestion of airborne fugitive particulates
- Dermal contact with soil while gardening/playing outdoors
- Incidental ingestion of soil while gardening/playing outdoors
- Ingestion of fresh homegrown fruits and vegetables

26.6.2.1.2 On-site Worker. Industrial land use is considered to be a plausible future option for this site at JPG. On-site industrial workers (adult males and females) are assumed to be individuals who could be exposed directly to contaminated media through the following pathways at Site 38:

- Inhalation/ingestion of airborne fugitive particulates from surface soils
- Incidental inhalation/dermal contact with soil

26.6.2.2 Exposure Point Concentrations.

26.6.2.2.1 Air. The estimated ambient air concentrations of COPCs at this site for the future on-site residents and the future on-site workers are presented in Table 26-5.

26.6.2.2.2 Soil. The concentrations of COPCs in surface soil at this site are presented in Table 26-4. No subsurface samples were collected at Site 38.

26.6.2.2.3 Fruits, Vegetables, and Crops. COPC concentrations in homegrown fruits and vegetables were estimated using the methods described in Section 5.1.5.2.8. Appendix U, Table U-17, documents the calculation of contaminant concentrations in fruits and vegetables at Site 38.

26.6.2.3 Human Exposure Doses.

26.6.2.3.1 Inhalation of Contaminated Air. Inhalation of airborne contaminants (VOCs and particulates) is a potential route of exposure for future on-site residents (adults and children) and future on-site workers at this site. The equation used for calculating human exposure

doses of COPCs due to inhalation of volatile and dust-bound contaminants is provided in Section 5.1.5.3.1, Table ~~5-12~~**5-11**. Table V-17, Appendix V, documents the calculation of human exposure doses at Site 38 due to inhalation of contaminated air.

26.6.2.3.2 Incidental Ingestion of Contaminated On-site Soil. Mouthing behavior (toddlers) and incidental ingestion of soil with recreational or work-related activities may expose human receptors to contaminated soil at a site via the oral route of exposure. The equation used to calculate the human exposure dose due to incidental ingestion of contaminated soil is presented in Section 5.1.5.3.2, Table ~~5-13~~**5-12**. This pathway was assumed to be complete at Site 38 for future on-site residents (adults and children) and future on-site workers. Table V-17, Appendix V, documents the calculation of human exposure doses due to incidental ingestion of soil at Site 38.

26.6.2.3.3 Dermal Contact with Contaminated On-site Soil. The chemicals in contaminated soil also may be absorbed into a receptor's body through dermal contact. The equation that was used to calculate chemical doses due to dermal contact with contaminated soil is presented in Section 5.1.5.3.3, Table ~~5-14~~**5-13**. This pathway is relevant for future on-site residents (adults and children) and future on-site workers at Site 38. Table V-17, Appendix V, documents the calculation of human exposure doses due to dermal contact with soil at Site 38.

26.6.2.3.4 Ingestion of Contaminated Fruits and Vegetables. Consumption of contaminated homegrown fruits and vegetables may be a source of chemical exposure for future on-site residents (adults and children). The equation used to calculate human exposure dose due to ingestion of contaminated fruits and vegetables is provided in Section 5.1.5.3.11, Table ~~5-23~~**5-22**. Table V-17, Appendix V, documents the calculation of human exposure doses due to ingestion of contaminated fruits and vegetables grown in surface soil at Site 38.

26.6.3 Risk Characterization

26.6.3.1 Chronic Health Hazards. The noncancer daily exposure doses calculated in the exposure assessment were used to calculate HQs for each of the COPCs possessing RfDs. Pathway-specific and overall HIs were then calculated for each receptor. The calculations of HQ and HI are described in Section 5.1.7.1. If an overall HI is calculated to be greater than 1.0 for a particular receptor, then the exposure pathway(s) primarily responsible for the result is identified as a "critical pathway(s)." For each critical pathway, those chemical contaminants responsible for the majority of the HI are listed as COCs. Table W-17, Appendix W, documents the calculation of the pathway- and chemical-specific HQs for the human receptors at Site 38. The pathway-specific and overall HIs are summarized in Table 26-6.

26.6.3.1.1 Future On-Site Residents. The overall HIs for the future on-site adult and toddler residents at Site 38 are calculated to be **0.001**~~0.002~~ and **0.005** ~~0.01~~, respectively. Both of these HIs are less than USEPA's risk management criterion. Thus, no critical exposure pathways or COCs are identified for these receptors. The existing contamination at Site 38 would not present a chemical hazard to future on-site resident adults or toddlers.

26.6.3.1.2 Future On-Site Workers. The overall HI for the future on-site worker at Site 38 is calculated to be **0.0003** ~~0.001~~, which is less than USEPA's risk management criterion. Thus, no critical exposure pathways or COCs are identified for this receptor population. The existing contamination at Site 38 would not present a chemical hazard to future on-site workers.

26.6.3.2 Excess Lifetime Cancer Risks. The cancer risks for each receptor were determined from the pathway-specific exposure doses and the route-specific SFs (Section 5.1.7.2). To assess the simultaneous exposure of a receptor population to multiple carcinogens from multiple exposure routes, ~~all of~~ the cancer risks calculated for a receptor population were summed. Each overall receptor cancer risk was then compared to USEPA's target risk range (1.0E-06 to 1.0E-04). If the total cancer risk for a receptor from ~~all~~ **the** exposure pathways is less than 1.0E-04, then it is concluded that the site(s) does not pose a significant risk to that receptor. If the overall cancer risk exceeds the target risk range, ~~any~~ **a** chemical individually associated with a risk level greater than 1.0E-05 is identified as a COC. COCs represent the primary contributors to the potential cancer risk for the receptor-specific exposure pathway under evaluation. Table W-17 (Appendix W) documents the calculation of the pathway- and chemical-specific cancer risks for the human receptors at Site 38. The pathway-specific and overall cancer risks are summarized in Table 26-6.

26.6.3.2.1 Future On-Site Residents. The overall cancer risks calculated for the future adults and toddlers living at Site 38 are **not available.** ~~2.5E-06 and 3.6E-06, respectively. Since both of these cancer risks are within USEPA's target risk range of 1.0E-06 to 1.0E-04,~~ **Therefore,** no critical exposure pathways or COCs are identified for these receptors.

26.6.3.2.2 Future On-Site Workers. The overall cancer risk calculated for the future workers at Site 38 is **3.12E-08**~~4.3E-07~~. Since this estimated cancer risk is below USEPA's target risk range of 1.0E-06 to 1.0E-04, no critical exposure pathways or COCs are identified for future workers.

26.6.3.3 Uncertainty/Sensitivity Analysis. The numerical risks/hazards calculated for Site 38 represent *conditional* estimates of risk based on various simplifying assumptions concerning contaminant exposure and toxicity. These estimates of risk/hazard are derived using a series of conservative procedures that address contaminant concentrations at the site, their fate in the environment, how someone currently or in the future might be exposed to these contaminants, and the toxicity of each chemical toward humans. The uncertainty analysis specifies, when appropriate, the critical assumptions made for the site so that the site-specific results can be interpreted by risk managers in a proper context.

To assist the risk managers in this project, a qualitative uncertainty analysis has been performed. The primary goals of a qualitative uncertainty analysis are (1) to itemize the major areas of uncertainty in the site-specific risk assessment and (2) to demonstrate that the assessment overall has been conservatively performed (i.e., that the potential risks/hazards at the site have not likely been underestimated, but may have been significantly overestimated).

The qualitative uncertainty analysis for this site is presented in Table 26-7. Based on this analysis, it can be concluded that this risk assessment is conservative. Some of the major uncertainties in this study that are most influential to the risks/hazards that were calculated include:

- Assumptions regarding receptors' exposure time (24 hours/day) and exposure frequency (350 days/year)
- Assumptions regarding receptors' food-chain ingestion rates (95th percentile of U.S. population)
- Maximum soil concentrations used

In addition, Phase I antimony results obtained by USATHAMA-certified methods were acceptable under USATHAMA QA/QC guidelines, but were later rejected in accordance with EPA CLP functional guidelines for data review. The rejected data were not used quantitatively in this risk assessment. Thus, the absence of analytical data for antimony may underestimate risk to human health and ecological receptors. (EPA 105).

26.7 ECOLOGICAL RISK ASSESSMENT

Based on protocols established in the PERA (Rust E&I 1997g), there were no potential ecological risks determined for Site 38. Site 38 consists of a narrow strip of land adjacent to the airport runway, which is covered with black cinders several inches thick. This site had an exceedance of the target ratio for toxic effects from nickel in soils. However, it was determined that background concentrations of nickel also resulted in an exceedance for one species and a new default value was used for nickel. This resulted in a determination that nickel contamination does not pose a risk to ecological receptors at Site 38. As a result, no further ecological risk analysis was undertaken.

26.8 CONCLUSIONS AND RECOMMENDATIONS

Geophysical survey results at the Flare Test Area (Site 38) indicate that no significant accumulation of buried metal that might represent unexploded flares or mortars exists. The soil sample collected at Site 38 was found to contain several metals exceeding their respective background concentrations, but only beryllium was found to be present at a concentration above the corresponding USEPA Region 9 PRG for soil. Results of the human health risk assessment indicate that carcinogenic risks are below or within the USEPA target range of 1E-06 to 1E-04 and chronic health hazards are ~~all~~ below the USEPA goal of 1.0. The contaminants detected at Site 38 do not appear to pose a risk to ecological receptors.

On the basis of the geophysical survey, Phase I soil sample results, and the risk assessment results, no further investigation of this site is ~~warranted~~**needed**. It is recommended that a Technical Memorandum for No Further Action be prepared and that this site should be removed from the FS process.

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TABLES

TABLE 26-1

Background Screening of Inorganic Chemicals Detected in Soil
Site 38 – Northwest - Southeast Runway Flare Test Area
Jefferson Proving Ground
Madison, Indiana

Analyte	Frequency of Detection[(a)]	Maximum Detected Value (µg/g)[(b)]	Soil Series Background Screening Value[(c)] (µg/g)	Exceeds Site-Specific Background?
Surface Soil				
Aluminum	1/1	9,340	11,000	No
Arsenic	1/1	3.6	9.26	No
Barium	1/1	58.8	84.5	No
Beryllium	1/1	0.688	0.52	**YES**
Boron	1/1	9.3	ND[(d)]	**YES**
Chromium	1/1	13.7	15.1	No
Cobalt	1/1	6.36	3.5	**YES**
Copper	1/1	5.74	5.64	**YES**
Lead	1/1	9.04	14.9	No
Manganese	1/1	179	302	No
Nickel	1/1	11.4	2.23	**YES**
Silver	1/1	0.0166	ND	**YES**
Vanadium	1/1	24.9	27.0	No
Zinc	1/1	18.3	19.5	No

Footnotes:
- (a) Number of samples in which the analyte was detected/total number of samples analyzed.
- (b) Micrograms per gram.
- (c) See Section 5.1.3.4.2 for an explanation of how the soil-series-specific background screening values were calculated.
- (d) Not detected.

TABLE 26-2

Summary of Analytical Results for the Surface Soil Sample FTA38SF001
Site 38 – Northwest - Southeast Runway Flare Test Area
Jefferson Proving Ground
Madison, Indiana

Analyte	Concentration (μg/g)[a]
Aluminum	9,340
Antimony	LT[b] 19.6 R[c]
Arsenic	3.60
Barium	58.8
Beryllium	0.688
Boron	9.30
Cadmium	LT 1.20
Calcium	5,820
Chromium	13.7
Cobalt	6.36
Copper	5.74
Iron	20,800
Lead	9.04
Magnesium	1,230
Manganese	179
Mercury	LT 0.05
Molybdenum	LT 14.3
Nickel	11.4
Potassium	501
Selenium	LT 0.45
Silver	0.0166
Sodium	94.5
Thallium	LT 34.3
Tin	LT 7.43
Vanadium	24.9
Zinc	18.3

General Note:
Sample was collected at a depth of 0 feet on 11/19/92 (EPA18).

Footnotes:
(a) Micrograms per gram.
(b) Less than the reporting limit.
(c) Antimony results are unusable due to quality control deficiencies.

TABLE 26-3

Soil Exposure Point Concentrations of Contaminants of Potential Concern
Site 38 – Northwest-Southeast Runway Flare Test Area
Jefferson Proving Ground
Madison, Indiana

Analyte	Frequency of Detection[a]	Range of Detected Values (µg/g)[b]	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[c] (µg/g)
Surface Soil						
Beryllium	1/1	0.688	NA[d]	NC[e]	NC	0.688
Boron	1/1	9.3	NA	NC	NC	9.3
Cobalt	1/1	6.36	NA	NC	NC	6.36
Copper	1/1	5.74	NA	NC	NC	5.74
Nickel	1/1	11.4	NA	NC	NC	11.4
Silver	1/1	0.0166	NA	NC	NC	0.0166

Footnotes:

(a) Number of samples in which the analyte was detected/total number of samples analyzed.
(b) Micrograms per gram.
(c) The 95% UCL (upper confidence limit of the mean) or the maximum detected value, whichever is lower (USEPA 1989b).
(d) Not applicable.
(e) Not calculated due to insufficient data.

TABLE 26-4

Selection of Contaminants of Potential Concern (COPC) in Soil Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 38 – Northwest-Southeast Runway Flare Test Area
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screening Data		
Chemical	**Residential PRG (µg/g)[a]**	**Exposure Point Conc. (µg/g)**	**Retained as Soil COPC?**
Surface Soil			
Beryllium	0.143	0.688	**YES**
Boron	586	9.3	No
Cobalt	456	6.36	No
Copper	285	5.74	No
Nickel	153	11.4	No
Silver	38.3	0.0166	No

General Notes:

1. PRGs were taken directly from the Region 9 PRG Table (USEPA 1998). Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:

(a) Micrograms per gram.

TABLE 26-5

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 38 – Northwest-Southeast Runway Flare Test Area
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Analyte	**Ambient Air PRG (μg/m³)[(a)]**	**Exposure Point Conc. (μg/m³)**	**Retained as Air COPC?**
Residential Scenario			
Aluminum	NA[(b)]	1.42E-02	**YES**
Arsenic	4.5E-04	5.34E-06	No
Barium	5.2E-02	6.75E-05	No
Beryllium	8.0E-04	4.18E-07	No
Cadmium	1.1E-03	1.31E-07	No
Chromium	2.3E-05	1.62E-05	No
Lead	1.5E+00[(c)]	9.74E-06	No
Manganese	5.1E-03	1.15E-03	No
Silver	NA	2.91E-05	**YES**
Thallium	NA	2.59E-06	**YES**
Vanadium	NA	2.63E-06	**YES**
Zinc	NA	6.72E-06	**YES**
Dioxins/Furans	4.5E-08	2.95E-13	No
Benzo(a)anthracene	9.2E-03	1.21E-08	No
Benzo(a)pyrene	9.2E-04	1.89E-08	No
Benzo(b)fluoranthene	9.2E-03	3.26E-08	No
DDE	2.0E-02	7.11E-09	No
Dibenz(a,h)anthracene	9.2E-04	1.42E-09	No
Dieldrin	4.2E-04	NA	No
Indeno(1,2,3-cd)pyrene	9.2E-03	7.10E-09	No
1,1-Dichloroethylene	3.8E-02	1.47E-09	No
Chlorobenzene	2.1E+00	1.72E-05	No

TABLE 26-5

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs)
Site 38 – Northwest-Southeast Runway Flare Test Area
Jefferson Proving Ground
Madison, Indiana

	USEPA Region 9 PRG Screen		
Analyte	**Ambient Air PRG (µg/m^3)[(a)]**	**Exposure Point Conc. (µg/m^3)**	**Retained as Air COPC?**
Industrial Scenario			
Aluminum	NA	1.73E-02	**YES**
Arsenic	4.5E-04	7.03E-06	No
Barium	5.2E-02	6.84E-05	No
Beryllium	8.0E-04	7.07E-06	No
Cadmium	1.1E-03	6.14E-07	No
Chromium	2.3E-05	3.26E-05	**YES**
Lead	1.5E+00[(c)]	9.74E-06	No
Manganese	5.1E-03	1.32E-03	No
Silver	NA	2.91E-05	**YES**
Thallium	NA	2.59E-06	**YES**
Vanadium	NA	1.25E-05	**YES**
Zinc	NA	5.30E-04	**YES**
Dioxins/Furans	4.5E-08	5.86E-12	No
Benzo(a)anthracene	9.2E-03	1.21E-08	No
Benzo(a)pyrene	9.2E-04	1.91E-08	No
Benzo(b)fluoranthene	9.2E-03	3.26E-08	No
DDE	2.0E-02	7.11E-09	No
Dibenz(a,h)anthracene	9.2E-04	1.42E-09	No
Dieldrin	4.2E-04	5.22E-10	No
Indeno(1,2,3-cd)pyrene	9.2E-03	7.11E-09	No
1,1-Dichloroethylene	3.8E-02	1.47E-09	No
Chlorobenzene	2.1E+00	1.74E-05	No

General Notes:
1. PRGs were taken directly from the Region 9 PRG Table (USEPA 1998). Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:
(a) Micrograms per cubic meter.
(b) Not available or not applicable.
(c) Federal ambient air quality criterion for lead.

TABLE 26-6

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 38 – Northwest-Southeast Runway Flare Test Area
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
Future On-site Resident Adult				
Incidental ingestion of soil	NA[a]		0.0005	
Dermal contact with soil	NA		0.0000	
Ingestion of homegrown fruits/vegetables	NA		0.0002	
Inhalation of VOCs[b] and fugitive dusts	NA		NA	
Total	NA	Total	0.0007	
Future On-site Resident Child				
Incidental ingestion of soil	NA		0.0044	
Dermal contact with soil	NA		0.0001	
Ingestion of homegrown fruits/vegetables	NA		0.0004	
Inhalation of VOCs and fugitive dusts	NA		NA	
Total	NA	Total	0.0049	

TABLE 26-6

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 38 – Northwest-Southeast Runway Flare Test Area
Jefferson Proving Ground
Madison, Indiana

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
		Future On-site Worker		
Incidental ingestion of soil	NA		0.0002	
Dermal contact with soil	NA		0.0000	
Inhalation of VOCs and fugitive dusts	3.18E-08		0.0001	
	3.18E-08	Total	0.0003	

Footnotes:

(a) Not available or not applicable.
(b) Volatile organic compounds.

TABLE 26-7

Qualitative Uncertainty Analysis
Site 38 – Northwest-Southeast Runway Flare Test Area
Jefferson Proving Ground
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
A. Human Behavior				
Future receptors' exposure duration	30 years	Medium	Medium	National upper-bound time (90th percentile) at one residence
Future receptors' exposure frequency	350 days/year	Medium	Medium	High-end value
Future receptors' exposure time	24 hours/day	Low	High	Maximum possible value
Future receptors' food-chain ingestion rates	NA[(a)]	Low	High	Nearly impossible for an average weight receptor to ingest daily the 95th percentile U.S. population consumption amounts
Exclusion of certain exposure pathways in the quantitative analysis	NA	Low	Low	Pathways eliminated are those that have low possibility of contributing risk to these receptors
B. Chemical Fate/Transport in the Environment				
Calculation of exposure point concentration of COC[(b)]/food-chain modeling	NA	Low	High	Conservative assumptions and input parameters
Use of air dispersion modeling to predict air concentrations	NA	Low	High	Conservative assumptions and input parameters

TABLE 26-7

Qualitative Uncertainty Analysis
Site 38 – Northwest-Southeast Runway Flare Test Area
Jefferson Proving Ground
Madison, Indiana

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
C. Chemical Toxicity				
Assumption that USEPA[c] reference doses truly represent toxicological thresholds	NA	Low	High	High degree of conservativeness utilized by USEPA in deriving RfDs[d] from toxicological literature
Assumption that USEPA carcinogenic slope factors truly represent dose-response phenomena	NA	Low-moderate	Moderate-high	Use of linearized, multi-stage mathematical model to predict cancer incidence at low exposure levels is USEPA policy; not currently supported by scientific data
Assumption of risk/hazard additivity	NA	Moderate	Moderate	Summation of chemical-specific risks/hazards may over- or under-predict risks/hazards to receptors
Screening out of certain contaminants based on USEPA criteria	NA	Low	Low	Chemicals present in concentrations less than Region 9 criteria eliminated

Footnotes:
(a) Not available or not applicable.
(b) Contaminant of concern.
(c) United States Environmental Protection Agency.
(d) Reference doses.

FIGURES

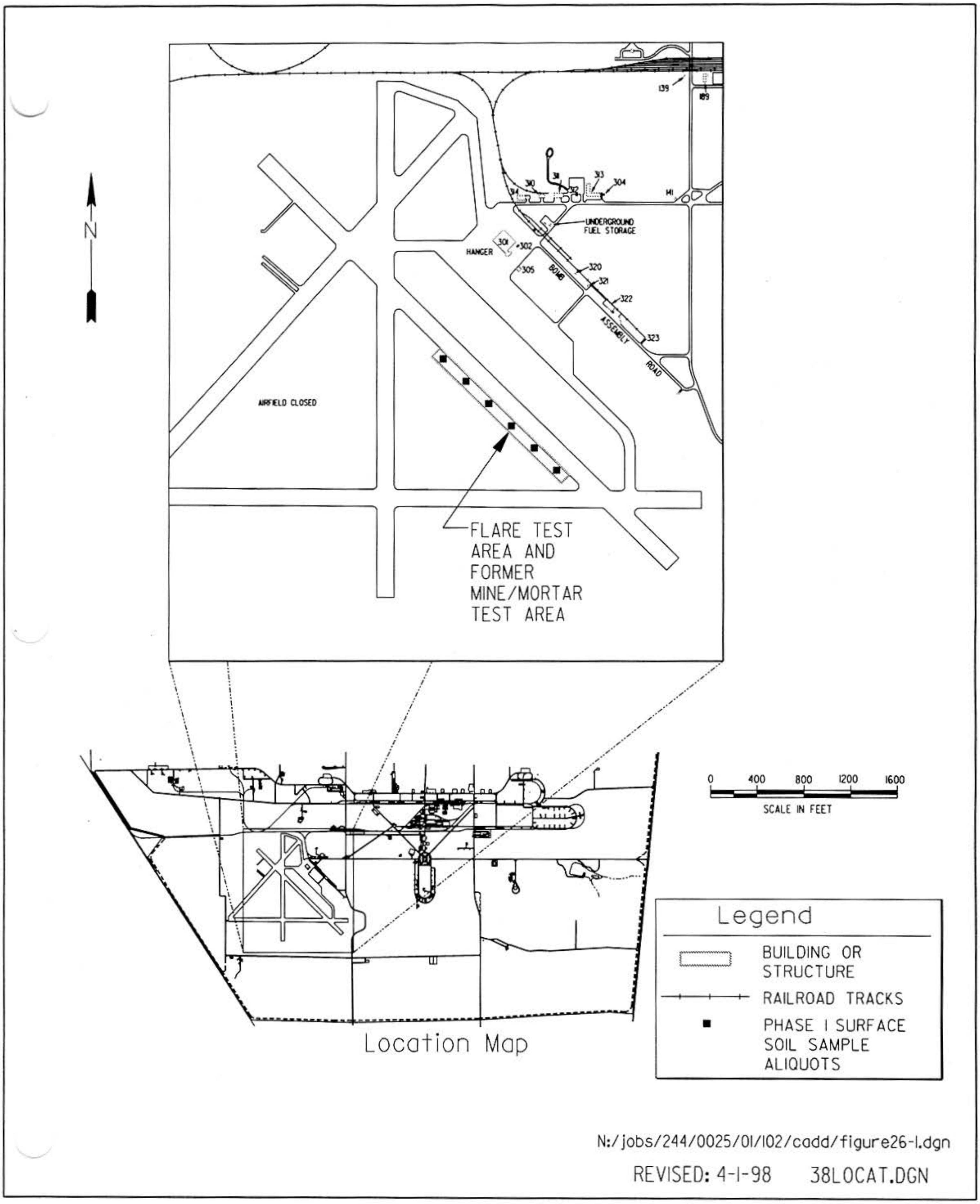

Figure 26-1. Sampling Locations at the Northwest-Southeast Runway Flare Test Area (Site 38)

27.0 BUILDING 281 INDOOR RANGE (SITE 42)

27.1 SITE CHARACTERISTICS

Building 281 is located north of Firing Line Road behind firing position J (Figure 27-1). The building is about 300 feet long and contains three firing lanes. The indoor range was previously used to test small arms for training, but has not been used for any purpose for some time. Lead dust and lead oxide inside the firing lanes were the primary COPCs. There was a low potential for lead to be transported outside of the building because, unlike the Building 295 Firing Range, there are no roof vents in Building 281. In June 1997, Interim Measures remedial action activities began for Building 281. The remedial action involved the washing of the walls with water and detergent, removal of contaminated soil on the floor, and the final application of a sealant on the walls to encapsulate any potentially remaining lead dust. Confirmation results and the final closure report for this action were not yet available for inclusion in the *Draft Phase II RI Report*. **Ferguson Harbour Incorporated (FHI) submitted the final closure report to the USACE in December 1998. As a result, this revision of the *Phase II RI Report* contains a summary of the FHI report. (EPA106)**

The area around the building is relatively flat, and there is a small drainage ditch leading from the north end of the building to the west toward a branch of Middle Fork Creek (Figure 2-1). The area surrounding the building is covered by either concrete or grass. There are no trees or shrubs within 100 feet of the building. The grass is not regularly mowed or burned off. At the time of the Phase I RI, abundant metal debris was scattered around the outside of the building as a result of firing activities at the nearby firing position.

The soils in the area belong to the Cobbsfork soil series. The depth to bedrock is probably about 40 feet, based on monitoring well boreholes drilled nearby at Building 279. In these monitoring wells, the bedrock formation encountered at the base of the glacial till was the Laurel Limestone of Silurian age. The regional bedrock groundwater gradient is toward the west-southwest (Figure 2-15).

No activities are currently conducted at the site. The nearby firing position and the small arms range were both inactive at the time of the RI.

27.2 PREVIOUS INVESTIGATIONS

This site was not included in any previous investigations, and no sample data were collected prior to the RI. It was necessary to collect data to determine the extent of possible lead contamination inside the building.

27.3 STUDY AREA INVESTIGATIONS

27.3.1 Phase I RI Field Activities

27.3.1.1 Soil. Data were collected to determine if the dirt floor and interior surfaces of the range were contaminated with lead dust or lead oxides. Three surface soil samples were collected inside of the building and analyzed for leachable metals by TCLP (Figure 27-1). These data were evaluated to determine the risk and the possible need for additional action. Ten wipe samples were collected from the firing range walls and analyzed for metals.

27.3.2 Phase II RI Field Activities

No Phase II RI activities were conducted at this site.

27.3.3 Interim Measures Activities (EPA106)

27.3.3.1 Sand and Soil Removal. The sand and soil from Building 281 (all firing lanes) was removed using a dry vacuum unit (King Vac) with a modified exhaust system to return vapors into the building.

27.3.3.2 Floor Covering. After the lead-contaminated sand and soil had been removed, the floor was covered with double layered 6-mil plastic sheeting to prevent the possibility of contaminated wash and rinse water from contacting the clean soils during the lead dust removal.

27.3.3.3 Lead Dust Removal. The removal of lead dust involved a five-phase approach: (1) vacuuming loose dust particles using a Hepa-vacuum; (2) spraying 1 gallon of a non-phosphatic soap and water mixture over an 80-square-foot area through an airless sprayer; (3) scrubbing the mixture into the surface with a brush; (4) rinsing with water; and (5) removing the excess water from the wall with a squeegie.

27.3.3.4 Encapsulation. After the lead dust was removed and the areas had dried, the surfaces were sprayed with an encapsulation epoxy-like paint. Lead Barrier Compound (L-B-C®) was used for the concrete walls and floors, and Asbestos Binding Compound (A-B-C®) was used on the dirt floors. The epoxy for the concrete floors and walls was applied at a 4-to-6-millimeter thickness.

27.3.3.5 Transportation and Disposal of Waste Contaminated sand and soil removed from the building was placed in roll-off box containers. The containers were staged in a storage area adjacent to the rear of the building. During the winter months some of the containers had to be stored at the front of Building 295 in order to keep the containers from sinking and freezing on wet cold ground. Each container was sealed at the door and lined with a plastic liner prior to the loading of any contaminated materials. All containers were covered at the end of each day. Contaminated wash and rinse water

was dumped into the hazardous waste containers in order to reduce waste. All storage areas and containers were inspected on a daily basis.

27.3.3.6 Confirmation Sampling and Analysis.

27.3.3.6.1 Wipe Samples. Total lead analysis SW846 6010 was performed on wipe samples taken from various sample locations throughout each firing lane. The analysis was performed in order to confirm decontamination levels of less than 2,000 ppm had been achieved. The laboratory analyses were performed by GP Environmental Services, Inc. from Gaithersburg, MD., which is certified by the USACE and the USEPA.

27.3.3.6.2 Water Samples. FHI obtained water samples as requested by the USEPA in order to provide QA/QC samples as a method of qualifying the results of the wipe samples. The water samples were representative of the final rinse phase of the concrete floor and wall decontamination activity.

27.3.3.6.3 Soil Samples. Soil samples were taken from locations at Building 295, lane 4 and Building 281, lanes 1 and 2. These samples were analyzed for lead and used as confirmation of meeting the prescribed cleanup levels.

27.4 DATA EVALUATION

27.4.1 Data Validation Results

No data validation was conducted for the Phase I data other than a review of the QA/QC results provided by the laboratory. Boron, calcium, copper, magnesium, and sodium were flagged as also being detected in the associated method blank. No other data were qualified or rejected.

QA/QC results from the Interim Measures confirmation sampling were summarized by the laboratory for each lot of data provided in Appendix A of the FHI closure report. Overall it appears that QA/QC requirements were met (EPA106).

27.4.2 Data Quality Summary

The Phase I RI data collected for Site 42 provided a qualitative assessment of potential contamination within the Building 281 Indoor Range. The data generated during Phase I were found to be acceptable. However, no risk criteria exist for wipe sample results and, therefore, these data were used only as a qualitative indication of contamination levels present on the building surfaces. The TCLP results provided an indication of whether contaminant concentrations in soils exceeded RCRA hazardous waste criteria. The Phase I data were acceptable for this determination as well. No risk characterization was deemed necessary based on the Phase I results.

27.4.3 Background Screening

Phase I sample results for wipe samples and TCLP metals results for soil samples could not be compared against background.

27.4.4 Summary of Analytical Results

Table 27-1 provides a summary of contaminants detected in wipe samples, and Table 27-2 provides a summary of contaminants detected in soil samples from Site 42. A complete listing of the results, including nondetected analytes, is included in Appendix N.

Tables 27-3 and 27-4 provide a summary of the confirmation sampling results provided in the FHI closure report for soil and wipe samples, respectively (EPA106).

27.5 NATURE AND EXTENT OF CONTAMINATION

Evaluation of the analytical data for the three soil samples revealed no metals exceeding RCRA limits for TCLP. Analysis of the 10 wipe samples collected from the firing lane walls revealed that several heavy metals were detected, including silver (2 samples), chromium (8 samples), nickel (6 samples), lead (5 samples), molybdenum (1 sample), and zinc (all 10 samples). The main concern at the firing range is lead dust, which was detected in half of the samples. Thus, lead dust on the walls were determined to be a concern at this site.

In summary, contamination of the dirt floor and interior walls by lead dust and lead oxide was the primary concern at this site. Neither lead nor any other metal exceeded RCRA limits for TCLP in the three soil samples collected from the dirt floor. Several metals were detected in wipe samples collected from the firing lane walls. Because no risk criteria are available for wipe sample data, the significance of these data is not known.

Although no risk characterization was performed for this site, the Interim Measures remedial action conducted in 1997 was designed to reduce or eliminate potential human exposure to contaminants associated with Building 281. This will allow Building 281 to be considered for reuse. Soil removal, the washing of the building's interior surfaces, and the spraying of a sealant to encapsulate any residual contamination effectively eliminated potential exposure pathways within the building.

Confirmation sample results indicate that the cleanup goals were met. Wipe samples analyzed for lead indicate that levels are well below the goal of 2,000 µg/wipe (Table 27-4). Water samples taken from the final rinse of the floor and wall decontamination confirmed the wipe sample results. Soil sample results were used to characterize the waste for proper off-site disposal. Special wastes were transported to Waste Management Inc.'s Louisville, Kentucky facility and hazardous waste was transported to their Fort Wayne, Indiana facility (EPA106).

27.6 HUMAN HEALTH RISK ASSESSMENT

Due to the interim measures activities completed for Site 42, no human health risk assessment was conducted.

27.7 ECOLOGICAL RISK ASSESSMENT

Because Site 42 is fully contained within Building 281, it was eliminated from further ecological risk analysis during the PERA (Rust E&I 1997g).

27.8 CONCLUSIONS AND RECOMMENDATIONS

Data collected from soils from the dirt floor of the Building 281 Indoor Range (Site 42) indicated that no metals in soils exceeded RCRA limits for TCLP. Wipe samples from the interior surfaces indicated that lead dust was present on the building surfaces. No risk characterization was performed for this site.

In 1997, interim measures remedial action was conducted at Site 42. Soil removal, the washing of the building interior surfaces, and the spraying of a sealant effectively reduced the potential for exposure to site contaminants. This action was performed to allow Building 281 to be considered for reuse. **Confirmatory sampling was conducted to verify that the interim measures were effective in reducing the potential for human exposure within the building. Results of this sampling show that the cleanup goals were met (EPA106).**

As a result of the interim measures conducted at Site 42, it is concluded that no further investigation under the RI is warranted. It is recommended that a No Further Action technical memorandum be prepared for this site and that the site be removed from the FS. ~~The memorandum will include the closure report being prepared and will provide further details of the interim action.~~

TABLES

TABLE 27-1

Summary of Phase I Remedial Investigation Wipe Results
Site 42 – Building 281 Indoor Range
Jefferson Proving Ground
Madison, Indiana

SAMPLE ID: Analyte	FRB42WP001 (µg/cm²)[a]	FRB42WP002 (µg/cm²)	FRB42WP003 (µg/cm²)	FRB42WP004 (µg/cm²)	FRB42WP005 (µg/cm²)	FRB42WP006 (µg/cm²)	FRB42WP007 (µg/cm²)	FRB42WP008 (µg/cm²)	FRB42WP009 (µg/cm²)	FRB42WP010 (µg/cm²)
Aluminum	1.20	1.50	1.60	1.20	0.53	0.67	0.67	1.60	0.49	0.26
Antimony	LT(b) 0.20	LT 0.20	LT 0.20	LT 0.20	LT 0.20	LT 0.20	LT 0.20	LT 0.20	LT 0.20	LT 0.20
Arsenic	LT 0.16	LT 0.16	LT 0.16	LT 0.16	LT 0.16	LT 0.16	LT 0.16	LT 0.16	LT 0.16	LT 0.16
Barium	0.082	0.14	0.21	0.046	LT 0.033	0.056	0.043	0.055	LT 0.033	LT 0.033
Beryllium	LT 0.0043	LT 0.0043	LT 0.0043	LT 0.0043	LT 0.0043	LT 0.0043	LT 0.0043	LT 0.0043	LT 0.0043	LT 0.0043
Boron	0.075	0.079	0.078	LT 0.066	0.11	0.098	0.079	0.079	0.076	0.18
Cadmium	LT 0.012	LT 0.012	LT 0.012	LT 0.012	LT 0.012	LT 0.012	LT 0.012	LT 0.012	LT 0.012	LT 0.012
Calcium	11.0	17.0	16.0	14.0	4.40	6.90	11.0	15.0	7.20	1.90
Chromium	0.077	0.041	0.035	0.012	LT 0.010	0.014	LT 0.010	0.019	0.011	2.60
Cobalt	LT 0.025	LT 0.025	LT 0.025	LT 0.025	LT 0.025	LT 0.025	LT 0.025	LT 0.025	LT 0.025	0.069
Copper	0.11	0.039	0.051	LT 0.028	0.32	LT 0.028	0.049	0.057	0.046	0.33
Iron	14.0	1.80	3.00	1.60	0.80	3.50	1.90	3.50	1.60	700
Lead	0.097	0.21	0.12	LT 0.074	LT 0.074	LT 0.074	0.24	0.28	0.16	LT 0.074
Magnesium	0.98	0.69	0.74	0.62	0.28	1.20	1.10	1.40	0.82	0.19
Manganese	0.10	LT 0.099	LT 0.099	LT 0.099	0.099	LT 0.099	LT 0.099	LT 0.099	LT 0.099	5.10
Molybdenum	0.14	LT 0.14	LT 0.14	LT 0.14	LT 0.14	LT 0.14	LT 0.14	LT 0.14	LT 0.14	0.93
Nickel	0.31	0.044	0.051	LT 0.027	LT 0.027	LT 0.027	0.030	0.046	LT 0.027	0.74
Potassium	LT 1.30	LT 1.30	LT 1.30	LT 1.30	LT 1.30	LT 1.30	LT 1.30	1.80	8.80	LT 1.30
Selenium	LT 0.21	LT 0.21	LT 0.21	LT 0.21	LT 0.21	LT 0.21	LT 0.21	LT 0.21	LT 0.21	LT 0.21
Silver	LT 20.0	0.0015	0.00021	LT .00008	LT .00008	LT .00008	LT .00008	LT .00008	LT .00008	LT .00008
Sodium	0.53	0.45	LT 0.39	0.40	0.46	0.66	0.45	0.76	2.40	2.40
Thallium	LT 0.34	LT 0.34	LT 0.34	LT 0.34	LT 0.34	LT 0.34	LT 0.34	LT 0.34	LT 0.34	LT 0.34
Tin	LT 0.074	LT 0.074	LT 0.074	LT 0.074	LT 0.074	LT 0.074	LT 0.074	LT 0.074	LT 0.074	LT 0.074
Vanadium	LT 0.014	LT 0.014	LT 0.014	LT 0.014	LT 0.014	LT 0.014	LT 0.014	LT 0.014	LT 0.014	LT 0.014
Zinc	0.14	0.068	0.062	0.040	0.029	0.038	0.055	0.062	0.050	0.05

General Note:
Samples were collected on 11/22/92 (EPA 18).

Footnotes:
(a) Micrograms per square centimeter.
(b) Less than the reporting limit.

TABLE 27-2

Summary of Toxicity Characteristic Leaching Procedure (TCLP) Results for Metals in Surface Soils Site 42 – Building 281 Indoor Range Jefferson Proving Ground Madison, Indiana

SAMPLE ID: Analyte	FRB42SF001 (µg/L)[a]	FRB42SF002 (µg/L)	FRB42SF003 (µg/L)
Arsenic	LT[b] 500	LT 500	LT 500
Barium	350	1,700	280
Cadmium	LT 5.00	18.0	36.0
Chromium	LT 20.0	LT 20.0	LT 20.0
Mercury	LT 0.40	LT 0.40	LT 0.40
Lead	LT 100	280	280
Selenium	LT 300	LT 300	LT 300
Silver	LT 20.0	LT 20.0	LT 20.0

General Note:

1. Samples were collected on 11/22/92 (EPA 18).

Footnotes:

(a) Micrograms per liter.
(b) Less than the reporting limit.

TABLE 27-3

Summary of Soil Sample Results for the Interim Measures Remedial Action
Site 42 – Building 281 Indoor Range
Jefferson Proving Ground
Madison, Indiana

SAMPLE ID: Analyte	S01-281 (mg/kg)[(a)]	S02-281 (mg/kg)	S03-281 (mg/kg)	S04-281 (mg/kg)	S05-281 (mg/kg)	S06-281 (mg/kg)	S07-281 (mg/kg)	S08-281 (mg/kg)	281-08A (mg/kg)
Aluminum	12,300	14,300	9,440	13,100	12,500	10,400	7,150	9,680	12,000
Antimony	LT[(b)]1.07	LT1.09	LT1.12	LT1.07	1.37	1.12	LT1.07	LT1.06	LT1.04
Arsenic	5.65	6.97	13.4	7.11	5.56	6.67	4.75	9.63	10.0
Barium	168	137	67.6	105	82.8	112	71.1	121	229
Beryllium	LT0.641	LT0.651	LT0.672	LT0.643	LT0.650	LT0.615	LT0.642	LT0.638	LT0.624
Calcium	4,180	23,600	3,900	3,620	6,380	9,160	43,800	31,500	33,100
Cadmium	LT0.641	LT0.651	LT0.672	LT0.643	LT0.650	LT0.615	0.792	8.64	LT2.27
Cobalt	10.0	11.4	4.25	6.25	6.83	8.90	6.54	14.9	12.7
Chromium	24.2	32.4	29.0	13.4	15.1	86.0	49.7	357	217
Copper	14.3	24.4	15.4	7.84	32.6	40.3	37.3	218	173
Iron	18,300	21,300	19,300	19,300	16,700	25,200	17400	57,300	57,100
Lead	25.1	19.8	15.1	15.1	53.4	121	83.6	231	480
Magnesium	1,910	8,790	1,570	1,890	3,040	2,980	9,480	9,670	6,150

TABLE 27-3

Summary of Soil Sample Results for the Interim Measures Remedial Action
Site 42 – Building 281 Indoor Range
Jefferson Proving Ground
Madison, Indiana

SAMPLE ID: Analyte	S01-281 (mg/kg)	S02-281 (mg/kg)	S03-281 (mg/kg)	S04-281 (mg/kg)	S05-281 (mg/kg)	S06-281 (mg/kg)	S07-281 (mg/kg)	S08-281 (mg/kg)	281-08A (mg/kg)
Manganese	349	462	350	316	331	434	387	742	818
Mercury	0.153	0.211	0.062	0.106	0.343	0.469	0.205	0.205	0.033
Nickel	18.3	93.6	66.8	7.06	12.4	74.3	67.0	302	129
Potassium	645	984	779	747	747	598	676	823	765
Selenium	LT1.07	LT1.09	LT1.12	LT1.08	LT1.08	LT1.03	LT1.07	LT1.06	LT1.04
Silver	LT0.641	LT0.651	LT0.672	LT0.650	LT0.650	LT0.615	LT0.642	LT0.638	LT0.624
Sodium	952	894	312	508	508	1,030	1,050	1,040	1,260
Thallium	LT2.14	LT2.17	LT2.24	LT2.17	LT2.17	LT2.05	LT2.14	LT2.13	LT2.30
Vanadium	26.7	32.7	34.3	31.1	27.6	25.6	16.2	21.9	28.5
Zinc	31.5	32.2	20.3	23.8	33.5	28.2	32.6	234	153

General Note:

1. Samples were collected on February 23, 1998 (EPA 18).

Footnote:

(a) mg/kg = milligram/kilogram
(b) LT = value is less than the reporting limit.

TABLE 27-4

Summary of Lead Results for Interim Measures Confirmatory Wipe Samples
Site 42 – Building 281 Indoor Range
Jefferson Proving Ground
Madison, Indiana

Wipe Sample ID	Lead Results (µg/wipe)[(a)]
W281-1A	40.1
W281-1B	76.2
W281-2A	22.8
W281-4A	19.3
W281-4B	4.34
W281-BRA	716
W281-BRB	102
W281-BRC	220
W281-SA	16.1
W281-7B	64.2
W281-AHA	23.7
W281-AHB	10.6
W281-AHC	106

General Note:
1. Samples were collected on February 23, 1998. (EPA 18)

Footnote:
(a) microgram per wipe sample

FIGURES

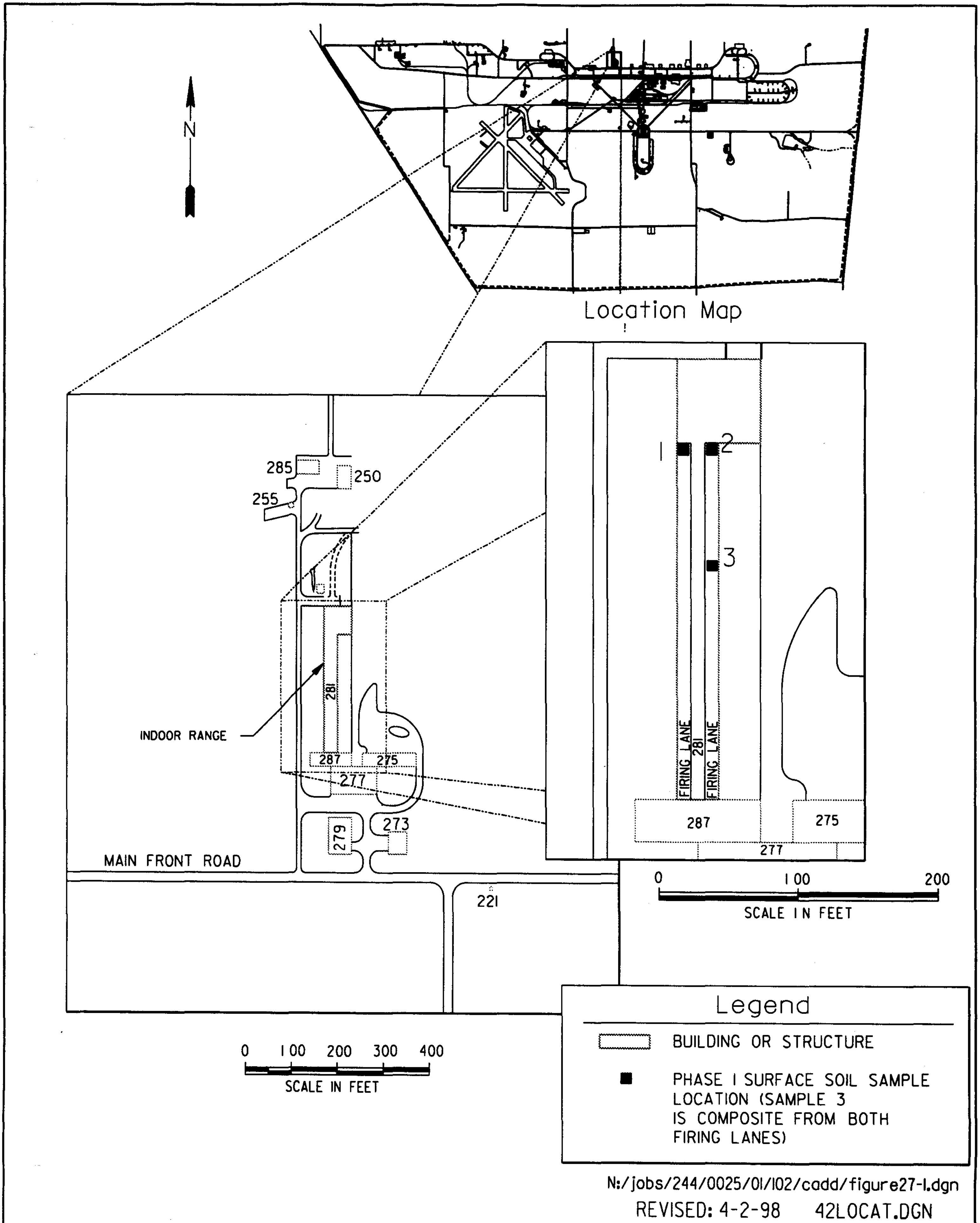

Figure 27-1. Sampling Locations at the Indoor Range, Building 281 (Site 42)

28.0 FACILITY-WIDE TRESPASSERS

28.1 HUMAN HEALTH RISK ASSESSMENT - CURRENT FACILITY-WIDE TRESPASSERS

28.1.1 Selection of Contaminants of Potential Concern

28.1.1.1 Surface Soil.

28.1.1.1.1 Summary of Preliminary COPCs. As discussed in Section 28.1.2.1, Site Conceptual Model, current trespassers at the JPG facility are assumed to have equal access to all areas of the property, including the sites under investigation. Therefore, a facility-wide exposure point concentration was calculated for each site-specific COPC in surface soil. A modifying factor for each site was calculated as the area of the site divided by the area of the facility south of the firing line, estimated to be 4,000 acres. The modifying factors were then multiplied by the respective chemical-specific exposure point concentrations for COPCs in surface soil for the individual sites. The modified concentrations were then summed to derive a facility-wide exposure point concentration for each chemical. These concentrations are provided in Table 28-1.

