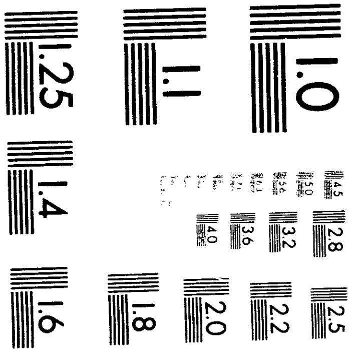
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Energy Systems Environmental Restoration Program
ORNL Environmental Restoration Program

A Radiological and Chemical Investigation of the 7500 Area Contamination Site at Oak Ridge National Laboratory, Oak Ridge, Tennessee

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EXECUTIVE SUMMARY

A radiological and chemical investigation of the 7500 Area Contamination Site at Oak Ridge National Laboratory (ORNL) was conducted intermittently from February 1992 through May 1992. The investigation was performed by the Measurement Applications and Development Group of the Health and Safety Research Division of ORNL at the request of the U.S. Department of Energy's Oak Ridge Operations Office and the ORNL Environmental Restoration Program.

On February 20, 1992, a nongovernment vehicle became mired in mud along a drainage ditch located on the west side of the High Flux Isotope Reactor (HFIR) Access Road. During the vehicle extraction process, an area of radioactively contaminated subsurface soil was exhumed. Shoe soles of six personnel assisting in the vehicle extraction process became contaminated by direct contact with contaminated mud. Additionally, a second nongovernment vehicle became contaminated from dispersed mud debris. The contamination was not evident until affected personnel advanced through the radiation monitoring station located at the entrance to the complex containing the HFIR and the Radiochemical Engineering Development Center (REDC).

Radiation control measures were immediately implemented by ORNL's Office of Radiation Protection at the point of the contamination incident (i.e., where the vehicle became mired in contaminated mud) and circumjacent area. A "Contamination Area" was established by surrounding the contaminated soil area with a plastic-link chain attached to metal posts; warning signs were posted on the chain boundary; and caution lights were employed along the HFIR Access Road. To minimize the potential of contaminant dispersion, a large sheet of plastic was spread over and beyond the boundary of detectable contamination. Additionally, a corrugated steel pipe was placed on top of the plastic along the drainage ditch route to channel surface runoff during storm events.

The contaminated soil area was determined subsequently to be positioned directly above several underground pipelines. The pipelines are aligned in parallel in a subsurface trench along the line route. There are two categories of lines that are differentiated by their size (2-, 3-, and 6-in. diam) and operational usage [liquid low-level waste (LLW) and process waste lines]. Three LLW lines (one active and two abandoned) and one abandoned process waste line are positioned in the trench. Pressurized and volume/material balance tests demonstrate no leaks or failures on the active LLW line.

The area of this investigation begins ~100 ft north of the contamination area, extends southward through the contamination area, follows the pipeline route along the gravel parking lot, and terminates at the asphalt-covered parking lot (a total distance of ~600 ft). The region between the contamination area and the valve pit (north) also was investigated, as well as the exterior perimeter of the contamination area established along the drainage ditch on the west side of the HFIR Access Road and the drainage ditch on the east side of the road. Soil samples were collected along the pipeline route.

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For purposes of correlating findings with specific areas, the site is categorized into four distinct areas: (1) general area (surrounding environs), (2) contamination area (location of contamination incident) and drainage ditch, (3) asphalt and gravel parking lots (pipeline survey excluding the contamination area), and (4) HFIR Access Road.

- **General area (surrounding environs).** Typical background gamma exposure rates measured at 1 m above the ground surface were generally found throughout the survey area [excluding the established contamination areas at (1) the point of the contamination incident and (2) the associated drainage ditch]. Gamma exposure rate measurements taken at ten locations throughout the survey area ranged from 7 to 9 μR/h (average 8 μR/h) at 1 m above the ground surface.

  A comprehensive surface gamma radiation scan and a limited beta radiation scan were conducted over the survey area. Results generally indicated typical background levels. However, some slightly elevated radiation anomalies were found on the ground surface. These included several spots that peppered areas in or near the contamination area. In most cases, sampling of surface (0- to 2-in. depth) anomalies for radionuclide screening analysis remediated the anomaly. Radiation measurements taken after sample removal generally showed background radiation levels at most of the sampled locations. The majority of the spots were determined to contain ^{60}Co and/or ^{137}Cs as demonstrated by gamma spectroscopy.

  One finding consisted of slightly contaminated leaves from a wild cherry tree located north of the contamination area. Analysis of fallen leaves from this tree demonstrated the presence of ^{90}Sr.

- **Contamination area (location of contamination incident) and drainage ditch.** Beta-gamma dose rates measured at 1 m above the ground surface inside the contamination area were ~20 mrad/h. Measurements taken at the soil surface at auger hole 24 indicated beta-gamma levels of ~120 mrad/h. Levels decreased and remained constant at 100 mrad/h at 14 in. and 18 in. of soil depth. Radionuclide analysis of a soil sample taken at 0 to 6 in. of soil depth revealed highest gross beta activity of 57,000 pCi/g. The primary contributor to gross beta contamination was ^{90}Sr at 25,000 pCi/g.

  Prior to riprapping the contamination area, gamma exposure rate measurements at 1 m above the ground surface were elevated at the eastern edge of the contamination area (18–28 μR/h). After riprapping, 1-m gamma levels decreased to 8 μR/h. (Riprap was used to reduce radiation exposures, minimize the dispersion of surface contamination, and subsequently prevent a similar contamination incident.)

  The finding of a radioactive snail shell in a contaminated soil sample (B1) collected in the contamination area provides evidence of contaminant uptake into the biota. Analysis of the isolated shell (B1S) demonstrated gross beta concentrations of 1,600,000 pCi/g (^{90}Sr contributed 760,000 pCi/g and ^{137}Cs contributed 1,800 pCi/g). Gross alpha concentrations of 69,000 pCi/g were also measured in the snail sample. Elevated concentrations of ^{228}Th were found in the soil sample (65 pCi/g) and snail sample (420 pCi/g). Strontium-90, ^{137}Cs, and ^{228}Th have been associated with operations at Building 7920 (REDC facility) and were likely present in transported liquid waste.

Analysis results of a water sample collected from a culvert downstream (south) of the drainage ditch and the contamination area demonstrated concentrations of total strontium at 49 pCi/L and gross beta concentrations of 95 pCi/L. The total strontium concentration of 49 pCi/L is well below the Derived Concentration Guide (DCG) ^{90}Sr limit of 1000 pCi/L for release of water that normally would not require treatment to further reduce the concentration.

Metals analysis of a soil sample collected in the contamination area (B24S) revealed five metals measured in significant, quantifiable amounts: Al (23,000 mg/kg), Cr (33.6 mg/kg), Fe (55,800 mg/kg), Li (25.6 mg/kg), and K (3820 mg/kg). A comparison of metal concentrations in soil from the 7500 Area Contamination Site to background concentrations is made. Results of soil data demonstrate iron concentrations to be the highest measured. The presence of elevated concentrations of iron is likely due to corrosion of iron equipment (e.g., piping) used in waste transport operations. Additionally, metals associated with HFIR wastes include aluminum and chromium; therefore, the presence of these metals may be plausible at this site. Inorganic lithium and potassium compounds have been used in operations at Building 7920 and most likely were present in transported liquid waste.

In comparison with selected soil cleanup levels proposed by the Tennessee Department of Environment and Conservation Division of Superfund [Hazardous Substance Site Remedial Action Cleanup Standards (Chapter 1200-1-13-.08, Draft, October 7, 1992)], we found concentrations of As, Cd, Cr, Pb, Hg, and Ni below their respective cleanup levels. For instance, respective industrial and residential cleanup levels for these metals are as follows: As (30 and 20 mg/kg), Cd (1 mg/kg), Cr (100 mg/kg), Pb (500 and 250 mg/kg), Hg (10 mg/kg), and Ni (1000 mg/kg).

Organic compound analysis of a soil sample collected in the contamination area (B24S) revealed that most concentrations were less than their respective practical quantitation limits (PQLs). Additionally, in comparison with selected soil cleanup levels proposed by the Tennessee Department of Environment and Conservation Division of Superfund [Hazardous Substance Site Remedial Action Cleanup Standards (Chapter 1200-1-13-.08, Draft, October 7, 1992)], we found concentrations of benzene, carbon tetrachloride, methylene chloride, pentachlorophenol, toluene, 1,1,1-trichloroethane, vinyl chloride, and total xylene below their respective cleanup levels. For instance, respective industrial and residential cleanup levels for these compounds are as follows: benzene (0.5 mg/kg), carbon tetrachloride (0.5 mg/kg), methylene chloride (2.5 mg/kg), pentachlorophenol (10 mg/kg), toluene (10 mg/kg), 1,1,1-trichloroethane (20 mg/kg), vinyl chloride (1 mg/kg), and total xylene (10 mg/kg). All volatile organic compounds were at or below their respective PQLs. All semivolatile compounds were at or below their respective PQLs with the exception of bis(2-ethylhexylphthalate). This compound was measured at a concentration of 14 μg/L, slightly above the PQL of 10 μg/L. In addition, of the 12 compounds tentatively identified in sample B24S, only 1 compound (octamethylcyclotetrasiloxane) was confirmed at low concentrations (700 μg/kg).

- **Asphalt and gravel parking lots (pipeline survey excluding contamination area).** Field survey measurements indicated low levels of surface gamma exposure rates (ranging from 6 to 10 μR/h) along the pipeline route over the asphalt and gravel parking lots. Most of the gamma levels were lower than typical background levels taken over uncontaminated land areas on the ORR. Additionally, results of analysis of soil samples collected from the gravel parking lot generally demonstrated background radionuclide concentrations. Based on these findings, there is not a detectable radiation exposure problem (based on gamma radiation measurements) or measurable contamination problem (based on direct beta-gamma measurements and soil sample analysis) at the parking lots.

- **HFIR Access Road.** Low levels of surface gamma exposure rates (ranging from 6 to 14 μR/h) and beta-gamma radiation were generally prevalent along the HFIR Access Road. However, two hot spots were found on the road surface. In the process of sampling these spots for analysis, the anomalies were actually remediated. Additionally, after riprap measures were implemented at the contamination area, gamma exposure rates at 1 m above the road surface averaged 8 μR/h. This value is less than the average 1 m gamma exposure rate value of 10 μR/h measured above ground surfaces at uncontaminated areas on the ORR.

The contamination hazard inside the zoned contamination area remains a significant problem. Radiation control measures implemented by ORNL's Office of Radiation Protection are adequate to warn the general public and occupational workers of the existing hazard and to prevent inadvertent intrusion into the area. To evaluate the radiation exposure hazard associated with the 7500 Area Contamination Site, only the direct exposure pathway will be considered. Based on the present physical condition of the contaminated area (riprap covered, moist soil) and the fact that the area presently cannot be used for public occupancy, the ingestion and inhalation pathways have relatively low probabilities of providing any exposure to civilian or occupational personnel. A conservative estimate of the direct exposure can be obtained using the maximum external gamma exposure rate of 9.3 μR/h (~9 μrem/h) measured at the southern edge of the contaminated area as the dose-equivalent rate for the following two scenarios:

- **Occupational.** Considering an occupational worker who is stationed at the location of maximum exposure rate for 8 h per day, 5 days per week, and 50 weeks per year (2000 h per year total exposure), the annual dose equivalent is about 18 mrem.

- **General public.** For the general public worst-case exposure, an intruder who stays at the location of maximum exposure rate for 24 h per day, 7 days per week, and 52 weeks per year (8736 h per year total exposure) would receive about 79 mrem due to external gamma radiation.

Conservative dose equivalent estimates from both scenarios are lower than the 100-mrem value specified in DOE Order 5480.11 as the annual limit for designating occupational workers as radiation workers and the limit for any member of the public who accesses a DOE site. Thus, based on conservative exposure scenarios, the site in its present condition does not pose an exposure hazard for members of the general public or occupational workers.

In conclusion, results of this investigation indicate that the source of radioactive contamination at the point of the contamination incident is from one of the underground abandoned lines. The contamination in soil is likely the result of residual contamination from years of waste transport and maintenance operations (e.g., replacement of degraded joints, upgrading or replacement of entire pipelines, and associated landscaping activities). However, because (1) there is currently an active LLW line positioned in the same subsurface trench with the abandoned lines and (2) the physical condition of the abandoned lines may be brittle, this inquiry could not determine which abandoned line was responsible for the subsurface contamination. Soil sampling at the location of the contamination incident and along the pipeline route was performed in a manner so as not to damage the active LLW line and abandoned lines.

Recommendations for corrective actions are included.

1. INTRODUCTION

A radiological and chemical investigation of the 7500 Area Contamination Site was conducted intermittently from February 1992 through May 1992. This survey was performed by the Measurement Applications and Development Group of the Health and Safety Research Division (HASRD) of the Oak Ridge National Laboratory (ORNL) at the request of the U.S. Department of Energy's (DOE's) Oak Ridge Operations Office and Environmental Restoration (ER) Program personnel at ORNL. Because the site is encompassed in the 7500 building complex, it was designated the "7500 Area Contamination Site" by ORNL Waste Management and Remedial Action Division and ER Program management personnel.

On February 20, 1992, a nongovernment vehicle became mired in mud along a drainage ditch located on the west side of the High Flux Isotope Reactor (HFIR) Access Road.* During the vehicle extraction process, an area of radioactively contaminated subsurface soil was exhumed. Shoe soles of six personnel assisting in the car expulsion process became contaminated by direct contact with contaminated mud. Additionally, a second nongovernment vehicle became contaminated from dispersed mud debris. The contamination was not evident until affected personnel advanced through the radiation monitor station located at the entrance to the HFIR/Radiochemical Engineering Development Center (REDC) complex.

Radiation control measures were immediately implemented by ORNL's Office of Radiation Protection at the point of the contamination incident (i.e., location where the vehicle became mired in contaminated mud) and circumjacent area. A "Contamination Area" was established by encompassing the contaminated soil area with a plastic-link chain attached to metal posts; warning signs were posted on the chain boundary; and caution lights were employed along the HFIR Access Road. To minimize the potential of contaminant dispersion, a large sheet of plastic was spread over and beyond the boundary of detectable contamination. Additionally, a corrugated steel pipe was placed on top of the plastic along the drainage ditch route to channel surface runoff during storm events. A view looking north at the contamination area is shown in Fig. 1.1. To the best of our resources, no historical or current surface radiological information would indicate a potential surface contamination concern at this location. In 1986, areas of elevated gamma radiation levels at selected locations on the Oak Ridge Reservation (ORR) were identified in an EG&G aerial radiological survey.[1] At the point of the incident at the 7500 Area Contamination Site, no surface ^{137}Cs-specific count rate anomalies were detected.

Radiological screening analyses, as requested by ORNL's Office of Radiation Protection, determined ^{90}Sr and ^{137}Cs† as the primary and secondary contaminants, respectively. Because (1) these radionuclides emit beta radiation and (2) the source of contamination was in subsurface soil, it is plausible that a near-surface, beta-gamma scanning survey at the incident

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*The location of the incident is ~600 ft north of guard post 19B (entrance to HFIR/REDC complex) and ~330 ft south of Building 7503.

†Barium-137*m*, a gamma emitter, is the daughter product of the beta-emitter ^{137}Cs.

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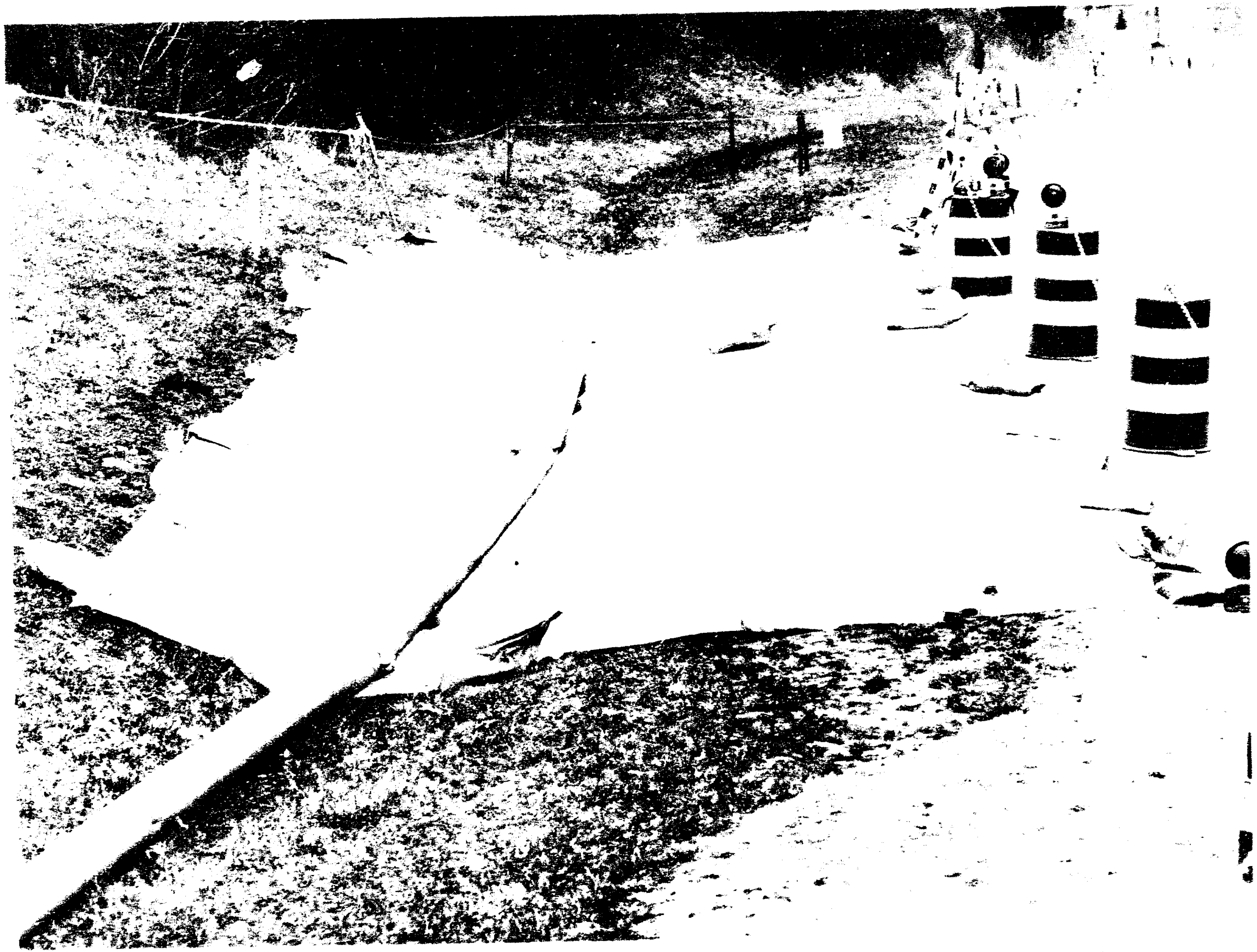

Fig. 1.1. View looking north at the location of surface contamination at the 7500 Area Contamination Site (March 1992).

point would not detect the subsurface contamination. Low concentrations of beta-emitting radionuclides in subsurface soil would probably not be detectable at the ground surface because of shielding provided by surface soil, ground cover, grass, etc., unless they have been taken up and transported to the surface by plants, by means of a groundwater seep, or by mechanical disturbance.

The contaminated soil area was subsequently determined to be positioned directly above several underground pipelines. The pipelines are aligned in parallel in a subsurface trench along the line route. There are two categories of lines that are differentiated by their size (2-, 3-, and 6-in. diam) and operational usage [liquid low-level waste (LLW) and process waste lines]. Three LLW lines (one active and two abandoned) and one abandoned process waste line are positioned in the trench and are described as follows:*

- One active 3-in. (cast iron) LLW line is used to transport waste from the HFIR collection tank to the Melton Valley Pumping Station (7567) collection tanks (T1 and T2). There are two types of tests routinely conducted on this line to determine line performance (pressurized and volume/material balance). Results of each test indicate no demonstrable failures.

- Two abandoned 2-in. (cast iron) LLW lines were formerly used in operations at the REDC complex [includes Building 7920 (formerly TRU) and Building 7930 (formerly the Thorium-Uranium Recycle Facility, TURF)].

- One abandoned 6-in. (cast iron) process line was formerly used in transporting wastes primarily from the HFIR/REDC Waste Collection Basin 7906, and secondarily from Waste Collection Basins 7905, 7907, and 7908.

It is believed that the source of surface contamination at the 7500 Area Contamination Site is from one of the abandoned LLW lines. Note that nonradioactive wastes in the LLW line may include sodium and potassium hydroxides and acids.

The 7500 Area Contamination Site is located in Waste Area Group (WAG) 8 as shown in Fig. 1.2 (ref. 2). The site is located in Melton Valley near ORNL grid coordinates (measured in feet) N18,100 and E32,400, north of the HFIR/REDC complex and west of the HFIR Access Road.[3] A diagram showing the general layout of the area is provided in Fig. 1.3. Figure 1.4 delineates the accessible areas surveyed. The area of investigation begins ~100 ft north of the contamination area, extends southward through the contamination area, follows the pipeline route along the gravel parking lot, and terminates at the asphalt-covered parking lot (a total distance of ~600 ft).[3] The region between the contamination area and the valve pit (north) also was investigated, as well as the exterior perimeter of the contamination area established along the drainage ditch on the west side of the HFIR Access Road and the drainage ditch on the east side of the road. Soil samples were collected along the pipeline route. Figure 1.5 illustrates the posted and roped contamination area established by ORNL's Office of Radiation Protection. The sampling procedures, protocols for sample analysis, and waste management plan for this task are specified in ref. 3.

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*C. B. Scott, Waste Management and Remedial Action Division, ORNL, personal communication to J. K. Williams, Health and Safety Research Division, ORNL, September 1992.

ORNL-DWG 87-8363R1

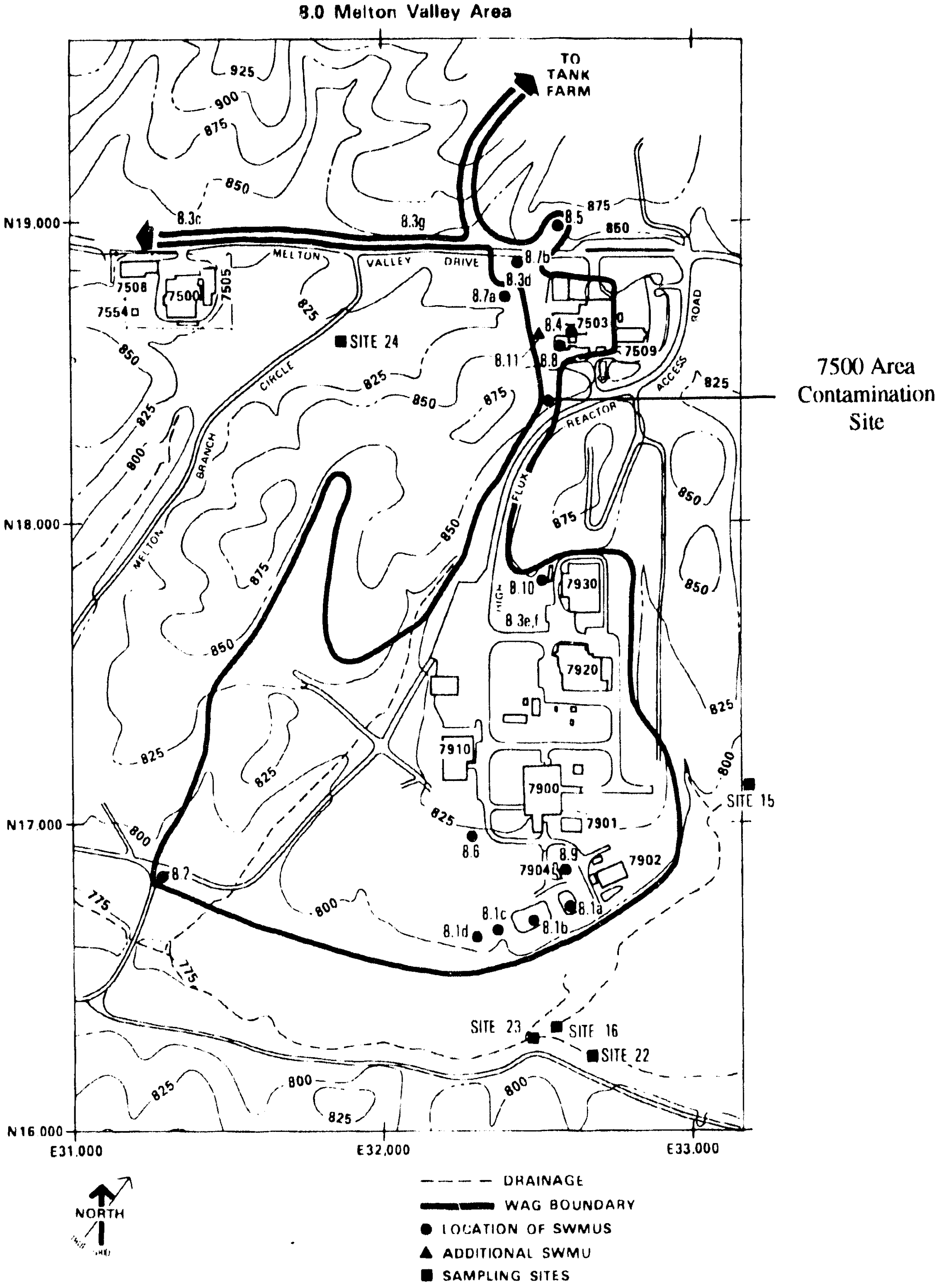

Fig. 1.2. Location of the 7500 Area Contamination Site in Waste Area Grouping 8.

