Tennessee Valley Authority, Post Office Box 2000, Spring City, Tennessee 37381-2000

November 28, 2001

50-390/391

Mr. Wayne Gregory, Director
Tennessee Department of Environment and Conservation
Division of Underground Storage Tanks
4th Floor, L & C Tower
401 Church Street
Nashville, Tennessee 37243-1541

Re: Environmental Assessment Report – Additional Sampling Requirements
Watts Bar Nuclear Plant
Chemical and Environmental Group
Spring City, Tennessee
Facility ID # 0-610035, Meigs County

Dear Sir:

On May 10, 2001, routine monitoring conducted in accordance with the approved Monitoring Only Program identified diesel fuel oil free product at the subject site. Free-product that was observed in downgradient monitoring well MW-2 has now diminished to almost immeasurable amounts. Subsequent correspondence from the DUST Chattanooga Field Office (July 25, 2001, to present) has required WBN to further delineate soil and groundwater contamination at the site and prepare an Environmental Assessment Report (EAR). Acknowledging the requirements of Rule 1200-1-15.06(6) and (7), WBN requests a return to the Monitoring Only Program.

The data collected to date and a thorough review of site hydrogeologic characteristics and engineered features at the release location provide compelling evidence to support the position that there is negligible risk to human health or the environment by allowing WBN to return to the Monitoring Only Program. Secondarily, this report demonstrates that additional subsurface investigations in areas downgradient of the known fuel oil free-product location present unwarranted plant safety and security issues. When all the relevant facts are reviewed it will become clear that this is the best option for WBN, the surrounding community, and TDEC.

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The attached report focuses on the details of the release. The most relevant factors are:

1. Extensive pressure testing was used to identify a leak in the diesel fuel oil transfer line and repairs were made. Evidence suggests that the release was of limited quantity.
2. The subsurface hydrogeology at WBN is very well characterized.
3. Soil and groundwater sampling indicates very limited diesel fuel oil contamination at the site.
4. The remoteness of the release. A water use survey shows that there are no water supplies within ½ mile of the site.
5. The impacted aquifer is classified as a non-drinking water supply.
6. The UST site ranking score was 233, well below the action number of 500.
7. Since the plant borders the Tennessee River, and regional groundwater movement is in the direction of the river, there are no downgradient groundwater supplies at the site.
8. The plant site is hydraulically isolated by Yellow Creek and the Tennessee River to the west, south, and east; it is hydraulically isolated to the north by the relatively impermeable Rome Formation. Therefore, it is highly unlikely that any off-site groundwater withdrawals would affect groundwater movement at the site.
9. The site groundwater sump continually controls hydraulic gradients and groundwater movement over an area extending well beyond the vicinity of the diesel release. Potentiometric maps based on site groundwater level measurements indicate that local groundwater movement in the diesel release area is always toward the sump.
10. The groundwater sump is likely to be recipient to any unattenuated fuel oil product remaining in subsurface soils. Therefore, the groundwater sump functions as an in situ pumping system to prevent off-site migration of fuel oil contaminants. The groundwater sump pump is automatically actuated by water level controls such that floating product would always be retained within the sump and product discharge would be prohibited.

Additional relevant factors not normally considered by the regulations include:

1. The proximity of this release to sensitive subsurface conduits and piping make it unsafe to install additional wells/borings downgradient of well MW-2. Unless a clear threat to the environment or human health exists, WBN is reluctant to install additional wells that may risk safe operation of the plant or the safety of the well drillers.
2. Any well/boring installations in this downgradient area will be situated within the "high" security zone of the plant site. The NRC has advised its licensees to maintain heightened security and is currently reviewing security regulations and procedures. Maintenance of high security within this region of the plant site is currently an issue, and well/boring installation activities would further encumber the WBN security staff and contractors.

In conclusion, based on the evidence presented, WBN requests to continue monitoring at the site in accordance with the Monitoring Only Program as directed by DUST in the letter dated January 23, 2001. Additionally, monitoring for the presence of free product at the site groundwater sump will be conducted on a weekly basis. Oil absorbent media will be maintained at this location for emergency use. Should free product be detected at the groundwater sump, TDEC DUST will be immediately notified and a product recovery system will be installed at this location.

We appreciate your attention to this matter. Should you require any additional information, please contact Rob Crawford at 423-365-8005, Lanny Brown at 423-365-8098, or Hank Julian at 865-632-1834.

Sincerely,

Edward R. Robinson
Environmental/Radwaste Superintendent

Enclosure

cc: (Enclosure)

Randy Slater, Field Office Manager
Environmental Assistance Center
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U.S. Nuclear Regulatory Commission
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Washington, D.C. 20555

TENNESSEE VALLEY AUTHORITY
River System Operations & Environment
Energy Research and Technology Applications

Watts Bar Nuclear Plant
Diesel Fuel Oil Update Report
Facility ID No. 0-610035

WR2001-2-85-146

Prepared by

Hank E. Julian
Environmental Engineering Services - East

Norris, Tennessee

November 2001

TVA

Table of Contents

Background

In April 2000, diesel fuel odors were observed in the Watts Bar Nuclear Plant (WBN) underground storm drain system downgradient of the aboveground diesel fuel storage area. A sheen of number 2 diesel fuel oil was subsequently identified at the stormwater drain system discharge outlet to the site Yard Holding Pond (YHP; Figure 1). An existing floating boom and oil absorbent pads have been used to contain the release of fuel oil at the YHP. Following a series of extensive pressure tests (TVA, 2000), it was determined that the release originated from leaking underground piping that transfers diesel fuel oil from the aboveground fuel storage tanks to the ~70,000-gallon diesel fuel oil underground storage tanks located at the site Diesel Generator Buildings. In accordance with directions from the Tennessee Department of Environment and Conservation (TDEC) Division of Underground Storage Tanks (DUST), an Initial Abatement Report was prepared and submitted on June 28, 2000. The leaking section of transfer line was repaired and returned to service on June 30, 2000.

Following site investigations, an Initial Site Characterization Report (ISCR) was prepared and submitted to TDEC on October 11, 2000 (TVA, 2000). An addendum to the ISCR (i.e., Free Product Removal Report) is dated November 20, 2000. Findings of the ISCR investigation are as follows:

- Soil contamination related to the diesel fuel oil release was limited to only 4 of 25 soil samples analyzed for EPH.
- Only one groundwater sample (downgradient well MW-2) has exhibited evidence of fuel oil contamination, and this measurement (1.9 mg/L) was only slightly greater than the cleanup level of 1.0 mg/L.
- A water use survey showed that there are no water supplies within ½ mile of the site.
- The impacted aquifer is classified as a non-drinking water supply.
- Since the plant borders the Tennessee River, and regional groundwater movement is in the direction of the river, there are no downgradient groundwater supplies at the site.
- The likelihood of impacting off-site groundwater supplies is considered nonexistent.
- The UST site ranking form was completed in accordance with TGD - the total site score from ranking is 233, well below the action number of 500.
- The site groundwater sump controls hydraulic gradients and groundwater movement over an area extending well beyond the vicinity of the diesel release.

- All groundwater and potential contaminant movement from the release location is toward the groundwater sump.
- No evidence of free product was observed at this time in site monitoring wells or the groundwater sump.

In January 2000, TDEC DUST approved recommendations for entering the Monitoring Only Program at the site. On May 10, 2001, routine monitoring was conducted at four site wells associated with the WBN diesel fuel oil release. Approximately 1.9 ft of fuel oil free-product was observed at downgradient well MW-2 using an oil/water interface meter. This was the first observation of free-product at the site. The TDEC Division of Underground Storage Tanks was immediately contacted to report the observation and a formal letter of notification was been transmitted to the Division. The Site Status Monitoring Report (June 1, 2001) also documented the observation in accordance with Technical Guidance Document (TGD)-007, Section III. Since May 30, 2001, monitoring and product removal has been conducted at a weekly frequency. Product levels at well MW-2 have now diminished to almost immeasurable amounts. Considering the relative impermeability of shallow soils at the site and the initial absence of free product at all site monitoring wells, the fuel oil product observed at well MW-2 is likely of limited quantity.

Subsequent correspondence from the DUST Chattanooga Field Office (July 25, 2001, to present) has required TVA's WBN to further delineate soil and groundwater contamination at the site and prepare an Environmental Assessment Report (EAR) in accordance with Rule 1200-1-15.06(6) and (7). Acknowledging the requirements of Rule 1200-1-15.06(6) and (7), this report has been prepared to illustrate that site conditions pose no threat to human health or the environment and that additional delineation of free product is unnecessary. Secondarily, this report demonstrates that additional subsurface investigations in areas downgradient of the known fuel oil free-product location present unwarranted plant safety and security issues.

Site Description

WBN is located in Rhea County, Tennessee, on the right bank of Chickamauga Lake at Tennessee River Mile (TRM) 528. The plant site is approximately two miles downstream of Watts Bar Dam. The site map shown in Figure 1 depicts the locations of the diesel fuel oil transfer line which extends from the aboveground diesel fuel storage tanks to the five underground diesel fuel storage tanks in the Diesel Generator Building (DGB) and Additional DGB. The locations of monitoring wells (MW-1 to MW-4) installed for the ISCR are also shown in Figure 1. The wells extend 25 to 27 ft deep to bedrock and are screened through the saturated zone. A groundwater sump is located approximately 190 ft southwest of MW-2. The

influence of this sump on groundwater movement at the site is discussed in ensuing sections of this report.

The subsurface geology at WBN is very well characterized with investigations that include 76 exploratory borings installed at the site from 1950 to 1970. Additional investigations at the site have included downhole geophysical tests, seismic refraction surveys, dynamic seismic tests, pressure bulb tests, and a suite of both field and laboratory analyses of site soils and bedrock (TVA, 1994). Subsequent boring investigations have included soils testing for major plant features (e.g., Essential Raw Cooling Water [ERCW] pipeline, 500 kV switchyard, cooling towers, DGB) as provided in TVA reports dated 1977 and 1979. Eight temporary piezometers were installed within overburden soils by Boggs (1982) to predict seasonal high groundwater levels in the vicinity of the ERCW.

Figure 2 shows the stratigraphic section derived from exploratory borings and investigations at the diesel release site. No discrepancies were observed between boring logs from previous characterization studies at WBN and borings at the diesel release site. The unconsolidated soils overlying bedrock at the site are composed primarily of alluvial deposits on the elevated flood plain near the lake shore, and terrace materials deposited by the Tennessee River when it was flowing at higher levels. The alluvium is composed of fine-grained, finely sorted, silts and clays with micaceous sand and some quartz gravel at depth. The thickness of the unit varies, but averages about 25 feet. Near the base of the terrace bench, the alluvial deposits feather out. Included in the alluvial material are some fairly well-defined beds of clay in the upper horizon, some containing carbonized fragments of wood. These are interpreted as old slough fillings (TVA, 1994).

The terrace deposits are much older than the recent flood plain deposits and their edge is marked by a distinct topographic bench approximately 30 feet deep. Historical borings show the thickness of the terrace deposits to vary from a minimum of 30 feet to a maximum of 46 feet. The upper portion of the unit is composed of sandy, silty clay, and the lower zone (below about elevation 715 ft-msl) is much coarser, consisting of pebbles, cobbles, and small boulders of quartz or quartzitic sandstone in a sandy clay matrix. As shown in Figure 2, the uppermost terrace deposits (about 40 ft) have been removed in the main plant area (near elevation 728 ft-msl). All horizontal surfaces were covered with at least 4 inches of concrete within 48 hours following completion of excavation to final grade. Backfill outside of the main plant structures (safety-related features) consists of "crusher-run" limestone and sand fill material (Section 1032 material). The granular fill material is suitable for compaction to a dense, stable mass and consists of sound, durable particles which are graded within the following limits.

	Percent by Weight	
Passing	Minimum	Maximum
1-1/4 inch	100	
1-inch	95	100
3/4-inch	70	100
3/8-inch	50	85
No. 4	33	65
No. 10	20	45
No. 40	8	25
No. 200	0	10

Although, no direct hydraulic conductivity measurements have been conducted for this backfill material. Methods relating hydraulic conductivity to grain size (Slichter, 1899 and Terzaghi, 1925) suggest values ranging from 3 x 10^{-2} to 8 x 10^{-4} cm/s.

Very little residual material (derived from weathering of the underlying shale) is present beneath terrace deposits at the site. Saprolite thickness averages only about 3 ft across the site. In most instances, terrace gravel deposits are immediately underlain by a few feet of soft unweathered Conasauga shale. Pronounced weathering might be observed along glauconitic limestone seams or in synclines along shale dip (TVA, 1994).

