Department of Energy
Office of Legacy Management

August 29, 2007

Mr. Paul Michalak
Fuel Cycle Licensing Branch, NMSS
Mail Stop T-8A33
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Michalak:

Enclosed for your review and concurrence is the document entitled *Radiological Release Survey Plan, Parcel of Property, Canonsburg, Pennsylvania Disposal Site, Canonsburg, Pennsylvania.* This radiological release survey for the west property at the Canonsburg UMTRCA Title I disposal site is a precursor for selling the approximately 2.5 acres of land that lie west and outside of the disposal cell fence line. The basic design philosophy underlying this plan was agreed to a conference call with your office in July.

We are planning to conduct the survey in late October or early November to allow effective use of a GPS unit after the leaves have fallen in the wooded area of the property. It is requested that you review the attached document and provide your concurrence, or comments, within time for us to meet this schedule.

If you have any questions, please contact me at (412) 386-4754 or email me at jack.craig@lm.doe.gov.

Sincerely,

Jack Craig
Digitally signed by Jack Craig
DN: cn=Jack Craig, c=us, o=u.s. government, ou=department of energy, National Energy Technology Laboratory
Date: 2007.09.04 09:02:32 -04'00'

Jack Craig
Site Manager

Enclosure

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Radiological Release Survey Plan
Parcel of Property
Canonsburg Pennsylvania Disposal Site
Canonsburg, Pennsylvania

August 27, 2007

Prepared by
DeNuke Contracting Services, Inc.
Oak Ridge, Tennessee

Prepared for
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Miamisburg, Ohio

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Acronyms and Abbreviations

CFR	Code of Federal Regulations
DCSI	DeNuke Contracting Services, Inc.
$DCGL_{EMC}$	Derived Concentration Guideline Level (Elevated Measurement Comparison)
$DCGL_W$	Derived Concentration Guideline Level (average)
DOE	Department of Energy
DQO	Data Quality Objective
EMC	Elevated Measurement Comparison
g	grams
ha	hectares
L	systematic sample location spacing
LBGR	Lower Bound of the Gray Region
LM	Legacy Management
m	meter
m^2	meter squared
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	minimum detectable concentration
N	number of samples for statistical testing
NaI	sodium iodide
NRC	Nuclear Regulatory Commission
pCi/g	Pico curies per gram
RESRAD	Residual Radioactive
SOR	Sum of Ratios

UMTRCA Uranium Mill Tailings Radiation Control Act

VSP Visual Sample Plan

W_r critical value for WRS test

WRS Wilcox Rank Sum

σ uncertainty in site radionuclide concentration data

Δ delta = $DCGL_W$ - LBGR

Metric/English Conversions

Metric Unit	Arithmetic Conversion	English Unit
Centimeter	Divide by 2.54	Inch
Meter	Multiply by 3.28	Feet
Square meter	Multiply by 10.76	Square feet
Kilometer	Divide by 1.61	Mile
hectare	Multiply by 2.47	Acre

Radiological Release Survey Plan
Parcel of Property
Canonsburg Pennsylvania Disposal Site
Canonsburg, Pennsylvania

1.0 INTRODUCTION

Beginning in approximately 1913, Standard Chemical operated a radium recovery plant at a site, near Canonsburg, Pennsylvania. The process separated radium from uranium ores; the uranium and other radioactive decay-chain daughter products were discarded at the site. Standard Chemical discontinued radium production in 1922 and, in 1929, Vitro Chemical Company began producing uranium for use in glass and ceramics. During World War II, Vitro Chemical Company conducted uranium separations for the Manhattan Project. Uranium separations from ores and recovery of uranium from wastes from other facilities continued after the War for the Atomic Energy Commission. In 1960, Vitro Chemical Company ceased operations at the Canonsburg site. Approximately 220,000 cubic yards of tailings and other wastes from the uranium production operations had been accumulated on the plant site. Partial cleanup was performed beginning in 1962, and in 1978, the site was included under new Federal legislation for remediation of uranium mill tailings. The Department of Energy (DOE) remediated the site under the Uranium Mill Tailings Radiation Control Act (UMTRCA), and placed contaminated materials from site and vicinity property remediation in an engineered disposal cell. The cell and surrounding property is referred to as the Canonsburg Pennsylvania Disposal Site and is included under the general U.S. Nuclear Regulatory Commission (NRC) license for UMTRCA Title 1 sites. Surveillance and maintenance of the disposal cell and surrounding site are conducted by the DOE Legacy Management Program. Further information regarding site history is available in References 1 - 4.

Approximately 1.2 hectares (3 acres) of property at the southwest end of the site is not necessary to maintain the integrity of the disposal cell. Because this parcel is not believed to contain significant levels of residual radioactive contamination, it is considered a candidate for release to the public for future beneficial use. Before this parcel can be released, DOE must demonstrate that any residual radioactive contamination satisfies applicable cleanup criteria or establish appropriate future land-use restrictions, based on the radiological conditions. This Plan describes the radiological survey to support a regulatory decision enabling future beneficial use of this property.

2.0 OBJECTIVE

The objective of this survey is to determine the current radiological conditions of the small parcel of property and to compare these conditions to radiological guidelines, which will assure that future property uses satisfy regulatory criteria (refer to Section 5.0).

3.0 SITE DESCRIPTION

The Canonsburg Pennsylvania Disposal Site is located on the west side of Canonsburg, PA, approximately 30 kilometers (20 miles) southwest of Pittsburgh, via Interstate 79 (Figure 1). Figure 2 indicates the location of the Canonsburg Pennsylvania Disposal Site, relative to Canonsburg. The Disposal Site, shown in Figure 3, occupies approximately 15 hectares, including the 2.4 hectare disposal cell, between Chartiers Creek and tracks of the Pittsburgh and Ohio Central Railroad. Access to the Disposal Site is restricted by chain link fencing. The 1.2-hectare parcel of land to be surveyed for release (Figures 3 and 4) is outside the security fence at the extreme southwest corner of the Disposal Site.

The property surface is uneven – particularly on the northern portion, which is nearer Chartiers Creek; up to approximately 7 meter (23 foot) variations in elevation occur across the parcel. The northern portions of the parcel are also heavily vegetated, including numerous mature hardwood trees. It is possible that some past subsurface disturbance may have occurred during the period of active site use; the maximum depth of such disturbances has been estimated by DOE at 1.5 to 2.0 meters. (Reference 4)