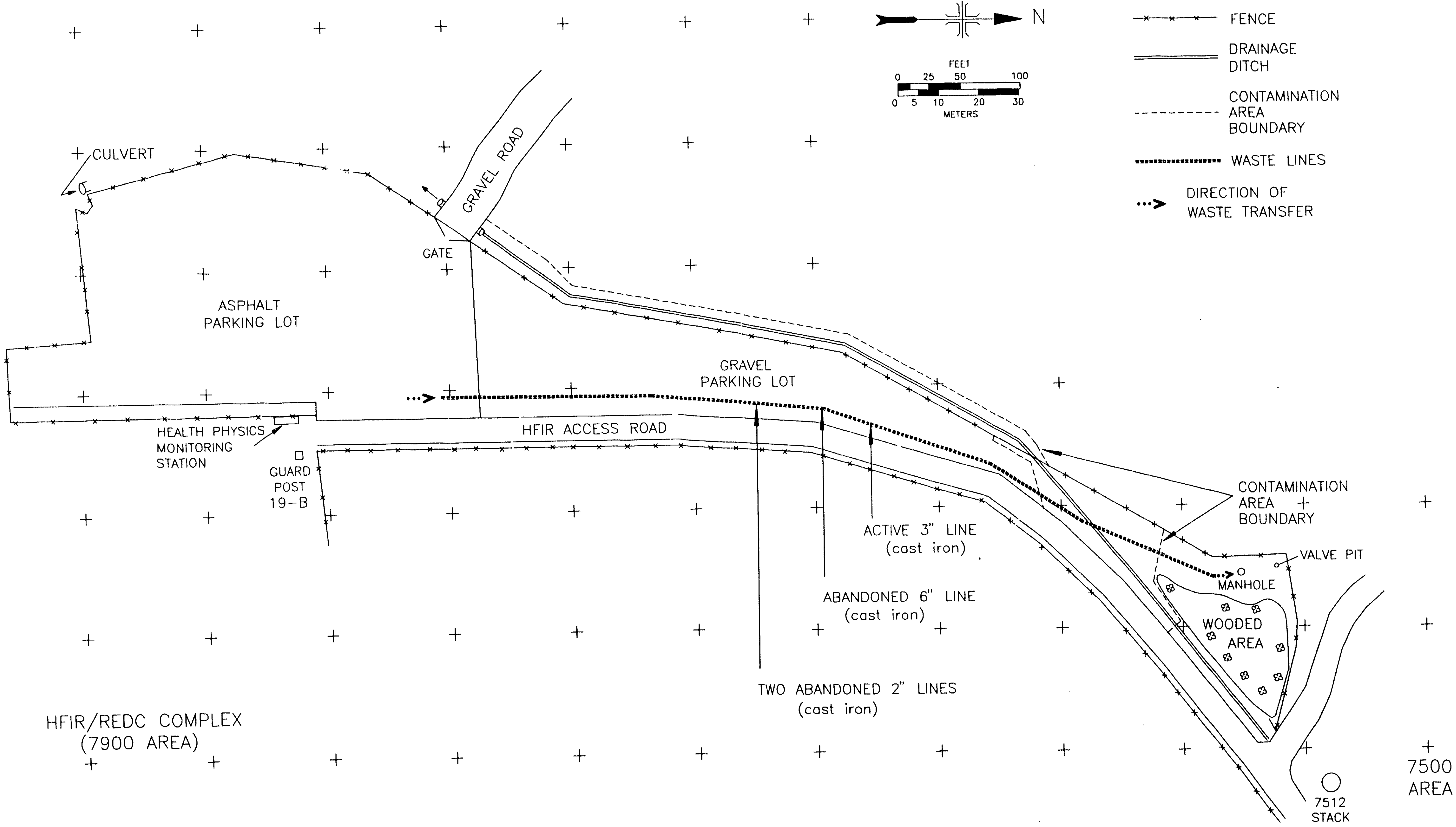

Fig. 1.3. Diagram of the 7500 Area Contamination Site.

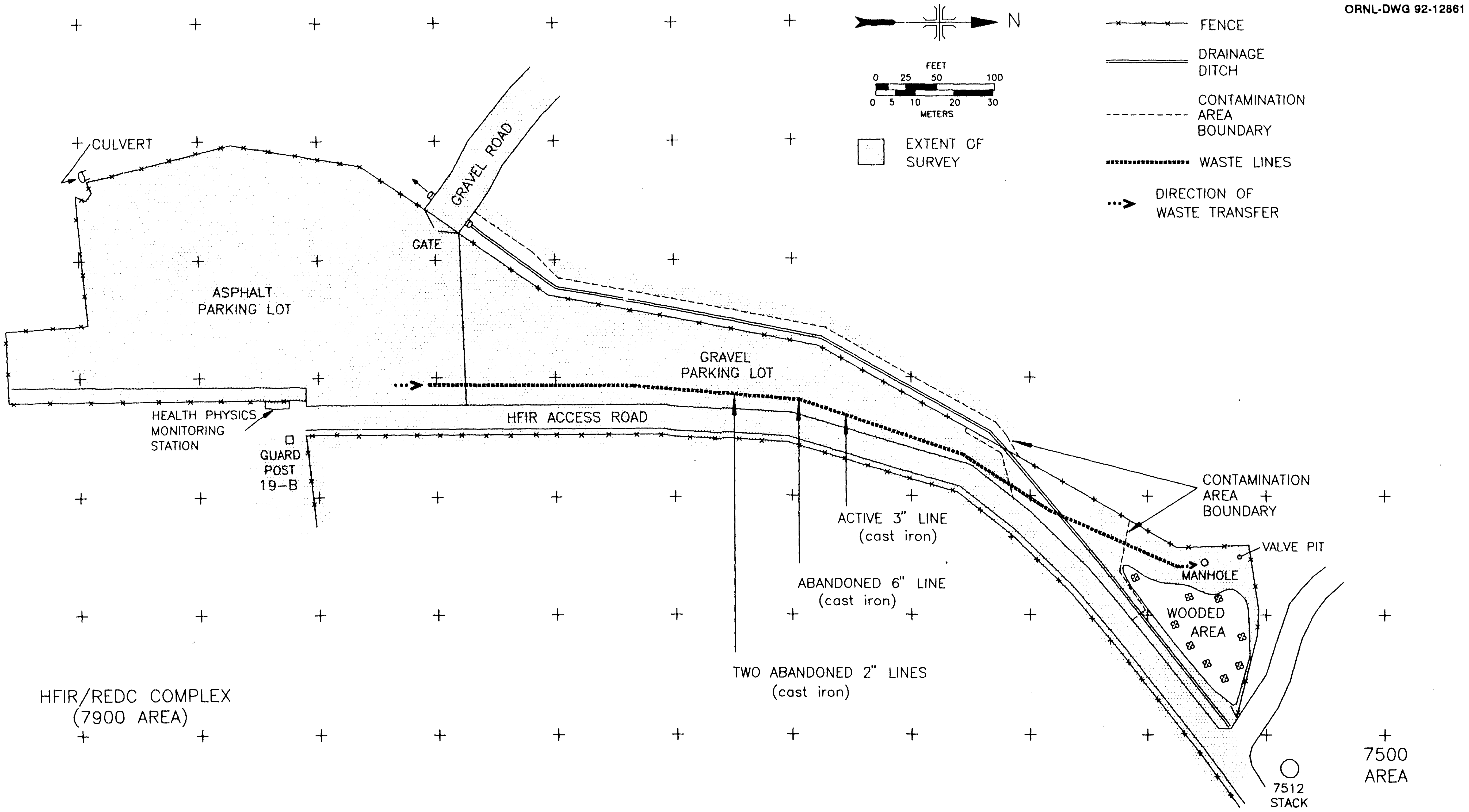

Fig. 1.4. Diagram of the 7500 Area Contamination Site with shading delineating the accessible areas surveyed in this investigation. Note: The contamination area including the contaminated drainage ditch were not surveyed.

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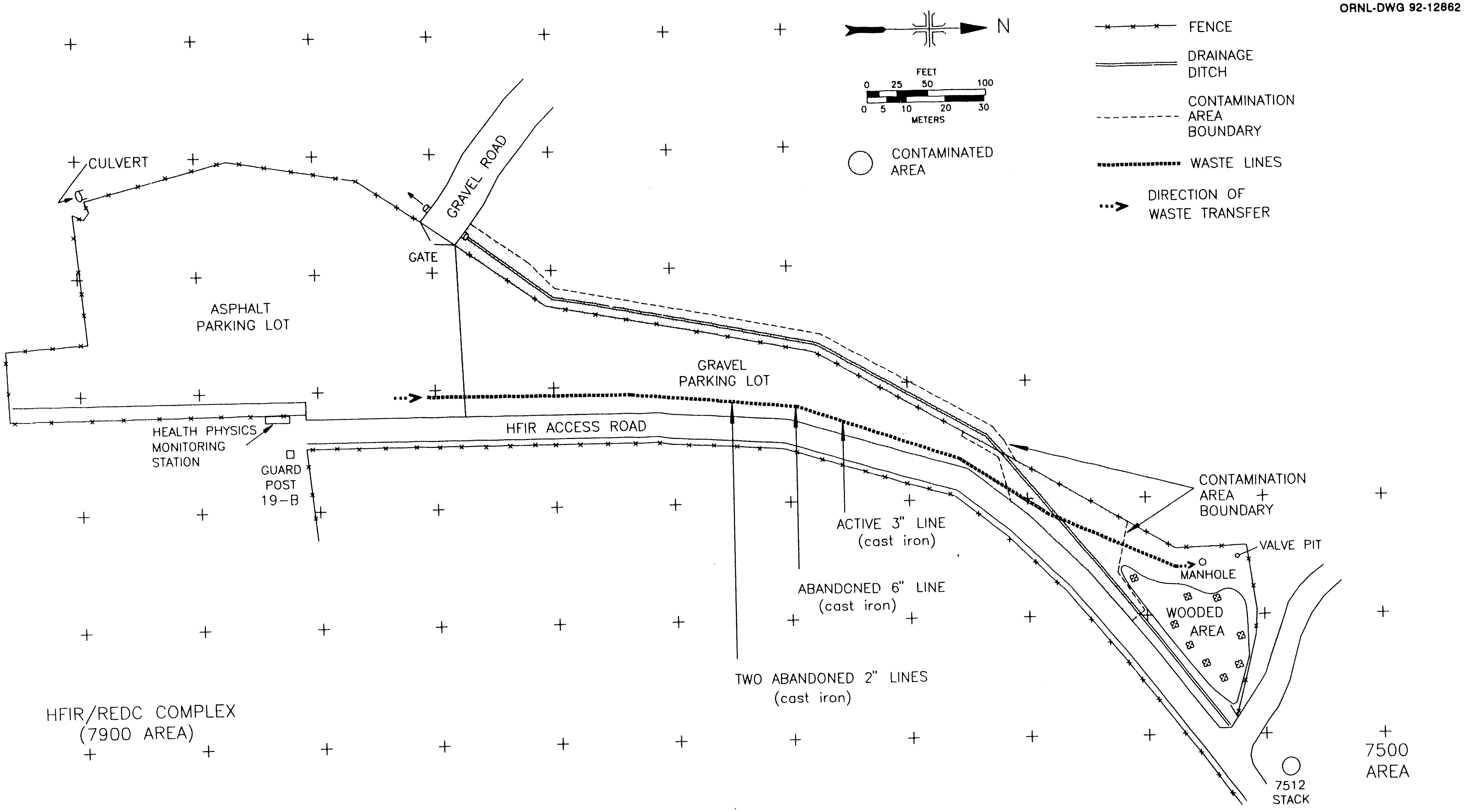

Fig. 1.5. Diagram of the 7500 Area Contamination Site with shading delineating the contamination area including the contaminated drainage ditch.

The survey included:

- A surface gamma scan of the survey area including the HFIR Access Road and parking lots (asphalt and gravel).
- A limited beta-gamma scan of the parking lots with a detector held ~5 cm (2 in.) above the asphalt and gravel surfaces as well as spot check measurements on contact with the ground surface. The detector was mounted on a rod to facilitate near-surface scanning.
- A surface beta-gamma scan along the HFIR Access Road using a Ludlum gas flow proportional floor monitor system.
- Radionuclide analysis of 16 soil samples taken along the pipeline route.
- Radionuclide analysis of four environmental samples (soil, snail, water, and leaves) collected from the site.
- Radiochemical analyses (radionuclides, organics, and inorganics) of one soil sample collected in the contamination area.
- Analysis of equipment presampling rinsate and field blank samples, employed as quality assurance/quality control parameters.
- Spot-check measurements for beta-gamma activity on contact with trees and other vegetation.
- Selected hot spot analysis using gamma spectrometry.

2. RADIOLOGICAL SURVEY METHODS

A description of typical methods and instrumentation providing guidance for the conduct of this survey is presented in *Procedures Manual for the ORNL Radiological Survey Activities (RASA) Program*, ORNL/TM-8600 (April 1987).[4] All direct measurement results presented in this report are gross readings; background radiation levels have not been subtracted. Similarly, all gamma exposure rate measurements presented in this report represent unshielded measurements (radiation shine* may confound actual gamma levels at a particular location). Background radionuclide concentrations have not been subtracted from radionuclide concentrations measured in environmental samples. Concentrations of gamma-emitting radionuclides in soil samples collected directly above the subsurface pipeline were determined by gamma spectrometry. Additionally, wet chemistry analysis procedures provided counts of gross alpha and gross beta activities in these samples. Counting errors near or greater than measured radionuclide concentrations in environmental samples indicate the radionuclide is probably not present.

At soil hot spot locations and other areas of interest, a portable gamma spectroscopy system was used for expeditious, in-field identification of gamma-emitting radionuclides. Additionally, field personnel and vehicles were checked for alpha and beta-gamma contamination prior to exiting the site.

2.1 GAMMA MEASUREMENTS

Gamma radiation was measured with a sodium iodide (NaI) scintillation probe connected to a Victoreen Model 490 Thyac III ratemeter. Because NaI gamma scintillators are energy dependent, measurements of gamma radiation levels made with these instruments must be normalized to pressurized ionization chamber (PIC) measurements to estimate gamma exposure rates.

The function developed for these conversions is

$$y = x \times \mathrm{CF}$$

where y is the exposure rate (μR/h), x is the scintillometer measurement [thousand counts per minute (kcpm)], and CF is the slope of the regression line calculated by plotting a selected number of PIC measurements (μR/h) vs scintillometer measurements (kcpm) at the same locations.

Because of the widespread distribution of measurements found in the survey area, two conversion factors were derived: for $x \leq 89$ kcpm, CF = 2.3; for $x \geq 90$ kcpm, CF = 2.5.

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*The term *shine* refers to gamma radiation emanating from a source or sources extrinsic to the area being defined. This extraneous radiation may increase gamma radiation levels above actual levels associated with the area of interest.

When gamma radiation levels exceeded the limits of the NaI gamma scintillator (800,000 cpm), measurements were made with a portable Bicron Analyst scaler/ratemeter with a Geiger-Mueller (GM) side-window probe (1000 mg/cm^2 wall thickness, closed configuration) and were converted to exposure rates by using the following instrument-specific conversion factor based on ^{137}Cs:

2000 cpm = 1 mR/h, or 2 cpm = 1 μR/h .

In some cases, measurements made with an open-window (30 mg/cm^2 wall thickness) Geiger-Mueller survey meter (GMSM) are also noted. (A closed-window GMSM measures only gamma radiation; an open-window configuration detects both beta and gamma radiation).

2.2 BETA-GAMMA MEASUREMENTS

Beta-gamma and gamma radiation levels were measured with a portable Bicron Analyst scaler/ratemeter with an Eberline HP-260 Geiger-Mueller pancake detector (<2-mg/cm^2 wall thickness) with fine mesh screen. The instrument was set in the open configuration to detect beta-gamma radiation.

After calibration of the detectors to a known strontium source at the ORNL Radiation Calibration Laboratory (RADCAL), beta radiation detection levels in counts per minute were converted to dose rates in millirads per hour using the following relationship:

2800 cpm = 1 mrad/h .

Inside the contamination area, radiation was also measured with an ORNL paper-shell cutie pie ionization chamber (standard model). It should be noted that during auger hole sampling, no conversion factor for the side-window beta-gamma (open-configuration mode) was needed. Counts-per-minute detection levels taken "down-hole" in soil were used to monitor for any increase in beta-gamma activity levels above typical background soil values.

Beta-gamma activity levels were also detected with a Ludlum Model 239-1F gas flow proportional floor monitor. This instrument was used to scan the HFIR Access Road. The floor monitor system, mounted on a four-wheeled cart, consists of a Ludlum Model 2221 scaler/ratemeter connected to a Ludlum Model 43-37 detector probe. The monitor system expedites the survey process by providing an efficient method for covering large, easily accessible areas of road surface. The Ludlum instrument is not calibrated to obtain quantitative measurements but provides only an estimate of the type and degree of contamination above a precisely determined detection limit.[5] In areas identified as elevated by the floor monitor, portable beta-gamma radiation detection instruments are employed to obtain precise measurements.

2.3 ALPHA MEASUREMENTS

Alpha radiation was measured with a portable Bicron Analyst alpha survey meter with a Model Q2101 "beer mug"-type zinc sulfide (ZnS) scintillation probe. Counts per minute were recorded for a direct, 60-s measurement and converted to disintegrations per minute (dpm) per 100 cm^2 using an instrument-specific conversion factor. Alpha radiation measurements were used for monitoring personnel, equipment, and sample containers for contamination.

2.4 GRID

Due to the urgency in completing the surface survey, a civil survey was not conducted, and therefore, exact north/east coordinates are not provided. However, every attempt was made to accurately reference landmark locations. Conversely, soil sampling locations along the pipeline route were accurately determined and referenced to the ORNL master grid by the ORNL Engineering Division. A diagram of the site with grid stations along the pipeline route is shown in Fig. 2.1. Hand-auger soil sampling was conducted intermittently along the pipeline route from stations 14+50 through 20+75. Sampling station 19+50 is located in the contamination area.

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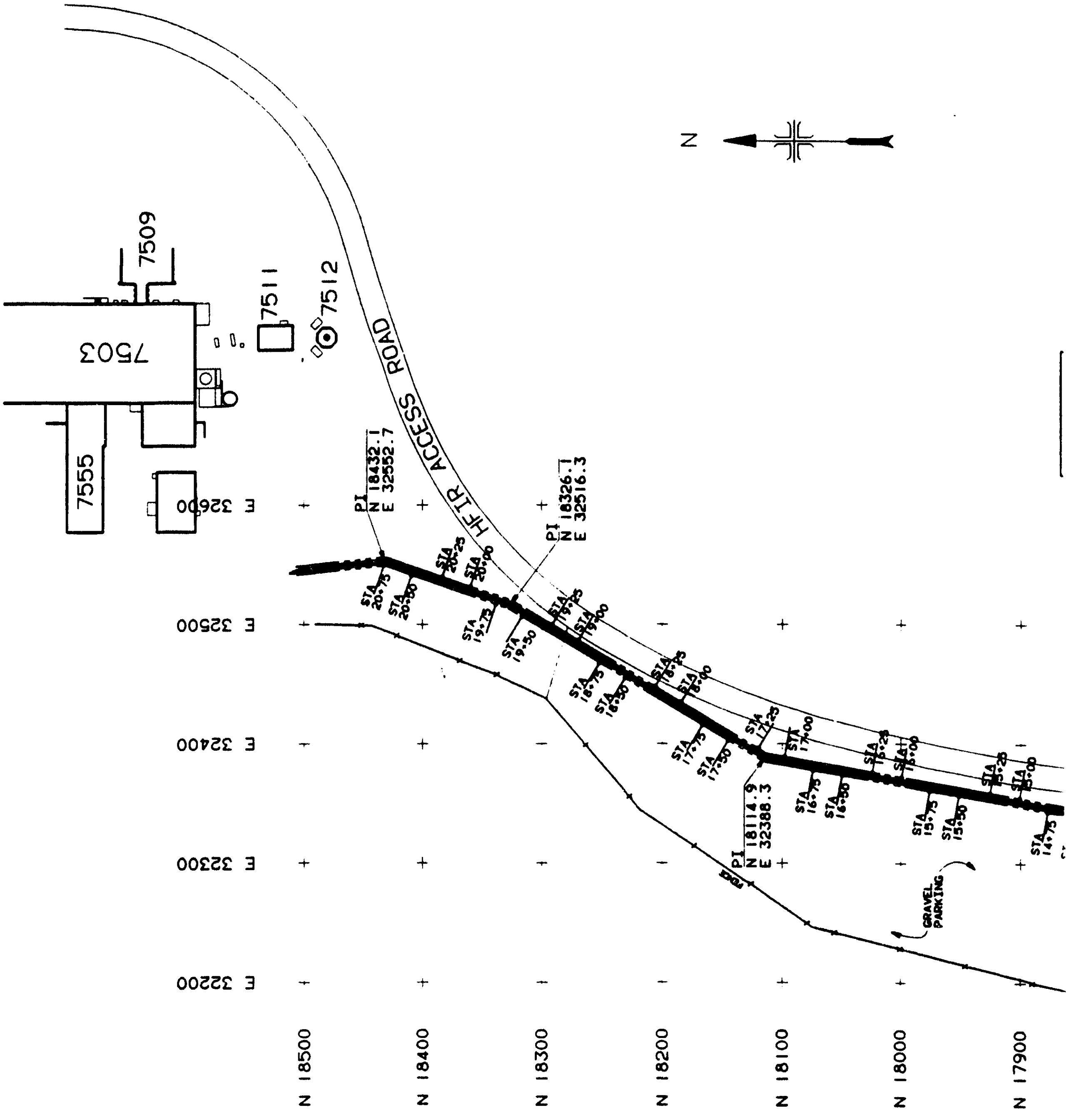

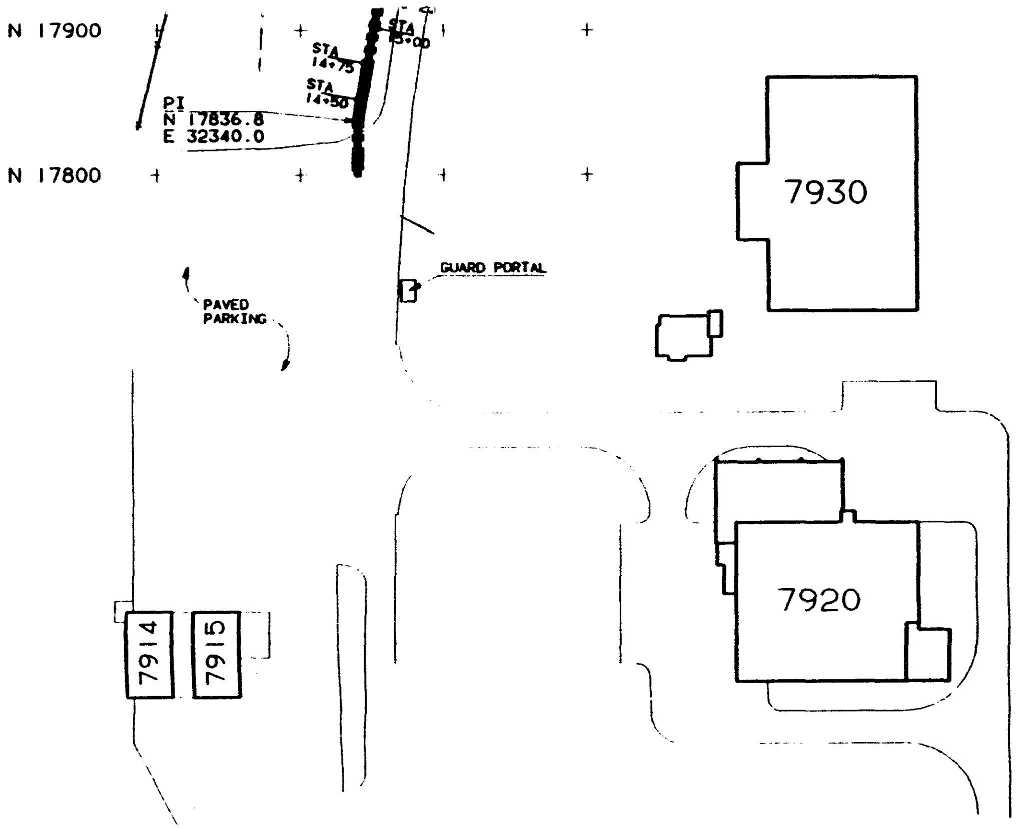

Fig. 2.1. Diagram showing auger hole soil sampling stations along the pipeline route at the 7500 Area Contamination Site.

3. RADIOCHEMICAL ANALYSIS METHODS

3.1 SCOPE

The analytical methodologies used for this project were consistent with U.S. Environmental Protection Agency (EPA) analytical level III. These methods and their corresponding detection limits can be found in ref. 3.

3.2 SELECTION OF LABORATORIES

The criteria used to select the laboratory follow. The laboratory had to be

- approved by the Analytical Projects Office,
- capable of performing the requested analyses as stated in the work plan,
- capable of receiving samples, and
- the lowest in overall cost.

The laboratory selected for the 7500 Area Project was EcoTek Laboratory Services Incorporated (LSI). EcoTek LSI was chosen by comparing the responses of other laboratories to the issued statement of work. Of the laboratories submitting responses to the statement of work, EcoTek LSI was the only laboratory capable of receiving the samples due to the radiation level of the samples.

3.3 QUALITY ASSURANCE/QUALITY CONTROL

The quality assurance/quality control of this project is being conducted according to the requirements of the EPA and Martin Marietta Energy Systems, Inc. The Analytical Level as defined by the EPA Data Quality Objectives document is Level III.[6] This level utilizes both contract laboratory program (CLP) methods and non-CLP methods. The GC/MS semivolatile and volatile organic analyses were performed according to the EPA CLP March 1990 Organics Statement of Work.[7] The nonhalogenated and aromatic volatile organics were performed according to the SW-846 GC/MS method 8240.[8] A modified EPA 8015 GC/FID method was used to analyze the samples for kerosene. This method was consistent with the California Leaking Underground Storage Tank method. The metals analyses were performed according to EPA SW-846 methods, while the radiological methods were performed according to laboratory-specific methods with the quality control being consistent with the EPA radiological methods written for Drinking Water Analyses (EPA 600/4/80-032).[9]

3.4 ORGANIC COMPOUNDS

3.4.1 Volatile Organic Analysis (GC/MS CLP OLM01.8 SOW Method)

The volatile organic compounds analyzed are listed in Table 7.1 of the 7500 Area Work Plan.[3] (It should be noted that the detection limits listed in the work plan do not correspond to CLP OLM01.8 SOW limits). The method employed for analyzing the soil sample for to CLP OLM01.8 SOW limits). The method employed for analyzing the soil sample for volatile organic compounds was the CLP GC/MS method (SOW OLM01.8). This method required that an inert gas be bubbled through a mixture of a 5-g sample and reagent water at elevated temperatures. The purgeables were transferred to the vapor phase, and the vapor was swept through a sorbent column where the purgeables were trapped. When the purging was complete, the sorbent column was heated and back-flushed with inert gas to desorb the purgeables onto a GC column. The GC was temperature programmed to separate the purgeables, which were then detected with a mass spectrometer.

3.4.2 Volatile Organic Analysis (SW-846 Method)

The volatile organics analyzed for by EPA method 8240 were the nonhalogenated volatile organics and aromatic volatile organics. This method was used because EcoTek LSI did not perform the methods outlined in the 7500 Area Work Plan.[3] This method is similar to the above method except that a larger sample purge size was used in order to achieve the required detection limits and the analysis of paraldehyde and acrylamide was done by Extracted Ion Current Profile (EICP). The EICP method identifies these compounds by searching the mass chromatogram for characteristic ions associated with these compounds.