Of the numerous sedimentary formations of Paleozoic age in the plant area, only the Conasauga Formation is directly involved in the foundation of the plant. The Conasauga bedrock at the site is composed of several hundred feet of interbedded shale and limestone. In the plant area, the ratio of limestone to shale is approximately 5.25 to 1. The shale, where fresh and unweathered, is banded and very fissile due to the deformation that the Conasauga Formation has been subjected. The limestone interbeds are medium crystalline, sandy, and contain thin zones of glauconite grains scattered throughout. The thickness of individual limestone beds is usually less than six inches. Data collected from approximately 5,500 ft of exploratory foundation boreholes indicate that groundwater occurrence in the Conasauga is confined to very small openings along fractures and bedding planes. Packer testing at 50 psi during early site studies showed little to no water acceptance by the Conasauga (TVA, 1994).

The controlling structural feature of the Watts Bar site is the Kingston fault. The trace of the fault lies along the prominent ridge approximately one mile northwest of the site. The Kingston fault dips to the southeast under the plant. Along its course, steeply dipping beds of the Rome Formation have been thrust over the gently dipping strata of the Chickamauga limestone. The strike of the Conasauga is N30°E at the site and the overall dip is to the southeast; however, many small, tightly folded, steeply pitching anticlines and synclines result in local variations to

the normal trend. Drill cores frequently exhibited dips ranging from vertical to horizontal and containing every angle between (TVA, 1994). Abrupt dips were also observed in the cores and were revealed in excavations indicating minor faulting and shearing.

The plant site is hydraulically isolated by Yellow Creek and the Tennessee River to the west, south, and east; it is hydraulically isolated to the north by the relatively impermeable Rome Formation. Therefore, it is highly unlikely that any off-site groundwater withdrawals would affect groundwater movement at the site (TVA, 1994). Figure 3 depicts regional groundwater movement at the site based on July 27, 2000, groundwater level measurements. As shown in the figure, regional groundwater movement is southerly, toward the Tennessee River.

The unconsolidated soils overlying bedrock at the diesel release site are composed primarily of alluvial terrace deposits (Figure 2). The approximate upper 15 ft of the unit is composed of sandy, silty clay, and the relatively permeable lower zone (6 to 7 ft thick) is much coarser, consisting of pebbles, cobbles, and small boulders of quartz/quartzitic sandstone in a sandy clay matrix. Based on permeameter testing by TVA (2000), the upper alluvium is expected to exhibit a vertical hydraulic conductivity on the order of 10^{-6} cm/s. Using the method of Seiler (1973), an estimate of the average hydraulic conductivity for terrace deposits is 3.7×10^{-3} cm/s based on grain-size data from 93 soil samples (TVA, 1993 – Attachment 1a). Based on 410 soil samples, porosity estimates from void ratio measurements indicate an average porosity of 0.41 (TVA, 1993 – Attachment 1b). Residual saprolite averages 3 ft thick beneath terrace deposits at the site. The low permeability Conasauga Formation comprises bedrock at the site. In the area downgradient (southwest) of well MW-2 (Figure 2), much of the terrace deposits have been removed and replaced with the Section 1032 fill material described above. Estimates indicate that the hydraulic conductivity of this media is likely on the order of terrace deposits.

Groundwater/Free Product Levels and Movement

Based on groundwater level measurements at the site, the groundwater sump appears to be the primary control for groundwater movement in soil at the site and is likely responsible for dewatering a large area surrounding its location. The groundwater sump maintains groundwater elevations below about 705 ft-msl at the Auxiliary Building. Potentiometric maps based on site groundwater level measurements indicate that local groundwater movement in the diesel release area is always toward the sump (Figure 4). The original observation of diesel fuel oil in the stormwater system may be due to interception of product by a stormwater line which crosses the diesel release site in the vicinity of well MW-2 (Figure 1). Although there is no evidence of diesel fuel oil within the groundwater sump, it is possible that the sump was initially recipient to small diesel fuel oil releases from the leaking transfer line. However, the control of water levels

within the sump should prohibit discharge of floating product. The groundwater sump discharges to the storm drain system, which ultimately discharges to the YHP.

Figure 5 shows groundwater elevations and product levels since the first observation of product at the site (period from 5/10 to 10/15/01). The upper plot depicts groundwater elevations for the measurement period. The adjusted MW-2 elevation data is also shown and is derived from the specific gravity of diesel fuel oil (0.85) and product thickness. As shown in the upper plot, groundwater elevations are correlated at site wells. Since May 10, 2001, the groundwater sump has also maintained consistent levels and an average elevation of 701.24 ft-msl. From May 10, 2001 to present, groundwater elevations in site wells have exhibited very small variances ranging from 0.01 to 0.23 ft^2 (Table 1). As shown in Table 2, data indicate that groundwater levels at the site are very stable and the groundwater sump appears to be the primary control for groundwater movement in the vicinity of the diesel fuel oil release. The lowest variance and standard deviation of groundwater elevations are observed at well MW-2, which is closest to the groundwater sump. The highest variance and standard deviation of groundwater elevations is associated with well MW-1, which is farthest from the sump. With the exception of well MW-1, there has been no evidence (i.e., odor or sheen) of diesel fuel oil in other site wells or the groundwater sump.

Table 1. Descriptive Statistics for Groundwater Elevations at Site Monitoring Wells and Groundwater Sump

	MW-1	MW-2 (adjusted)	MW-3	MW-4	Groundwater Sump
Count	26	28	26	26	26
Minimum (ft-msl)	717.07	711.72	713.04	714.52	700.14
Maximum (ft-msl)	718.79	712.23	713.89	715.41	705.18
Mean (ft-msl)	717.65	711.88	713.49	714.85	701.24
Median (ft-msl)	717.53	711.87	713.51	714.86	700.27
Standard Deviation (ft)	0.48	0.10	0.23	0.21	1.32
Variance (ft^2)	0.23	0.01	0.05	0.04	1.73

The lower plot of Figure 5 shows the decreasing product thickness at well MW-2 since product measurements and removal began on May 10, 2001. The product thickness at MW-2 has decreased from 1.9 ft on May 10, 2001, to an average thickness of 0.13 ft since July 2, 2001. The product thickness at well MW-2 has now diminished to almost immeasurable amounts.

Although surface waters at the stormwater system discharge outlet to the YHP have exhibited a visible sheen of diesel fuel oil, the leaking section of fuel oil transfer line has been identified as the release source and has been replaced. There have been no observations of product at the YHP for several months. The floating boom at the YHP continues to be maintained for

containment in case diesel fuel oil should reappear at this location, and the area is continually monitored.

As shown in Section A-A' of Figure 2, the groundwater table resides within terrace deposits downgradient of the diesel release location. The horizontal hydraulic gradient between the diesel release area (near well MW-4) and well MW-2 is less than three percent. Based on the parameters provided in Attachment 2, EPA's Hydrocarbon Spill Screening Model (HSSM; Weaver et al., 1994) was used to simulate the lateral spreading of diesel fuel oil in terrace deposits beneath the site. The model simulation assumes a 2 m^2 source of fuel oil product pooled on the water table beneath the release location that is continually supplied for 120 days. Lateral spreading of fuel oil by capillary forces is neglected, as is spreading due to heterogeneity, since the soil is assumed to be of uniform composition. Based on the assumptions listed in Attachment 2, HSSM model predictions indicate that the light nonaqueous liquid (LNAPL) phase from the release location might be expected to arrive at the well MW-2 location about 310 days after contact with the water table. The hydrogeologic assumptions inherent in this estimate is admittedly oversimplified. However, the first detection of free product at well MW-2 (May 10, 2001) occurred 405 days after initial observation of a diesel release at the site (April 1, 2000). A previous sampling event 282 days after initial observation of a diesel release at the site indicated no free product at well MW-2.

Considering the relative impermeability of shallow soils at the site (10^{-6} cm/s) and the initial absence of free product at monitoring wells MW-4 and MW-2, the fuel oil product observed at well MW-2 is likely of limited quantity. The groundwater sump continues to control groundwater movement at the site and is likely to be recipient to any unattenuated fuel oil product remaining in subsurface soils. In essence, therefore, the groundwater sump functions as an in situ pumping system at the site to prevent off-site migration of fuel oil contaminants.

Plant Safety and Security Issues

Should additional drilling/boring work be required to further define the extent of free product at the site, investigations would be required downgradient of well MW-2 in the general direction of the groundwater sump (Figure 4). This area of the plant site is congested with subsurface pipelines, electrical lines, cable tunnels, and appurtenances. Furthermore, many of these lines are absolutely critical to plant safety and operation. Although plant design drawings show the locations of underground features, field routing during construction is not accurately depicted on as-built drawings.

The plant design drawings shown in Figures 6 – 10 illustrate the potential locations of major subsurface lines that might be encountered in drilling attempts at the site. The area of potential

drilling downgradient of well MW-2 are highlighted in yellow. The Refueling Water Storage Tank is located immediately downgradient of well MW-2. The ERCW pipelines and Cable Tunnel are probably the largest subsurface lines in this area. The ERCW pipelines are overlain by a concrete missile shield. Other subsurface lines in the immediate area include those for: hydrogen (H_2), nitrogen, water, fuel/lube oil, fire protection, waste fluids, storm drains, and other miscellaneous lines. There are also likely to be underground field-routed electrical lines in the area that are not shown on design drawings. Considering the high density of underground lines in this area, additional subsurface investigations downgradient of the known fuel oil free product introduce serious plant operation and safety issues.

Well MW-2 is located on the edge of a fence that delineates site security levels. Hence, any well/boring installations in this downgradient area will be situated within the "high" security zone of the plant site. Considering that a drilling contractor would be necessary for any supplementary well/boring work, rigorous security protocols would be required at the site. Immediately after the terrorist attacks of September 11, 2001, the Nuclear Regulatory Commission (NRC) advised nuclear power plants to attain the highest level of security. The NRC has advised its licensees to maintain heightened security and is currently reviewing security regulations and procedures. Maintenance of high security within this region of the plant site is currently an issue, and well/boring installation activities would further encumber the WBN security staff.

Conclusions and Recommendations

Acknowledging the requirements of Rule 1200-1-15.06(6) and (7), conditions at the diesel release site pose no threat to human health or the environment and additional delineation of free product is unnecessary. Furthermore, additional subsurface investigations in areas downgradient of the known fuel oil free product location present unwarranted plant safety and security issues.

As indicated in the ISCR (TVA, 2000), the WBN site is hydrogeologically isolated and the likelihood of offsite contaminant migration is negligible. The fuel oil product observed at well MW-2 is likely of limited quantity. The groundwater sump continues to control groundwater movement at the site and is likely to be recipient to any unattenuated fuel oil product remaining in subsurface soils. In essence, therefore, the groundwater sump functions as an in situ pumping system at the site to prevent off-site migration of fuel oil contaminants.

It is recommended to continue monitoring at the site in accordance with the Monitoring Only Program and as directed by DUST in the letter dated January 23, 2001. Additionally, monitoring for the presence of free product at the site groundwater sump will be conducted on a weekly basis. Oil absorbent media will be maintained at this location for emergency use. The

groundwater sump pump is automatically actuated by water level controls such that floating product should always be retained within the sump. Should free product be detected at the groundwater sump, TDEC DUST will be immediately notified and a product recovery system will be installed at this location.