28.1.1.1.2 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for each preliminary soil COPC for current trespassers was compared to the chemical-specific Region 9 residential soil PRG (Table 28-2). One-tenth of the PRG was used for noncarcinogens. As a result of the screening, all chemicals in surface soil were eliminated as COPCs for facility-wide trespassers.

28.1.1.2 Air.

28.1.1.2.1 Summary of Preliminary COPCs. Ambient air concentrations to which current trespassers at JPG might be exposed were estimated using air emission/dispersion modeling, as described in Appendix R. For determining ambient air concentrations in the current scenario for facility-wide receptors, only those sites not completely vegetated or covered with concrete were assumed to contribute to the current average air concentrations at the facility. Table R-2 in Appendix R presents the estimated average facility-wide ambient air concentrations under the current land use scenario.

28.1.1.2.2 Region 9 Preliminary Remediation Goal Screening. The facility-wide exposure point concentration for each preliminary air COPC for current receptors was compared to the chemical-specific Region 9 air PRG (Table 28-3). One-tenth of the PRG was used for noncarcinogens. The exception was lead, for which the full PRG was used. As a result of the screening, aluminum, chromium, thallium, and vanadium are retained as air COPCs for current trespassers.

28.1.1.3 Surface Water and Sediment.

28.1.1.3.1 Summary of Preliminary COPCs. There are three surface water bodies at the JPG facility in which current trespassers may come into contact with COPCs in surface water and sediment. The selection of preliminary COPCs in sediment and surface water in Harberts Creek is discussed in Sections 7.6.1.4 and 7.6.1.5, respectively. The selection of preliminary COPCs in sediment and surface water in the pond adjacent to Gate 19 Landfill (Site 9) is discussed in Sections 12.6.1.4 and 12.6.1.5, respectively. The selection of preliminary COPCs in sediment in the drainage ditch south of the Yellow Sulfur Disposal Area is discussed in Section 17.4.3.2.

28.1.1.3.2 Region 9 Preliminary Remediation Goal Screening. The preliminary COPCs in sediment and surface water at the three surface water bodies mentioned above were compared to Region 9 tap water PRGs. Tables that summarize the screening process are found in Section 7.0 (Harberts Creek), Section 12.0 (pond at Gate 19 Landfill), and Section 17.0 (drainage ditch south of the Yellow Sulfur Disposal Area). Table 28-4 summarizes the final COPCs in sediment and surface water.

28.1.2 Exposure Assessment

28.1.2.1 Site Conceptual Model. Once the COPCs have been identified for a site, these results along with project data such as regional land uses, future land development possibilities, site hydrogeology, etc. are used to finalize a site-specific conceptual model for the quantitative assessment. This model schematically describes the relationship between the contaminants at a site and any potentially impacted human populations. It details the various current and potentially future uses of the site and then describes for each scenario the various exposure pathways by which the human populations may come into contact with the contaminated environmental media at the site.

JPG is currently a closed, fenced, former munitions/weapons testing facility. As such, there are no people who specifically work at or frequent any of the sites under investigation in this RI. There are, however, several types of individuals who could potentially be affected by the existing contamination at the facility. One of these receptor groups is composed of facility trespassers at JPG. In this case, these individuals (assumed to be adolescents) would most likely roam throughout the facility since there are no barriers, etc., limiting access to any of these sites once the individual gets into the facility. Therefore, the trespasser would be expected and is assumed to be potentially impacted by multiple sites at the facility.

To assess the potential risks/hazards to these individuals, it was initially assumed that the facility would remain in its present state, and then that these individuals would wander throughout, thereby coming into contact with contaminants at all of the sites in proportion to their sizes relative to the facility area.

With respect to this risk assessment analysis, trespassers are assumed to come into contact with facility contaminants through the following exposure pathways:

- Inhalation of VOCs and fugitive particulates from soils
- Incidental ingestion of surface soils
- Dermal contact with surface soils
- Incidental ingestion of surface water
- Dermal contact with surface water
- Incidental ingestion of sediments
- Dermal contact with sediments

28.1.2.2 Exposure Point Concentrations.

28.1.2.2.1 Air. The estimated ambient air concentrations of COPCs at the facility for the current trespasser are presented in Table 28-3.

28.1.2.2.2 Soil. No COPCs were retained in soil for facility-wide trespassers.

28.1.2.2.3 Surface Water and Sediment. The concentrations of COPCs in surface water and sediment in the three surface water bodies are presented in Table 28-4.

28.1.2.3 Human Exposure Doses.

28.1.2.3.1 Inhalation of Contaminated Air. Inhalation of airborne contaminants (VOCs and particulates) is a potential route of exposure for trespassers at the facility. The equation used for calculating human exposure doses of COPCs due to inhalation of volatile and dust-bound contaminants is provided in Table 5-**11**~~12~~, along with the values of the exposure variables. Section 5.1.5.3.1 explains the exposure variables in further detail. Table V-19, Appendix V, documents the calculation of trespasser exposure doses due to inhalation of contaminated air.

28.1.2.3.2 Incidental Ingestion of Sediment. Trespassers may be exposed to contaminated sediments while wading in facility surface water bodies. The equation to calculate human exposure doses due to incidental ingestion of contaminated sediments is provided in Table 5-**20**~~21~~, along with the assumed values for the exposure parameters. Details of the derivation of the exposure variables are provided in Section 5.1.5.3.9. Table V-19, Appendix V, documents the calculation of trespasser exposure doses due to incidental ingestion of contaminated sediment while wading.

28.1.2.3.3 Dermal Contact with Sediment. Current trespassers wading in surface water at the facility may also come into dermal contact with sediment-bound contaminants. The equation to calculate human exposure doses due to dermal contact with contaminated

sediments is provided in Table 5-**21**~~22~~, along with the values assumed for the exposure parameters. The derivation of the exposure variables is discussed in detail in Section 5.1.5.3.10. Table V-19, Appendix V, documents the calculation of trespasser exposure doses due to dermal contact with contaminated sediment while wading.

28.1.2.3.4 Incidental Ingestion of Surface Water. Water ingested while wading in contaminated surface waters may be a source of exposure for facility-wide adolescent trespassers in the current scenario. The equation to calculate human exposure doses due to incidental ingestion of contaminated surface water is provided in Table 5-**18**~~19~~ along with the assumed values for the exposure parameters. Section 5.1.5.3.7 provides details of the derivation of these exposure variables. Table V-19, Appendix V, documents the calculation of trespassers exposure doses due to incidental ingestion of contaminated surface water while wading.

28.1.2.3.5 Dermal Contact with Surface Water. Current trespassers may also absorb chemicals through the skin while wading in surface water locations at the facility. The equation that was used to calculate human exposure doses due to dermal contact with contaminated surface water is provided in Table 5-**19**~~20~~, along with the assumed values for the exposure parameters. Section 5.1.5.3.8 provides the details of the derivation of these exposure variables. Table V-19, Appendix V, documents the calculation of trespasser exposure doses due to dermal contact with surface water while wading.

28.1.3 Risk Characterization

28.1.3.1 Chronic Health Hazards. The noncancer daily exposure doses calculated in the exposure assessment were used to calculate HQs for each of the COPCs possessing RfDs. Pathway-specific and overall HIs were then calculated for each receptor. The calculations of HQ and HI are described in Section 5.1.7.1. If an overall HI is calculated to be greater than 1.0 for a particular receptor, then the exposure pathway(s) primarily responsible for the result is identified as a "critical pathway(s)." For each critical pathway, those chemical contaminants responsible for the majority of the HI are listed as COCs. Table W-19, Appendix W, documents the calculation of the pathway- and chemical-specific HQs for current facility-wide trespassers. The pathway-specific and overall HIs are summarized in Table 28-5.

The overall HI for the current trespassers is calculated to be 0.10. This HI is less than the USEPA's risk management criterion of 1.0. Therefore, no critical exposure pathways or noncarcinogenic COCs are identified for this receptor.

28.1.3.2 Excess Lifetime Cancer Risks. The cancer risks for each receptor were determined from the pathway-specific exposure doses and the route-specific SFs, as described in Section 5.1.7.2. To assess the simultaneous exposure of a receptor population to multiple carcinogens from multiple exposure routes, all of the cancer risks calculated for a receptor population were summed. Each overall receptor cancer risk was then compared to USEPA's target risk range (1.0E-06 to 1.0E-04). If the total cancer risk for a receptor from all exposure pathways is less than 1.0E-04, then it is concluded that the site(s) does not pose a significant

risk to that receptor. If the overall cancer risk exceeds the target risk range, any chemical individually associated with a risk level greater than 1.0E-05 is identified as a COC. COCs represent the primary contributors to the potential cancer risk for the receptor-specific exposure pathway under evaluation. Table W-19, Appendix W, documents the calculation of the pathway- and chemical-specific cancer risks for the current trespassers. The pathway-specific and overall cancer risks are summarized in Table 28-5.

The overall cancer risk for the current trespassers is calculated to be **4.8**~~2.2~~E-06. This cancer risk is within the USEPA's target risk range of 1.0E-06 to 1.0E-04. Therefore, no critical exposure pathways or carcinogenic COCs are identified for this receptor.

28.1.3.3 Uncertainty/Sensitivity Analysis. The numerical risks/hazards calculated for current trespassers represent *conditional* estimates of risk based on various simplifying assumptions concerning contaminant exposure and toxicity. These estimates of risk/hazard are derived using a series of conservative procedures that address contaminant concentrations at the facility, their fate in the environment, how someone currently might be exposed to these contaminants, and the toxicity of each chemical toward humans. The uncertainty analysis specifies, when appropriate, the critical assumptions made for the receptors so that the results can be interpreted by risk managers in a proper context.

To assist the risk managers in this project, a qualitative uncertainty analysis has been performed. The primary goals of a qualitative uncertainty analysis are (1) to itemize the major areas of uncertainty in the scenario-specific risk assessment and (2) to demonstrate that the assessment overall has been conservatively performed (i.e., that the potential risks/hazards have not likely been underestimated, but may have been significantly overestimated).

The qualitative uncertainty analysis for the current trespasser scenario is presented in Table 28-6. Based on this analysis, it can be concluded that this risk assessment is conservative.

Some of the major uncertainties in this study that are most influential to the risks/hazards that were calculated include:

- Air dispersion modeling used to calculate ambient air concentrations at the facility
- Receptors' exposure frequency at surface water body locations
- Receptors' sediment ingestion rates

28.2 HUMAN HEALTH RISK ASSESSMENT - FUTURE FACILITY-WIDE HUNTERS

28.2.1 Selection of Contaminants of Potential Concern

28.2.1.1 Surface Soil.

28.2.1.1.1 Summary of Preliminary COPCs. As discussed in Section 28.2.2.1, Site Conceptual Model, future hunters at the JPG facility are assumed to have equal access to all areas of the property, including the sites under investigation. Therefore, a facility-wide exposure point concentration was calculated for each site-specific COPC in surface soil. A modifying factor for each site was calculated as the area of the site divided by the area of the facility south of the firing line, estimated to be 4,000 acres. The modifying factors were then multiplied by the respective chemical-specific exposure point concentrations for COPCs in surface soil for the individual sites. The modified concentrations were then summed to derive a facility-wide exposure point concentration for each chemical. These concentrations are the same as those used for the current facility-wide trespassers provided in Table 28-1.

28.2.1.1.2 Region 9 Preliminary Remediation Goal Screening. The exposure point concentration for each preliminary soil COPC for future hunters was compared to the chemical-specific Region 9 residential soil PRG (Table 28-7). One-tenth of the PRG was used for noncarcinogens. As a result of the screening, all chemicals in surface soil were eliminated as COPCs for facility-wide hunters.

28.2.1.2 Air.

28.2.1.2.1 Summary of Preliminary COPCs. Ambient air concentrations to which future hunters at JPG might be exposed were estimated using air emission/dispersion modeling, as described in Appendix R. For determining ambient air concentrations in the future scenario for facility-wide hunters, all sites were assumed to be industrial except for the five sites designated agricultural. Each site with particulate-bound COPCs in surface soil (metals, SVOCs, and dioxins/furans) and/or volatile COPCs in surface/subsurface soil combined was assumed to contribute to the air concentrations at the facility. Table R-3 in Appendix R presents the estimated average facility-wide ambient air concentrations under this future land use scenario.

28.2.1.2.2 Region 9 Preliminary Remediation Goal Screening. The facility-wide exposure point concentration for each preliminary air COPC for future receptors was compared to the chemical-specific Region 9 air PRG (Table 28-8). One-tenth of the PRG was used for noncarcinogens. The exception was lead, for which the full PRG was used. As a result of the screening, aluminum, chromium, thallium, and vanadium are retained as air COPCs for future hunters.

28.2.1.3 Surface Water and Sediment.

28.2.1.3.1 Summary of Preliminary COPCs. There are three surface water bodies at the JPG facility in which future hunters may come into contact with COPCs in surface water and sediment. The selection of preliminary COPCs in sediment and surface water in Harberts Creek is discussed in Sections 7.6.1.4 and 7.6.1.5, respectively. The selection of preliminary COPCs in sediment and surface water in the pond adjacent to Gate 19 Landfill (Site 9) is discussed in Sections 12.6.1.4 and 12.6.1.5, respectively. The selection of preliminary COPCs in sediment in the drainage ditch south of the Yellow Sulfur Disposal Area is discussed in Section 17.4.3.2.

28.2.1.3.2 Region 9 Preliminary Remediation Goal Screening. The preliminary COPCs in sediment and surface water at the three surface water bodies mentioned above were compared to Region 9 tap water PRGs. Tables that summarize the screening process are found in Section 7.0 (Harberts Creek), Section 12.0 (pond at Gate 19 Landfill), and Section 17.0 (drainage ditch south of the Yellow Sulfur Disposal Area). Table 28-9 summarizes the final COPCs in sediment and surface water for future hunters.

28.2.2 Exposure Assessment

28.2.2.1 Site Conceptual Model. According to the site-specific conceptual model, one of the receptor groups is composed of future hunters at the facility if the property remains non-residential. In this scenario, these individuals (assumed to be adults) would most likely roam throughout the facility since there are no barriers, etc., limiting access to any of the sites. Therefore, the future hunter would be expected and is assumed to be potentially exposed to contaminants at multiple sites at the facility.

To assess the potential risks/hazards to these individuals, it was initially assumed that these individuals would wander throughout, thereby coming into contact with contaminants at all of the sites in proportion to their sizes relative to the facility area.

With respect to this risk assessment analysis, future hunters are assumed to come into contact with facility contaminants through the following exposure pathways:

- Inhalation of VOCs and fugitive particulates from soils
- Incidental ingestion of surface soils
- Dermal contact with surface soils
- Incidental ingestion of surface water
- Dermal contact with surface water
- Incidental ingestion of sediments

- Dermal contact with sediments

28.2.2.2 Exposure Point Concentrations.

28.2.2.2.1 Air. The estimated ambient air concentrations of COPCs at the facility for the future hunter are presented in Table 28-8.

28.2.2.2.2 Soil. No COPCs were retained in soil for facility-wide hunters.

28.2.2.2.3 Surface Water and Sediment. The concentrations of COPCs in surface water and sediment in the three surface water bodies are presented in Table 28-9.

28.2.2.3 Human Exposure Doses.

28.2.2.3.1 Inhalation of Contaminated Air. Inhalation of airborne contaminants (VOCs and particulates) is a potential route of exposure for future hunters at the facility. The equation used for calculating human exposure doses of COPCs due to inhalation of volatile and dust-bound contaminants is provided in Section 5.1.5.3.1, Table 5-**11**~~12~~. Table V-23, Appendix V, documents the calculation of hunter exposure doses due to inhalation of contaminated air.

28.2.2.3.2 Incidental Ingestion of Sediment. Hunters may be exposed to contaminated sediments while wading in facility surface water bodies. The equation to calculate human exposure doses due to incidental ingestion of contaminated sediments is provided in Section 5.1.5.3.9, Table 5-**20**~~21~~. Table V-23, Appendix V, documents the calculation of trespasser exposure doses due to incidental ingestion of contaminated sediment while wading.

28.2.2.3.3 Dermal Contact with Sediment. Future hunters wading in surface water at the facility may also come into dermal contact with sediment-bound contaminants. The equation to calculate human exposure doses due to dermal contact with contaminated sediments is provided in Section 5.1.5.3.10, Table 5-**21**~~22~~. Table V-23, Appendix V, documents the calculation of trespasser exposure doses due to dermal contact with contaminated sediment while wading.

28.2.2.3.4 Incidental Ingestion of Surface Water. Water ingested while wading in contaminated surface waters may be a source of exposure for facility-wide hunters in the future scenario. The equation to calculate human exposure doses due to incidental ingestion of contaminated surface water is provided in Section 5.1.5.3.7, Table 5-**18**~~19~~. Table V-23, Appendix V, documents the calculation of trespasser exposure doses due to incidental ingestion of contaminated surface water while wading.

28.2.2.3.5 Dermal Contact with Surface Water. Future hunters may also absorb chemicals through the skin while wading in surface water locations at the facility. The equation which

was used to calculate human exposure doses due to dermal contact with contaminated surface water is provided in Section 5.1.5.3.8, Table 5-**19**~~20~~. Table V-23, Appendix V, documents the calculation of hunter exposure doses due to dermal contact with surface water while wading.

28.2.3 Risk Characterization

28.2.3.1 Chronic Health Hazards. The noncancer daily exposure doses calculated in the exposure assessment were used to calculate HQs for each of the COPCs possessing RfDs. Pathway-specific and overall HIs were then calculated for each receptor. The calculations of HQs and HIs are described in Section 5.1.7.1. If an overall HI is calculated to be greater than 1.0 for a particular receptor, then the exposure pathway(s) primarily responsible for the result is identified as a "critical pathway(s)." For each critical pathway, those chemical contaminants responsible for the majority of the HI are listed as COCs. Table W-23, Appendix W, documents the calculation of the pathway- and chemical-specific HQs for future facility-wide hunters. The pathway-specific and overall HIs are summarized in Table 28-10. The overall HI for the future hunters is calculated to be **0.011**~~0.007~~. This HI is less than the USEPA's risk management criterion of 1.0. Therefore, no critical exposure pathways or noncarcinogenic COCs are identified for this receptor.

28.2.3.2 Excess Lifetime Cancer Risks. The cancer risks for each receptor were determined from the pathway-specific exposure doses and the route-specific SFs, as described in Section 5.1.7.2. To assess the simultaneous exposure of a receptor population to multiple carcinogens from multiple exposure routes, all of the cancer risks calculated for a receptor population were summed. Each overall receptor cancer risk was then compared to USEPA's target risk range (1.0E-06 to 1.0E-04). If the total cancer risk for a receptor from all exposure pathways is less than 1.0E-04, then it is concluded that the site(s) does not pose a significant risk to that receptor. If the overall cancer risk exceeds the target risk range, any chemical individually associated with a risk level greater than 1.0E-05 is identified as a COC. COCs represent the primary contributors to the potential cancer risk for the receptor-specific exposure pathway under evaluation. Table W-23, Appendix W, documents the calculation of the pathway- and chemical-specific cancer risks for the future hunters. The pathway-specific and overall cancer risks are summarized in Table 28-10.

The overall cancer risk for the future hunters is calculated to be **1.3E-06**~~4.5E-07~~. This cancer risk is **within** ~~below~~ the USEPA's target risk range of 1.0E-06 to 1.0E-04. Therefore, no critical exposure pathways or carcinogenic COCs are identified for this receptor.

28.2.3.3 Uncertainty/Sensitivity Analysis. The numerical risks/hazards calculated for future hunters represent *conditional* estimates of risk based on various simplifying assumptions concerning contaminant exposure and toxicity. These estimates of risk/hazard are derived using a series of conservative procedures that address contaminant concentrations at the facility, their fate in the environment, how someone currently might be exposed to these contaminants, and the toxicity of each chemical toward humans. The uncertainty analysis specifies, when appropriate, the critical assumptions made for the receptors so that the results can be interpreted by risk managers in a proper context.

To assist the risk managers in this project, a qualitative uncertainty analysis has been performed. The primary goals of a qualitative uncertainty analysis are (1) to itemize the major areas of uncertainty in the scenario-specific risk assessment and (2) to demonstrate that the assessment overall has been conservatively performed (i.e., that the potential risks/hazards have not likely been underestimated, but may have been significantly overestimated).

The qualitative uncertainty analysis for the future hunter scenario is presented in Table 28-11. Based on this analysis, it can be concluded that this risk assessment is conservative. Some of the major uncertainties in this study that are most influential to the risks/hazards that were calculated include:

- Air dispersion modeling used to calculate ambient air concentrations at the facility
- Receptors' exposure frequency at surface water body locations
- Receptors' sediment ingestion rates

28.3 CONCLUSIONS AND RECOMMENDATIONS

To evaluate potential facility-wide risks due to exposure to multiple contaminated sites south of the firing line, an assessment was conducted for the current facility-wide trespasser and the future facility-wide hunter. These two scenarios assume that a person will be exposed to multiple site contaminants through several exposure pathways including air, surface water, sediments, and soil.

For the current facility-wide trespasser, estimates of chronic health hazards indicate that there are no hazards that exceed risk management criteria. Cancer risk estimates show that cancer risks are within the USEPA target range of 1E-04 to 1E-06.

The facility-wide trespasser or hunter could come in contact with UXO. However, the Army conducted an archive search report, which identified areas of potential UXO concerns. These areas are being cleared to a 4-foot depth as agreed upon by the Army. Other areas in which UXO are discovered by either Interim Removal Actions, frost heave, or accidental discovery will be handled by the Army on a site-by-site basis and will include access restrictions. The Army intends to handle its responsibility with regards to UXO issues as they arise. Deed restrictions will also be included in future land transfer in relation to UXO concerns. These deed restrictions will be incorporated in the FOST and land transfer deed documents. **(EPA11) (IN31)**

For the future facility-wide hunter, estimates for chronic health hazards and for cancer risks indicate that there are no hazards or risks exceeding USEPA risk management criteria.

On the basis of both assessments, it is recommended that no further investigation of these scenarios be conducted.

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TABLES

TABLE 28-1

Facility-Wide Exposure Point Concentrations in Surface Soil

	Site 1	Site 2	Site 27	Sites 3/4	Sites 5/6	Sites 7/21B
	Modifying Factor[a]					
	3.18E-05	**3.59E-06**	**1.72E-03**	**9.60E-04**	**3.25E-04**	**2.03E-05**
COPC[b] in Surface Soil	Site-Adjusted Concentration[c] (µg/g)[d]					
Aluminum	9.02E-01	8.29E-02	4.39E+01	1.32E+01	---[e]	2.63E-01
Arsenic	2.46E-04	4.91E-05	2.47E-02	3.07E-04	---	---
Barium	---	---	---	1.82E-01	---	1.62E-02
Beryllium	2.33E-05	2.70E-06	1.92E-03	2.88E-05	---	1.15E-05
Cadmium	---	---	---	3.55E-04	---	---
Chromium	9.78E-04	---	6.22E-02	1.92E-03	---	---
Lead	---	---	---	2.63E-02	---	---
Manganese	2.84E-02	2.98E-03	3.02E+00	1.37E+00	---	1.22E-02
Silver	---	---	1.38E-01	---	---	---
Thallium	---	---	7.90E-03	6.14E-04	---	---
Vanadium	---	---	1.25E-02	---	---	---
Zinc	---	---	---	1.81E-02	---	---
Dioxins/Furans	3.59E-10	---	---	6.75E-10	1.05E-08	---
Benzo(a)anthracene	---	---	---	3.26E-05	---	---
Benzo(a)pyrene	---	---	---	2.88E-05	---	---
Benzo(b)fluoranthene	---	---	---	3.84E-05	---	---
Chlorobenzene	---	---	---	---	---	---
DDE	---	---	---	1.92E-05	---	---
Dibenz(a,h)anthracene	---	---	---	3.84E-06	---	---
Dieldrin	---	---	---	---	---	---
Indeno(1,2,3-c,d)pyrene	---	---	---	1.92E-05	---	---

TABLE 28-1

Facility-Wide Exposure Point Concentrations in Surface Soil

	Sites 9/10	Site 13	Sites 21A/30	Site 25	Site 31	Site 33
	Modifying Factor					
	6.46E-04	**2.53E-06**	**1.52E-05**	**2.34E-04**	**6.94E-07**	**2.22E-04**
COPC in Surface Soil	**Site-Adjusted Concentration (µg/g)**					
Aluminum	1.16E+01	---	---	---		4.80E+00
Arsenic	---	---	---	---	8.61E-06	---
Barium	---	---	---	---	5.15E-04	---
Beryllium	4.65E-04	---	---	---	3.99E-07	---
Cadmium	---	1.35E-05	---	---	---	---
Chromium	---	2.05E-04	---	1.95E-02	---	---
Lead	---	---	---	---	---	---
Manganese	1.57E+00	---	---	8.00E-02	6.94E-04	1.51E-01
Silver	---	---	---	---	---	---
Thallium	---	---	---	6.01E-03	---	---
Vanadium	8.01E-03	2.75E-04	---	---	---	---
Zinc	---	1.46E-02	---	---	---	---
Dioxins/Furans	---	---	---	---	---	2.00E-08
Benzo(a)anthracene	---	---	---	---	---	---
Benzo(a)pyrene	7.10E-05	---	---	7.09E-05	---	---
Benzo(b)fluoranthene	---	---	---	1.57E-04	---	---
Chlorobenzene	---	2.53E-05	---	---	---	---
DDE	---	---	---	---	---	---
Dibenz(a,h)anthracene	---	---	---	---	---	---
Dibenz(a,h)anthracene	---	---	---	---	---	---
Dieldrin	---	---	4.25E-05	---	---	---
Indeno(1,2,3-c,d)pyrene	---	---	---	---	---	---

TABLE 28-1

Facility-Wide Exposure Point Concentrations in Surface Soil

COPC in Surface Soil	Site 34	Site 38	Site 39	Total Facility-Wide Exposure Point Concentration(f) (µg/g)
	Modifying Factor			
	1.95E-05	8.26E-04	4.57E-03	
	Site-Adjusted Concentration (µg/g)			
Aluminum	2.73E-01	---	6.51E+01	1.40E+02
Arsenic	---	---	5.48E-02	8.01E-02
Barium	---	---	---	1.99E-01
Beryllium	---	5.69E-04	---	3.02E-03
Cadmium	---	---	---	3.69E-04
Chromium	---	---	2.96E-01	3.81E-01
Lead	---	---	---	2.63E-02
Manganese	9.00E-03	---	2.65E+00	8.90E+00
Silver	---	---	---	1.38E-01
Thallium	---	---	---	1.45E-02
Vanadium	---	---	---	2.08E-02
Zinc	---	---	---	3.28E-02
Dioxins/Furans	---	---	---	3.15E-08
Benzo(a)anthracene	---	---	---	3.26E-05
Benzo(a)pyrene	---	---	---	1.71E-04
Benzo(b)fluoranthene	---	---	---	1.96E-04
Chlorobenzene	---	---	---	2.53E-05
DDE	---	---	---	1.92E-05
Dibenz(a,h)anthracene	---	---	---	3.84E-06
Dieldrin	---	---	---	4.25E-05
Indeno(1,2,3-cd)pyrene	---	---	---	1.92E-05

Footnotes:

(a) Calculated by dividing the area of each site by the area of JPG south of the firing line.
(b) Contaminant of potential concern.
(c) Calculated by multiplying the modifying factor times the site-specific COPC concentration in surface soil.
(d) Micrograms per gram.
(e) Not applicable or not available.
(f) Calculated by summing the chemical-specific site-adjusted concentrations.

TABLE 28-2

Selection of Contaminants of Potential Concern (COPC) in Surface Soil Based on USEPA Region 9 Preliminary Remediation Goals (PRGs), Current Site-Wide Trespassers

	USEPA Region 9 PRG Screen		
Chemical	**Residential PRG (µg/g)[a]**	**Exposure Point Conc. (µg/g)**	**Retained as Soil COPC?**
Aluminum	7.67E+03	1.40E+02	No
Arsenic	3.80E-01	8.01E-02	No
Barium	5.27E+02	1.99E-01	No
Beryllium	1.40E-01	3.02E-03	No
Cadmium	3.80E+00	3.69E-04	No
Chromium	3.00E+01	3.81E-01	No
Lead	4.00E+02[b]	2.63E-02	No
Manganese	3.18E+02	8.90E+00	No
Silver	3.83E+01	1.38E-01	No
Thallium	6.10E-01	1.45E-02	No
Vanadium	5.40E+01	2.08E-02	No
Zinc	2.30E+03	3.28E-02	No
Dioxins/Furans	3.77E-06	3.15E-08	No
Benzo(a)anthracene	6.10E-01	3.26E-05	No
Benzo(a)pyrene	6.10E-02	1.71E-04	No
Benzo(b)fluoranthene	6.10E-01	1.96E-04	No
Chlorobenzene	6.47E+00	2.53E-05	No
DDE	1.31E+00	1.92E-05	No
Dibenz(a,h)anthracene	6.10E-02	3.84E-06	No
Dieldrin	3.00E-02	4.25E-05	No
Indeno(1,2,3-cd)pyrene	6.10E-01	1.92E-05	No

Note:
PRGs were taken directly from the Region 9 PRG Table (USEPA 1998). Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:
(a) Micrograms per gram.
(b) Full PRG used for lead.

TABLE 28-3

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs), Current Facility-Wide Trespassers

	USEPA Region 9 PRG Screen		
Chemical	**Ambient Air PRG (µg/m^3)[a]**	**Exposure Point Conc. (µg/m^3)**	**Retained as Air COPC?**
Aluminum	---[b]	1.19E-04	**YES**
Arsenic	4.5E-04	---	No
Barium	5.2E-02	7.35E-06	No
Beryllium	8.0E-04	1.50E-06	No
Cadmium	1.1E-03	---	No
Chromium	2.3E-05	3.12E-05	**YES**
Lead	1.5E+00[c]	---	No
Manganese	5.1E-03	1.33E-04	No
Silver	---	---	No
Thallium	---	9.61E-06	**YES**
Vanadium	---	1.14E-07	**YES**
Zinc	---	---	No
Dioxins/Furans	4.5E-08	---	No
Benzo(a)anthracene	9.2E-03	---	No
Benzo(a)pyrene	9.2E-04	1.14E-07	No
Benzo(b)fluoranthene	9.2E-03	2.51E-07	No
DDE	2.0E-02	---	No
Dibenz(a,h)anthracene	9.2E-04	---	No
Dieldrin	4.2E-04	4.25E-08	No
Indeno(1,2,3-cd)pyrene	9.2E-03	---	No
1,1-Dichloroethylene	3.8E-02	3.97E-09	No
Chlorobenzene	2.1E+00	6.19E-06	No

Note:
PRGs were taken directly from the Region 9 PRG Table (USEPA 1998). Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:
(a) Micrograms per cubic meter.
(b) Not applicable.
(c) Federal ambient air quality criterion for lead.

TABLE 28-4

Summary of Sediment and Surface Water Contaminants of Potential Concern for Current Facility-Wide Trespassers

COPC	Exposure Point Concentration in Sediment (μg/g)[a]	Exposure Point Concentration in Surface Water (μg/L)[b]
Harberts Creek (Sites 2 and 27)		
Aluminum	22,100	---[c]
Arsenic	26.1	---
Beryllium	2.34	---
Chromium	44.7	---
Iron	76,087	---
Manganese	2,200	---
Vanadium	138	---
Pond Adjacent to the Burning Ground at Gate 19 Landfill		
Aluminum	19,550	---
Beryllium	1.39	---
Manganese	4,800	259
1,3,5-Trinitrobenzene	---	0.472
Drainage Ditch South of the Yellow Sulfur Disposal Area (Site 14)		
Aluminum	18,100	---
Barium	696	---
Beryllium	1.0	---
Chromium	87.9	---

Footnotes:

(a) Micrograms per gram.
(b) Micrograms per liter.
(c) Not available or not applicable.

TABLE 28-5

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards, Current Facility-Wide Trespassers

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
Inhalation of VOCs[a] and fugitive dusts	1.13E-08		0.0001	
Incidental ingestion of sediment (Harberts Creek)	6.32E-07		0.0130	
Dermal contact with sediment (Harberts Creek)	4.20E-06		0.0652	
Incidental ingestion of sediment (drainage pathway at Yellow Sulfur Disposal Area)	NA[b]		0.0037	
Dermal contact with sediment (drainage pathway at Yellow Sulfur Disposal Area)	NA		0.0083	
Incidental ingestion of sediment (pond at Gate 19 Landfill)	NA		0.0033	
Dermal contact with sediment (pond at Gate 19 Landfill)	NA		0.0073	
Incidental ingestion of surface water (pond at Gate 19 Landfill)	NA		0.0004	
Dermal contact with surface water (pond at Gate 19 Landfill)	NA		0.00004	
Total	4.84E-06		0.1013	

Footnotes:
(a) Volatile organic compounds.
(b) Not applicable or not available.

TABLE 28-6

Qualitative Uncertainty Analysis
Current Facility-Wide Trespassers

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
A. Human Behavior				
Current receptors' exposure frequency	72 days/year	Low	High	Current trespasser unlikely to visit each surface water body 72 times per year
Current receptors' sediment ingestion rates	NA[a]	Low	High	Highly unlikely that receptors would ingest sediment each and every time they visit the surface water bodies
Exclusion of certain exposure pathways in the quantitative analysis	NA	Low	Low	Pathways eliminated are those that have low possibility of contributing risk to these receptors
B. Chemical Fate/Transport in the Environment				
Use of air dispersion modeling to predict air concentrations	NA	Low	High	Conservative assumptions and input parameters
C. Chemical Toxicity				
Assumption that USEPA[b] reference doses truly represent toxicological thresholds	NA	Low	High	High degree of conservativeness utilized by USEPA in deriving RfDs[c] from toxicological literature
Assumption that USEPA carcinogenic slope factors truly represent dose-response phenomena	NA	Low-moderate	Moderate-high	Use of linearized, multi-stage mathematical model to predict cancer incidence at low exposure levels is USEPA policy; not currently supported by scientific data

TABLE 28-6

Qualitative Uncertainty Analysis
Current Facility-Wide Trespassers

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
Assumption of risk/hazard additivity	NA	Moderate	Moderate	Summation of chemical-specific risks/hazards may over- or under-predict risks/hazards to receptors
Screening out of certain contaminants based on USEPA criteria	NA	Low	Low	Chemicals present in concentrations less than Region 9 criteria eliminated

Footnotes:
(a) Not available or not applicable.
(b) U.S. Environmental Protection Agency.
(c) Reference doses.

TABLE 28-7

Selection of Contaminants of Potential Concern (COPC) in Surface Soil Based on USEPA Region 9 Preliminary Remediation Goals (PRGs), Future Facility-Wide Hunters

	USEPA Region 9 PRG Screen		
Chemical	**Residential PRG (µg/g)[a]**	**Exposure Point Conc. (µg/g)**	**Retained as Soil COPC?**
Aluminum	7.67E+03	1.40E+02	No
Arsenic	3.80E-01	8.01E-02	No
Barium	5.27E+02	1.99E-01	No
Beryllium	1.40E-01	3.02E-03	No
Cadmium	3.80E+00	3.69E-04	No
Chromium	3.00E+01	3.81E-01	No
Lead	4.00E+02[b]	2.63E-02	No
Manganese	3.18E+02	8.90E+00	No
Silver	3.83E+01	1.38E-01	No
Thallium	6.10E-01	1.45E-02	No
Vanadium	5.40E+01	2.08E-02	No
Zinc	2.30E+03	3.28E-02	No
Dioxins/Furans	3.77E-06	3.15E-08	No
Benzo(a)anthracene	6.10E-01	3.26E-05	No
Benzo(a)pyrene	6.10E-02	1.71E-04	No
Benzo(b)fluoranthene	6.10E-01	1.96E-04	No
Chlorobenzene	6.47E+00	2.53E-05	No
DDE	1.31E+00	1.92E-05	No
Dibenz(a,h)anthracene	6.10E-02	3.84E-06	No
Dieldrin	3.00E-02	4.25E-05	No
Indeno(1,2,3-cd)pyrene	6.10E-01	1.92E-05	No

Note:

PRGs were taken directly from the Region 9 PRG Table (USEPA 1998). Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:

(a) Micrograms per gram.
(b) Full PRG used for lead.

TABLE 28-8

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs), Future Facility-Wide Hunters

Chemical	USEPA Region 9 PRG Screen		
	Ambient Air PRG (µg/m^3)[(a)]	Exposure Point Conc. (µg/m^3)	Retained as Air COPC?
Aluminum	---[(b)]	5.56E-02	**YES**
Arsenic	4.5E-04	3.64E-05	No
Barium	5.2E-02	5.32E-05	No
Beryllium	8.0E-04	1.18E-06	No
Cadmium	1.1E-03	2.73E-07	No
Chromium	2.3E-05	1.83E-04	**YES**
Lead	1.5E+00[(c)]	7.32E-06	No
Manganese	5.1E-03	2.99E-03	No
Silver	---	4.98E-05	**YES**
Thallium	---	5.89E-06	**YES**
Vanadium	---	8.09E-06	**YES**
Zinc	---	1.94E-04	**YES**
Dioxins/Furans	4.5E-08	2.57E-11	No
Benzo(a)anthracene	9.2E-03	9.08E-09	No
Benzo(a)pyrene	9.2E-04	4.23E-08	No
Benzo(b)fluoranthene	9.2E-03	8.61E-08	No
DDE	2.0E-02	5.34E-09	No
Dibenz(a,h)anthracene	9.2E-04	1.07E-09	No
Dieldrin	4.2E-04	1.28E-08	No
Indeno(1,2,3-cd)pyrene	9.2E-03	5.34E-09	No
1,1-Dichloroethylene	3.8E-02	---	No
Chlorobenzene	2.1E+00	---	No

Note:

PRGs were taken directly from the Region 9 PRG Table (USEPA 1998). Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:

(a) Micrograms per cubic meter.
(b) Not applicable.
(c) Federal ambient air quality criterion for lead.

TABLE 28-9

Summary of Sediment and Surface Water Contaminants of Potential Concern
Future Facility-Wide Hunters

Contaminant	Exposure Point Concentration in Sediment (μg/g)[a]	Exposure Point Concentration in Surface Water (μg/L)[b]
Harberts Creek (Sites 2 and 27)		
Aluminum	22,100	---[c]
Arsenic	26.1	---
Beryllium	2.34	---
Chromium	44.7	---
Iron	76,087	---
Manganese	2,200	---
Vanadium	138	---
Pond Adjacent to the Burning Ground at Gate 19 Landfill		
Aluminum	19,550	---
Beryllium	1.39	---
Manganese	4,800	259
1,3,5-Trinitrobenzene	---	0.472
Drainge Ditch South of the Yellow Sulfur Disposal Area (Site 14)		
Aluminum	18,100	---
Barium	696	---
Beryllium	1.0	---
Chromium	87.9	---

Footnotes:
(a) Micrograms per gram.
(b) Micrograms per liter.
(c) Not available or not applicable.

TABLE 28-10

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards - Future Facility-Wide Hunters

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Chemicals of Concern	Pathway-specific Hazard Index	Noncarcinogenic Chemicals of Concern
Inhalation of VOCs[a] and fugitive dusts	5.64E-09		0.0001	
Incidental ingestion of sediment (Harberts Creek)	1.24E-07		0.0027	
Dermal contact with sediment (Harberts Creek)	2.70E-07		0.0031	
Incidental ingestion of sediment (drainage pathway at Yellow Sulfur Disposal Area)	1.08E-08		0.0003	
Dermal contact with sediment (drainage pathway at Yellow Sulfur Disposal Area)	9.10E-09		0.0002	
Incidental ingestion of sediment (pond at Gate 19 Landfill)	1.51E-08		0.0005	
Dermal contact with sediment (pond at Gate 19 Landfill)	1.27E-08		0.0004	
Incidental ingestion of surface water (pond at Gate 19 Landfill)	NA[b]		0.0000	
Dermal contact with surface water (pond at Gate 19 Landfill)	NA		0.0000	
Total	4.47E-07		0.0073	

Footnotes:
(a) Volatile organic compounds.
(b) Not available or not applicable.

TABLE 28-11

Qualitative Uncertainty Analysis
Future Facility-Wide Hunters

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Overestimation	Comments
A. Human Behavior				
Future receptors' exposure frequency	9 days/year	Low	High	Future hunters unlikely to visit each surface water body 9 times per year
Future receptors' sediment ingestion rates	NA[(a)]	Low	High	Highly unlikely that receptors would ingest sediment each and every time they visit the surface water bodies
Exclusion of certain exposure pathways in the quantitative analysis	NA	Low	Low	Pathways eliminated are those that have low possibility of contributing risk to these receptors
B. Chemical Fate/Transport in the Environment				
Use of air dispersion modeling to predict air concentrations	NA	Low	High	Conservative assumptions and input parameters
C. Chemical Toxicity				
Assumption that USEPA[(b)] reference doses truly represent toxicological thresholds	NA	Low	High	High degree of conservativeness utilized by USEPA in deriving RfDs[(c)] from toxicological literature
Assumption that USEPA carcinogenic slope factors truly represent dose-response phenomena	NA	Low-moderate	Moderate-high	Use of linearized, multi-stage mathematical model to predict cancer incidence at low exposure levels is USEPA policy; not currently supported by scientific data

TABLE 28-11

Qualitative Uncertainty Analysis
Future Facility-Wide Hunters

		Potential for:		
Key Assumption/ Input Parameter	**Selected Value**	**Underestimation**	**Overestimation**	**Comments**
Assumption of risk/hazard additivity	NA	Moderate	Moderate	Summation of chemical-specific risks/hazards may over- or under-predict risks/hazards to receptors
Screening out of certain contaminants based on USEPA criteria	NA	Low	Low	Chemicals present in concentrations less than Region 9 criteria eliminated

Foonotes:
(a) Not available or not applicable.
(b) U.S. Environmental Protection Agency.
(c) Reference doses.

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29.0 OFF-FACILITY (NEARBY) RESIDENTS

29.1 HUMAN HEALTH RISK ASSESSMENT - CURRENT OFF-FACILITY RESIDENTS

29.1.1 Selection of Contaminants of Potential Concern

29.1.1.1 Air.

29.1.1.1.1 Summary of Preliminary COPCs. Ambient air concentrations to which current nearby off-facility residents might be exposed were estimated using air emission/dispersion modeling, as described in Appendix R. For determining ambient air concentrations in the current scenario for nearby off-facility residents, only those sites not completely vegetated or covered with concrete were assumed to contribute to the maximum air concentrations at an off-facility location. Table R-2 in Appendix R presents the estimated maximum off-facility ambient air concentrations under the current land use scenario.

29.1.1.1.2 Region 9 Preliminary Remediation Goal Screening. The maximum off-facility exposure point concentration for each preliminary air COPC for current receptors was compared to the chemical-specific Region 9 air PRG (Table 29-1). One-tenth of the PRG was used for noncarcinogens. The exception was lead, for which the full PRG was used. As a result of the screening, aluminum, chromium, thallium, and vanadium are retained as air COPCs for current nearby off-facility residents.

29.1.2 Exposure Assessment

29.1.2.1 Site Conceptual Model. Once the COPCs have been identified for a site, these results along with project data (i.e., regional land uses, future land development possibilities, site hydrogeology, etc.) are used to finalize a site-specific conceptual model for the quantitative assessment. This model schematically describes the relationship between the contaminants at a site and any potentially impacted human populations. It details the various current and potentially future uses of the site and then describes for each scenario the various exposure pathways by which the human populations may come into contact with the contaminated environmental media at the site.

There are several types of individuals that could potentially be affected by the existing contamination at the facility. One of these receptor groups is composed of current off-facility (i.e., nearby) rural residents who are located within the air dispersion zone of surface/ subsurface contaminants at JPG. Low volatility contaminants in surface soils are dispersed in ambient air as windblown dusts. Volatile contaminants in both surface and subsurface soils emanate from the soils and are dispersed by the wind, as well. Individuals living near the closed facility therefore would be expected to be breathing air that has been impacted to some degree by the facility contamination.

This risk assessment therefore addressed this off-facility exposure scenario. The single exposure pathway evaluated in this scenario is:

- Inhalation of VOCs and fugitive particulates from soils

29.1.2.2 Exposure Point Concentrations.

29.1.2.2.1 Air. The estimated maximum off-facility ambient air concentrations of COPCs for the current off-facility resident are presented in Table 29-1.