3.4.3 Semivolatile Organic Analysis (GC/MS CLP OLM01.8 SOW Method)

Note that the detection limits listed in the work plan do not correspond to CLP OLM01.8 SOW limits. The method required an extraction of ~30 g of soil with a 1:1 mixture methylene chloride-acetone. The intermediate extract was taken to a final volume of 10 mL. Five milliliters of the extract was cleaned up using the Gel Permeation Chromatography method, and the final concentration volume was taken to 0.5 mL. This was then introduced onto the GC column and the semivolatile components detected with a mass spectrometer.

3.4.4 Kerosene Analysis (Modified EPA Method 8015)

The modified 8015 method involved the determination of semivolatile organics (kerosene) by extraction and subsequent GC analysis. A sample was extracted with a solvent and concentrated to a volume of ~1 mL. After concentration, the extract was injected into a GC, and compounds in the effluent were detected by a GC equipped with a flame ionization detector.

3.5 INORGANIC COMPOUNDS (METALS)

The project used Inductively Coupled Plasma (ICP), Graphite Furnace Atomic Absorption (GFAA), and Cold Vapor Atomic Absorption (CVAA) to analyze for metals.

The ICP, GFAA, and CVAA methods were performed according to the EPA SW-846 methods.[8] Specific analytical methods used for metals analysis are listed in Table 7.7 of the 7500 Area Work Plan.[3] The above methods required that soil samples be digested before analysis. The soil samples were prepared by digesting 1 g of the sample in nitric acid and hydrogen peroxide. The digestate was then refluxed with nitric acid or hydrochloric acid. Hydrochloric acid was used as the final reflux acid for the ICP analysis of Al, Sb, Ba, Be, Ca, Cd, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, K, Ag, Na, Tl, V, and Zn. Nitric acid was employed as the final reflux acid for the GFAA analysis of As, Pb, Se, and Tl. The final analysis volume was brought up to 100 mL. The preparation method for CVAA involved the reduction of the mercury to its elemental state and then analyzing using an atomic absorption spectrometer.

The analysis of the sample by ICP was based on the measurement of atomic emission by an optical spectroscopic technique. The sample was nebulized, and the aerosol produced was transported to the plasma torch where the excitation occurred. Characteristic atomic line emission spectra were produced by a radiofrequency inductively coupled plasma. The spectra were dispersed by a grating spectrometer, and the intensities of the lines were processed. Background correction was performed in order to compensate for the variable background contribution.

The analysis of the sample by GFAA was based on the atomization of the sample. In this technique the sample was atomized by a furnace. A light beam was directed through the vapor containing the ground-state atoms into a monochromator and onto a detector that measured the amount of absorbed light. The absorption depends upon the presence of free unexcited ground-state atoms. The wavelength of the light beam was characteristic of only the metal being determined, so the energy absorbed was a measure of the concentration of the metal in the sample.

The analysis of mercury involves the aeration of the mercury from solution in a closed system. The mercury vapor passed through a cell positioned in the path of the light from the atomic absorption spectrometer. The absorbance was measured as a function of the mercury concentration.

3.6 RADIONUCLIDES

Selected radionuclides of interest include gross alpha, gross beta, ^{90}Sr, isotopic U, ^{99}Tc, isotopic Pu, and gamma-emitting nuclides (^{241}Am, isotopic Cm, ^{133}Ba, ^{57}Co, ^{60}Co, ^{51}Cr, ^{152}Eu, ^{154}Eu, ^{155}Eu, ^{181}Hf, ^{192}Ir, ^{40}K, ^{226}Ra, ^{103}Ru, ^{65}Zn, and ^{95}Zr). A complete list of analytes is provided in Appendix B. The methods used to analyze the above radionuclides were specific to the laboratory, and the quality control was based on the EPA radiochemical procedures for drinking water.[9] Those procedures detail the necessary quality control requirements for this project.

3.6.1 Gamma Spectroscopy

The prepared sample was placed in a container and counted on a gamma spectrometry system which was calibrated with National Institute of Science and Technology (NIST) traceable standards. The spectrum was collected and analyzed for the presence of gamma-emitting radionuclides. The peaks present in the spectrum were compared to a nuclide library and the gamma emitters identified. These peaks were quantified and isotopic concentrations calculated.

3.6.2 Gross Alpha and Gross Beta

The sample was evaporated onto a 5-cm stainless steel planchet. The activity of the deposited residue was then measured using a gas flow proportional counter which was calibrated with NIST traceable standards. The analysis was applicable for isotopes that emit alpha particles having energies above 3.9 MeV and maximum beta energies above 0.1 MeV. Volatile radionuclides such as radon, some technetium, cesium, and iodine compounds were not measured because of the preparation method.

3.6.3 Strontium-90

In the preparation of the sample, stable carriers were added to the sample to aid in the separation of interfering isotopes from the strontium isotopes. Interferences from calcium and other radionuclides were removed by one or more precipitations of the strontium carrier as strontium nitrate. The precipitates were subsequently counted using a gas proportional counter.

3.6.4 Isotopic Uranium

Aliquots of the samples were traced with ^{232}U and analyzed for isotopic uranium (^{234}U, ^{235}U, and ^{238}U). The samples were converted to a chloride form and loaded onto an anion exchange column using 12 *N* hydrochloric acid. After rinsing the column, the uranium was selectively stripped from the column using a solution of 1 *M* hydrochloric acid. The solution was electroplated and analyzed for uranium isotopes by alpha spectrometry using pulse height analysis. All alpha spectrometers were calibrated with NIST traceable standards.

3.6.5 Technetium-99

Aliquots of the sample were prepared in a 9 *N* sulfuric acid solution, traced with ^{99m}Tc, and separated from the sample matrix by extraction into tributyl phosphate. A portion of the organic phase was transferred to a liquid scintillation vial and scintillation cocktail added. The vial was first gamma-counted, measuring the ^{99m}Tc concentration, to determine the chemical recovery. The sample vial was stored to allow for decay of the ^{99m}Tc. After sufficient decay of the 6-h half-life ^{99m}Tc, the vial was beta counted in a liquid scintillation counter to determine the ^{99}Tc activity.

3.6.6 Isotopic Plutonium

Aliquots of sample were traced with ^{236}Pu and analyzed for isotopic plutonium (^{238}Pu, $^{239/240}$Pu, and ^{242}Pu). The samples were loaded onto an anion exchange column using 8 *N* nitric acid. After rinsing the column, the plutonium was selectively stripped from the column using a solution of 9 *M* hydrochloric acid and ammonium iodide. One half of the solution was electroplated and analyzed for alpha-emitting plutonium isotopes by alpha spectroscopy. Quantification of the alpha-emitting isotopes was done by quantifying the observed peak areas of the isotopes of interest and the peak area of the tracer isotope added to the sample. The observed peak of the tracer isotope is used to calculate the chemical recovery of the sample.

4. SURVEY RESULTS

4.1 BACKGROUND RADIATION LEVELS

Background gamma exposure rates measured at uncontaminated outdoor areas on the Oak Ridge Reservation (ORR) are listed in Table 4.1. Eighteen measurements taken at nine locations ranged from 8 to 13 μR/h (average 10 μR/h) at 1 m above the ground surface and from 10 to 17 μR/h (average 13 μR/h) at the surface.

Table 4.1. Radiation levels measured in uncontaminated areas on the Oak Ridge Reservation

Type of radiation measurement[a]	Radiation level (μR/h)	
	Range	Average
Gamma exposure rate at 1 m above the ground surface	8-13	10
Gamma exposure rate at ground surface	10-17	13

[a] Values were obtained from 18 measurements taken from 9 locations on the Oak Ridge Reservation.

4.2 GAMMA EXPOSURE RATE MEASUREMENTS AND HOT SPOT SCREENING ANALYSIS

4.2.1 Measurements Taken at the Surface

A comprehensive surface gamma radiation scan was conducted over the survey area. Typical background surface gamma levels (excluding the posted contamination area and localized hot spots) were generally found throughout the site. Surface gamma exposure rates generally ranged from 6 to 14 μR/h as depicted in Fig. 4.1. In general, low levels of gamma radiation were prevalent over the asphalt and gravel parking lots and the HFIR Access Road with the exception of isolated hot spots.

Several surface hot spots (i.e., small areas with elevated gamma and/or beta-gamma radiation levels) were found primarily inside or near the contamination area. Approximately 42 anomalies (ranging in size from 15 to 60 cm^2 diam) were found as depicted on Fig. 4.2. Thirty-three hot spots were sampled after recording the spot location and levels of gamma and beta-gamma radiation. Table 4.2 provides specific radiation measurements of the ground surface before and after sampling. In most instances, sampling of surface soil anomalies (0–2 in. of soil depth) for radionuclide screening analysis remediated the anomaly. Field measurements taken after sample removal generally showed background radiation levels at most of the sampled locations. However, it should be noted that at 21 hot spot locations,

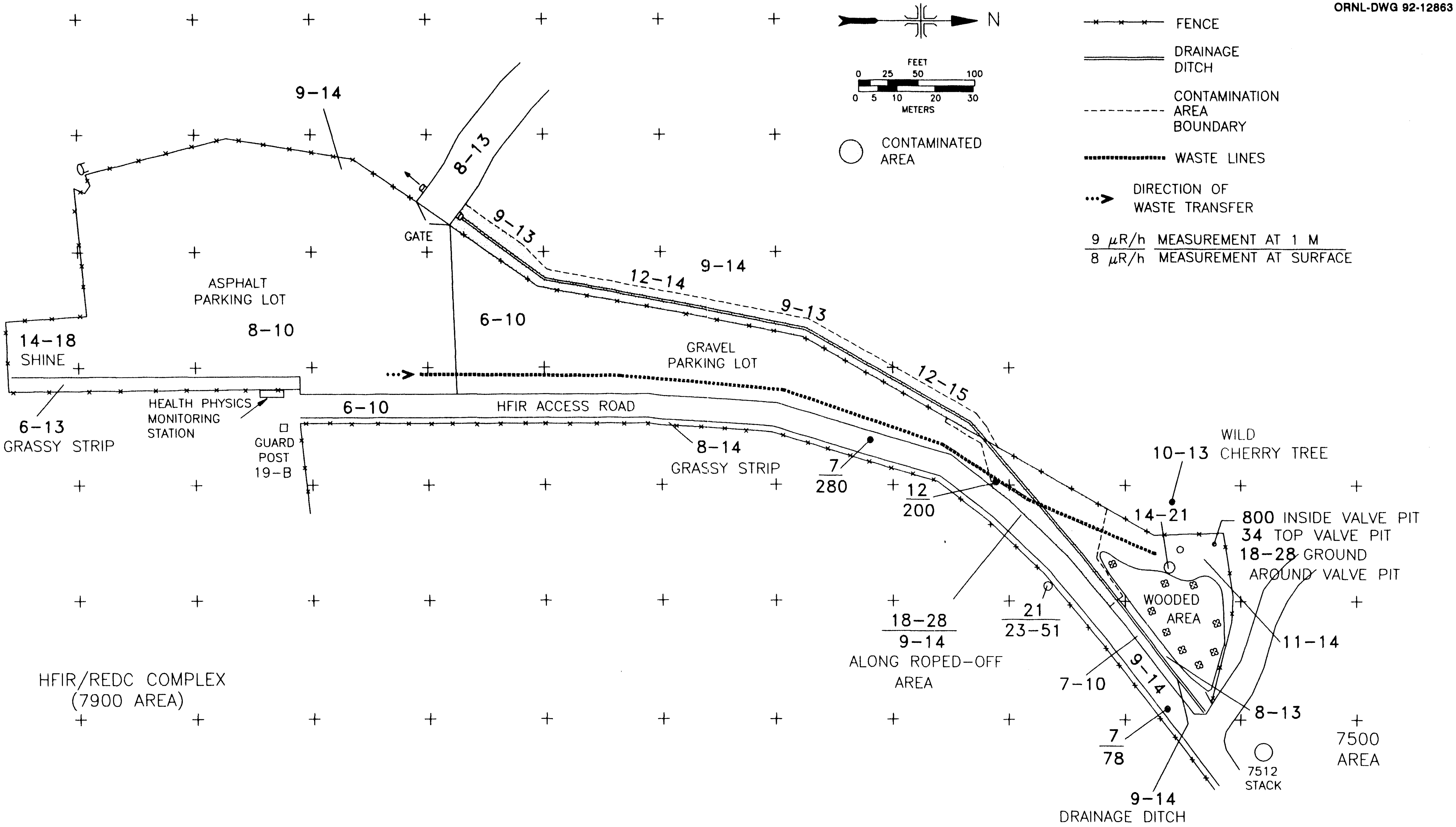

Fig. 4.1. Diagram showing results of gamma exposure rate measurements (μR/h) taken at the 7500 Area Contamination Site.

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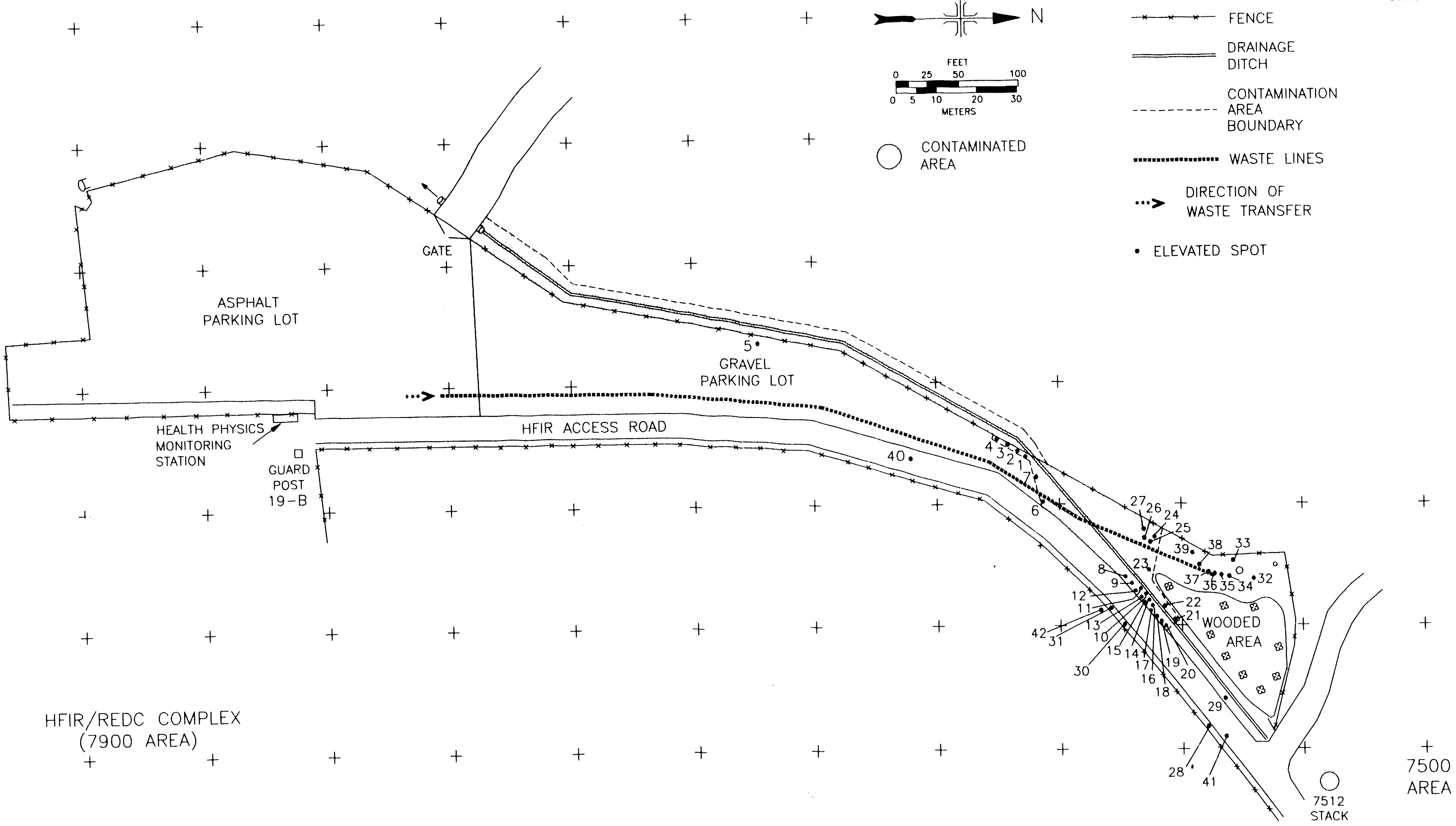

Fig. 4.2. Diagram showing the locations (in numerical order) of surface radiation hot spots at the 7500 Area Contami[illegible] Site.
Note: Table 4.2 provides respective radiation measurements at each location.

Table 4.2. Gamma exposure rates and beta-gamma dose rates at selected elevated spots at the 7500 Area Contamination Site

Location[a]	Gamma exposure rate (μR/h)			Beta-gamma dose rate (mrad/h)		Approximate area (cm^2)	Remarks
	1 m	Surface	After 5-cm surface sample removed	Surface	After 5-cm surface sample removed		
1	12	16	*b*	0.1	*b*	15	No sample taken; contamination part of ditch-line zone
2	12	13	*b*	0.8	*b*	15	No sample taken; surface measurement <0.04 mrad/h
3	10	10	*b*	0.5	*b*	15	No sample taken; surface measurement <0.04 mrad/h
4	9	10	8	0.1	0.03	15	All radiological contamination at this location contained in sample
5	7	6	*b*	0.1	*b*	15	No sample taken; surface measurement <0.04 mrad/h
6	12	200	97[c]	1.2	0.1[c]	15	Contamination remains at this site
7	9	8	8	0.07	0.02	15	All radiological contamination at this location contained in sample
8	18	13	11	0.2	0.03	30	Complete area not sampled; >0.04 mrad/h around sampling point
9	13	11	*b*	0.05	*b*	15	No sample taken; surface measurement <0.04 mrad/h
10	10	9	11	0.7	0.02	15	All radiological contamination at this location contained in sample

Table 4.2 (continued)

Location[a]	Gamma exposure rate (μR/h)			Beta-gamma dose rate (mrad/h)		Approximate area (cm^2)	Remarks
	1 m	Surface	After 5-cm surface sample removed	Surface	After 5-cm surface sample removed		
11	9	8	10	1.0	0.02	15	All radiological contamination at this location contained in sample
12	11	9	9	0.1	0.03	15	All radiological contamination at this location contained in sample; 0.04 mrad/h around location
13	9	8	9	0.04	0.03	15	All radiological contamination at this location contained in sample
14	9	9	10	1.1	0.02	15	All radiological contamination at this location contained in sample
15	9	8	9	1.6	0.02	15	All radiological contamination at this location contained in sample
16	9	9	10	0.06	0.03	15	All radiological contamination at this location contained in sample
17	9	8	8	0.2	0.02	15	All radiological contamination at this location contained in sample
18	8	8	9	0.3	0.02	15	All radiological contamination at this location contained in sample
19	8	53	9	0.8	0.02	15	All radiological contamination at this location contained in sample
20	9	10	10	0.4	0.02	15	All radiological contamination at this location contained in sample

Table 4.2 (continued)

	Gamma exposure rate (μR/h)			Beta-gamma dose rate (mrad/h)		Approximate area (cm^2)	Remarks
Location[a]	1 m	Surface	After 5-cm surface sample removed	Surface	After 5-cm surface sample removed		
21	10	11	13	0.2	0.03	15	All radiological contamination at this location contained in sample; location near edge of elevated drainage ditch
22	12	12	16	0.5	0.03	15	No detectable contamination on surface after sample removed; location near edge of elevated drainage ditch
23	12	11	13	0.2	0.02	15	No detectable contamination on surface after sample removed
24	10	10	12	0.2	0.03	15	No detectable contamination on surface after sample removed
25	11	10	12	0.5	0.02	15	No detectable contamination on surface after sample removed
26	11	11	13	0.1	0.03	15	No detectable contamination on surface after sample removed
27	10	10	13	0.05	0.02	15	No detectable contamination on surface after sample removed
28	9	64	9	0.6	0.02	15	No detectable contamination on surface after sample removed
29	8	8	9	0.1	0.03	15	No detectable contamination on surface after sample removed

Table 4.2 (continued)

	Gamma exposure rate (μR/h)			Beta-gamma dose rate (mrad/h)			
Location[a]	1 m	Surface	After 5-cm surface sample removed	Surface	After 5-cm surface sample removed	Approximate area (cm^2)	Remarks
30	9	8	9	0.6	0.01	60	No detectable contamination on surface after sample removed
31	9	8	9	0.4	0.02	15	No detectable contamination on surface after sample removed
32	11	11	[b]	0.07	[b]	15	No sample taken; location not found; surface measurement <0.04 mrad/h
33	10	10	[b]	0.2	[b]	15	No sample taken; location not found; surface measurement <0.04 mrad/h
34	10	11	13	0.2	0.03	15	No detectable contamination on surface after sample removed
35	10	12	14	0.09	0.05	15	Area with highest measurement removed; region measuring 0.04–0.05 mrad/h remaining
36	11	12	13	0.3	0.03	30	No detectable contamination on surface after sample removed
37	11	12	15	0.1	0.03	30	No detectable contamination on surface after sample removed
38	10	11	13	0.1	0.03	15	No detectable contamination on surface after sample removed

Table 4.2 (continued)

Location[a]	Gamma exposure rate (μR/h)			Beta-gamma dose rate (mrad/h)		Approximate area (cm²)	Remarks
	1 m	Surface	After 5-cm surface sample removed	Surface	After 5-cm surface sample removed		
39	10	10	*b*	0.09	*b*	15	Location not found when returned to sample; evidence of animal digging at base of flag
40	9	370	7[d]	4.0	0.04[d]	15	No detectable contamination on surface after sample removed
41	8	94	8[d]	1.3	0.02[d]	15	No detectable contamination on surface after sample removed
42	21	51	*e*	0.06	*e*	*f*	No sample taken. Surface gamma exposure rate ~23 to 46 μR/h

[a] Locations shown on Fig. 4.2.

[b] Original contamination not located at time of sampling.

[c] After 6-cm surface sample removed.

[d] After removal of surface contamination on asphalt pavement of HFIR Access Road.

[e] Not applicable.

[f] Contamination appears to be part of a contiguous area ~2 m in diameter.

gamma levels actually increased after the 5-cm surface sample was collected for analysis. These slightly elevated gamma levels are most likely due to the geometry of down-hole measurements and not the presence of fugitive contamination. The majority of sampled soil hot spots were determined to be ^{60}Co and/or ^{137}Cs as demonstrated by gamma spectroscopy screening analysis.

Two anomalies sampled were located on the HFIR Access Road (hot spots 40 and 41, Fig. 4.2). Hot spot 40, located south of the contamination area, was sampled and determined to contain ^{152}Eu (36 nCi/g), ^{154}Eu (9.7 nCi/g), and ^{155}Eu (~ 1 nCi/g). The total activity of this 10-g sample was ~480 nCi. Hot spot 41, located north of the contamination area, was sampled and determined to contain ^{60}Co (~ 4.5 nCi/g). The total activity of this 38-g sample was ~171 nCi.

At several locations, above-background gamma radiation levels were attributable to radiation shine (i.e., radiation emanating from surrounding sources). For example, elevated gamma and beta-gamma radiation levels were measured in regions adjacent to the contamination area and contaminated drainage ditch (see Figs. 4.1 and 4.3). Additionally, gamma radiation levels were slightly elevated at the south end of the asphalt parking lot (14–18 μR/h) in close proximity to the HFIR/REDC complex. Elevated radiation levels were detected at a valve pit located on the north end of the survey area. Gamma exposure rates of 800 μR/h were measured inside the valve pit, 34 μR/h at the top of the pit, and 18-28 μR/h at the ground surface circumjacent to the pit (Fig. 4.1).

4.2.2 Measurements Taken 1 m Above the Surface

Prior to applying rock riprap over the contamination area, gamma exposure rate measurements at 1 m above the ground surface were elevated at the eastern edge of the contamination area (see Fig. 4.1). Gamma radiation levels adjacent to the contamination area ranged from 18 to 28 μR/h.

Figure 4.4 delineates the area covered with rock riprap. Figure 4.5 depicts gamma exposure rate measurements taken with a PIC after riprap and hot spot remediation actions were taken (as conducted by ORNL's Office of Radiation Protection). Riprap measures consist of a plastic sheet with two layers of rocks over the contaminated area. (Rock riprap measures were employed to reduce radiation exposures, minimize the dispersion of surface contamination, and subsequently prevent a similar contamination incident). Site gamma exposure rate measurements ranged from 7 to 9 μR/h (averaged 8 μR/h) at 1 m above the ground surface. Note that gamma levels decreased to ~8 μR/h at two locations on the eastern edge of the contamination area (as compared to 18–28 μR/h before riprap and hot spot sampling actions).

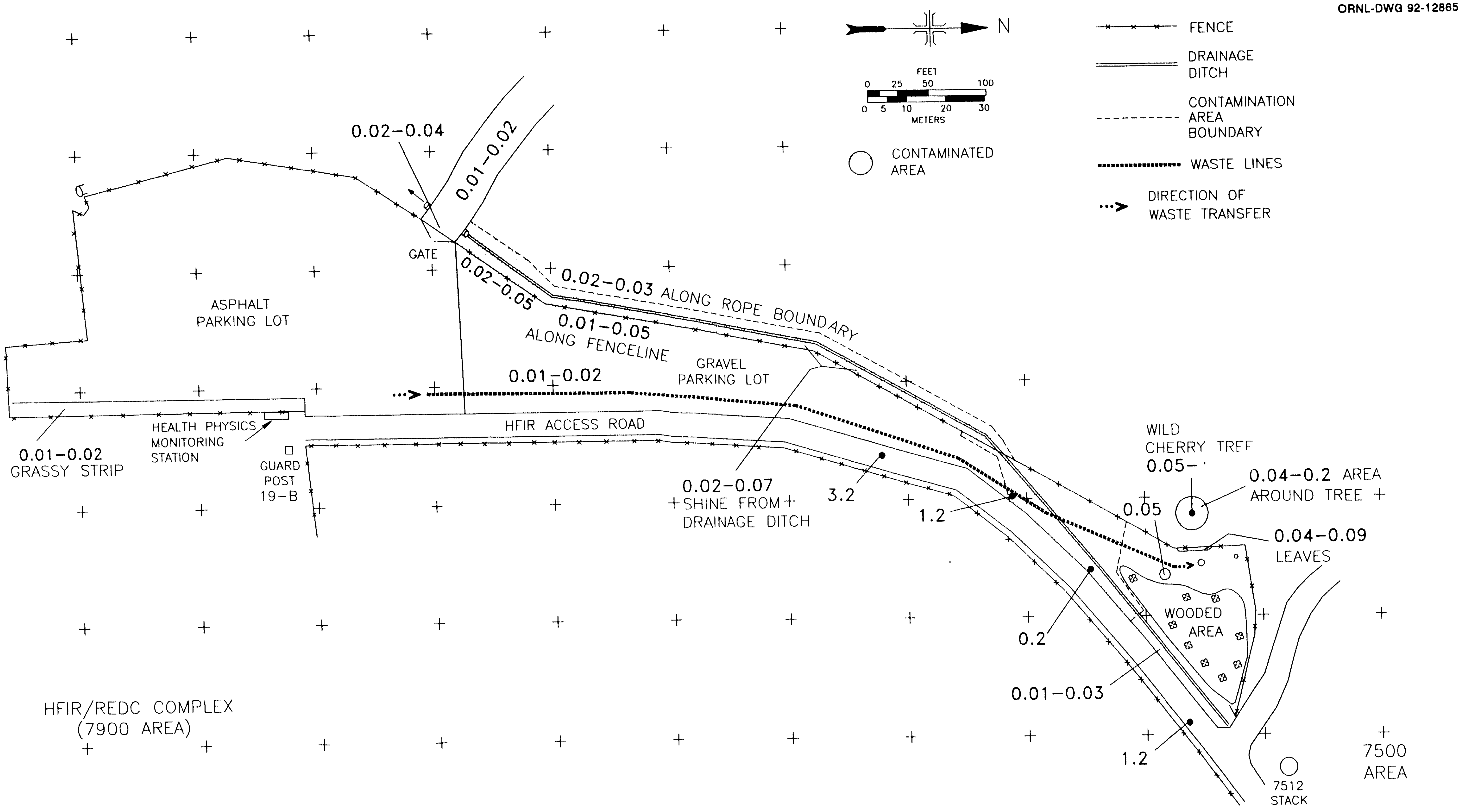

Fig. 4.3. Diagram showing results of beta-gamma measurements (mrad/h) taken at the 7500 Area Contamination Site.