Figure 1. Canonsburg, Pennsylvania, Site Location Map

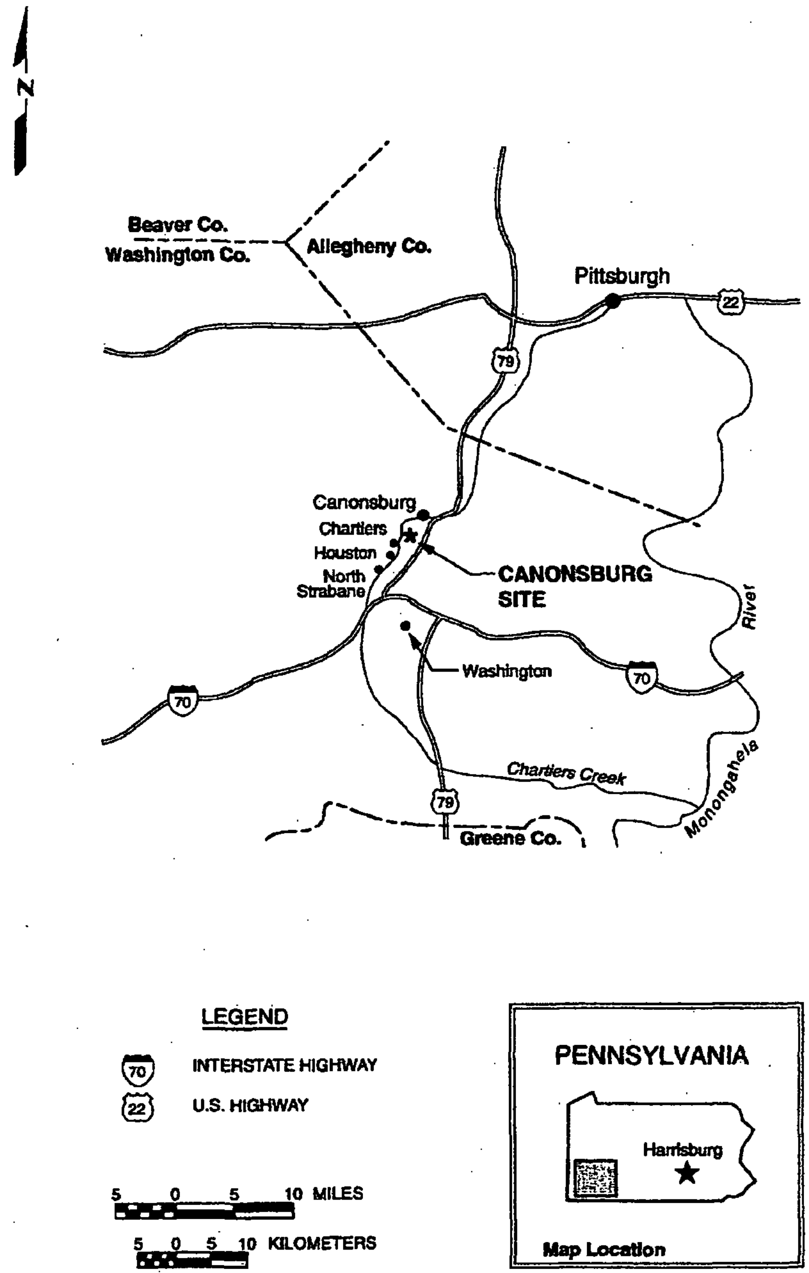


Figure 2. Canonsburg Area, Indicating Location of the Canonsburg, Pennsylvania Disposal Site

Figure 3. Disposal Site, Indicating Location of Parcel Being Surveyed

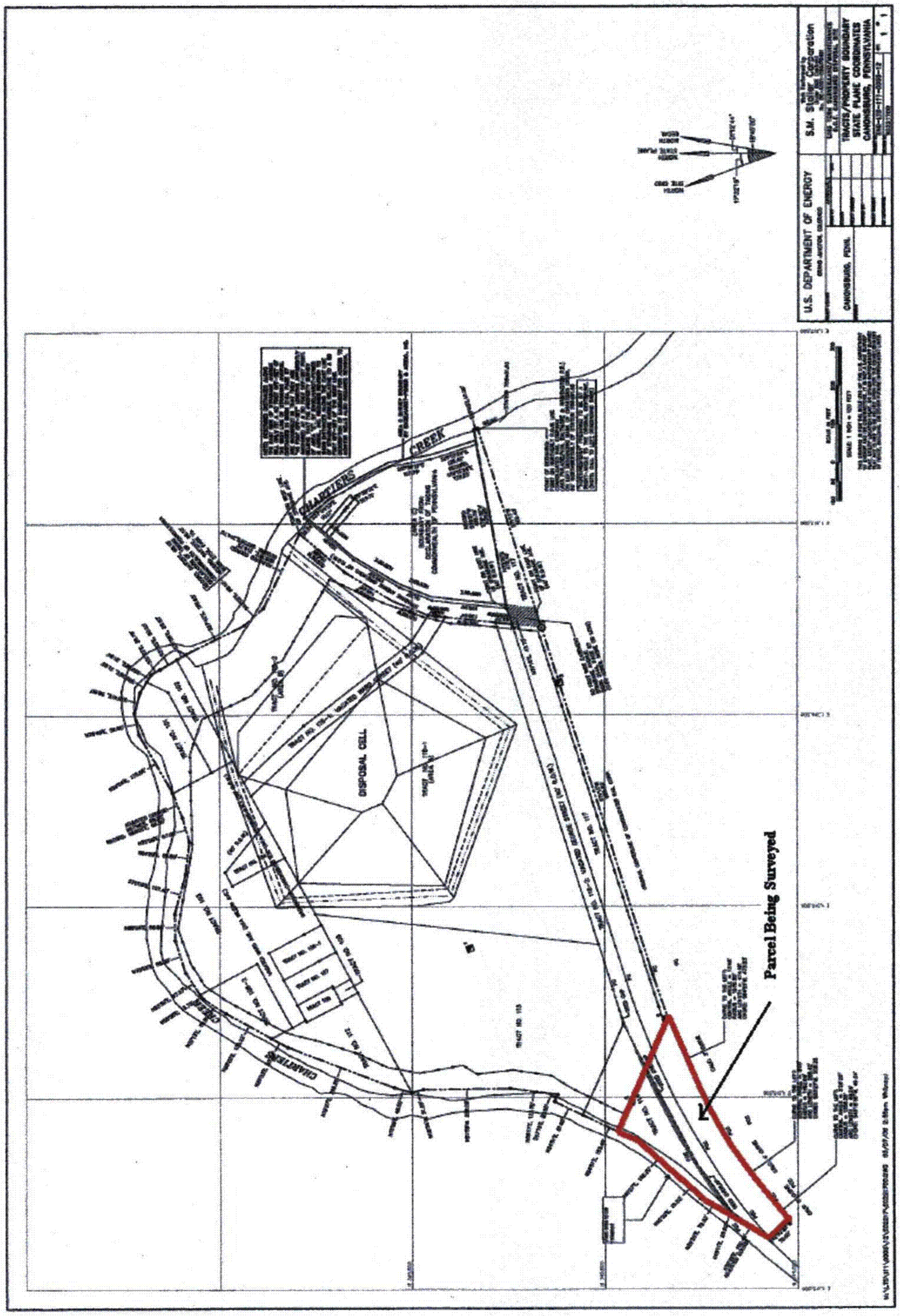
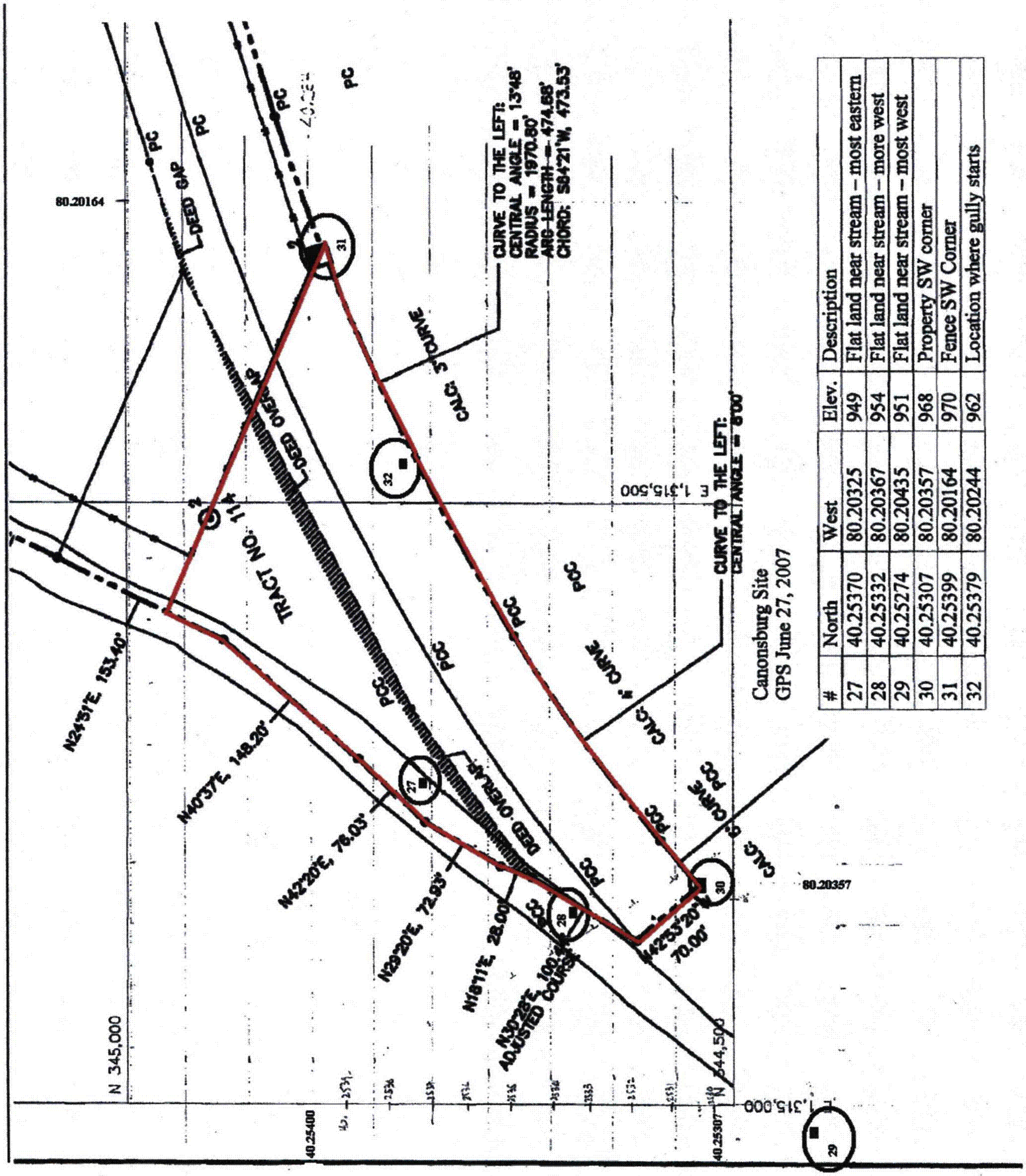