29.1.2.3 Human Exposure Doses.

29.1.2.3.1 Inhalation of Contaminated Air. Inhalation of airborne contaminants (VOCs and particulates) is a potential route of exposure for nearby off-facility residents. The equation used for calculating human exposure doses of COPCs due to inhalation of volatile and dust-bound contaminants is provided in Section 5.1.5.3.1, Table 5-**11**~~12~~, along with the values of the exposure variables. Table V-20, Appendix V, documents the calculation of off-facility resident exposure doses due to inhalation of contaminated air.

29.1.3 Risk Characterization

29.1.3.1 Chronic Health Hazards. The noncancer daily exposure doses calculated in the exposure assessment were used to calculate HQs for each of the COPCs possessing RfDs. Pathway-specific and overall HIs were then calculated for each receptor. The calculations of HQs and HIs are described in Section 5.1.7.1. If an overall HI is calculated to be greater than 1.0 for a particular receptor, then the exposure pathway(s) primarily responsible for the result is identified as a "critical pathway(s)." For each critical pathway, those chemical contaminants responsible for the majority of the HI are listed as COCs. Table W-20, Appendix W, documents the calculation of the pathway- and chemical-specific HQs for current nearby off-facility residents. The pathway-specific and overall HIs are summarized in Table 29-2.

The overall HIs for the current nearby off-facility adult and toddler residents are calculated to be **0.0016**~~0.0004~~ and **0.0059**~~0.0014~~, respectively. These HIs are less than the USEPA's risk management criterion of 1.0. Therefore, no critical exposure pathways or noncarcinogenic COCs are identified for these receptors.

29.1.3.2 Excess Lifetime Cancer Risks. The cancer risks for each receptor were determined from the pathway-specific exposure doses and the route-specific SFs (see Section 5.1.7.2). To assess the simultaneous exposure of a receptor population to multiple carcinogens from multiple exposure routes, all of the cancer risks calculated for a receptor population were summed. Each overall receptor cancer risk was then compared to USEPA's target risk range (1.0E-06 to 1.0E-04). If the total cancer risk for a receptor from all exposure pathways is less than 1.0E-04, then it is concluded that the site(s) does not pose a significant risk to that receptor. If the overall cancer risk exceeds the target risk range, any chemical individually associated with a risk level greater than 1.0E-05 is identified as a COC. COCs represent the

primary contributors to the potential cancer risk for the receptor-specific exposure pathway under evaluation. Table W-20, Appendix W, documents the calculation of the pathway- and chemical-specific cancer risks for the current off-facility residents. The pathway-specific and overall cancer risks are summarized in Table 29-2.

The overall cancer risks calculated for the current off-facility adult and toddler residents are **8.1**~~7.9~~E-07 and **6.1**~~5.9~~E-07, respectively. These cancer risks are less than the USEPA's target risk range of 1.0E-06 to 1.0E-04. Therefore, no critical exposure pathways or carcinogenic COCs are identified for these receptors.

29.1.3.3 Uncertainty/Sensitivity Analysis. The numerical risks/hazards calculated for current off-facility (nearby) residents represent *conditional* estimates of risk based on various simplifying assumptions concerning contaminant exposure and toxicity. These estimates of risk/hazard are derived using a series of conservative procedures that address contaminant concentrations at the facility, their fate in the environment, how someone currently might be exposed to these contaminants, and the toxicity of each chemical toward humans. The uncertainty analysis specifies, when appropriate, the critical assumptions made for the receptors so that the results can be interpreted by risk managers in a proper context.

To assist the risk managers in this project, a qualitative uncertainty analysis has been performed. The primary goals of a qualitative uncertainty analysis are (1) to itemize the major areas of uncertainty in the scenario-specific risk assessment and (2) to demonstrate that the assessment overall has been conservatively performed (i.e., that the potential risks/hazards have not likely been underestimated, but may have been significantly overestimated).

The qualitative uncertainty analysis for the current off-facility resident is presented in Table 29-3. Based on this analysis, it can be concluded that this risk assessment is conservative. Some of the major uncertainties in this study that are most influential to the risks/hazards that were calculated include:

- Air dispersion modeling used to calculate ambient air concentrations off the facility

- Receptors' exposure time (24 hours/day)

- Receptors' exposure duration (30 years)

29.2 HUMAN HEALTH RISK ASSESSMENT - FUTURE OFF-FACILITY RESIDENTS

29.2.1 Selection of Contaminants of Potential Concern

29.2.1.1 Air.

29.2.1.1.1 Summary of Preliminary COPCs. Ambient air concentrations to which future off-facility residents might be exposed were estimated using air emission/dispersion modeling, as described in Appendix R. The locations for the three groups of future off-facility receptors are described in Appendix S, Saturated Zone Transport Modeling. For determining ambient air concentrations in the future residential scenario for the facility, all sites were assumed to be residential except for the five sites designated agricultural. It was assumed that particulate emissions from the strictly residential sites would be negligible because the home sites would be covered with dense vegetation (lawns) and pavement. Therefore, under the residential scenario only the agricultural sites contribute to the air concentrations at future off-facility locations. Table R-5 in Appendix R presents the estimated ambient air concentrations at the various future off-facility locations.

29.2.1.1.2 Region 9 Preliminary Remediation Goal Screening. The maximum off-facility exposure point concentration for each preliminary air COPC for future receptors was compared to the chemical-specific Region 9 air PRG (Tables 29-4 and 29-5). One-tenth of the PRG was used for noncarcinogens. The exception was lead, for which the full PRG was used. As a result of the screening, aluminum, chromium, silver, thallium, vanadium, and zinc were retained as COPCs in air for future residents at off-facility Receptor Point A. Aluminum, silver, thallium, vanadium, and zinc were retained as air COPCs for future residents at off-facility receptor point B. For off-facility recreational users of Middle Fork Creek (Receptor Point C), aluminum, silver, thallium, vanadium, and zinc were retained.

29.2.1.2 Groundwater. **Exposure to contaminated groundwater was assumed to occur at the facility boundary. (EPA 143)**

29.2.1.2.1 Summary of Preliminary COPCs. As described in Appendix S, concentrations of all chemicals detected above background in groundwater at the facility were modeled to two off-site receptor locations: (1) Receptor Point A - Laurel Aquifer and (2) Receptor Point B - Jefferson-Louisville Aquifer. Two scenarios were modeled for Receptor Point B. In the first scenario, groundwater contamination at Sites 9, 10, 12A, and 12B was assumed to migrate to the receptor point in the Jefferson-Louisville Aquifer. In the second scenario (referred to as Receptor Point B*), groundwater contamination at Sites 9 and 10 was assumed to have been remediated, so that only Sites 12A and 12B contribute to the off-site contamination in the Jefferson-Louisville aquifer. The concentrations of the preliminary groundwater COPCs at these receptor points are summarized in Table 13, Appendix S.

29.2.1.2.2 Region 9 Preliminary Remediation Goal Screening. The exposure point concentrations for each preliminary groundwater COPC at receptor points A and B for future off-site residential receptors were compared to chemical-specific Region 9 tap water PRGs (Tables 29-6, 29-7, and 29-8). One-tenth of the PRG was used for noncarcinogens. The exception was lead, for which the full PRG was used. As a result of the screening, arsenic, 1,1-dichloroethylene, and 4-amino-2,6-dinitrotoluene were retained as groundwater COPCs for future residential receptors at Receptor Point A - Laurel Aquifer. Aluminum, antimony, barium, beryllium, chromium, molybdenum, 1,1-dichloroethylene, 4-chloro-3-cresol, and benzo(a)anthracene were retained as groundwater COPCs for future residential receptors at Receptor Point B - Jefferson-Louisville Aquifer. If only Sites 12A and 12B were assumed to contribute to the contaminant concentrations at Receptor Point B, 1,1-dichloroethylene was the only groundwater COPC retained at Receptor Point B.

29.2.1.3 Surface Water.

29.2.1.3.1 Summary of Preliminary COPCs. As described in Appendix S, Middle Fork Creek was determined to be a discharge point for groundwater contaminants migrating beyond the JPG facility boundary. The concentrations of the preliminary surface water COPCs in Middle Fork Creek are summarized in Table 13, Appendix S.

29.2.1.3.2 Region 9 Preliminary Remediation Goal Screening. The exposure point concentrations for each preliminary surface water COPC at Middle Fork Creek were compared to chemical-specific Region 9 tap water PRGs (Table 29-9). One-tenth of the PRG was used for noncarcinogens. The exception was lead, for which the full PRG was used. As a result of the screening, 1,1-dichloroethylene was retained as a surface water COPC for future recreational users of Middle Fork Creek.

29.2.2 Exposure Assessment

29.2.2.1 Site Conceptual Model. Once the COPCs have been identified for a site, these results along with project data such as regional land uses, future land development possibilities, site hydrogeology, etc. are used to finalize a site-specific conceptual model for the quantitative assessment. This model schematically describes the relationship between the contaminants at a site and any potentially impacted human populations. It details the various current and potentially future uses of the site and then describes for each scenario the various exposure pathways by which the human populations may come into contact with the contaminated environmental media at the site.

There are several types of individuals that could potentially be affected by the existing contamination at the facility. One of these receptor groups is composed of future off-facility residents. Future residents living near JPG could become exposed to facility contamination by several indirect routes. Volatile chemicals in soils and non/low volatile chemicals in surface soils could be airborne via wind erosion and dispersion in air at off-site locations where individuals live. Also, contaminants in groundwater beneath the facility could migrate past the property boundaries and into the capture zones of future nearby residential wells.

Finally, local residents could recreate in the nearby Middle Fork Creek, which is another receptor medium for on-site groundwater contamination.

Therefore, to quantitatively assess the potential health risk to these individuals, this risk assessment assumed that at some time in the future the following exposure pathways would be complete for off-site residents:

- Inhalation of VOCs and fugitive particulates from soils
- Ingestion of groundwater
- Dermal contact with groundwater
- Inhalation of VOCs in groundwater while showering/bathing
- Incidental ingestion of surface water (Middle Fork Creek)
- Dermal contact with surface water (Middle Fork Creek)

29.2.2.2 Exposure Point Concentrations.

29.2.2.2.1 Air. The estimated maximum off-facility ambient air concentrations of COPCs for the future off-facility residents are presented in Tables **29-4 and 29-5.**~~ 29-3 and 29-4.~~

29.2.2.2.2 Groundwater. The estimated groundwater COPC concentrations at receptor points A and B are presented in Tables **29-6, 29-7, and 29-8.**~~29-5, 29-6, and 29-7.~~

29.2.2.2.3 Shower Air. COPC concentrations in shower air were estimated using the methods described in Appendix T. Table 29-10 summarizes the shower air concentrations for future off-site receptors.

29.2.2.2.4 Surface Water. The estimated concentrations of COPCs in Middle Fork Creek are presented in Table 29-9.

29.2.2.3 Human Exposure Doses.

29.2.2.3.1 Inhalation of Contaminated Air. Inhalation of airborne contaminants (VOCs and particulates) is a potential route of exposure for future off-facility residents. The equation used for calculating human exposure doses of contaminants of potential concern due to inhalation of volatile and dust-bound contaminants is provided in Section 5.1.5.3.1, Table 5-**11**~~12~~, along with the values of the exposure variables. Table V-22, Appendix V, documents the calculation of off-facility resident exposure doses due to inhalation of contaminated air.

29.2.2.3.2 Ingestion of Contaminated Groundwater. Contaminated drinking water may be a source of chemical exposure for future off-site residents (adults and children). The equation

used to calculate human exposure doses due to ingestion of contaminated drinking water is provided in Section 5.1.5.3.4, Table 5-**14**~~15~~, along with the assumed values for the exposure parameters. Table V-22, Appendix V, documents the calculation of human exposure doses due to ingestion of contaminated off-facility groundwater.

29.2.2.3.3 Dermal Contact with Contaminated Groundwater. Exposure via dermal contact with chemicals in groundwater may occur when receptors (future off-facility residents) shower or bathe. The equation used to calculate daily chemical doses due to dermal contact with contaminated groundwater is provided in Section 5.1.5.3.5, Table 5-**15**~~16~~. Table V-22, Appendix V, documents the calculation of human exposure doses due to dermal contact with contaminated groundwater.

29.2.2.3.4 Inhalation of Volatile Organic Chemicals While Showering/Bathing. Inhalation of VOCs while showering/bathing is a potential route of exposure when these contaminants are present in residential water systems. The equation that was used to calculate human exposure dose due to inhalation of VOCs while showering/bathing is provided in Section 5.1.5.3.6, Table 5-**17**~~18~~. Table V-22, Appendix V, documents the calculation of human exposure doses due to inhalation of VOCs while showering.

29.2.2.3.5 Incidental Ingestion of Surface Water. Water ingested while wading in Middle Fork Creek may be a source of exposure for future off-facility residents who recreate in this surface water body. The equation to calculate human exposure doses due to incidental ingestion of contaminated surface water is provided in Section 5.1.5.3.7, Table 5-**18**~~19~~, along with the assumed values for the exposure parameters. Table V-22, Appendix V, documents the calculation of human exposure doses due to incidental ingestion of contaminated surface water while wading in Middle Fork Creek.

29.2.2.3.6 Dermal Contact with Surface Water. Future residents may also absorb chemicals through the skin while wading in Middle Fork Creek. The equation used to calculate human exposure doses due to dermal contact with contaminated surface water is provided in Section 5.1.5.3.8, Table 5-**19**~~20~~, along with the assumed values for the exposure parameters. Table V-22, Appendix V, documents the calculation of human exposure doses due to dermal contact with surface water while wading.

29.2.3 Risk Characterization

29.2.3.1 Chronic Health Hazards. The noncancer daily exposure doses calculated in the exposure assessment were used to calculate HQs for each of the COPCs possessing RfDs. Pathway-specific and overall HIs were then calculated for each receptor. The calculations of HQ and HI are described in Section 5.1.5.1.1. If an overall HI is calculated to be greater than 1.0 for a particular receptor, then the exposure pathway(s) primarily responsible for the result is identified as a "critical pathway(s)." For each critical pathway, those chemical contaminants responsible for the majority of the HI are listed as COCs. Table W-22, Appendix W, documents the calculation of the pathway- and chemical-specific HQs for future off-facility residents. The pathway-specific and overall HIs are summarized in Table 29-11.

29.2.3.1.1 Off-Site Receptor Point A - Laurel Aquifer. The overall HIs for the future off-site adult and toddler residents consuming groundwater from the Laurel aquifer are calculated to be **0.01**~~0.02~~ and **0.02**~~0.05~~, respectively. Both of these HIs are less than the USEPA's risk management criterion of 1.0. Therefore, no critical exposure pathways or noncarcinogenic COCs are identified for these receptors.

29.2.3.1.2 Off-Site Receptor Point B - Jefferson-Louisville Aquifer. The overall HIs for the future off-site adult and toddler residents consuming groundwater from the Jefferson-Louisville aquifer are calculated to be **2.1**~~3.4~~ and **4.8**~~7.8~~, respectively. Both of these HIs exceed the USEPA's risk management criterion of 1.0. The critical exposure pathway for both receptors is ingestion of groundwater, and manganese is the noncarcinogenic COC.

Manganese is naturally occurring in groundwater at the JPG facility. The relative contribution of background groundwater concentrations of manganese to the groundwater hazards for off-site receptors at Receptor Point B were estimated by comparing the average groundwater background concentration of manganese to the average concentration in groundwater at Sites 3/4 and 9/10, the sites from which manganese was modeled off-site. Background manganese accounts for approximately 72 percent of the total manganese concentration in groundwater at Sites 3/4, and for approximately 30 percent of the total manganese concentration at Sites 9/10. However, almost all of the manganese at Receptor Point B originates from Sites 9/10.

Background manganese in groundwater would contribute approximately 22 percent to the total HI estimated for the groundwater exposure pathways at off-site Receptor Point B.

29.2.3.1.3 Off-Site Receptor Point B* - Jefferson-Louisville Aquifer. If Sites 12A and 12B are assumed to be the only sites contributing to groundwater contamination off-site to this aquifer (i.e., if the groundwater contamination at Sites 9 and 10 is remediated), the overall HIs for the future adult and toddler residents are calculated to be 0.07 and 0.17, respectively. Since both of these HIs are less than the USEPA's risk management criterion of 1.0, no critical exposure pathways or noncarcinogenic COCs are identified for these receptors.

29.2.3.1.4 Off-Site Receptor Point C - Middle Fork Creek. The overall HIs for off-site adult and child receptors recreating in Middle Fork Creek are calculated to be less than the USEPA's risk management criterion of 1.0. Therefore, no critical exposure pathways or noncarcinogenic COCs are identified for these receptors.

29.2.3.2 Excess Lifetime Cancer Risks. The cancer risks for each receptor were determined from the pathway-specific exposure doses and the route-specific SFs, as described in Section 5.1.5.1.2. To assess the simultaneous exposure of a receptor population to multiple carcinogens from multiple exposure routes, all of the cancer risks calculated for a receptor population were summed. Each overall receptor cancer risk was then compared to USEPA's target risk range (1.0E-06 to 1.0E-04). If the total cancer risk for a receptor from all exposure pathways is less than 1.0E-04, then it is concluded that the site(s) does not pose a significant risk to that receptor. If the overall cancer risk exceeds the target risk range, any chemical

individually associated with a risk level greater than 1.0E-05 is identified as a COC. COCs represent the primary contributors to the potential cancer risk for the receptor-specific exposure pathway under evaluation. Table W-22, Appendix W, documents the calculation of the pathway- and chemical-specific cancer risks for the future off-facility residents. The pathway-specific and overall cancer risks are summarized in Table 29-11.

29.2.3.2.1 Off-Site Receptor Point A - Laurel Aquifer. The overall cancer risks for the future off-site adult and toddler residents consuming groundwater from the Laurel aquifer are calculated to be **6.8**~~6.9~~E-06 and 3.2E-06, respectively. Both of these cancer risks are within the USEPA's target risk range of 1.0E-06 to 1.0E-04. Therefore, no critical exposure pathways or carcinogenic COCs are identified for these receptors.

29.2.3.2.2 Off-Site Receptor Point B - Jefferson-Louisville Aquifer. The overall cancer risks for the future off-site adult and toddler residents consuming groundwater from the Jefferson-Louisville aquifer are calculated to be **1.9**~~2.3~~E-04 and **9.0E-05**~~1.0E-04~~, respectively. The cancer risk for the toddler is at the upper end of the USEPA's target risk range of 1.0E-06 to 1.0E-04. Therefore, no critical exposure pathways or carcinogenic COCs are identified for the toddler receptor. Ingestion of groundwater and inhalation of VOCs while showering are critical exposure pathways for the adult receptor. The compound 1,1-dichloroethylene is the primary carcinogenic COC.

In April 1998, after completion of the draft RI, the USEPA withdrew the oral slope factor for beryllium from IRIS. Beryllium is therefore no longer a carcinogenic COC for future adult residents ingesting groundwater at Receptor Point B.

29.2.3.2.3 Off-Site Receptor Point B* - Jefferson-Louisville Aquifer. If Sites 12A and 12B are assumed to be the only sites contributing to groundwater contamination off-site in this aquifer (i.e., if the groundwater contamination at Sites 9 and 10 is remediated), the overall cancer risks for the future adult and toddler residents are calculated to be 1.9E-04 and **8.9**~~8.5~~E-05, respectively. The cancer risk for the toddler is within the USEPA's target risk range of 1.0E-06 to 1.0E-04. Therefore, no critical exposure pathways or carcinogenic COCs are identified for this receptor. Ingestion of groundwater and inhalation of VOCs while showering are the critical exposure pathways for the adult receptor, and 1,1,-dichloroethylene is the sole carcinogenic COC.

29.2.3.2.4 Off-Site Receptor Point C - Middle Fork Creek. The overall cancer risks for off-site adult and child receptors recreating in Middle Fork Creek are calculated to be **6.5**~~9.3~~E-08 and **2.9**~~5.3~~E-08, respectively. Since both of these cancer risks are less than the USEPA's target cancer risk of 1.0E-06 to 1.0E-04, no critical exposure pathways or carcinogenic COCs are identified for these receptors.

29.2.3.3 Uncertainty/Sensitivity Analysis. The numerical risks/hazards calculated for future off-facility residents represent *conditional* estimates of risk based on various simplifying assumptions concerning contaminant exposure and toxicity. These estimates of risk/hazard are derived using a series of conservative procedures that address contaminant concentrations

at the facility, their fate in the environment, how someone currently might be exposed to these contaminants, and the toxicity of each chemical toward humans. The uncertainty analysis specifies, when appropriate, the critical assumptions made for the receptors so that the results can be interpreted by risk managers in a proper context.

To assist the risk managers in this project, a qualitative uncertainty analysis has been performed. The primary goals of a qualitative uncertainty analysis are (1) to itemize the major areas of uncertainty in the scenario-specific risk assessment and (2) to demonstrate that the assessment overall has been conservatively performed (i.e., that the potential risks/hazards have not likely been underestimated, but may have been significantly overestimated).

The qualitative uncertainty analysis for the future off-facility residents is presented in Table 29-12. Based on this analysis, it can be concluded that this risk assessment is conservative. Some of the major uncertainties in this study that are most influential to the risks/hazards that were calculated include:

- Assumption that on-facility groundwater contamination merges to yield maximum cumulative impacts off site
- Maximum on-facility groundwater concentrations used in the model
- Receptors' exposure duration (30 years)
- Receptors' exposure frequency (350 days/year)

29.3 CONCLUSIONS AND RECOMMENDATIONS

An assessment was conducted to evaluate the potential risks associated with contaminants in air in the form of windblown dust being transported to nearby off-site residents. The results of this assessment indicate that exposure to the potential dusts by nearby residents will not result in cancer risks or chronic health hazards. Cancer risk and chronic health hazard estimates were well below the USEPA target range and HI goal, respectively. As a result, no further investigation of this potential contaminant pathway is necessary.

For the future off-facility resident, the air pathway plus the groundwater and surface water pathways were evaluated. The assessment of risk to future off-facility residents assumed exposure to contaminants in windblown dust, exposure to surface water where contaminated groundwater is assumed to discharge in the future, and exposure to groundwater where contaminants have migrated off-site in the future. The contaminants in surface water and groundwater were assumed to have originated from the Sites 12A and 12B solvent-related groundwater plumes (based on no remedial action being performed).

Results of the risk assessment for the future off-facility resident indicate that there is little future risk associated with the air pathway. There also appears to be little risk associated with

exposure to contaminated surface water. The only future risks to off-facility residents that exceed the USEPA risk management criteria are those associated with ingestion of groundwater within the Jefferson-Louisville Aquifer, which assumes that migration of solvent-related contamination in the future is not subject to remedial action or natural attenuation/ biodegradation processes.

It is recommended that remedial action and/or long-term groundwater monitoring be conducted on the solvent plumes at Sites 21A and 21B to reduce these potential future risks to human health. As stated in Section 29.2.3.3, these risk estimates have been based on very conservative assumptions and the risks are likely overestimated.

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TABLES

TABLE 29-1

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs), Current Off-Facility (Nearby) Residents

	USEPA Region 9 PRG Screen		
Chemical	Ambient Air PRG ($\mu g/m^3$)[(a)]	Exposure Point Conc. ($\mu g/m^3$)	Retained as Air COPC
Aluminum	---[(b)]	1.12E-03	**YES**
Arsenic	4.5E-04	---	No
Barium	5.2E-02	6.87E-05	No
Beryllium	8.0E-04	1.30E-06	No
Cadmium	1.1E-03	---	No
Chromium	2.3E-05	2.28E-04	**YES**
Lead	1.5E+00[(c)]	---	No
Manganese	5.1E-03	9.38E-04	No
Silver	---	---	No
Thallium	---	7.03E-05	**YES**
Vanadium	---	1.06E-06	**YES**
Zinc	---	---	No
Dioxins/Furans	4.5E-08	---	No
Benzo(a)anthracene	9.2E-03	---	No
Benzo(a)pyrene	9.2E-04	8.29E-07	No
Benzo(b)fluoranthene	9.2E-03	1.84E-06	No
DDE	2.0E-02	---	No
Dibenz(a,h)anthracene	9.2E-04	---	No
Dieldrin	4.2E-04	7.16E-07	No
Indeno(1,2,3-cd)pyrene	9.2E-03	---	No
1,1-Dichloroethylene	3.8E-02	9.54E-08	No
Chlorobenzene	2.1E+00	9.64E-06	No

Notes:

PRGs were taken directly from the Region 9 PRG Table (USEPA 1996c). Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:

[a] Micrograms per cubic meter.
[b] Not applicable.
[c] Federal ambient air quality criterion for lead.

TABLE 29-2

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Current Nearby Off-Facility Residents

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
		Adult Resident		
Inhalation of VOCs[a] and fugitive dusts	8.06E-07		0.0016	
		Child Resident		
Inhalation of VOCs and fugitive dusts	6.07E-07		0.0059	

Footnotes:
[a] Volatile organic compounds.

TABLE 29-3

Qualitative Uncertainty Analysis, Current Off-Facility (Nearby) Residents

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
A. Human Behavior				
Current receptors' exposure time	24 hours/day	Low	High	Maximum possible value
Current receptors' exposure duration	30 years	Low	High	National upper-bound time (90th percentile) at one residence
Exclusion of certain exposure pathways in the quantitative analysis	NA[a]	Low	Low	Pathways eliminated are those that have low possibility of contributing risk to these receptors
B. Chemical Fate/Transport in the Environment				
Use of air dispersion modeling to predict air concentrations	NA	Low	High	Conservative assumptions and input parameters
C. Chemical Toxicity				
Assumption that USEPA[b] reference doses truly represent toxicological thresholds	NA	Low	High	High degree of conservativeness utilized by USEPA in deriving RfDs[c] from toxicological literature
Assumption that USEPA carcinogenic slope factors truly represent dose-response phenomena	NA	Low-moderate	Moderate-high	Use of linearized, multi-stage mathematical model to predict cancer incidence at low exposure levels is USEPA policy; not currently supported by scientific data
Assumption of risk/hazard additivity	NA	Moderate	Moderate	Summation of chemical-specific risks/hazards may over- or under-predict risks/hazards to receptors
Screening out of certain contaminants based on USEPA criteria	NA	Low	Low	Chemicals present in concentrations less than Region 9 criteria eliminated

Footnotes:

[a] Not available or not applicable.
[b] U.S. Environmental Protection Agency.
[c] Reference doses.

TABLE 29-4

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs), Future Off-Facility Consumers of Groundwater

	USEPA Region 9 PRG Screen		
Chemical	Ambient Air PRG (μg/m^3)[(a)]	Exposure Point Conc. (μg/m^3)	Retained as Air COPC
Off-Site Receptor Point A - Laurel Aquifer			
Aluminum	---[(b)]	6.15E-02	**YES**
Arsenic	4.5E-04	3.40E-05	No
Barium	5.2E-02	1.54E-05	No
Beryllium	8.0E-04	2.64E-06	No
Cadmium	1.1E-03	3.00E-08	No
Chromium	2.3E-05	8.66E-05	**YES**
Lead	1.5E+00[(c)]	2.22E-06	No
Manganese	5.1E-03	4.25E-03	No
Silver	---	1.89E-04	**YES**
Thallium	---	1.12E-05	**YES**
Vanadium	---	1.71E-05	**YES**
Zinc	---	1.53E-06	**YES**
Dioxins/Furans	4.5E-08	2.42E-13	No
Benzo(a)anthracene	9.2E-03	2.76E-09	No
Benzo(a)pyrene	9.2E-04	6.09E-09	No
Benzo(b)fluoranthene	9.2E-03	1.13E-08	No
DDE	2.0E-02	1.62E-09	No
Dibenz(a,h)anthracene	9.2E-04	3.24E-10	No
Dieldrin	4.2E-04	---	No
Indeno(1,2,3-cd)pyrene	9.2E-03	1.62E-09	No
1,1-Dichloroethylene	3.8E-02	1.06E-09	No
Chlorobenzene	2.1E+00	2.87E-06	No

TABLE 29-4

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs), Future Off-Facility Consumers of Groundwater

	USEPA Region 9 PRG Screen		
Chemical	Ambient Air PRG (µg/m^3)[(a)]	Exposure Point Conc. (µg/m^3)	Retained as Air COPC
Off-Site Receptor Point B - Jefferson-Louisville Aquifer			
Aluminum	---	2.95E-03	**YES**
Arsenic	4.5E-04	1.45E-06	No
Barium	5.2E-02	4.99E-06	No
Beryllium	8.0E-04	1.13E-07	No
Cadmium	1.1E-03	9.72E-09	No
Chromium	2.3E-05	4.12E-06	No
Lead	1.5E+00[(c)]	7.20E-07	No
Manganese	5.1E-03	2.15E-04	No
Silver	---	7.99E-06	**YES**
Thallium	---	6.02E-07	**YES**
Vanadium	---	7.24E-07	**YES**
Zinc	---	4.97E-07	**YES**
Dioxins/Furans	4.5E-08	4.01E-14	No
Benzo(a)anthracene	9.2E-03	8.93E-10	No
Benzo(a)pyrene	9.2E-04	2.31E-09	No
Benzo(b)fluoranthene	9.2E-03	4.43E-09	No
DDE	2.0E-02	5.25E-10	No
Dibenz(a,h)anthracene	9.2E-04	1.05E-10	No
Dieldrin	4.2E-04	---	No
Indeno(1,2,3-cd)pyrene	9.2E-03	5.25E-10	No
1,1-Dichloroethylene	3.8E-02	1.30E-09	No
Chlorobenzene	2.1E+00	8.75E-07	No

Notes:
PRGs were taken directly from the Region 9 PRG Table (USEPA 1996c). Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:
[a] Micrograms per cubic meter.
[b] Not applicable.
[c] Federal ambient air quality criterion for lead.

TABLE 29-5

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goals (PRGs), Future Off-Facility Recreational Users of Middle Fork Creek

	USEPA Region 9 PRG Screen		
Chemical	Ambient Air PRG (µg/m³)[a]	Exposure Point Conc. (µg/m³)	Retained as Air COPC
Aluminum	---[b]	5.97E-03	**YES**
Arsenic	4.5E-04	3.03E-06	No
Barium	5.2E-02	7.60E-06	No
Beryllium	8.0E-04	2.36E-07	No
Cadmium	1.1E-03	1.48E-08	No
Chromium	2.3E-05	9.57E-06	No
Lead	1.5E+00[c]	1.10E-06	No
Manganese	5.1E-03	4.32E-04	No
Silver	---	1.67E-05	**YES**
Thallium	---	1.55E-06	**YES**
Vanadium	---	1.51E-06	**YES**
Zinc	---	7.56E-07	**YES**
Dioxins/Furans	4.5E-08	8.30E-14	No
Benzo(a)anthracene	9.2E-03	1.36E-09	No
Benzo(a)pyrene	9.2E-04	7.95E-09	No
Benzo(b)fluoranthene	9.2E-03	1.66E-08	No
DDE	2.0E-02	8.00E-10	No
Dibenz(a,h)anthracene	9.2E-04	1.60E-10	No
Dieldrin	4.2E-04	---	No
Indeno(1,2,3-cd)pyrene	9.2E-03	8.00E-10	No
1,1-Dichloroethylene	3.8E-02	1.32E-08	No
Chlorobenzene	2.1E+00	1.45E-06	No

Notes:

PRGs were taken directly from the Region 9 PRG Table (USEPA 1996c). Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:

a Micrograms per cubic meter.
b Not applicable.
c Federal ambient air quality criterion for lead.

TABLE 29-6

Selection of Contaminants of Potential Concern (COPC) in Groundwater Based on USEPA Region 9 Preliminary Remediation Goals (PRGs), Off-Site Receptor Point A - Laurel Aquifer

	USEPA Region 9 PRG Screen		
Chemical	**Tap Water PRG (µg/L)[(a)]**	**Exposure Point Conc. (µg/L)**	**Retained as GW COPC**
Aluminum	3.65E+03	8.15E+01	No
Antimony	1.46E+00	1.23E-02	No
Arsenic	4.48E-02	4.75E-02	**YES**
Barium	2.56E+02	2.44E-01	No
Beryllium	1.56E-02	3.30E-04	No
Boron	3.29E+02	1.58E+00	No
Chromium	1.83E+01	1.66E-01	No
Cobalt	2.19E+02	8.98E-03	No
Copper	1.36E+02	1.13E-02	No
Lead	4.00E+00[(b)]	8.31E-03	No
Manganese	1.70E+02	1.38E+00	No
Mercury	1.10E+00	1.40E-04	No
Molybdenum	1.83E+01	1.24E-01	No
Nickel	7.30E+01	7.71E-02	No
Selenium	1.83E+01	4.57E-03	No
Vanadium	2.56E+01	4.46E-02	No
Zinc	1.10E+03	1.59E-01	No
1,1-Dichloroethane	8.11E+01	1.10E-04	No
1,1-Dichloroethylene	4.56E-02	7.21E-01	**YES**
1,1,1-Trichloroethane	7.92E+01	9.22E-06	No
1,1,2-Trichloroethane	2.00E-01	1.34E-05	No
1,2-Dichloroethane	1.23E-01	9.20E-07	No
1,2-Dichloroethylene (mixed isomers)	5.48E+00	7.14E-03	No
4-Amino-2,6-dinitrotoluene	---[(c)]	1.85E-04	**YES**
Acetone	6.08E+01	2.24E-09	No
Benzene	3.86E-01	6.94E-06	No

TABLE 29-6

Selection of Contaminants of Potential Concern (COPC) in Groundwater Based on USEPA Region 9 Preliminary Remediation Goals (PRGs), Off-Site Receptor Point A - Laurel Aquifer

	USEPA Region 9 PRG Screen		
Chemical	Tap Water PRG (µg/L)[(a)]	Exposure Point Conc. (µg/L)	Retained as GW COPC
Carbon disulfide	2.07E+00	7.51E-04	No
Chloroethane (ethyl chloride)	7.05E+01	1.93E-10	No
Chloromethane (methyl chloride)	1.51E+00	6.86E-11	No
Dimethylphthalate	3.65E+04	3.81E-10	No
Methylene chloride	4.28E+00	1.94E-10	No
Pyrene	1.83E+01	7.69E-11	No
Toluene	7.23E+01	3.88E-06	No
Trichloroethylene	1.64E+00	6.61E-03	No
Vinyl chloride	1.98E-02	1.05E-04	No
o-Xylene	1.43E+02	1.42E-11	No
Xylene, mixed isomers	1.43E+02	7.46E-11	No

Notes:
PRGs were taken directly from the Region 9 PRG Table (USEPA 1996c). Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:
[a] Micrograms per liter.
[b] Full PRG used for lead.
[c] Not available or not applicable.

TABLE 29-7

Selection of Contaminants of Potential Concern (COPC) in Groundwater Based on USEPA Region 9 Preliminary Remediation Goals (PRGs), Off-Site Receptor Point B - Jefferson-Louisville Aquifer

	USEPA Region 9 PRG Screen		
Chemical	**Tap Water PRG (µg/L)[a]**	**Exposure Point Conc. (µg/L)**	**Retained as GW COPC**
Aluminum	3.65E+03	8.07E+03	**YES**
Antimony	1.46E+00	2.75E+00	**YES**
Barium	2.56E+02	2.70E+02	**YES**
Beryllium	1.56E-02	6.58E-01	**YES**
Chromium	1.83E+01	3.55E+01	**YES**
Cobalt	2.19E+02	1.62E+01	No
Copper	1.36E+02	1.01E+01	No
Manganese	1.70E+02	2.00E+03	**YES**
Mercury	1.10E+00	7.90E-02	No
Molybdenum	1.83E+01	2.83E+01	**YES**
Nickel	7.30E+01	3.32E+01	No
Selenium	1.83E+01	2.80E+00	No
Vanadium	2.56E+01	2.44E+01	No
Zinc	1.10E+03	3.09E+01	No
1,1-Dichloroethane	8.11E+01	1.62E+00	No
1,1-Dichloroethylene	4.56E-02	2.36E+01	**YES**
1,1,1-Trichloroethane	7.92E+01	2.77E+00	No
1,1,2-Trichloroethane	2.00E-01	5.77E-03	No
1,2-Dichloroethane	1.23E-01	1.24E-02	No
1,2-Dichloroethylene (mixed isomers)	5.48E+00	2.33E-01	No
1,3,5-Trinitrobenzene	1.83E-01	6.60E-02	No
2-Chlorophenol	3.84E+00	1.00E+00	No
4-Chloro-3-cresol	---[b]	1.50E+00	**YES**
Acenaphthene	3.65E+01	5.60E-01	No
Acetone	6.08E+01	1.52E-08	No
Benzene	3.86E-01	4.62E-05	No

TABLE 29-7

Selection of Contaminants of Potential Concern (COPC) in Groundwater Based on USEPA Region 9 Preliminary Remediation Goals (PRGs), Off-Site Receptor Point B - Jefferson-Louisville Aquifer

	USEPA Region 9 PRG Screen		
Chemical	Tap Water PRG (µg/L)[(a)]	Exposure Point Conc. (µg/L)	Retained as GW COPC
Benzo(a)anthracene	9.21E-02	3.40E-01	**YES**
Benzoic acid	1.46E+04	2.78E-03	No
Bis(2-ethylhexyl)phthalate	4.80E+00	3.70E+00	No
Butylbenzyl phthalate	7.30E+02	7.50E-01	No
Carbon disulfide	2.07E+00	4.79E-03	No
Chloroethane (ethyl chloride)	7.05E+01	3.68E-08	No
Chloroform	1.65E-01	1.16E-02	No
Diethyl phthalate	2.92E+03	8.10E-01	No
Dimethylphthalate	3.65E+04	5.20E+00	No
Di-n-butylphthalate	3.65E+02	3.80E+00	No
Di-n-octylphthalate	7.30E+01	2.70E-01	No
Fluoranthene	1.46E+02	2.50E-01	No
Methylethyl ketone (2-butanone)	1.90E+02	1.47E-08	No
Methyl isobutyl ketone (MIBK)	1.58E+01	1.31E-11	No
Naphthalene	2.43E+01	4.93E-11	No
Pentachlorophenol	5.60E-01	3.13E-13	No
Pyrene	1.83E+01	4.30E-01	No
Toluene	7.23E+01	3.07E-02	No
Trichloroethylene	1.64E+00	7.20E-02	No
Vinyl chloride	1.98E-02	6.85E-03	No
o-Xylene	1.43E+02	7.17E-11	No
Xylene, mixed isomers	1.43E+02	8.44E-11	No

Notes:

. PRGs were taken directly from the Region 9 PRG Table (USEPA 1996c). Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:

[a] Micrograms per liter.
[b] Not available or not applicable.

TABLE 29-8

Selection of Contaminants of Potential Concern (COPC) in Groundwater Based on USEPA Region 9 Preliminary Remediation Goals (PRGs), Off-Site Receptor Point B* - Jefferson-Louisville Aquifer

	USEPA Region 9 PRG Screen		
Chemical	Tap Water PRG (µg/L)[(a)]	Exposure Point Conc. (µg/L)	Retained as GW COPC
1,1-Dichloroethane	8.11E+01	1.12E+00	No
1,1-Dichloroethylene	4.56E-02	2.36E+01	**YES**
1,1,1-Trichloroethane	7.92E+01	2.20E+00	No
1,1,2-Trichloroethane	2.00E-01	5.77E-03	No
1,2-Dichloroethane	1.23E-01	1.24E-02	No
1,2-Dichloroethylene (mixed isomers)	5.48E+00	2.33E-01	No
Acetone	6.08E+01	1.52E-08	No
Benzene	3.86E-01	4.62E-05	No
Benzoic acid	1.46E+04	2.78E-03	No
Butylbenzyl phthalate	7.30E+02	4.42E-11	No
Carbon disulfide	2.07E+00	4.79E-03	No
Chloroethane (ethyl chloride)	7.05E+01	3.68E-08	No
Chloroform	1.65E-01	1.16E-02	No
Diethyl phthalate	2.92E+03	1.48E-11	No
Dimethylphthalate	3.65E+04	3.99E-11	No
Di-n-butylphthalate	3.65E+02	1.79E-10	No
Methylethyl ketone (2-butanone)	1.90E+02	1.47E-08	No
Methyl isobutyl ketone (MIBK)	1.58E+01	1.31E-11	No
Naphthalene	2.43E+01	4.93E-11	No
Pentachlorophenol	5.60E-01	3.13E-13	No
Pyrene	1.83E+01	2.32E-11	No
Toluene	7.23E+01	3.07E-02	No
Trichloroethylene	1.64E+00	7.20E-02	No
Vinyl chloride	1.98E-02	6.85E-03	No
o-Xylene	1.43E+02	7.17E-11	No
Xylene, mixed isomers	1.43E+02	8.44E-11	No

Notes

PRGs were taken directly from the Region 9 PRG Table (USEPA 1996c). Values for noncarcinogens are 1/10 of the Region 9 PRG.

* Sites 12A and 12B are assumed to be the only contributing sites.

[a] Micrograms per liter.

TABLE 29-9

Selection of Contaminants of Potential Concern (COPC) in Groundwater Based on USEPA Region 9 Preliminary Remediation Goals (PRGs), Off-Site Receptor Point C - Middle Fork Creek

	USEPA Region 9 PRG Screen		
Chemical	Tap Water PRG (µg/L)[(a)]	Exposure Point Conc. (µg/L)	Retained as GW COPC
Aluminum	3.65E+03	1.19E-01	No
Arsenic	4.48E-02	2.25E-03	No
Barium	2.56E+02	6.95E-02	No
Mercury	1.10E+00	4.25E-06	No
Molybdenum	1.83E+01	9.09E-04	No
Zinc	1.10E+03	7.62E-04	No
1,1-Dichloroethane	8.11E+01	3.42E-01	No
1,1-Dichloroethylene	4.56E-02	1.08E+00	**YES**
1,1,1-Trichloroethane	7.92E+01	2.88E+00	No
1,1,2-Trichloroethane	2.00E-01	5.98E-03	No
1,2-Dichloroethane	1.23E-01	8.46E-04	No
1,2-Dichloroethylene (mixed isomers)	5.48E+00	8.97E-03	No
Acetone	6.08E+01	1.87E-11	No
Benzene	3.86E-01	5.23E-06	No
Benzoic acid	1.46E+04	1.10E-03	No
Butylbenzyl phthalate	7.30E+02	0.00E+00	No
Carbon disulfide	2.07E+00	4.66E-04	No
Chloroethane (ethyl chloride)	7.05E+01	1.78E-06	No
Chloroform	1.65E-01	1.06E-03	No
Diethyl phthalate	2.92E+03	4.85E-14	No
Dimethylphthalate	3.65E+04	6.54E-67	No
Di-n-butylphthalate	3.65E+02	0.00E+00	No
Methylene chloride	4.28E+00	5.86E-07	No
Methylethyl ketone (2-butanone)	1.90E+02	8.32E-54	No
Methyl isobutyl ketone (MIBK)	1.58E+01	2.94E-57	No
Naphthalene	2.43E+01	5.35E-16	No
Pentachlorophenol	5.60E-01	4.35E-07	No
Pyrene	1.83E+01	2.80E-52	No
Toluene	7.23E+01	1.64E-02	No
Trichloroethylene	1.64E+00	1.82E-01	No

TABLE 29-9

Selection of Contaminants of Potential Concern (COPC) in Groundwater Based on USEPA Region 9 Preliminary Remediation Goals (PRGs), Off-Site Receptor Point C - Middle Fork Creek

	USEPA Region 9 PRG Screen		
Chemical	Tap Water PRG (µg/L)[(a)]	Exposure Point Conc. (µg/L)	Retained as GW COPC
Vinyl chloride	1.98E-02	4.71E-04	No
o-Xylene	1.43E+02	3.52E-08	No
Xylene, mixed isomers	1.43E+02	7.84E-15	No

Notes:
PRGs were taken directly from the Region 9 PRG Table (USEPA 1996c). Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:
[a] Micrograms per liter.

TABLE 29-10

Shower Air Concentrations of Volatile Chemicals
Future Off-Site Receptors

Volatile Chemical	Exposure Point Concentration in Groundwater (ug/L[a] = mg/m3[b])	Exposure Point Concentration in Shower Air (mg/m^3)
Off-Site Receptor Point A – Laurel Aquifer		
1,1,-Dichloroethylene	7.21E-01	2.50E-03
Off-Site Receptor Point B – Jefferson-Louisville Aquifer		
1,1-Dichloroethylene	2.36E+01	8.19E-02
Off-Site Receptor Point B*-Jefferson-Louisville Aquifer		
1,1,-Dichloroethylene	2.36E+01	8.19E-02

Footnotes:
- * Sites 12A and 12B are assumed to be the only contributing sites.
- a Micrograms per liter.
- b Milligrams per cubic meter.

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TABLE 29-11

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards for Future Off-Facility Receptors

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
Future Resident Adult at Receptor Point A - Laurel Aquifer				
Inhalation of VOCs[a] and fugitive dusts	3.06E-07		0.0006	
Ingestion of groundwater	5.92E-06		0.0065	
Dermal contact with groundwater	1.49E-07		0.0001	
Inhalation of VOCs while showering	4.26E-07		NA[b]	
Total	6.8E-06		0.0072	
Future Resident Child at Receptor Point A - Laurel Aquifer				
Inhalation of VOCs and fugitive dusts	2.31E-07		0.0022	
Ingestion of groundwater	2.76E-06		0.0152	
Dermal contact with groundwater	2.84E-08		0.0001	
Inhalation of VOCs while showering	1.65E-07		NA	
Total	3.18E-06		0.0175	
Future Resident Adult at Receptor Point B - Jefferson-Louisville Aquifer				
Inhalation of VOCs and fugitive dusts	NA		NA	
Ingestion of groundwater	1.69E-04	Benzo(a)anthracene (1.7%), 1,1-dichloroethylene (98.3%)	2.0453	Manganese (58.2%)
Dermal contact with groundwater	4.83E-06		0.0057	
Inhalation of VOCs while showering	1.40E-05	1,1-Dichloroethylene	NA	
Total	1.88E-04		2.051	

TABLE 29-11

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards for Future Off-Facility Receptors

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
Future Resident Child at Receptor Point B - Jefferson-Louisville Aquifer				
Inhalation of VOCs and fugitive dusts	NA		NA	
Ingestion of groundwater	7.89E-05	1,1-Dichloroethylene (98.3%)	4.7725	Manganese (58.2%)
Dermal contact with groundwater	9.19E-07		0.0054	
Inhalation of VOCs while showering	5.41E-06		NA	
Total	8.52E-05		4.7779	
Future Resident Adult at Receptor Point B* - Jefferson-Louisville Aquifer				
Inhalation of VOCs and fugitive dusts	NA		0.0004	
Ingestion of groundwater	1.66E-04	1,1-Dichloroethylene (100%)	0.0718	
Dermal contact with groundwater	4.83E-06		0.0021	
Inhalation of VOCs while showering	1.40E-05	1,1-Dichloroethylene (100%)	NA	
Total	1.85E-04		0.0743	
Future Resident Child at Receptor Point B* - Jefferson-Louisville Aquifer				
Inhalation of VOCs and fugitive dusts	NA		0.0016	
Ingestion of groundwater	7.76E-05		0.1676	
Dermal contact with groundwater	9.19E-07		0.0020	
Inhalation of VOCs while showering	5.41E-06		NA	

TABLE 29-11

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards for Future Off-Facility Receptors

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
Total	8.39E-05		0.1712	
Future Recreational User Adult at Middle Fork Creek				
Inhalation of VOCs and fugitive dusts	NA		NA	
Incidental ingestion of surface water	1.96E-08		0.0000	
Dermal contact with surface water	4.39E-08		0.0000	
Total	6.35E-08		0.0000	
Future Recreational User Child at Middle Fork Creek				
Inhalation of VOCs and fugitive dusts	NA		NA	
Incidental ingestion of surface water	1.83E-08		0.0000	
Dermal contact with surface water	2.09E-08		0.0000	
Total	3.92E-08		0.0000	

Footnotes:

* The assumption is made that only Sites 12A and 12B contribute to the off-site groundwater contamination at Receptor Point B.