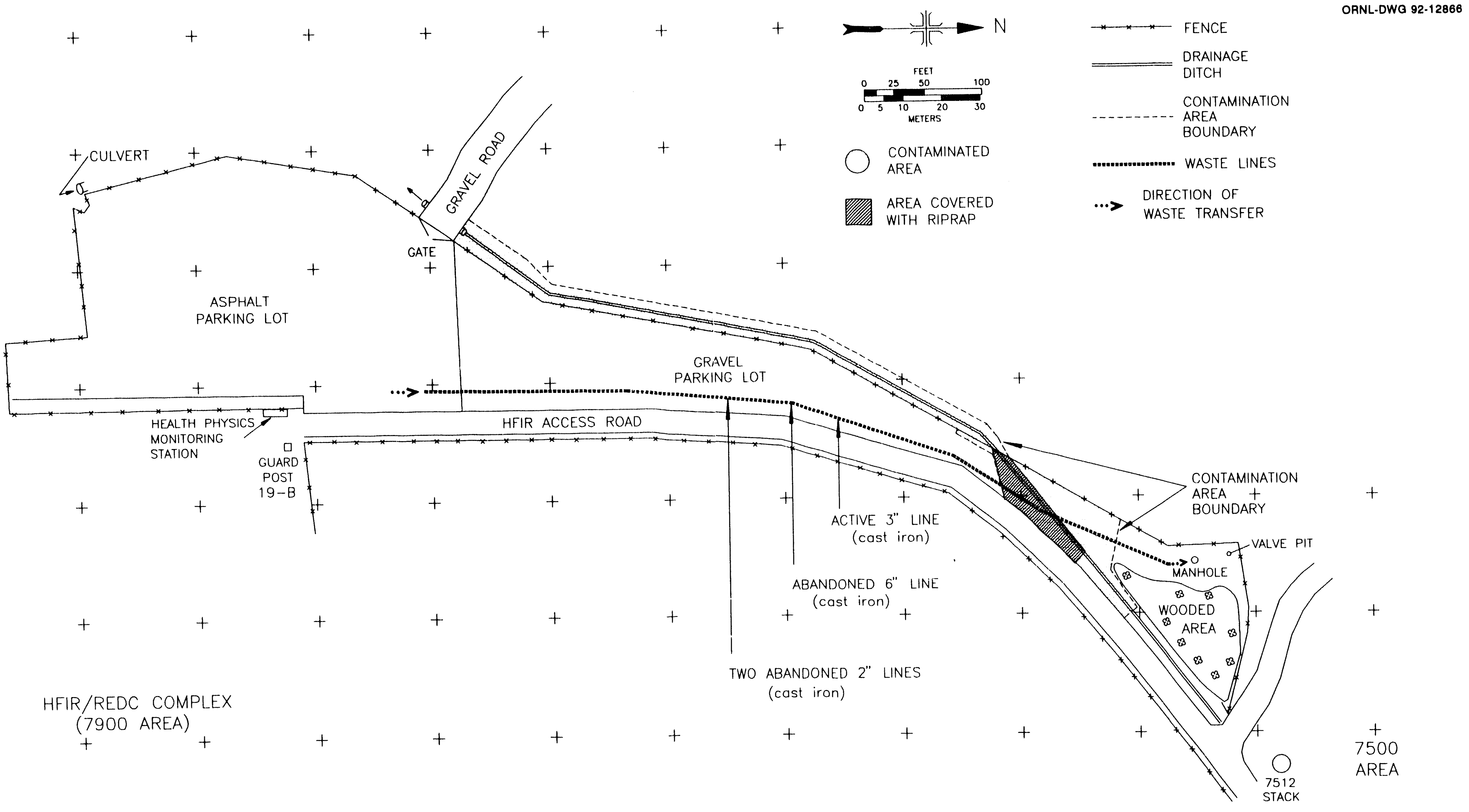

Fig. 4.4. Diagram of the 7500 Area Contamination Site with shading delineating the location of riprap in the contamination area.

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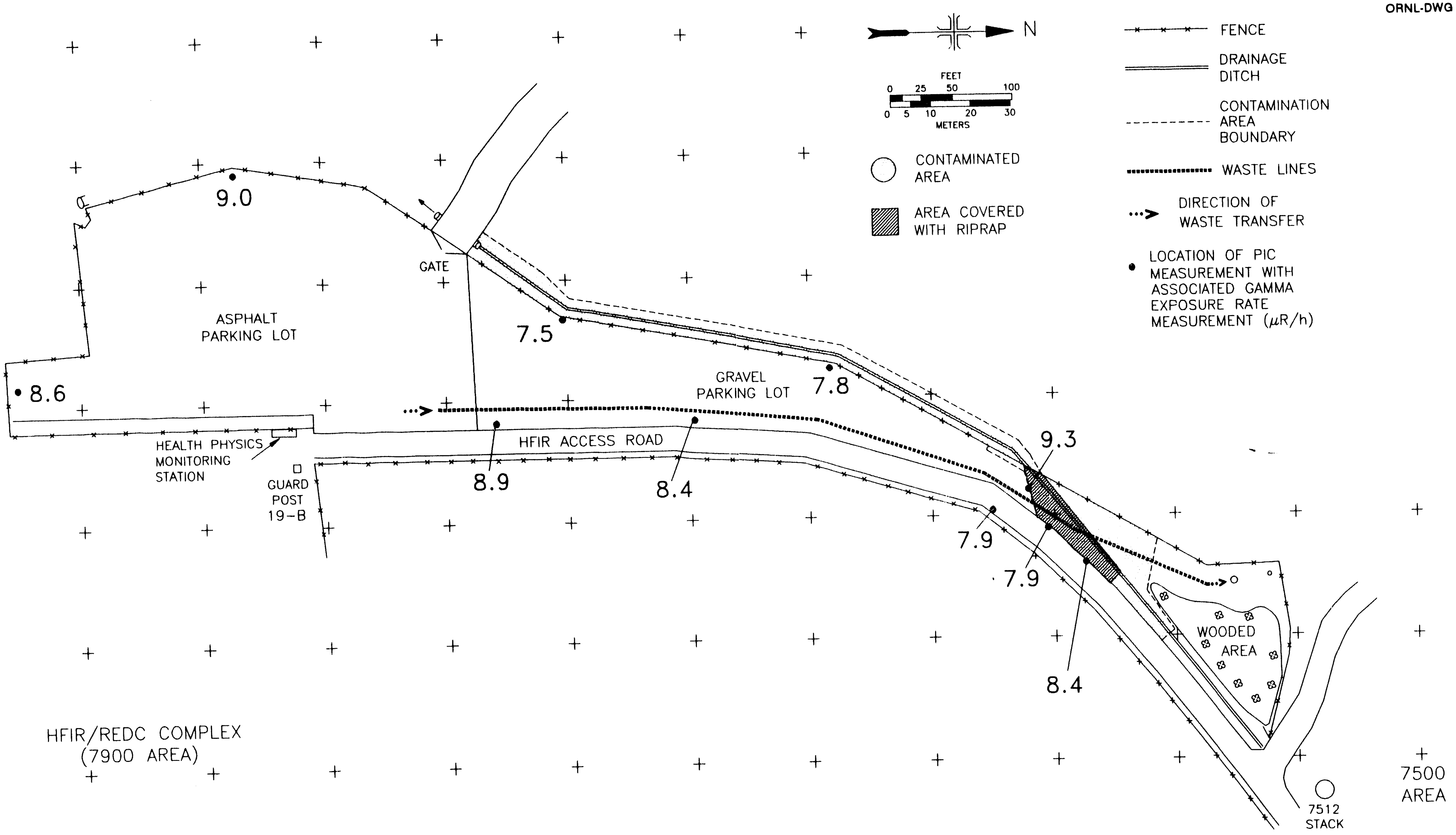

Fig. 4.5. Diagram showing the locations of pressurized ionization chamber (PIC) measurements at 1 m above the surface with associated gamma exposure rate values (μR/h) at the 7500 Area Contamination Site.

4.3 ENVIRONMENTAL SAMPLE ANALYSIS

Table 4.3 provides results of radionuclide analysis of four environmental samples. Sampling locations are shown on Fig. 4.6. Sample B1 was initially collected outside of the established contamination area; however, the boundary was later relocated to include this region. While analyzing the B1 soil sample, an ORNL Analytical Chemistry technician discovered and isolated a snail shell that was determined to be radioactive. The shell (~10 mm diam) weighed 0.12915 g, which was dissolved and diluted to 25 mL for analysis. Results of analysis of the soil sample (B1) and isolated snail sample (B1S) demonstrate high concentrations of several radionuclides, particularly ^{90}Sr, ^{137}Cs, and ^{228}Th (see Table 4.3). Gross beta concentrations of the snail sample were 1,600,000 pCi/g (^{90}Sr contributed 760,000 pCi/g and ^{137}Cs contributed 1,800 pCi/g). Gross alpha concentrations of 69,000 pCi/g were also measured in the snail sample. In the associated soil sample, gross alpha concentrations were 2,500 pCi/g, whereas gross beta concentrations were 1,200 pCi/g (^{90}Sr contributed 1,000 pCi/g and ^{137}Cs contributed 270 pCi/g). Elevated concentrations of ^{228}Th were also found in samples B1 and B1S (65 and 420 pCi/g, respectively).

Contaminated leaves measuring 0.04-0.09 mrad/h (Fig. 4.3) were detected near the contamination area. It is suspected that these leaves originated from a contaminated wild cherry tree located north of the contamination area (see Figs. 4.1 and 4.3). Gamma radiation levels ranged from 10 to 13 μR/h on contact with the tree trunk, and contact beta-gamma measurements ranged from 0.05 to 1.1 mrad/h. Analysis of several fallen leaves show elevated concentrations of ^{90}Sr (2200 pCi/g, sample V1, Table 4.3).

Table 4.3 provides analysis results of a water sample (W1) collected from a culvert located downstream (south) of the drainage ditch/contamination area. Results show concentrations of 49 pCi/L for total radioactive strontium (^{89}Sr + ^{90}Sr) and 95 pCi/L for other beta emitters.

4.4 BETA-GAMMA AND ALPHA MEASUREMENTS

A limited surface beta-gamma radiation scan was conducted over the survey area. Elevated beta-gamma radiation levels were measured in close proximity to the contamination area and drainage ditch (see Fig. 4.3). Beta-gamma radiation levels were also recorded for several hot spot anomalies located near the contaminated area. This information was previously described in Sect. 4.2.1 and Table 4.2. Note that two hot spots (i.e., contaminated mud) identified on the HFIR Access Road by ORNL's Office of Radiation Protection were remediated and the road surface subsequently decontaminated.

As mentioned in Sect. 2, alpha radiation measurements were used primarily for monitoring personnel during survey activities. No detectable alpha contamination was detected on personnel. Additionally, selected spot-check measurements on soil and road surfaces revealed no detectable alpha contamination.

Table 4.3. Concentrations of ^{60}Co, ^{137}Cs, gross alpha, gross beta, strontium, and ^{228}Th in environmental samples collected at the 7500 Area Contamination Site

Sample ID[a]	Media	Concentration (pCi/g or pCi/L)					
		^{60}Co	^{137}Cs	Gross alpha	Gross beta	Strontium	^{228}Th
B1	Soil	<25	270 ± 100	2,500 ± 200	1,200 ± 200	1,000 ± 2,000[b]	65 ± 20
B1S	Snail	*c*	1,800 ± 100	69,000 ± 40	1,600,000 ± 20,000	760,000 ± 50,000[b]	420 ± 200
W1	Water	-8.1 ± 8	1.9 ± 10	1.8 ± 3	95 ± 10	49 ± 10[d]	*c*
V1	Leaves	-0.27 ± 4	-2.7 ± 5	*c*	*c*	2,200 ± 30[d]	*c*

[a] Sample locations are shown on Fig. 4.6.
[b] Strontium-90.
[c] Not measured.
[d] Total strontium.

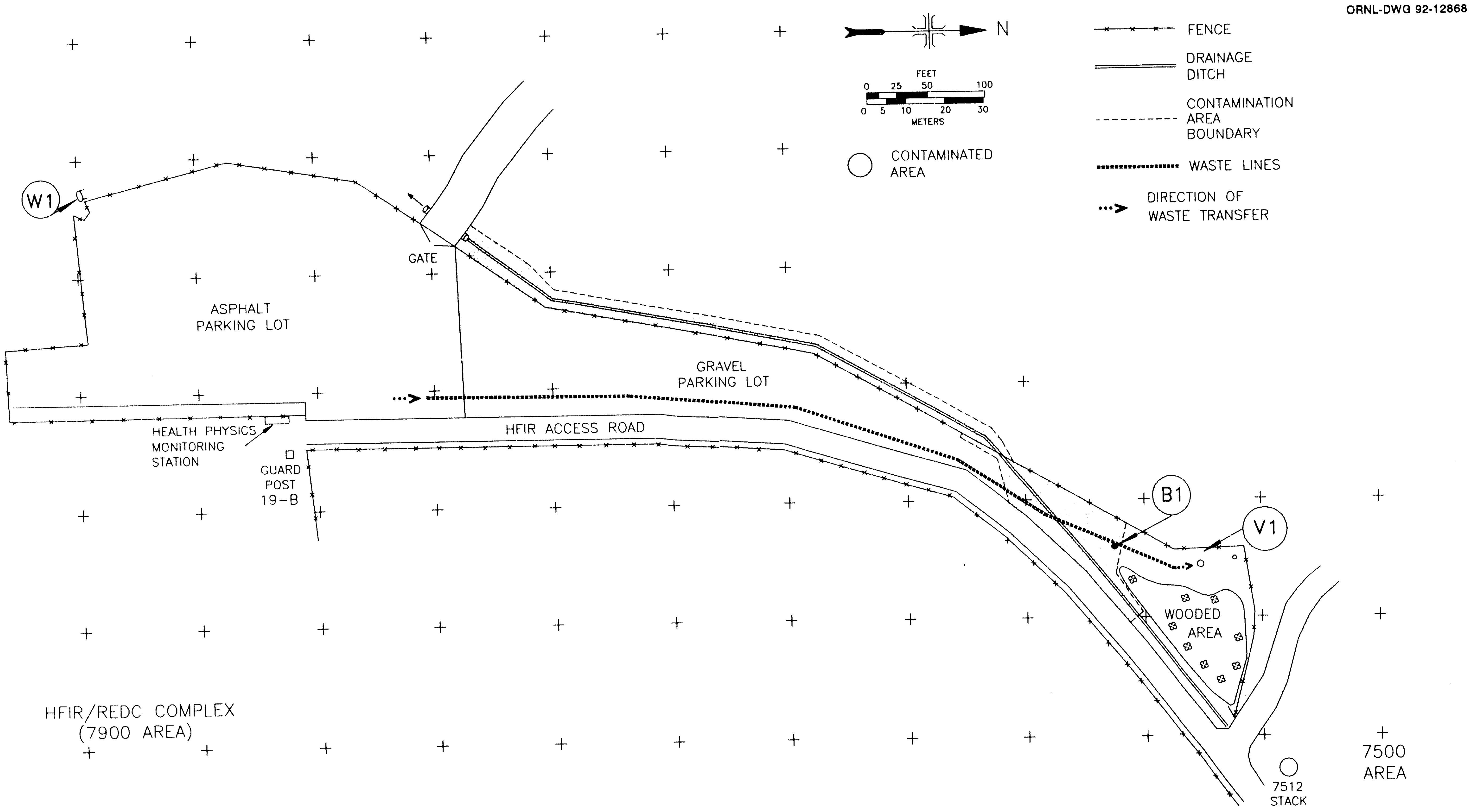

Fig. 4.6. Diagram showing locations of environmental samples at the 7500 Area Contamination Site.

4.5 AUGER HOLE SAMPLE ANALYSIS AND GAMMA LOGGING OF AUGER HOLES

Gamma hole logging was performed in each of 24 auger holes along the pipeline route (i.e., traversing the asphalt and gravel parking lots and extending through the contamination area). The purpose of hole logging is to characterize and further define the extent of possible surface and subsurface radioactive contamination. The logging technique used here is not radionuclide specific. However, logging data, in conjunction with soil analyses data, may be used to estimate regions of elevated radionuclide concentrations in auger holes when compared with background levels for the area. Counts-per-minute activity predominantly increased with soil depth (i.e., proximity to pipelines). For instance, auger hole B03 exhibited a significant increase in gamma activity at 24 in. of soil depth. However, results of analysis of a soil sample collected from this hole demonstrate background radionuclide concentrations (Table 4.4). Therefore, the elevated gamma values were due to radiation emanating from the pipelines.

Data from the gamma profiles of the logged auger holes are graphically represented in Appendix A, Figs. A.1 through A.24. A photograph showing hand-auger soil sampling in the gravel parking lot is provided (Fig. 4.7).

Excluding the soil sample taken in the contamination area [auger hole (B24)], analytical results of 16 soil samples taken from selected auger holes along the pipeline route revealed maximum gross beta concentrations of 7.8 pCi/g and gross alpha concentrations of 4.7 pCi/g. Highest concentrations were measured in sample B21S18E, auger hole 21 at 12–18 in. of soil depth located south of the contamination area. These levels represent typical background soil concentrations (see Table 4.4). No soil samples were collected from auger holes B02, B04, B08, B10, B12, B14, B16, B18, and B23. Two samples per hole were collected from auger holes B01 and B22.

As expected, highest radiation levels were measured inside the contamination area (auger hole B24). Beta-gamma activity levels measured at 1 m above the ground surface inside the contamination area were ~20 mrad/h. Measurements taken at the soil surface of the auger hole showed beta-gamma levels of up to ~120 mrad/h. Levels decreased and remained constant at 100 mrad/h at 14 in. and 18 in. of soil depth. Radionuclide analysis of a soil sample taken at 0 to 6 in. of soil depth revealed highest gross beta activity of 57,000 pCi/g. The primary contributor to gross beta contamination was ^{90}Sr at 25,000 pCi/g. A detailed breakdown of radiological results is provided in Sect. 4.6.3. A photograph showing hand-auger soil sampling in the contamination area is provided in Fig. 4.8. Figure 4.9 is a photograph of the contamination area. Figure 4.10 shows rock riprap over the contamination area.

Table 4.4. Concentrations of ^{60}Co, ^{137}Cs, gross alpha, gross beta, and ^{40}K in soil samples collected at the 7500 Area Contamination Site

Station[a]	Sample ID[b]	Borehole No.	Sample depth (in.)	Estimated depth of waste lines (in.)	Solids %	Concentration (pCi/g dry weight)				
						^{60}Co	^{137}Cs	Gross alpha[c]	Gross beta[c]	^{40}K
14+50	B01S18E	1	18–24	35	85	0.092 ±0.1	0.089 ±0.1	4.4±2	2.3±1	18±2
14+50	B01S24E	1	24–30	35	85	0.098 ±0.1	−0.051 ±0.1	2.6±1	5.1±2	20±2
15+00	B03S24E	3	18–24	40	87	0.047 ±0.1	0.019 ±0.1	2.5±2	3.4±2	16±2
15+50	B05S23E	5	19–23	40	87	−0.065 ±0.2	0.012 ±0.1	2.9±2	3.7±2	22±2
15+75	B06S29E	6	24–29	46	84	0.093 ±0.08	−0.0064±0.1	4.2±2	6.1±2	20±2
16+00	B07S24E	7	18–24	43	85	0.0095±0.1	−0.035 ±0.1	3.0±1	4.4±2	20±2
16+50	B09S24E	9	18–24	44	85	0.11 ±0.1	−0.013 ±0.1	3.1±2	4.1±2	19±2
17+00	B11S24E	11	18–24	42	91	0.11 ±0.1	0.027 ±0.1	3.3±1	4.2±1	19±2
17+50	B13S23E	13	18–23	44	88	−0.083 ±0.2	0.046 ±0.1	3.1±2	4.1±2	19±2
18+00	B15S24E	15	18–24	45	74	0.051 ±0.09	−0.029 ±0.1	4.4±2	4.4±2	17±1
18+50	B17S23E	17	18–23	43	85	0.0032±0.2	−0.038 ±0.1	3.5±2	3.2±2	16±2

Table 4.4 (continued)

Station[a]	Sample ID[b]	Borehole No.	Sample depth (in.)	Estimated depth of waste lines (in.)	Solids %	Concentration (pCi/g dry weight)				
						^{60}Co	^{137}Cs	Gross alpha[c]	Gross beta[c]	^{40}K
19+00	B19S24E	19	18–24	36	84	−0.013 ±0.2	0.026 ±0.1	3.5±2	5.5±2	20±2
34′E,17′ N of 19+00	B20S18E	20	12–18	*d*	83	0.026 ±0.1	−0.016 ±0.1	2.9±1	5.5±2	16±2
143′N of 19+00, 46′E of 20+50	B21S18E	21	12–18	*d*	87	−0.0062±0.1	−0.0062±0.1	4.7±2	7.8±2	17±2
20+25	B22S12E	22	6–12	15	84	−0.068 ±0.2	−0.026 ±0.1	2.2±1	5.1±2	18±2
20+25	B22S12E[e]	22	6–12	15	83	0.020 ±0.2	0.0033±0.1	2.2±1	5.2±2	20±2

[a] Sample locations are shown on Fig. 2.1.

[b] Format of sample ID is detailed in Sect 4.7 of S. N. Burman, D. C. Landguth, M. S. Uziel, T. L. Hatmaker, and P. F. Tiner, *Comprehensive Work Plan and Health and Safety Plan for the 7500 Area Contamination Site Sampling at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, ORNL/ER-93, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., May 1992.

[c] Gross alpha and gross beta were determined by leaching 20 g of soil with nitric acid. An aliquot of the leachate was analyzed for gross alpha activity and gross beta activity.

[d] Not applicable.

[e] Duplicate sample.

ORNL-PHOTO 6551-92

Fig. 4.7. Hand-auger soil sampling directly above the subsurface pipeline at the gravel parking lot at the 7500 Area Contamination Site (May 1992).

Fig. 4.8. Hand-auger soil sampling at the subsurface pipeline in the contamination area at the 7500 Area Contamination Site (May 1992)

ORNL PHOTO 757-93

Fig. 4.9. View looking south at rock riprap at the 7500 Area Contamination Site (December 1992).

ORNL PHOTO 758-93

Fig. 4.10. View looking north at rock riprap at the 7500 Area Contamination Site (December 1992).

4.6 ANALYSIS OF SAMPLE FROM THE CONTAMINATION AREA

The comprehensive analytical results are given in Appendix B. Laboratory analysis was performed by EcoTek LSI. Described below are selected results from a soil sample collected in the contamination area (B24S). In addition, an equipment presampling rinsate sample (B24B) and a field blank sample (B24E) were collected to appraise quality assurance/quality control.

4.6.1 Organics

A summary of selective analytical results for each sample follows.

4.6.1.1 Volatiles

- Soil (B24S): Concentrations of volatile organic compounds were below quantitation limit (BQL) levels using method CLP SOW OLM01.8. The practical quantitation limit (PQL) used in this analysis was 10 μg/L for all volatile organic compounds except those specified in Appendix B using SW-846 (method 8240). Additionally, paraldehyde and acrylamide were not detected using the extracted ion current profile method.

- Presampling rinsate (B24B): Concentrations of analytes represent BQL levels except for methylene chloride* (4 μg/L), chloroform (2 μg/L), and 1,2-dichloropropane (2 μg/L) using method CLP SOW OLM01.8. However, these concentrations are less than the PQL (10 μg/L). Using SW-846 (method 8240), concentrations of analytes represent BQL values except for toluene (2 μg/L). Total xylene was found to be at the PQL (1 μg/L). Additionally, paraldehyde and acrylamide were not detected using the extracted ion current profile method.

- Field blank (B24E): Concentrations of analytes represent BQL levels except for methylene chloride* (4 μg/L), chloroform (2 μg/L), and 1,2-dichloropropane (2 μg/L) using method CLP SOW OLM01.8. However, these values are less than the PQL (10 μg/L). Using SW-846 (method 8240), values for all analytes represent BQL levels except for toluene (2 μg/L). Total xylene was found to be at the PQL (1 μg/L). Additionally, paraldehyde and acrylamide were not detected using the extracted ion current profile method.

4.6.1.2 Semivolatiles

- Soil (B24S): Concentrations of analytes represent BQL levels except for bis(2-ethylhexyl)phthalate (72 μg/kg) using method CLP SOW OLM01.8. However, this concentration is less than the PQL (370 μg/kg). Twelve compounds were tentatively identified, and only one of these, octamethylcyclotetrasiloxane, could be confirmed (700 μg/kg).

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*Methylene chloride is a common laboratory contaminant that is present in virtually all volatile method blanks. When this analyte is detected in a sample, it is "B" flagged to indicate that this compound was found in the associated blank as well as in the sample. It indicates possible or probable contamination of the blank or sample (see Appendix B).

- Presampling rinsate (B24B): Concentrations of analytes represent BQL levels except for diethylphthalate (1 μg/L), di-*n*-butylphthalate (2 μg/L), and bis(2-ethylhexyl)phthalate (14 μg/L) using method CLP SOW OLM01.8. With the exception of bis(2-ethylhexyl)phthalate, values for these compounds are less than their respective PQLs. Nineteen compounds were tentatively identified, and only one, 2-(2-butoxyethoxyl)-ethanol, could be confirmed (11 μg/L). Note that this compound was found in the associated method blank sample as well as in the sample.