References

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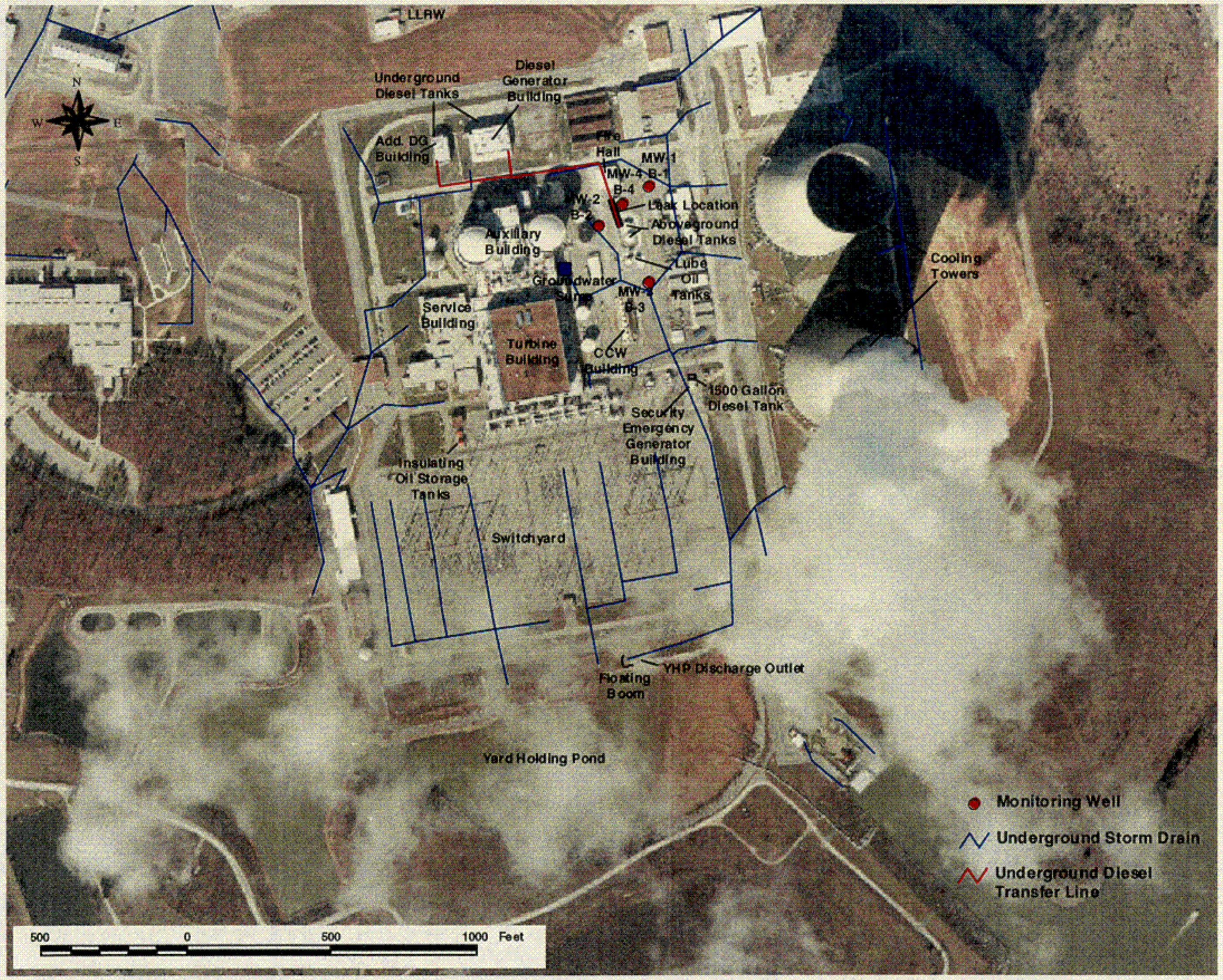

Figure 1. Site Map

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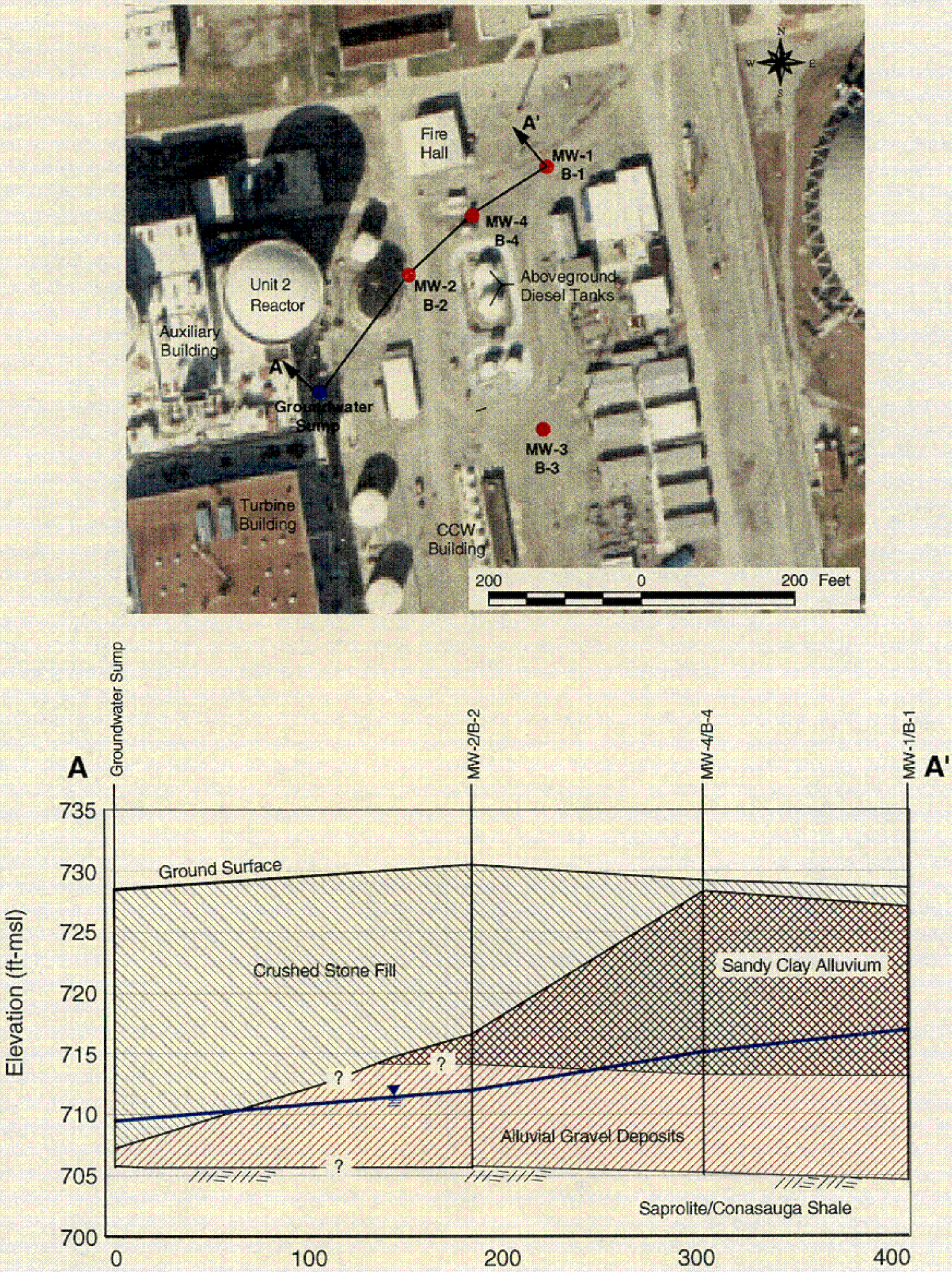

Figure 2. Stratigraphic Cross-Section Across Area of Investigation

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Figure 3. Regional Potentiometric Surface Based on 07/27/2000 Groundwater Level Measurements

C03

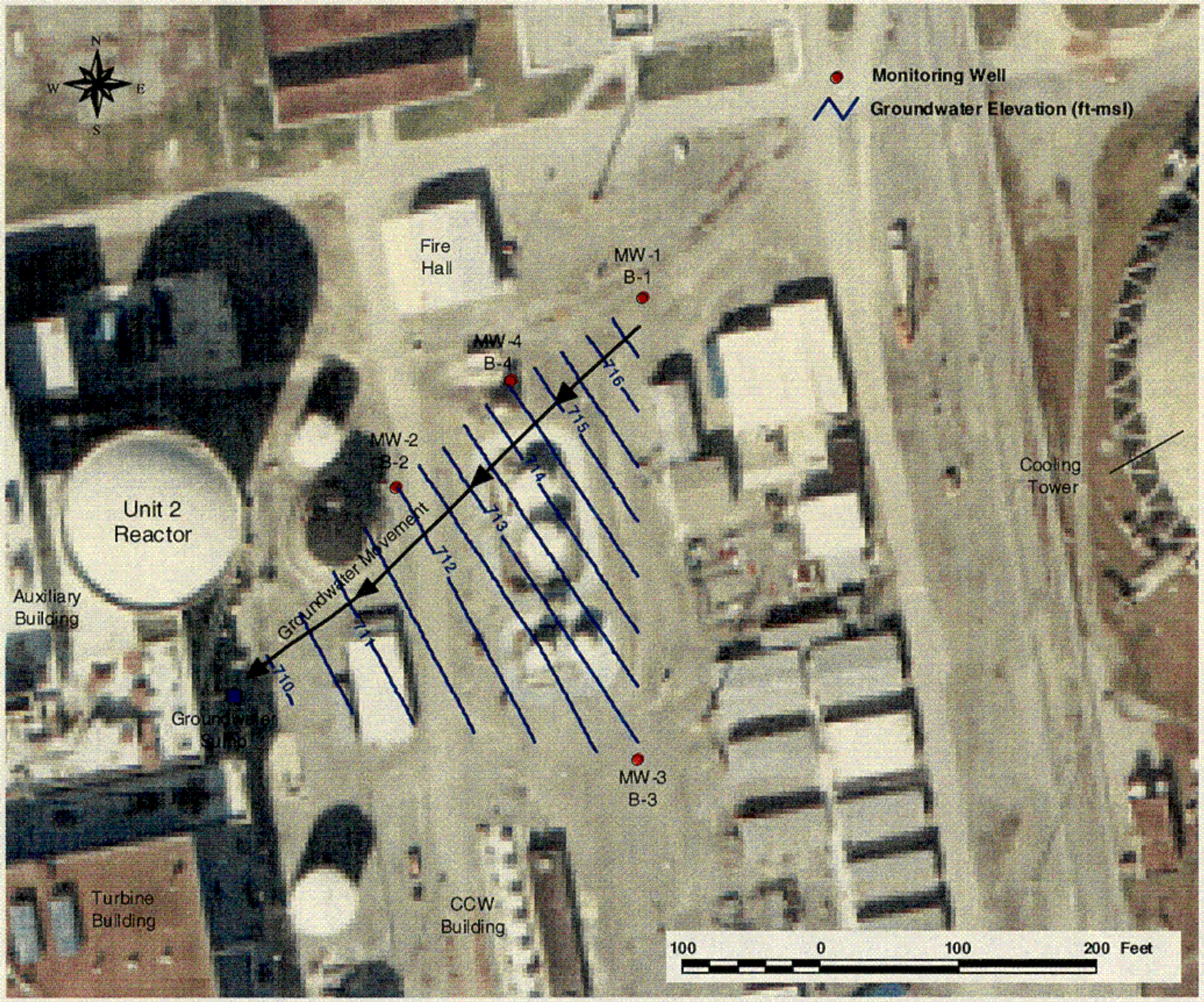

Figure 4. Potentiometric Surface Based on 9/26/2000 Groundwater Level Measurements

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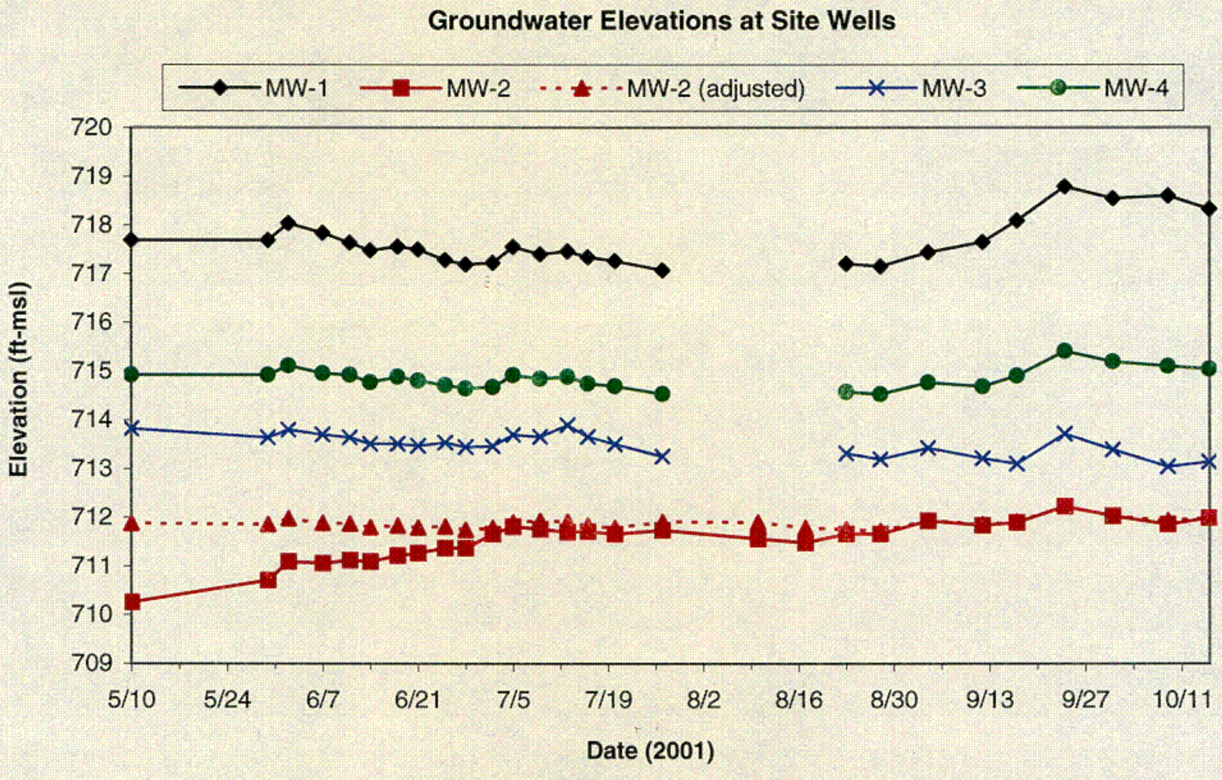