Figure 4. Drawing of Parcel of Property to be Surveyed



#	North	West	Elev.	Description
27	40.25370	80.20325	949	Flat land near stream – most eastern
28	40.25332	80.20367	954	Flat land near stream – more west
29	40.25274	80.20435	951	Flat land near stream – most west
30	40.25307	80.20357	968	Property SW corner
31	40.25399	80.20164	970	Fence SW Corner
32	40.25379	80.20244	962	Location where gully starts

4.0 DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) are qualitative and quantitative statements that establish systematic approach for data collection design in order to make determinations regarding the radiological status, relative to approved guideline levels. The 7-step DQO process as applied to radiological surveys for release decisions is described in Section 2 and Appendix D of the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (Reference 5). The DQO process has been incorporated into the MARSSIM guidance, which is the basis for survey design and implementation. The site-specific DQOs are summarized in Table 4-1.

Table 4-1. DQOs for Survey of Parcel at Canonsburg Disposal Site

DQO Element		Response
1	Problem Statement	DOE seeks to release a parcel of property at the southwest end of the Canonsburg Disposal Site for beneficial reuse. Portions of the property are considered impacted, based on operational history and previous radiological surveys. The current radiological status must be determined to support a decision regarding release.
2	Decisions to be Made	Concentrations of radionuclides in soil, relative to authorized guidelines for release.
3	Decision Inputs	Relative levels (gross count rate) of surface and subsurface direct gamma radiation and average and maximum concentrations (pCi/g) of Ra-226, Th-230, and U_{Nat} in surface and subsurface soil. These data will be obtained from walkover scans, borehole gamma logs, and surface and subsurface soil samples obtained from the surveys described in this Plan.
4	Study Boundaries	Surface and subsurface soils to maximum depth of 2m within the boundaries of the subject parcel of land.
5	Decision Rule for Release	The Wilcox Rank Sum test will be used to statistically evaluate the survey findings. **If** the test determines that radiological conditions satisfy the authorized guidelines, **Then** conclude that the parcel meets requirements for release for reuse. **If** the test or survey findings determine that portions do not satisfy the authorized guidelines, **Then** identify and further characterize those portions that do not meet requirements for release for reuse.
6	Decision Uncertainty	False negative (Type I, α) and false positive (Type II, β) error rates are set at 0.05.
7	Optimize Decision	Initial survey unit boundaries will be set and the survey designed for Class II contamination potential, based on an

		assumption that the property is impacted but that radiological guidelines will be met for both surface and subsurface soils. Based on walkover scans, gamma logs of boreholes, and soil sample analyses, portions of the parcel which do not appear to satisfy guidelines will be reclassified as Class 1 and resurveyed to provide better definition of the conditions, relative to guidelines, and to allow DOE to reevaluate the boundaries of property to be released and actions/controls for those portions which cannot be released.

Surveys will be implemented by trained/qualified personnel, using properly calibrated and maintained equipment and in accordance with documented procedures. Appendix B contains a list of applicable DCSI procedures, applicable to this survey. DCSI quality assurance/quality control programs applicable to radiological surveys will be followed. Measurement sensitivities less than guideline levels enable quantification of contaminants at or below guideline at a 95% confidence level. The following are the data quality indicators for precision, accuracy, representativeness, completeness, and comparability:

- Precision is determined by comparison of replicate values from field measurements and sample analyses; the objective is a relative percent difference of 20 percent or less at 50 percent of the guideline value.

- Accuracy is the degree of agreement with the true or known value; the objective for this parameter is +/- 20 percent at 50 percent of the guideline value.

- Representativeness and comparability do not have numeric values. Performance is assured through selection and proper implementation of sampling and measurement techniques.

- Completeness refers to the portion of the data that meets acceptance criteria and is thus acceptable for statistical testing; the objective for this survey is 90 percent.

5.0 RADIOLOGICAL CONTAMINANTS AND GUIDELINE LEVELS

Based on historic operations and previous radiological surveys, uranium in natural isotopic U-234, U-235, and U-238 abundances and members of the naturally occurring U-238 and U-235 decay series, separated from uranium during radium and uranium production operations – specifically Ra-226 and Th-230, are the principal radiological contaminants that may remain on the land parcel of interest. A 1980 radiological survey of a property at the west end of the property (also known as the F. V. Smigiel property or vicinity property CA-111) identified discrete deposits of radiological contamination (Reference 6). Cleanup was recommended at that time, but it is unclear as to whether such cleanup was performed, or, if so, the extent of such cleanup activities. The property was later acquired by DOE, at which time it became part of the Canonsburg Disposal Site and was therefore deleted from the list of vicinity properties. A survey in 1984 indicated

that the Smigiel property satisfied the 100 pCi/g of Ra-226 cleanup criterion for the disposal site. However, further detail as to the current contaminants and levels on this property is not available. More recent monitoring suggests that portions of the property may have been remediated. A review of aerial photographs, current physical conditions, and drawings from earlier surveys suggests that the parcel of interest is all or at least partially west of the former vicinity property CA-111. Periodic surveys at the site fence line by the Commonwealth of Pennsylvania have not identified elevated direct radiation levels (Reference 2). Although considered impacted, based on the available information, this parcel is not believed to contain significant levels of residual radioactive contamination; however, sufficient information to document the radiological status and demonstrate acceptable conditions for release for beneficial use are not available.

The NRC indicated that dose-based radionuclide concentrations (guideline levels), equivalent to the NRC 10 CFR 20, Subpart E limit of 25 mrem/yr to the future occupant/user would be appropriate for release from the general license. Concentrations of uranium isotopes, Th-230, and Ra-226 in soil, were calculated using the RESRAD (version 6.3) modeling code and site-specific parameters for future industrial use with restrictions on digging and groundwater use (Reference 7 and 8). The supporting development of these guidelines is presented in Appendix A. Resulting guideline concentrations or Derived Concentration Guideline Levels ($DCGL_{W}s$) are presented in Table 5-1.

Table 5-1. $DCGL_{W}s$ for Potential Radiological Contaminants at the Canonsburg Disposal Site.