- Field blank (B24E): Concentrations of analytes represent BQL levels except for diethylphthalate (2 μg/L), di-*n*-butylphthalate (1 μg/L), and bis(2-ethylhexyl)phthalate (3 μg/L) using method CLP SOW OLM01.8. However, these values are less than their PQL (9 μg/L). Nineteen compounds were tentatively identified, and only one, 2-(2-butoxyethoxyl)-ethanol, could be confirmed (15 μg/L). Note that this compound was found in the associated method blank sample as well as in the sample.

4.6.1.3 Petroleum hydrocarbons

Analysis of one petroleum hydrocarbon, kerosene, was performed in samples B24S, B24B, and B24E. Results show concentrations below the quantitation limit of detection in all samples.

4.6.2 Inorganics (Metals)

Table 4.5 provides results of metals analysis from a soil sample collected in the contamination area (B24S). In addition, an equipment presampling rinsate sample (B24B) and a field blank sample (B24E) were collected to appraise quality assurance/quality control.

4.6.3 Radionuclides

Comprehensive sample analysis results are provided in Appendix B. Analyses of radioactive components in samples B24S (42 analytes), B24B (35 analytes), and B24E (35 analytes) were conducted. Table 4.6 provides results of measurable radionuclide concentrations identified in a soil sample (B24S) collected in the contamination area (sampling station 19+50). With the exception of ^{40}K found at concentrations of 110 pCi/L in sample B24B, no other radionuclides were measured above their respective detection limits in samples B24B and B24E.

Table 4.5. Results of metals analysis from soil, presampling rinsate, and field blank samples collected at the 7500 Area Contamination Site[a]

Analyte	B24S[b] (mg/kg or ppm)	B24B[c] (μg/L or ppb)	B24E[d] (μg/L or ppb)
Aluminum	23,000	28.1	40
Antimony	<1.12	<10.0	<10.0
Arsenic	6.78	<1.0	<1.0
Barium	93.2	<1.0	<1.0
Beryllium	1.03	<1.0	<1.0
Cadmium	<0.11	<1.0	<1.0
Calcium	927	39.3	60.8
Chromium	33.6	<2.0	2.16
Cobalt	22.6	<3.0	<3.0
Copper	15.6	110	115
Iron	55,800	25.2	39.6
Lead	13.8	7.41	5.83
Lithium	25.6	<1.0	<1.0
Magnesium	2730	<17.0	<17.0
Manganese	656	<1.0	1.32
Mercury	0.03	1.2	1.06
Nickel	23.6	<3.0	<3.0
Potassium	3820	<282	<282
Selenium	<0.10	<1.0	<1.0
Silver	<0.44	<4.0	<4.0
Sodium	64.4	66.7	72.7
Strontium	6.54	<1.0	5.6
Thallium	<0.10	1.05	1.59
Vanadium	30.1	<2.0	<2.0
Zinc	48.5	128	121

[a] Case narratives for metals analysis are provided in Appendix B.
[b] Soil sample collected in the contamination area (station 19+50).
[c] Equipment presampling rinsate sample.
[d] Field blank sample.

Table 4.6. Concentrations of radionuclides and gross activity in a soil sample (B24S) collected in the contamination area at the 7500 Area Contamination Site

Analyte	Results (pCi/g)	2-sigma error
Gross alpha	1700[a]	210
Gross beta	57,000[b]	590
Cesium-137	16	2
Potassium-40	19	3.1
Strontium-90	25,000[c]	40
Uranium-234	3.5	0.85
Uranium-238	2.1	0.58

[a] The 1700 pCi/g of gross alpha activity is likely a false positive result. This value is the result of "cross-talk" in the gas flow proportional counter. Unfortunately, this instrument was configured to detect alpha and beta activities in simultaneous counting mode, which allowed ~3% of beta activity to spill over into the alpha detection. Based on analytical results of alpha-emitting radionuclides (e.g., ^{239}Pu), there appears to be no verifiable alpha contamination. Radionuclide-specific analysis for ^{244}Cm, an alpha emitter, was not performed in this survey. However, any future analysis of environmental samples collected from this area should include ^{244}Cm analysis.

[b] Gross beta concentrations are influenced by ^{90}Y.

[c] Strontium-90 activity is determined from the ^{90}Y activity. A case narrative for ^{90}Sr is provided in Appendix B.

5. SIGNIFICANCE OF FINDINGS

For purposes of correlating findings with specific areas, the site is categorized into four distinct areas. They are as follows: (1) general area (surrounding environs), (2) contamination area (location of contamination incident) and drainage ditch, (3) asphalt and gravel parking lots (pipeline survey excluding the contamination area), and (4) HFIR Access Road. A site radiological hazard evaluation is provided at the end of this section.

5.1 GENERAL AREA (SURROUNDING ENVIRONS)

Typical background gamma exposure rates measured at 1 m above the ground surface were generally found throughout the survey area [excluding the established contamination areas at (1) the point of the contamination incident and (2) the associated drainage ditch]. Gamma exposure rate measurements taken at ten locations throughout the survey area ranged from 7 to 9 μR/h (average 8 μR/h) at 1 m above the ground surface. For comparison purposes, gamma exposure rates measured at uncontaminated outdoor areas on the ORR ranged from 8 to 13 μR/h (averaged 10 μR/h) at 1 m above the ground surface and 10 to 17 μR/h (average 13 μR/h) at the ground surface.

A comprehensive surface gamma radiation scan (and limited beta radiation scan) was conducted over the survey area. Results generally indicate typical background levels. However, some slightly elevated radiation anomalies were found on the ground surface. These include several spots that peppered areas in or near the contamination area. In most cases, sampling of surface (0- to 2-in. depth) anomalies for radionuclide screening analysis remediated the anomaly. Radiation measurements taken after sample removal generally showed background radiation levels at most of the sampled locations. The majority of spots were determined to be ^{60}Co and/or ^{137}Cs as demonstrated by gamma spectroscopy.

One finding consisted of slightly contaminated leaves from a wild cherry tree located north of the contamination area. Analysis of fallen leaves from this tree demonstrate the presence of ^{90}Sr. Strontium-90 acts as an analog of calcium, which is readily taken up by vascular plants. Only one tree was found to be contaminated after spot-check measurements of several trees; however, it is likely that other vegetation along the drainage ditch is contaminated.

5.2 CONTAMINATION AREA (LOCATION OF CONTAMINATION INCIDENT) AND DRAINAGE DITCH

Beta-gamma dose rates measured at 1 m above the ground surface inside the contamination area were ~20 mrad/h. Measurements taken at the soil surface at auger hole 24 (inside the contamination area) indicate beta-gamma levels of ~120 mrad/h. Levels decreased and remained constant at 100 mrad/h at 14 in. and 18 in. of soil depth. Radionuclide analysis of a soil sample taken at 0 to 6 in. of soil depth revealed highest gross beta activity of 57,000 pCi/g. The primary contributor to gross beta contamination was ^{90}Sr at 25,000 pCi/g. The presence of contamination in soil is most likely the result of residual contamination from years of waste transport and maintenance operations (e.g., replacement of degraded joints, upgrading or replacement of entire pipelines, and associated landscaping activities). In the early 1970s at a different site, there was a failure in one of the cast iron LLW lines. It is believed that the line failure resulted from neoprene gasket deterioration probably due to corrosion from small quantities of solvents in the waste solution.*

Prior to riprap actions at the contamination area, gamma exposure rate measurements at 1 m above the ground surface were elevated at the eastern edge of the contamination area (18–28 μR/h). After riprap measures, 1-m gamma levels at this location decreased to 8 μR/h.

As previously described in Sect. 4.3, sample B1 was initially collected outside of the established contamination area; however, the boundary was later relocated to include this region. The finding of a radioactive snail shell in this soil sample provides evidence of contaminant uptake (e.g., ^{90}Sr and ^{137}Cs) into the biota. Results of analysis of the snail demonstrate gross beta concentrations of 1,600,000 pCi/g (^{90}Sr contributed 760,000 pCi/g and ^{137}Cs contributed 1,800 pCi/g). Gross alpha concentrations of 69,000 pCi/g were also measured in the snail sample. In the associated soil sample, gross alpha concentrations were 2,500 pCi/g, whereas gross beta concentrations were 1,200 pCi/g (^{90}Sr contributed 1,000 pCi/g and ^{137}Cs contributed 270 pCi/g). Elevated concentrations of ^{228}Th were found in samples B1 and B1S (65 and 420 pCi/g, respectively). Strontium-90, ^{137}Cs, and ^{228}Th have been associated with operations at Building 7920 (REDC facility) and were likely present in transported liquid waste.*

Metals analysis of a soil sample collected in the contamination area (B24S) revealed five metals measured in significant, quantifiable amounts: Al (23,000 mg/kg), Cr (33.6 mg/kg), Fe (55,800 mg/kg), Li (25.6 mg/kg), and K (3820 mg/kg). Table 5.1 compares concentrations of metals in soil from the 7500 Area Contamination Site with background concentrations at ORNL, ORR, and Roane County locations. Results of soil data demonstrate iron concentrations to be the highest measured. The presence of elevated concentrations of iron is likely due to corrosion of iron equipment (e.g., piping) used in waste transport operations. Additionally, metals associated with HFIR wastes include aluminum and chromium, and therefore, the presence of these metals may be plausible at this site. Inorganic lithium and potassium compounds have been used in operations at Building 7920 and most likely were present in transported liquid waste.*

In comparison with selected soil cleanup levels proposed by the Tennessee Department of Environment and Conservation Division of Superfund [Hazardous Substance Site Remedial Action Cleanup Standards (Chapter 1200-1-13-.08, Draft, October 7, 1992)], we found concentrations of As, Cd, Cr, Pb, Hg, and Ni below their respective cleanup levels. For instance, respective industrial and residential cleanup levels for these metals are as follows: As (30 and 20 mg/kg), Cd (1 mg/kg), Cr (100 mg/kg), Pb (500 and 250 mg/kg), Hg (10 mg/kg), and Ni (1000 mg/kg).

Organic compound analysis of a soil sample collected in the contamination area (B24S) revealed all concentrations were less than their respective practical quantitation limits (PQLs). In comparison with selected soil cleanup levels proposed by the Tennessee Department of

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*J. E. Bigelow, Chemical Technology Division, ORNL, personal communication to J. K. Williams, Health and Safety Research Division, ORNL, May 1993.

Table 5.1. Comparison of metal concentrations in soil
[mg/kg or ppm (dry wt)]

Analyte	7500[a]	ORR (AS)[b]	ORNL (AS)[b]	ORR (BSCP)[c]	ROA (BSCP)[c]
Aluminum	23,000	20,000	16,000	20,700	15,400
Antimony	<1.12	<5.7	<6.0	*d*	*d*
Arsenic	6.78	<6.7	<8.6	6.24	5.86
Barium	93.2	110	150	99.1	87.9
Beryllium	1.03	1.0	1.2	0.781	0.647
Cadmium	<0.11	1.9	2.8	*d*	*d*
Calcium	927	11,000	19,000	907	798
Chromium	33.6	27	27	24.70	27.30
Cobalt	22.6	19	19	14.50	21.40
Copper	15.6	20	24	16.1	11
Iron	55,800	26,000	30,000	29,400	25,400
Lead	13.8	38	<27	20.30	23.60
Lithium	25.6	<1,700	<1,800	16.2	11.2
Magnesium	2,730	3,200	5,600	2,850	1,580
Manganese	656	1,100	1,700	997	1,720
Mercury	0.03	1.2	0.099	0.316	0.161
Nickel	23.6	21	26	23.5	16.7
Potassium	3,820	*e*	*e*	2,300	1,300
Selenium	<0.10	<5.7	<6.1	*d*	0.728
Silver	<0.44	<3.1	<6.3	*d*	*d*
Sodium	64.4	<570	<600	*d*	*d*
Strontium	6.54	17	22	7.93	4.97
Thallium	<0.10	*e*	*e*	0.164	0.104
Vanadium	30.1	36	34	34.2	32.2
Zinc	48.5	66	350	50.6	40.7

[a] Results of one soil sample collected from the contamination area at the 7500 Area Contamination Site, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

[b] *Oak Ridge Reservation Environmental Report for 1991,* ES/ESH-22/V2, pp. 7-3 and 7-4 (October 1992). Taken from Table 7.1 (1991 summary of inorganic analysis of soil at ORNL air stations) and Table 7.2 (1991 summary of inorganic analysis of soil at ORR air stations). All values are average values. AS = air stations.

[c] *Annual Report on the Background Soil Characterization Project on the Oak Ridge Reservation, Oak Ridge, Tennessee, Results of Phase I Investigation,* DOE/OR/01-1136 (May 1993). Taken from Table 5.1 (summary statistics for inorganics). Results of Dismal Gap Formation/Horizon A samples from the Oak Ridge Reservation (ORR) and Roane County (ROA). All values are median values. BSCP = Background Soil Characterization Project.

[d] Not detected.

[e] No data.

Environment and Conservation Division of Superfund [Hazardous Substance Site Remedial Action Cleanup Standards (Chapter 1200-1-13-.08, Draft, October 7, 1992)], we find concentrations of benzene, carbon tetrachloride, methylene chloride, pentachlorophenol, toluene, 1,1,1-trichloroethane, vinyl chloride, and total xylene below their respective cleanup levels. For instance, respective industrial and residential cleanup levels for these compounds are as follows: benzene (0.5 mg/kg), carbon tetrachloride (0.5 mg/kg), methylene chloride

(2.5 mg/kg), pentachlorophenol (10 mg/kg), toluene (10 mg/kg), 1,1,1-trichloroethane (20 mg/kg), vinyl chloride (1 mg/kg), and total xylene (10 mg/kg). In addition, results generally show no meaningful concentrations above practical quantitation limits (PQLs) in samples B24B and B24E. All volatile organic compounds were at or below their respective PQLs. All semivolatile compounds were at or below their respective PQLs with the exception of bis(2-ethylhexylphthalate). This compound was measured at a concentration of 14 μg/L, slightly above the PQL of 10 μg/L. In addition, of the 12 compounds tentatively identified in sample B24S, only 1 compound (octamethylcyclotetrasiloxane) was confirmed at low concentrations (700 μg/kg). Analysis results of one petroleum hydrocarbon, kerosene, show concentrations below the quantitation limit of detection for all samples. Analysis of presampling rinsate (B24B) and field blank (B24E) samples provided low concentrations of two analytes: copper at 110 μg/L and 115 μg/L, and zinc at 128 μg/L and 121 μg/L. Although deionized water was used (i.e., ASTM type 2), most likely, the water source (distillery system) was not entirely pristine.

It should be noted that only one representative soil sample was collected from the contamination area at a soil depth of 18 in. The location of the pipeline is estimated to be ~2 ft below the sampling depth. Most likely, higher concentrations of radionuclides, inorganics, and organics are present in soil at close proximity to the pipelines.

Analysis results for a water sample collected from a culvert located downstream (south) of the drainage ditch/contamination area demonstrate concentrations of total strontium of 49 pCi/L and gross beta concentrations of 95 pCi/L. The total strontium concentration of 49 pCi/L is well below the Derived Concentration Guide (DCG) ^{90}Sr limit of 1000 pCi/L for release of water that normally would not require treatment to further reduce the concentration.[10]

5.3 ASPHALT AND GRAVEL PARKING LOTS (PIPELINE SURVEY EXCLUDING CONTAMINATION AREA)

Field survey measurements indicate low levels of surface gamma exposure rates (ranging from 6 to 10 μR/h) along the pipeline route over the asphalt and gravel parking lots. Most of the gamma levels were lower than typical background levels taken over uncontaminated land areas on the ORR. Additionally, results of analysis of soil samples collected from the gravel parking lot (above the subsurface pipeline) demonstrate background concentrations of radionuclides. Note that soil sampling depths above the pipeline varied because extreme care was taken so as not to damage the active LLW line and abandoned lines. During the course of the field survey (excluding soil sampling inside the contamination area), no transferable contamination was detected on survey team members, shoes, protective clothing, vehicles, or instruments. Based on these findings, there is not a detectable radiation exposure problem (based on gamma radiation measurements) or measurable contamination problem (based on direct beta-gamma measurements and soil sample analysis) at the parking lots.

5.4 HFIR ACCESS ROAD

Low levels of surface gamma exposure rates (ranging from 6 to 14 μR/h) and beta-gamma radiation were generally prevalent along the HFIR Access Road. However, two hot spots were found on the road surface. In the process of sampling these spots for analysis, the anomalies were actually remediated. Additionally, after riprap measures were implemented at the contamination area, gamma exposure rates at 1 m above the road surface averaged 8 μR/h. This value is less than the average 1-m gamma exposure rate value of 10 μR/h measured above ground surfaces at uncontaminated areas on the ORR. Survey findings further indicate that decontamination efforts at two other road hot spot locations (i.e., contaminated mud) in close proximity to the contamination area (identified by ORNL's Office of Radiation Protection at the time of the contamination incident) were successful.

5.5 EVALUATION OF RADIATION EXPOSURE HAZARD

The contamination hazard inside the zoned contamination area remains a significant problem. Radiation control measures taken by ORNL's Office of Radiation Protection are adequate to warn the general public and occupational workers of the existing hazard and prevent inadvertent intrusion into the area. Periodic monitoring circumjacent to and downgradient of the contamination area is imperative to assess whether or not the contamination is dispersing (e.g., via surface runoff).

To evaluate the radiation exposure hazard associated with the 7500 Area Contamination Site, only the direct exposure pathway will be considered. Based on the present physical condition of the contaminated area (rock-riprap covered, moist soil) and the fact that the area presently cannot be used for public occupancy, the ingestion and inhalation pathways have relatively low probabilities of providing any exposure to civilian or occupational personnel. A conservative estimate of the direct exposure can be obtained using the maximum external gamma exposure rate of 9.3 μR/h (~9 μrem/h) measured at the southern edge of the contaminated area as the dose-equivalent rate for the following two scenarios:

- Occupational: Considering an occupational worker who is stationed at the location of maximum exposure rate for 8 h per day, 5 days per week, and 50 weeks per year (2000 h per year total exposure), the annual dose equivalent is about 18 mrem.

- General public: For the general public worst-case exposure, an intruder who stays at the location of maximum exposure rate for 24 h per day, 7 days per week, and 52 weeks per year (8736 h per year total exposure) would receive about 79 mrem due to external gamma radiation.

Conservative dose equivalent estimates from both scenarios are lower than the 100-mrem value specified in DOE Order 5480.11 as the annual limit for designating occupational workers as radiation workers and the limit for any member of the public who accesses a DOE site.[11] Thus, based on conservative exposure scenarios, the site in its present condition does not pose an exposure hazard for members of the general public or occupational workers.

6. RECOMMENDATIONS FOR CORRECTIVE ACTIONS

The presence of elevated beta-gamma radiation levels at the ground surface and verified ^{90}Sr contamination in sampled soil warrant corrective action measures. Two basic approaches to interim corrective actions are (1) isolation of the contaminated area (e.g., roping), including measures to minimize the dispersion and/or redistribution of fugitive radionuclides, and (2) removal, treatment (if required), and disposal of contaminated soil and subsequent stabilization of the treated areas. Health risk assessments should be conducted and used in the evaluation of remedial action options. Because (1) ^{90}Sr contamination was confirmed in sampled soil and (2) an active LLW line is located in the subsurface trench beneath surface soil contamination, the removal, treatment, and disposal of contaminated soil may pose a greater health risk than leaving it in situ. A "leave-in-place" option, coupled with the application of proven, demonstrable technologies for long-term stabilization and/or further reduction of radiation exposures, should be considered.

There is an immediate need to conduct a surface radiation survey of the waste transfer lines located along public roads and restricted-access roads. Although aerial radiological surveys are extremely important in providing an indication of above-background, gamma-radiation levels, they are generally unable to detect surface alpha- or beta-radiation contamination, which is sometimes present at waste line leak sites. Systematic surface soil sampling (0–15 cm) and quantitative radiological analysis along waste transfer line routes, and spot-check measurements and sampling of vegetation along or in close proximity to lines would provide an indication of contaminant dispersion.

The problem of contaminated trees and other aboveground forest biomass presents itself as one of the most delicate issues in corrective and/or remedial action planning. The basic dilemma is striking a reasonable balance between the extent of cleanup and probable disturbance to the forest/watershed ecosystem. It has been strongly suggested that widespread deforestation in the White Oak Creek watershed (i.e., cutting or killing trees) would result in potentially adverse ecological consequences.* One such effect is the creation of hydrological disturbances by profoundly increasing the net hydrologic input into the area (by approximately 30%), possibly increasing runoff and, subsequently, radionuclide migration away from contaminated areas. A second dilemma is an increase in cation leaching (Ca^{2+}) from watersheds. One might anticipate an increase in ^{90}Sr leaching from the White Oak Creek drainage to the Clinch River should widespread deforestation occur. However, it is reasonable to recommend targeting "problem trees" (i.e., those trees showing highly elevated surface beta-gamma activity levels with a survey meter) for removal and disposal only on a case-by-case basis.*

Corrective action options listed below consist of ground-surface measures to limit human exposures to radioactivity, minimize surficial dispersion of radiological contamination, and monitor any such dispersion. Not every contamination situation would involve the implementation of all recommendations listed below; rather, the recommendations should be considered individually or in appropriate combinations. Because only one sample was collected

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*C. T. Garten, Jr., Environmental Sciences Division, ORNL, personal communication to J. K. Williams, Health and Safety Research Division, ORNL, March 1993.

in the contamination area, the results of analysis for organics, inorganics, and radionuclides may not provide an adequate representation of the area. Therefore, additional sampling with analysis is recommended.

The primary concern in assessing appropriate corrective actions is the minimization of exposures of personnel to radiation. These recommendations are in accordance with the radiation safety policy of ORNL to conduct all operations in such a manner that personnel exposures to radiation are maintained at a level as low as reasonably achievable (ALARA).

It is not within the scope of this investigation to identify and/or correlate federal and state environmental laws and their applicability for a suggested corrective action; however, it is important to mention that any remedial action at the 7500 Area Contamination Site must be in accord with applicable federal and state laws and DOE orders. The reference section includes two detailed sources listing major environmental laws[12] and proposed guidance for remedial action strategies at sites previously contaminated with radioactive materials at ORNL.[13]

Isolation of Areas of Contaminated Soil and Vegetation

- Radiation control measures were implemented by ORNL's Office of Radiation Protection at the point of the contamination incident and circumjacent area. A "Contamination Area" was established by encompassing the contaminated soil area with a plastic-link chain attached to metal posts. Warning signs were posted on the chain boundary, and caution lights were employed along the HFIR Access Road because the roadway was partially blocked. "Contamination Area" signs were posted on the chain boundary as deemed appropriate by ORNL's Office of Radiation Protection. The measured level of surface contamination in the area is specified on the signs as well as personnel protection requirements. In addition, "No Parking" signs were posted along the west side of the HFIR Access Road, adjacent to the riprap area.

- Interim surface contaminant-stabilization measures are currently in place at the contaminated soil area. Prior to placement of riprap (i.e., large rocks on the ground surface), a large sheet of plastic was spread over and beyond the boundary of detectable contamination to minimize the potential for contaminant dispersion. Additionally, a corrugated steel pipe was placed on top of the plastic along the drainage ditch route to channel surface runoff that may occur during storm events. Currently, the application of riprap appears to be an appropriate interim measure until remedial actions are conducted. External radiation levels were reduced at the contaminated soil area as a result of shielding provided by large riprap on the ground surface.

- A weatherproof diagram of the contamination area depicting current radiation levels should be maintained, updated, and made readily available to authorized personnel requiring access into this area. Instructions to contact responsible area personnel (e.g., ORNL's Office of Radiation Protection and/or ER Program personnel) with current telephone numbers should be included.

- Institutional control measures (e.g., radiation control procedures) should be maintained for a specified period of time until remedial action is completed. Periodic monitoring for fugitive radionuclides in soil, surface water, and vegetation should be performed along and downgradient of the drainage ditch.

- Radiation protection and monitoring measures (e.g., personal radiation monitoring devices) should be considered for personnel not affiliated with Martin Marietta Energy Systems, Inc., who may become involved with activities at the 7500 Area Contamination Site. (Note: Energy Systems personnel are required to wear badge dosimeters.) All activities that disturb and/or disperse radioactivity at this site should cease if personnel involved with such operations do not wear some type of radiation monitoring devices and protective gear. Personal respirators would minimize the potential for inhalation of radioactively contaminated soil and dust particles.

- The contaminated wild cherry tree should be identified with yellow or magenta paint, using a predetermined configuration placed at some specific height on the tree trunk. Additionally, the contaminated-tree area should be encircled by a roped or fenced boundary with "Contaminated Foliage" signs attached. This type of sign should specify the radiation hazard and date of such designation.

- The dispersion of fugitive radionuclides by litter fall of contaminated trees poses a significant localized health risk and complex remediation problem. One option to minimize the dispersion of contaminated leaves is to chemically terminate the tree, leave it standing, and periodically monitor contamination in and around the tree area.

Removal, Treatment, and Disposal of Contaminated Soil and Vegetation

- Contaminated soil should be removed, treated (if required), and disposed of in a designated radioactive waste disposal site. Excavation and removal of the contaminated material must be carried out in full compliance with current guidelines. It is essential that personnel from ORNL's Office of Radiation Protection be present to monitor activities associated with any disturbance of soil at the 7500 Area Contamination Site.

- The identified contaminated wild cherry tree could be removed and buried in a designated radioactive waste disposal site; however, if additional trees are found to be contaminated, extensive tree removal may facilitate ^{90}Sr leaching from the site.* A meeting involving key ORNL personnel from the Environmental Sciences Division and the former Environmental and Health Protection Division was held to discuss strategies for dealing with ^{90}Sr-contaminated trees in the area around Trench 7. The meeting attendees concluded that at least for the present, it is preferable to leave the trees in place so as not to create an ecological disturbance that would increase radionuclide releases from the site.

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*C. T. Garten, Jr., Environmental Sciences Division, ORNL, personal communication to J. K. Williams, Health and Safety Research Division, ORNL, July 1991.

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4. T. E. Myrick, B. A. Berven, W. D. Cottrell, W. A. Goldsmith, and F. F. Haywood, *Procedures Manual for the ORNL Radiological Survey Activities (RASA) Program*, ORNL/TM-8600, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., April 1987.

5. R. D. Foley and R. F. Carrier, *Radiological Characterization Survey of the Former Diamond Magnesium Company Site, 720 Fairport-Nursery Road, Painesville, Ohio (DMP001, DMP002)*, ORNL/TM-11817, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., December 1991.

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8. U.S. Environmental Protection Agency, *Test Methods for Evaluating Solid Waste*, SW-846, 3rd Edition, Las Vegas, Nevada, 1987.

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11. DOE Order 5480.11, *Radiation Protection for Occupational Workers*, 1989.