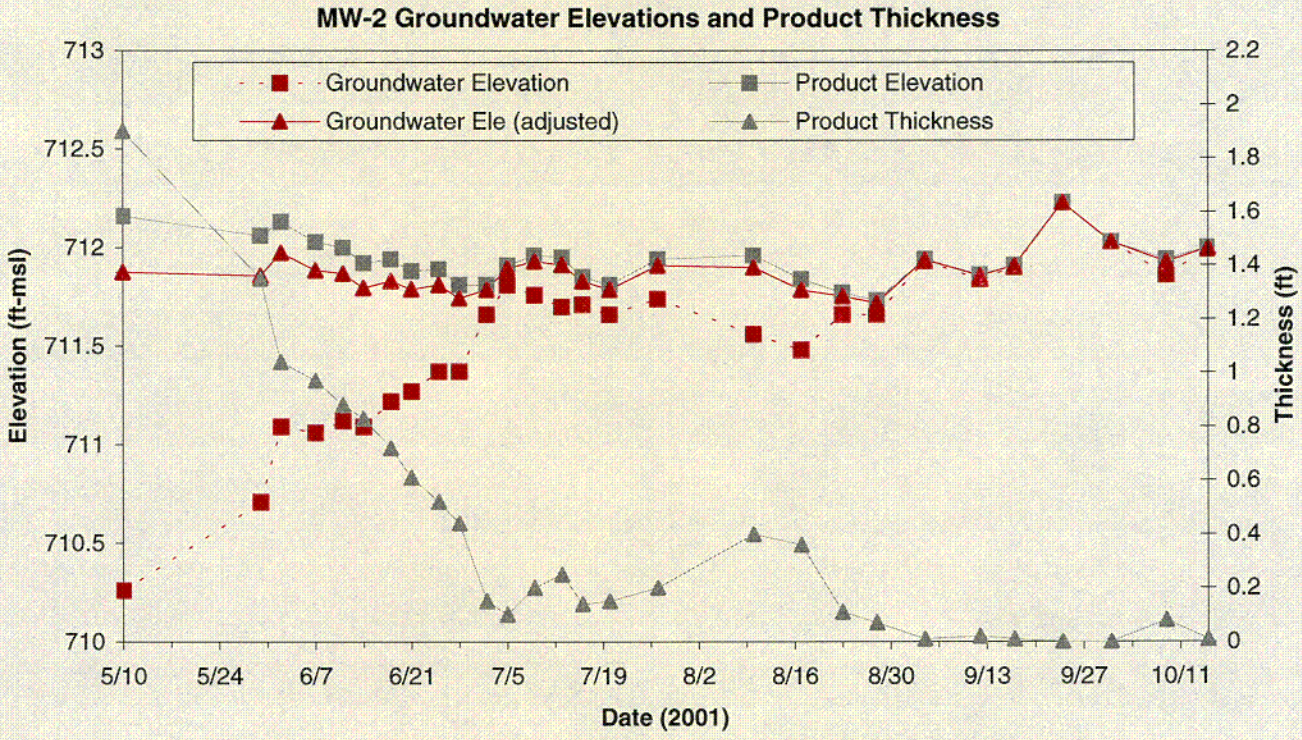

Figure 5. Groundwater and Free Product Levels at Site Wells

C05

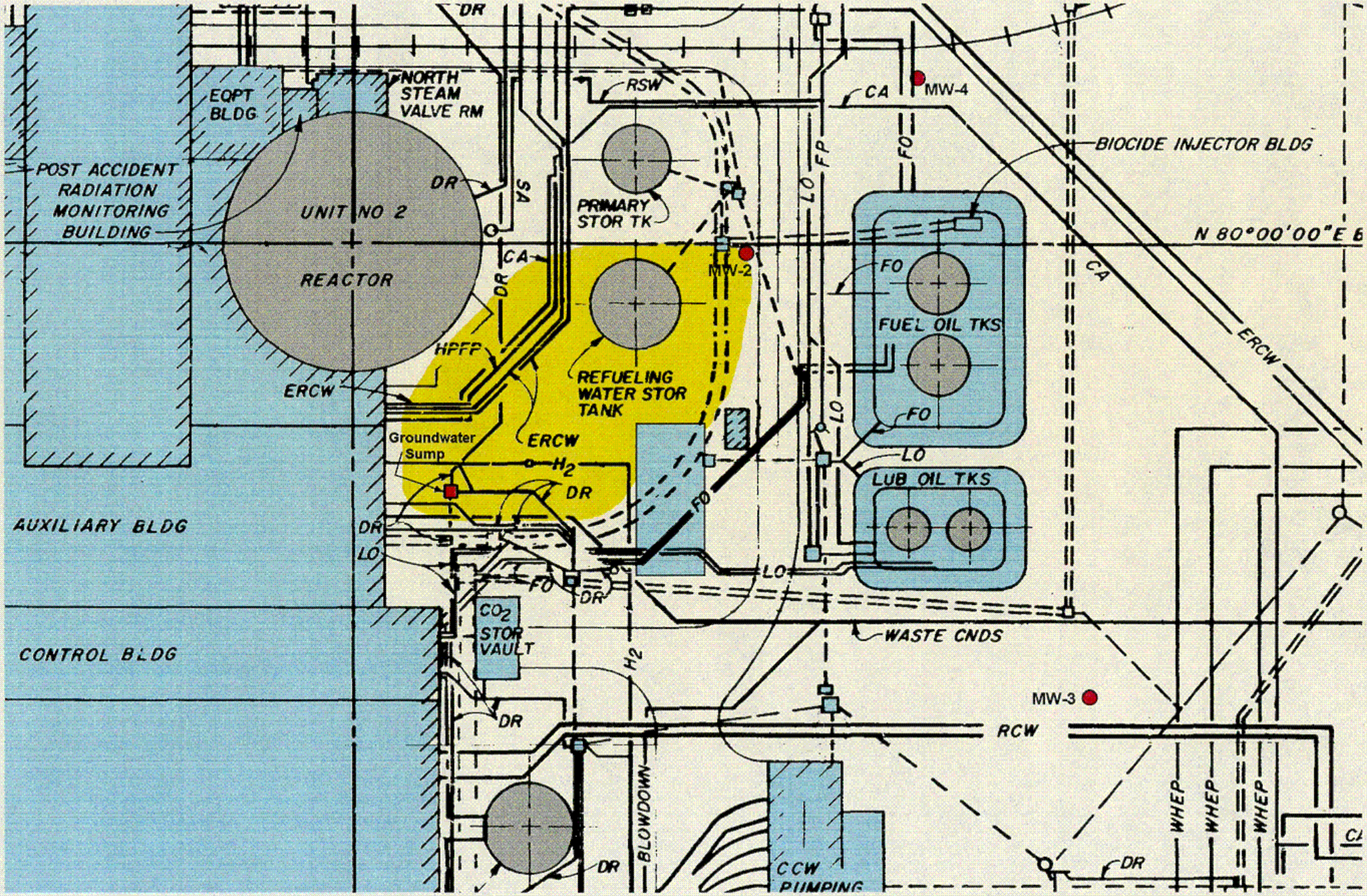

Figure 6. Site Map Showing the Locations of Various Pipelines and Appurtenances

C06

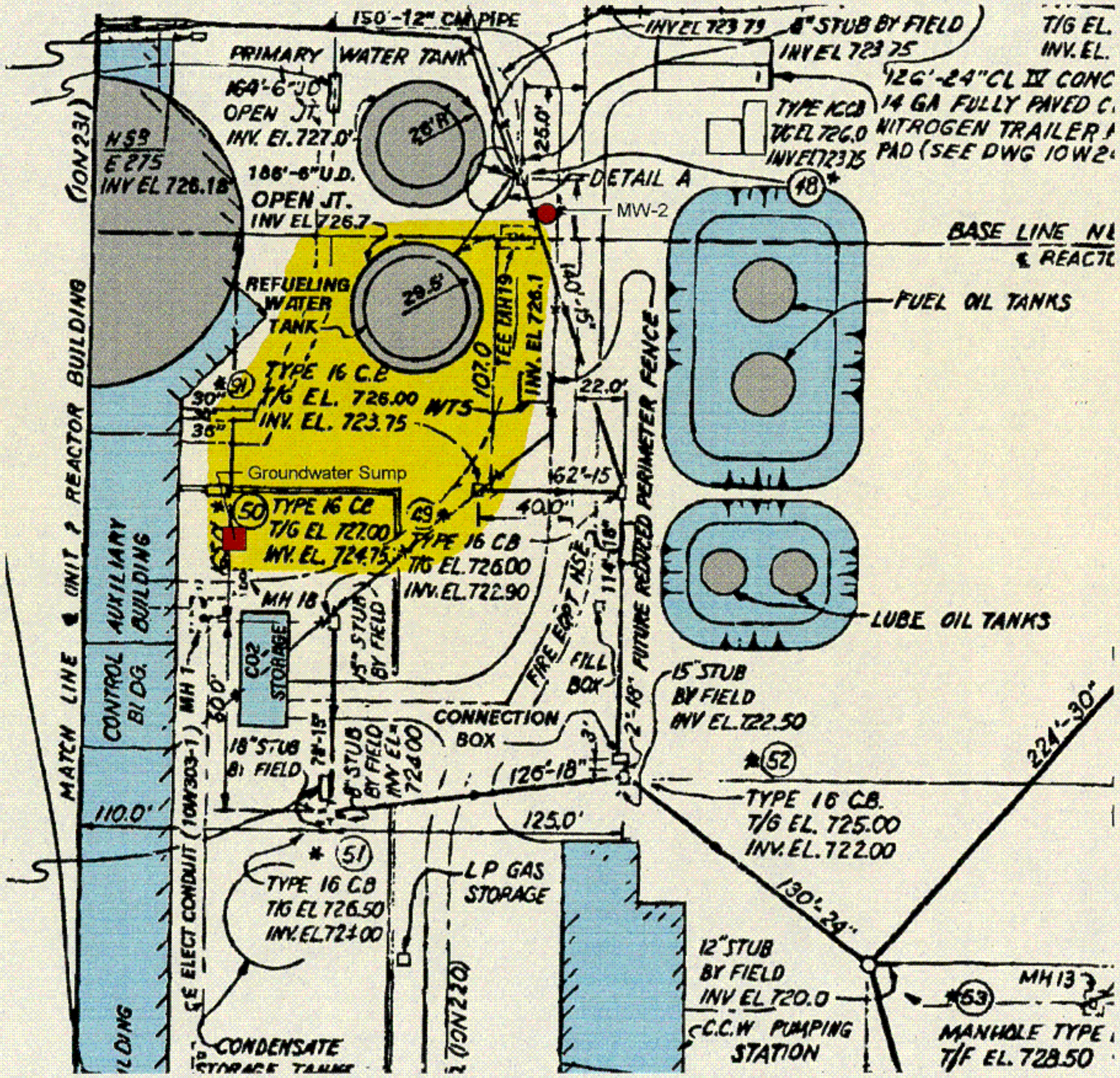

Figure 7. Site Map Showing the Locations of Storm Drains

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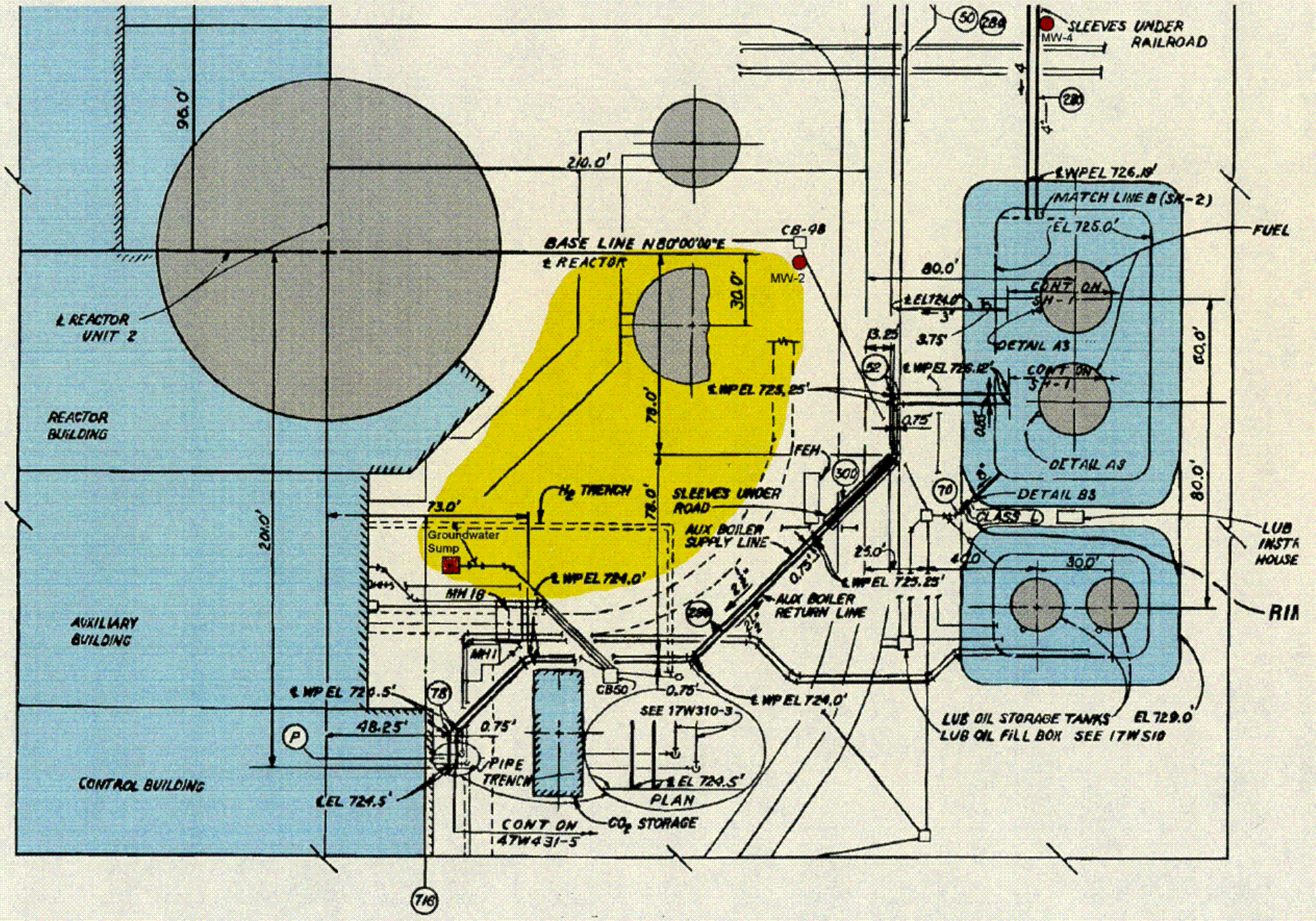

Figure 8. Site Map Showing the Locations of Fuel oil Pipelines

C08

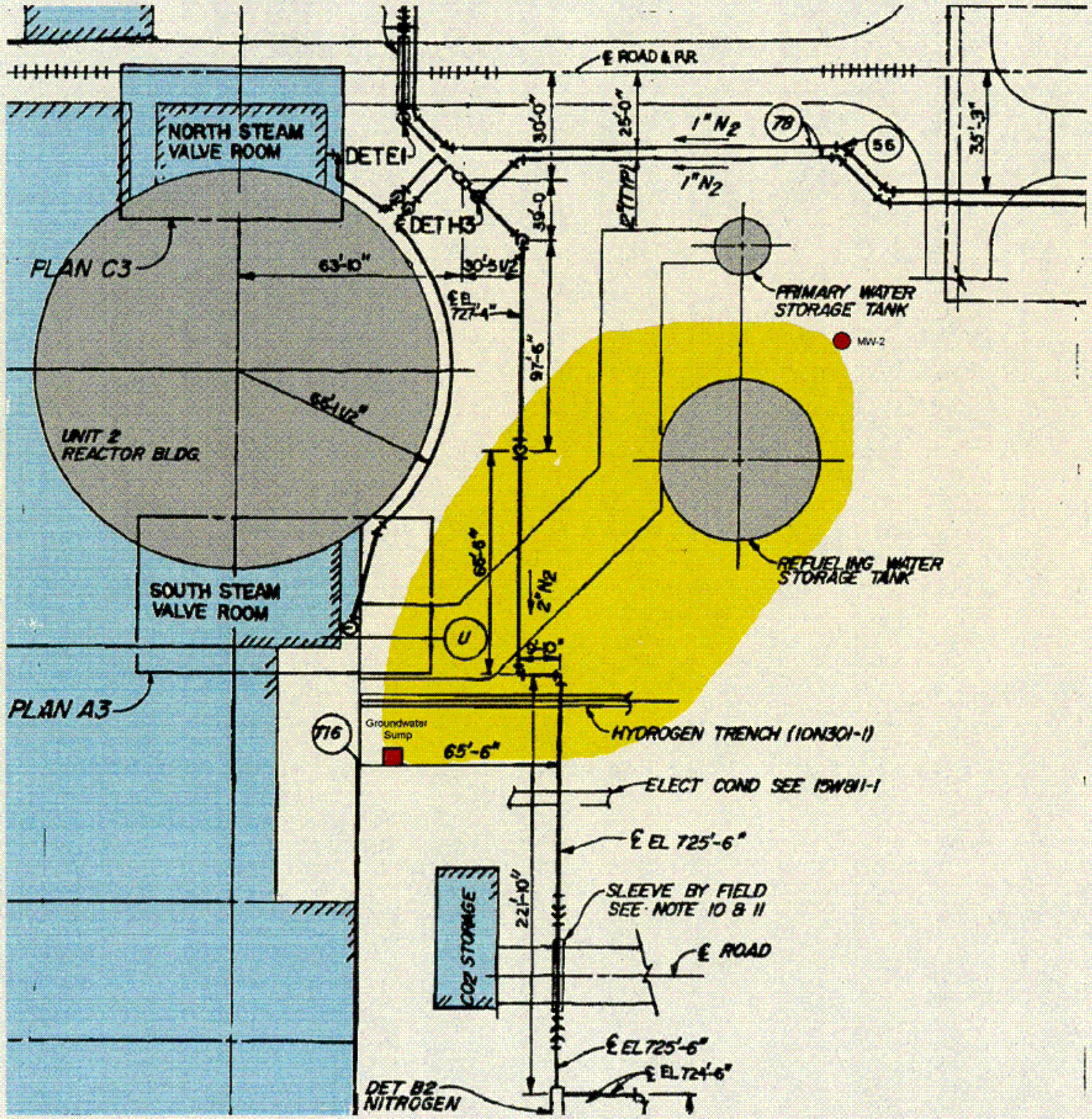

Figure 9. Site Map Showing the Locations of Nitrogen Pipelines

C09

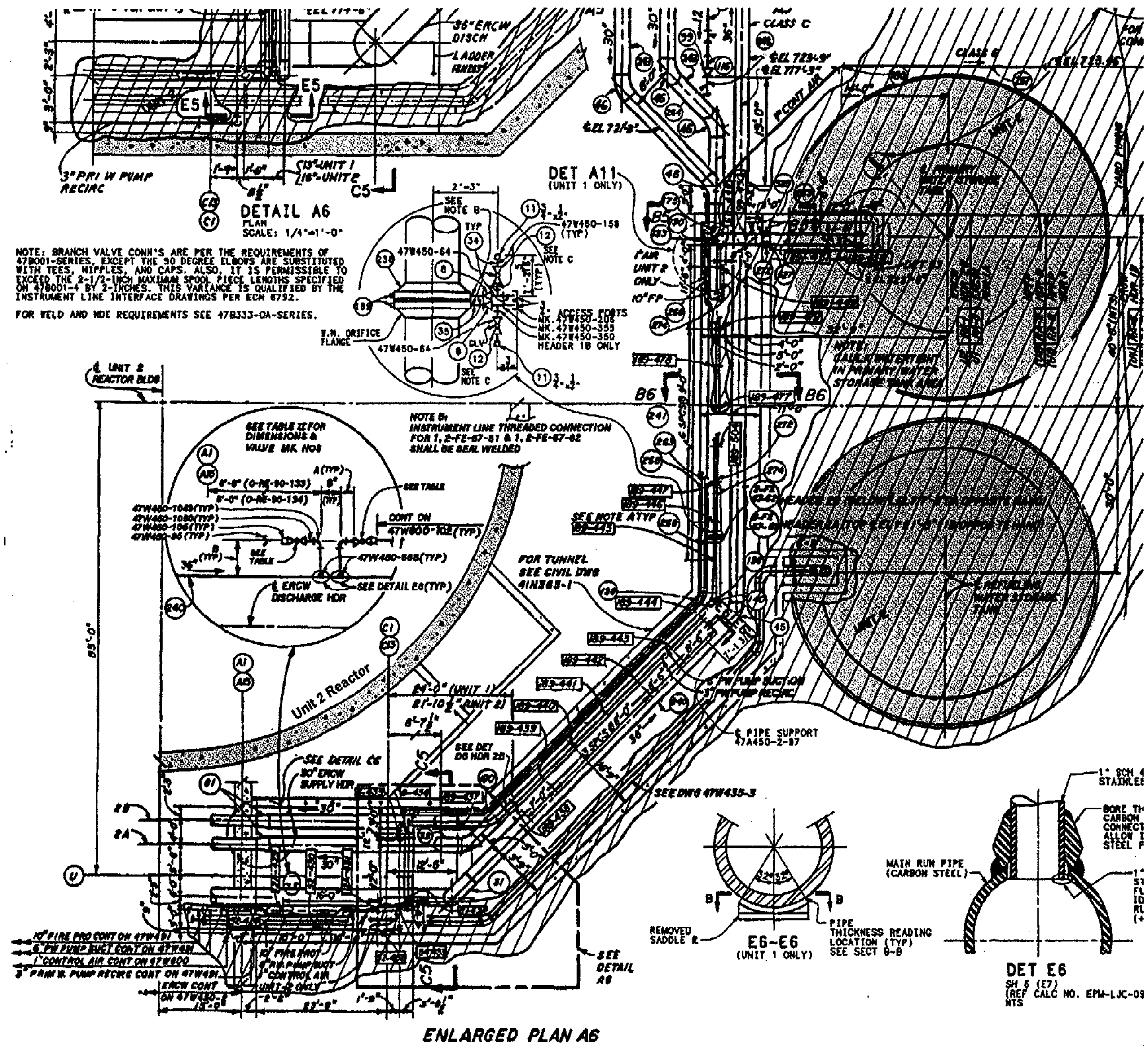

Figure 10. ERCW and Miscellaneous Lines in the Vicinity of Unit 2 Reactor and Water Tanks

Signature Page

We, the undersigned, certify under penalty of law, including but not limited to penalties for perjury, that the information contained in this report form and on any attachments, is true, accurate and complete to the best of our knowledge, information, and belief. We are aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for intentional violations.

Edward R. Robinson [signature] 11/28/01
Owner/Operator (Print name) Signature Date

ENVIRONMENTAL / RADWASTE SUPERINTENDENT
Title (Print)

Henry E. Julian, P.E., P.G. [signature] 11/19/01
P.E. or P.G. (Print name) Signature Date

PE: 021114 PG: TN3790
Tennessee Registration #

Note: Each of the above signatures shall be notarized separately with the following statement.

STATE OF TENNESSEE COUNTY OF ANDERSON

Sworn to and subscribed before me by HENRY E JULIAN on this date

11-19-01. My commission expires 1-23-02.