Radionuclide	$DCGL_{W}$ (pCi/g)			
	Surface (0-15 cm)	Subsurface (15-30 cm)	Subsurface (100-115 cm)	Subsurface (200-215 cm)
Ra-226	2.4	2.8	2.9	13
Th-230	250	160	160	220
U-238 *	590	8,200	460,000	530,000

* Based on uranium at natural abundances of U-238, U-235, and U-234 isotopes.

These $DCGL_{W}s$ are net (above background) concentrations of radionuclides; appropriate adjustments for local naturally occurring (background) concentrations in soil will be made to sample analysis results before comparing data to the respective criteria. If more than one of the radionuclides is present, comparison with guidelines will be conducted using the Unity Rule (see Section 7.3.5).

If individual surface locations contain levels exceeding the $DCGL_{W}s$ in Table 5-1 and reclassification and resurvey as Class 1 is necessary, small areas with activity exceeding the DCGLs may be acceptable. Area Factors for various surface areas have been calculated (Appendix A). The $DCGL_{W}s$ in Table 5-1 are multiplied by these Area Factors to determine acceptable concentrations, known as Elevated Measurement Concentrations (EMCs), for small areas. The resulting guideline values are referred to as $DCGL_{EMC}s$ and are presented in Table 5-2.

Table 5-2. $DCGL_{EMC}$s for Various Impacted Areas

Area (m^2)	$DCGL_{EMC}$ (pCi/g)		
	Ra-226	Th-230	U-238
1	112	4790	4103
3	43	2989	2494
10	16	1493	1436
30	7.0	724	1053
100	2.5	282	838
300	2.5	273	742

6.0 SURVEY APPROACH

6.1 General

This survey plan was prepared in accordance with the guidelines and recommendations presented in the *"Multi-Agency Radiation Survey and Site Investigation Manual"* (MARSSIM), NUREG-1575 (Reference 5) and NUREG-1757 *"Consolidated NMSS Decommissioning Guidance"* (Reference 9). The process emphasizes the use of Data Quality Objectives and Data Quality Assessment, along with a quality assurance/quality control program. The graded approach concept is followed to assure that survey efforts are maximized in those areas having the greatest potential for residual contamination or the highest potential for adverse impacts of residual contamination.

Radiological surveys will be performed by trained radiological technicians, who are following standard, written procedures and using properly calibrated instruments, sensitive to the potential contaminants. Appendix B contains a list of DeNuke Consulting Services, Inc (DCSI) procedures, applicable to this survey. DCSI procedures for quality assurance in survey activities will be followed. A health and safety program, consistent with that of DOE Legacy Management will be implemented.

6.2 Survey Reference System

A civil survey of the site will be performed and a 10 m x 10 m grid system will be established to provide a means for referencing measurement and sampling locations. The grid pattern will be referenced to the Pennsylvania State Planar Coordinate System. A map of the site, indicating the grid pattern and planar coordinates will be prepared.

6.3 Classification of Areas by Contamination Potential

For the purposes of guiding the degree and nature of survey coverage, MARSSIM first classifies areas as *impacted*, i.e., areas that may have residual radioactivity from licensed activities, or *non-impacted*, i.e., areas that are considered unlikely to have residual radioactivity from licensed activities. Non-impacted areas do not require further

evaluation. For impacted areas MARSSIM identifies three classifications of areas, according to contamination potential.

- Class 1 Areas: Areas that have, or had prior to remediation, a potential for contamination (based on operating history or previous monitoring) above the $DCGL_W$.
- Class 2 Areas: Areas that have, or had prior to remediation, a potential for contamination but are not expected to have concentrations of residual radioactivity that exceed the $DCGL_W$.
- Class 3 Areas: Impacted areas that are not expected to contain residual radioactive material or are expected to contain levels of contamination that are a small fraction of the $DCGL_W$.

Based on the operating history and results of recent monitoring, the parcel of property is considered to be impacted, Class 2 for this survey design. If contamination in excess of $DCGL_W$s is identified by the survey, investigation, reclassification, and resurvey will be conducted, as appropriate.

6.4 Survey Units

Impacted areas are divided into survey units for ease in implementing surveys and as a basis for demonstrating compliance with guidelines. A survey unit is a portion of a site with common contaminants and contamination potential. A survey unit consists of contiguous surfaces or areas. MARSSIM recommends the following survey unit areas for open land:

Class 1	Up to 2000 m^2
Class 2	2000 to 10000 m^2
Class 3	no limit

For this survey design, the parcel will be divided into two Class 2 survey units with approximately equal areas of 6000 m^2. The actual survey unit boundaries will be established after the civil survey is completed and the scale drawing of the parcel becomes available.

6.5 Instrumentation

Because this survey is limited to open land areas, the only survey instrument type to be used is a 2" x 2" Ludlum Model 44-10 sodium iodide (NaI) gamma scintillation detector, coupled with a Ludlum Model 2221 ratemeter/scaler readout/display instrument. This instrument combination will be used for walkover gamma surface scans. The walkover scan detection sensitivity at a nominal site background level of 12,000 cpm for the potential contaminants, estimated using the guidance in MARSSIM and NUREG-1507 (Reference 10), is as follows:

Ra-226	1.5 pCi/g

Th-230	87 pCi/g
U-238	32 pCi/g

Survey techniques are chosen with the objective of achieving detection sensitivities of ≤ 50% of the guideline. This assures identification of areas of elevated activity, having a size and activity level that could adversely impact the average for the survey units.

The same instrument combination will be used to perform gamma logs of boreholes to monitor relative count rates at various subsurface locations.

Instruments will have current calibrations in accordance with ANSI N323B (Reference 11). Operational and background checks will be performed at the beginning of each day of survey activity and whenever there is reason to question instrument performance. Defective instruments will be removed from service and data obtained with that instrument since its previous acceptable performance, will not be accepted.

6.6 Determining Data Requirements

Data needs for statistical tests for release survey application are determined as follows:

6.6.1 Calculate the relative shift (Δ/σ)

$$\Delta/\sigma = (DCGL_W - LBGR)/\sigma$$

- The $DCGL_W$ for potential multiple contaminants is unity, i.e., 1.0.
- The LBGR (the Lower Bound of the Gray Region) is initially selected as ½ of the $DCGL_W$ as recommended by MARSSIM; this value is therefore 0.5.
- σ should be determined empirically from actual survey data, however, for planning purposes, lacking empirical survey unit data the value of σ may be set at 30 % of the $DCGL_W$, or 0.3.
  The resulting relative shift of 1.67 is within the range of 1 to 3, recommended by MARSSIM.

6.6.2 Determine decision errors.

The DQOs for this project establish a decision error of 0.05 for both Type I (alpha) and Type II (beta) errors.

6.6.3 Determine the number of data points required.

<u>Wilcox Rank Sum (WRS) Test</u>

The minimum number of fixed measurements required when the WRS is computed by the following equation:

$$N = \frac{1}{2} \times \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{3(P_r - 0.5)^2}$$

Where:

N = the minimum number of measurements required for each survey area or reference area;

$Z_{1-\alpha}$ = the percentile represented by the α decision error;

$Z_{1-\beta}$ = the percentile represented by the β decision error; and

P_r = the probability that a random measurement from the survey unit exceeds a random measurement from the reference area by less than the DCGL when the survey unit median is equal to the LBGR concentration above background.

Values of P_r, $Z_{1-\alpha}$, and $Z_{1-\beta}$ are obtained from Tables 5.1 and 5.2 of MARSSIM. P_r is a function of the relative shift, and $Z_{1-\alpha}$ and $Z_{1-\beta}$ depend on the selected values for α and β.

The value of N computed for the WRS test applies for both the survey unit and the reference area (i.e., at least N measurements should be performed in both areas). To ensure against lost or unusable data, the value of N will be increased by at least a factor of 1.2 when assigning the number of measurements to be made. As an alternate to this calculation, the value of N for the WRS test can be obtained from MARSSIM Table 5.3. The number of data points (samples) for the WRS test, based on a relative shift of 1.67 and decision errors of 0.05 is 16.

At least 16 samples will be obtained from each survey unit and from the background reference area.