12. E. L. Etnier and R. S. Weaver, *Applicable or Relevant and Appropriate Requirements (ARARs) for Remedial Action at the Oak Ridge Reservation, A Compendium of Major Environmental Laws*, ES/ER/TM-1, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., July 1991.

13. D. C. Kocher, "Proposed Guidance for the Development of Remedial Action Strategies at Radioactively Contaminated Sites," *Radiation Protection Management* 6(3), 44-52 (1989).

Appendix A

GAMMA PROFILE GRAPHS OF AUGER HOLES

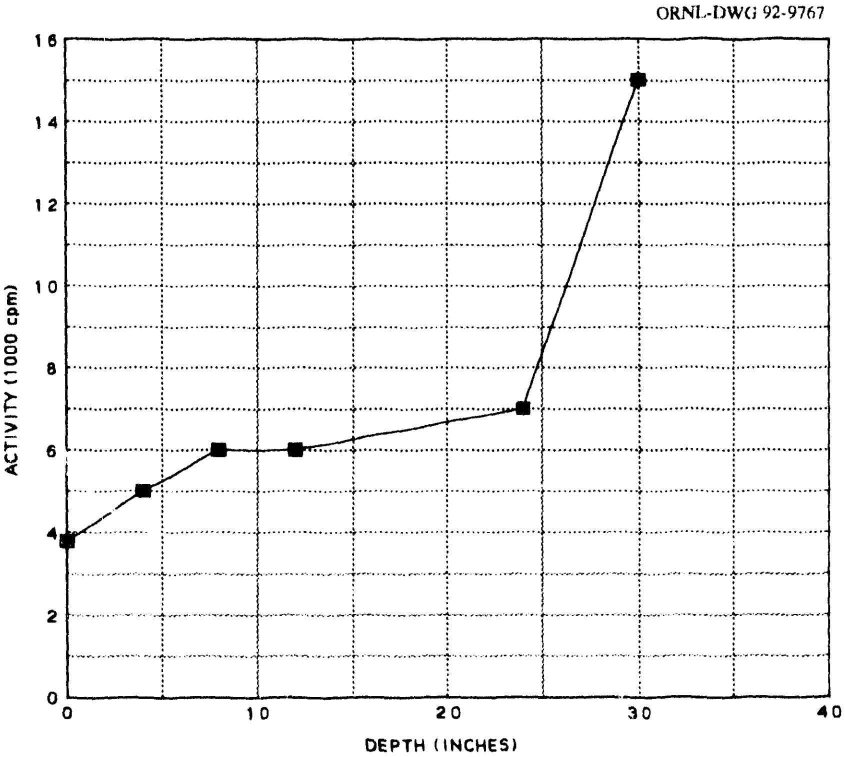


Fig. A.1. Gamma profile of auger hole B01

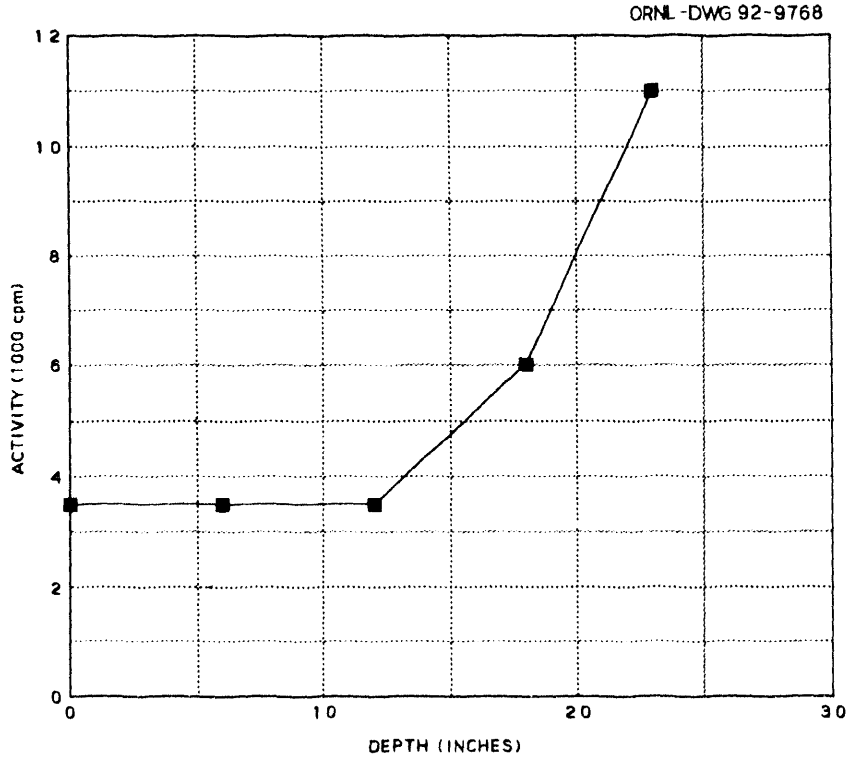


Fig. A.2. Gamma profile of auger hole B02

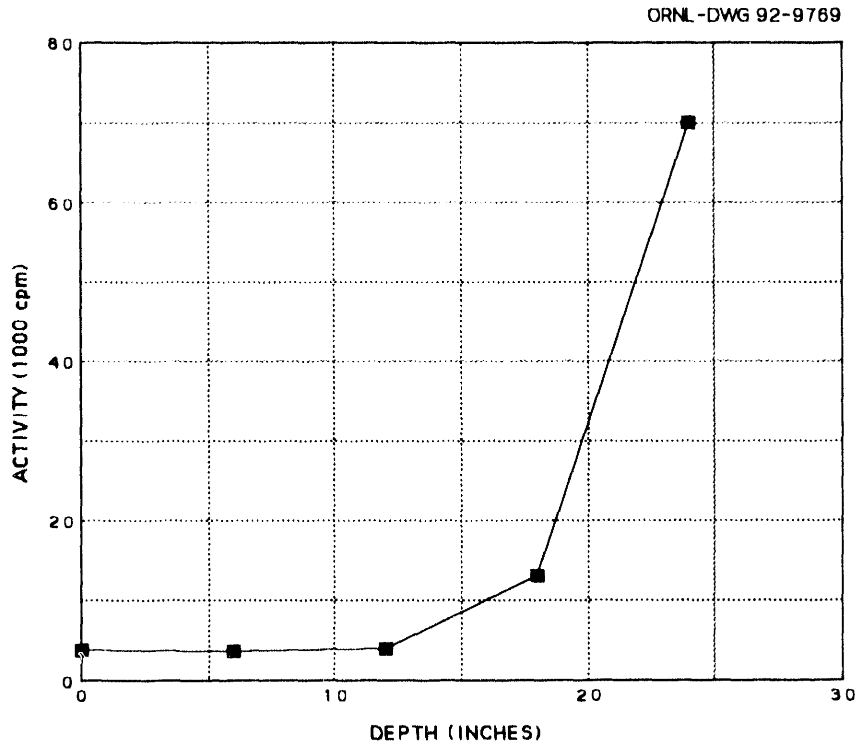


Fig. A.3. Gamma profile of auger hole B03

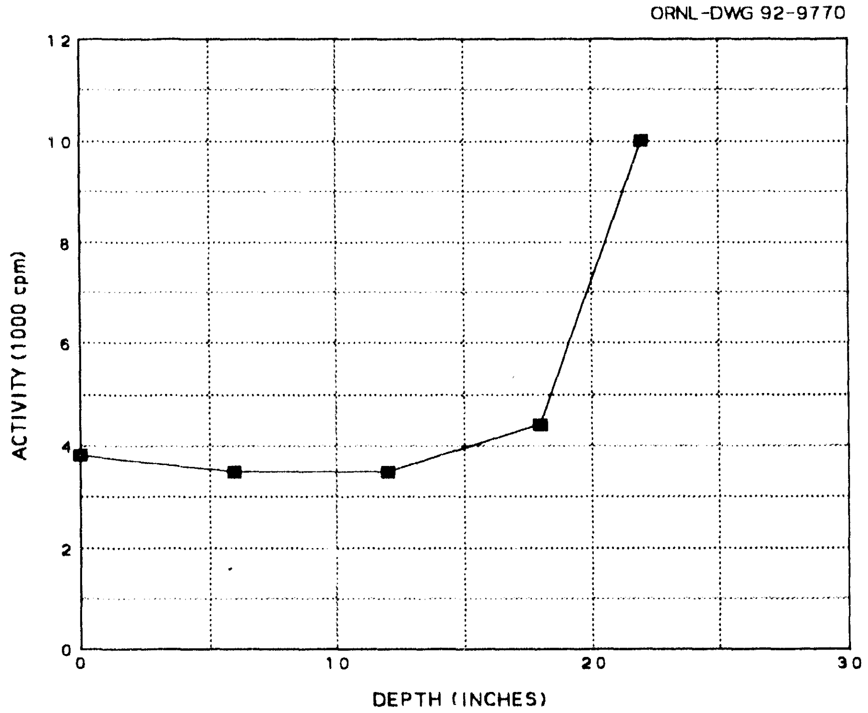


Fig. A.4. Gamma profile of auger hole B04

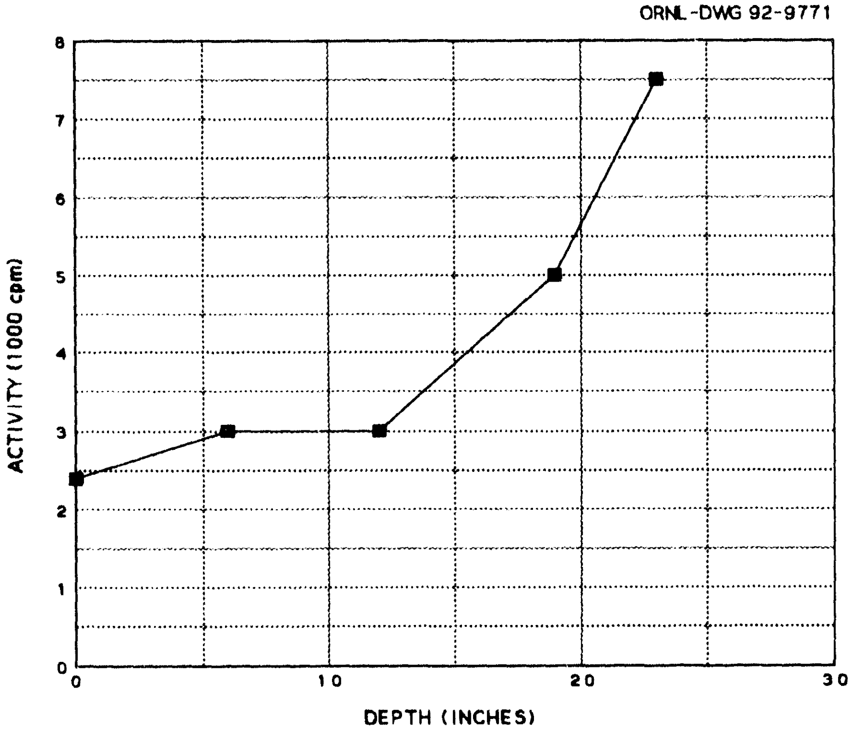

ORNL-DWG 92-9771

Fig. A.5. Gamma profile of auger hole B05

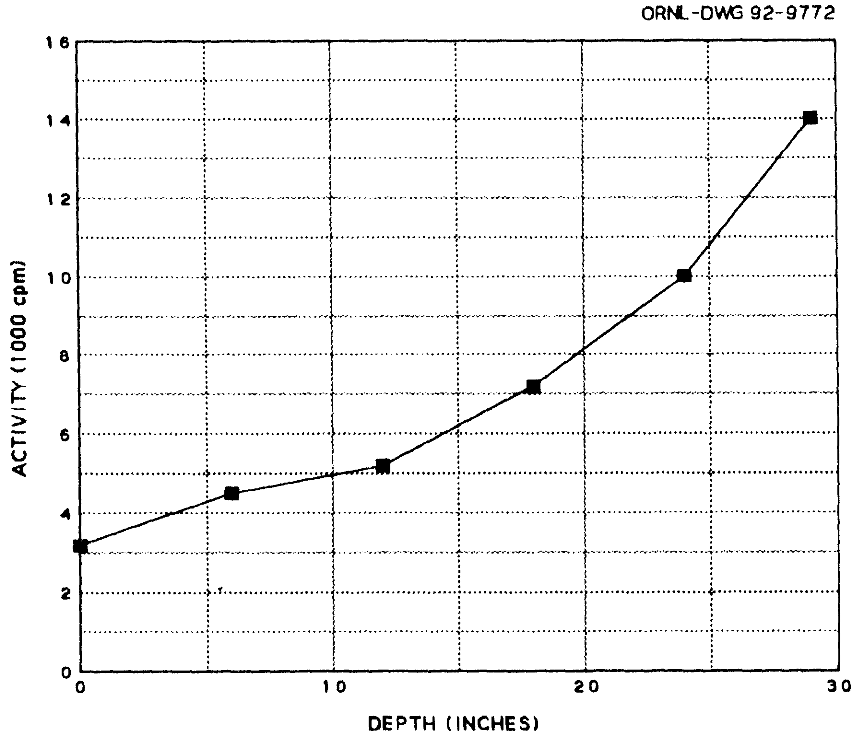

ORNL-DWG 92-9772

Fig. A.6. Gamma profile of auger hole B06

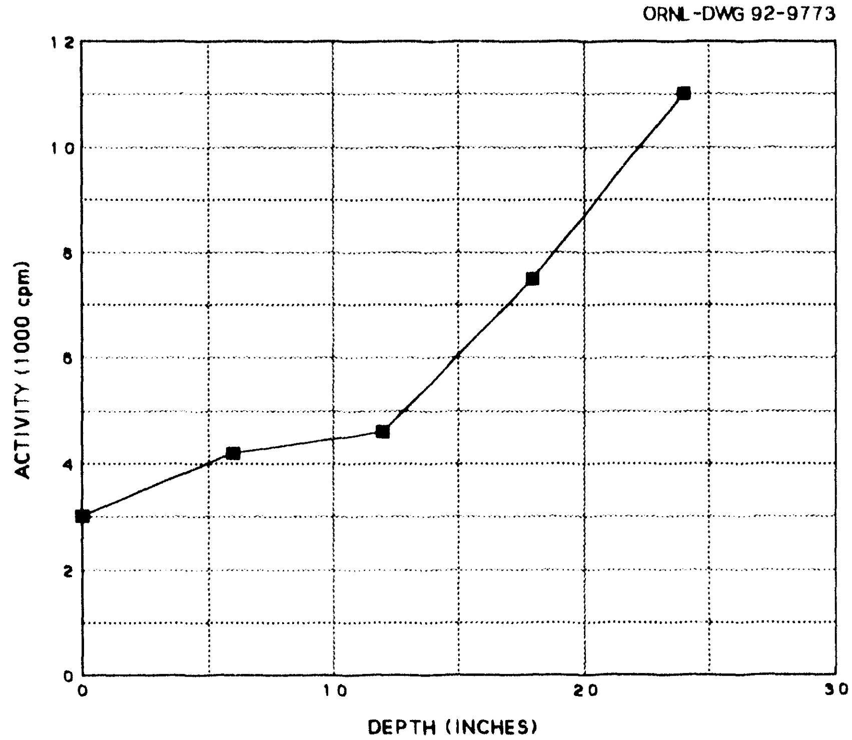


Fig. A.7. Gamma profile of auger hole B07

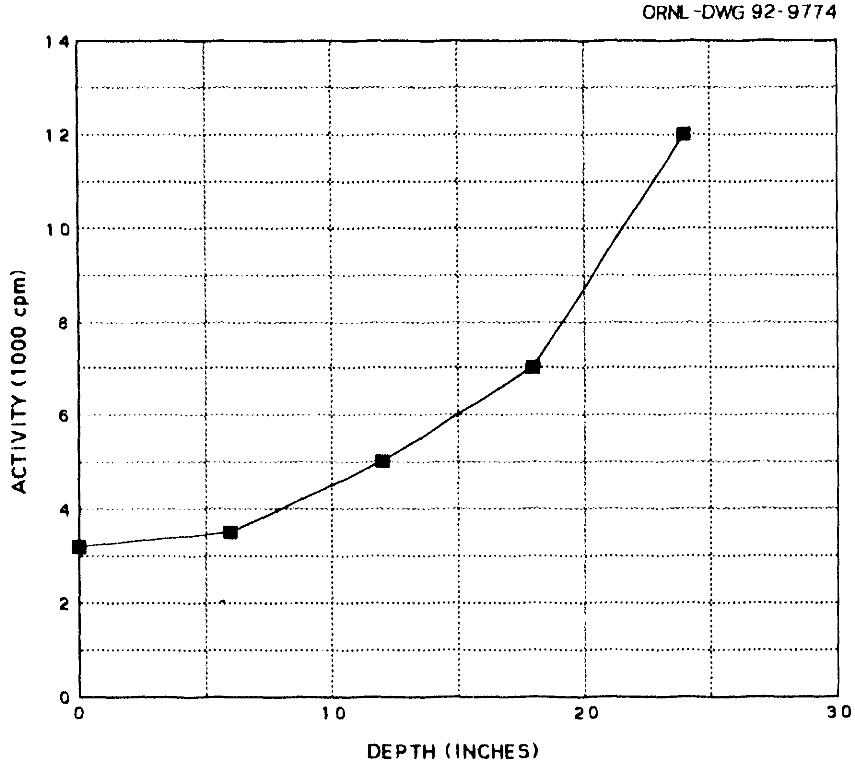


Fig. A.8. Gamma profile of auger hole B08

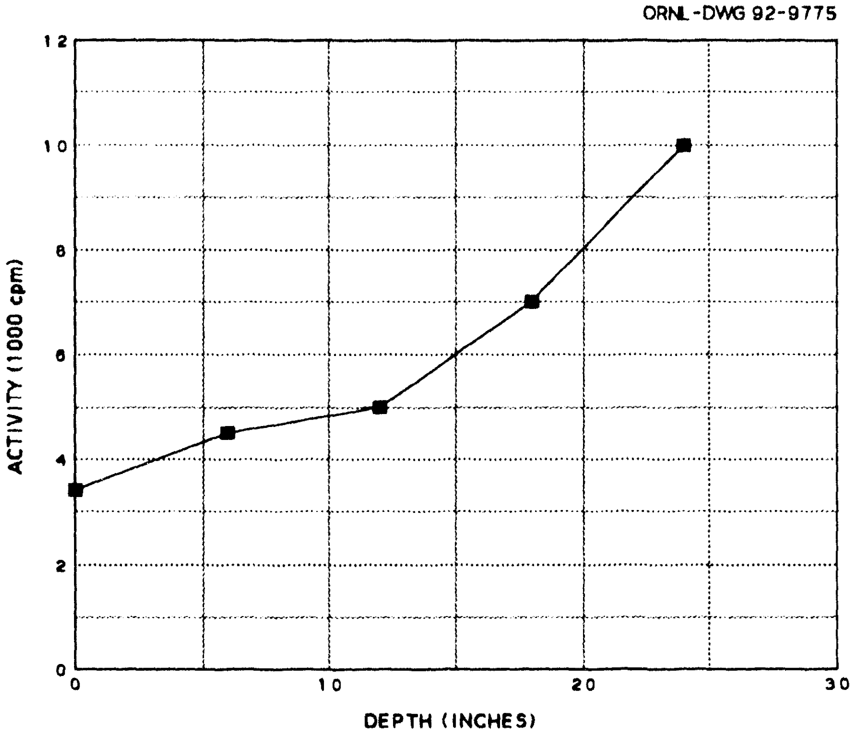


Fig. A.9. Gamma profile of auger hole B09

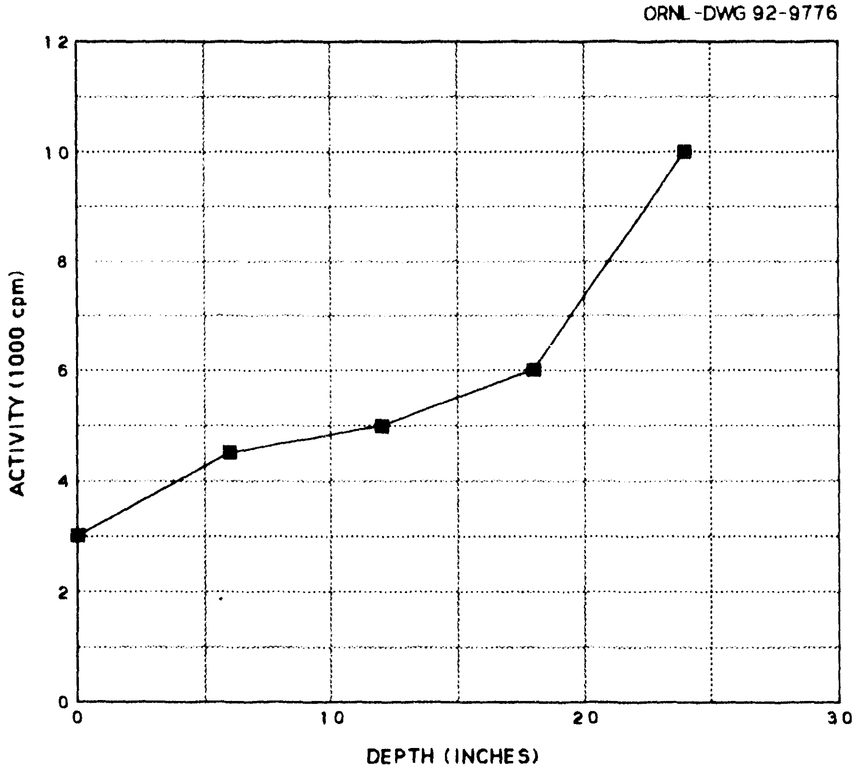


Fig. A.10. Gamma profile of auger hole B10

ORNL-DWG 92-9777

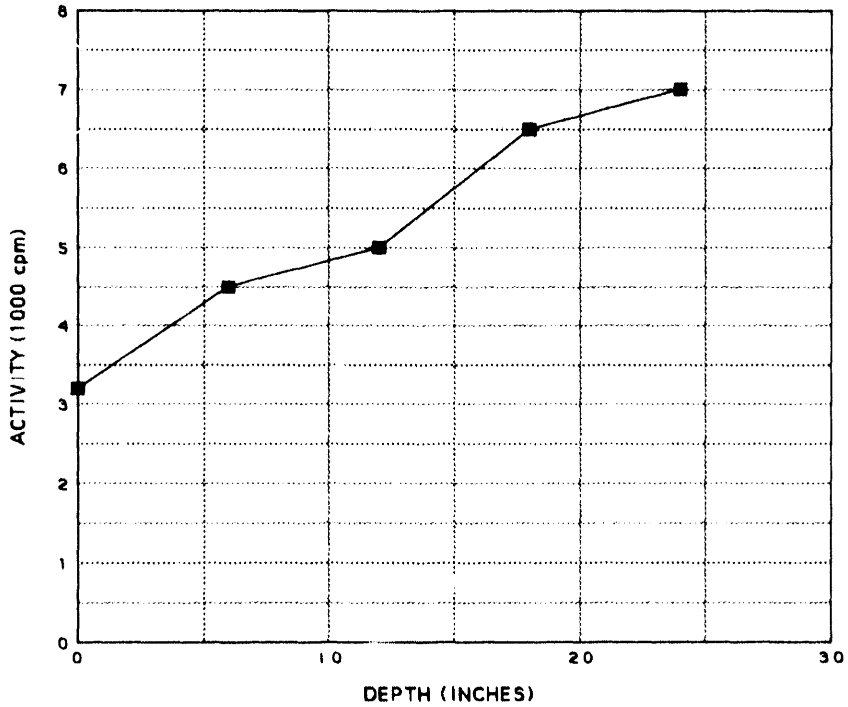


Fig. A.11. Gamma profile of auger hole B11

ORNL-DWG 92-9778

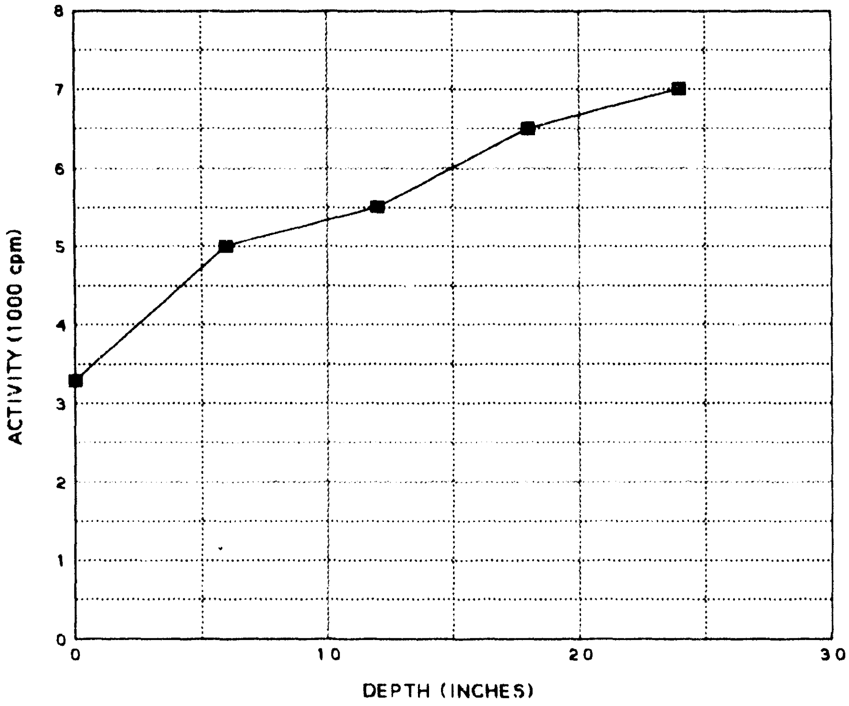


Fig. A.12. Gamma profile of auger hole B12

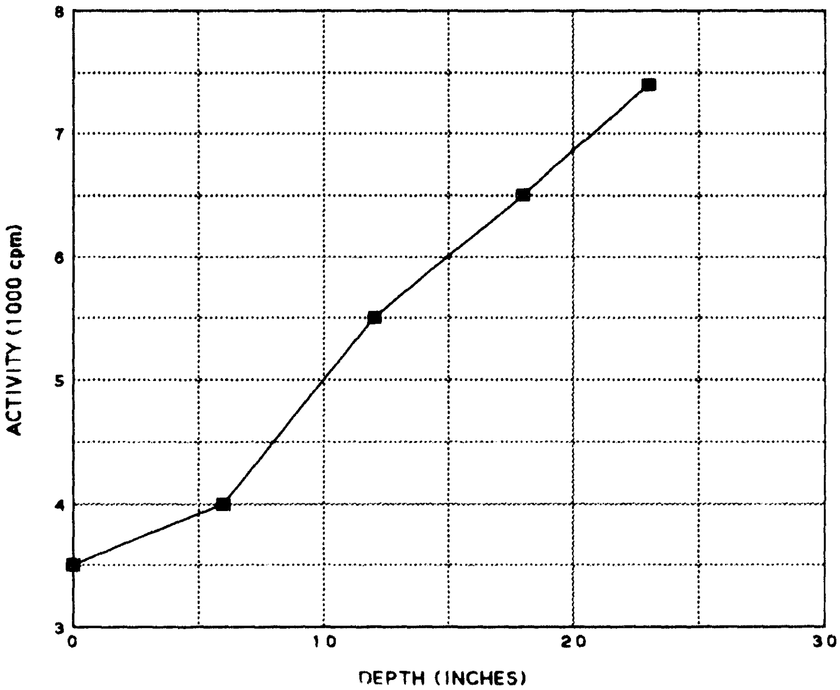


Fig. A.1 a profile of auger hole B13

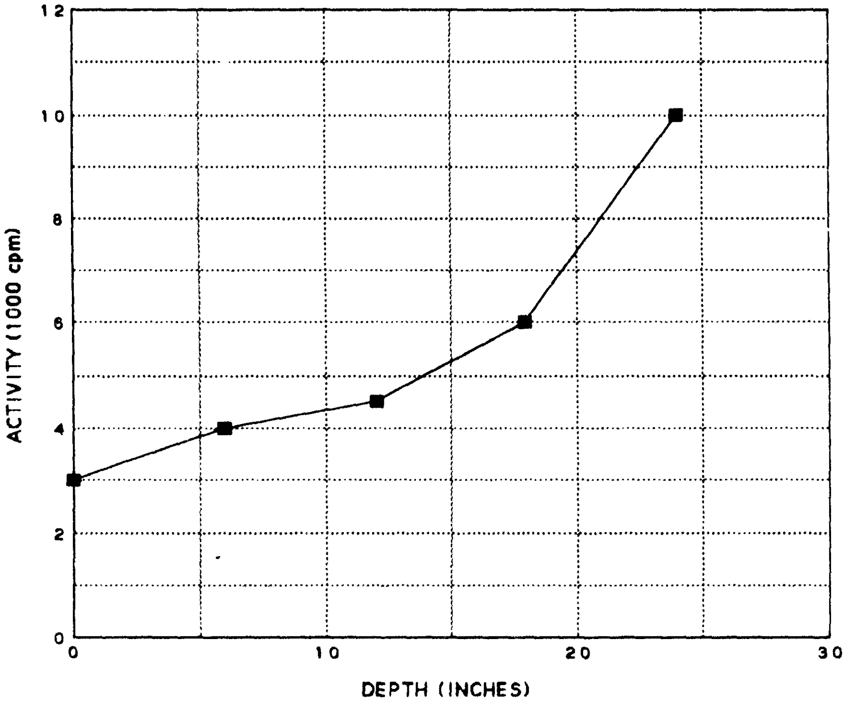


Fig. A.14. Gamma profile of auger hole B14

ORNL-DWG 92-9781

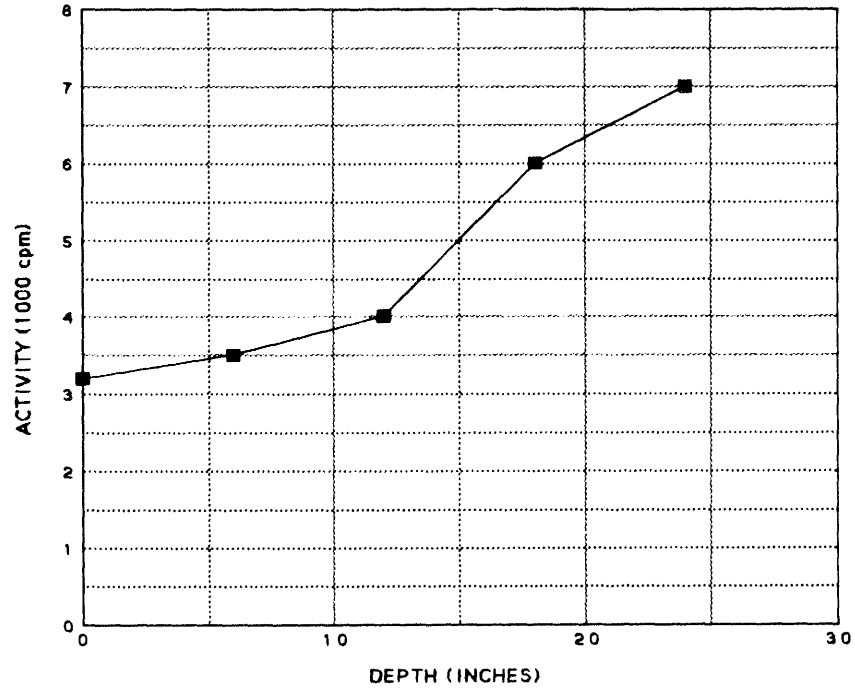


Fig. A.15. Gamma profile of auger hole B15

ORNL-DWG 92-9782

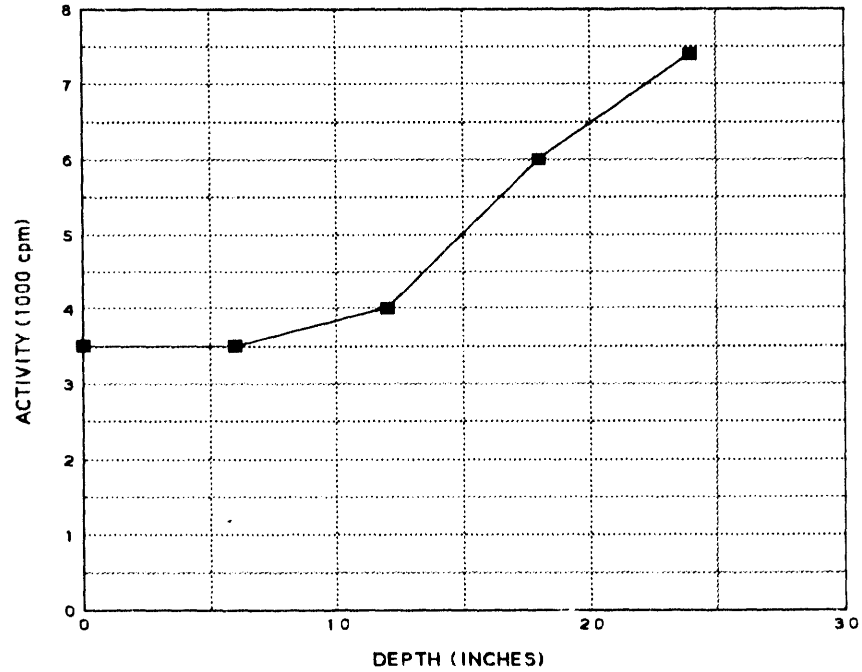


Fig. A.16. Gamma profile of auger hole B16

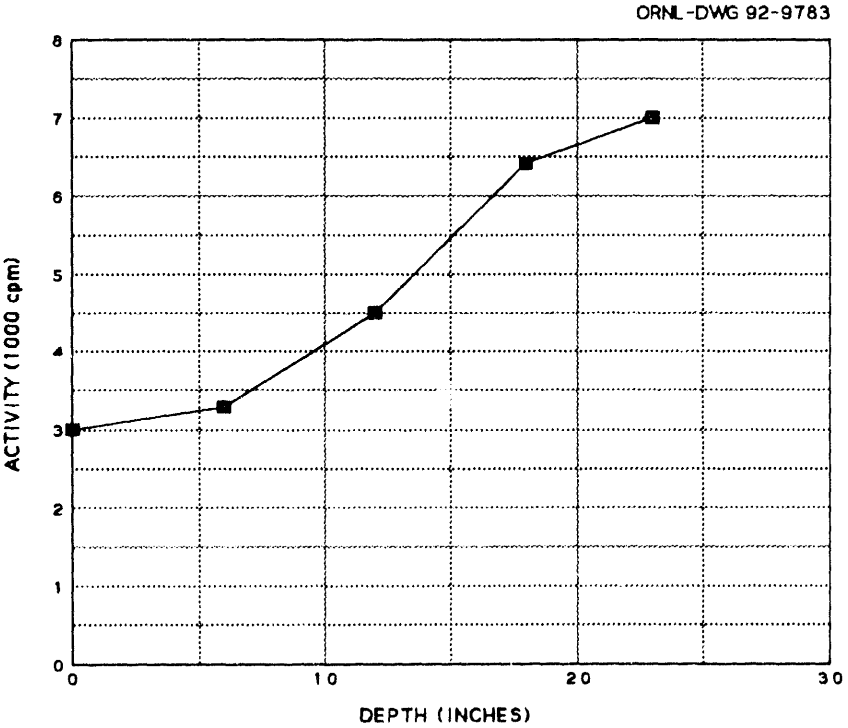


Fig. A.17. Gamma profile of auger hole B17

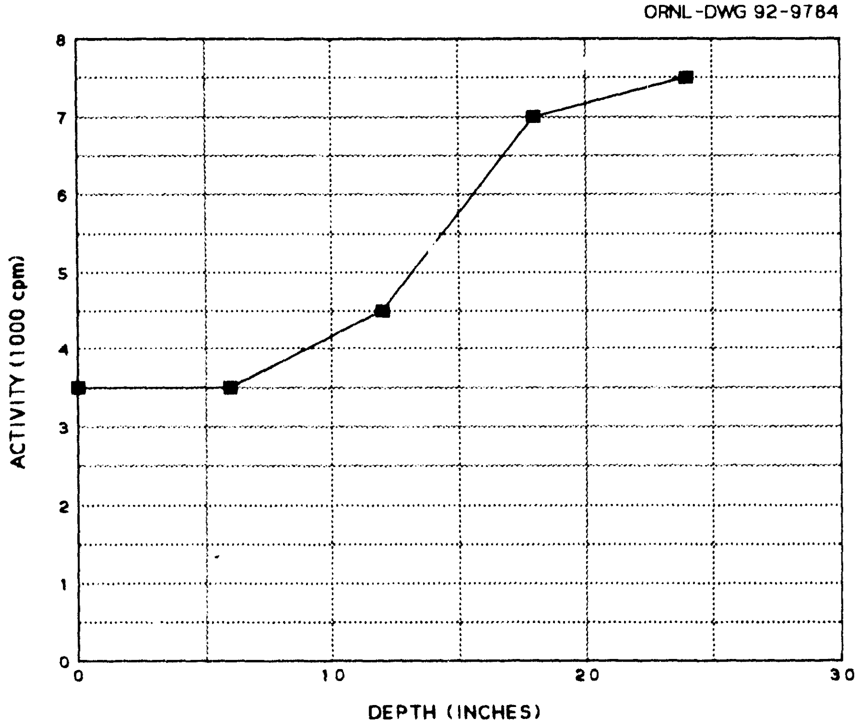


Fig. A.18. Gamma profile of auger hole B18

ORNL-DWG 92-9785

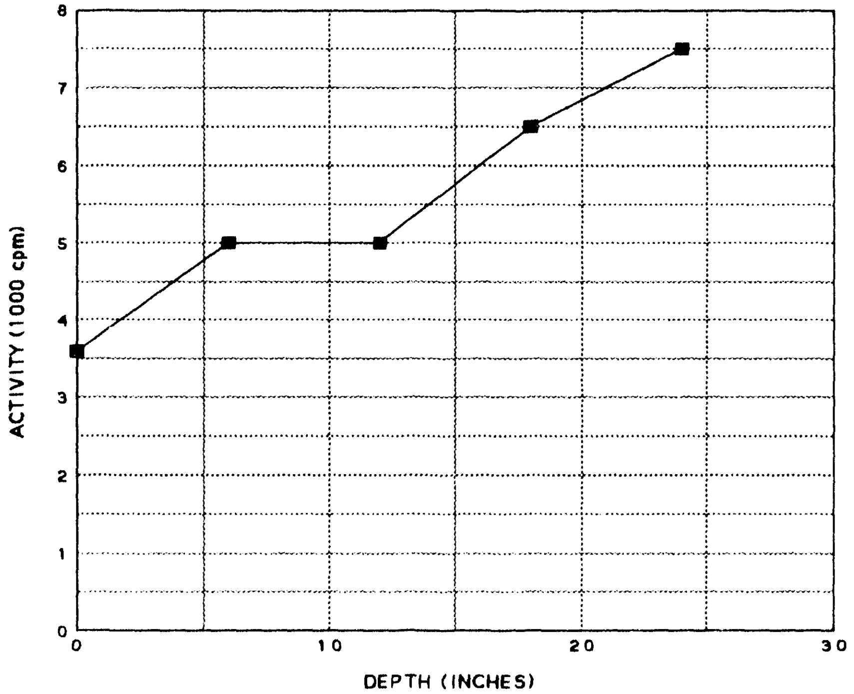


Fig. A.19. Gamma profile of auger hole B19

ORNL-DWG 92-9786

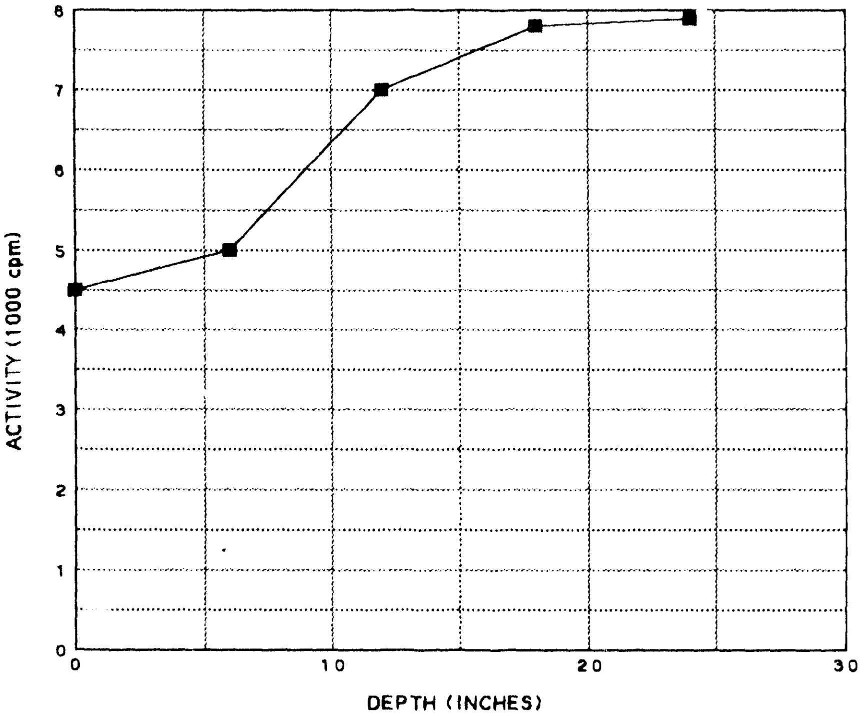


Fig. A.20. Gamma profile of auger hole B20

ORNL-DWG 92-9787

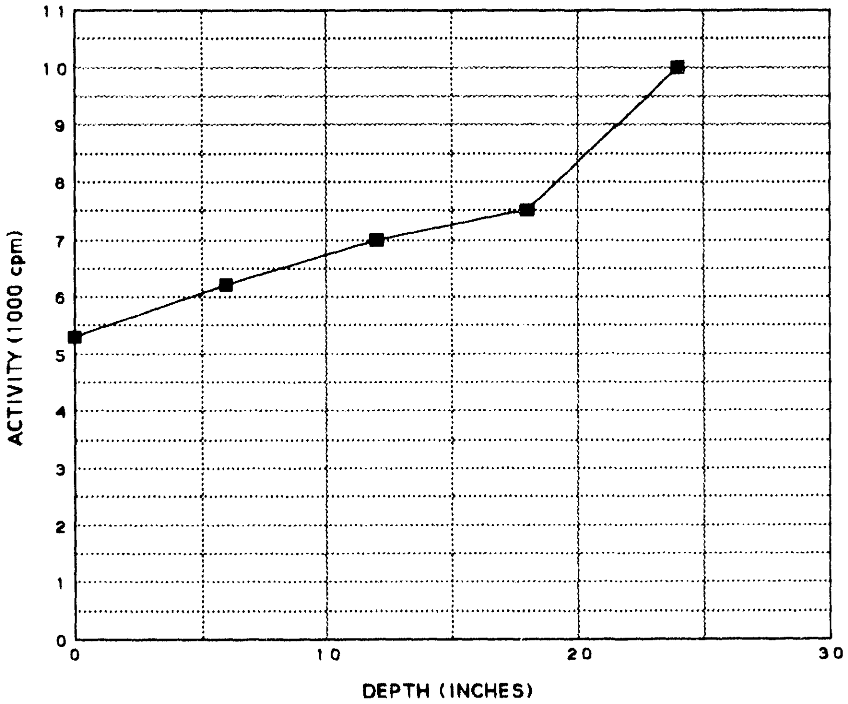


Fig. A.21. Gamma profile of auger hole B21

ORNL-DWG 92-9788

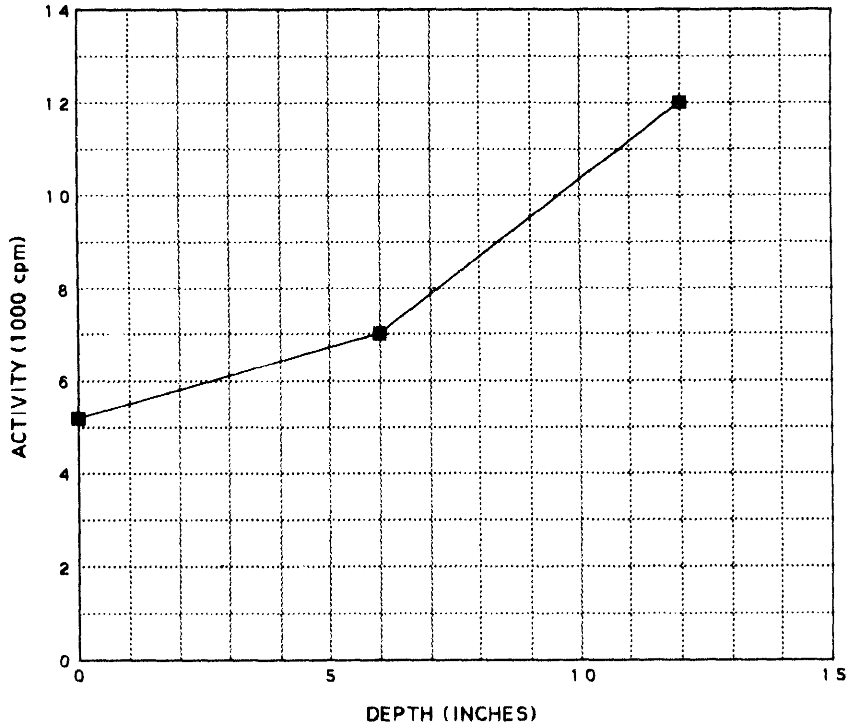


Fig. A.22. Gamma profile of auger hole B22

ORNL-DWG 92-9789

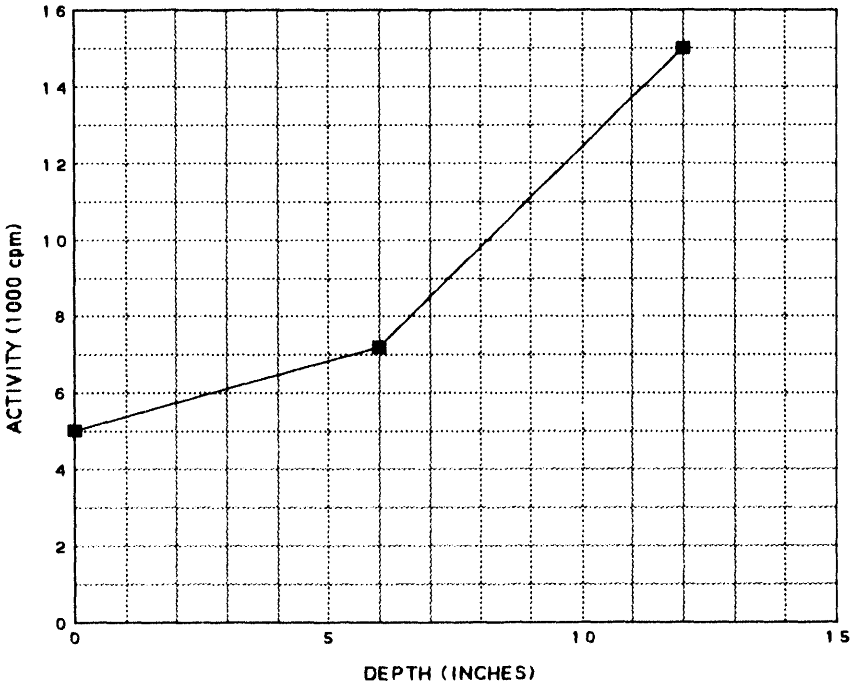


Fig. A.23. Gamma profile of auger hole B23

ORNL-DWG 92-9790