DARLENE BUCKNER [signature] 11-19-01
Notary Public (Print name) Signature Date

Stamp/Seal

Attachment 1a. Estimates of Hydraulic Conductivity from Grain-size Data Using Method of Seiler (1973)

	Grain-size Parameters									
Boring	d60 (mm)	d10 (mm)	d25 (mm)	U (d60/d10)	C(U)	K (cm/s) 5<U<17	K (cm/s) U>17	log K 5<U<17	log K U>17	Reference
US-126-4	0.20	0.00	0.04	44.44	15.60		2.496E-04		-3.603	TVA (1979)
US-126-4	0.20	0.01	0.04	40.00	14.00		2.240E-04		-3.650	TVA (1979)
US-127-5	1.00	0.02	0.05	50.00	18.50		4.625E-04		-3.335	TVA (1979)
US-127-5	1.00	0.01	0.05	100.00	79.00		1.975E-03		-2.704	TVA (1979)
US-125-3-PT2	14.00	0.30	1.40	46.67	17.00		3.332E-01		-0.477	TVA (1979)
US-126-4-P-1	12.00	0.16	0.60	75.00	38.00		1.368E-01		-0.864	TVA (1979)
US-126-4-PT5	0.14	0.01	0.04	28.00	10.60		1.531E-04		-3.815	TVA (1979)
US-126A-4-PT2	0.40	0.03	0.08	13.33	84.00	7.560E-04		-3.121		TVA (1979)
US-127-1	18.00	0.30	1.00	60.00	25.00		2.500E-01		-0.602	TVA (1979)
US-127-5	0.70	0.01	0.05	87.50	55.80		1.395E-03		-2.855	TVA (1979)
US-127-6	0.14	0.01	0.03	23.33	9.60		8.640E-05		-4.063	TVA (1979)
HD-127-3-PT1	20.00	0.30	1.00	66.67	30.60		3.060E-01		-0.514	TVA (1979)
HD-127-5-P-4	0.50	0.02	0.06	27.78	10.60		3.816E-04		-3.418	TVA (1979)
US-128-3	0.08	0.00	0.02	18.75	8.90		2.003E-05		-4.698	TVA (1979)
US-128C-2-P-1	11.00	0.15	0.50	73.33	36.00		9.000E-02		-1.046	TVA (1979)
SH-128-2	0.60	0.01	0.06	50.00	18.50		6.660E-04		-3.177	TVA (1979)
SH-128-3	0.20	0.00	0.01	50.00	18.50		3.626E-05		-4.441	TVA (1979)
US-129-3-P-2	7.00	0.07	0.45	94.59	68.00		1.377E-01		-0.861	TVA (1979)
US-130-8	0.90	0.02	0.14	45.00	16.00		3.136E-03		-2.504	TVA (1979)
US-130-9	0.21	0.01	0.05	21.00	9.20		1.863E-04		-3.730	TVA (1979)
HD-130-3	11.00	0.20	0.47	55.00	21.00		4.639E-02		-1.334	TVA (1979)
HD-130-5-P-1	1.40	0.06	0.23	23.33	9.60		5.078E-03		-2.294	TVA (1979)
127,128	7.00	0.11	0.50	63.64	28.20		7.050E-02		-1.152	TVA (1979)
129	10.00	0.10	0.50	100.00	79.00		1.975E-01		-0.704	TVA (1979)
127 & 128	8.40	0.11	0.50	76.36	39.20		9.800E-02		-1.009	TVA (1979)
US-126-4	0.20	0.00	0.04	44.44	15.60		2.496E-04		-3.603	TVA (1979)
US-126-4	0.20	0.00	0.04	44.44	15.60		2.496E-04		-3.603	TVA (1979)
US-127	1.00	0.02	0.05	50.00	18.50		4.625E-04		-3.335	TVA (1979)
US-127-5	1.00	0.01	0.05	100.00	79.00		1.975E-03		-2.704	TVA (1979)
127,128	7.00	0.10	0.50	70.00	33.00		8.250E-02		-1.084	TVA (1979)
129	10.00	0.11	0.50	90.91	60.80		1.520E-01		-0.818	TVA (1979)
US-125-3-PT2	13.00	0.30	1.30	43.33	15.20		2.569E-01		-0.590	TVA (1979)
US-126-4-P-1	12.00	0.17	0.60	70.59	39.20		1.411E-01		-0.850	TVA (1979)
US-126-4-PT5	0.14	0.01	0.04	23.33	9.60		1.536E-04		-3.814	TVA (1979)
US-126A-4-PT2	0.40	0.03	0.08	14.29	75.00	5.880E-04		-3.231		TVA (1979)
US-127-1	18.00	0.30	1.00	60.00	25.00		2.500E-01		-0.602	TVA (1979)
US-127-5	0.70	0.01	0.05	87.50	55.80		1.395E-03		-2.855	TVA (1979)
US-127-6	0.13	0.01	0.03	21.67	9.40		8.460E-05		-4.073	TVA (1979)
HD-127-3-PT1	20.00	0.30	1.00	66.67	30.60		3.060E-01		-0.514	TVA (1979)
HD-127-5-P-4	0.50	0.02	0.06	27.78	10.60		3.816E-04		-3.418	TVA (1979)
US-128-3	0.08	0.00	0.01	19.50	9.00		1.764E-05		-4.754	TVA (1979)
US-128C-2-P-1	11.00	0.15	0.50	73.33	36.00		9.000E-02		-1.046	TVA (1979)
SH-128-2	0.60	0.01	0.06	50.00	18.50		6.660E-04		-3.177	TVA (1979)
SH-128-3	0.20	0.00	0.01	50.00	18.50		3.127E-05		-4.505	TVA (1979)
US-129-3-P-2	7.00	0.07	0.42	94.59	68.00		1.200E-01		-0.921	TVA (1979)
US-130-8	0.90	0.02	0.13	41.47	14.40		2.434E-03		-2.614	TVA (1979)
US-130-9	0.22	0.01	0.04	22.00	9.40		1.820E-04		-3.740	TVA (1979)
HD-130-3	11.00	0.18	0.50	61.90	26.60		6.650E-02		-1.177	TVA (1979)
SS-110-1A	2.00	0.10	0.40	20.00	9.00		1.440E-02		-1.842	TVA (1977)
SS-110-2A	1.00	0.07	0.35	14.29	75.00	3.675E-03		-2.435		TVA (1977)
SS-110-3A	0.80	0.06	0.31	12.50	94.00	3.850E-03		-2.415		TVA (1977)
SS-110-4A	0.10	0.00	0.01	50.00	18.50		1.850E-05		-4.733	TVA (1977)
SS-113-1A	24.00	1.50	9.00	16.00	61.00	1.373E+00		0.138		TVA (1977)
SS-113-2A	8.00	0.13	0.40	64.00	28.20		4.512E-02		-1.346	TVA (1977)
SS-113-3A	2.00	0.12	0.45	16.67	57.00	8.208E-03		-2.086		TVA (1977)
SS-113-4A	2.00	0.05	0.21	44.44	15.60		6.880E-03		-2.162	TVA (1977)
SS-113-5A	7.80	0.09	0.50	86.67	54.20		1.355E-01		-0.868	TVA (1977)
SS-113-6A	0.62	0.11	0.30	5.64	190.00	2.299E-02		-1.638		TVA (1977)
SS-113-7A	5.10	0.06	0.40	80.95	45.40		7.264E-02		-1.139	TVA (1977)
SS-116-1A	14.00	0.40	1.80	35.00	12.50		4.050E-01		-0.393	TVA (1977)

Attachment 1a (continued). Estimates of Hydraulic Conductivity from Grain-size Data Using Method of Seiler [1973]

Boring	Grain-size Parameters d60 (mm)	d10 (mm)	d25 (mm)	U (d60/d10)	C(U)	K (cm/s) 5<U<17	K (cm/s) U>17	log K 5<U<17	log K U>17	Reference
SS-116-3A	0.50	0.06	0.22	8.33	150.00	5.400E-03		-2.268		TVA (1977)
SS-116-4A	1.80	0.10	0.43	18.00	8.80		1.627E-02		-1.789	TVA (1977)
SS-116-5A	1.10	0.07	0.38	16.92	57.00	2.408E-03		-2.618		TVA (1977)
SS-118-2A	1.20	0.06	0.40	20.00	9.00		1.440E-02		-1.842	TVA (1977)
SS-118-3A	3.80	0.12	0.50	31.67	11.60		2.900E-02		-1.538	TVA (1977)
SS-118-4A	2.00	0.06	0.35	32.26	11.60		1.421E-02		-1.847	TVA (1977)
SS-118-5A	3.00	0.09	0.45	33.33	11.90		2.410E-02		-1.618	TVA (1977)
SS-118-6A	0.10	0.00	0.01	33.33	11.90		2.332E-05		-4.632	TVA (1977)
SS-122-1A	18.00	0.20	0.85	90.00	59.00		4.263E-01		-0.370	TVA (1977)
SS-122-2A	17.00	0.17	1.00	100.00	79.00		7.900E-01		-0.102	TVA (1977)
SS-122-4A	5.80	0.16	0.60	36.25	12.80		4.608E-02		-1.336	TVA (1977)
SS-122-5A	6.80	0.28	0.75	24.29	9.80		5.513E-02		-1.259	TVA (1977)
SS-122-6A	1.80	0.08	0.40	24.00	9.80		1.568E-02		-1.805	TVA (1977)
SS-122-7A	4.90	0.13	0.70	37.69	13.40		6.566E-02		-1.183	TVA (1977)
US-21-4-P1	0.17	0.03	0.12	5.67	190.00	1.710E-03		-2.767		TVA (1977)
US-21-4-P315	0.17	0.00	0.07	42.50	15.20		7.448E-04		-3.128	TVA (1977)
US-21	0.13	0.01	0.06	21.67	9.40		3.384E-04		-3.471	TVA (1977)
US-30-5-P3	0.12	0.00	0.13	48.00	17.50		2.734E-03		-2.563	TVA (1977)
US-30	0.20	0.03		6.67	170.00	1.530E-03		-2.815		TVA (1977)
US-30	0.18	0.01		14.58	67.00	9.648E-05		-4.016		TVA (1977)
US-30	0.17	0.01		14.17	75.00	1.080E-04		-3.967		TVA (1977)
US-30-8-P3	0.17	0.03	0.90	5.67	190.00	1.710E-03		-2.767		TVA (1977)
US-39	0.29	0.05		5.80	190.00	4.750E-03		-2.323		TVA (1977)
SS-12	0.20	0.02		11.76	94.00	2.717E-04		-3.566		TVA (1977)
SS-12	0.48	0.03		17.14	57.00	4.469E-04		-3.350		TVA (1977)
US-13-2	0.12	0.01	0.06	12.00	94.00	9.400E-05		-4.027		TVA (1977)
SS-17	0.17	0.01		17.00	57.00	5.700E-05		-4.244		TVA (1977)
SS-44	0.22	0.01		16.92	57.00	9.633E-05		-4.016		TVA (1977)
SS-51	1.00	0.14		7.14	170.00	3.332E-02		-1.477		TVA (1977)
US-29-6	0.10	0.01	0.05	20.00	9.00		2.250E-04		-3.648	TVA (1977)
US-29-6	0.12	0.01	0.07	24.00	9.80		4.802E-04		-3.319	TVA (1977)
US-44-5	0.40	0.01	0.12	30.77	11.30		1.627E-03		-2.789	TVA (1977)
US-60-2	9.00	0.40	0.01	22.50	9.60		9.600E-06		-5.018	TVA (1977)