6.7 Determining Measurement Locations

Sampling will be performed over a systematic triangular measurement pattern. The data point spacing will be determined based on the number of measurements required and the area of the survey unit, as follows:

$$L = \sqrt{\frac{A}{0.866N}}$$ (Reference 5)

Where:

L = grid spacing,

A = the total area of the survey unit, and

N = the desired number of measurements (from Section 6.6.3)

For ease in application, values of L may be rounded to the nearest whole meter.

Based on a survey unit area of 6000 m^2 and 16 samples, the sample pattern spacing is 21 m. A random starting point for this survey pattern will be established, once the civil survey is completed and actual boundaries of the survey units have been established. Visual Sample Plan (VSP) will be used to automate generation of a random-start systematic sampling pattern.

As an alternative to VSP, coordinates of the random starting point, relative to the southwest corner of the survey unit, will be determined by multiplying the north/south and east/west dimensions of the survey unit by numbers, selected from a random number table or computer-generated random number. Beginning at this location, the pattern will be manually laid out over the survey unit corresponding to the site grid east/west and north/south directions. A row of points will be established parallel to one of the survey unit axes at intervals of L. Additional rows will then be added parallel to the first row at spacing of 0.866L from the first row, with points on alternate rows spaced mid-way between the points from the previous row.

Supplemental survey locations and those which will not be used for statistical testing purposes may be selected, based on professional judgment, site knowledge, and findings as the survey progresses. Because these survey locations are typically not pre-planned, the basis for selection of such locations will be documented in the survey report.

6.8 Background Reference Area

For applications involving the WRS Test, reference areas must be of the same material as the survey unit being evaluated, but without a history of potential contamination by licensed operations. The number of reference data points must be the same (± 20%) as the number of data points required from the survey unit. An open land area of similar soil type and area as the parcel being evaluated will be identified in the vicinity (within several kilometers) of the parcel and a minimum of 16 samples of surface soil will be collected for reference purposes.

6.9 Integrated Survey Strategy

Survey data will consist of surface scans and borehole gamma logs to identify locations of residual contamination and samples of soil, analyzed for potential contaminants. Supplemental samples will be obtained, as necessary, to supplement the information from these systematic survey activities. Survey techniques are described in more detail in this section.

6.9.1 Gamma Surface Scans

Gamma surface scans will be performed on land surfaces to identify locations of residual surface activity. NaI gamma scintillation detectors will be used for these scans. Scanning will be performed by moving the detector in a serpentine pattern, while advancing at a rate of approximately 0.5 m per second. The distance between the detector and the surface will be maintained within 5 cm. Scan

coverage will be 100%. Audible signals will be monitored and locations of elevated direct levels identified for further investigation. Where satellite signals are available, GPS-based data logging will also be performed to confirm the adequacy of coverage and changes in relative gross gamma levels.

6.9.2 Surface Soil Sampling

Samples of surface (upper 15 cm) soil will be obtained from selected locations using a hand trowel or bucket auger. Approximately 500 to 1000 g of soil will be collected at each sampling location. Soil sampling will be conducted at locations chosen on a systematic and judgmental basis. The systematic samples will be located following the MARSSIM random start, triangular grid, approach, described in Sections 6.5 and 6.6, above. Supplemental (judgmental) samples will be collected at locations determined to be suspect via the gamma scans or where, by historical/operational assessment, it is prudent to do so.

6.9.3 Subsurface Investigations

Boreholes will be drilled, using bucket augers, and removed soil will be staged according to depth. Subsurface investigations will be to the level of undisturbed soil, based on visual appearances of the removed soil. Boreholes and removed soil will be gamma logged for indications of areas of elevated response. Samples of approximately 500 to 1000 g of soil will be collected from the removed soil and/or borehole sidewalls at locations corresponding to increased gross gamma levels.

6.10 Sample Analysis

Samples will be forwarded to a DOE-approved laboratory for analysis following the established contract for Ra-226 (by gamma spectrometry), Th-230 (by isotopic thorium), and total uranium (by gamma spectrometry or fluorimetry). Minimum detectable concentrations will be ≤25% of the $DCGL_{WS}$. Analytical data packages will be adequate to support independent verification and validation.

6.11 Investigations

Levels are established, which, when exceeded, indicate that further measurements and/or sampling may be necessary to confirm the validity of a survey finding relative to radiological criteria and survey unit classification. For Class 1 and 2 areas, the investigation level for samples is ≥ $DCGL_W$ for any of the potential contaminants and any above-background levels of other contaminants. The investigation level for gamma scans is >MDC_{scan}.

If it is confirmed that residual activity exists in excess of the investigation level, additional measurements will be made to determine the extent of the area of elevated activity and to provide reasonable assurance that other areas of elevated activity do not

exist. Documentation will be compiled containing the results from the investigation surveys and showing any areas where residual activity was confirmed to be in excess of the investigation level. If residual activity in excess of the applicable investigation level is confirmed, the documentation will also address the potential source(s) of the activity and the impact this has on the original classification assigned to the survey unit. A decision will then be made regarding reclassification and resurvey of the unit in whole or in part.

7.0 DATA ASSESSMENT AND EVALUATION

7.1 Conversion to Units for Comparison with Guidelines

As necessary, data will be converted to units of the guidelines to enable comparison for compliance.

7.2 Data Verification and Evaluation

Survey data will be reviewed to ensure that they are complete, fully documented, and technically acceptable. Review for data acceptability includes, at a minimum, the following:

- Compliance with survey instructions as specified in the survey package
- The instrument calibration was current and traceable to NIST standards.
- The field instruments were source checked with satisfactory results before and after use each day data are collected or if unsatisfactory, data obtained with that instrument since its previous acceptable performance check was evaluated for acceptability.
- The detection sensitivities (MDCs) and assumptions used to develop them were appropriate for the instruments and techniques used to perform the survey.
- The survey methods used to collect data were proper for the types of radiation involved and for the media being surveyed.
- The chain-of-custody was tracked from the point of sample collection to the point of obtaining results.
- The data set is comprised of qualified measurement results collected in accordance with the survey design, which accurately reflects the radiological status of the facility.
- The data has been properly recorded and records are complete, legible, signed, and dated.

If the data review criteria were not met, the discrepancy will be reviewed and the decision to accept or reject the data will be documented in accordance with approved procedures.

7.3 Data Assessment and Compliance

7.3.1 Data Quantity

As assessment will be performed to ensure that the data are adequate to support a decision regarding the radiological status of the survey unit. Simple assessment methods such as comparing the survey data to the $DCGL_W$ are first performed. If all data meet the $DCGL_W$, the data set may be further evaluated for a release decision. The average and standard deviation for the data set are calculated and the relative shift is recalculated

$$\text{relative shift} = \frac{\text{DCGL - data mean}}{\text{data standard deviation}}$$

Based on this relative shift value and the accepted Type 1 and Type 2 decision errors, the number of data points required for statistical testing is determined. If this number is less than the number of data points collected, the quantity of data is adequate for demonstrating compliance; if the recalculated number is greater than the number of data points collected then additional data must be obtained to assure the necessary power of the statistical test. Additional data requirements are met by samples at randomly selected locations in the survey unit.

7.3.2 Elevated Measurement Comparison

Each sample concentration will be compared with the $DCGL_{EMC}$ value for the associated impacted area. If the concentration exceeds the $DCGL_{EMC}$, the survey unit is not acceptable for release. If the concentration is below the $DCGL_{EMC}$, compliance with the survey unit average concentration requirement will be determined for all elevated areas as follows:

$$\delta/DCGL_W + \Sigma\ [(\text{average concentration in elevated area} - \delta)/DCGL_{EMC}] < 1$$

Where δ is average concentration for the remainder of the survey unit.

If this condition is not satisfied, the survey unit does not comply with established guidelines, and further evaluation is not necessary.

7.3.3 Statistical Analysis

Results for release decision purposes may be evaluated without performing complex statistical analysis. An assessment of the measurement results is used to quickly determine whether the survey unit passes or fails the release criterion or whether one of the statistical analyses must be performed. The evaluation matrices are presented in Table 7-1.