[a] Volatile organic compounds.

[b] Not available or not applicable.

TABLE 29-12

Qualitative Uncertainty Analysis
Future Off-Facility Residents

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Overestimation	Comments
A. Human Behavior				
Future receptors' exposure frequency	350 days/year	Low	High	High-end value
Future receptors' exposure duration	30 years	Low	High	National upper-bound time (90th percentile) at one residence
Future receptors' drinking water rate	2 L/day[(a)]	Low	High	Water consumption rates are high-end values obtained from published distribution data
Exclusion of certain exposure pathways in the quantitative analysis	NA[(b)]	Low	Low	Pathways eliminated are those that have low possibility of contributing risk to these receptors
B. Chemical Fate/Transport in the Environment				
Modeling of exposure point concentration of COCs[(c)]	NA	Low	High	Maximum on-site groundwater concentrations used in model
All on-site plumes converge to yield maximum cumulative off-site impact	NA	Low	High	Highly unlikely scenario
Shower model used to predict concentrations of VOCs in shower air	NA	Low	High	Conservative assumptions and input parameters
C. Chemical Toxicity				
Assumption that USEPA[(d)] reference doses truly represent toxicological thresholds	NA	Low	High	High degree of conservativeness utilized by USEPA in deriving RfDs[(e)] from toxicological literature

TABLE 29-12

Qualitative Uncertainty Analysis
Future Off-Facility Residents

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
Assumption that USEPA carcinogenic slope factors truly represent dose-response phenomena	NA	Low-moderate	Moderate-high	Use of linearized, multi-stage mathematical model to predict cancer incidence at low exposure levels is USEPA policy; not currently supported by scientific data
Assumption of risk/hazard additivity	NA	Moderate	Moderate	Summation of chemical-specific risks/hazards may over- or under-predict risks/hazards to receptors
Screening out of certain contaminants based on USEPA criteria	NA	Low	Low	Chemicals present in concentrations less than Region 9 criteria eliminated

Footnotes:

[a] Liters per day.
[b] Not applicable.
[c] Contaminant of concern.
[d] U.S. Environmental Protection Agency.
[e] Reference doses.

30.0 CURRENT FACILITY TENANTS/RESIDENTS

30.1 HUMAN HEALTH RISK ASSESSMENT

30.1.1 Selection of Contaminants of Potential Concern

30.1.1.1 Air.

30.1.1.1.1 Summary of Preliminary COPCs. Ambient air concentrations to which current facility tenants/residents might be exposed were estimated using air emission/dispersion modeling, as described in Appendix R. For determining ambient air concentrations in the current scenario for current facility tenants/residents, only those sites not completely vegetated or covered with concrete were assumed to contribute to the maximum air concentrations at the facility. Table R-2 in Appendix R presents the estimated maximum on-facility ambient air concentrations under the current land use scenario at a tenant/resident location.

30.1.1.1.2 Region 9 Preliminary Remediation Goal Screening. The maximum on-facility exposure point concentration for each preliminary air COPC for current tenants/residents was compared to the chemical-specific Region 9 air PRG (Table 30-1). One-tenth of the PRG was used for noncarcinogens. The exception was lead, for which the full PRG was used. As a result of the screening, aluminum, chromium, thallium, and vanadium are retained as air COPCs for current facility tenants/residents.

30.1.2 Exposure Assessment

30.1.2.1 Site Conceptual Model. Once the COPCs have been identified for a site, these results along with project data such as regional land uses, future land development possibilities, site hydrogeology, etc. are used to finalize a site-specific conceptual model for the quantitative assessment. This model schematically describes the relationship between the contaminants at a site and any potentially impacted human populations. It details the various current and potentially future uses of the site and then describes for each scenario the various exposure pathways by which the human populations may come into contact with the contaminated environmental media at the site.

There are several types of individuals who could potentially be affected by the existing contamination at the facility. One of these receptor groups is composed of the current tenants/residents who work/live in several of the buildings on the facility. None of these buildings is located at any of the sites being investigated in this RI, and these individuals have been instructed not to enter any of these sites because of the existing contamination. Also, only adults currently reside/work at the facility. To assess the potential risk/hazards to these individuals, it was determined that their main exposure pathway to the existing contamination at the facility would be:

- Inhalation of VOCs and fugitive particulates from soils

Although these individuals do not enter any of the contaminated sites at the facility, windblown soils and volatile chemicals could impact the ambient air where these people work/live. Therefore, this one exposure pathway is quantitatively addressed in this assessment. It is assumed, as with the off-facility receptors, that these individuals would be simultaneously exposed to contaminants released from multiple sites. Thus, a cumulative impact analysis was performed.

30.1.2.2 Exposure Point Concentrations.

30.1.2.2.1 Air. The estimated maximum ambient air concentrations of COPCs at a current on-facility tenant/resident location are presented in Table 30-1.

30.1.2.3 Human Exposure Doses.

30.1.2.3.1 Inhalation of Contaminated Air. Inhalation of airborne contaminants (VOCs and particulates) is a potential route of exposure for on-facility tenants/residents. The equation used for calculating human exposure doses of COPCs due to inhalation of volatile and dust-bound contaminants is provided in Table 5-**11**~~12~~, along with the values of the exposure variables. Section 5.1.5.3.1 explains the exposure variables in further detail. Table V-21, Appendix V, documents the calculation of on-facility tenant/resident exposure doses due to inhalation of contaminated air.

30.1.3 Risk Characterization

30.1.3.1 Chronic Health Hazards. The noncancer daily exposure doses calculated in the exposure assessment were used to calculate HQs for each of the COPCs possessing RfDs. Pathway-specific and overall HIs were then calculated for each receptor. The calculations of HQs and HIs are described in Section 5.1.7.1. If an overall HI is calculated to be greater than 1.0 for a particular receptor, then the exposure pathway(s) primarily responsible for the result is identified as a "critical pathway(s)." For each critical pathway, those chemical contaminants responsible for the majority of the HI are listed as COCs. Table W-21, Appendix W, documents the calculation of the pathway- and chemical-specific HQs for current on-facility tenants/residents. The pathway-specific and overall HIs are summarized in Table 30-2.

The overall HIs for the current on-facility adult resident and tenant (**commercial** worker) are calculated to be **0.007** ~~0.002~~ and **0.0023**~~0.0006~~, respectively. These HIs are less than the USEPA's risk management criterion of 1.0. Therefore, no critical exposure pathways or noncarcinogenic COCs are identified for these receptors.

30.1.3.2 Excess Lifetime Cancer Risks. The cancer risks for each receptor were determined from the pathway-specific exposure doses and the route-specific SFs, as described in Section 5.1.7.2. To assess the simultaneous exposure of a receptor population to multiple carcinogens from multiple exposure routes, all of the cancer risks calculated for a receptor population were summed. Each overall receptor cancer risk was then compared to USEPA's

target risk range (1.0E-06 to 1.0E-04). If the total cancer risk for a receptor from all exposure pathways is less than 1.0E-04, then it is concluded that the site(s) does not pose a significant risk to that receptor. If the overall cancer risk exceeds the target risk range, any chemical individually associated with a risk level greater than 1.0E-05 is identified as a COC. COCs represent the primary contributors to the potential cancer risk for the receptor-specific exposure pathway under evaluation. Table W-21, Appendix W, documents the calculation of the pathway- and chemical-specific cancer risks for the current on-facility tenants/residents. The pathway-specific and overall cancer risks are summarized in Table 30-2.

The overall cancer risks calculated for the current on-facility adult resident and tenant (**commercial** worker) are **3.6**~~3.5~~E-06 and **9.8** ~~6.9~~E-07, respectively. These cancer risks are within or below the USEPA's target risk range of 1.0E-06 to 1.0E-04. Therefore, no critical exposure pathways or carcinogenic COCs are identified for these receptors.

30.1.3.3 Uncertainty/Sensitivity Analysis. The numerical risks/hazards calculated for current on-facility tenants/ residents represent *conditional* estimates of risk based on various simplifying assumptions concerning contaminant exposure and toxicity. These estimates of risk/hazard are derived using a series of conservative procedures that address contaminant concentrations at the facility, their fate in the environment, how someone currently might be exposed to these contaminants, and the toxicity of each chemical toward humans. The uncertainty analysis specifies, when appropriate, the critical assumptions made for the receptors so that the results can be interpreted by risk managers in a proper context.

To assist the risk managers in this project, a qualitative uncertainty analysis has been performed. The primary goals of a qualitative uncertainty analysis are (1) to itemize the major areas of uncertainty in the scenario-specific risk assessment and (2) to demonstrate that the assessment overall has been conservatively performed (i.e., that the potential risks/hazards have not likely been underestimated, but may have been significantly overestimated).

The qualitative uncertainty analysis for the current on-facility tenants/resident is presented in Table 30-3. Based on this analysis, it can be concluded that this risk assessment is conservative. Some of the major uncertainties in this study that are most influential to the calculated risks/hazards include:

- Air dispersion modeling used to calculate ambient air concentrations at the facility
- Receptors' exposure time (24 hours/day)
- Receptors' exposure duration (30 years)

30.2 CONCLUSIONS AND RECOMMENDATIONS

Because the former military housing area is currently occupied by on-site residents and many other buildings are occupied by workers, the current facility tenants/residents exposure

scenario was evaluated. For this scenario, the pathway of concern was inhalation due to windblown dust potentially originating from contaminated sites south of the Firing Line.

The results of this assessment indicate that there are no chronic health hazards associated with this scenario. Cancer risk estimates show that for the facility resident the risks are within the USEPA target range of 1E-04 to 1E-06. For the facility tenant, the risk estimates are below the target range.

Based on the risk assessment results for the current facility residents and tenants, it is recommended that no further investigation be conducted for these scenarios.

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TABLES

TABLE 30-1

Selection of Contaminants of Potential Concern (COPC) in Air Based on USEPA Region 9 Preliminary Remediation Goal (PRGs), Current Facility Tenants/Residents

Chemical	USEPA Region 9 PRG Screen		
	Ambient Air PRG (µg/m³)[a]	**Exposure Point Conc. (µg/m³)**	**Retained as Air COPC?**
Aluminum	---[b]	9.62E-03	**YES**
Arsenic	4.5E-04	---	No
Barium	5.2E-02	5.92E-04	No
Beryllium	8.0E-04	2.31E-06	No
Cadmium	1.1E-03	---	No
Chromium	2.3E-05	1.01E-03	**YES**
Lead	1.5E+00[c]	---	No
Manganese	5.1E-03	4.14E-03	No
Silver	---	---	No
Thallium	---	3.11E-04	**YES**
Vanadium	---	9.18E-06	**YES**
Zinc	---	---	No
Dioxins/Furans	4.5E-08	---	No
Benzo(a)anthracene	9.2E-03	---	No
Benzo(a)pyrene	9.2E-04	3.67E-06	No
Benzo(b)fluoranthene	9.2E-03	8.13E-06	No
DDE	2.0E-02	---	No
Dibenz(a,h)anthracene	9.2E-04	---	No
Dieldrin	4.2E-04	1.41E-06	No
Indeno(1,2,3-cd)pyrene	9.2E-03	---	No
1,1-Dichloroethylene	3.8E-02	4.66E-09	No
Chlorobenzene	2.1E+00	6.89E-06	No

Note:
PRGs were taken directly from the Region 9 PRG Table (USEPA 1998). Values for noncarcinogens are 1/10 of the Region 9 PRG.

Footnotes:
(a) Micrograms per cubic meter.
(b) Not applicable.
(c) Federal ambient air quality criterion for lead.

TABLE 30-2

Summary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards for Current Facility Tenants/Residents

Exposure Pathway	Pathway-specific Cancer Risk	Carcinogenic Contaminants of Concern	Pathway-specific Hazard Index	Noncarcinogenic Contaminants of Concern
		Adult Resident		
Inhalation of VOCs[a] and fugitive dusts	3.57E-06		0.0069	
		Adult Worker		
Inhalation of VOCs and fugitive dusts	9.84E-07		0.0023	

Footnote:

(a) Volatile organic compounds.

TABLE 30-3

Qualitative Uncertainty Analysis
Current On-Facility Tenants/Residents

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
A. Human Behavior				
Current receptors' exposure time	24 hours/day	Low	High	Maximum possible value
Current receptors' exposure duration	30 years	Low	High	National upper-bound time (90th percentile) at one residence
Exclusion of certain exposure pathways in the quantitative analysis	NA[(a)]	Low	Low	Pathways eliminated are those that have low possibility of contributing risk to these receptors
B. Chemical Fate/Transport in the Environment				
Use of air dispersion modeling to predict air concentrations	NA	Low	High	Conservative assumptions and input parameters
C. Chemical Toxicity				
Assumption that USEPA[(b)] reference doses truly represent toxicological thresholds	NA	Low	High	High degree of conservativeness utilized by USEPA in deriving RfDs[(c)] from toxicological literature
Assumption that USEPA carcinogenic slope factors truly represent dose-response phenomena	NA	Low-moderate	Moderate-high	Use of linearized, multi-stage mathematical model to predict cancer incidence at low exposure levels is USEPA policy; not currently supported by scientific data

TABLE 30-3

Qualitative Uncertainty Analysis
Current On-Facility Tenants/Residents

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
Assumption of risk/hazard additivity	NA	Moderate	Moderate	Summation of chemical-specific risks/hazards may over- or under-predict risks/hazards to receptors
Screening out of certain contaminants based on USEPA criteria	NA	Low	Low	Chemicals present in concentrations less than Region 9 criteria eliminated

Footnotes:
(a) Not available or not applicable.
(b) U.S. Environmental Protection Agency.
(c) Reference doses.

31.0 ECOLOGICAL RISK ASSESSMENT - SITE 11

No revisions have been made to this section because the work is being performed by others.

31.1 ECOLOGICAL SITE DESCRIPTION

The Open Burning Area for Explosive Residue (Site 11) is a former active-powder burning area located in the southeastern corner of the installation (Figure 31-1). The site had been used since the early 1950s to burn excess propellants. Approximately 60,000 pounds of excess propellants per year were open burned at this location. Until 1995, the burning was conducted in metal trays with locking covers; however, in the past, the open burning was conducted directly on the ground surface. Site 11 is undergoing a closure plan under RCRA; however, no closure plan sampling data were available at the time of this report. In September 1997, it was observed that all of the former burn pans had been removed from the site.

The fenced area, consisting of approximately 1.6 acres, is characterized as flat to gently rolling with the surface sloping gently to the north toward a branch of Harberts Creek located about 1,200 feet away. The soils in this area belong to the Cobbsfork soil series. The glacial till is about 40 to 45 feet thick and underlain by Jeffersonville Limestone of Devonian age.

Ecologically, this site is an open field that was infrequently mowed and burned until 1995. Early to mid-successional flatwoods surround the site in all directions. The soil may have been plowed under at one time, and it was included in the open burning program until 1995. The regrowth vegetation is very weedy and not uniform. Several disturbed areas are bare with only minimal vegetation. Typical observed species included various sedges and rushes near drainages, hop-clover, clover, aster, dock, pepper grass, and mullein. The only birds or wildlife observed were crows. Crayfish holes were observed in the area.

31.2 SITE 11 INVESTIGATIONS

For convenience to the reader, summary statistics, EPCs, risk driver HQs, total RME and CT HIs are provided in this section. All intakes and other non risk-driving HQs are located in Appendix AA.

31.2.1 Phase I Activities

The Phase I summary statistics for Site 11 are provided in Table 31-1. Table 31-2 provides the EPCs for Site 11.

31.2.2 Phase II Activities

Phase II sampling activities were not performed at this site. RCRA closure plan data were not available at the time of this report.

31.2.3 Phase III Activities

The Phase III summary statistics for Site 11 are provided in Table 31-3. Table 31-4 provides the EPCs for Site 11. The field activities conducted at Site 11 are described in Section 5.3.3.3.

31.3 EXPOSURE AND ECOLOGICAL EFFECTS PROFILE

Birds and mammals may be exposed to COPCs by direct contact with or ingestion of soil. No surface water data were available at Site 11. To determine the estimated intakes of the COPCs, various key receptor species were selected to evaluate the impacts to area wildlife. The key receptors evaluated for Site 11 include mourning dove, chimney swift, American kestrel, wild turkey, white-footed mouse, eastern cottontail, red fox, little brown myotis, plants, and soil fauna.

The exposure pathways and receptors evaluated at this site are as follows:

- Terrestrial Ecosystem
  - All wildlife receptors—soil ingestion
  - All wildlife receptors—dietary ingestion
  - Plants—direct contact with soil
  - Soil fauna—direct contact with soil

31.3.1 Selection of COPCs

Inorganic analytes from soil data collected during Phases I and III were compared to the JPG Phase II background data set (Section 5.3.2.1). Analytes that were not statistically elevated relative to background were removed from consideration as COPCs**.** The COPCs for Site 15 in the various media are presented in Tables 31-1 through 31-4.

Only silver, boron, lead, and di-n-butyl phthalate were retained as COPCs for Site 11 Phase I. All other inorganics were removed as COPCs since their soil concentrations were not statistically elevated above background. There were no detects of explosives, herbicides, or SVOCs in the Phase I surface soil data.

Only cadmium, manganese, molybdenum, selenium, vanadium, and zinc were retained as COPCs for ecological study Site 11 Phase III. All other inorganics were removed as COPCs since their soil concentrations were not statistically elevated above background.

31.3.2 Comparison to Reference Area Concentrations

Concentrations of COPCs were not significantly higher than those at the reference areas.

31.3.3 Earthworm Toxicity Test

The null hypothesis is "the number of dead earthworms is similar among all locations". The χ^2 test statistic was 49.25 with a degrees of freedom of 40, which resulted in a p value of 0.1498. Since this p-value exceeds 0.1, the site location may bear no relation to earthworm mortality when this test is used.

ANOVA on the arcsine-transformed data provides a different interpretation. The p-value for ANOVA is 0.0016, indicating a significant difference between the mean mortality from one location to another at the 95 percent confidence level. A 95 percent LSD test indicated that mortality was significantly lower at Site 11 than at the Rossmoyne reference area, but that mortality at Site 11 overlapped (was not significantly different from) that observed at the Avonburg or Cobbsfork reference area. The statistical analysis therefore indicates that earthworm mortality is not likely to be significantly affected by existing site conditions at Site 11.

31.3.4 Phytotoxicity Test

The phytotoxicity early seedling growth test resulted in data for percent germination and biomass. The results are summarized in Appendix Z. There was little variability in germination rates. The germination data were neither normal nor log-normal. The biomass data on a wet-weight basis were lognormal. Percent germination at Site 11 ranged from 89 to 100 percent.

ANOVA of the germination data resulted in a p-value of 0.1480, which is greater than 0.05, indicating that location does not have a statistically significant effect on germination at the 95 percent confidence level. An ANOVA of the biomass data resulted in a p-value of 0.0037, indicating site location has a significant effect on wet weight biomass at the 95 percent confidence level. The lowest biomass observed in the study was the biomass for the Cobbsfork reference area. An LSD multiple range test revealed that the wet-weight biomass for Site 11 was not significantly different from that of the three reference areas.

The biomass data indicate that existing site conditions at Site 11 will not significantly decrease plant growth or reproduction relative to effects observed in controls.

31.3.5 Soil Fauna Community Structure

The number of individuals per sample (density) was log-normal. The number of species was neither normal nor log-normal. Diversity ranged from 0 to 97 percent at the reference areas, indicating that this parameter is so inherently variable at JPG that it may not be useful to identify contaminant-related effects. The number of individuals was not significantly different

by location when the log-transformed data were analyzed by ANOVA. The number of invertebrate species was not statistically significantly different at the 95 percent confidence level when analyzed by the Kruskal-Wallis test. There does not appear to be any effect of site location on soil invertebrates, although community similarity will be examined in a later version.

31.4 RISK CHARACTERIZATION

31.4.1 Risk Estimation

The HIs are summarized for each sampling event and receptor below. The HIs have been grouped by order of magnitude for discussion purposes. HIs based on RME and CT exposure parameters are presented. In addition, a conservative NOAEL-based TRV and a dose at which population-level effects may occur (LOAEL-based TRV) were used to establish the lower and upper bounds on toxicity, respectively. These values define the risk boundaries. There are thus four sets of HI values for each location and sampling event (i.e., NOAEL-RME, NOAEL-CT, LOAEL-RME, and LOAEL-CT). The exposure intakes, HQs, and HIs are presented in Appendix AA. Figures 31-2 through 31-9 show the total NOAEL and LOAEL-based HI risks for both the RME and CT exposure scenarios by receptor. The reference area RME-NOAEL HIs were presented graphically only on the RME-NOAEL site graphs due to the low risks generally observed.

Site 11

Phase I RME NOAEL HIs
(See Figure 31-2)
Key Receptors with HI range 0-1: Mourning Dove, Wild Turkey, Red Fox, Chimney Swift, American Kestrel, Little Brown Myotis, Soil Fauna
HI Range 1.1-10: Eastern Cottontail, Plants
HI Range 10.1-100: White-footed Mouse, Eastern Cottontail, Soil Fauna
HI Range 100.1-1000: None

Phase I RME LOAEL HIs
(See Figure 31-3)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Red Fox, Little Brown Myotis, Eastern Cottontail, Plants, Soil Fauna
HI Range 1.1-10: White-footed Mouse
HI Range 10.1-100: None
HI Range 100.1-1000: None

Phase I CT NOAEL HIs
(See Figure 31-4)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, American Kestrel, Red Fox, Little Brown Myotis

HI Range 1.1-10: Eastern Cottontail
HI Range 10.1-100: White-footed Mouse
HI Range 100.1-1000: None

Phase I CT LOAEL HIs
(See Figure 31-5)
Key Receptors with HI range 0-1: Wild Turkey, Red Fox, American Kestrel, Mourning Dove, Chimney Swift, Little Brown Myotis, Eastern Cottontail
HI Range 1.1-10: White-footed Mouse
HI Range 10.1-100: None
HI Range 100.1-1000: None

Site 11

Phase III RME NOAEL HIs
(See Figure 31-6)
Key Receptors with HI range 0-1: Mourning Dove, Chimney Swift, Wild Turkey, Red Fox
HI Range 1.1-10: American Kestrel, Little Brown Myotis, Soil Fauna
HI Range 10.1-100: Eastern Cottontail, Plants
HI Range 100.1-1000: White-footed Mouse

Phase III RME LOAEL HIs
(See Figure 31-7)
Key Receptors with HI range 0-1: Mourning Dove, Wild Turkey, American Kestrel, Red Fox, Chimney Swift, Little Brown Myotis, Soil Fauna, Plants
HI Range 1.1-10: Eastern Cottontail
HI Range 10.1-100: White-footed Mouse
HI Range 100.1-1000: None

Phase III CT NOAEL HIs
(See Figure 31-8)
Key Receptors with HI range 0-1: Wild Turkey, American Kestrel, Mourning Dove, Chimney Swift, Red Fox
HI Range 1.1-10: Little Brown Myotis
HI Range 10.1-100: White-footed Mouse, Eastern Cottontail
HI Range 100.1-1000: None

Phase III CT LOAEL HIs
(See Figure 31-9)
Key Receptors with HI range 0-1: Wild Turkey, Red Fox, American Kestrel, Mourning Dove, Chimney Swift, Little Brown Myotis
HI Range 1.1-10: Eastern Cottontail
HI Range 10.1-100: White-footed Mouse
HI Range 100.1-1000: None

31.4.2 Risk Description

No Phase III analytes were statistically elevated at Site 11 relative to the reference areas. All COPCs at Site 11 were within the expected ambient concentrations predicted by the data from the reference areas.

The soils at Site 11 did not produce elevated levels of mortality in earthworms relative to that observed at the reference areas, nor was the soil fauna diversity obviously affected. Plant germination and biomass were not significantly different at Site 11 than at the reference areas.

RME NOAEL-based risks at Site 11 are lower than those at the reference areas (Figures 31-2 and 31-6) for both Phase I and III data. The HIs for each reference area and the inherent JPG Phase II background risks can be found in Section 32.

The Phase I and III RME LOAEL-based HIs for Site 11 were similar to or less than the RME LOAEL based HIs (Figure 31-3 and 31-7) at the reference areas.

The HI results indicate that Site 11 is not a significant ecological risk since HIs are similar to those at the reference areas. The HI results are supported by the results of the biometric studies, which measured a lack of population and individual level effects in earthworms and other soil invertebrates, and in plants. The results suggest that the NOAEL TRVs are overly conservative for this site, since ambient levels of inorganics in the reference areas produce high risk estimates, yet no analytes statistically exceed measured concentrations at the reference areas. Consideration of all lines of evidence support the conclusion that contamination at Site 11 is not a likely threat to ecological health at JPG.

31.4.2.1 Risk Drivers. Risk drivers associated with Site 11 are summarized in Tables 31-5 through 31-8. A COPC was categorized as a risk driver if it produced an HQ greater than or equal to 1 for any exposure pathway.

31.4.3 Uncertainty Analysis

There were only 2 data sets at this site. However, there were 14 soil samples in Phase I and 5 in Phase III, which is a fair sampling coverage in this small area. This reduces uncertainty since the sampling effort should be adequate.

Uncertainty in the exposure estimates is due primarily to:

- Variability in the exposure parameters, which produce a natural distribution of the variables in the intake equations for each of the receptors;
- Exposure parameters derived from literature and not measured on site;
- Uncertainty in the dietary ingestion pathway, which utilized BAFs to predict dietary concentrations;

- Variation in the concentrations of COPCs in the environment;
- Uncertainty as to whether the most conservative pathways have been addressed and evaluated.

The predicted effect of each of these sources of uncertainty on the risk assessment is as follows:

Variability in the exposure parameters—Because both the average and RME scenarios were quantitatively addressed, this source of uncertainty is expected to have no overall effect on the risk assessment results.

Exposure parameters derived from literature—Because so many ecological receptors were quantitatively considered in the ecological risk assessment, this source of uncertainty is expected to have no overall effect on the risk assessment.

Uncertainty in the dietary ingestion pathway—The use of literature-based BAFs or BCFs is expected to overestimate as opposed to underestimate concentrations in the dietary pathway. This is because under laboratory conditions, animals are chronically exposed on a daily basis and supposedly reach steady state. In the wild, as animals move in and out of contaminated areas, metabolism and excretion are expected to reduce the body burden. Use of field-based BAFs from TEAD is not expected to overestimate or underestimate risk for these analytes, since these data were measured in conjunction with co-located soil samples.

Variation in the concentrations of COPCs in the environment—This uncertainty is not expected to bias the risk assessment towards underestimation of risk since maximum or UCL95 concentrations were used in all exposure scenarios to estimate the EPCs.

Uncertainty whether the most conservative pathways have been addressed—The receptors were considered carefully by the DSG and typically have high exposure rates due to their life-histories (i.e., ground-feeding or burrowing). Therefore, this source of uncertainty is not expected to impact the risk assessment.

Uncertainty in the ecological analysis is less than the uncertainty in the exposure estimates because these data were gathered as part of a site-specific, controlled field study. There were sufficient samples collected at each site (n=5) to identify within and between site variability. The data identify the potential for adverse effects to species that form the basis of the JPG food web, that is, the plants and soil fauna.

31.5 RISK ASSESSMENT SUMMARY AND CONCLUSIONS

The following summary and conclusions are based on an initial review of the data. A full evaluation of whether or not the data meet all DQOs, and further statistical examination, will be made prior to finalizing these results for the next version of this report.

- Based on the ecological effects data, there are no ecological effects at this site.
- Site 11 does not represent a significant ecological risk.

TABLES

Table 31-1. Summary Statistics for COPCs at JPG Site 11 - Metals & Semi-volatile Organic Compounds (SVOCs) in Soil - Phase I

Site	Medium	Analyte Code	Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Std. Deviation	UCL95 [a]	EPC µg/g [b]
11	CSO [c]	AG	Silver	7	14	50	0.01	0.04	0.02	0.01	0.02	0.02
11	CSO	B	Boron	2	14	14	3.32	9.91	4.25	2.37	5.38	5.38
11	CSO	PB	Lead	14	14	100	7.92	790.0	240.6	241.4	354.9	354.9
11	CSO	DNBP	Di-n-butyl phthalate	1	2	50	0.65	2.50	1.58	1.31	7.42	2.50

[a]Upper 95% confidence limit.

[b]Exposure point concentration, micrograms per gram, equivalent to parts per million.

[c]Surface soil.

Table 31-2. Summary of COPC Exposure Point Concentrations by Medium for Site 11 - Phase I

	Measured Concentrations in Abiotic Media				Estimated Concentrations in Biotic Media							
Analyte Name	Filtered Surface Water (µg/L) [a]	Sediment (mg/kg) [b]	Unfiltered Surface Water (mg/L) [c]	Soil (mg/kg)	Plant (mg/kg)	Invertebrate (mg/kg)	Mouse (mg/kg)	Swift (mg/kg)	Aquatic Plants (mg/kg)	Benthic Invertebrate (mg/kg)	Fish (mg/kg)	Frogs (mg/kg)
Boron				5.38	2.15E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Di-n-butyl phthalate				2.50	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead				354.9	4.61E+01	2.48E+01	3.41E-02	1.85E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Silver				0.02	9.60E-04	2.40E-03	1.73E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

[a]Micrograms per liter, equivalent to parts per billion.

[b]Milligrams per kilograms, equivalent to parts per million.

[c]Milligrams per liter, equivalent to parts per million.

Table 31-3. Summary Statistics for COPCs at JPG Eco Site 11 - Metals in Soil - Phase III

Site	Medium	Analyte Code	Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Std. Deviation	UCL95 [a]	EPC µg/g [b]
11	CSO [c]	CD	Cadmium	5	5	100	0.04	0.08	0.05	0.01	0.07	0.07
11	CSO	MN	Manganese	5	5	100	42.40	96.80	65.87	20.36	85.29	85.29
11	CSO	MO	Molybdenum	2	5	40	3.67	5.00	4.49	0.70	5.16	5.00
11	CSO	SE	Selenium	2	5	40	0.25	0.41	0.29	0.07	0.36	0.36
11	CSO	V	Vanadium	5	5	100	15.30	21.90	18.34	2.36	20.59	20.59
11	CSO	ZN	Zinc	5	5	100	12.40	14.70	13.37	0.84	14.17	14.17

[a]Upper 95% confidence limit.

[b]Exposure point concentration, micrograms per gram, equivalent to parts per million.

[c]Surface soil.

Table 31-4. Summary of COPC Exposure Point Concentrations by Medium for Site 11 - Phase III

	Measured Concentrations in Abiotic Media				Estimated Concentrations in Biotic Media							
Analyte Name	Filtered Surface Water (µg/L) [a]	Sediment (mg/kg) [b]	Unfiltered Surface Water (mg/L) [c]	Soil (mg/kg)	Plant (mg/kg)	Invertebrate (mg/kg)	Mouse (mg/kg)	Swift (mg/kg)	Aquatic Plants (mg/kg)	Benthic Invertebrate (mg/kg)	Fish (mg/kg)	Frogs (mg/kg)
Cadmium				0.07	2.80E-02	2.60E-01	3.49E-04	5.35E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Manganese				85.29	3.16E+00	3.24E+00	9.81E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Molybdenum				5.00	1.25E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Selenium				0.36	3.41E+00	2.82E+00	6.53E-01	3.72E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Vanadium				20.59	6.18E-02	1.85E-01	2.57E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc				14.17	7.79E+00	9.35E+00	5.76E-01	1.08E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00

[a]Micrograms per liter, equivalent to parts per billion.

[b]Milligrams per kilograms, equivalent to parts per million.

[c]Milligrams per liter, equivalent to parts per million.

Table 31-5. Summary of DERA RME Risk Drivers for Site 11 - Phase 1

11	NOAEL-Based HQs Due to Soil Ingestion or Direct Contact - RME		NOAEL-Based HQs Due to Dietary Ingestion - RME		Total NOAEL-Based HQs Summed Across Pathways - RME		
Parameter	**White-footed Mouse**	**Eastern Cottontail**	**White-footed Mouse**	**Eastern Cottontail**	**White-footed Mouse**	**Eastern Cottontail**	**Plants**
Boron			3.22		3.26		
Lead	2.30	1.03	11.29	1.99	13.60	3.01	1.98
HI_NOAEL	**2.30**	**1.03**	**14.52**	**1.99**	**16.86**	**3.01**	**1.98**

11	LOAEL-Based HQs Due to Dietary Ingestion - RME	Total LOAEL-Based HQs Summed Across Pathways - RME
Parameter	**White-footed Mouse**	**White-footed Mouse**
Boron	1.61	1.63
HI_LOAEL	**1.61**	**1.63**

Table 31-6. Summary of DERA CT Risk Drivers for Site 11 - Phase 1

11	NOAEL-Based HQs Due to Soil Ingestion CT	NOAEL-Based HQs Due to Dietary Ingestion - CT	Total NOAEL-Based HQs Summed Across Pathways - CT	
Parameter	**White-footed Mouse**	**White-footed Mouse**	**White-footed Mouse**	**Eastern Cottontail**
Boron		1.99	2.02	
Lead	1.43	6.99	8.42	1.22
HI_NOAEL	**1.43**	**8.99**	**10.43**	**1.22**

11	Total LOAEL-Based HQs Summed Across Pathways - CT
Parameter	**White-footed Mouse**
Boron	1.01
HI_LOAEL	**1.01**

Table 31-7. Summary of DERA RME Risk Drivers for Site 11 - Phase III

11	NOAEL-Based HQs Due to Soil Ingestion or Direct Contact - RME					NOAEL-Based HQs Due to Dietary Ingestion - RME			Total NOAEL-Based HQs Summed Across Pathways - RME					
Parameter	American Kestrel	White-footed Mouse	Eastern Cottontail	Plants	Soil Fauna	White-footed Mouse	Eastern Cottontail	Little Brown Myotis	American Kestrel	White-footed Mouse	Eastern Cottontail	Little Brown Myotis	Plants	Soil Fauna
Molybdenum						2.65				3.09				
Selenium						104.38	15.42	2.24		104.63	15.53	2.25		
Vanadium	1.36	32.10	14.28	10.30	1.03	9.44			1.38	41.53	14.92	1.10	10.30	1.03
HI_NOAEL	1.36	32.10	14.28	10.30	1.03	116.47	15.42	2.24	1.38	149.24	30.45	3.35	10.30	1.03

11	LOAEL-Based HQs Due to Soil Ingestion - RME		LOAEL-Based HQs Due to Dietary Ingestion - RME		Total LOAEL-Based HQs Summed Across Pathways - RME	
Parameter	White-footed Mouse	Eastern Cottontail	White-footed Mouse	Eastern Cottontail	White-footed Mouse	Eastern Cottontail
Selenium			6.96	1.03	6.98	1.04
Vanadium	10.70	4.76	3.15		13.84	4.97
HI_LOAEL	10.70	4.76	10.10	1.03	20.82	6.01

Table 31-8. Summary of DERA CT Risk Drivers for Site 11 - Phase III

11	NOAEL-Based HQs Due to Soil Ingestion - CT		NOAEL-Based HQs Due to Dietary Ingestion - CT			Total NOAEL-Based HQs Summed Across Pathways - CT		
Parameter	White-footed Mouse	Eastern Cottontail	White-footed Mouse	Eastern Cottontail	Little Brown Myotis	White-footed Mouse	Eastern Cottontail	Little Brown Myotis
Molybdenum			1.64			1.91		
Selenium			64.61	6.26	2.12	64.76	6.30	2.12
Vanadium	19.87	5.79	5.84			25.71	6.05	1.04
HI_NOAEL	19.87	5.79	72.09	6.26	2.12	92.37	12.35	3.16

11	LOAEL-Based HQs Due to Soil Ingestion - CT		LOAEL-Based HQs Due to Dietary Ingestion - CT	Total LOAEL-Based HQs Summed Across Pathways - CT	
Parameter	White-footed Mouse	Eastern Cottontail	White-footed Mouse	White-footed Mouse	Eastern Cottontail
Selenium			4.31	4.32	
Vanadium	6.62	1.93	1.95	8.57	2.02
HI_LOAEL	6.62	1.93	6.25	12.89	2.02

FIGURES

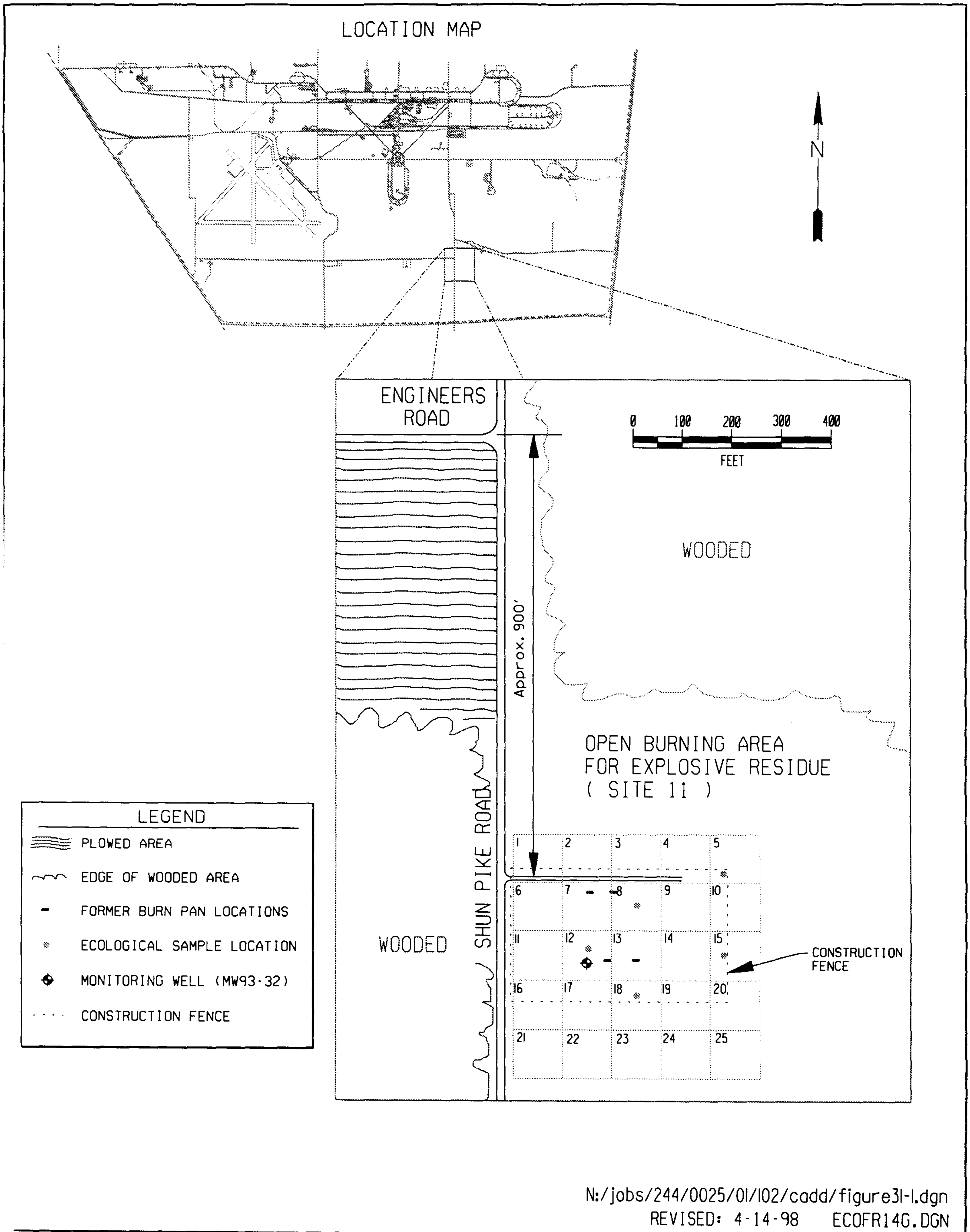

Figure 31-1. Burn Area for Explosive Residue (Site 11)

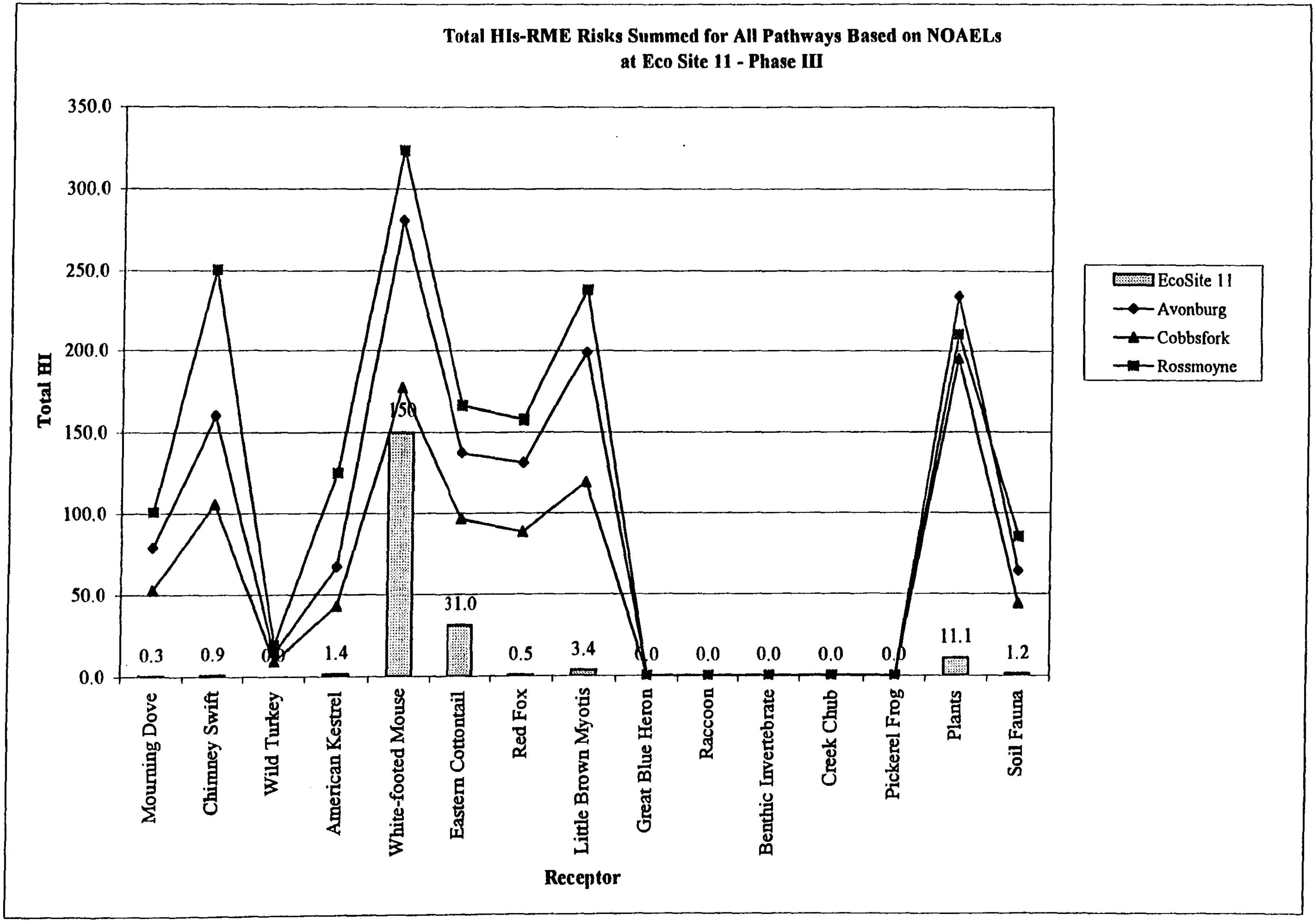

Figure 31-2. Total HIs - RME Risks Summed for All Pathways Based on NOAELs at Eco Site 11 - Phase III