Average log K = **-2.424**
Average K = **3.767E-03 cm/s**

Attachment 1b. Estimates of Porosity from Void Ratio Measurements

Boring	Void Ratio	Porosity	Reference
US-125	0.699	0.411	TVA (1979)
US-125	0.671	0.402	TVA (1979)
US-126	0.636	0.389	TVA (1979)
US-126A	0.579	0.367	TVA (1979)
US-127	0.243	0.195	TVA (1979)
US-127	0.708	0.415	TVA (1979)
US-127	0.697	0.411	TVA (1979)
HD-127	0.470	0.320	TVA (1979)
US-128A	0.621	0.383	TVA (1979)
SH-128	0.427	0.299	TVA (1979)
US-129	0.898	0.473	TVA (1979)
HD-129	0.367	0.268	TVA (1979)
HD-129	0.981	0.495	TVA (1979)
US-130	0.311	0.237	TVA (1979)
US-130	0.213	0.176	TVA (1979)
US-130	0.851	0.460	TVA (1979)
HD-130	0.411	0.291	TVA (1979)
HD-130	0.683	0.406	TVA (1979)
SS-130-A	0.536	0.349	TVA (1979)
SS-130-A	0.743	0.426	TVA (1979)
US-126-4	0.648	0.393	TVA (1979)
US-126-4	0.694	0.410	TVA (1979)
US-126-4	0.703	0.413	TVA (1979)
US-126-4	0.938	0.484	TVA (1979)
US-126-4	0.738	0.425	TVA (1979)
US-126-4	0.742	0.426	TVA (1979)
US-126-4	0.723	0.420	TVA (1979)
US-127-5	1.007	0.502	TVA (1979)
US-127-5	0.851	0.460	TVA (1979)
US-127-5	1.016	0.504	TVA (1979)
US-127-5	0.996	0.499	TVA (1979)
US-127-5	0.644	0.392	TVA (1979)
US-127-5	0.590	0.371	TVA (1979)
US-127-5	0.641	0.391	TVA (1979)
US-127-5	0.652	0.395	TVA (1979)
US-128A-2	0.635	0.388	TVA (1979)
US-128A-2	0.664	0.399	TVA (1979)
US-128A-2	0.661	0.398	TVA (1979)
US-128A-2	1.031	0.508	TVA (1979)
US-128A-2	0.979	0.495	TVA (1979)
US-128A-2	0.920	0.479	TVA (1979)
US-128A-2	0.936	0.483	TVA (1979)
US-129-3	0.953	0.488	TVA (1979)
US-129-3	0.902	0.474	TVA (1979)
US-129-3	0.978	0.494	TVA (1979)
US-129-3	0.908	0.476	TVA (1979)
US-129-3	0.918	0.479	TVA (1979)
US-129-3	0.894	0.472	TVA (1979)
US-129-3	1.077	0.519	TVA (1979)
US-130-7	0.895	0.472	TVA (1979)
US-130-7	0.951	0.487	TVA (1979)
US-130-7	0.941	0.485	TVA (1979)
US-130-7	0.823	0.451	TVA (1979)
US-130-7	0.831	0.454	TVA (1979)
US-130-7	0.823	0.451	TVA (1979)
US-130-7	0.753	0.430	TVA (1979)
US-30	0.500	0.333	TVA (1977)
US-30	0.500	0.333	TVA (1977)
US-30	0.490	0.329	TVA (1977)
US-30	0.780	0.438	TVA (1977)
US-30	0.590	0.371	TVA (1977)
US-30	0.560	0.359	TVA (1977)
US-1	0.590	0.371	TVA (1977)
US-1	0.610	0.379	TVA (1977)
US-1	0.590	0.371	TVA (1977)
US-1	0.510	0.338	TVA (1977)
US-1	0.550	0.355	TVA (1977)
US-1	0.500	0.333	TVA (1977)
US-1	0.780	0.438	TVA (1977)
US-1	0.920	0.479	TVA (1977)
US-2	0.750	0.429	TVA (1977)
US-2	0.630	0.387	TVA (1977)
US-2	0.620	0.383	TVA (1977)
US-2	0.480	0.324	TVA (1977)
US-2	0.740	0.425	TVA (1977)
US-2	0.560	0.359	TVA (1977)
US-2	0.590	0.371	TVA (1977)
US-4	0.790	0.441	TVA (1977)
US-4	0.680	0.405	TVA (1977)
US-4	0.720	0.419	TVA (1977)
US-4	0.760	0.432	TVA (1977)
US-4	0.800	0.444	TVA (1977)
US-4	0.800	0.444	TVA (1977)
US-4	0.780	0.438	TVA (1977)
US-4	0.730	0.422	TVA (1977)
US-5	0.550	0.355	TVA (1977)
US-5	0.700	0.412	TVA (1977)
US-5	0.800	0.444	TVA (1977)
US-5	0.570	0.363	TVA (1977)
US-5	0.620	0.383	TVA (1977)
US-5	0.660	0.398	TVA (1977)
US-5	0.600	0.375	TVA (1977)
US-5	0.620	0.383	TVA (1977)
US-5	0.590	0.371	TVA (1977)
US-6	0.940	0.485	TVA (1977)
US-6	0.720	0.419	TVA (1977)
US-6	0.730	0.422	TVA (1977)
US-6	0.600	0.375	TVA (1977)
US-6	0.660	0.398	TVA (1977)
US-6	0.740	0.425	TVA (1977)
US-6	0.560	0.359	TVA (1977)
US-6	0.970	0.492	TVA (1977)
US-6	0.920	0.479	TVA (1977)
US-6	0.870	0.465	TVA (1977)
US-7	0.770	0.435	TVA (1977)
US-7	0.640	0.000	TVA (1977)
US-7	0.700	0.000	TVA (1977)
US-7	0.880	0.000	TVA (1977)
US-7	0.890	0.000	TVA (1977)
US-7	0.930	0.000	TVA (1977)
US-7	0.820	0.000	TVA (1977)
US-7	0.850	0.000	TVA (1977)
US-7	0.690	0.000	TVA (1977)
US-7	0.700	0.000	TVA (1977)
US-7	0.700	0.000	TVA (1977)
SS-7A	0.730	0.422	TVA (1977)
SS-7A	0.690	0.408	TVA (1977)
SS-7A	0.740	0.425	TVA (1977)
SS-7A	0.840	0.457	TVA (1977)
SS-7A	0.780	0.438	TVA (1977)
SS-7A	0.800	0.444	TVA (1977)
SS-7A	0.760	0.432	TVA (1977)
SS-7A	0.740	0.425	TVA (1977)
US-21	0.888	0.470	TVA (1977)
US-21	0.744	0.427	TVA (1977)
US-21	0.634	0.388	TVA (1977)
US-21	0.771	0.435	TVA (1977)
US-21	0.687	0.407	TVA (1977)
US-21	0.771	0.435	TVA (1977)
US-21	0.716	0.417	TVA (1977)
US-21	0.767	0.434	TVA (1977)
US-25	0.736	0.424	TVA (1977)
US-25	0.693	0.409	TVA (1977)
US-25	0.652	0.395	TVA (1977)
US-25	0.741	0.426	TVA (1977)
US-25	0.745	0.427	TVA (1977)
US-25	0.741	0.426	TVA (1977)
US-25	0.744	0.427	TVA (1977)

Attachment 1b (continued). Estimates of Porosity from Void Ratio Measurements

Boring	Void Ratio	Porosity	Reference
US-30	0.907	0.476	TVA (1977)
US-30	0.802	0.445	TVA (1977)
US-30	0.777	0.437	TVA (1977)
US-30	0.726	0.421	TVA (1977)
US-30	0.804	0.446	TVA (1977)
US-30	0.885	0.469	TVA (1977)
US-30	0.771	0.435	TVA (1977)
US-30	0.684	0.406	TVA (1977)
US-30	0.647	0.393	TVA (1977)
US-30	0.669	0.401	TVA (1977)
US-31A	0.596	0.373	TVA (1977)
US-31A	0.598	0.374	TVA (1977)
US-31A	0.708	0.415	TVA (1977)
US-31A	0.697	0.411	TVA (1977)
US-31A	0.887	0.470	TVA (1977)
US-36	0.828	0.453	TVA (1977)
US-36	0.865	0.464	TVA (1977)
US-36	1.240	0.554	TVA (1977)
US-36	0.814	0.449	TVA (1977)
US-36	0.826	0.452	TVA (1977)
US-36	0.723	0.420	TVA (1977)
US-36	0.724	0.420	TVA (1977)
US-36	0.716	0.417	TVA (1977)
US-36	0.668	0.400	TVA (1977)
US-39	1.063	0.515	TVA (1977)
US-39	0.887	0.470	TVA (1977)
US-39	0.868	0.465	TVA (1977)
US-39	0.870	0.465	TVA (1977)
US-40	0.883	0.469	TVA (1977)
US-40	0.861	0.463	TVA (1977)
US-40	0.884	0.469	TVA (1977)
US-40	0.888	0.470	TVA (1977)
US-42	0.803	0.445	TVA (1977)
US-42	0.963	0.491	TVA (1977)
US-42	0.903	0.475	TVA (1977)
US-21	0.897	0.473	TVA (1977)
US-21	0.796	0.443	TVA (1977)
US-21	0.634	0.388	TVA (1977)
US-21	0.771	0.435	TVA (1977)
US-21	0.687	0.407	TVA (1977)
US-21	0.767	0.434	TVA (1977)
US-21	0.716	0.417	TVA (1977)
US-21	0.767	0.434	TVA (1977)
US-25	0.814	0.449	TVA (1977)
US-25	0.719	0.418	TVA (1977)
US-25	0.682	0.405	TVA (1977)
US-25	0.788	0.441	TVA (1977)
US-25	0.800	0.444	TVA (1977)
US-25	0.751	0.429	TVA (1977)
US-25	0.801	0.445	TVA (1977)
US-30	0.907	0.476	TVA (1977)
US-30	0.802	0.445	TVA (1977)
US-30	0.952	0.488	TVA (1977)
US-30	0.807	0.447	TVA (1977)
US-30	0.789	0.441	TVA (1977)
US-30	0.795	0.443	TVA (1977)
US-30	0.792	0.442	TVA (1977)
US-30	0.778	0.438	TVA (1977)
US-30	0.684	0.406	TVA (1977)
US-30	0.647	0.393	TVA (1977)
US-30	0.669	0.401	TVA (1977)
US-31	0.644	0.392	TVA (1977)
US-31	0.632	0.387	TVA (1977)
US-31	0.749	0.428	TVA (1977)
US-31	0.734	0.423	TVA (1977)
US-31	0.916	0.478	TVA (1977)
US-36	0.870	0.465	TVA (1977)
US-36	0.865	0.464	TVA (1977)
US-36	0.846	0.458	TVA (1977)
US-36	0.814	0.449	TVA (1977)
US-36	0.885	0.469	TVA (1977)
US-36	0.764	0.433	TVA (1977)
US-36	0.724	0.420	TVA (1977)
US-36	0.716	0.417	TVA (1977)
US-36	0.668	0.400	TVA (1977)
US-3	0.579	0.367	TVA (1977)
US-3	0.644	0.392	TVA (1977)
US-3	0.605	0.377	TVA (1977)
US-3	0.610	0.379	TVA (1977)
US-3	0.670	0.401	TVA (1977)
US-3	0.700	0.412	TVA (1977)
US-3	0.527	0.345	TVA (1977)
US-5	0.653	0.395	TVA (1977)
US-5	0.741	0.426	TVA (1977)
US-5	0.596	0.373	TVA (1977)
US-5	0.523	0.343	TVA (1977)
US-5	0.485	0.327	TVA (1977)
US-5	0.635	0.388	TVA (1977)
US-5	0.637	0.389	TVA (1977)
US-5	0.602	0.376	TVA (1977)
US-7	0.655	0.396	TVA (1977)
US-7	0.484	0.326	TVA (1977)
US-7	0.542	0.351	TVA (1977)
US-7	0.609	0.378	TVA (1977)
US-7	0.649	0.394	TVA (1977)
US-7	0.614	0.380	TVA (1977)
US-7	0.629	0.386	TVA (1977)
US-7	0.603	0.376	TVA (1977)
US-7	0.656	0.396	TVA (1977)
US-7	0.655	0.396	TVA (1977)
US-11	0.664	0.399	TVA (1977)
US-11	0.997	0.499	TVA (1977)
US-11	0.753	0.430	TVA (1977)
US-11	0.780	0.438	TVA (1977)
US-11	0.507	0.336	TVA (1977)
US-13	0.801	0.445	TVA (1977)
US-13	0.692	0.409	TVA (1977)
US-13	0.716	0.417	TVA (1977)
US-3-2	0.674	0.403	TVA (1977)
US-3-2	0.613	0.380	TVA (1977)
US-3-2	0.586	0.369	TVA (1977)
US-3-2	0.585	0.369	TVA (1977)
US-3-2	0.662	0.398	TVA (1977)
US-3-2	0.686	0.407	TVA (1977)
US-3-2	0.636	0.389	TVA (1977)
US-3-2	0.619	0.382	TVA (1977)
US-3-2	0.623	0.384	TVA (1977)
US-3-2	0.695	0.410	TVA (1977)
US-3-5	0.675	0.403	TVA (1977)
US-3-5	0.685	0.407	TVA (1977)
US-3-5	0.677	0.404	TVA (1977)
US-3-5	0.694	0.410	TVA (1977)
US-3-5	0.636	0.389	TVA (1977)
US-3-5	0.626	0.385	TVA (1977)
US-3-5	0.701	0.412	TVA (1977)
US-3-5	0.678	0.404	TVA (1977)
US-3-5	0.660	0.398	TVA (1977)
US-3-5	0.655	0.396	TVA (1977)
US-5-1	0.639	0.390	TVA (1977)
US-5-1	0.609	0.378	TVA (1977)
US-5-1	0.606	0.377	TVA (1977)
US-5-1	0.608	0.378	TVA (1977)
US-5-1	0.690	0.408	TVA (1977)
US-5-1	0.696	0.410	TVA (1977)
US-5-1	0.671	0.402	TVA (1977)
US-5-2	0.770	0.435	TVA (1977)