Table 7-1. Interpretation of Sample Measurements When the Contaminant is Present in Background.

Measurement Results	Conclusion
Difference between maximum survey unit concentration and minimum reference area concentration is less than the $DCGL_W$.	Survey unit meets release criterion.
Difference of survey unit average concentration and reference average concentrations greater than the $DCGL_W$.	Survey unit fails.
Difference between any survey unit concentration and any reference area concentration is greater than the $DCGL_W$, and the difference of survey unit average concentration and reference area average concentration is less than the $DCGL_W$.	Conduct WRS test.

The statistical test is based on the null hypothesis (H_o) that the residual radioactivity in the survey unit exceeds the $DCGL_W$. There must be sufficient survey data at or below the $DCGL_W$ to reject the null hypothesis and conclude the survey unit meets the site release criterion. Statistical analyses may be performed using a computer software program or, if necessary, using hand calculations.

7.3.4 Wilcox Rank Sum Test

The WRS test, or WRS Unity Rule (NUREG-1505, Chapter 11), is used when the radionuclide of concern is present in the background or measurements are used that are not radionuclide-specific. In addition, this test is valid only when "less than" measurement results do not exceed 40 percent of the data set.

The WRS test is applied as follows:

1. The background reference area measurements are adjusted by adding the DCGL to each background reference area measurement,

$$X_i,\ Z_i = X_i + DCGL.$$

2. The number of adjusted background reference area measurements, m, and the number of survey unit measurements, n, are summed to obtain N, (N = m + n).

3. The measurements are pooled and ranked in order of increasing size from 1 to N. If several measurements have the same value, they are assigned the average rank of that group of measurements.

4. The ranks of the adjusted background reference area measurements are summed to obtain W_r.

5. The value of W_r is compared with the critical value in Table I.4 of NUREG-1575 (MARSSIM). If W_r is greater than the critical value, the survey unit meets the site release dose criterion. If W_r is less than or equal to the critical value, the survey unit fails to meet the criterion.

7.3.5 Unity Rule

Multiple radionuclides will be accounted for using a sum of ratios (SOR) or "unity rule" approach as described in NUREG-1505 Chapter 11. SOR equivalents will be calculated for each sample as follows:

$$\text{SOR} = \frac{C_1}{DCGL_1} + \frac{C_2}{DCGL_2} + \ldots \frac{C_n}{DCGL_n} \leq 1$$

Where:

C_n = Concentration of radionuclide n and

$DCGL_n$ = $DCGL_W$ of radionuclide n

The unity rule equivalent results will be used to demonstrate compliance. If the application of the WRS test is necessary, this test will be applied using the unity rule equivalent results and assuming that the $DCGL_W$ is equal to 1.0.

An example of a WRS test using the unity rule is provided in NUREG-1505, Page 11-3, Section 11.4. If the WRS test is used, background concentrations will also be converted to Unity Rule Equivalents prior to performing this test.

7.3.6 Data Conclusions

The results of the statistical tests allow one of two conclusions. The first conclusion is that the survey unit meets the unrestricted use criterion. The data provides statistically significant evidence that the level of residual radioactivity in the survey unit does not exceed the release criterion. Their decision is made with sufficient confidence and without further analysis.

The second conclusion that can be made is that the survey unit fails to meet the release criterion. The data are not conclusive in showing that the residual radioactivity is less than the release criterion. The data may be analyzed further to determine the reason for the failure.

Possible reasons are that:

1. the average residual radioactivity exceeds the $DCGL_W$, or

2. the test did not have sufficient power to reject the null hypothesis (i.e., the result is due to random statistical fluctuation).

The power of the statistical test is a function of the number of measurements made and the standard deviation in measurements data. The power is determined from 1-β where β is the value for Type II errors. A retrospective power analysis may be performed using the methods described in Appendices I.9 and I.10 of NUREG-1575 (MARSSIM). A greater number of measurements increases the probability of passing if the survey unit actually meets the release criterion. If failure was due to the presence of residual radioactivity in excess of the release criterion, the survey unit must be remediated and resurveyed for release purposes or conditions noted for future actions.

7.3.7 Compliance

This evaluation is designed to demonstrate that radioactive materials have been removed from the parcel of property to the extent that residual levels of radioactive contamination are below the radiological guidelines for release. The site-specific radiological criteria presented in this plan demonstrate compliance with the criteria of 10 CFR 20.1402.

If the measurement results pass these requirements, then the survey unit is suitable for release.

7.3.8 Graphical Data Presentation

Survey data may be graphed to identify patterns, relationships or possible anomalies which might not be apparent using other methods of review. A posting plat or a frequency plat may be made. Other special graphical representations of the data will be made as needed. MARSSIM Section 8.2.2.2 provides additional information regarding graphical data presentation.

Posting Plots

Posting plots may be used to identify spatial patterns in the data. The posting plot consists of the survey unit map with the numerical data shown at the location from which it was obtained. Posting plots can reveal patches of elevated radioactivity or local areas in which the $DCGL_W$ is exceeded. Posting plots can be generated for background reference areas to point out spatial trends that might adversely affect the use of the data. Incongruities in the background data may be the result of residual, undetected activity, or they may just reflect background variability.

Frequency Plots

Frequency plots may be used to examine the general shape of the data distribution. Frequency plots are basically bar charts showing data points within a given range of values. Frequency plots reveal such things as skewness and bimodality (having two peaks). Skewness may be the result of a few areas of

elevated activity. Multiple peaks in the data may indicate the presence of isolated areas of residual radioactivity or background variability due to soil types or differing materials of construction. Variability may also indicate the need to more carefully match background reference areas to survey units or to subdivide the survey unit.

8.0 SURVEY REPORT

A report will be prepared, describing the survey activities and findings. This report will be a stand-alone document containing the information necessary to demonstrate compliance with the site release guidelines. This information includes:

1. Description of the survey area, including operational history, decommissioning actions performed, and current physical conditions.

2. Radiological contaminants and criteria

3. Survey unit design information (classification, data requirements, survey pattern).

4. Survey unit sampling locations and corresponding data, including field survey data forms and analytical reports.

5. Survey unit investigations performed and their results, including field survey data forms and analytical reports.

6. Background/reference area data.

7. Survey unit data assessment results

8. Comparison of results with guidelines

9. Conclusions; including recommendations for future survey activities, if appropriate..

9.0 REFERENCES

1. Standard Chemical Company, Marie Curie, and Canonsburg, Joel O. Lubenau, February 12, 2005.

2. Radiological Status of Southwest Corner of the Canonsburg Pennsylvania Disposal Site, Doc. No. 50249600, DOE, July 2006.

3. Canonsburg, Pennsylvania Disposal Site Fact Sheet, DOE no date.

4. Design and Perform Radiological Survey for the West Property at Canonsburg, PA Disposal Site, Statement of Work, J.M. Stoller Corp.

5. NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIN)," Revision 1, October 18, 2000.

6. Results of the Radiological Survey at Canonsburg Site Vicinity Property CA 111, Oak Ridge National Laboratory, February 1982.

7. ANL/EAP, "Users Manual for RESRAD Version 6, Argonne National Laboratory," no date.

8. "Data Collection Handbook to Support Modeling Impacts of Radioactive Material in Soil," C. Yu et al, April 1993.

9. NUREG 1757, "Consolidated NMSS Decommissioning Guidance," September, 2002.

10. NUREG-1507, "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions," December 1997.

11. ANSI N323B-2003, "American National Standard for Radiation Protection Instrumentation Test and Calibration, Portable Survey Instrumentation for Near Background Operation," 2004.

Appendix A

DCGL Development for the Canonsburg Disposal Site

DCGL Development Narrative

The radionuclides of concern for the Canonsburg property are Ra-226, Th-230, and Natural Uranium. In discussions with SM Stoller Corp., State of Pennsylvania, and NRC representatives it was determined that DCGL modeling would be based upon a dose criteria of 25 mrem/y annual exposure limit, at any point over the next 1000 years, under an occupational exposure scenario. The property would carry a water use restriction on the deed.