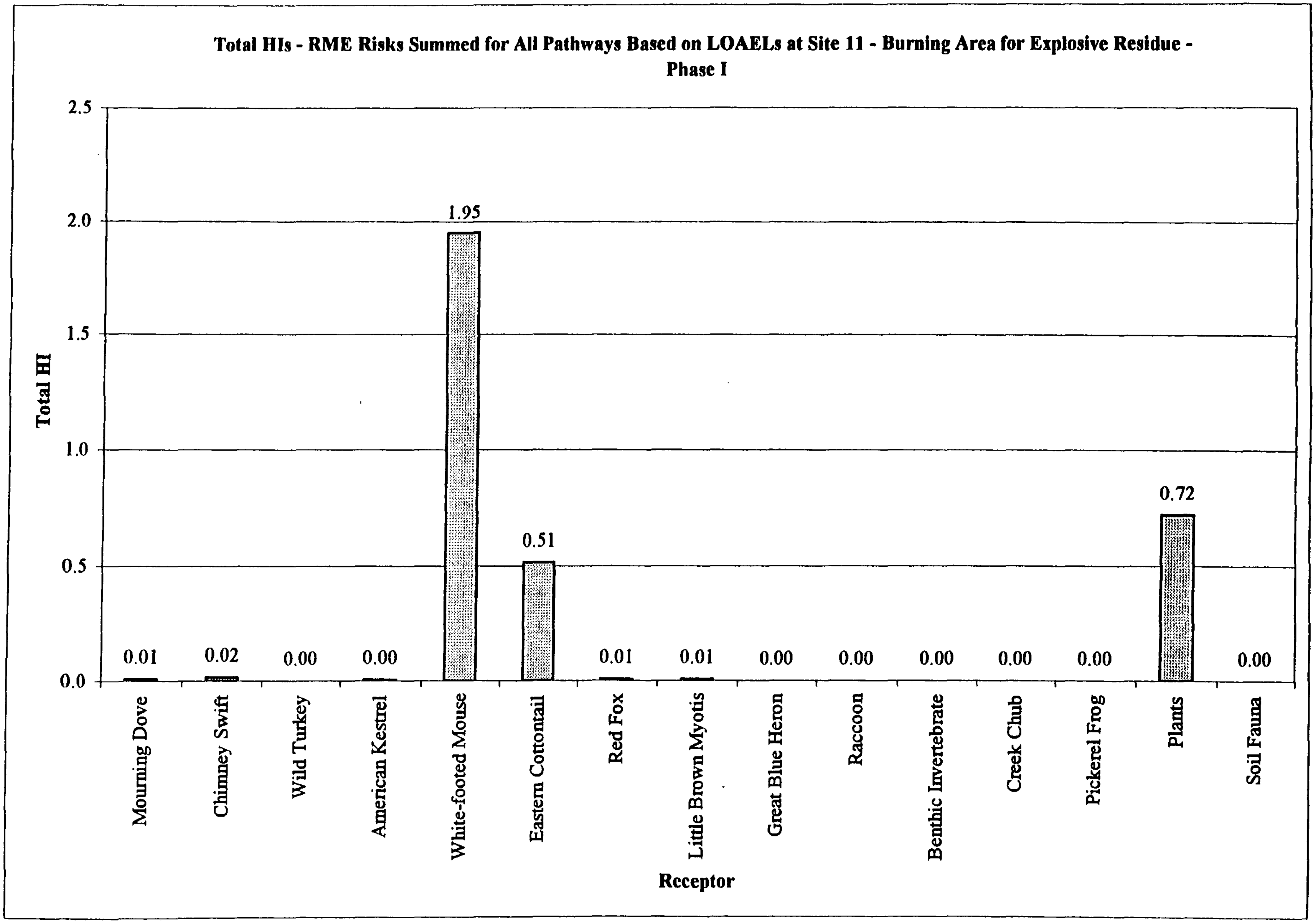

Figure 31-3. Total HIs - RME Risks Summed for All Pathways Based on LOAELs at Site 11 - Burn Area for Explosive Residue Phase I

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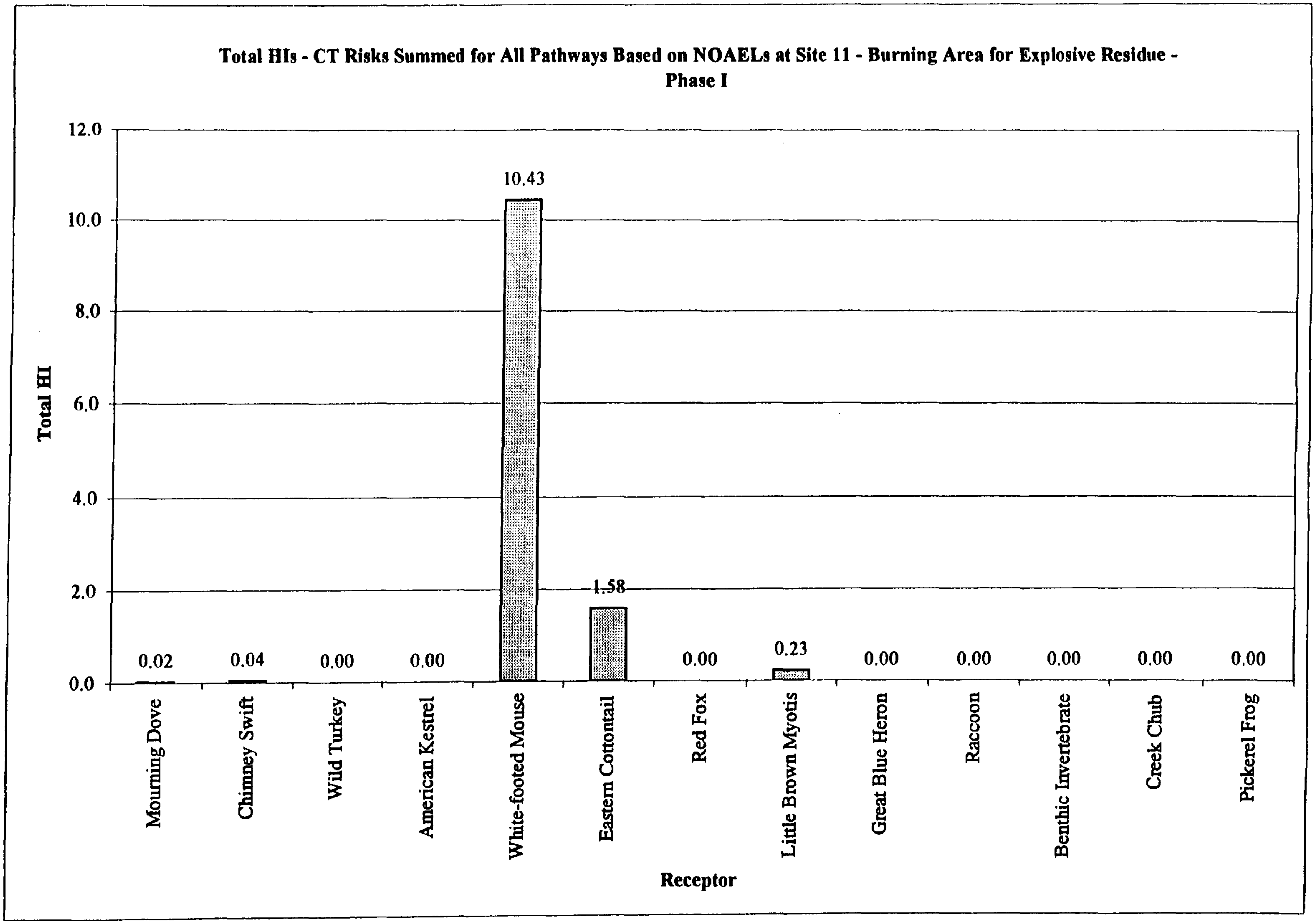

Figı ˀ1-4. Total HIs - CT Risks Summed for All Pathways Bas n NOAELs at Site 11 - Burn Area for Explosive Residue - Phase I

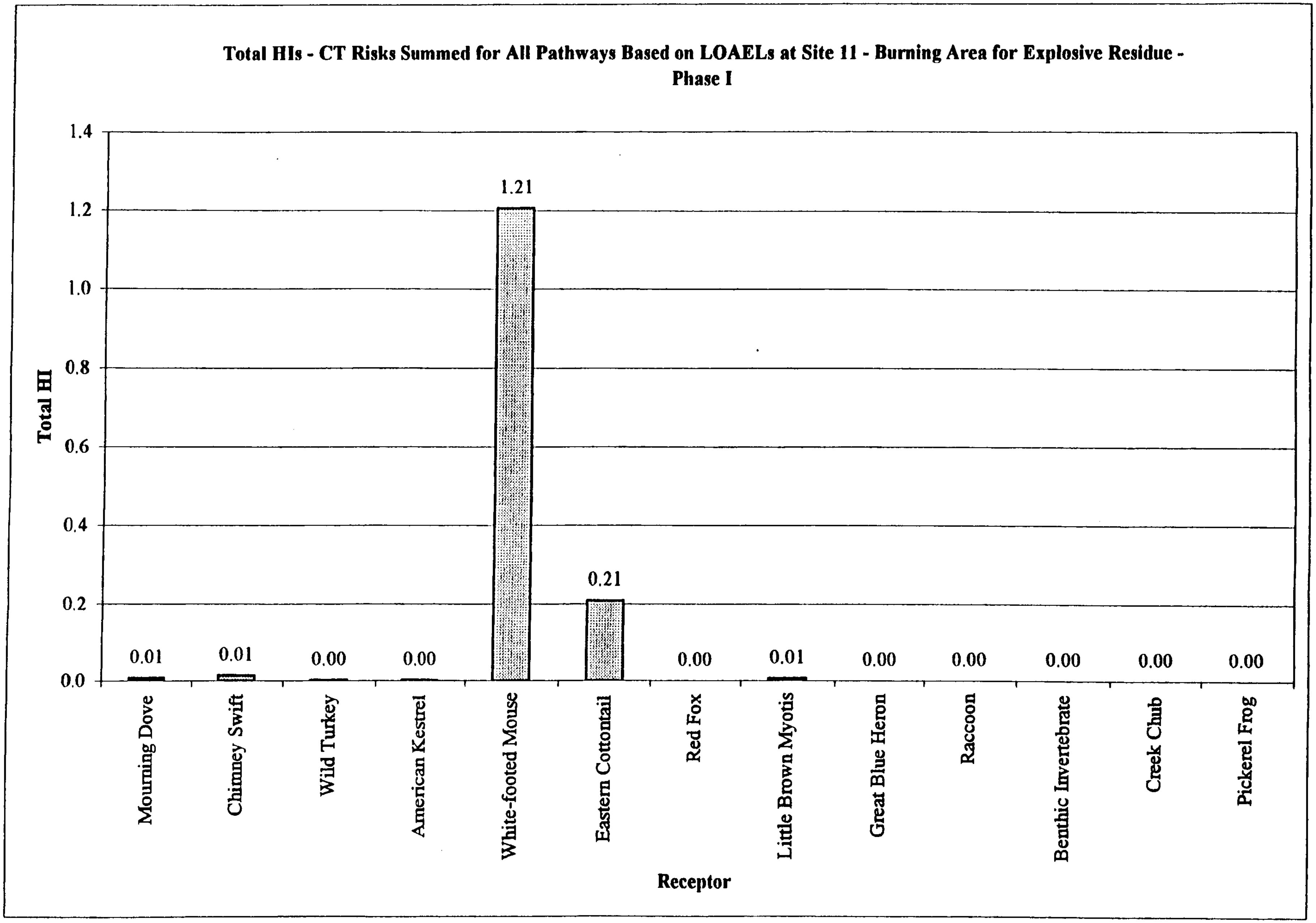

Figure 31-5. Total HIs - CT Risks Summed for All Pathways Based on LOAELs at Site 11 - Burn Area for Explosive Residue Phase I

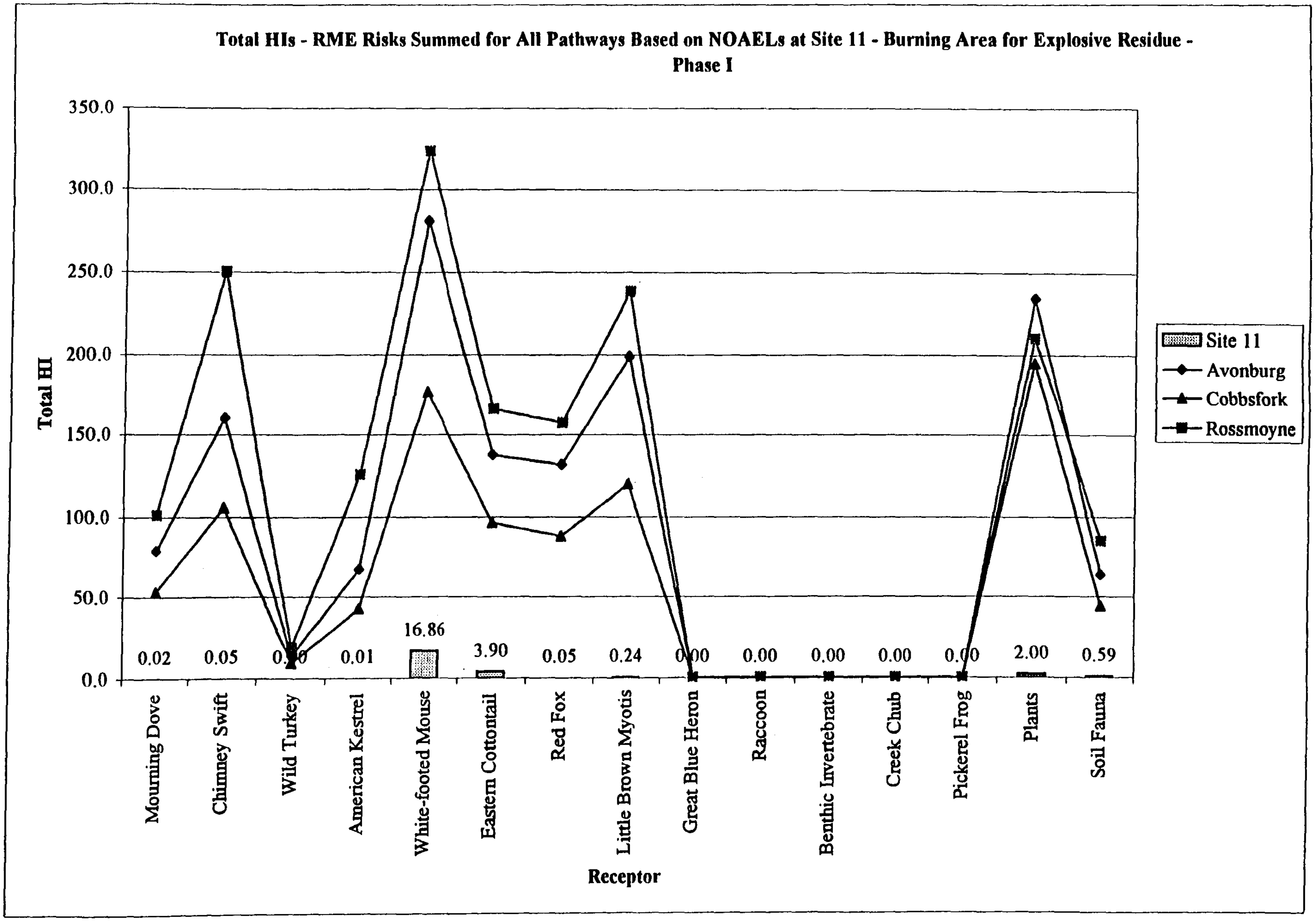

Figure 31-6. Total HIs - RME Risks Summed for All Pathways Based on NOAELs at Site 11 - Burning Area for Explosive Residue - Phase I

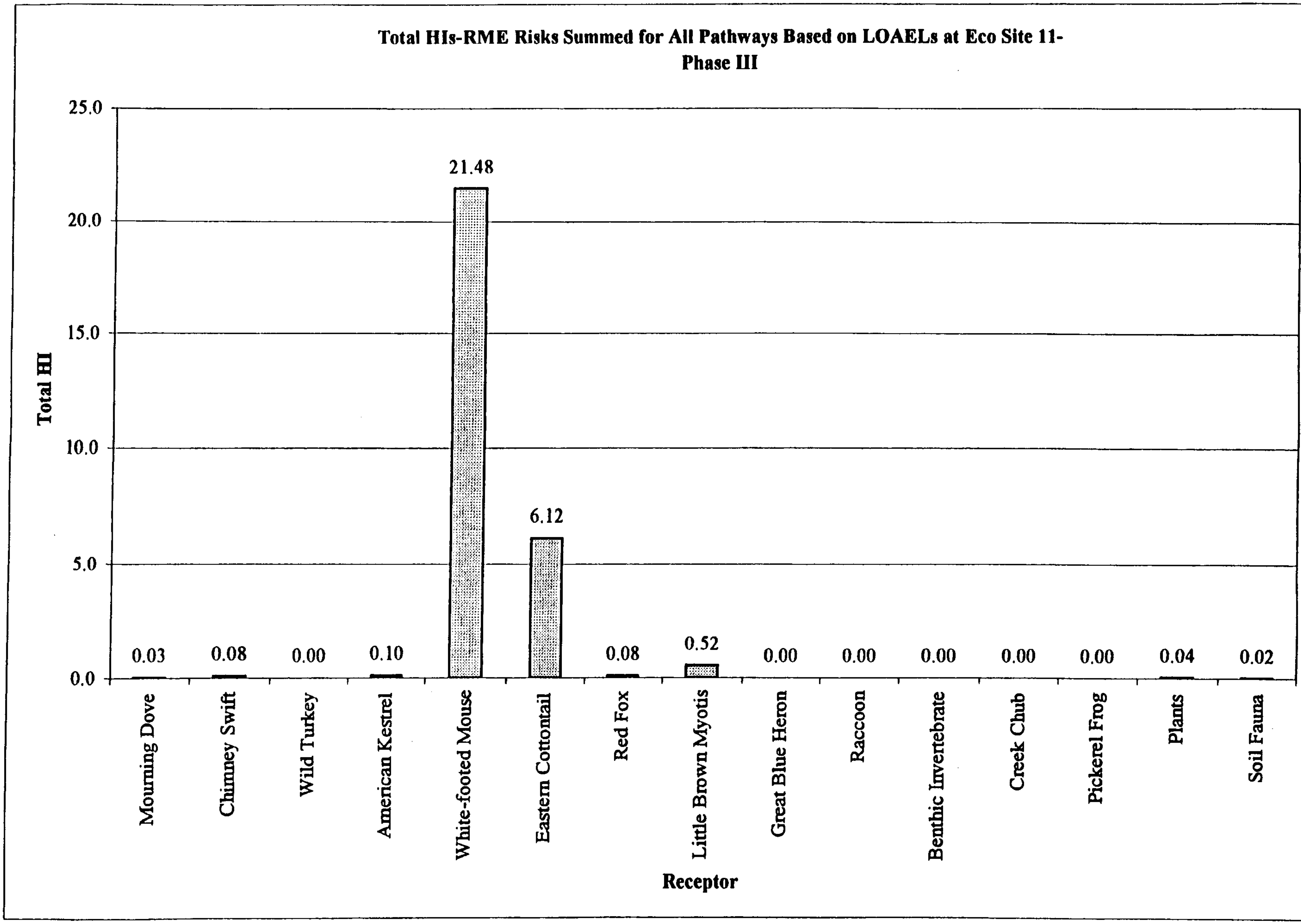

Figure 31-7. Total HIs - RME Risks Summed for All Pathways Based on LOAELs at Eco Site 11 - Phase III

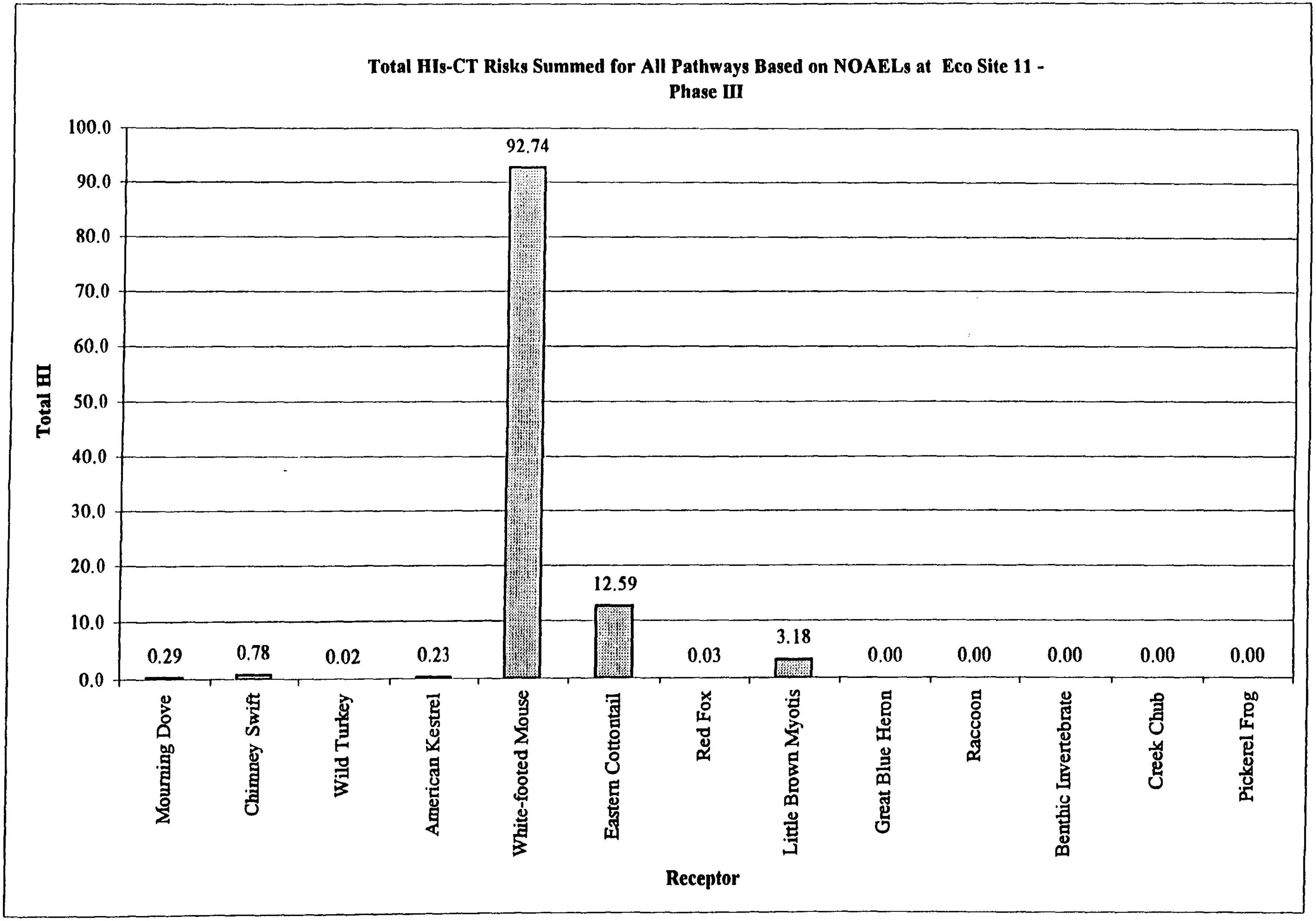

Figure 31-8. Total HIs - CT Risks Summed for All Pathways Based on NOAELs at Eco Site 11 - Phase III

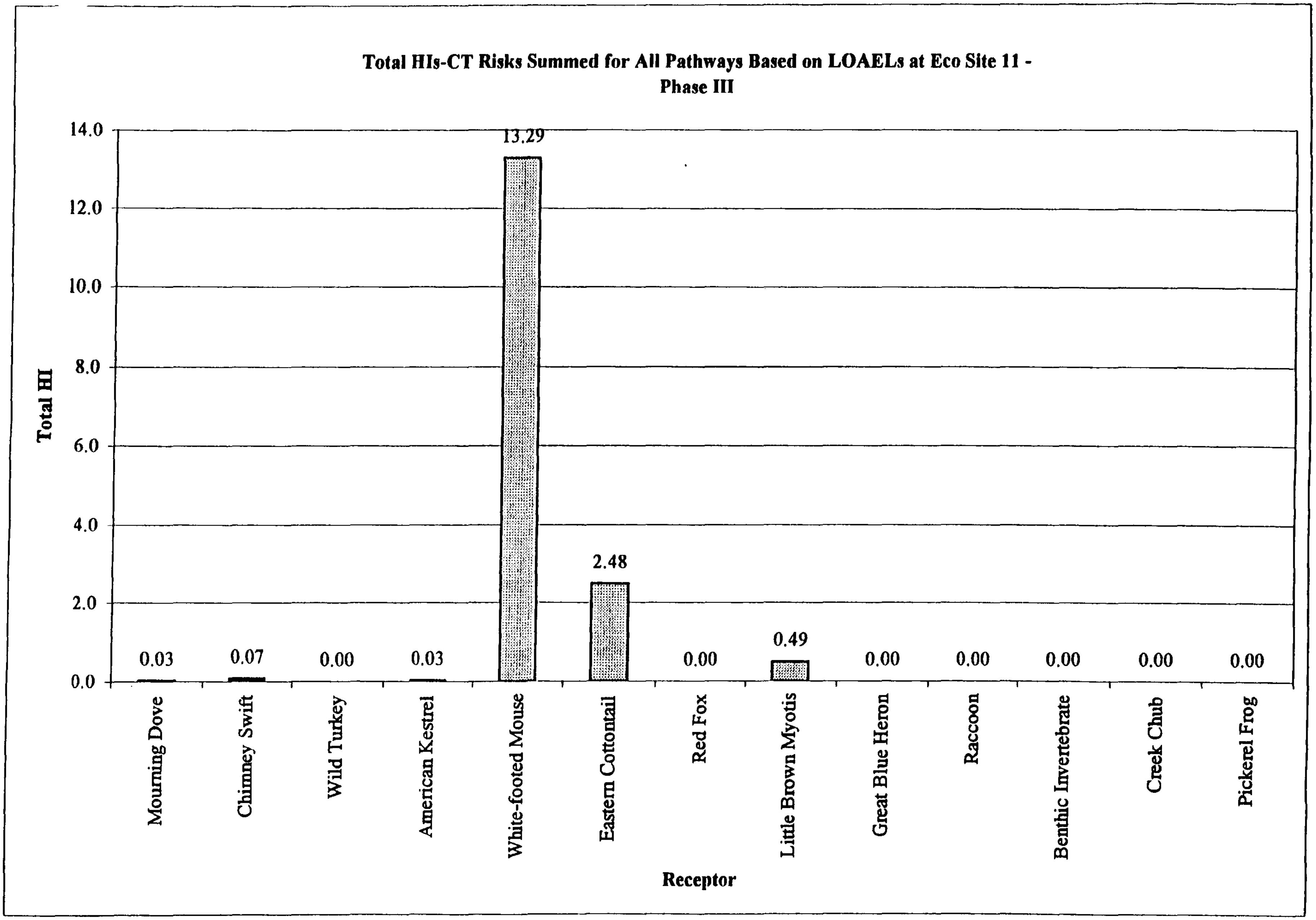

Figure 31-9. Total HIs - CT Risks Summed for All Pathways Based on LOAELs at Eco Site 11 - Phase III

32.0 TERRESTRIAL REFERENCE AREAS AND JPG PHASE II BACKGROUND

32.1 ECOLOGICAL SITE DESCRIPTION

The majority of JPG soil types are represented by three main soil types: Avonburg, Cobbsfork, and Rossmoyne. Three terrestrial reference areas were selected in order to represent each major JPG soil type. The reference areas are located in unimpacted areas on JPG where Phase II background sampling had established that there was little chance of Army-related contamination. These locations ~~were,~~ called Avonburg, Cobbsfork, and Rossmoyne reference areas (Figures 32-1 through 32-3)**, are situated at three different areas of this site (refer to Figure 5-1). (EPA-217)** The habitat at each of the reference areas is characterized as generally flat and heavily wooded.

The new reference area data collected in the Fall of 1997 (Phase III) were used for comparison to previous analytical results and to evaluate ecological characteristics, including soil microfauna composition and plant community structure. Risks related to site contamination were compared to risks calculated for the three reference areas to establish a baseline for inherent risk due to ambient concentrations of inorganics in the environment.

The JPG Phase II background represented the combination of data from soil samples collected at each of the three reference areas. These data were collected in the Fall of 1995. By combining the data from the three areas, a total of 20 samples was obtained, which provided a more statistically robust data set.

32.2 REFERENCE AREA INVESTIGATIONS

For convenience to the reader, summary statistics, EPCs, risk driver HQs, total RME and CT HIs are provided in this section. All intakes and other non risk-driving HQs are located in Appendix AA. **The chemicals for each medium that were evaluated in the DERA are presented on the EPC tables in this section. Refer to Appendix AA for details pertaining to the specific data sets (e.g., sample numbers, depths, dates, etc.) used in the risk assessment for the Avonburg, Cobbsfork, and Rossmoyne reference areas. (EPA-179)**

32.2.1 Phase I Activities

Phase I soil data were collected for background purposes; however, it was decided that the data were collected in proximity to known contamination and were therefore suspect and unsuitable for background.

32.2.2 Phase II Activities

Phase II sampling activities conducted in the Fall of 1995 established the JPG Phase II background data set. Refer to Section 5.3.2.1.1 for the discussion on the JPG Phase II background data evaluation. The summary statistics for the background data set are provided in Table 5.3-2. Table 32-7 provides the EPCs for the JPG Phase II background.

32.2.3 Phase III Activities

The Phase III summary statistics and EPCs for the Avonburg reference area are provided in Table 32-1 and Table 32-2, respectively. The Phase III summary statistics and EPCs for the Cobbsfork reference area are provided in Table 32-3 and Table 32-4, respectively. The Phase III summary statistics and EPCs for the Rossmoyne reference area are provided in Table 32-5 and Table 32-6, respectively. The Phase III ecological reference area sampling took place in the same vicinity as the Phase II background sampling but occurred in the Fall of 1997.

32.3 EXPOSURE AND ECOLOGICAL EFFECTS PROFILE

The exposure and ecological effects profile for the reference areas serve to establish baseline conditions for the biotic and abiotic variables addressed in the ecological risk assessment.

Birds and mammals may be exposed to metals by direct contact with or ingestion of soil. No surface water data were available at the reference areas or JPG Phase II background locations. To determine the estimated intakes of the inorganics, various key receptor species were selected to evaluate the impacts to area wildlife. The key receptors evaluated for the reference areas and JPG Phase II background included mourning dove, chimney swift, American kestrel, wild turkey, white-footed mouse, eastern cottontail, red fox, little brown myotis, plants, and soil fauna.

The exposure pathways and receptors evaluated at these locations are as follows:

- Terrestrial Ecosystem
  - All wildlife receptors—soil ingestion
  - All wildlife receptors—dietary ingestion
  - Plants—direct contact with soil
  - Soil fauna—direct contact with soil

32.3.1 Selection of COPCs

By definition, there are no COPCs in the reference areas or background since these areas are unimpacted by former Army activities. However, there are naturally occurring concentrations of inorganics. **At this site there are no statistically significant differences associated with the effects data; therefore, no apparent site-related effects are expected to occur from exposures to organics or inorganics at ambient concentrations. (EPA 218)**

The reference area data were used to document risks to the receptors due to exposure to naturally occurring inorganics; this is termed the inherent risk. This is important because of the uncertainty in the TRVs that are used to establish the HQs in the risk characterization. It is not uncommon for the TRVs to be so conservative that risks are indicated under ambient conditions. Therefore, when interpreting ecological risk, it is important to identify the inherent risks from the site-related risks. (EPA 181 a, b)

Since silver, boron, mercury, and tin were not detected in the JPG Phase II background data, these analytes were retained as COPCs wherever they occurred in the site-specific data.

32.3.2 Comparison of Reference Area Concentrations to Site Concentrations

Arsenic was significantly different by site ($p = 0.005$). However, arsenic concentrations at the JPG sites overlapped those at the reference areas, and there was no trend in concentration by whether the location was impacted or not. The Rossmoyne reference area had one of the highest mean arsenic concentrations.

Barium was significantly different by location ($p = 0.0045$). Sites 3 and 14 had obviously higher barium concentrations than those observed at the reference areas.

Beryllium was different by location ($p = 0.006$). Sites 9 and 25 had higher concentrations than other areas or the reference areas.

Cobalt was significantly different by location ($p = 0.0039$). Sites 3 and 9 had significantly higher concentrations than at any of the three reference areas.

Iron was significantly different by location ($p = 0.053$). However, concentrations at the JPG sites overlapped those at the reference areas, and there was no trend in concentration by whether the location was impacted or not. The Rossmoyne reference area had one of the highest mean iron concentrations.

Manganese was significantly different by location ($p < 0.0000$). Sites 3 and 9 had significantly higher concentrations than at any of the three reference areas or other JPG sites.

Nickel was significantly different by location ($p = 0.0001$). Sites 3 and 9 had significantly higher concentrations than at any of the three reference areas.

Lead was significantly different by location ($p = 0.0275$). However, concentrations at most of the JPG sites overlapped those at the reference areas, and there was no trend in concentration by whether the location was impacted or not, except Site 14, which had higher lead concentrations than the reference areas.

Selenium was significantly different by location (p = 0.0242). However, concentrations at most of the JPG sites overlapped or were lower than those at the reference areas, except Site 39, which had higher selenium concentrations than the reference areas.

Vanadium was significantly different by location (p = 0.0058). However, concentrations at most of the JPG sites overlapped or were lower than those at the reference areas.

Zinc was significantly different by location (p = 0.0003). However, concentrations at most of the JPG sites overlapped or were lower than those at the reference areas, except Sites 3 and 9, which had higher concentrations than at the reference areas.

Boron, cadmium, chromium, copper, mercury, molybdenum, antimony, tin, TOC, and thallium did not differ significantly by location. **TOC of reference area soils ranged from 1920 to 11,500 mg/kg. (EPA192)**

The pH of reference area soils ranged from 4.93 to 6.16. (EPA192) The pH data were significantly different by location ($p < 0.0000$). The reference areas were significantly lower than all JPG sites except for Site 39. The pH at Site 39 overlapped that at the reference areas.

32.3.3 Earthworm Toxicity Test

Earthworm mortality generally ranged from 0 to 10 percent at the reference areas; however, at Rossmoyne Grid 24, mortality was 15 percent. ~~(Appendix Z).~~ **Refer to Table 8.7-12a for results of the earthworm toxicity testing. (EPA191)** -This indicates that naturally occurring earthworm mortality can be as high as 15 percent. Mortality in excess of 15 percent was observed only at Site 9 (Grid 15) and Site 39 (Grid 14). At all other locations, earthworm mortality appeared similar to that observed at the reference areas.

The null hypothesis is that "the number of dead earthworms is similar among all locations". The χ^2 test statistic was 49.25 with a degrees of freedom of 40, which resulted in a p value of 0.1498. Since this p-value exceeds 0.1, the hypothesis that row and columns are independent cannot be rejected. Therefore, the site location may bear no relation to earthworm mortality when this test is used.

ANOVA on the arcsine-transformed data provides a different interpretation. The p-value for ANOVA is 0.0016, indicating a significant difference between the mean mortality from one location to another at the 95 percent confidence level. A 95 percent LSD test indicated that mortality was significantly higher at Sites 9 and 39 than at Avonburg, Cobbsfork, 11, 14/15, 25, and 3/4, but that mortality at Sites 9 and 39 overlapped, or was not significantly higher than, that observed at the Rossmoyne reference area. The statistical analysis therefore indicates that earthworm mortality is not likely to be significantly affected by existing site conditions at JPG.

32.3.4 Phytotoxicity Test

The phytotoxicity early seedling growth test resulted in data for percent germination and biomass. The results are summarized in Appendix Z. There was little variability in germination rates with the exception of Site 3/4 Grid 2, where percent germination was only 43. The germination data were neither normal nor log-normal. The biomass data on a wet-weight basis were lognormal.

ANOVA of the germination data resulted in a p-value of 0.1480, which is greater than 0.05, indicating that location does not have a statistically significant effect on germination at the 95 percent confidence level. ANOVA of the biomass data resulted in a p-value of 0.0037, indicating site location has a significant effect on wet weight biomass at the 95 percent confidence level. The lowest biomass observed in the study was the biomass for the Cobbsfork reference area. An LSD multiple range test revealed that Avonburg and Cobbsfork reference areas had significantly lower biomass than the Rossmoyne reference area, Site 9, and Site 25. The biomass for all other JPG sites overlapped, or was not significantly different from, the biomass measurements from the Cobbsfork and Avonburg reference areas.

The one low germination therefore appears aberrant and may be due to chance alone. The biomass data indicate that existing site conditions at JPG will not significantly decrease plant growth or reproduction relative to effects observed in controls. Instead, the JPG sites appear more productive than the reference areas.

32.3.5 Soil Fauna Community Structure

The number of individuals per sample (density) was log-normal. The number of species was neither normal nor log-normal. Diversity ranged from 0 to 97 percent at the reference areas, indicating that this parameter is so inherently variable at JPG that it may not be useful to identify contaminant-related effects. The number of individuals was not significantly different by location when the log transformed data were analyzed by ANOVA. The number of invertebrate species was not statistically significantly different at the 95 percent confidence level when analyzed by the Kruskal-Wallis test. There does not appear to be any affect of site location on soil invertebrates, although community similarity may be examined in a later version.

32.4 RISK CHARACTERIZATION

32.4.1 Risk Estimation

The HIs for the reference areas and JPG Phase II background, which represent inherent risk, are summarized for each sampling event and receptor below. The HIs have been grouped by order of magnitude for discussion purposes. HIs based on RME and CT exposure parameters are presented. In addition, a conservative NOAEL-based TRV and a dose at which population-level effects may occur (LOAEL-based TRV) were used to establish the lower and

upper bounds on toxicity, respectively. These values define the risk boundaries. There are thus four sets of HI values for each location and sampling event (NOAEL-RME, NOAEL-CT, LOAEL-RME, and LOAEL-CT). The exposure intakes, HQs, and HIs are presented in Appendix AA. Figures 32-4 through 32-19 show the total NOAEL and LOAEL-based HI risks for both the RME and CT exposure scenarios by receptor.

Avonburg

Phase III RME NOAEL HIs
(See Figure 32-4)
Key Receptors with HI range 0-1: None
HI Range 1.1-10: None
HI Range 10.1-100: Mourning Dove, Wild Turkey, American Kestrel, Soil Fauna
HI Range 100.1-1000: Chimney Swift, White-footed Mouse, Eastern Cottontail, Red Fox, Little Brown Myotis, Plants

Phase III RME LOAEL HIs
(See Figure 32-5)
Key Receptors with HI range 0-1: None
HI Range 1.1-10: Mourning Dove, Wild Turkey, American Kestrel, Soil Fauna
HI Range 10.1-100: Chimney Swift, White-footed Mouse, Eastern Cottontail, Red Fox, Little Brown Myotis, Plants
HI Range 100.1-1000: None

Phase III CT NOAEL HIs
(See Figure 32-6)
Key Receptors with HI range 0-1: None
HI Range 1.1-10: None
HI Range 10.1-100: Mourning Dove, Wild Turkey, American Kestrel, Red Fox
HI Range 100.1-1000: Chimney Swift, White-footed Mouse, Eastern Cottontail, Little Brown Myotis

Phase III CT LOAEL HIs
(See Figure 32-7)
Key Receptors with HI range 0-1: None
HI Range 1.1-10: Mourning Dove, Wild Turkey, American Kestrel
HI Range 10.1-100: Chimney Swift, White-footed Mouse, Eastern Cottontail, Red Fox, Little Brown Myotis
HI Range 100.1-1000: None

Cobbsfork

Phase III RME NOAEL HIs
(See Figure 32-8)
Key Receptors with HI range 0-1: None
HI Range 1.1-10: Wild Turkey
HI Range 10.1-100: Mourning Dove, American Kestrel, Eastern Cottontail, Red Fox, Soil Fauna
HI Range 100.1-1000: Chimney Swift, White-footed Mouse, Little Brown Myotis, Plants

Phase III RME LOAEL HIs
(See Figure 32-9)
Key Receptors with HI range 0-1: None
HI Range 1.1-10: Mourning Dove, Wild Turkey, American Kestrel, Soil Fauna
HI Range 10.1-100: Chimney Swift, White-footed Mouse, Eastern Cottontail, Red Fox, Little Brown Myotis, Plants
HI Range 100.1-1000: None

Phase III CT NOAEL HIs
(See Figure 32-10)
Key Receptors with HI range 0-1: None
HI Range 1.1-10: Wild Turkey
HI Range 10.1-100: Mourning Dove, Chimney Swift, American Kestrel, Eastern Cottontail, Red Fox
HI Range 100.1-1000: White-footed Mouse, Little Brown Myotis

Phase III CT LOAEL HIs
(See Figure 32-11)
Key Receptors with HI range 0-1: Wild Turkey
HI Range 1.1-10: Mourning Dove, Chimney Swift, American Kestrel
HI Range 10.1-100: White-footed Mouse, Eastern Cottontail, Red Fox, Little Brown Myotis
HI Range 100.1-1000: None

Rossmoyne

Phase III RME NOAEL HIs
(See Figure 32-12)
Key Receptors with HI range 0-1: None
HI Range 1.1-10: None
HI Range 10.1-100: Wild Turkey, Soil Fauna
HI Range 100.1-1000: Mourning Dove, Chimney Swift, American Kestrel, White-footed Mouse, Eastern Cottontail, Red Fox, Little Brown Myotis, Plants

Phase III RME LOAEL HIs
(See Figure 32-13)
Key Receptors with HI range 0-1: None
HI Range 1.1-10: Wild Turkey, Soil Fauna
HI Range 10.1-100: Mourning Dove, Chimney Swift, American Kestrel, White-footed Mouse, Eastern Cottontail, Red Fox, Little Brown Myotis, Plants
HI Range 100.1-1000: None

Phase III CT NOAEL HIs
(See Figure 32-14)
Key Receptors with HI range 0-1: None
HI Range 1.1-10: None
HI Range 10.1-100: Mourning Dove, Wild Turkey
HI Range 100.1-1000: Chimney Swift, American Kestrel, White-footed Mouse, Eastern Cottontail, Red Fox, Little Brown Myotis

Phase III CT LOAEL HIs
(See Figure 32-15)
Key Receptors with HI range 0-1: None
HI Range 1.1-10: Wild Turkey
HI Range 10.1-100: Mourning Dove, Chimney Swift, American Kestrel, White-footed Mouse, Eastern Cottontail, Red Fox, Little Brown Myotis
HI Range 100.1-1000: None

JPG Phase II Background

Phase II RME NOAEL HIs
(See Figure 32-16)
Key Receptors with HI range 0-1: None
HI Range 1.1-10: None
HI Range 10.1-100: Mourning dove, Wild turkey, American kestrel, Soil fauna
HI Range 100.1-1000: Chimney swift, White-footed mouse, Eastern cottontail, Red fox, Little brown myotis, Plants

Phase II RME LOAEL HIs
(See Figure 32-17)
Key Receptors with HI range 0-1: None
HI Range 1.1-10: Mourning dove, Wild turkey, American kestrel, Soil fauna
HI Range 10.1-100: Chimney swift, White-footed mouse, Eastern cottontail, Red fox, Little brown myotis, Plants
HI Range 100.1-1000: None

Phase II CT NOAEL HIs
(See Figure 32-18)
Key Receptors with HI range 0-1: None
HI Range 1.1-10: Wild turkey
HI Range 10.1-100: Mourning dove, American kestrel, Red fox
HI Range 100.1-1000: Chimney swift, White-footed mouse, Eastern cottontail, Little brown myotis

Phase II CT LOAEL HIs
(See Figure 32-19)
Key Receptors with HI range 0-1: None
HI Range 1.1-10: Mourning dove, Wild turkey, American kestrel
HI Range 10.1-100: Chimney swift, White-footed mouse, Eastern cottontail, Red fox, Little brown myotis
HI Range 100.1-1000: None

32.4.2 Risk Description

By definition, there should be no site-related risk at the reference areas and background. What the HIs demonstrate is the inherent risk due to naturally occurring concentrations of inorganics in the environment. AUFs are set to 1 for the reference areas and JPG Phase II background, since the reference areas and background are presumed to cover large areas and contain many individual home ranges. Another way of stating this is that the reference areas and background make up the universe of ambient exposure. In contrast, JPG sites are small and may contain only a few home ranges or merely part of a home range, depending on the receptor in question. By comparing HIs from the reference areas to those at the sites, an indication of relative risk due to former Army activities can be obtained. By comparing the soil analytical data from the reference areas to that at the sites, an indication of which COPCs are statistically elevated in the environment is obtained. There were no adverse effects observed within the reference areas for the earthworm toxicity test, phytotoxicity test, or soil fauna community structure analysis.

32.4.2.1 Risk Drivers/Summary of Lines of Evidence. Inherent risk drivers associated with the Phase III ecological reference areas and JPG Phase II background are summarized in Tables 32-8 through 32-15. An analyte was categorized as an inherent risk driver if it produced an HQ greater than or equal to 1 for any exposure pathway.

In addition, to provide an overall summary of the multiple lines of evidence that were evaluated for the Sites, a summary table was developed. The lines of evidence were primarily hazard index (HI) calculations for a number of different receptors, but for the terrestrial ecosystem, toxicity testing was also conducted. Refer to Table 7.7-11a for a summary of the terrestrial lines of evidence. An evaluation was made of which terrestrial measurement endpoints were most sensitive in determining the potential for an ecological. (EPA180a,b)

<u>Terrestrial Ecosystem</u>

The most sensitive of the terrestrial measurement endpoints for Avonburg are white-footed mice, plants, and little brown myotis. The highest reasonable maximum exposure (RME) no observed adverse effect level (NOAEL)-based hazard indices (HIs) for each of these receptors at Avonburg are 281 (white-footed mice), 234 (plants), and 199 (little brown myotis). The primary contributor of risk to white-footed mice is selenium (RME NOAEL HQ of 157) through dietary ingestion. The primary contributor of risk to plants is aluminum (RME NOAEL HQ of 211) through direct contact with soil. The primary contributor of risk to little brown myotis is selenium (RME NOAEL HQ of 98) through dietary ingestion.

The most sensitive of the terrestrial measurement endpoints for Cobbsfork are plants and white-footed mice. The highest reasonable maximum exposure (RME) no observed adverse effect level (NOAEL)-based HIs for each of these receptors at Cobbsfork are 195 (plants) and 176 (white-footed mice). The primary contributor of risk to plants is aluminum (RME NOAEL HQ of 179) through direct contact with soil. The primary contributor of risk to white-footed mice is selenium (RME NOAEL HQ of 84) through dietary ingestion.

The most sensitive of the terrestrial measurement endpoints for Rossmoyne are white-footed mice, chimney swift, and little brown myotis. The highest reasonable maximum exposure (RME) no observed adverse effect level (NOAEL)-based HIs for each of these receptors at Rossmoyne are 324 (white-footed mice), 250 (chimney swift), and 238 (little brown myotis). The primary contributor of risk to white-footed mice is selenium (RME NOAEL HQ of 140) through dietary ingestion. The primary contributor of risk to chimney swift is vanadium (RME NOAEL HQ of 160) through ingestion of soil. The primary contributor of risk to little brown myotis is selenium (RME NOAEL HQ of 87) through dietary ingestion.