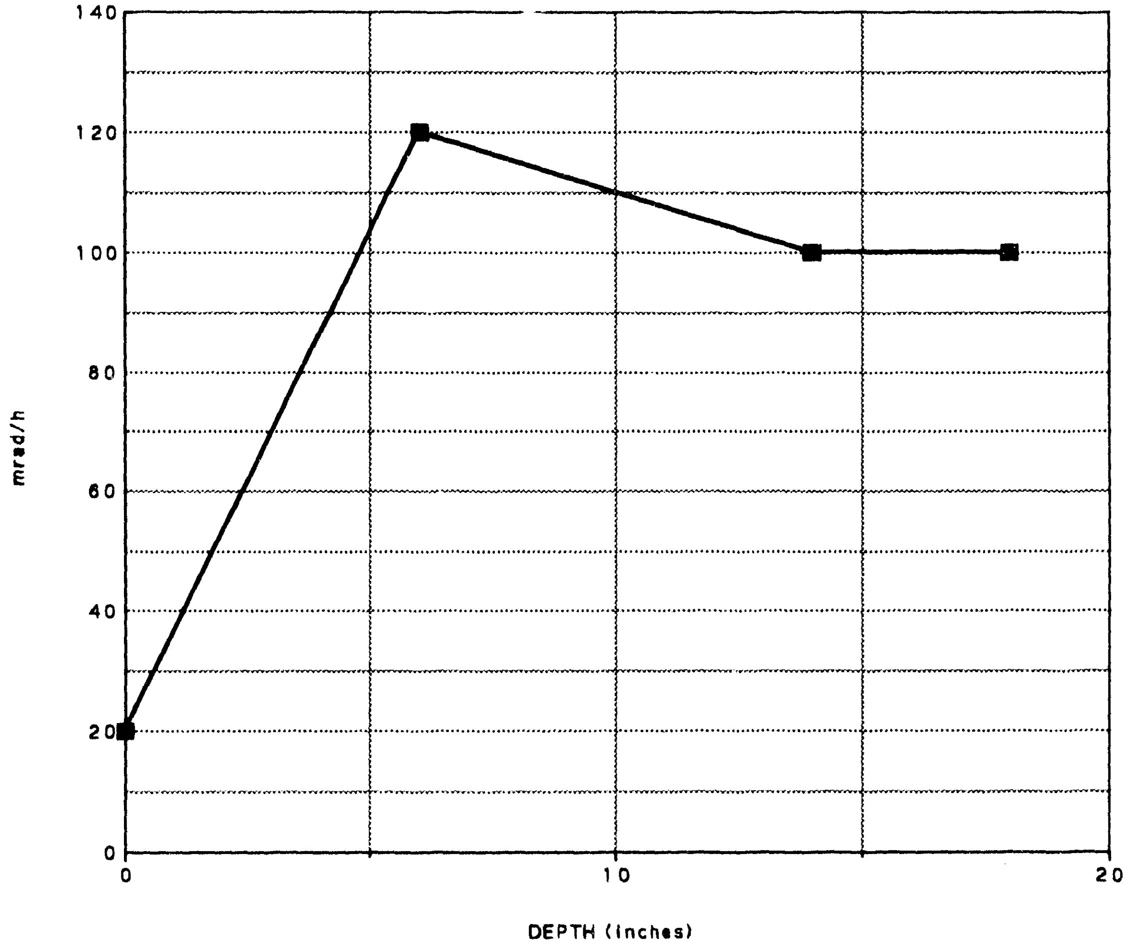


Fig. A.24. Beta-gamma profile of auger hole B24. Measurements were taken with an ORNL paper-shell cutie pie ionization chamber.

Appendix B

CHEMICAL AND RADIOLOGICAL ANALYSIS OF SOIL, PRESAMPLING RINSATE, AND FIELD BLANK SAMPLES

EcoTek LSI
EcoTek Laboratory Services Incorporated

July 1, 1992

Dr. Charlotte Kimbrough
Martin Marietta Energy Systems
P. O. Box 2003
Hwy. 58, Blair Road
Oak Ridge, TN 37831-7169

References: SOW MAD/AS-01

Dear Dr. Kimbrough:

Enclosed along with this letter are the partial results for the sample(s) received June 5, 1992. The remaining results will follow as soon as possible.

Please contact Mike Buchanan at (404)244-0827 if you have any questions. Also, please refer to LSDG number 2483 in future correspondence.

Sincerely,

ECOTEK LABORATORY SERVICES, INC.

Donald L. Dihel
Quality Assurance Manager

Mike Buchanan
Laboratory Manager

Enclosures.
DLD/JMB/crb

EcoTek LSI
EcoTek Laboratory Services Incorporated

CASE NARRATIVE FOR CLP VOLATILE ANALYSIS---SOW OLM01.8

Client: Martin Marietta Environmental Services
LSDG: 2483
Project: 7500 Area Contamination/SOW MAD/AS-01

* All volatile organics were analyzed by GC/MS on Hewlett-Packard MSD 5970---Inst. ID. 7002---Inst. ID. 7003.

* Chromatography was performed on a 2.4m x 2.0mm ID glass column packed with 1% SP 1000 Carbopack B and/or a 75m x 0.53mm DB-624 megabore column. Samples were purged via Tekmar LSC-2/ALS and/or OI 4460A/OIC MPM-16 onto traps composed of silica gel/charcoal/Tenax. Operating temperatures are 220°C, 250°C, 280°C respectively for the injector, jet separator, source/interface.

* Sample purge size was 5 ml for aqueous matrices unless noted otherwise.

* The reports of the TCL and TIC compounds identified and quantified in the samples are contained in the following sections of the data package. Also included are the appropriate calibration and quality control data where applicable. Data was obtained from HP RTE-A series computer with Aquarius software.

* The following exceptions and/or considerations should be noted for the sample group contained within.

- Methylene chloride (and in many cases acetone) is a common laboratory contaminant that is present in virtually all volatile method blanks. When these analytes are detected in a sample they are "B" flagged to indicate that this analyte was found in the associated blank as well as in the sample. It indicates possible/probable blank/sample contamination and warns the data user to take appropriate action. When any sample needs dilution for analysis, the background contaminant analyte value is factored for this dilution. All of these factors should be considered when the data is evaluated.