Overview of RESRAD Parameter Selection

The RESRAD developed dose results were derived using default RESRAD default settings except as noted below.

- "File Titles" were selected to be representative of each particular run.
- "Contamination Zone" was set at 10,000 m^2 for site wide $DGCL_W$ runs and was varied, between 1 and 300 m^2, for the $DCGL_{EMC}$ runs.
- "Contamination depth" was set at 0.15 meters.
- "Cover Depth" was set at 0 for the $DCGL_{EMC}$ runs, and was varied between 0 and 2.0 meter for the $DCGL_W$ runs such that the "contamination zones" were modeled at 0.0 to 0.15 m, 0.15 to 0.30 m, 1.0 to 1.15 m, and 2.0 to 2.15 m.
- "Indoor Time Fraction" & "Outdoor Time Fraction" were set at 0.17 and 0.06 based upon recommendations found in the RESRAD Users Manual, Table 2.3.
- Contamination concentrations were ran at 1 pCi/g for Ra-226, Th-230, U-238, U-234, and U-235.

Pathway selection included External Gamma, Inhalation, Soil Ingestions, and Radon following the recommendations for the industrial use scenario. A summary of the RESRAD run parameters is provided in Table A-15. The actually RESRAD Runs were printed and provided to SM Stoller such that they may be kept on file for future reference.

DCGL Derivation Results

Tables A-1 through A-14 provide the process by which the RESRAD runs were assessed against the 25 mrem dose criteria and how the final DGCL values were derived.

Radium and Thorium Derivation

The DCGL numbers for Radium and Thorium are developed in a straight forward process in which the dose result, in mrem/y per pCi/g, is solved for an unknown pCi/g quantity delivering a 25 mrem/y dose, as in the example below:

Step 1 –

RESRAD Run for Ra-226 returns a result of 10.29 mrem/y with in input concentration of 1 pCi/g.

Step 2 -

Solve for 25 mrem/y.

$$25\text{ mrem/y} = (\text{XpCi/g})\frac{10.29\text{ mrem/y}}{XpCi/g}$$

Becomes:

$$XpCi/g = \frac{25\text{ mrem/y}}{10.29 mrem/y} = 2.4$$

Uranium Derivation

Determining the Uranium DCGLs is slightly more difficult because there are three naturally occurring isotopes of uranium found in nature; U-238, U-235, and U-238. The activity from each of these isotopes is summed to get the total activity due to natural uranium, or as it is sometimes referred to, U-Nat. The term "U-Nat" or "natural uranium" does not indicate that the uranium is unprocessed, only that it has not been enriched or depleted in the U-235 uranium isotope. In nature the activity (in disintegrations per unit time) from natural uranium is divided among the three isotopes as follows:

U-238: 49.5%
U-235: 2.2%
U-234: 48.3%

Th-234 and Pa-234m are two short-lived decay progeny associated with U-238 that reach an activity equilibrium with U-238 within a few hundred days. These radionuclides produce several low energy gamma rays at a rate of about 0.05 for each U-natural disintegration. U-235 and its short-lived decay progeny produce about 0.02 gamma decays for each U-natural disintegration. Gamma production associated with the decay of U-234 is insignificant in comparison to U-235 and U-238. Thus, in the field, when using gamma scanning instrumentation, the primary uranium isotope detected is U-238, thus for sake of convenience and clarity the DGGL for Total Uranium is presented in terms of U-238 activity. This derivation was produced as follows.

Step 1 –

Produce mrem/y result with an input of 1 pCi/g concentration for the three uranium isotopes. The result, at a depth of 0-15 cm, and a surface area of 10,000 m^2, is:

U-238: 2.96E-2
U-235: 1.31E-1
U-234: 7.07E-3

Step 2 –

Weight each dose in terms of activity faction for each isotope by multiplying the dose by the faction of activity provided by each isotope. This has the effect of splitting the dose among the isotopes based on each isotope's contribution to a total activity of 1 pCi/g.

U-238: 2.96E-2 x 0.495 = 1.47E-2 mrem/y per 0.495 pCi/g
U-235: 1.31E-1 x 0.022 = 2.87E-3 mrem/y per 0.022 pCi/g
U-234: 7.07E-3 x 0.483 = 3.41E-3 mrem/y per 0.483 pCi/g

Step 3 –

Sum the dose produced the three isotopes at a summed decay rate of 1 pCi/g.

$$\frac{1.47E-2mrem/y}{0.495pC/g}+\frac{2.87E-3mrem/y}{0.022pCi/g}+\frac{3.41E-3mrem/y}{0.483pCi/g}=\frac{2.10E-2mrem/y}{pCi/g}$$

Step 4 –

Solve for the concentration of uranium in pCi/g required to produce the dose criteria of 25 mrem/y.

$$25\text{ mrem/y} = (\text{XpCi/g})\frac{2.10\text{E - 2mrem/y}}{pCi/g}$$

Becomes:

$$XpCi/g=\frac{25\text{ mrem/y}}{2.10E-2mrem/y}=1.19E3$$

Step – 5

Provide DGGL in terms of U-238 alone. Note that the 1190 pCi/g of natural uranium activity from Step 4 results in a dose of 25 mrem/y. To provide this result in terms of U-238 activity only, the total result is simply multiplied by the U-238 activity fraction.

1.19E3 pCi/g x 0.495 = 5.90E2 pCi/g.

Thus, 590 pCi/g of U-239 equates to a 25 mrem/y dose from natural uranium.

Canonsburg DCGL Development (August 2007)

Table 1	Dose from 1 pCi/g concentration in soil in mrem (RESRAD)				
CZ	Ra-226	Th-230	U-234	U-235	U-238
0 to 15	10.29	0.099	7.07E-03	1.31E-01	2.96E-02
15 to 100	8.925	0.1564	4.04E-04	5.18E-03	2.41E-03
100 to 115	8.643	0.1539	5.62E-05	1.16E-10	2.46E-08
200 to 215	1.867	0.1161	4.85E-05	2.10E-29	3.09E-08

Table 2		
[1]DCGL (pCi/g) at an allowed Dose of 25 mrem		
0 to 15	2.4	252.5
15 to 100	2.8	159.8
100 to 115	2.9	162.4
200 to 215	13.4	215.3

[1] 25 mrem divided by mrem per pCi/g

Table 3		U-234	U-235	U-238
[2]Natural Uranium Activity Fractions:		0.483	0.022	0.495
CZ		[3]Activity Weighted Dose Contribution (mrem)		
0 to 15		3.41E-03	2.87E-03	1.47E-02
15 to 100		1.95E-04	1.14E-04	1.19E-03
100 to 115		2.72E-05	2.56E-12	1.22E-08
200 to 215		2.34E-05	4.62E-31	1.53E-08

[2] Activity fraction per pCi/g from each uranium isotope at natural abundances
[3] mrem per pCi/g x activity fraction at one pCi/g total activity

Table 4	
CZ	[4] Summed Uranium dose (mrem) at 1 pCi/g Total Uranium Activity
0 to 15	2.10E-02
15 to 100	1.50E-03
100 to 115	2.72E-05
200 to 215	2.34E-05

[4] the summated dose for each of the 3 uranium isotopes at a total activity of 1 pCi/g.

Table 5	
CZ	[1]DCGL (pCi/g) at an allowed dose of 25 mrem from total Uranium
0 to 15	1.19E+03
15 to 100	1.66E+04
100 to 115	9.20E+05
200 to 215	1.07E+06

[1] 25 mrem divided by mrem per pCi/g

Table 6	
CZ	[5]U-238 Contribution alone (pCi/g)
0 to 15	5.90E+02
15 to 100	8.24E+03
100 to 115	4.56E+05
200 to 215	5.28E+05

[5] Total-Uranium DGCG equating to 25 mrem (Table 5) x activity fraction for U-238 (0.495). Rounded to 2 significant figures.