The HQs for the three reference areas were derived using Phase III data. (EPA180a,b)

32.4.3 Uncertainty Analysis

Uncertainty in the exposure estimates is due primarily to:

- Variability in the exposure parameters, which produce a natural distribution of the variables in the intake equations for each of the receptors;
- Exposure parameters derived from literature and not measured on site;
- Uncertainty in the dietary ingestion pathway, which utilized BAFs to predict dietary concentrations;
- Variation in the concentrations of COPCs in the environment;

- Uncertainty whether the most conservative pathways have been addressed and evaluated.

The predicted effect of each of these sources of uncertainty on the risk assessment is as follows:

Variability in the exposure parameters—Because both the average and RME scenarios were quantitatively addressed, this source of uncertainty is expected to have no overall effect on the risk assessment results.

Exposure parameters derived from literature—Because so many ecological receptors were quantitatively considered in the ecological risk assessment, this source of uncertainty is expected to have no overall effect on the risk assessment.

Uncertainty in the dietary ingestion pathway—The use of literature-based BAFs or BCFs is expected to overestimate as opposed to underestimate concentrations in the dietary pathway. This is because under laboratory conditions, animals are chronically exposed on a daily basis and supposedly reach steady state. In the wild, as animals move in and out of contaminated areas, metabolism and excretion are expected to reduce the body burden. Use of field-based BAFs from TEAD (Rust E&I 1997) is not expected to overestimate or underestimate risk for these analytes, since these data were measured in conjunction with co-located soil samples.

Variation in the concentrations of COPCs in the environment—This uncertainty is not expected to bias the risk assessment towards underestimation of risk since maximum or UCL95 concentrations were used in all exposure scenarios to estimate the EPCs.

Uncertainty whether the most conservative pathways have been addressed—The receptors were considered carefully by the DSG and typically have high exposure rates due to their life-histories (i.e., ground-feeding or burrowing). Therefore, this source of uncertainty is not expected to impact the risk assessment.

Uncertainty in the ecological analysis is less than the uncertainty in the exposure estimates because these data were gathered as part of a site-specific, controlled field study. There were sufficient samples collected at each site (n=5) to identify within and between site variability. The data identify the potential for adverse effects to species that form the basis of the JPG food web, that is, the plants and soil fauna.

32.5 ECOLOGICAL RISK ASSESSMENT SUMMARY AND CONCLUSIONS

Multiple lines of evidence were evaluated for the ecological assessment conducted at the three reference sites. For all three reference areas, terrestrial lines of evidence were evaluated. The lines of evidence were primarily HI calculations for a number of different receptors, but toxicity testing was also conducted. Refer to Table 7.7-11a for a summary of the terrestrial ecosystem lines of evidence. (EPA180a,b)

The following is an overall summary of the key results of the ecological risk assessment for the reference areas.~~The following summary and conclusions are based on an initial review of the data. A full evaluation of whether or not the data meet all DQOs, and further statistical examination, will be made prior to finalizing these results for the next version of this report.~~

- The reference area data define variability in the ecological effects data.
- The reference area and JPG Phase II background data define inherent risk due to ambient levels of inorganic~~e~~s in soil at JPG

TABLES

Table 32-1
Summary Statistics for Analytes in Surface Soil
Ecological Site - Avonburg - Phase III
Jefferson Proving Ground
Madison, Indiana

Site	Analyte	Number of Detections	Number of Samples	% Detects	Minimum	Maximum	Average	Std. Deviation	UCL95 [(a)]	EPC µg/g [(b)]	Exceed Background (Bkg)?	Retain as COPC[(c)]?	Comment
AVONBURG	Silver	0	5	0	NC[(d)]	NC	NC	NC	NC	NC	NA[(e)]	No (N)	Not a COPC
AVONBURG	Aluminum	5	5	100	7450	11500	9106	1513	10548	10548	NA	Y	Reference concentration
AVONBURG	Arsenic	5	5	100	3.49	8.90	6.38	2.18	8.46	8.46	NA	Y	Reference concentration
AVONBURG	Boron	0	5	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
AVONBURG	Barium	5	5	100	40.20	46.60	42.81	3.01	45.68	45.68	NA	Y	Reference concentration
AVONBURG	Beryllium	5	5	100	0.30	0.42	0.35	0.04	0.39	0.39	NA	Y	Reference concentration
AVONBURG	Cadmium	2	5	40	0.03	0.10	0.08	0.03	0.11	0.10	NA	Y	Reference concentration
AVONBURG	Cobalt	5	5	100	0.94	3.75	2.34	1.10	3.39	3.39	NA	Y	Reference concentration
AVONBURG	Chromium	5	5	100	9.76	16.30	13.79	2.93	16.59	16.30	NA	Y	Reference concentration
AVONBURG	Copper	5	5	100	4.26	6.63	5.19	0.99	6.13	6.13	NA	Y	Reference concentration
AVONBURG	Cyanide	0	5	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
AVONBURG	Iron	5	5	100	8060	17300	12812	3639	16282	16282	NA	Y	Reference concentration
AVONBURG	Mercury	2	5	40	0.05	0.06	0.06	0.01	0.06	0.06	NA	Y	Reference concentration
AVONBURG	Manganese	5	5	100	96.80	180.0	134.42	37.44	170.1	170.1	NA	Y	Reference concentration
AVONBURG	Molybdenum	3	5	60	2.49	6.10	4.50	1.37	5.80	5.80	NA	Y	Reference concentration
AVONBURG	Nickel	5	5	100	3.19	6.16	4.88	1.20	6.02	6.02	NA	Y	Reference concentration
AVONBURG	Lead	5	5	100	8.54	12.10	10.47	1.46	11.86	11.86	NA	Y	Reference concentration
AVONBURG	Antimony	0	5	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
AVONBURG	Selenium	3	5	60	0.25	0.70	0.36	0.19	0.54	0.54	NA	Y	Reference concentration
AVONBURG	Tin	0	5	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
AVONBURG	Thallium	0	5	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
AVONBURG	Vanadium	5	5	100	20.50	37.50	27.60	6.61	33.90	33.90	NA	Y	Reference concentration
AVONBURG	Zinc	5	5	100	16.10	22.30	18.50	2.61	20.99	20.99	NA	Y	Reference concentration

General Note:

1. Calcium, magnesium, sodium and potassium were not included in risk assessment as they are macronutrients.

Footnotes:

(a) Upper 95% confidence limit.

(b) Exposure point concentration, micrograms per gram, equivalent to parts per million.

(c) Contaminant of potential concern.

(d) Not calculated. Not a COPC.

(e) Not applicable or not evaluated.

Table 32-2
Summary of Exposure Point Concentrations by Medium
Ecological Site - Avonburg - Phase III
Jefferson Proving Ground
Madison, Indiana

	Measured Concentrations in Abiotic Media				Estimated Concentrations in Biotic Media								
Analyte Name	**Filtered Surface Water (µg/L) [(a)]**	**Sediment (mg/kg) [(b)]**	**Unfiltered Surface Water (mg/L) [(c)]**	**Soil (mg/kg)**	**Plant (mg/kg)**	**Invertebrate (mg/kg)**	**Mouse (mg/kg)**	**Swift (mg/kg)**	**Aquatic Plants (mg/kg)**	**Benthic Invertebrate (mg/kg)**	**Fish (mg/kg)**	**Frogs (mg/kg)**
Aluminum				10548	4.22E+01	1.16E+02	2.90E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic				8.46	1.78E-01	9.56E-01	1.47E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Barium				45.68	6.71E+00	1.64E+00	8.15E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beryllium				0.39	1.57E-03	4.33E-03	1.08E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium				0.10	4.00E-02	3.72E-01	4.99E-04	7.65E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt				3.39	6.09E-02	1.18E-01	1.57E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium				16.30	1.96E-01	4.24E-01	3.18E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper				6.13	6.07E-01	5.39E+00	4.68E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Iron				16282	6.51E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead				11.86	1.54E+00	8.30E-01	1.14E-03	6.19E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Manganese				170.1	6.29E+00	6.46E+00	1.96E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury				0.06	1.20E-04	8.64E-02	5.51E-02	1.12E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Molybdenum				5.80	1.45E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel				6.02	2.65E-01	3.01E-01	1.21E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Selenium				0.54	5.14E+00	4.26E+00	9.85E-01	5.61E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Vanadium				33.90	1.02E-01	3.05E-01	4.23E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc				20.99	1.15E+01	1.39E+01	8.53E-01	1.60E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Footnotes:

(a) Micrograms per liter, equivalent to parts per billion.
(b) Milligrams per kilogram, equivalent to parts per million.
(c) Milligrams per liter, equivalent to parts per million.

Table 32-3
Summary Statistics forAnalytes in Surface Soil
Ecological Site Cobbsfork - Phase III
Jefferson Proving Ground
Madison, Indiana

Site	Analyte	Number of Detections	Number of Samples	% Detects	Minimum	Maximum	Average	Std. Deviation	UCL95 [(a)]	EPC µg/g [(b)]	Exceed Background (Bkg)?	Retain as COPC[(c)]?	Comment
COBBSFORK	Silver	0	5	0	NC[(d)]	NC	NC	NC	NC	NC	NA[(e)]	No (N)	Not a COPC
COBBSFORK	Aluminum	5	5	100	7010	9720	7955	1065	8970	8970	NA	Yes (Y)	Reference concentration.
COBBSFORK	Arsenic	5	5	100	3.13	4.23	3.50	0.42	3.91	3.91	NA	Y	Reference concentration.
COBBSFORK	Boron	0	5	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
COBBSFORK	Barium	5	5	100	32.20	41.20	36.08	3.54	39.46	39.46	NA	Y	Reference concentration.
COBBSFORK	Beryllium	4	5	80	0.11	0.26	0.22	0.06	0.28	0.26	NA	Y	Reference concentration.
COBBSFORK	Cadmium	0	5	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
COBBSFORK	Cobalt	4	5	80	0.72	2.35	1.23	0.67	1.87	1.87	NA	Y	Reference concentration.
COBBSFORK	Chromium	5	5	100	9.52	12.50	10.79	1.19	11.92	11.92	NA	Y	Reference concentration.
COBBSFORK	Copper	5	5	100	2.88	4.31	3.49	0.53	4.00	4.00	NA	Y	Reference concentration.
COBBSFORK	Cyanide	0	5	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
COBBSFORK	Iron	5	5	100	7560	9395	8305	681.0	8954	8954	NA	Y	Reference concentration.
COBBSFORK	Mercury	1	5	20	0.05	0.06	0.05	0.01	0.06	0.06	NA	Y	Reference concentration.
COBBSFORK	Manganese	5	5	100	34.70	44.60	40.19	4.25	44.24	44.24	NA	Y	Reference concentration.
COBBSFORK	Molybdenum	2	5	40	2.45	5.00	4.22	1.15	5.32	5.00	NA	Y	Reference concentration.
COBBSFORK	Nickel	4	5	80	1.92	3.57	2.79	0.68	3.43	3.43	NA	Y	Reference concentration.
COBBSFORK	Lead	5	5	100	7.46	12.40	9.14	1.90	10.94	10.94	NA	Y	Reference concentration.
COBBSFORK	Antimony	1	5	20	0.25	0.29	0.26	0.02	0.27	0.27	NA	Y	Reference concentration.
COBBSFORK	Selenium	1	5	20	0.25	0.31	0.26	0.03	0.29	0.29	NA	Y	Reference concentration.
COBBSFORK	Tin	1	5	20	1.19	5.00	3.45	1.81	5.18	5.00	NA	Y	Reference concentration.
COBBSFORK	Thallium	1	5	20	0.50	0.63	0.53	0.06	0.58	0.58	NA	Y	Reference concentration.
COBBSFORK	Vanadium	5	5	100	19.50	24.15	21.37	1.76	23.05	23.05	NA	Y	Reference concentration.
COBBSFORK	Zinc	5	5	100	12.00	14.20	13.12	0.95	14.02	14.02	NA	Y	Reference concentration.

General Note:

1. Calcium, magnesium, sodium and potassium were not included in risk assessment as they are macronutrients.

Footnotes:

(a) Upper 95% confidence limit.

(b) Exposure point concentration, micrograms per gram, equivalent to parts per million.

(c) Contaminant of potential concern.

(d) Not calculated. Not a COPC.

(e) Not applicable or not evaluated.

Table 32-4
Summary of Exposure Point Concentrations by Medium
Ecological Site - Cobbsfork - Phase III
Jefferson Proving Ground
Madison, Indiana

	Measured Concentrations in Abiotic Media				Estimated Concentrations in Biotic Media							
Analyte Name	Filtered Surface Water (µg/L) (a)	Sediment (mg/kg) (b)	Unfiltered Surface Water (mg/L) (c)	Soil (mg/kg)	Plant (mg/kg)	Invertebrate (mg/kg)	Mouse (mg/kg)	Swift (mg/kg)	Aquatic Plants (mg/kg)	Benthic Invertebrate (mg/kg)	Fish (mg/kg)	Frogs (mg/kg)
Aluminum				8970	3.59E+01	9.87E+01	2.47E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Antimony				0.27	7.10E-02	5.16E-02	6.20E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic				3.91	8.21E-02	4.42E-01	6.80E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Barium				39.46	5.80E+00	1.42E+00	7.04E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beryllium				0.26	1.04E-03	2.86E-03	7.15E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium				11.92	1.43E-01	3.10E-01	2.32E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt				1.87	3.37E-02	6.55E-02	8.70E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper				4.00	3.96E-01	3.52E+00	3.06E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Iron				8954	3.58E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead				10.94	1.42E+00	7.66E-01	1.05E-03	5.71E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Manganese				44.24	1.64E+00	1.68E+00	5.09E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury				0.06	1.20E-04	8.64E-02	5.51E-02	1.12E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Molybdenum				5.00	1.25E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel				3.43	1.51E-01	1.72E-01	6.90E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Selenium				0.29	2.75E+00	2.27E+00	5.26E-01	2.99E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium				0.58	2.32E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tin				5.00	1.50E-01	0.00E+00	1.70E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Vanadium				23.05	6.92E-02	2.07E-01	2.88E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc				14.02	7.71E+00	9.25E+00	5.70E-01	1.07E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Footnotes:
(a) Micrograms per liter, equivalent to parts per billion.
(b) Milligrams per kilogram, equivalent to parts per million.
(c) Milligrams per liter, equivalent to parts per million.

Table 32-5
Summary Statistics for Analytes in Surface Soil
Ecological Site - Rossmoyne - Phase III
Jefferson Proving Ground
Madison, Indiana

Site	Analyte	Number of Detects	Number of Samples	% Detects	Minimum	Maximum	Average	Std. Deviation	UCL 95 [(a)]	EPC µg/g [(b)]	Exceed Background (Bkg)?	Retain as COPC[(c)] ?	Comment
ROSSMOYNE	Silver	0	5	0	NC	NC	NC	NC	NC	NC	NA(e)	No (N)	Not a COPC
ROSSMOYNE	Aluminum	5	5	100	7905	9510	8419	660.9	9049	9049	NA	Yes (Y)	Reference concentration.
ROSSMOYNE	Arsenic	5	5	100	3.67	13.70	9.77	4.08	13.67	13.67	NA	Y	Reference concentration.
ROSSMOYNE	Boron	0	5	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
ROSSMOYNE	Barium	5	5	100	38.40	72.20	48.02	13.85	61.22	61.22	NA	Y	Reference concentration.
ROSSMOYNE	Beryllium	5	5	100	0.31	0.65	0.52	0.13	0.64	0.64	NA	Y	Reference concentration.
ROSSMOYNE	Cadmium	5	5	100	0.04	2.90	0.67	1.25	1.86	1.86	NA	Y	Reference concentration.
ROSSMOYNE	Cobalt	1	5	20	0.80	2.39	1.50	0.65	2.11	2.11	NA	Y	Reference concentration.
ROSSMOYNE	Chromium	5	5	100	11.70	20.10	16.32	3.38	19.54	19.54	NA	Y	Reference concentration.
ROSSMOYNE	Copper	5	5	100	3.93	5.88	4.93	0.78	5.68	5.68	NA	Y	Reference concentration.
ROSSMOYNE	Cyanide	0	5	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
ROSSMOYNE	Iron	5	5	100	9750	34400	20760	9648	29959	29959	NA	Y	Reference concentration.
ROSSMOYNE	Mercury	0	5	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
ROSSMOYNE	Manganese	5	5	100	89.75	358.0	182.9	119.2	296.5	296.5	NA	Y	Reference concentration.
ROSSMOYNE	Molybdenum	2	5	40	2.91	5.00	4.03	0.93	4.92	4.92	NA	Y	Reference concentration.
ROSSMOYNE	Nickel	5	5	100	3.98	6.72	5.19	1.27	6.40	6.40	NA	Y	Reference concentration.
ROSSMOYNE	Lead	5	5	100	9.17	23.50	14.49	5.82	20.04	20.04	NA	Y	Reference concentration.
ROSSMOYNE	Antimony	1	5	20	0.25	0.36	0.27	0.05	0.32	0.32	NA	Y	Reference concentration.
ROSSMOYNE	Selenium	4	5	80	0.25	0.55	0.37	0.12	0.48	0.48	NA	Y	Reference concentration.
ROSSMOYNE	Tin	1	5	20	1.52	5.00	3.36	1.71	4.99	4.99	NA	Y	Reference concentration.
ROSSMOYNE	Thallium	0	5	0	NC	NC	NC	NC	NC	NC	NA	N	Not a COPC
ROSSMOYNE	Vanadium	5	5	100	21.50	43.40	33.86	8.22	41.70	41.70	NA	Y	Reference concentration.
ROSSMOYNE	Zinc	5	5	100	16.25	27.00	19.37	4.40	23.56	23.56	NA	Y	Reference concentration.

General Note:

1. Calcium, magnesium, sodium and potassium were not included in risk assessment as they are macronutrients.

Footnotes:

(a) Upper 95% confidence limit.

(b) Exposure point concentration, micrograms per gram, equivalent to parts per million.

(c) Contaminant of potential concern.

(d) Not calculated. Not a COPC.

(e) Not applicable or not evaluated.

Table 32-6
Summary of Exposure Point Concentrations by Medium
Ecological Site - Rossmoyne - Phase III
Jefferson Proving Ground
Madison, Indiana

	Measured Concentrations in Abiotic Media				Estimated Concentrations in Biotic Media							
Analyte Name	Filtered Surface Water (µg/L) (a)	Sediment (mg/kg) (b)	Unfiltered Surface Water (mg/L) (c)	Soil (mg/kg)	Plant (mg/kg)	Invertebrate (mg/kg)	Mouse (mg/kg)	Swift (mg/kg)	Aquatic Plants (mg/kg)	Benthic Invertebrate (mg/kg)	Fish (mg/kg)	Frogs (mg/kg)
Aluminum				9049	3.62E+01	9.95E+01	2.49E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Antimony				0.32	8.42E-02	6.11E-02	7.35E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic				13.67	2.87E-01	1.54E+00	2.38E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Barium				61.22	9.00E+00	2.20E+00	1.09E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beryllium				0.64	2.56E-03	7.04E-03	1.76E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium				1.86	7.44E-01	6.92E+00	9.29E-03	1.42E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium				19.54	2.34E-01	5.08E-01	3.81E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt				2.11	3.80E-02	7.39E-02	9.81E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper				5.68	5.62E-01	5.00E+00	4.34E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Iron				29959	1.20E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead				20	2.61E+00	1.40E+00	1.92E-03	1.05E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Manganese				297	1.10E+01	1.13E+01	3.41E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Molybdenum				4.92	1.23E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel				6.40	2.82E-01	3.20E-01	1.29E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Selenium				0.48	4.58E+00	3.80E+00	8.78E-01	5.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tin				4.99	1.50E-01	0.00E+00	1.69E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Vanadium				41.70	1.25E-01	3.75E-01	5.20E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc				23.56	1.30E+01	1.56E+01	9.57E-01	1.80E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Footnotes:
(a) Micrograms per liter, equivalent to parts per billion.
(b) Milligrams per kilogram, equivalent to parts per million.
(c) Milligrams per liter, equivalent to parts per million.

Table 32-7
Summary of Exposure Point Concentrations by Medium
Phase II Background Data
Jefferson Proving Ground
Madison, Indiana

	Measured Concentrations in Abiotic Media				Estimated Concentrations in Biotic Media							
Analyte Name	Filtered Surface Water (µg/L) [(a)]	Sediment (mg/kg) [(b)]	Unfiltered Surface Water (mg/L) [(c)]	Soil (mg/kg)	Plant (mg/kg)	Invertebrate (mg/kg)	Mouse (mg/kg)	Swift (mg/kg)	Aquatic Plants (mg/kg)	Benthic Invertebrate (mg/kg)	Fish (mg/kg)	Frogs (mg/kg)
Aluminum				9003	3.60E+01	9.90E+01	2.48E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Antimony				0.45	1.19E-01	8.62E-02	1.04E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic				5.55	1.16E-01	6.27E-01	9.65E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Barium				57.09	8.39E+00	2.06E+00	1.02E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beryllium				0.36	1.44E-03	3.97E-03	9.93E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium				0.29	1.16E-01	1.08E+00	1.45E-03	2.22E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Chromium				11.73	1.41E-01	3.05E-01	2.29E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt				2.89	5.20E-02	1.01E-01	1.34E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper				4.45	4.40E-01	3.91E+00	3.40E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Iron				10318	4.13E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead				14.89	1.94E+00	1.04E+00	1.43E-03	7.77E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Manganese				263.6	9.75E+00	1.00E+01	3.03E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Molybdenum				5.00	1.25E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel				3.12	1.37E-01	1.56E-01	6.28E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Selenium				0.53	4.99E+00	4.13E+00	9.55E-01	5.44E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium				0.50	2.00E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Vanadium				22.74	6.82E-02	2.05E-01	2.84E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc				17.69	9.73E+00	1.17E+01	7.19E-01	1.35E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Footnotes:

(a) Micrograms per liter, equivalent to parts per billion.

(b) Milligrams per kilogram, equivalent to parts per million.

(c) Milligrams per liter, equivalent to parts per million.

Table 32-8
Summary of Detailed Ecological Risk Assessment Reasonable Maximum Exposure (RME) Risk Drivers
Ecological Site Avonburg - Phase III
Jefferson Proving Ground
Madison, Indiana

Avonburg	NOAEL[a]-Based HQs[b] Due to Soil Ingestion or Direct Contact - RME										NOAEL-Based HQs Due to Dietary Ingestion - RME						
Parameter	**Mourning Dove**	**Chimney Swift**	**Wild Turkey**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**	**Plants**	**Soil Fauna**	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**
Aluminum		1.36			8.01	8.26	5.79	5.52	210.97	4.22				2.94			2.98
Arsenic					7.33	7.55	5.29	5.05						24.05	2.36	7.78	27.95
Cadmium												2.97	2.52				
Cobalt																	
Chromium		1.58							3.26	40.75							
Iron	2.69	5.17		1.81	4.23	4.36	3.05	2.91		16.28							
Molybdenum														3.08	1.15		
Nickel																	
Selenium											4.33	6.88	6.50	157.48	53.90	62.21	98.28
Vanadium	67.60	129.76	11.45	45.36	52.84	54.46	38.16	36.41	16.95	1.70	1.75	10.06	8.51	15.54	2.43	5.17	16.06
HI[c]_NOAEL	**70.30**	**137.9**	**11.45**	**47.16**	**72.41**	**74.63**	**52.29**	**49.89**	**231.2**	**62.95**	**6.08**	**19.91**	**17.52**	**203.1**	**59.84**	**75.16**	**145.3**

Avonburg	Total NOAEL-Based HQs Summed Across Pathways - RME									
Parameter	**Mourning Dove**	**Chimney Swift**	**Wild Turkey**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**	**Plants**	**Soil Fauna**
Aluminum		1.48			10.96	8.75	6.77	8.50	210.97	4.22
Arsenic					31.38	9.91	13.07	33.00		
Cadmium		3.07		2.55						
Cobalt					1.18					
Chromium		1.93							3.26	40.75
Iron	2.78	5.17		1.81	4.64	4.62	3.22	2.91		16.28
Molybdenum					3.58	1.47				
Nickel										
Selenium	4.38	6.98		6.53	157.85	54.28	62.48	98.54		
Vanadium	69.35	139.82	11.80	53.86	68.38	56.89	43.33	52.46	16.95	1.70
HI_NOAEL	**76.52**	**158.4**	**11.80**	**64.75**	**278.0**	**135.9**	**128.9**	**195.4**	**231.2**	**62.95**

Table 32-8
Summary of Detailed Ecological Risk Assessment Reasonable Maximum Exposure (RME) Risk Drivers
Ecological Site Avonburg - Phase III
Jefferson Proving Ground
Madison, Indiana

Avonburg	LOAEL[d]-Based HQs Due to Soil Ingestion - RME								
Parameter	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**	**Plants**	**Soil Fauna**
Aluminum				4.06	4.19	2.93	2.80	14.45	3.77
Arsenic									
Iron	1.35	2.58		2.11	2.18	1.53	1.46		
Selenium									
Vanadium	4.51	8.65	3.02	17.61	18.15	12.72	12.14		
HI_LOAEL	**5.85**	**11.23**	**3.02**	**23.79**	**24.52**	**17.18**	**16.39**	**14.45**	**3.77**

Avonburg	LOAEL-Based HQs Due to Dietary Ingestion - RME						
Parameter	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**
Aluminum				1.49			1.51
Arsenic				1.90			2.21
Iron							
Selenium	2.16	3.44	3.25	10.50	3.59	4.15	6.55
Vanadium				5.18		1.72	5.35
HI_LOAEL	**2.16**	**3.44**	**3.25**	**19.07**	**3.59**	**5.87**	**15.62**

Avonburg	Total LOAEL-Based HQs Summed Across Pathways - RME								
Parameter	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**	**Plants**	**Soil Fauna**
Aluminum				5.56	4.44	3.43	4.31	14.45	3.77
Arsenic				2.48		1.03	2.61		
Iron	1.39	2.58		2.32	2.31	1.61	1.46		
Selenium	2.19	3.49	3.27	10.52	3.62	4.17	6.57		
Vanadium	4.62	9.32	3.59	22.79	18.96	14.44	17.49		
HI_LOAEL	**8.21**	**15.39**	**6.86**	**43.67**	**29.33**	**24.69**	**32.43**	**14.45**	**3.77**

Footnotes:

(a) No Observed Adverse Effect Level

(b) Hazard Quotient

(c) Hazard Index

(d) Lowest Observed Adverse Effect Level

Table 32-9
Summary of Detailed Ecological Risk Assesment Central Tendency (CT) Risk Drivers
Ecological Site Avonburg - Phase II
Jefferson Proving Ground
Madison, Indiana

Avonburg	NOAEL[(a)]-Based HQs[(b)] Due to Soil Ingestion - CT								NOAEL-Based HQs Due to Dietary Ingestion - CT						
Parameter	**Mourning Dove**	**Chimney Swift**	**Wild Turkey**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**
Aluminum		1.23			4.96	8.06	3.74	5.43				1.82			2.93
Arsenic					4.53	7.37	3.42	4.96				14.89	2.30	5.03	27.48
Cadmium										2.70	2.44				
Chromium		1.43													
Iron	2.65	4.69		1.75	2.62	4.26	1.98	2.87							
Molybdenum												1.90	1.13		
Selenium									4.26	6.24	6.31	97.47	52.63	40.26	96.64
Vanadium	66.51	117.76	10.14	44.04	32.71	53.18	24.69	35.80	1.72	9.13	8.26	9.62	2.37	3.35	15.79
HI[(c)]_NOAEL	**69.16**	**125.11**	**10.14**	**45.79**	**44.82**	**72.87**	**33.83**	**49.06**	**5.98**	**18.07**	**17.01**	**125.70**	**58.44**	**48.63**	**142.83**

Avonburg	Total NOAEL-Based HQs Summed Across Pathways - CT							
Parameter	**Mourning Dove**	**Chimney Swift**	**Wild Turkey**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**
Aluminum		1.35			6.78	8.54	4.38	8.35
Arsenic					19.42	9.68	8.46	32.44
Cadmium		2.78		2.47				
Chromium		1.75						
Iron	2.74	4.69		1.75	2.87	4.51	2.09	2.87
Molybdenum					2.22	1.43		
Selenium	4.31	6.34		6.34	97.70	53.01	40.43	96.89
Vanadium	68.23	126.89	10.46	52.30	42.32	55.55	28.04	51.59
HI_NOAEL	**75.28**	**143.80**	**10.46**	**62.87**	**171.31**	**132.72**	**83.39**	**192.14**

Table 32-9
Summary of Detailed Ecological Risk Assesment Central Tendency (CT) Risk Drivers
Ecological Site Avonburg - Phase II
Jefferson Proving Ground
Madison, Indiana

Avonburg	**LOAEL[d]-Based HQs Due to Soil Ingestion - CT**							**LOAEL-Based HQs Due to Dietary Ingestion - CT**						
Parameter	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**
Aluminum				2.51	4.09	1.90	2.75							1.48
Arsenic											1.18			2.17
Iron	1.32	2.34		1.31	2.13		1.43							
Selenium								2.13	3.12	3.15	6.50	3.51	2.68	6.44
Vanadium	4.43	7.85	2.94	10.90	17.73	8.23	11.93				3.21		1.12	5.26
HI_LOAEL	**5.76**	**10.20**	**2.94**	**14.73**	**23.94**	**10.13**	**16.12**	**2.13**	**3.12**	**3.15**	**10.88**	**3.51**	**3.80**	**15.36**

Avonburg	**Total LOAEL-Based HQs Summed Across Pathways - CT**						
Parameter	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**
Aluminum				3.44	4.33	2.22	4.24
Arsenic				1.53			2.56
Iron	1.37	2.34		1.44	2.26	1.04	1.43
Selenium	2.16	3.17	3.17	6.51	3.53	2.70	6.46
Vanadium	4.55	8.46	3.49	14.11	18.52	9.35	17.20
HI_LOAEL	**8.07**	**13.97**	**6.66**	**27.03**	**28.64**	**15.31**	**31.88**

Footnotes:

(a) No Observed Adverse Effect Level

(b) Hazard Quotient

(c) Hazard Index

(d) Lowest Observed Adverse Effect Level

Table 32-10
Summary of Detailed Ecological Risk Assessment Reasonable Maximum Exposure (RME) Risk Drivers
Ecological Site Cobbsfork - Phase III
Jefferson Proving Ground
Madison, Indiana

Cobbsfork	**NOAEL[(a)]-Based HQs[(b)] Due to Soil Ingestion or Direct Contact - RME**										**NOAEL-Based HQs Due to Dietary Ingestion - RME**						
Parameter	**Mourning Dove**	**Chimney Swift**	**Wild Turkey**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**	**Plants**	**Soil Fauna**	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**
Aluminum		1.15			6.81	7.02	4.92	4.69	179.41	3.59				2.50			2.53
Arsenic					3.39	3.49	2.45	2.33						11.12	1.09	3.59	12.92
Chromium		1.15							2.38	29.80							
Iron	1.48	2.84			2.33	2.40	1.68	1.60		8.95							
Molybdenum														2.65			
Selenium											2.31	3.67	3.47	84.08	28.78	33.22	52.48
Tin					7.73	7.97	5.58	5.33						5.68	3.56	4.30	
Vanadium	45.97	88.23	7.78	30.84	35.93	37.03	25.95	24.76	11.53	1.15	1.19	6.84	5.79	10.56	1.65	3.52	10.92
HI[(c)]_NOAEL	**47.45**	**93.38**	**7.78**	**30.84**	**56.19**	**57.91**	**40.57**	**38.71**	**193.32**	**43.50**	**3.50**	**10.51**	**9.25**	**116.60**	**35.08**	**44.63**	**78.84**

Cobbsfork	**Total NOAEL-Based HQs Summed Across Pathways - RME**									
Parameter	**Mourning Dove**	**Chimney Swift**	**Wild Turkey**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**	**Plants**	**Soil Fauna**
Aluminum		1.26			9.32	7.44	5.76	7.23	179.41	3.59
Arsenic					14.50	4.58	6.04	15.25		
Chromium		1.41							2.38	29.80
Iron	1.53	2.84			2.55	2.54	1.77	1.60		8.95
Molybdenum					3.09	1.26				
Selenium	2.34	3.73		3.49	84.28	28.98	33.36	52.61		
Tin					13.42	11.52	9.88	5.33		
Vanadium	47.16	95.07	8.03	36.63	46.50	38.68	29.46	35.67	11.53	1.15
HI_NOAEL	**51.03**	**104.31**	**8.03**	**40.11**	**173.65**	**95.02**	**86.28**	**117.70**	**193.32**	**43.50**

Table 32-10
Summary of Detailed Ecological Risk Assessment Reasonable Maximum Exposure (RME) Risk Drivers
Ecological Site Cobbsfork - Phase III
Jefferson Proving Ground
Madison, Indiana

Cobbsfork	LOAEL[d]-Based HQs Due to Soil Ingestion - RME									LOAEL-Based HQs Due to Dietary Ingestion - RME						
Parameter	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**	**Plants**	**Soil Fauna**	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**
Aluminum				3.46	3.56	2.49	2.38	12.29	3.20				1.27			1.28
Arsenic																1.02
Iron		1.42		1.16	1.20											
Selenium										1.16	1.84	1.73	5.61	1.92	2.21	3.50
Vanadium	3.06	5.88	2.06	11.98	12.34	8.65	8.25						3.52		1.17	3.64
HI_LOAEL	**3.06**	**7.30**	**2.06**	**16.60**	**17.10**	**11.14**	**10.63**	**12.29**	**3.20**	**1.16**	**1.84**	**1.73**	**10.40**	**1.92**	**3.39**	**9.44**

Cobbsfork	Total LOAEL-Based HQs Summed Across Pathways - RME								
Parameter	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**	**Plants**	**Soil Fauna**
Aluminum				4.72	3.77	2.92	3.66	12.29	3.20
Arsenic				1.14			1.20		
Iron		1.42		1.28	1.27				
Selenium	1.17	1.86	1.74	5.62	1.93	2.22	3.51		
Vanadium	3.14	6.34	2.44	15.50	12.89	9.82	11.89		
HI_LOAEL	**4.31**	**9.62**	**4.19**	**28.26**	**19.87**	**14.96**	**20.27**	**12.29**	**3.20**

Footnotes:

(a) No Observed Adverse Effect Level

(b) Hazard Quotient

(c) Hazard Index

(d) Lowest Observed Adverse Effect Level

Table 32-11
Summary of Detailed Ecological Risk Assessment Central Tendency (CT) Risk Drivers
Eco Site Cobbsfork - Phase III
Jefferson Proving Ground
Madison, Indiana

Cobbsfork	**NOAEL[(a)]-Based HQs[(b)] Due to Soil Ingestion - CT**								**NOAEL-Based HQs Due to Dietary Ingestion - CT**						
Parameter	**Mourning Dove**	**Chimney Swift**	**Wild Turkey**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**
Aluminum		1.05			4.22	6.86	3.18	4.62				1.55			2.49
Arsenic					2.10	3.41	1.58	2.29				6.88	1.06	2.33	12.70
Chromium		1.05													
Iron	1.46	2.58			1.44	2.34	1.09	1.58							
Molybdenum												1.64			
Selenium									2.27	3.33	3.37	52.04	28.10	21.49	51.60
Tin					4.79	7.78	3.61	5.24				3.52	3.47	2.78	
Vanadium	45.23	80.07	6.90	29.94	22.24	36.16	16.79	24.34	1.17	6.21	5.62	6.54	1.61	2.28	10.73
HI[(c)]_NOAEL	**46.68**	**84.74**	**6.90**	**29.94**	**34.78**	**56.55**	**26.25**	**38.07**	**3.44**	**9.54**	**8.99**	**72.17**	**34.25**	**28.88**	**77.52**

Cobbsfork	**Total NOAEL-Based HQs Summed Across Pathways - CT**							
Parameter	**Mourning Dove**	**Chimney Swift**	**Wild Turkey**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**
Aluminum		1.15			5.77	7.27	3.73	7.10
Arsenic					8.98	4.47	3.91	15.00
Chromium		1.28						
Iron	1.51	2.58			1.58	2.48	1.15	1.58
Molybdenum					1.91	1.23		
Selenium	2.30	3.38		3.39	52.17	28.30	21.59	51.73
Tin					8.30	11.25	6.40	5.24
Vanadium	46.40	86.28	7.11	35.56	28.78	37.77	19.06	35.08
HI_NOAEL	**50.20**	**94.67**	**7.11**	**38.95**	**107.48**	**92.78**	**55.83**	**115.72**

Table 32-11
Summary of Detailed Ecological Risk Assessment Central Tendency (CT) Risk Drivers
Eco Site Cobbsfork - Phase III
Jefferson Proving Ground
Madison, Indiana

Cobbsfork	**LOAEL[d]-Based HQs Due to Soil Ingestion - CT**							**LOAEL-Based HQs Due to Dietary Ingestion - CT**						
Parameter	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**
Aluminum				2.14	3.48	1.61	2.34							1.26
Arsenic														1.00
Iron		1.29			1.17									
Selenium								1.14	1.67	1.68	3.47	1.87	1.43	3.44
Vanadium	3.02	5.34	2.00	7.41	12.05	5.60	8.11				2.18			3.58
HI_LOAEL	**3.02**	**6.63**	**2.00**	**9.55**	**16.70**	**7.21**	**10.45**	**1.14**	**1.67**	**1.68**	**5.65**	**1.87**	**1.43**	**9.28**

Cobbsfork	**Total LOAEL-Based HQs Summed Across Pathways - CT**						
Parameter	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**
Aluminum				2.92	3.68	1.89	3.60
Arsenic							1.18
Iron		1.29			1.24		
Selenium	1.15	1.69	1.69	3.48	1.89	1.44	3.45
Vanadium	3.09	5.75	2.37	9.59	12.59	6.35	11.69
HI_LOAEL	**4.24**	**8.73**	**4.06**	**15.99**	**19.40**	**9.68**	**19.93**

Footnotes:

(a) No Observed Adverse Effect Level

(b) Hazard Quotient

(c) Hazard Index

(d) Lowest Observed Adverse Effect Level

Table 32-12
Summary of Detailed Ecological Risk Assessment Reasonable Maximum Exposure (RME) Risk Drivers
Ecological Site Rossmoyne - Phase III
Jefferson Proving Ground
Madison, Indiana

Rossmoyne	**NOAEL[(a)]-Based HQs[(b)] Due to Soil Ingestion or Direct Contact - RME**										**NOAEL-Based HQs Due to Dietary Ingestion - RME**							
Parameter	**Mourning Dove**	**Chimney Swift**	**Wild Turkey**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**	**Plants**	**Soil Fauna**	**Mourning Dove**	**Chimney Swift**	**Wild Turkey**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**
Aluminum		1.16			6.87	7.08	4.96	4.74	180.98	3.62					2.53			2.55
Arsenic					11.84	12.20	8.55	8.16	1.37						38.86	3.81	12.57	45.16
Barium															1.00			
Cadmium		1.73									3.10	55.33	1.60	46.81	9.76		3.09	12.14
Chromium		1.89							3.91	48.85								
Iron	4.95	9.51	1.40	3.32	7.78	8.02	5.62	5.36		29.96								
Molybdenum															2.61			
Selenium											3.86	6.13		5.79	140.36	48.04	55.45	87.60
Tin					7.72	7.95	5.57	5.32							5.67	3.55	4.29	
Vanadium	83.16	159.61	14.08	55.79	65.00	66.99	46.94	44.79	20.85	2.09	2.15	12.38		10.47	19.11	2.99	6.36	19.75
HI[(c)]_NOAEL	**88.11**	**173.9**	**15.48**	**59.12**	**99.21**	**102.3**	**71.64**	**68.36**	**207.1**	**84.51**	**9.11**	**73.84**	**1.60**	**63.06**	**219.9**	**58.39**	**81.77**	**167.20**

Rossmoyne	**Total NOAEL-Based HQs Summed Across Pathways - RME**									
Parameter	**Mourning Dove**	**Chimney Swift**	**Wild Turkey**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**	**Plants**	**Soil Fauna**
Aluminum		1.27			9.40	7.51	5.81	7.29	180.98	3.62
Arsenic					50.70	16.01	21.12	53.32	1.37	
Barium					1.22					
Cadmium	4.00	57.06	1.86	47.41	9.85		3.16	12.20		
Chromium	1.09	2.31		1.02					3.91	48.85
Iron	5.12	9.51	1.44	3.32	8.55	8.50	5.93	5.36		29.96
Molybdenum					3.04	1.24				
Selenium	3.91	6.22		5.82	140.69	48.38	55.69	87.83		
Tin					13.39	11.50	9.86	5.32		
Vanadium	85.31	171.99	14.52	66.26	84.11	69.98	53.30	64.54	20.85	2.09
HI_NOAEL	**99.42**	**248.4**	**17.82**	**123.8**	**321.0**	**163.1**	**154.9**	**235.9**	**207.1**	**84.51**

Table 32-12
Summary of Detailed Ecological Risk Assessment Reasonable Maximum Exposure (RME) Risk Drivers
Ecological Site Rossmoyne - Phase III
Jefferson Proving Ground
Madison, Indiana

Rossmoyne	LOAEL[d]-Based HQs Due to Soil Ingestion - RME									LOAEL-Based HQs Due to Dietary Ingestion - RME						
Parameter	Mourning Dove	Chimney Swift	American Kestrel	White-footed Mouse	Eastern Cottontail	Red Fox	Little Brown Myotis	Plants	Soil Fauna	Mourning Dove	Chimney Swift	American Kestrel	White-footed Mouse	Eastern Cottontail	Red Fox	Little Brown Myotis
Aluminum				3.49	3.59	2.52	2.40	12.40	3.23				1.28			1.29
Arsenic													3.07			3.57
Cadmium											3.69	3.12				
Chromium																
Iron	2.48	4.75	1.66	3.89	4.01	2.81	2.68									
Selenium										1.93	3.07	2.90	9.36	3.20	3.70	5.84
Vanadium	5.54	10.64	3.72	21.67	22.33	15.65	14.93						6.37		2.12	6.58
HI_LOAEL	**8.02**	**15.39**	**5.38**	**29.04**	**29.93**	**20.97**	**20.01**	**12.40**	**3.23**	**1.93**	**6.75**	**6.02**	**20.08**	**3.20**	**5.82**	**17.28**

Rossmoyne	Total LOAEL-Based HQs Summed Across Pathways - RME								
Parameter	Mourning Dove	Chimney Swift	American Kestrel	White-footed Mouse	Eastern Cottontail	Red Fox	Little Brown Myotis	Plants	Soil Fauna
Aluminum				4.77	3.81	2.95	3.70	12.40	3.23
Arsenic				4.00	1.26	1.67	4.21		
Cadmium		3.80	3.16						
Chromium		1.16							
Iron	2.56	4.75	1.66	4.27	4.25	2.97	2.68		
Selenium	1.95	3.11	2.91	9.38	3.23	3.71	5.86		
Vanadium	5.69	11.47	4.42	28.04	23.33	17.77	21.51		
HI_LOAEL	**10.20**	**24.29**	**12.15**	**50.46**	**35.87**	**29.06**	**37.95**	**12.40**	**3.23**

Footnotes:

(a) No Observed Adverse Effect Level

(b) Hazard Quotient

(c) Hazard Index

(d) Lowest Observed Adverse Effect Level

Table 32-13
Summary of Detailed Ecological Risk Assessment Central Tendency (CT) Risk Drivers
Ecological Site Rossmoyne - Phase III
Jefferson Proving Ground
Madison, Indiana

Rossmoyne	NOAEL[(a)]-Based HQs[(b)] Due to Soil Ingestion - CT								NOAEL-Based HQs Due to Dietary Ingestion - CT							
Parameter	**Mourning Dove**	**Chimney Swift**	**Wild Turkey**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**	**Mourning Dove**	**Chimney Swift**	**Wild Turkey**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**
Aluminum		1.06			4.25	6.92	3.21	4.66					1.56			2.51
Arsenic					7.33	11.91	5.53	8.02					24.05	3.72	8.13	44.41
Cadmium		1.57							3.05	50.22	1.42	45.44	6.04		2.00	11.93
Chromium		1.71														
Iron	4.87	8.63	1.24	3.23	4.82	7.83	3.64	5.27								
Molybdenum													1.62			
Selenium									3.80	5.56		5.62	86.87	46.91	35.88	86.13
Tin					4.78	7.77	3.61	5.23					3.51	3.46	2.78	
Vanadium	81.82	144.86	12.47	54.17	40.23	65.41	30.37	44.04	2.11	11.23		10.16	11.83	2.92	4.12	19.42
HI[(c)]_NOAEL	**86.69**	**157.82**	**13.71**	**57.39**	**61.41**	**99.84**	**46.36**	**67.21**	**8.96**	**67.01**	**1.42**	**61.23**	**135.48**	**57.02**	**52.91**	**164.40**

Rossmoyne	Total NOAEL-Based HQs Summed Across Pathways - CT							
Parameter	**Mourning Dove**	**Chimney Swift**	**Wild Turkey**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**
Aluminum		1.16			5.82	7.33	3.76	7.17
Arsenic					31.38	15.63	13.66	52.42
Cadmium	3.93	51.78	1.64	46.03	6.10		2.05	12.00
Chromium	1.07	2.10						
Iron	5.04	8.63	1.28	3.23	5.29	8.30	3.84	5.27
Molybdenum					1.88	1.21		
Selenium	3.84	5.65		5.65	87.08	47.24	36.03	86.36
Tin					8.29	11.23	6.38	5.23
Vanadium	83.93	156.09	12.86	64.33	52.06	68.33	34.49	63.45
HI_NOAEL	**97.82**	**225.40**	**15.78**	**119.24**	**197.89**	**159.28**	**100.21**	**231.90**

Table 32-13
Summary of Detailed Ecological Risk Assessment Central Tendency (CT) Risk Drivers
Ecological Site Rossmoyne - Phase III
Jefferson Proving Ground
Madison, Indiana