Attachment 1b (continued). Estimates of Porosity from Void Ratio Measurements

Boring	Void Ratio	Porosity	Reference
US-5-2	0.772	0.436	TVA (1977)
US-5-2	0.691	0.409	TVA (1977)
US-5-2	0.673	0.402	TVA (1977)
US-5-2	0.752	0.429	TVA (1977)
US-5-2	0.781	0.439	TVA (1977)
US-5-2	0.745	0.427	TVA (1977)
US-5-2	0.753	0.430	TVA (1977)
US-5-2	0.743	0.426	TVA (1977)
US-5-2	0.743	0.426	TVA (1977)
US-5-2	0.762	0.432	TVA (1977)
US-5-7	0.774	0.436	TVA (1977)
US-5-7	0.713	0.416	TVA (1977)
US-5-7	0.697	0.411	TVA (1977)
US-5-7	0.582	0.368	TVA (1977)
US-5-7	0.663	0.399	TVA (1977)
US-5-7	0.633	0.388	TVA (1977)
US-5-7	0.604	0.377	TVA (1977)
US-5-7	0.619	0.382	TVA (1977)
US-5-7	0.528	0.346	TVA (1977)
US-5-7	0.529	0.346	TVA (1977)
US-7-1	0.622	0.383	TVA (1977)
US-7-1	0.582	0.368	TVA (1977)
US-7-1	0.560	0.359	TVA (1977)
US-7-1	0.637	0.389	TVA (1977)
US-7-1	0.713	0.416	TVA (1977)
US-7-1	0.690	0.408	TVA (1977)
US-7-1	0.705	0.413	TVA (1977)
US-7-1	0.692	0.409	TVA (1977)
US-7-1	0.657	0.396	TVA (1977)
US-7-1	0.705	0.413	TVA (1977)
US-7-6	0.590	0.371	TVA (1977)
US-7-6	0.637	0.389	TVA (1977)
US-7-6	0.648	0.393	TVA (1977)
US-7-6	0.662	0.398	TVA (1977)
US-7-6	0.675	0.403	TVA (1977)
US-7-6	0.593	0.372	TVA (1977)
US-7-6	0.537	0.349	TVA (1977)
US-7-8	0.642	0.391	TVA (1977)
US-7-8	0.634	0.388	TVA (1977)
US-7-8	0.636	0.389	TVA (1977)
US-7-10	0.578	0.366	TVA (1977)
US-7-10	0.600	0.375	TVA (1977)
US-7-10	0.614	0.380	TVA (1977)
US-7-10	0.756	0.431	TVA (1977)
US-7-10	0.686	0.407	TVA (1977)
US-7-10	0.611	0.379	TVA (1977)
US-7-10	0.677	0.404	TVA (1977)
US-7-10	0.678	0.404	TVA (1977)
US-7-10	0.697	0.411	TVA (1977)
US-11-1	0.728	0.421	TVA (1977)
US-11-1	0.649	0.394	TVA (1977)
US-11-1	0.645	0.392	TVA (1977)
US-11-1	0.681	0.405	TVA (1977)
US-11-1	0.661	0.398	TVA (1977)
US-11-1	0.642	0.391	TVA (1977)
US-11-1	0.637	0.389	TVA (1977)
US-11-1	0.693	0.409	TVA (1977)
US-11-1	0.766	0.434	TVA (1977)
US-11-1	0.802	0.445	TVA (1977)
US-11-2	0.901	0.474	TVA (1977)
US-11-2	0.857	0.461	TVA (1977)
US-11-2	0.963	0.491	TVA (1977)
US-11-2	0.947	0.486	TVA (1977)
US-11-2	1.068	0.516	TVA (1977)
US-11-2	1.060	0.515	TVA (1977)
US-11-2	1.039	0.510	TVA (1977)
US-11-3	0.734	0.423	TVA (1977)
US-11-3	0.743	0.426	TVA (1977)
US-11-3	0.762	0.432	TVA (1977)
US-13-1	0.865	0.464	TVA (1977)
US-13-1	0.836	0.455	TVA (1977)
US-13-1	0.844	0.458	TVA (1977)
US-13-1	0.762	0.432	TVA (1977)
US-13-1	0.754	0.430	TVA (1977)
US-13-1	0.748	0.428	TVA (1977)
US-13-2	0.569	0.363	TVA (1977)
US-13-2	0.580	0.367	TVA (1977)
US-13-2	0.578	0.366	TVA (1977)
US-13-2	0.583	0.368	TVA (1977)
US-13-2	0.572	0.364	TVA (1977)
US-13-2	0.567	0.362	TVA (1977)
US-13-2	0.937	0.484	TVA (1977)
US-13-2	0.936	0.483	TVA (1977)
US-13-2	0.912	0.477	TVA (1977)
A-2	0.816	0.449	TVA (1977)
B-1	0.790	0.441	TVA (1977)
C-1	0.970	0.492	TVA (1977)
D-1	1.021	0.505	TVA (1977)
A-2	0.803	0.445	TVA (1977)
A-2	0.840	0.457	TVA (1977)
A-2	0.805	0.446	TVA (1977)
B-1	0.788	0.441	TVA (1977)
B-1	0.791	0.442	TVA (1977)
B-1	0.792	0.442	TVA (1977)
C-1	0.995	0.499	TVA (1977)
C-1	0.951	0.487	TVA (1977)
C-1	0.963	0.491	TVA (1977)
D-1	0.999	0.500	TVA (1977)
D-1	1.038	0.509	TVA (1977)
D-1	1.025	0.506	TVA (1977)
US-27	0.580	0.367	TVA (1977)
US-27	0.674	0.403	TVA (1977)
US-29	0.854	0.461	TVA (1977)
US-29	0.734	0.423	TVA (1977)
US-29	0.888	0.470	TVA (1977)
US-29	0.893	0.472	TVA (1977)
US-29	0.901	0.474	TVA (1977)
US-29	0.783	0.439	TVA (1977)
US-29	0.731	0.422	TVA (1977)
US-44	0.819	0.450	TVA (1977)
US-44	0.684	0.406	TVA (1977)
US-44	0.644	0.392	TVA (1977)
US-44	0.556	0.357	TVA (1977)
US-44	0.740	0.425	TVA (1977)
US-44	0.713	0.416	TVA (1977)
US-46	0.585	0.369	TVA (1977)
US-46	0.738	0.425	TVA (1977)
US-46	0.720	0.419	TVA (1977)
US-46	0.470	0.320	TVA (1977)
US-49	0.626	0.385	TVA (1977)
US-49	0.474	0.322	TVA (1977)
US-49	0.583	0.368	TVA (1977)
US-55	0.735	0.424	TVA (1977)
US-55	0.780	0.438	TVA (1977)
US-55	0.779	0.438	TVA (1977)
US-58	0.523	0.343	TVA (1977)
US-58	0.608	0.378	TVA (1977)
US-58	0.741	0.426	TVA (1977)
US-59	0.789	0.441	TVA (1977)
US-59	1.466	0.594	TVA (1977)
US-59	0.666	0.400	TVA (1977)
US-59	2.348	0.701	TVA (1977)
US-59	0.989	0.497	TVA (1977)
US-59	0.597	0.374	TVA (1977)
US-60	0.731	0.422	TVA (1977)
US-60	0.581	0.367	TVA (1977)
Average =	**0.729**	**0.415**	

Attachment 1c. Soil Dry Bulk Density Measurements

Boring	Dry Bulk Density (lb/ft3)	Dry Bulk Density (kg/m3)	Reference
US-125	98.4	1576.2	TVA (1979)
US-125	100.1	1603.4	TVA (1979)
US-126	131.3	2103.2	TVA (1979)
US-126A	108.8	1742.8	TVA (1979)
US-127	135.0	2162.4	TVA (1979)
US-127	100.5	1609.8	TVA (1979)
US-127	100.9	1616.2	TVA (1979)
US-127	117.6	1883.7	TVA (1979)
US-128	128.7	2061.5	TVA (1979)
US-128	105.1	1683.5	TVA (1979)
US-128A	122.6	1963.8	TVA (1979)
US-128A	105.6	1691.5	TVA (1979)
SH-128	121.1	1939.8	TVA (1979)
US-129	11.2	179.4	TVA (1979)
US-129	90.7	1452.8	TVA (1979)
HD-129	122.7	1965.4	TVA (1979)
HD-129	87.7	1404.8	TVA (1979)
US-130	129.0	2066.3	TVA (1979)
US-130	138.5	2218.5	TVA (1979)
US-130	92.4	1480.1	TVA (1979)
US-130	108.1	1731.5	TVA (1979)
US-130	119.9	1920.6	TVA (1979)
HD-130	107.5	1721.9	TVA (1979)
HD-130	119.7	1917.4	TVA (1979)
HD-130	104.4	1672.3	TVA (1979)
SS-130-A	112.0	1794.0	TVA (1979)
SS-130-A	100.3	1606.6	TVA (1979)
125	121.6	1947.8	TVA (1979)
126	121.8	1951.0	TVA (1979)
127,128	133.7	2141.6	TVA (1979)
129	122.0	1954.2	TVA (1979)
130	121.6	1947.8	TVA (1979)
US-126-4	105.7	1693.1	TVA (1979)
US-126-4	102.8	1646.7	TVA (1979)

Boring	Dry Bulk Density (lb/ft3)	Dry Bulk Density (kg/m3)	Reference
US-126-4	102.3	1638.6	TVA (1979)
US-126-4	89.9	1440.0	TVA (1979)
US-126-4	100.2	1605.0	TVA (1979)
US-126-4	100.0	1601.8	TVA (1979)
US-126-4	101.1	1619.4	TVA (1979)
US-127-5	85.5	1369.5	TVA (1979)
US-127-5	92.8	1486.5	TVA (1979)
US-127-5	85.2	1364.7	TVA (1979)
US-127-5	86.0	1377.5	TVA (1979)
US-127-5	105.2	1685.1	TVA (1979)
US-127-5	108.8	1742.8	TVA (1979)
US-127-5	105.4	1688.3	TVA (1979)
US-127-5	103.9	1664.3	TVA (1979)
US-128A-2	104.6	1675.5	TVA (1979)
US-128A-2	102.8	1646.7	TVA (1979)
US-128A-2	103.0	1649.9	TVA (1979)
US-128A-2	84.2	1348.7	TVA (1979)
US-128A-2	86.4	1384.0	TVA (1979)
US-128A-2	89.1	1427.2	TVA (1979)
US-128A-2	88.4	1416.0	TVA (1979)
US-129-3	88.2	1412.8	TVA (1979)
US-129-3	90.6	1451.2	TVA (1979)
US-129-3	87.1	1395.2	TVA (1979)
US-129-3	90.3	1446.4	TVA (1979)
US-129-3	89.8	1438.4	TVA (1979)
US-129-3	91.0	1457.6	TVA (1979)
US-129-3	82.9	1327.9	TVA (1979)
US-130-7	980.3	15702.4	TVA (1979)
US-130-7	87.7	1404.8	TVA (1979)
US-130-7	88.1	1411.2	TVA (1979)
US-130-7	93.8	1502.5	TVA (1979)
US-130-7	93.4	1496.1	TVA (1979)
US-130-7	93.8	1502.5	TVA (1979)
US-130-7	97.6	1563.4	TVA (1979)
Average =	**115.1**	**1844.0**	

Attachment 2. HSSM Model Input

CONSTANTS & MATRIX PROPERTIES

Saturated vertical hydraulic conductivity = 3.2 m/d (TVA, 1993)
Ratio of horizontal to vertical conductivity = 10
Porosity = 0.41 (TVA, 1993)
Residual water saturation = 0.10 (Weaver et al., 1994)
Van Genuchten's n = 1.430 (Weaver et al., 1994)

WATER EVENT CHARACTERISTICS

Dynamic viscosity = 1.0 cp
Density = 1.0 g/cm^3
Recharge Flux = 0.35E-03 m/d
Max krw during infiltration = 0.50 (Brakensiek et al., 1981)
Depth to water table = 4.3 m

DIESEL FUEL OIL EVENT CHARACTERISTICS

Dynamic viscosity = 5.9 cp (Weaver et al., 1994)
Density = 0.87 g/cm^3 (Weaver et al., 1994)
Residual LNAPL saturation = 0.15

CAPILLARY SUCTION PARAMETERS

Van Genuchten's alpha = .858E-01 m^{-1} (Weaver et al., 1994)
Water surface tension = 68.0 dyne/cm (Weaver et al., 1994)
Diesel fuel oil surface tension = 30.0 dyne/cm (Wu and Hottel, 1991)

OILENS SUBMODEL PARAMETERS

Radius of diesel fuel oil source = 2.0 m
Radius multiplying factor = 1.001
Thickness of capillary fringe = 0.10 m
Vertical dispersivity = 0.10 m
Groundwater gradient = 0.03
LNAPL residual in aquifer = 0.10
Maximum LNAPL Saturation in lens = 0.80
Water Solubility of Diesel Fuel = 2.76 mg/L (API, 1994)
Longitudinal dispersivity = 10.0 m (Weaver et al., 1994)
Transverse dispersivity = 1.0 m (Weaver et al., 1994)
Aquifer thickness = 3.0 m

CALCULATED PARAMETERS

Saturated vertical LNAPL hydraulic conductivity = 0.472 m/d
Approx. Brooks and Corey lambda = 0.387
Air Entry Head = 8.10 m
Trapped air saturation = 0.732E-01
Darcy velocity = 0.96 m/d
Seepage velocity = 2.341 m/d
Retardation factor = 1.0
Water saturation = 0.395
Water flux = 0.35E-03 m/d
Maximum Diesel Fuel Conductivity = 0.56E-01 m/d