Table 7	Final DCGLs (pCi/g)			
Depth	Ra-226	Th-230	U-238	
0 to 15	2.4	250	590	
15 to 100	2.8	160	8200	
100 to 115	2.9	160	460000	
200 to 215	13	220	530000	

DeNuke, NCK, August 2007

Canonsburg DCGL-EMC Development (August 2007)

Table 8 Dose from 1 pCi/g concentration in soil in mrem (RESRAD)

m^2	Ra-226	Th-230	U-234	U-235	U-238
1	2.24E-01	5.22E-03	1.77E-03	1.43E-02	3.73E-03
3	5.80E-01	8.36E-03	2.01E-03	3.05E-02	6.71E-03
10	1.54E+00	1.67E-02	2.32E-03	6.19E-02	1.24E-02
30	3.58E+00	3.45E-02	2.66E-03	8.66E-02	1.73E-02
100	9.91E+00	8.88E-02	3.18E-03	1.08E-01	2.20E-02
300	1.01E+01	9.17E-02	4.01E-03	1.18E-01	2.46E-02
10000	1.03E+01	9.90E-02	7.07E-03	1.31E-01	2.96E-02

Table 9

[1] DCGL (pCi/g) at an allowed Dose of 25 mrem

1	111.6	4791.1
3	43.1	2989.0
10	16.2	1493.4
30	7.0	724.4
100	2.5	281.6
300	2.5	272.5
10000	2.4	252.5

[1] 25 mrem divided by mrem per pCi/g

Table 10

			U-234	U-235	U-238
[2] Natural Uranium Activity Fractions:			0.483	0.022	0.495
m^2		[3] Activity Weighted Dose Contribution (mrem)			
1			8.53E-04	3.15E-04	1.85E-03
3			9.68E-04	6.70E-04	3.32E-03
10			1.12E-03	1.36E-03	6.14E-03
30			1.28E-03	1.91E-03	8.56E-03
100			1.54E-03	2.37E-03	1.09E-02
300			1.94E-03	2.59E-03	1.22E-02
10000			3.41E-03	2.87E-03	1.47E-02

[2] Activity fraction per pCi/g from each uranium isotope at natural abundances
[3] mrem per pCi/g x activity fraction at one pCi/g total activity

Table 11

m^2	[4] Summed Uranium dose (mrem) at 1 pCi/g Total Uranium Activity
	3.02E-03
3	4.96E-03
10	8.62E-03
30	1.17E-02
100	1.48E-02
300	1.67E-02
10000	2.10E-02

[4] the summated dose for each of the 3 uranium isotopes at a total activity of 1 pCi/g.

Table 12

m^2	[1] DCGL (pCi/g) at an allowed dose of 25 mrem from total Uranium
1	8.29E+03
3	5.04E+03
10	2.90E+03
30	2.13E+03
100	1.69E+03
300	1.50E+03
10000	1.19E+03

[1] 25 mrem divided by mrem per pCi/g

Table 13

m^2	[5] U-238 Contribution alone (pCi/g)
1	4.10E+03
3	2.49E+03
10	1.44E+03
30	1.05E+03
100	8.38E+02
300	7.42E+02
10000	5.90E+02

[5] Total-Uranium DGCG equating to 25 mrem (Table 5) x activity fraction for U-238 (0.495).

Table 14 Final DCGLs (pCi/g)

m^2	Ra-226	Th-230	U-238
1	111.6	4,791.1	4,102.6
3	43.1	2,989.0	2,494.0
10	16.2	1,493.4	1,435.9
30	7.0	724.4	1,053.3
100	2.5	281.6	837.5
300	2.5	272.5	741.6
10000	2.4	252.5	590.4

DeNuke, NCK, August 2007

Table A-15 RESRAD Input

Canonsburg DCGL – EMC Development Summary of Doses									
	CZ (cm)	CZ (cm)	CZ (cm)	Area (m^2)	Area (m^2)	Area (m^2)	Area (m^2)	Area (m^2)	Area (m^2)
	0-15	15-30	100-115	1	3	10	30	100	300
	RESULT (mrem/yr)								
Ra-226	1.03E+01	8.93E+00	1.03E+01	8.93E+00	1.03E+01	8.93E+00	1.03E+01	8.93E+00	1.03E+01
Th-230	9.90E-02	1.56E-01	1.54E-01	5.22E-03	8.36E-03	1.67E-02	3.45E-02	8.88E-02	9.17E-02
U-238	2.96E-02	2.41E-03	2.46E-08	3.73E-03	6.71E-03	1.24E-02	1.73E-02	2.20E-02	2.46E-02
Total Uranium				1.98E-02	3.92E-02	7.66E-02	1.07E-01	1.33E-01	1.47E-01

DCGL Model Input Selection (variables not listed were set a the RESRAD Default Values)									
Default	Area of Contaminated Zone (m^2)								
1E4	1E4	1E4	1E4	1	3	10	30	100	300
	Thickness of Contaminated Zone (set at 0.15 meters for all runs)								
2	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
	Initial Principal Radionuclide (1 pCi/g for all runs)								
100	1	1	1	1	1	1	1	1	1
	Cover Depth (m)								
0	0	0.15	1.0	0	0	0	0	0	0
	Indoor Fraction								
0.5	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
	Outdoor Fraction								
0.25	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
	Pathway								
External	Active	Active	Active	Active	Active	Active	Active	Active	Active
Inhalation	Active	Active	Active	Active	Active	Active	Active	Active	Active
Ingestion	Active	Active	Active	Active	Active	Active	Active	Active	Active
Radon	Active	Active	Active	Active	Active	Active	Active	Active	Active
All others	Suppressed	Suppressed	Suppressed	Suppressed	Suppressed	Suppressed	Suppressed	Suppressed	Suppressed

Appendix B

List of DCSI Procedures Applicable to Release Survey of Property at Canonsburg Disposal Site

Table of DCSI Procedures

Procedure Number	Procedure Title
DENUKE-HS-100	ES&H Plan, Volume 1
DENUKE-HS-100.100	Health and Safety Plan for Radiological Survey Activities
DENUKE-QA-100	Quality Assurance Plan
DENUKE-QA-100.100	Quality Assurance for Radiological Survey Activities
DENUKE-RP-105	Instrumentation and Measurement: General
DENUKE-RP-105.100	Instrumentation: Calibration
DENUKE-RP-105.200	Instrumentation: Setup and Performance Checks
DENUKE-RP-105.300	Instrument Selection and Use
DENUKE-RP-105.304	Operation of Ludlum Model 2221 Ratemeter/Scaler
DENUKE-RP-105.308	Operation of Ludlum Model 44-10 Gamma Scintillation Detector
DENUKE-RP-105.319	Perform QC Check of the Trimble Pro XRS Sub-Meter GPS
DENUKE-RP-105.320	Checking Satellite Availability for GPS Work
DENUKE-RP-105.327	Field Operation of the Trimble GeoXT Handheld GPS Unit
DENUKE-RP-105.400	Calculating Detection Sensitivity
DENUKE-RP-105.500	Radiological Survey Activities
PROCEDURE 1.1	Clearing to Provide Access
PROCEDURE 1.2	Reference Grid System
PROCEDURE 1.3	Background Measurements and Sampling
PROCEDURE 2.1	Instrumentation: Calibration & Quality Control
PROCEDURE 2.2	Surface Scanning
PROCEDURE 2.5	Subsurface Scanning (Borehole Logging)
PROCEDURE 2.6	Monitoring Personnel and Equipment for Radioactive Contamination
PROCEDURE 2.7	Preparing Samples for Transportation
PROCEDURE 3.2	Soil Sampling
PROCEDURE 3.6	Environmental Sample Identification
PROCEDURE 3.7	Sample Chain-of-Custody
PROCEDURE 4.1	Calculating Detection Sensitivity
APPENDIX A	Sample Survey Data Forms
DENUKE-TR-110	Training & Qualification of Personnel