Rossmoyne	**LOAEL[(d)]-Based HQs Due to Soil Ingestion - CT**							**LOAEL-Based HQs Due to Dietary Ingestion - CT**						
Parameter	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**
Aluminum				2.16	3.51	1.63	2.36							1.27
Arsenic											1.90			3.51
Cadmium									3.35	3.03				
Chromium														
Iron	2.44	4.31	1.61	2.41	3.92	1.82	2.64							
Selenium								1.90	2.78	2.81	5.79	3.13	2.39	5.74
Vanadium	5.45	9.66	3.61	13.41	21.80	10.12	14.68				3.94		1.37	6.47
HI_LOAEL	**7.89**	**13.97**	**5.22**	**17.98**	**29.23**	**13.57**	**19.68**	**1.90**	**6.13**	**5.84**	**11.63**	**3.13**	**3.76**	**16.99**

Rossmoyne	**Total LOAEL-Based HQs Summed Across Pathways - CT**						
Parameter	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**
Aluminum				2.95	3.72	1.91	3.63
Arsenic				2.48	1.23	1.08	4.14
Cadmium		3.45	3.07				
Chromium		1.05					
Iron	2.52	4.31	1.61	2.64	4.15	1.92	2.64
Selenium	1.92	2.82	2.83	5.81	3.15	2.40	5.76
Vanadium	5.60	10.41	4.29	17.35	22.78	11.50	21.15
HI_LOAEL	**10.04**	**22.05**	**11.80**	**31.23**	**35.03**	**18.80**	**37.32**

Footnotes:

(a) No Observed Adverse Effect Level

(b) Hazard Quotient

(c) Hazard Index

(d) Lowest Observed Adverse Effect Level

Table 32-14
Summary of Detailed Ecological Risk Assessment Reasonable Maximum Exposure (RME) Risk Drivers
Phase II Background
Jefferson Proving Ground
Madison, Indiana

JPG Bkg.	NOAEL[a]-Based HQs[b] Due to Soil Ingestion or Direct Contact - RME										NOAEL-Based HQs Due to Dietary Ingestion - RME							
Parameter	**Mourning Dove**	**Chimney Swift**	**Wild Turkey**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**	**Plants**	**Soil Fauna**	**Mourning Dove**	**Chimney Swift**	**Wild Turkey**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**
Aluminum		1.16			6.84	7.05	4.94	4.71	180.06	3.60					2.51			2.54
Arsenic					4.80	4.95	3.47	3.31							15.77	1.55	5.10	18.32
Barium																		
Cadmium												8.64		7.31	1.52			1.90
Chromium		1.13							2.35	29.34								
Cobalt																		
Iron	1.71	3.27		1.14	2.68	2.76	1.94	1.85		10.32								
Molybdenum															2.65	1.00		
Selenium											4.20	6.67		6.31	152.80	52.30	60.36	95.36
Vanadium	45.35	87.05	7.68	30.43	35.45	36.54	25.60	24.43	11.37	1.14	1.17	6.75		5.71	10.42	1.63	3.47	10.77
HI[c]_NOAEL	**47.35**	**93.18**	**7.75**	**31.77**	**50.35**	**51.71**	**36.23**	**34.57**	**193.9**	**44.42**	**5.90**	**22.06**	**0.26**	**19.32**	**185.7**	**56.57**	**70.07**	**128.9**

JPG Bkg.	Total NOAEL-Based HQs Summed Across Pathways - RME									
Parameter	**Mourning Dove**	**Chimney Swift**	**Wild Turkey**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**	**Plants**	**Soil Fauna**
Aluminum		1.27			9.35	7.47	5.78	7.25	180.06	3.60
Arsenic					20.57	6.49	8.57	21.63		
Barium					1.14					
Cadmium		8.91		7.40	1.54			1.91		
Chromium		1.39							2.35	29.34
Cobalt					1.01					
Iron	1.76	3.27		1.14	2.94	2.93	2.04	1.85		10.32
Molybdenum					3.09	1.26				
Selenium	4.25	6.77		6.34	153.16	52.67	60.62	95.61		
Vanadium	46.53	93.80	7.92	36.14	45.87	38.17	29.07	35.20	11.37	1.14
HI_NOAEL	**53.36**	**115.7**	**8.25**	**51.13**	**238.8**	**109.2**	**107.5**	**163.7**	**193.9**	**44.42**

Table 32-14
Summary of Detailed Ecological Risk Assessment Reasonable Maximum Exposure (RME) Risk Drivers
Phase II Background
Jefferson Proving Ground
Madison, Indiana

JPG Bkg.	LOAEL[(d)]-Based HQs Due to Soil Ingestion - RME									LOAEL-Based HQs Due to Dietary Ingestion - RME						
Parameter	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**	**Plants**	**Soil Fauna**	**Mourning Dove**	**Chimney Swift**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**
Aluminum				3.47	3.57	2.50	2.39	12.33	3.22				1.27			1.29
Arsenic													1.24			1.45
Iron		1.64		1.34	1.38											
Selenium										2.10	3.34	3.15	10.19	3.49	4.02	6.36
Vanadium	3.02	5.80	2.03	11.82	12.18	8.53	8.14						3.47		1.16	3.59
HI_LOAEL	**3.07**	**7.52**	**2.06**	**16.73**	**17.20**	**11.09**	**10.58**	**12.34**	**3.23**	**2.16**	**3.93**	**3.65**	**16.73**	**3.69**	**5.32**	**12.70**

JPG Bkg.	Total LOAEL-Based HQs Summed Across Pathways - RME									
Parameter	**Mourning Dove**	**Chimney Swift**	**Wild Turkey**	**American Kestrel**	**White-footed Mouse**	**Eastern Cottontail**	**Red Fox**	**Little Brown Myotis**	**Plants**	**Soil Fauna**
Aluminum					4.74	3.79	2.93	3.68	12.33	3.22
Arsenic					1.62			1.71		
Iron		1.64			1.47	1.46	1.02			
Selenium	2.13	3.39		3.17	10.21	3.51	4.04	6.37		
Vanadium	3.10	6.25		2.41	15.29	12.72	9.69	11.73		
HI_LOAEL	**5.33**	**11.95**	**0.04**	**6.11**	**33.99**	**21.76**	**17.87**	**23.55**	**12.34**	**3.23**

Footnotes:

(a) No Observed Adverse Effect Level

(b) Hazard Quotient

(c) Hazard Index

(d) Lowest Observed Adverse Effect Level

Table 32-15
Summary of Detailed Ecological Risk Assessment Central Tendency (CT) Risk Drivers
Phase II Background
Jefferson Proving Ground
Madison, Indiana

JPG Bkg.	NOAEL[a]-Based HQs[b] Due to Soil Ingestion - CT								NOAEL-Based HQs Due to Dietary Ingestion - CT							
Parameter	Mourning Dove	Chimney Swift	Wild Turkey	American Kestrel	White-footed Mouse	Eastern Cottontail	Red Fox	Little Brown Myotis	Mourning Dove	Chimney Swift	Wild Turkey	American Kestrel	White-footed Mouse	Eastern Cottontail	Red Fox	Little Brown Myotis
Aluminum		1.05			4.23	6.88	3.20	4.63					1.56			2.50
Arsenic					2.97	4.83	2.24	3.25					9.76	1.51	3.30	18.01
Cadmium										7.84		7.10				1.86
Chromium		1.03														
Iron	1.68	2.97		1.11	1.66	2.70	1.25	1.82								
Molybdenum													1.64			
Selenium									4.13	6.06		6.12	94.57	51.07	39.06	93.76
Vanadium	44.62	79.00	6.80	29.54	21.94	35.68	16.56	24.02	1.15	6.13		5.54	6.45	1.59	2.24	10.59
HI[c]_NOAEL	**46.59**	**84.56**	**6.86**	**30.84**	**31.16**	**50.50**	**23.44**	**33.99**	**5.80**	**20.02**	**0.23**	**18.76**	**114.9**	**55.24**	**45.34**	**126.7**

JPG Bkg.	Total NOAEL-Based HQs Summed Across Pathways - CT							
Parameter	Mourning Dove	Chimney Swift	Wild Turkey	American Kestrel	White-footed Mouse	Eastern Cottontail	Red Fox	Little Brown Myotis
Aluminum		1.15			5.79	7.29	3.74	7.13
Arsenic					12.73	6.34	5.54	21.27
Cadmium		8.09		7.19				1.87
Chromium		1.26						
Iron	1.74	2.97		1.11	1.82	2.86	1.32	1.82
Molybdenum					1.91	1.23		
Selenium	4.18	6.15		6.15	94.79	51.43	39.23	94.01
Vanadium	45.78	85.13	7.01	35.08	28.39	37.27	18.81	34.61
HI_NOAEL	**52.50**	**105.0**	**7.30**	**49.64**	**146.5**	**106.7**	**69.57**	**161.0**

Table 32-15
Summary of Detailed Ecological Risk Assessment Central Tendency (CT) Risk Drivers
Phase II Background
Jefferson Proving Ground
Madison, Indiana

JPG Bkg.	LOAEL[d]-Based HQs Due to Soil Ingestion - CT							LOAEL-Based HQs Due to Dietary Ingestion - CT						
Parameter	Mourning Dove	Chimney Swift	American Kestrel	White-footed Mouse	Eastern Cottontail	Red Fox	Little Brown Myotis	Mourning Dove	Chimney Swift	American Kestrel	White-footed Mouse	Eastern Cottontail	Red Fox	Little Brown Myotis
Aluminum				2.15	3.49	1.62	2.35							1.27
Arsenic														1.42
Iron		1.49			1.35									
Selenium								2.07	3.03	3.06	6.30	3.40	2.60	6.25
Vanadium	2.97	5.27	1.97	7.31	11.89	5.52	8.01				2.15			3.53
HI_LOAEL	**2.99**	**6.77**	**1.98**	**9.52**	**16.79**	**7.17**	**10.39**	**2.09**	**3.03**	**3.06**	**8.78**	**3.60**	**2.69**	**12.47**

JPG Bkg.	Total LOAEL-Based HQs Summed Across Pathways - CT						
Parameter	Mourning Dove	Chimney Swift	Wild Turkey	American Kestrel	White-footed Mouse	Eastern Cottontail	Red Fox	Little Brown Myotis
Aluminum					2.94	3.70	1.90	3.62
Arsenic					1.00			1.68
Iron		1.49				1.43		
Selenium	2.09	3.07		3.08	6.32	3.43	2.62	6.27
Vanadium	3.05	5.68		2.34	9.46	12.42	6.27	11.54
HI_LOAEL	**5.18**	**10.26**	**0.01**	**5.42**	**20.11**	**21.23**	**10.89**	**23.14**

Footnotes:

(a) No Observed Adverse Effect Level

(b) Hazard Quotient

(c) Hazard Index

(d) Lowest Observed Adverse Effect Level

FIGURES

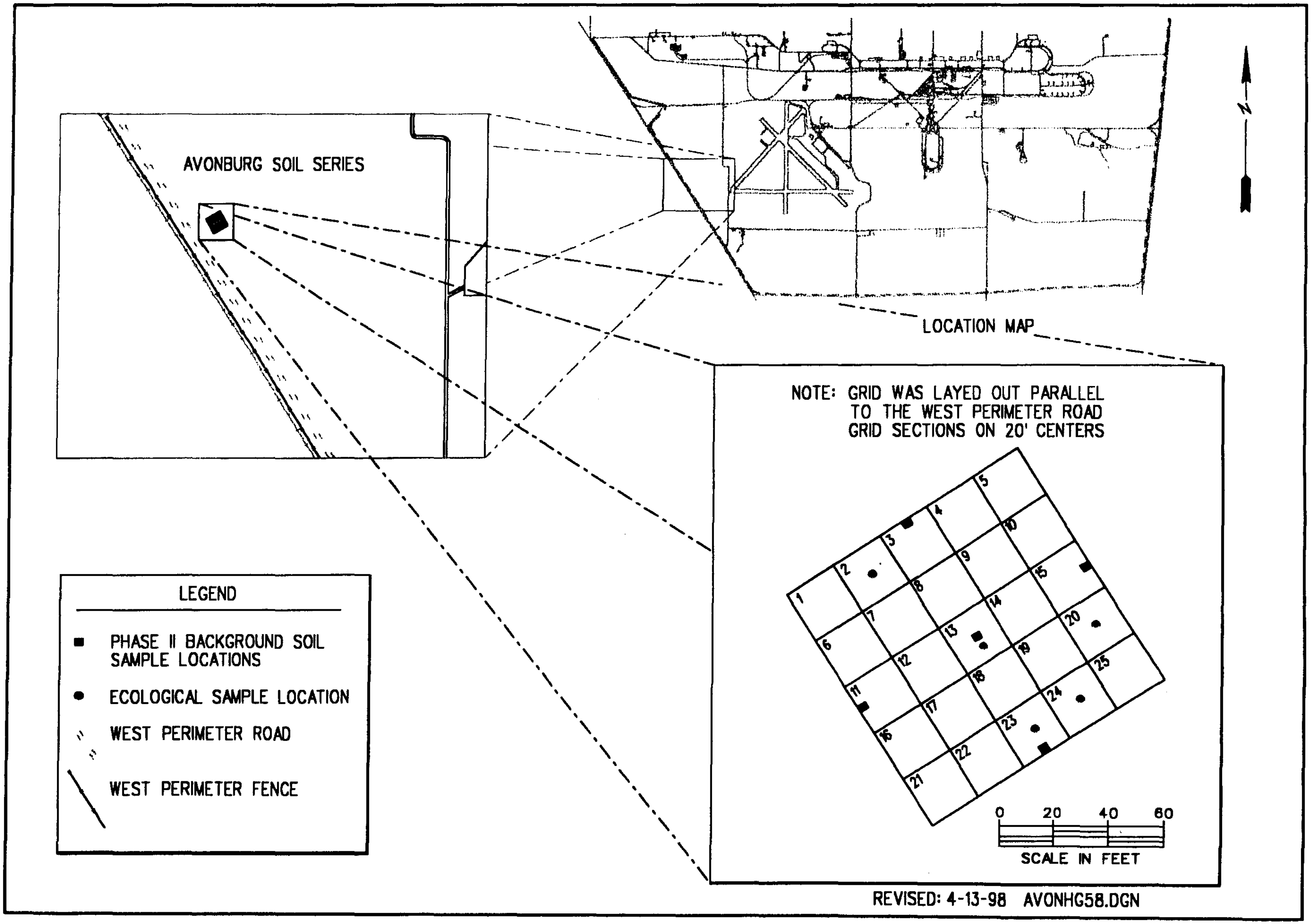

Figure 32-1. Reference Area Soil Locations - Avonburg Series

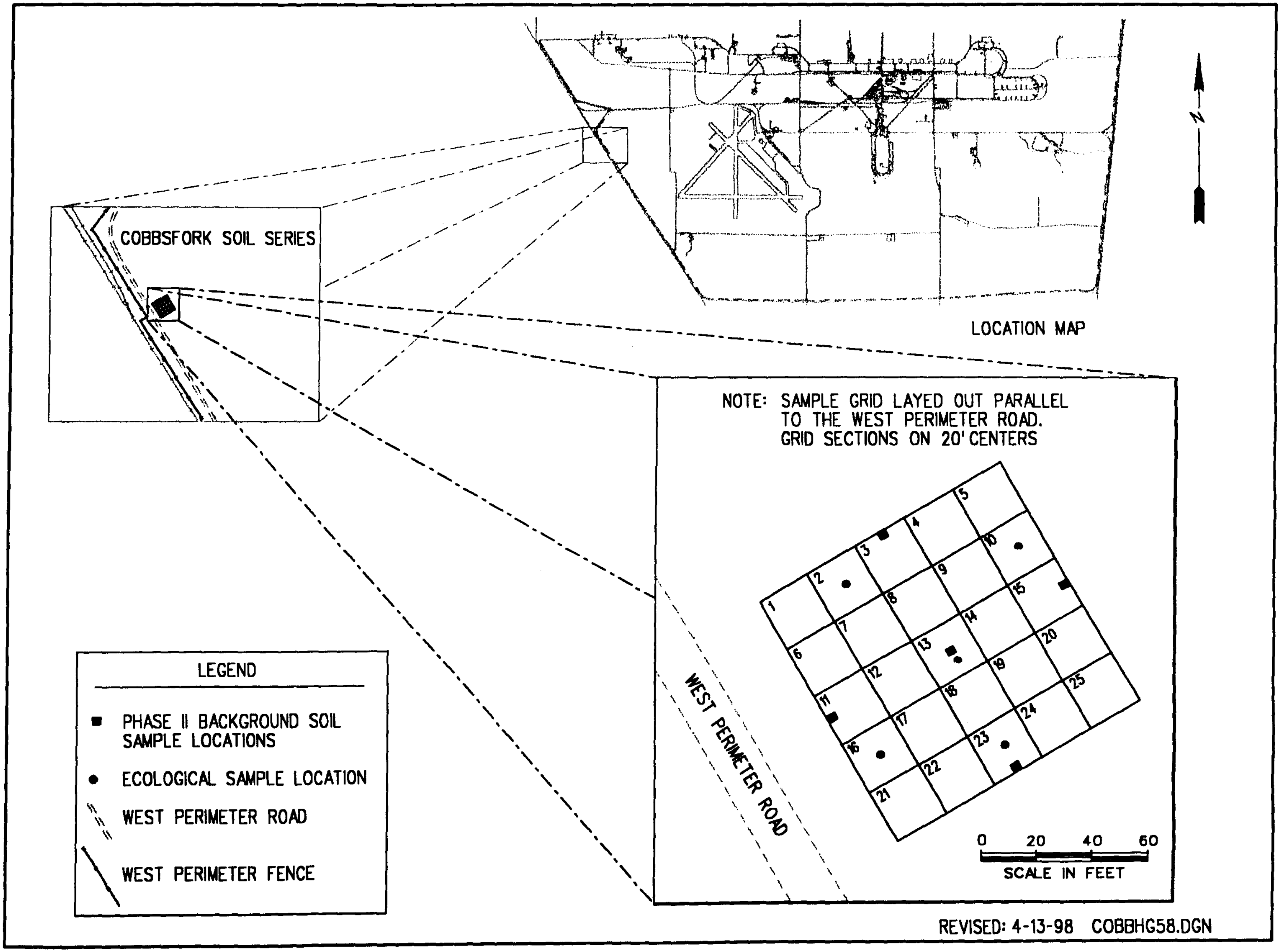

Figure 32-2. Reference Area Soil Locations - Cobbsfork Series

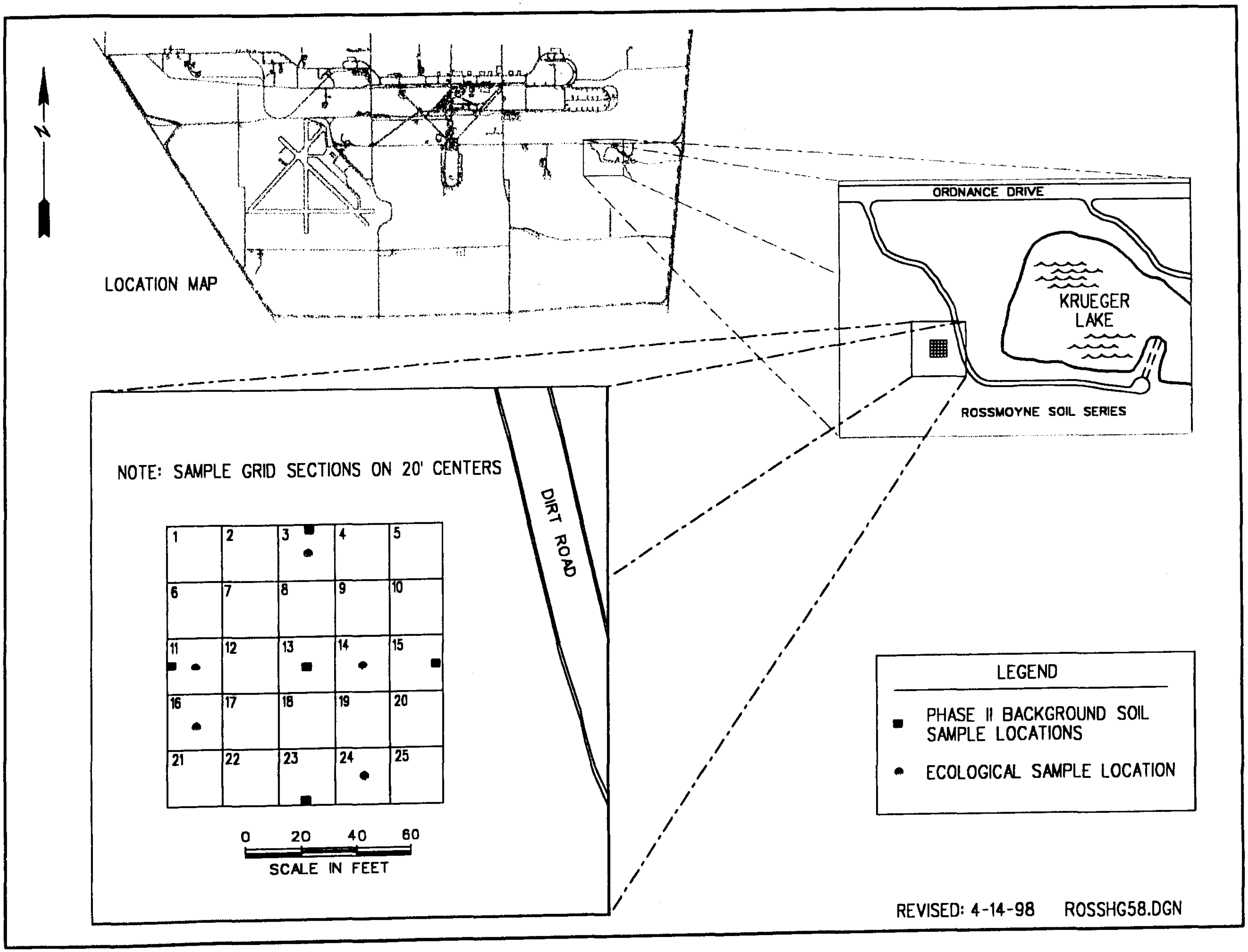

Figure 32-3. Reference Area Soil Locations - Rossmoyne Series

Figure 32-4 Total HIs-RME Risks Summed for All Pathways Based on NOAELs at EcoSite Avonburg - Phase III

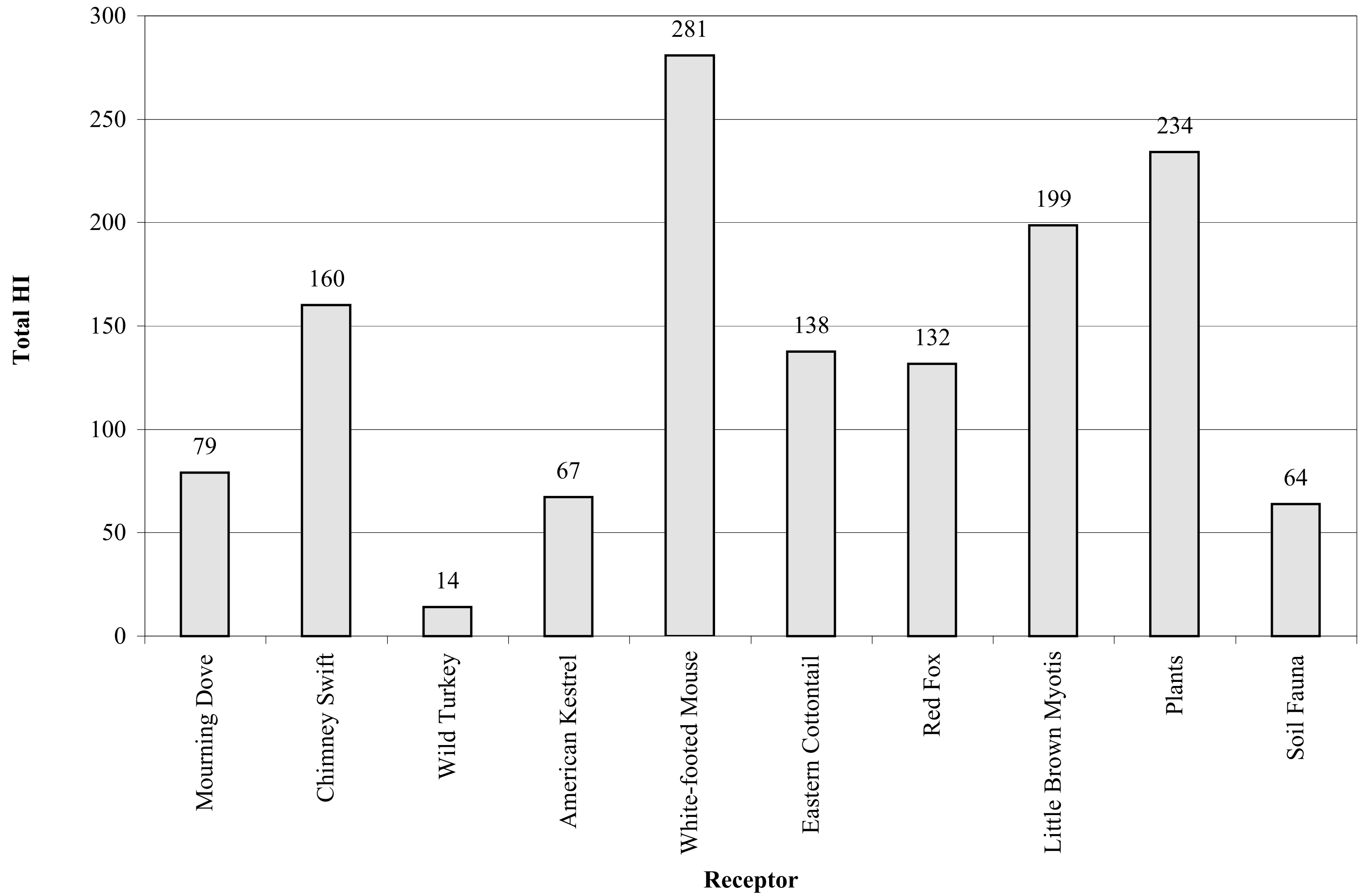

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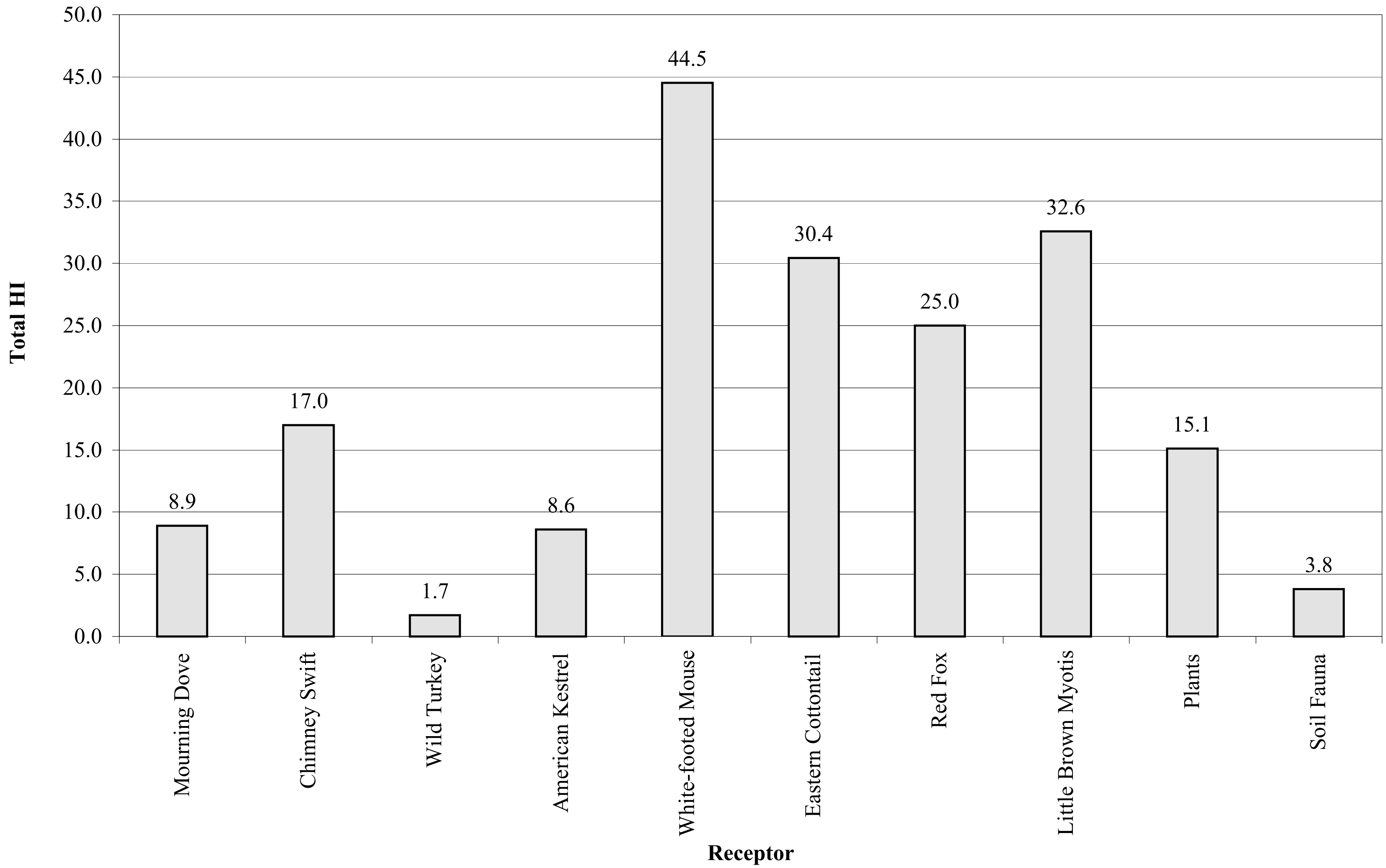
Figure 32-5 Total HIs-RME Risks Summed for All Pathways Based on LOAELs at EcoSite Avonburg - Phase III



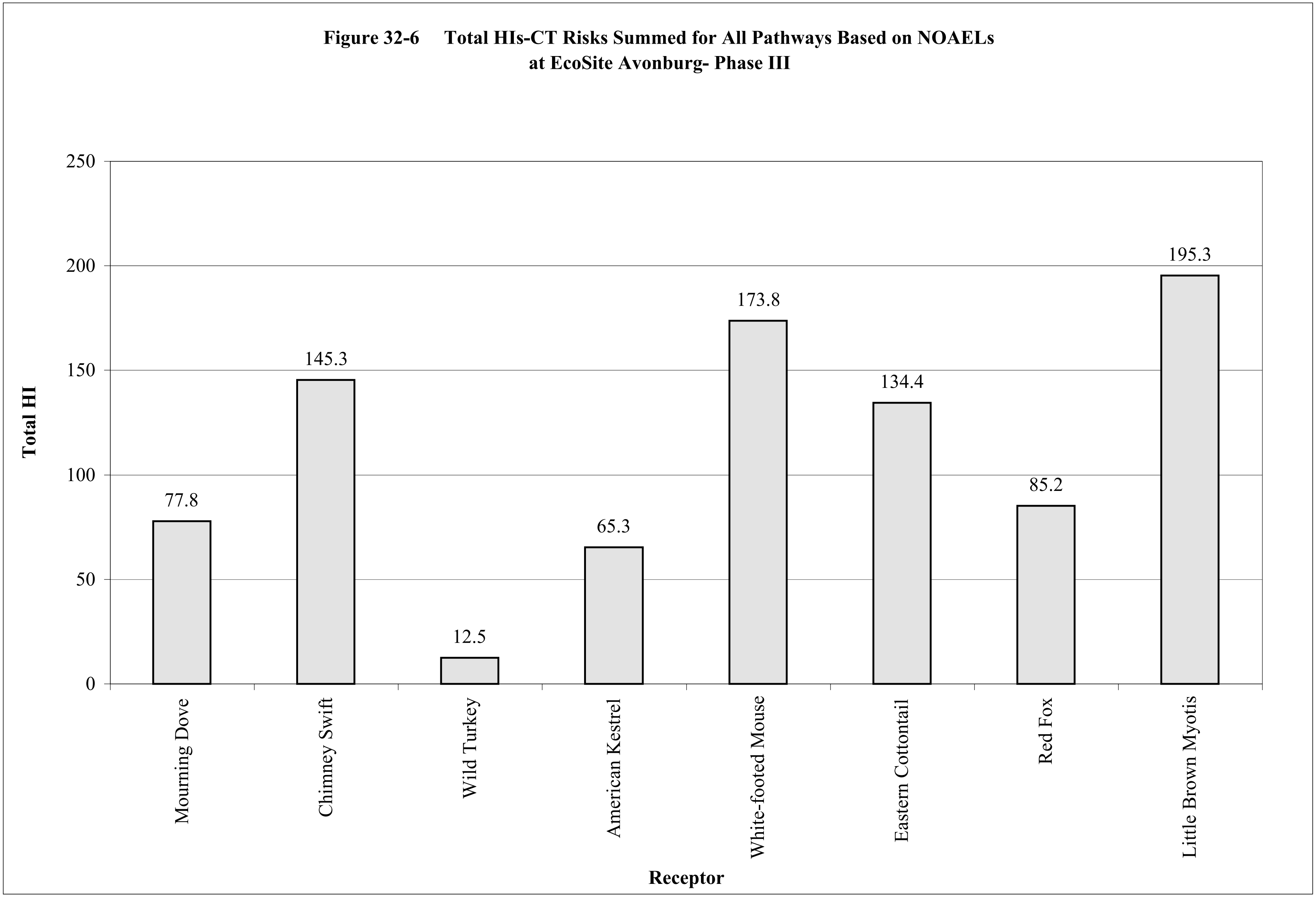
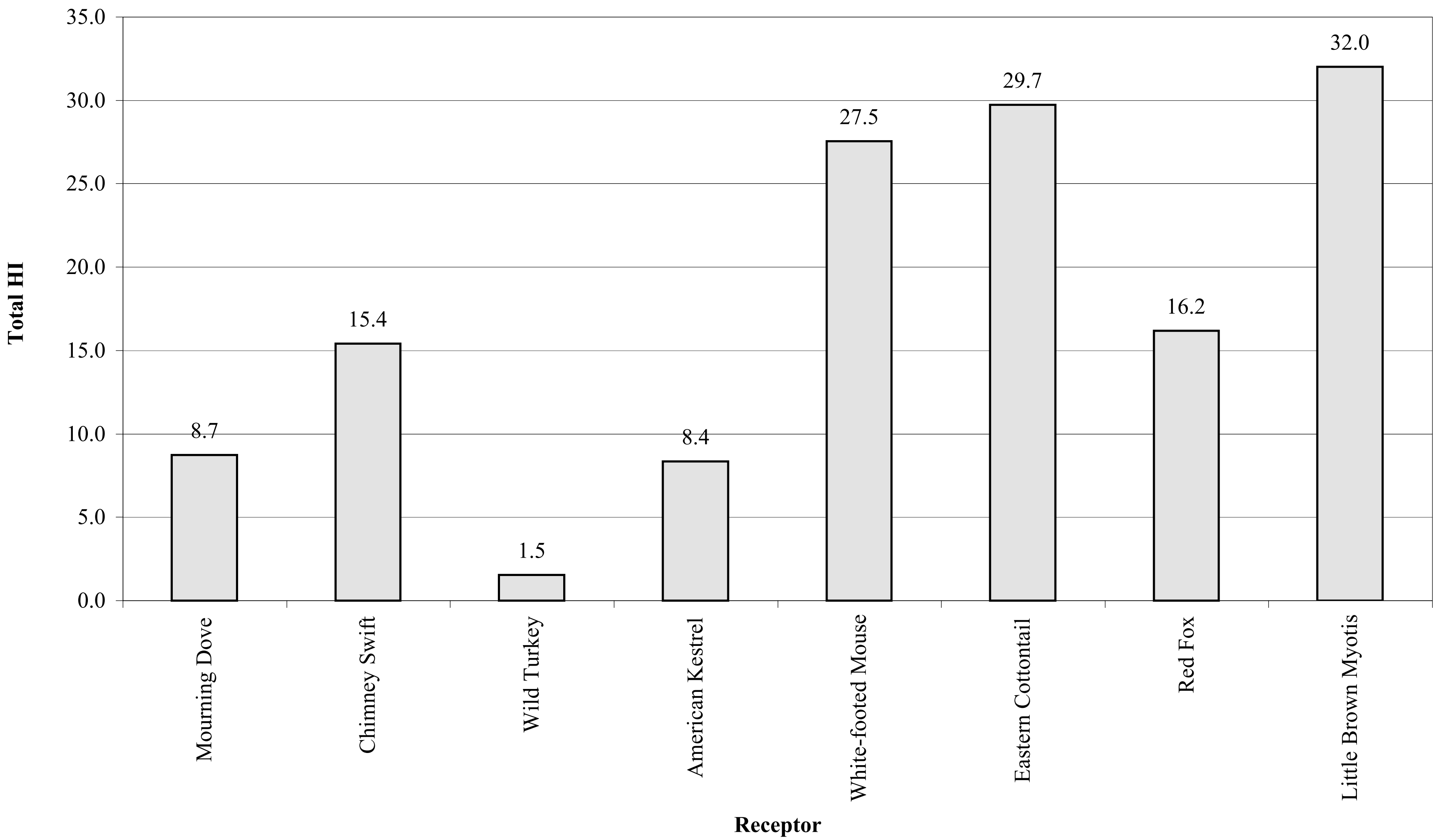


Figure 32-6 Total HIs-CT Risks Summed for All Pathways Based on NOAELs
at EcoSite Avonburg- Phase III
Total HI
250
200
150
100
50
0
77.8
145.3
12.5
65.3
173.8
134.4
85.2
195.3
Mourning Dove
Chimney Swift
Wild Turkey
American Kestrel
White-footed Mouse
Eastern Cottontail
Red Fox
Little Brown Myotis
Receptor

Figure 32-7 Total HIs-CT Risks Summed for All Pathways Based on LOAELs at EcoSite Avonburg - Phase III



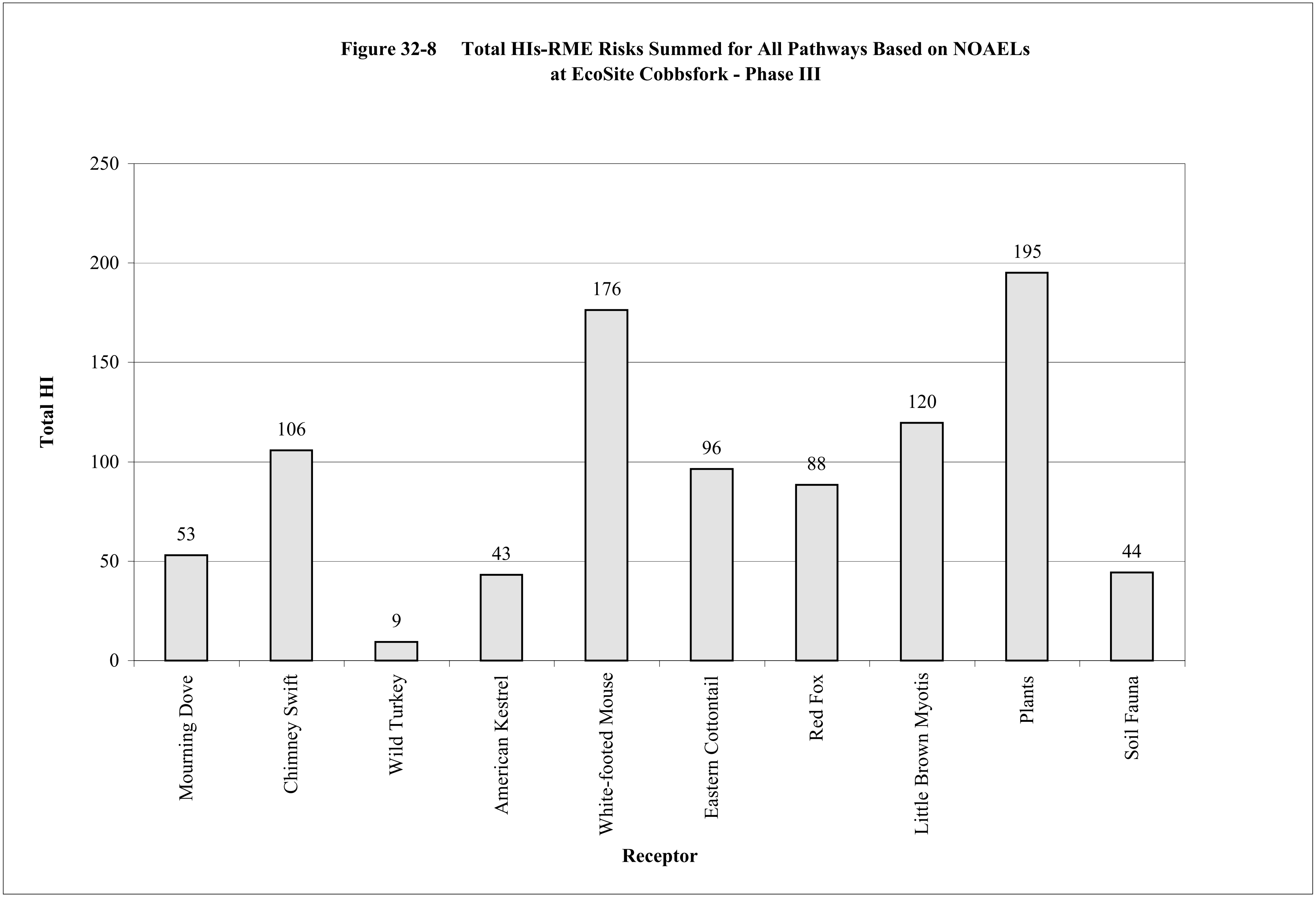


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Figure 32-9 Total HIs-RME Risks Summed for All Pathways Based on LOAELs at EcoSite Cobbsfork-Phase III

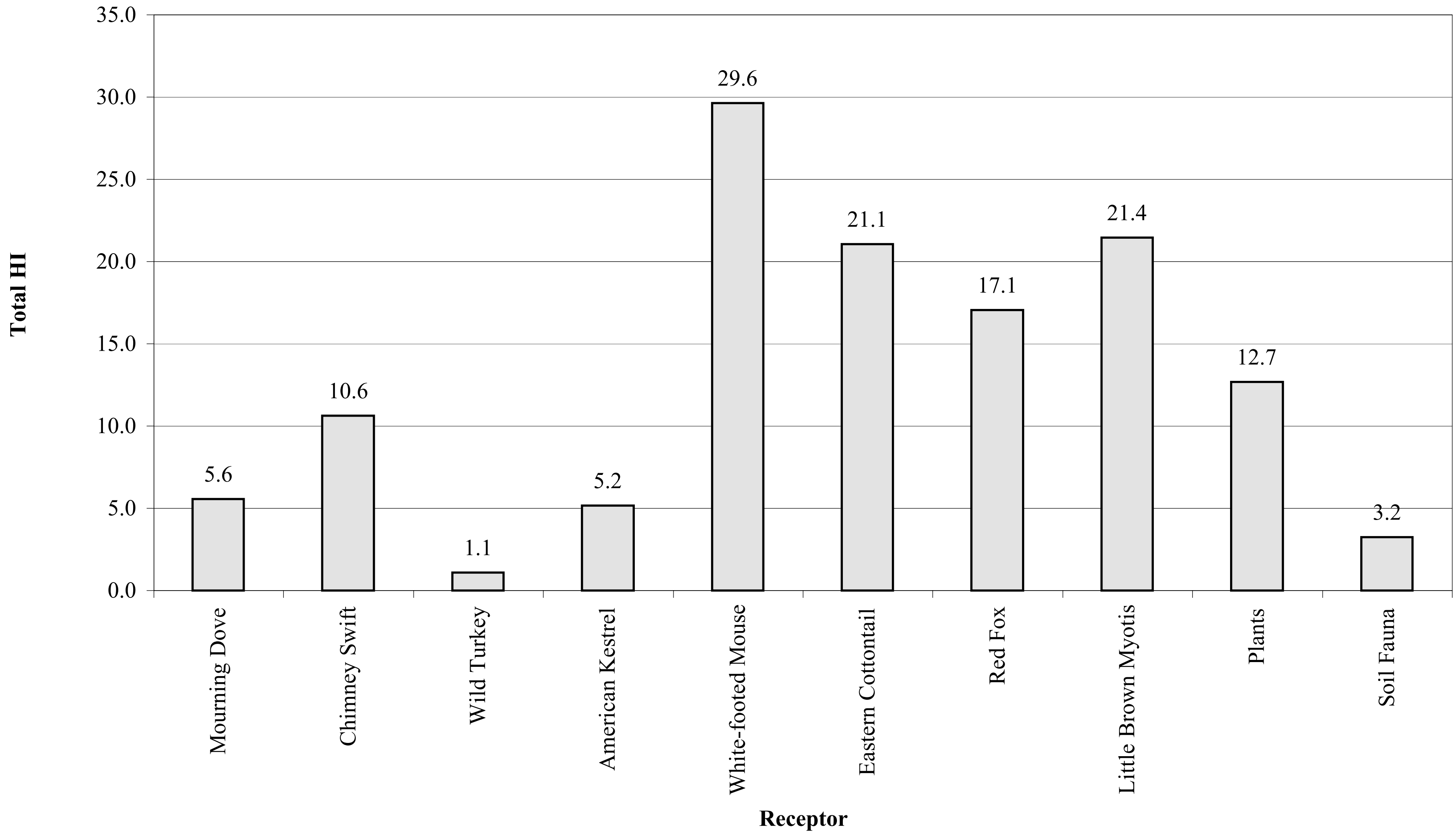

Figure 32-10 Total HIs-CT Risks Summed for All Pathways Based on NOAELs at EcoSite Cobbsfork - Phase III

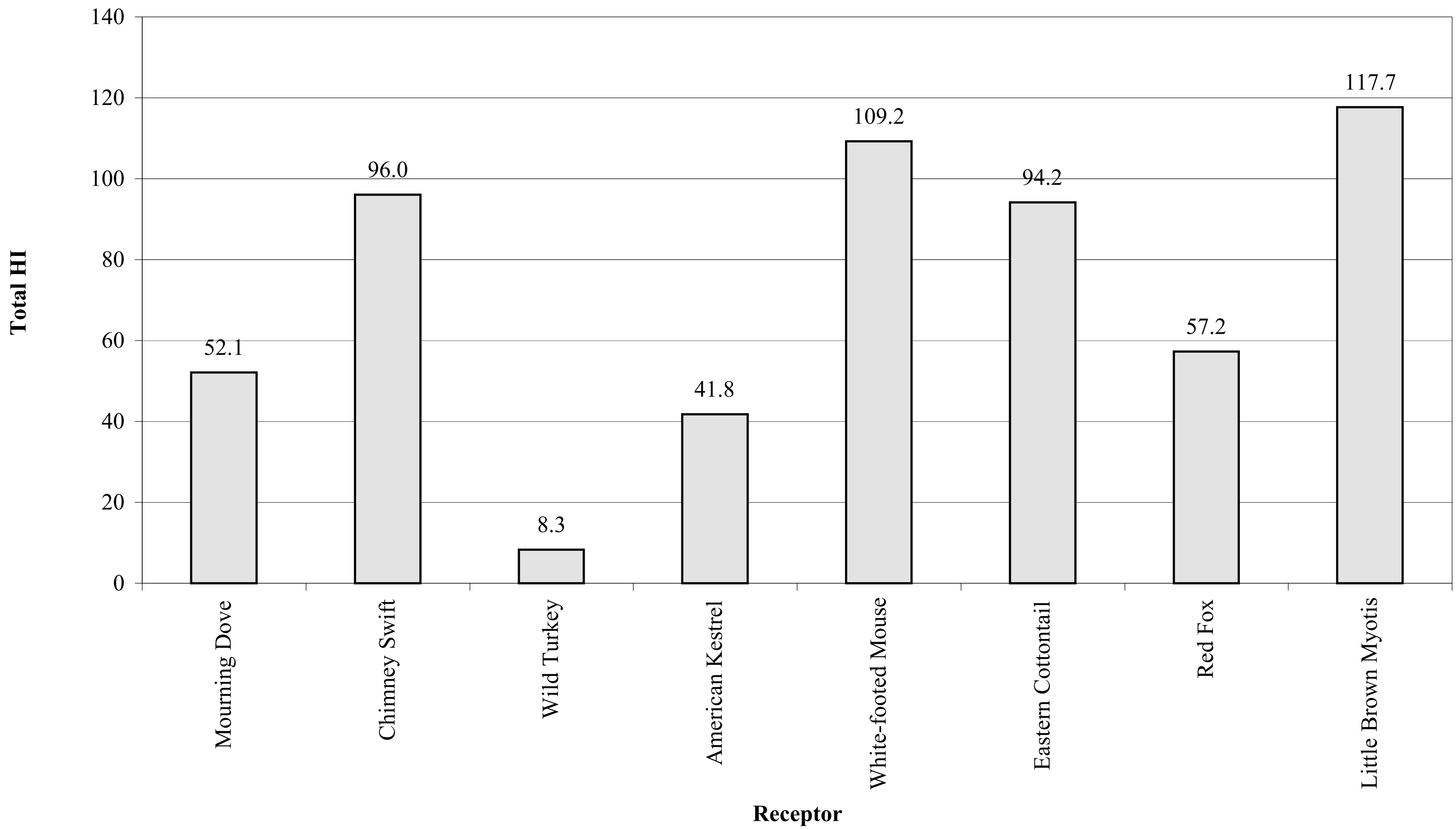

Figure 32-11 Total HIs-CT Risks Summed for All Pathways Based on LOAELs at EcoSite Cobbsfork - Phase III

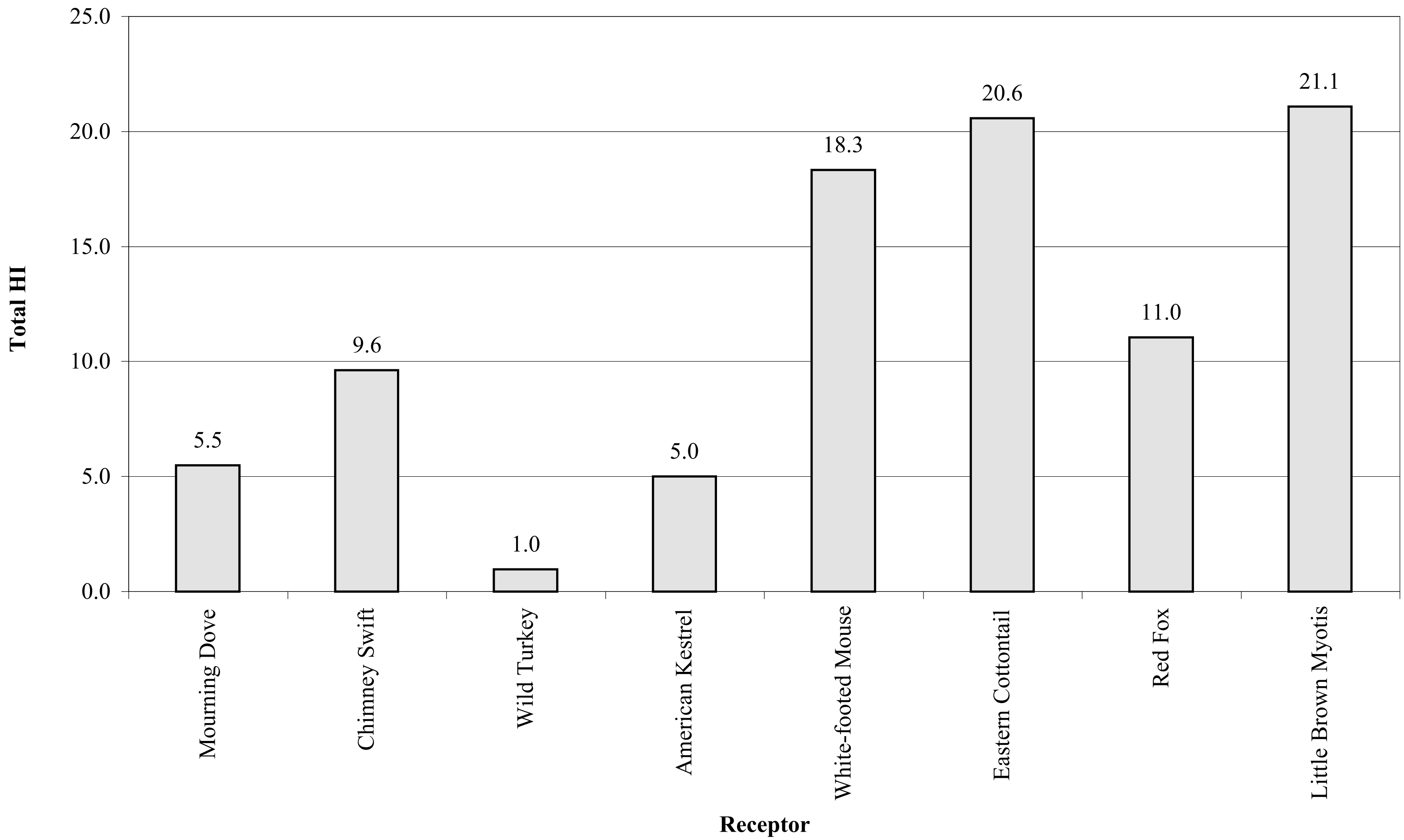

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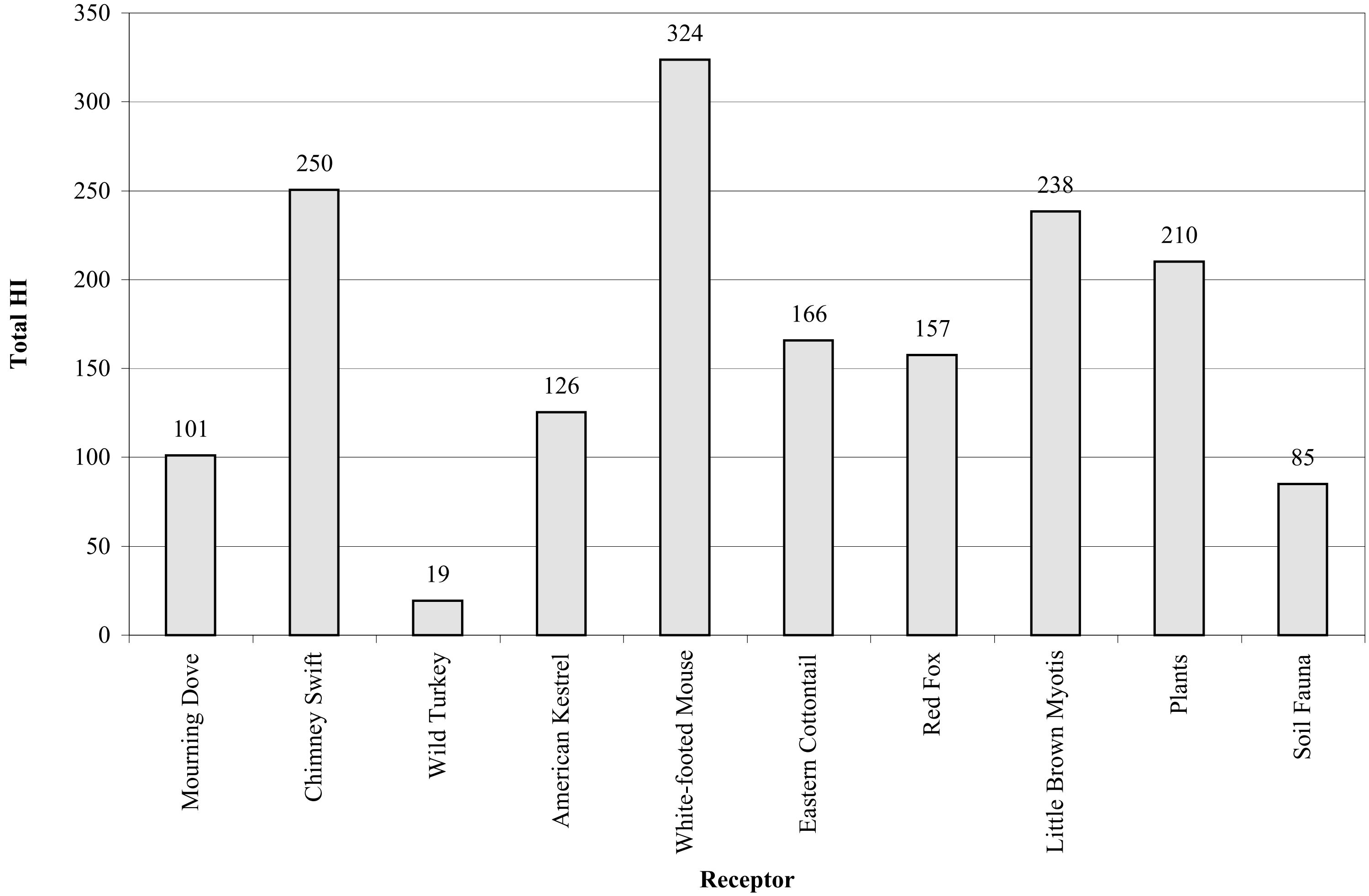
Figure 32-12 Total HIs-RME Risks Summed for All Pathways Based on NOAELs at EcoSite Rossmoyne - Phase III



N:\jobs\244\0025\01\ET ECO Files\JPG\Phase3\Risk2\P3erarosMWH.xls\Figure 32-12

Figure 32-13 Total HIs-RME Risks Summed for All Pathways Based on LOAELs at EcoSite Rossmoyne -Phase III

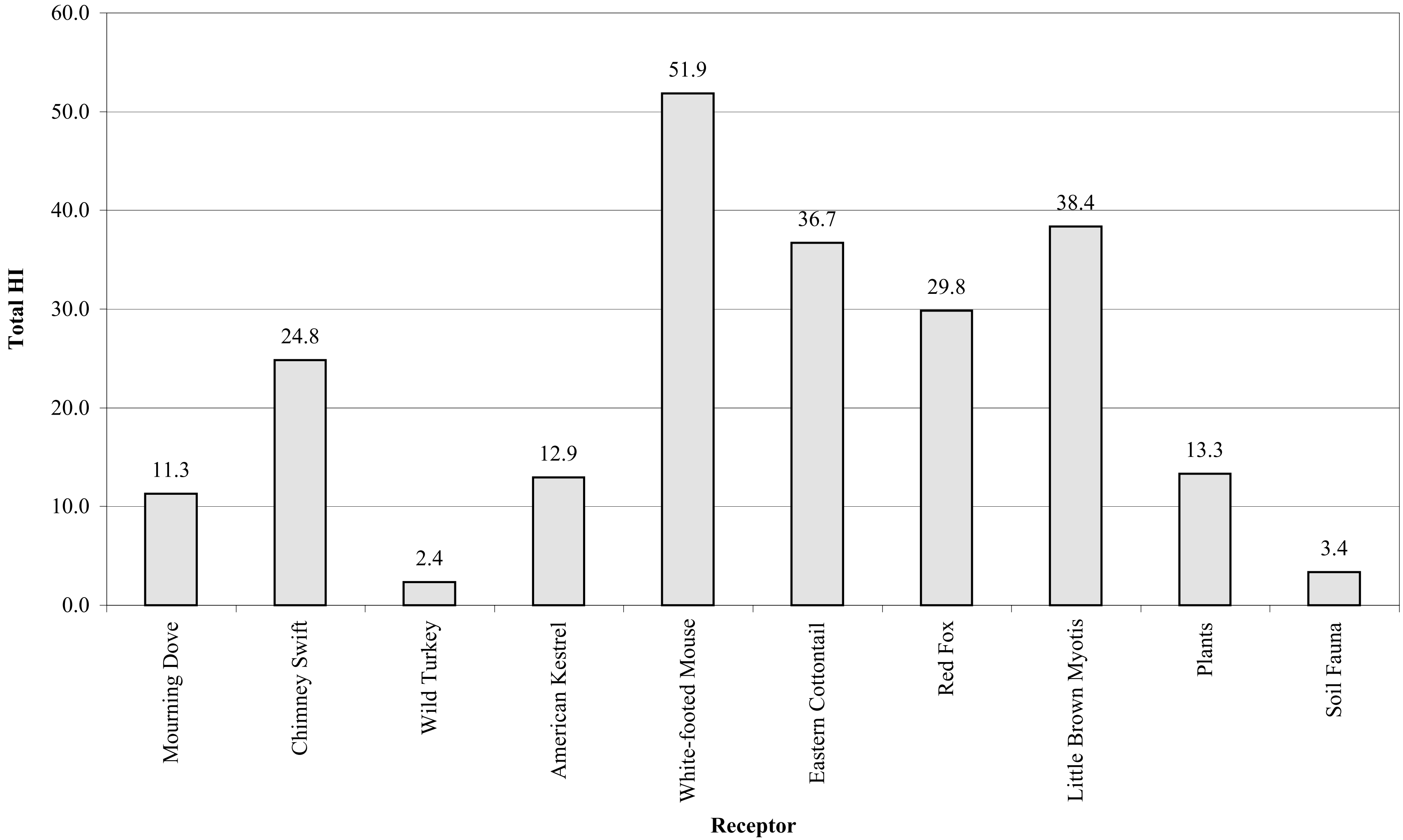
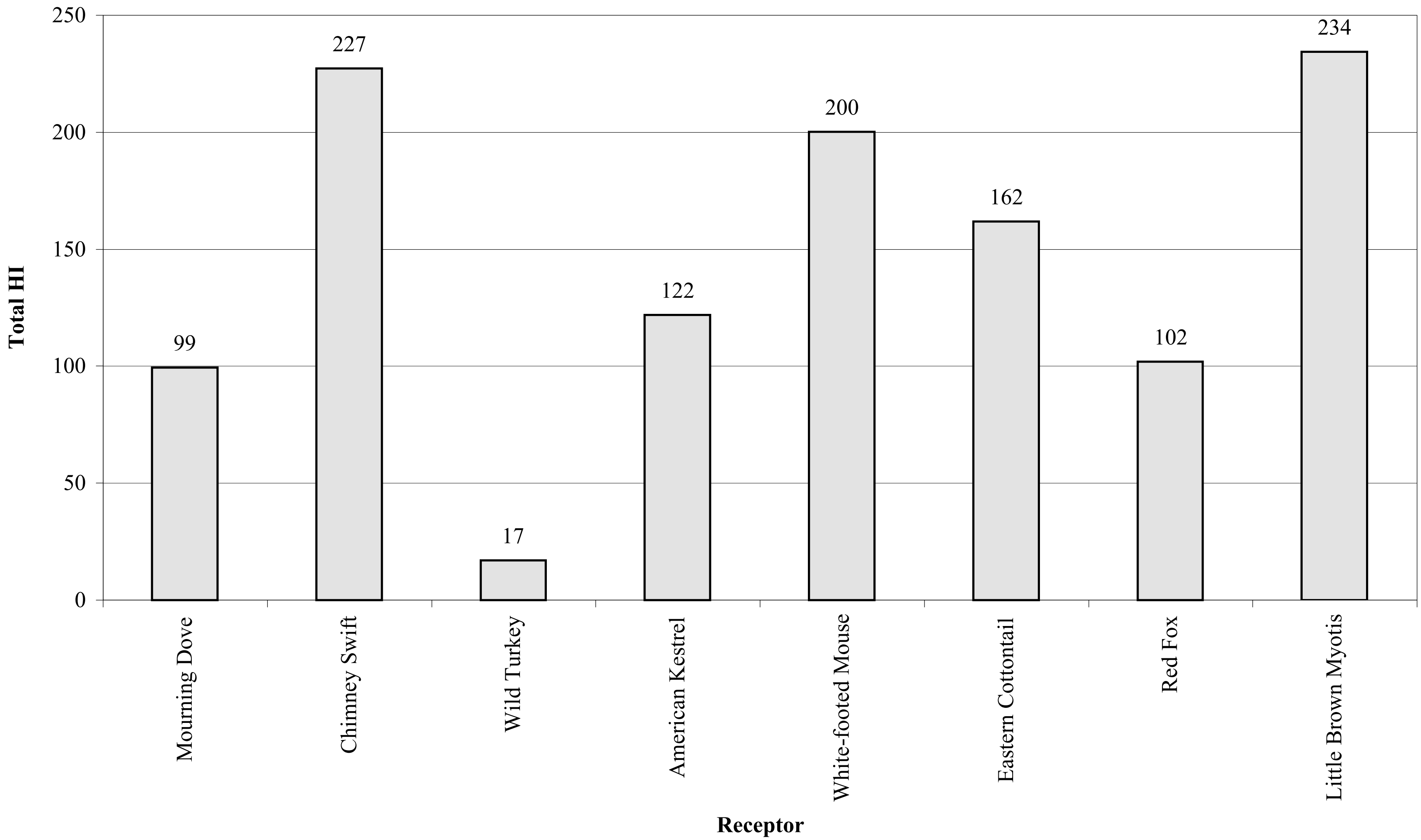
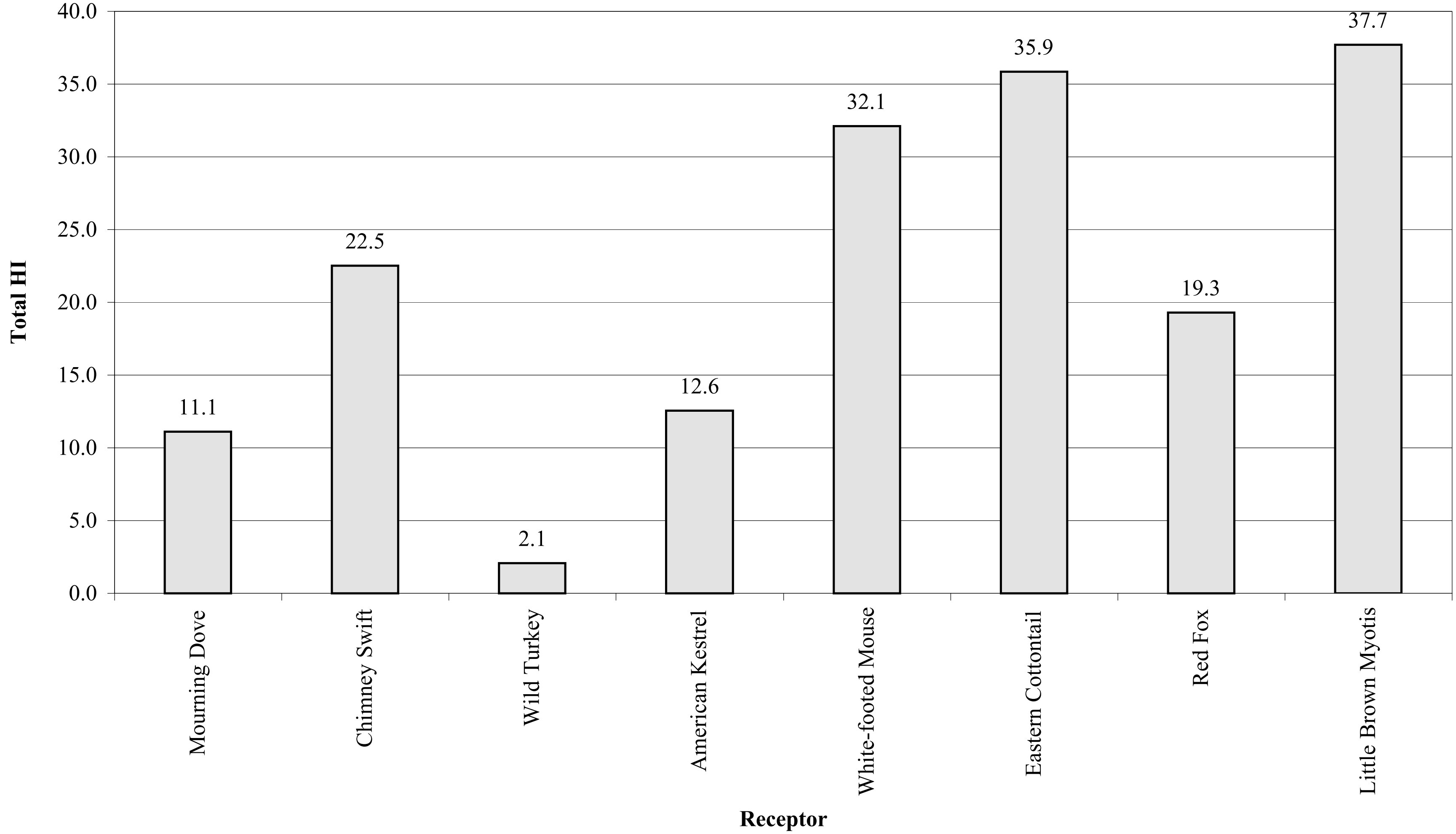


Figure 32-14 Total HIs-CT Risks Summed for All Pathways Based on NOAELs at EcoSite Rossmoyne -Phase III



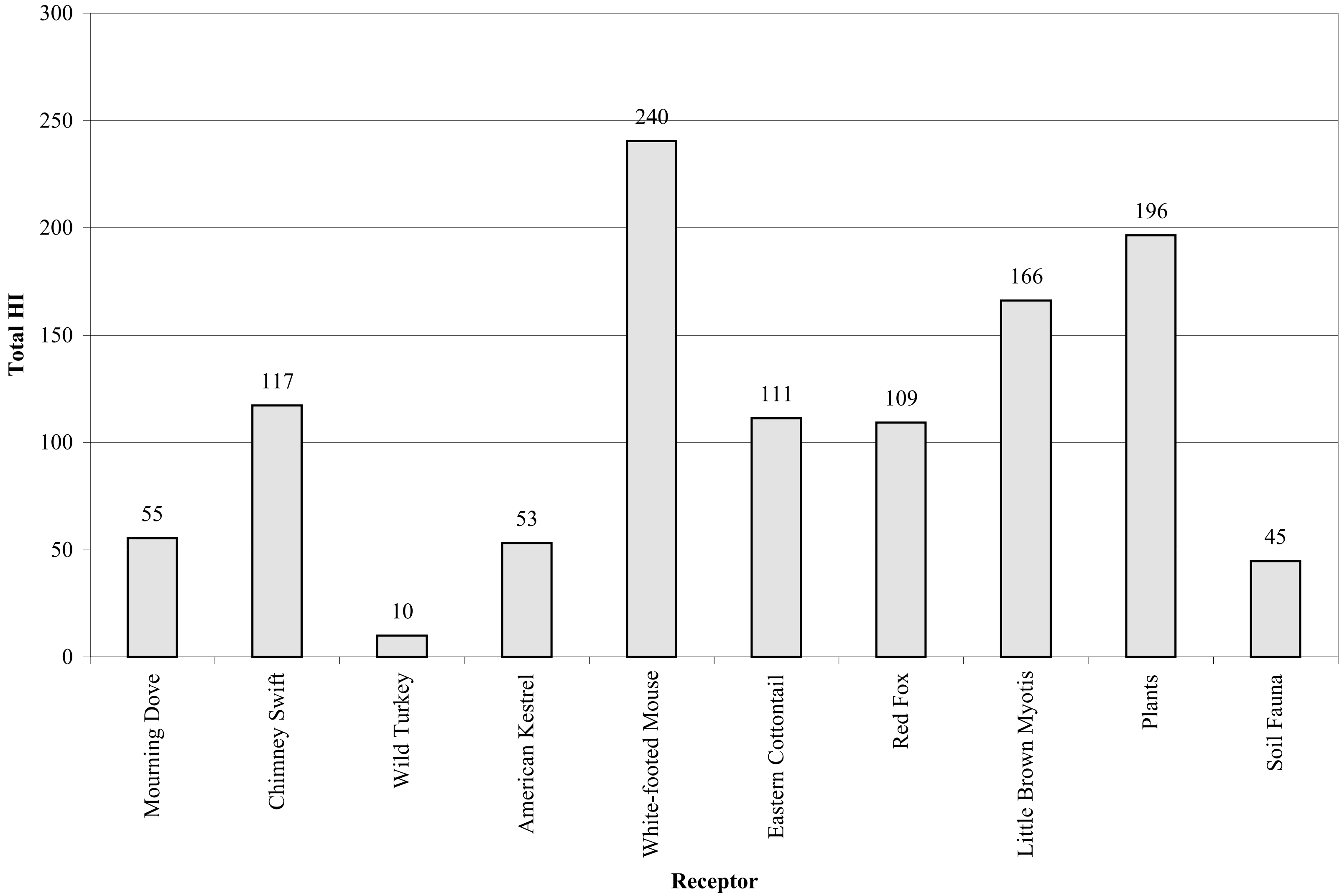
N:\jobs\244\0025\01\ET ECO Files\JPG\Phase3\Risk2\P3erarosMWH.xls\Figure 32-14

Figure 32-15 Total HIs-CT Risks Summed for All Pathways Based on LOAELs at EcoSite Rossmoyne -Phase III



N:\jobs\244\0025\01\ET ECO Files\JPG\Phase3\Risk2\P3erarosMWH.xls\Figure 32-15

Figure 32-16 Total HIs-RME Risks Summed for All Pathways Based on NOAELs for JPG Phase II Background



N:\jobs\244\0025\01\ET ECO Files\JPG\Phase2\Risk2\Era_bkgMWH.xls\Figure 32-16

Figure 32-17 Total HIs-RME Risks Summed for All Pathways Based on LOAELs for JPG Phase II Background

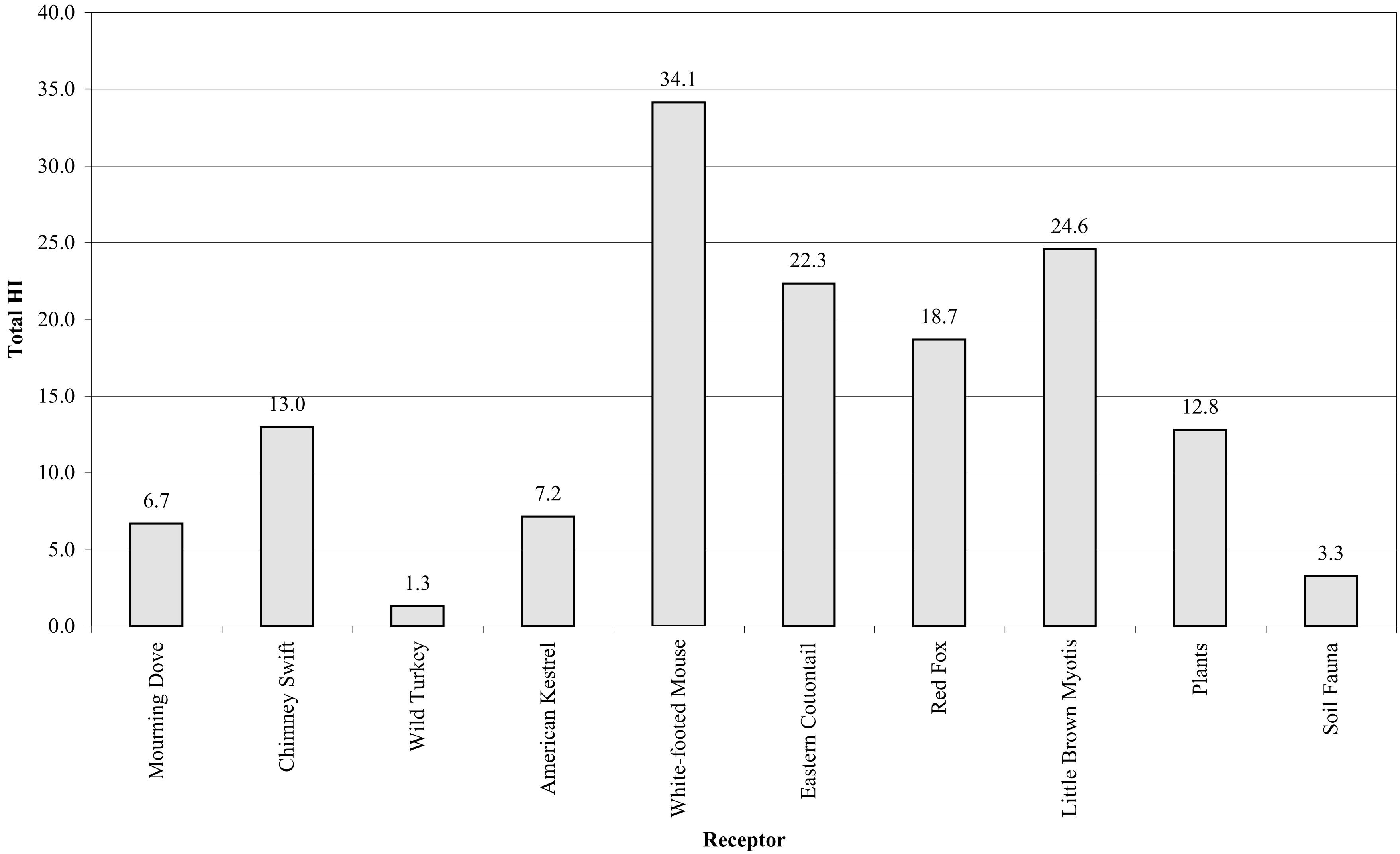
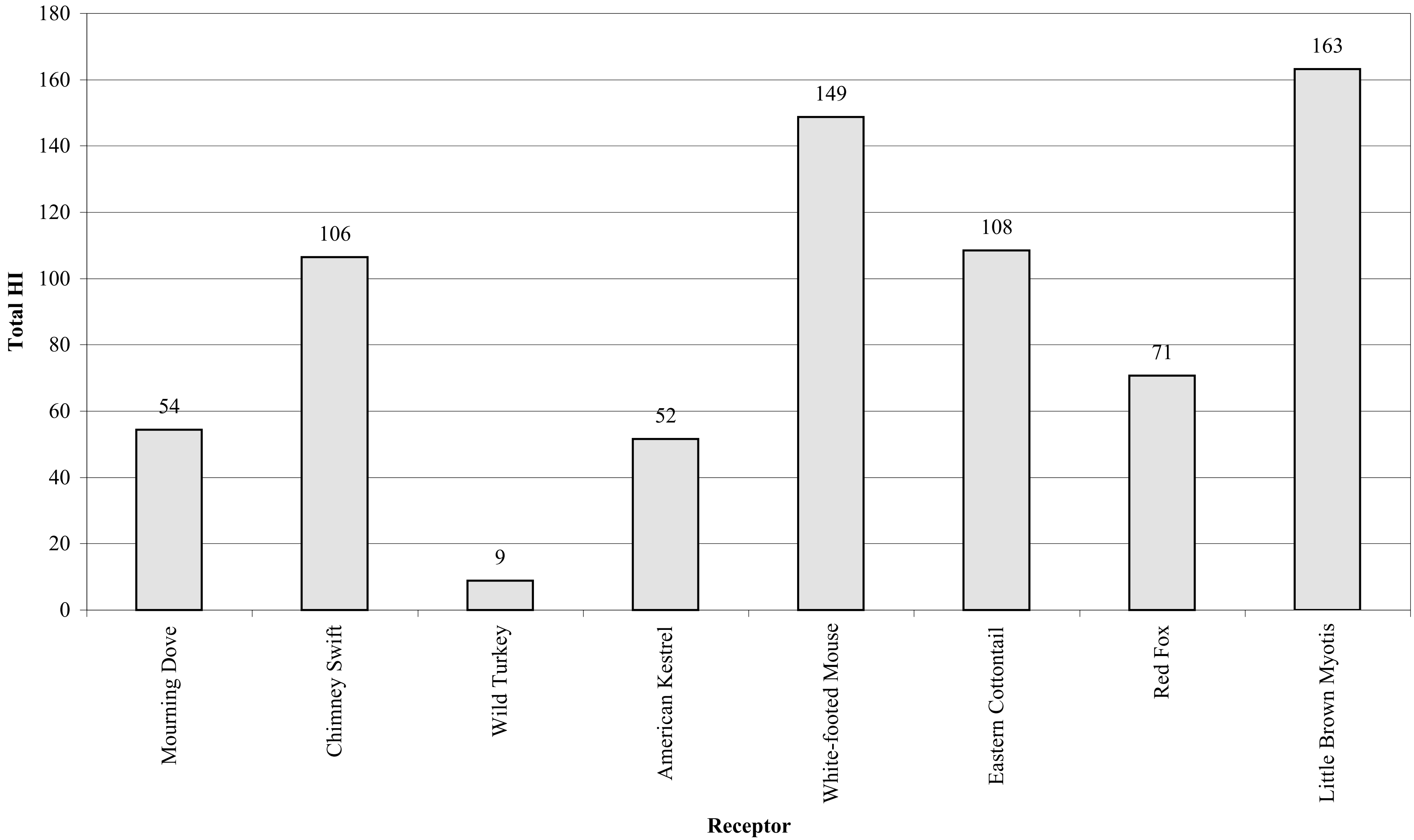
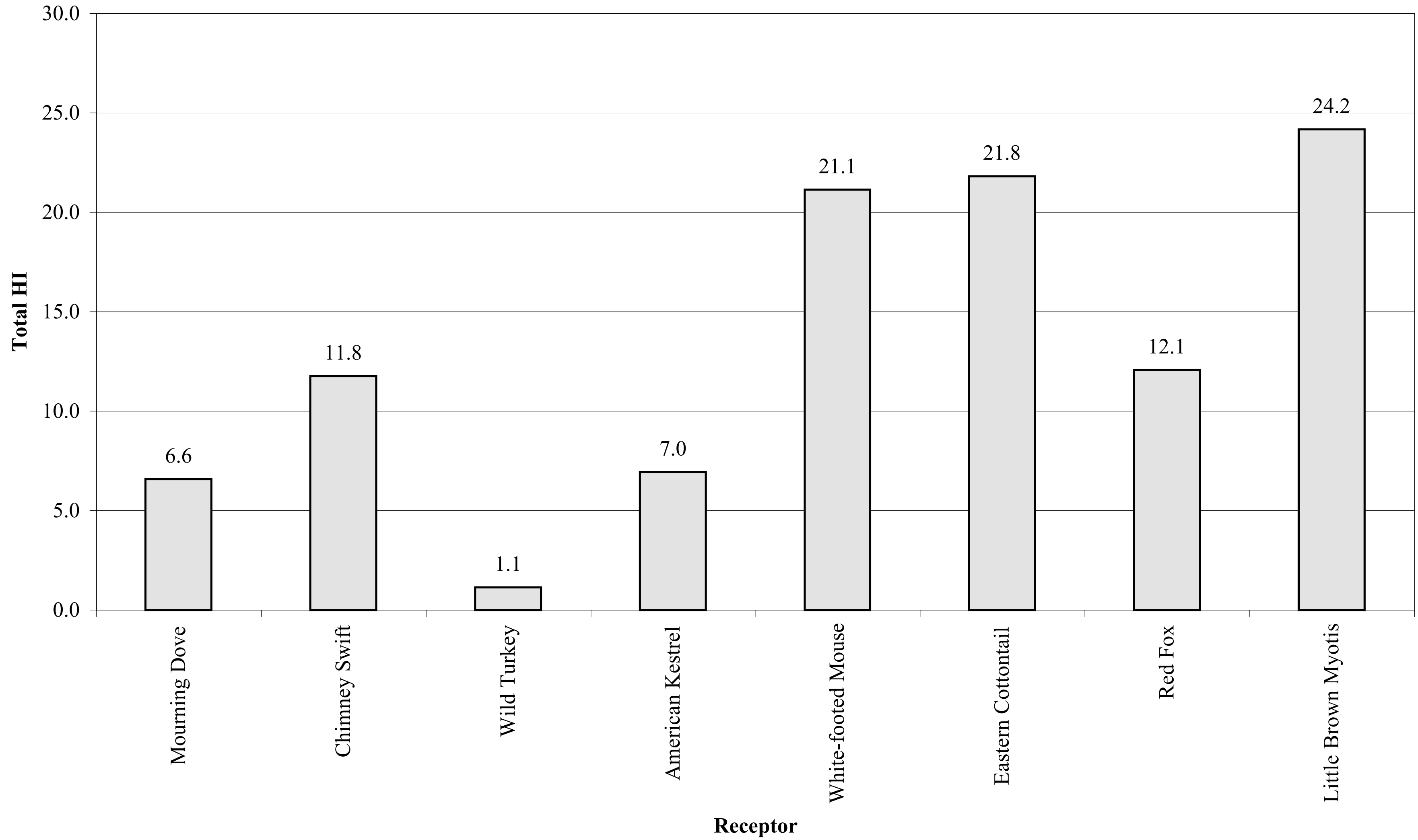


Figure 32-18 Total HIs-CT Risks Summed for All Pathways Based on NOAELs for JPG Phase II Background



N:\jobs\244\0025\01\ET ECO Files\JPG\Phase2\Risk2\Era_bkgMWH.xls\Figure 32-18

Figure 32-19 Total HIs-CT Risks Summed for All Pathways Based on LOAELs for JPG Phase II Background



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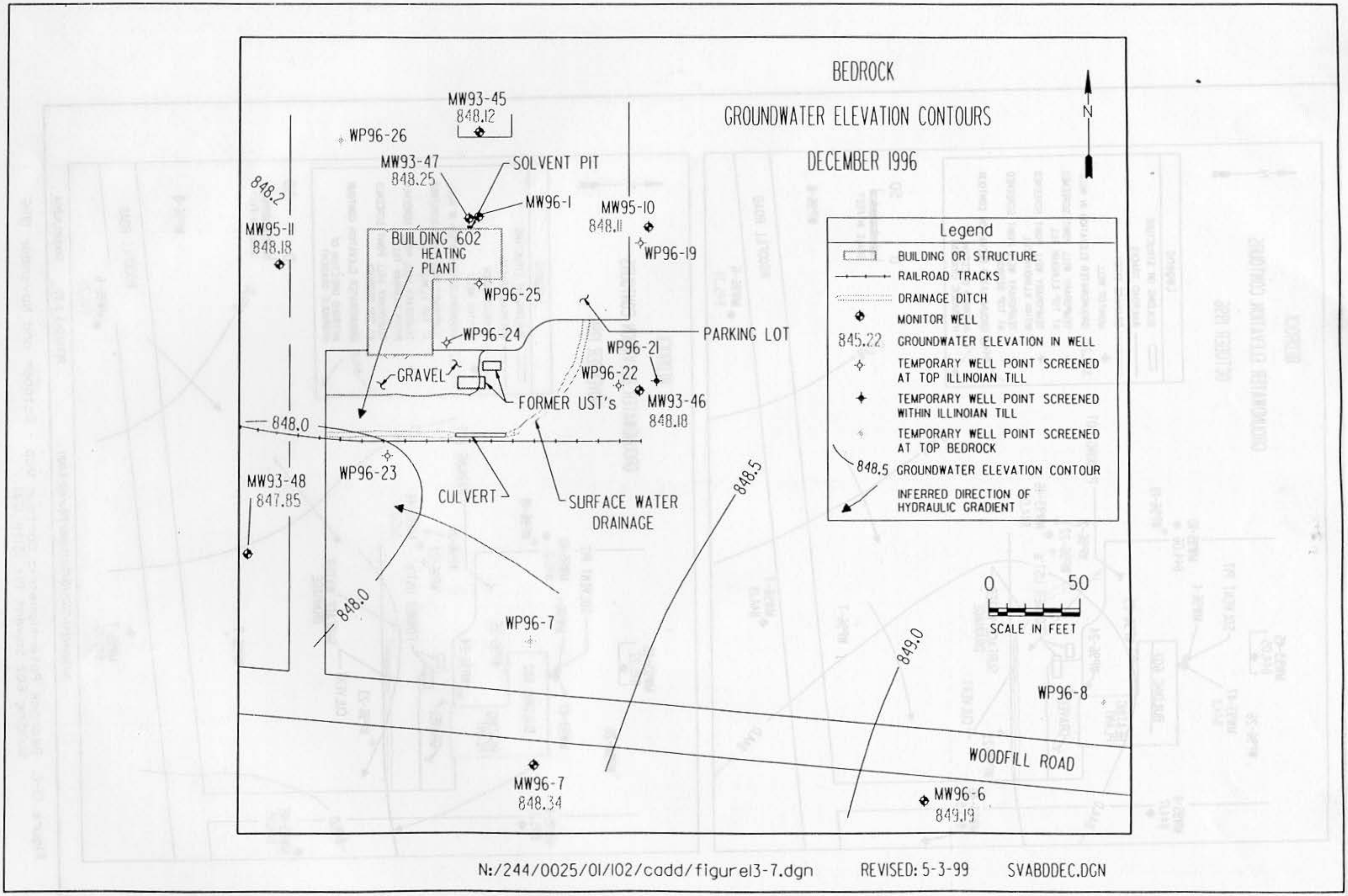

Figure 13-7. Bedrock Potentiometric Contour Map - December 1996
Building 602 Solvent Pit (Site 12A)

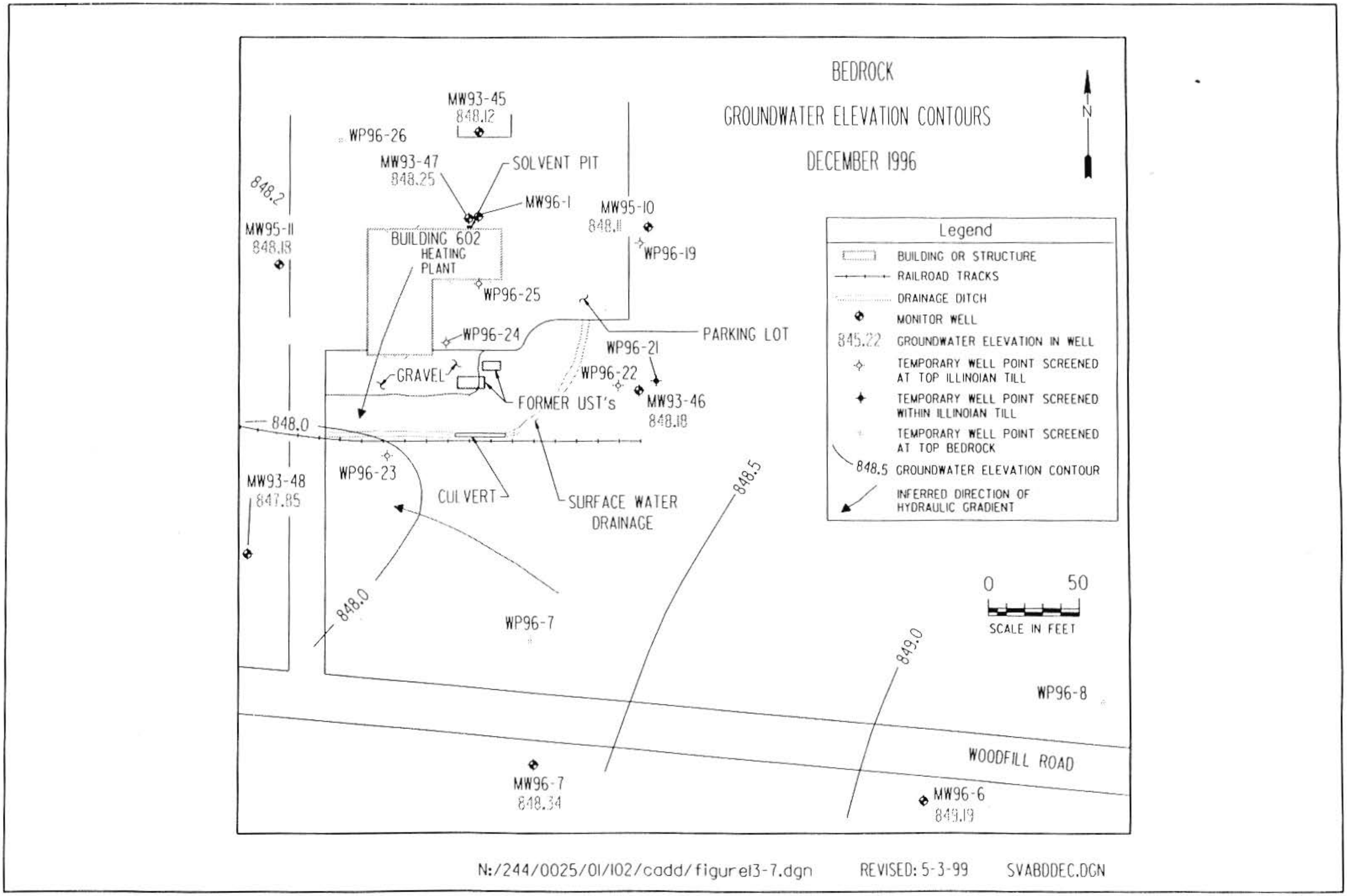

Figure 13-7. Bedrock Potentiometric Contour Map - December 1996
Building 602 Solvent Pit (Site 12A)