- Surrogate recovery for all samples, blanks and spikes were within acceptable limits.

- A matrix spike and matrix spike duplicate were performed on sample B24B. Recoveries and RPDs were well within acceptable limits.

EcoTek LSI
EcoTek Laboratory Services Incorporated

Volatile Organic Analytical Results
CLP SOW OLMO1.8

Client:	*Martin Marietta*	*Client Sample No.:*	*B24S*
Lab Sample ID:	*248301*	*Client Reference No.:*	*SOW MAD/AS-01*
Matrix:	*Water*	*Date Received:*	*June 8, 1992*
Dilution Factor:	*1*	*Date Analyzed:*	*June 11, 1992*

CAS Number	*Compound Name*	*Result ug/l*	*PQL ug/l*	*Note*
74873	Chloromethane	BQL	10	
74839	Bromomethane	BQL	10	
75014	Vinyl Chloride	BQL	10	
75003	Chloroethane	BQL	10	
75092	Methylene Chloride	BQL	10	
67641	Acetone	BQL	10	
75150	Carbon Disulfide	BQL	10	
75354	1,1-Dichloroethene	BQL	10	
75343	1,1-Dichloroethane	BQL	10	
156605	1,2-Dichloroethene (total)	BQL	10	
67663	Chloroform	BQL	10	
107062	1,2-Dichloroethane	BQL	10	
78933	2-Butanone	BQL	10	
71556	1,1,1-Trichloroethane	BQL	10	
56235	Carbon Tetrachloride	BQL	10	
75274	Bromodichloromethane	BQL	10	
78875	1,2-Dichloropropane	BQL	10	
10061015	cis-1,3-Dichloropropene	BQL	10	
79016	Trichloroethene	BQL	10	
124481	Dibromochloromethane	BQL	10	
79005	1,1,2-Trichloroethane	BQL	10	

Lab Sample ID: *248301* *Client Sample No.:* *B24S*

CAS Number	Compound Name	Result ug/l	PQL ug/l	Note
71432	Benzene	BQL	10	
10061026	Trans-1,3-Dichloropropene	BQL	10	
75252	Bromoform	BQL	10	
108101	4-Methyl-2-pentanone	BQL	10	
591786	2-Hexanone	BQL	10	
127184	Tetrachloroethene	BQL	10	
79345	1,1,2,2-Tetrachloroethane	BQL	10	
108883	Toluene	BQL	10	
108907	Chlorobenzene	BQL	10	
100414	Ethylbenzene	BQL	10	
100425	Styrene	BQL	10	
1330207	Xylene (total)	BQL	10	

PQL = Practical Quantitation Limit

BQL = Below Quantitation Limit

* = *Indicates an estimated value when the mass spectral data indicate the presence of a compound that meets the identification criteria in which the result is less than the practical quantitation limit but greater than zero.*

B = This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable contamination and warns the data user to take appropriate action.

Volatile Surrogate Recovery Data

Lab Sample ID: 248301

Client Sample No.: B24S

Surrogate Compound	% Recovery	QC Limits	Notes
Toluene-d8	99	88-110	
Bromofluorobenzene	98	86-115	
1,2-Dichloroethane-d4	94	76-114	

D = Surrogate diluted out
*** = Surrogate recovery outside QC Limits

Surrogates are compounds added to the sample prior to purging to monitor the purge efficiency.
Lower surrogate recoveries may indicate possible matrix effect and/or lower purge efficiency.

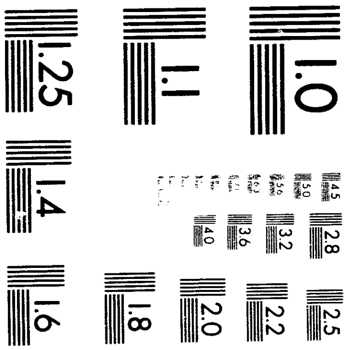
Attachment A

EcoTek LSI
EcoTek Laboratory Services Incorporated

Volatile Organic Analytical Results
CLP SOW OLMO1.8

Client:	*Martin Marietta*	*Client Sample No.:*	*B24B*
Lab Sample ID:	*248302*	*Client Reference No.:*	*SOW MAD/AS-01*
Matrix:	*Water*	*Date Received:*	*June 8, 1992*
Dilution Factor:	*1*	*Date Analyzed:*	*June 10, 1992*

CAS Number	Compound Name	Result ug/l	PQL ug/l	Note
74873	Chloromethane	BQL	10	
74839	Bromomethane	BQL	10	
75014	Vinyl Chloride	BQL	10	
75003	Chloroethane	BQL	10	
75092	Methylene Chloride	4	10	B*
67641	Acetone	BQL	10	
75150	Carbon Disulfide	BQL	10	
75354	1,1-Dichloroethene	BQL	10	
75343	1,1-Dichloroethane	BQL	10	
156605	1,2-Dichloroethene (total)	BQL	10	
67663	Chloroform	2	10	*
107062	1,2-Dichloroethane	BQL	10	
78933	2-Butanone	BQL	10	
71556	1,1,1-Trichloroethane	BQL	10	
56235	Carbon Tetrachloride	BQL	10	
75274	Bromodichloromethane	BQL	10	
78875	1,2-Dichloropropane	2	10	*
10061015	cis-1,3-Dichloropropene	BQL	10	
79016	Trichloroethene	BQL	10	
124481	Dibromochloromethane	BQL	10	
79005	1,1,2-Trichloroethane	BQL	10	


1.0
1.1
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2.0
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3.2
3.6
4.0
4.5
5.0
5.6
6.3

Lab Sample ID: 248302 *Client Sample No.:* B24B

CAS Number	Compound Name	Result ug/l	PQL ug/l	Note
71432	Benzene	BQL	10	
10061026	Trans-1,3-Dichloropropene	BQL	10	
75252	Bromoform	BQL	10	
108101	4-Methyl-2-pentanone	BQL	10	
591786	2-Hexanone	BQL	10	
127184	Tetrachloroethene	BQL	10	
79345	1,1,2,2-Tetrachloroethane	BQL	10	
108883	Toluene	BQL	10	
108907	Chlorobenzene	BQL	10	
100414	Ethylbenzene	BQL	10	
100425	Styrene	BQL	10	
1330207	Xylene (total)	BQL	10	

PQL = Practical Quantitation Limit

BQL = Below Quantitation Limit

* = *Indicates an estimated value when the mass spectral data indicate the presence of a compound that meets the identification criteria in which the result is less than the practical quantitation limit but greater than zero.*

B = This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable contamination and warns the data user to take appropriate action.

Volatile Surrogate Recovery Data

Lab Sample ID: *248302* *Client Sample No.:* *B24B*

Surrogate Compound	*% Recovery*	*QC Limits*	*Notes*
Toluene-d8	*97*	*88-110*	
Bromofluorobenzene	*99*	*86-115*	
1,2-Dichloroethane-d4	*99*	*76-114*	

D = Surrogate diluted out
**** = Surrogate recovery outside QC Limits*

Surrogates are compounds added to the sample prior to purging to monitor the purge efficiency. Lower surrogate recoveries may indicate possible matrix effect and/or lower purge efficiency.

EcoTek LSI
EcoTek Laboratory Services Incorporated

Volatile Organic Analytical Results
CLP SOW OLMO1.8

Client:	*Martin Marietta*	*Client Sample No.:*	*B24E*
Lab Sample ID:	*248303*	*Client Reference No.:*	*SOW MAD/AS-01*
Matrix:	*Water*	*Date Received:*	*June 8, 1992*
Dilution Factor:	*1*	*Date Analyzed:*	*June 10, 1992*

CAS Number	*Compound Name*	*Result ug/l*	*PQL ug/l*	*Note*
74873	Chloromethane	BQL	10	
74839	Bromomethane	BQL	10	
75014	Vinyl Chloride	BQL	10	
75003	Chloroethane	BQL	10	
75092	Methylene Chloride	4	10	B*
67641	Acetone	BQL	10	
75150	Carbon Disulfide	BQL	10	
75354	1,1-Dichloroethene	BQL	10	
75343	1,1-Dichloroethane	BQL	10	
156605	1,2-Dichloroethene (total)	BQL	10	
67663	Chloroform	2	10	*
107062	1,2-Dichloroethane	BQL	10	
78933	2-Butanone	BQL	10	
71556	1,1,1-Trichloroethane	BQL	10	
56235	Carbon Tetrachloride	BQL	10	
75274	Bromodichloromethane	BQL	10	
78875	1,2-Dichloropropane	2	10	*
10061015	cis-1,3-Dichloropropene	BQL	10	
79016	Trichloroethene	BQL	10	
124481	Dibromochloromethane	BQL	10	
79005	1,1,2-Trichloroethane	BQL	10	

Lab Sample ID: *248303* *Client Sample No.:* *B24E*

CAS Number	*Compound Name*	*Result ug/l*	*PQL ug/l*	*Note*
71432	*Benzene*	*BQL*	*10*	
10061026	*Trans-1,3-Dichloropropene*	*BQL*	*10*	
75252	*Bromoform*	*BQL*	*10*	
108101	*4-Methyl-2-pentanone*	*BQL*	*10*	
591786	*2-Hexanone*	*BQL*	*10*	
127184	*Tetrachloroethene*	*BQL*	*10*	
79345	*1,1,2,2-Tetrachloroethane*	*BQL*	*10*	
108883	*Toluene*	*BQL*	*10*	
108907	*Chlorobenzene*	*BQL*	*10*	
100414	*Ethylbenzene*	*BQL*	*10*	
100425	*Styrene*	*BQL*	*10*	
1330207	*Xylene (total)*	*BQL*	*10*	

PQL = Practical Quantitation Limit

BQL = Below Quantitation Limit

** = Indicates an estimated value when the mass spectral data indicate the presence of a compound that meets the identification criteria in which the result is less than the practical quantitation limit but greater than zero.*

B = This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable contamination and warns the data user to take appropriate action.

Volatile Surrogate Recovery Data

Lab Sample ID: *248303*	*Client Sample No.:* *B24E*

Surrogate Compound	*% Recovery*	*QC Limits*	*Notes*
Toluene-d8	*97*	*88-110*	
Bromofluorobenzene	*101*	*86-115*	
1,2-Dichloroethane-d4	*98*	*76-114*	

D = Surrogate diluted out
**** = Surrogate recovery outside QC Limits*

Surrogates are compounds added to the sample prior to purging to monitor the purge efficiency. Lower surrogate recoveries may indicate possible matrix effect and/or lower purge efficiency.

Volatile Organic Analytical Results
CLP SOW OLMO1.8

Client:	Martin Marietta	Client Sample No.:	B24T
Lab Sample ID:	248304	Client Reference No.:	SOW MAD/AS-01
Matrix:	Water	Date Received:	June 8, 1992
Dilution Factor:	1	Date Analyzed:	June 10, 1992

CAS Number	Compound Name	Result ug/l	PQL ug/l	Note
74873	Chloromethane	BQL	10	
74839	Bromomethane	BQL	10	
75014	Vinyl Chloride	BQL	10	
75003	Chloroethane	BQL	10	
75092	Methylene Chloride	4	10	B*
67641	Acetone	7	10	*
75150	Carbon Disulfide	BQL	10	
75354	1,1-Dichloroethene	BQL	10	
75343	1,1-Dichloroethane	BQL	10	
156605	1,2-Dichloroethene (total)	BQL	10	
67663	Chloroform	BQL	10	
107062	1,2-Dichloroethane	BQL	10	
78933	2-Butanone	BQL	10	
71556	1,1,1-Trichloroethane	BQL	10	
56235	Carbon Tetrachloride	BQL	10	
75274	Bromodichloromethane	BQL	10	
78875	1,2-Dichloropropane	BQL	10	
10061015	cis-1,3-Dichloropropene	BQL	10	
79016	Trichloroethene	BQL	10	
124481	Dibromochloromethane	BQL	10	
79005	1,1,2-Trichloroethane	BQL	10	

Lab Sample ID: *248304* *Client Sample No.:* *B24T*

CAS Number	*Compound Name*	*Result ug/l*	*PQL ug/l*	*Note*
71432	*Benzene*	*BQL*	*10*	
10061026	*Trans-1,3-Dichloropropene*	*BQL*	*10*	
75252	*Bromoform*	*BQL*	*10*	
108101	*4-Methyl-2-pentanone*	*BQL*	*10*	
591786	*2-Hexanone*	*BQL*	*10*	
127184	*Tetrachloroethene*	*BQL*	*10*	
79345	*1,1,2,2-Tetrachloroethane*	*BQL*	*10*	
108883	*Toluene*	*3*	*10*	*
108907	*Chlorobenzene*	*BQL*	*10*	
100414	*Ethylbenzene*	*BQL*	*10*	
100425	*Styrene*	*BQL*	*10*	
1330207	*Xylene (total)*	*BQL*	*10*	

PQL = Practical Quantitation Limit

BQL = Below Quantitation Limit

* = *Indicates an estimated value when the mass spectral data indicate the presence of a compound that meets the identification criteria in which the result is less than the practical quantitation limit but greater than zero.*

B = This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable contamination and warns the data user to take appropriate action.

Volatile Surrogate Recovery Data

Lab Sample ID: 248304 *Client Sample No.:* B24T

Surrogate Compound	*% Recovery*	*QC Limits*	*Notes*
Toluene-d8	96	88-110	
Bromofluorobenzene	97	86-115	
1,2-Dichloroethane-d4	94	76-114	

D = Surrogate diluted out
**** = Surrogate recovery outside QC Limits*

Surrogates are compounds added to the sample prior to purging to monitor the purge efficiency. Lower surrogate recoveries may indicate possible matrix effect and/or lower purge efficiency.

Volatile Organic Analytical Results
CLP SOW OLMO1.8

Client:	*Martin Marietta*	*Client Sample No.:*	*Method Blank*
Lab Sample ID:	*VBLKWA*	*Client Reference No.:*	*SOW MAD/AS-01*
Matrix:	*Water*	*Date Received:*	*June 8, 1992*
Dilution Factor:	*1*	*Date Analyzed:*	*June 10, 1992*

CAS Number	*Compound Name*	*Result ug/l*	*PQL ug/l*	*Note*
74873	*Chloromethane*	*BQL*	*10*	
74839	*Bromomethane*	*BQL*	*10*	
75014	*Vinyl Chloride*	*BQL*	*10*	
75003	*Chloroethane*	*BQL*	*10*	
75092	*Methylene Chloride*	*5*	*10*	*
67641	*Acetone*	*BQL*	*10*	
75150	*Carbon Disulfide*	*BQL*	*10*	
75354	*1,1-Dichloroethene*	*BQL*	*10*	
75343	*1,1-Dichloroethane*	*BQL*	*10*	
156605	*1,2-Dichloroethene (total)*	*BQL*	*10*	
67663	*Chloroform*	*BQL*	*10*	
107062	*1,2-Dichloroethane*	*BQL*	*10*	
78933	*2-Butanone*	*BQL*	*10*	
71556	*1,1,1-Trichloroethane*	*BQL*	*10*	
56235	*Carbon Tetrachloride*	*BQL*	*10*	
75274	*Bromodichloromethane*	*BQL*	*10*	
78875	*1,2-Dichloropropane*	*BQL*	*10*	
10061015	*cis-1,3-Dichloropropene*	*BQL*	*10*	
79016	*Trichloroethene*	*BQL*	*10*	
124481	*Dibromochloromethane*	*BQL*	*10*	
79005	*1,1,2-Trichloroethane*	*BQL*	*10*	

Lab Sample ID: *VBLKWA* *Client Sample No.:* *Method Blank*

CAS Number	*Compound Name*	*Result ug/l*	*PQL ug/l*	*Note*
71432	Benzene	BQL	10	
10061026	Trans-1,3-Dichloropropene	BQL	10	
75252	Bromoform	BQL	10	
108101	4-Methyl-2-pentanone	BQL	10	
591786	2-Hexanone	BQL	10	
127184	Tetrachloroethene	BQL	10	
79345	1,1,2,2-Tetrachloroethane	BQL	10	
108883	Toluene	BQL	10	
108907	Chlorobenzene	BQL	10	
100414	Ethylbenzene	BQL	10	
100425	Styrene	BQL	10	
1330207	Xylene (total)	BQL	10	

PQL = Practical Quantitation Limit

BQL = Below Quantitation Limit

* = *Indicates an estimated value when the mass spectral data indicate the presence of a compound that meets the identification criteria in which the result is less than the practical quantitation limit but greater than zero.*

B = This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable contamination and warns the data user to take appropriate action.

Volatile Surrogate Recovery Data

Lab Sample ID: VBLKWA

Client Sample No.: Method Blank

Surrogate Compound	% Recovery	QC Limits	Notes
Toluene-d8	96	88-110	
Bromofluorobenzene	98	86-115	
1,2-Dichloroethane-d4	94	76-114	

D = Surrogate diluted out
*** = Surrogate recovery outside QC Limits

Surrogates are compounds added to the sample prior to purging to monitor the purge efficiency. Lower surrogate recoveries may indicate possible matrix effect and/or lower purge efficiency.

Attachment A

EcoTek LSI
EcoTek Laboratory Services Incorporated

Client: Martin Marietta
LSDG: 2483
Method: CLP SOW OLMO1.8
Client Reference No.: SOW MAD/AS-01

Sample Receipt Date: June 8,1992
Date of Collection: May 31,1992
Date of Analysis: June 10,1992

MS/MSD ANALYTICAL RESULTS
VOLATILE

Lab Sample ID: 248302MS
Client Sample ID: B24B

Spike Compound	% Recovery QC Limits *	Spike Amount (µg/l)	Unspiked Sample Result (µg/l)	Spiked Sample Result (µg/l) (MS)	% Spike Recovery (MS)	Duplicate Spike Sample Result (µg/l) (MSD)	% Spike Recovery (MSD)	%RPD
1,1-Dichloroethene	61-145	50	0	45	89	45	90	0
Trichloroethene	71-120	50	0	50	101	49	99	2
Benzene	76-127	50	0	51	102	52	104	2
Toluene	76-125	50	0	51	102	50	100	2
Chlorobenzene	75-130	50	0	49	98	48	95	3

* = EPA CLP SOW OLMO1.8 Form III VOA-1
D = Detected

EcoTek LSI
EcoTek Laboratory Services Incorporated

CASE NARRATIVE FOR SPECIAL VOLATILES ANALYSIS USING SW-846 METHOD 8240

Client: Martin Marietta Environmental Services
LSDG: 2483
Project: 7500 Area Contamination/SOW MAD/AS-01

* All volatile organics were analyzed by GC/MS on an HPMSD 5970 Inst. ID. 7002 or Inst. ID. 7004 or HPMSD 5971 Inst. ID. 7101
* Chromatography was performed on a 2.4m x 2.0mm ID glass column packed with 1% SP 1000 Carbopack B and/or a 75m x 0.53mm DB-624 megabore column. Samples were purged via Tekmar LSC-2/ALS and/or OI 4460A/OIC MPM-16 onto traps composed of silica gel/charcoal/Tenax. Operating temperatures are 220°C, 250°C, 280°C respectively for the injector, jet separator, source/interface.
* Sample purge size was 5 ml for aqueous matrices unless noted otherwise.
* The reports of the target compounds identified and quantified in the samples are contained in the following sections of the data package. Also included are the appropriate calibration and quality control data where applicable. Data was obtained from HP RTE-A series computer with Aquarius software.
* Practical Quantitation Limits (PQL) are based on those listed in SW846 Method 8240 factored for any necessary dilutions.
* The following exceptions and/or considerations should be noted for the sample group contained within.

- A larger sample purge size (25ml) was utilized in order to achieve the requested detection limit for the BTEX compounds.

- All samples for this phase of the project were analyzed for a specific group of compounds only (see final report).

- The surrogate recoveries for the blank and all samples associated with this phase of the case, with the exception of B24T, were within acceptable QC limits. Sample B24T had one non-compliant surrogate on the initial analysis. This sample was reanalyzed and the same surrogate was non-compliant.

- Analysis for the analytes Paraldehyde and Acrylamide was performed by EICP (Extracted Ion Current Profile) in which the mass chromatogram is searched for using the characteristic ions for these two compounds.

EcoTek LSI
EcoTek Laboratory Services Incorporated

Volatile Organic Analytical Results
SW-846 Method 8240

Client:	*Martin Marietta*	*Client Sample No.:*	*B24S*
Lab Sample ID:	*248301*	*Client Reference No.:*	*SOW MAD/AS-01*
Matrix:	*Water*	*Date Received:*	*June 8, 1992*
Dilution Factor:	*1*	*Date Analyzed:*	*June 11, 1992*

CAS Number	*Compound Name*	*Result ug/l*	*PQL ug/l*	*Note*
78933	2-Butanone	BQL	20	
71432	Benzene	BQL	1	
108101	4-Methyl-2-pentanone	BQL	10	
64175	Ethanol	BQL	2000	
60297	Diethylether	BQL	10	
108883	Toluene	BQL	1	
100414	Ethylbenzene	BQL	1	
1330207	Xylene (total)	BQL	1	*
123637	Paraldehyde ** #	ND	NA	
79061	Acrylamide ** #	ND	NA	

NA = Not Applicable

PQL = Practical Quantitation Limit

BQL = Below Quantitation Limit

* = *Indicates an estimated value when the mass spectral data indicate the presence of a compound that meets the identification criteria in which the result is less than the practical quantitation limit but greater than zero.*

B = This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable contamination and warns the data user to take appropriate action.

 # = See Case Narrative

*** = Analysis for this analyte by EICP (Extracted Ion Current Profile)*

ND = Not Detected

EcoTek LSI
EcoTek Laboratory Services Incorporated

Volatile Surrogate Recovery Data

Lab Sample ID: 248301 *Client Sample No.:* B24S

Surrogate Compound	% Recovery	QC Limits	Notes
Toluene-d8	101	88-110	
Bromofluorobenzene	96	86-115	
1,2-Dichloroethane-d4	97	76-114	

D = Surrogate diluted out
*** = Surrogate recovery outside QC Limits

Surrogates are compounds added to the sample prior to purging to monitor the purge efficiency. Lower surrogate recoveries may indicate possible matrix effect and/or lower purge efficiency.

EcoTek LSI
EcoTek Laboratory Services Incorporated

Volatile Organic Analytical Results
SW-846 Method 8240

Client:	*Martin Marietta*	*Client Sample No.:*	*B24B*
Lab Sample ID:	*248302*	*Client Reference No.:*	*SOW MAD/AS-01*
Matrix:	*Water*	*Date Received:*	*June 8, 1992*
Dilution Factor:	*1*	*Date Analyzed:*	*June 11, 1992*

CAS Number	*Compound Name*	*Result ug/l*	*PQL ug/l*	*Note*
78933	*2-Butanone*	*BQL*	*20*	
71432	*Benzene*	*BQL*	*1*	
108101	*4-Methyl-2-pentanone*	*BQL*	*10*	
64175	*Ethanol*	*BQL*	*2000*	
60297	*Diethylether*	*BQL*	*10*	
108883	*Toluene*	*2*	*1*	
100414	*Ethylbenzene*	*BQL*	*1*	
1330207	*Xylene (total)*	*1*	*1*	*
123637	*Paraldehyde ** #*	*ND*	*NA*	
79061	*Acrylamide ** #*	*ND*	*NA*	

NA = Not Applicable

PQL = Practical Quantitation Limit

BQL = Below Quantitation Limit

** = Indicates an estimated value when the mass spectral data indicate the presence of a compound that meets the identification criteria in which the result is less than the practical quantitation limit but greater than zero.*

B = This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable contamination and warns the data user to take appropriate action.

 # = See Case Narrative

*** = Analysis for this analyte by EICP (Extracted Ion Current Profile)*

ND = Not Detected

Volatile Surrogate Recovery Data

Lab Sample ID: *248302*   *Client Sample No.:* *B24B*

Surrogate Compound	*% Recovery*	*QC Limits*	*Notes*
Toluene-d8	*107*	*88-110*	
Bromofluorobenzene	*95*	*86-115*	
1,2-Dichloroethane-d4	*109*	*76-114*	

D = Surrogate diluted out
**** = Surrogate recovery outside QC Limits*

Surrogates are compounds added to the sample prior to purging to monitor the purge efficiency. Lower surrogate recoveries may indicate possible matrix effect and/or lower purge efficiency.

EcoTek LSI
EcoTek Laboratory Services Incorporated

Volatile Organic Analytical Results
SW-846 Method 8240

Client:	*Martin Marietta*	*Client Sample No.:*	*B24E*
Lab Sample ID:	*248303*	*Client Reference No.:*	*SOW MAD/AS-01*
Matrix:	*Water*	*Date Received:*	*June 8, 1992*
Dilution Factor:	*1*	*Date Analyzed:*	*June 11, 1992*

CAS Number	*Compound Name*	*Result ug/l*	*PQL ug/l*	*Note*
78933	*2-Butanone*	*BQL*	*20*	
71432	*Benzene*	*BQL*	*1*	
108101	*4-Methyl-2-pentanone*	*BQL*	*10*	
64175	*Ethanol*	*BQL*	*2000*	
60297	*Diethylether*	*BQL*	*10*	
108883	*Toluene*	*2*	*1*	
100414	*Ethylbenzene*	*BQL*	*1*	
1330207	*Xylene (total)*	*1*	*1*	*
123637	*Paraldehyde ** #*	*ND*	*NA*	
79061	*Acrylamide ** #*	*ND*	*NA*	

NA = Not Applicable

PQL = Practical Quantitation Limit

BQL = Below Quantitation Limit

* = *Indicates an estimated value when the mass spectral data indicate the presence of a compound that meets the identification criteria in which the result is less than the practical quantitation limit but greater than zero.*

B = This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable contamination and warns the data user to take appropriate action.

 # = See Case Narrative

*** = Analysis for this analyte by EICP (Extracted Ion Current Profile)*

ND = Not Determined

EcoTek LSI
EcoTek Laboratory Services Incorporated

Volatile Surrogate Recovery Data

Lab Sample ID: 248303 Client Sample No.: B24E

Surrogate Compound	% Recovery	QC Limits	Notes
Toluene-d8	97	88-110	
Bromofluorobenzene	105	86-115	
1,2-Dichloroethane-d4	114	76-114	

D = Surrogate diluted out
*** = Surrogate recovery outside QC Limits

Surrogates are compounds added to the sample prior to purging to monitor the purge efficiency. Lower surrogate recoveries may indicate possible matrix effect and/or lower purge efficiency.

EcoTek LSI
EcoTek Laboratory Services Incorporated

Volatile Organic Analytical Results
SW-846 Method 8240

Client:	Martin Marietta	Client Sample No.:	B24T
Lab Sample ID:	248304	Client Reference No.:	SOW MAD/AS-01
Matrix:	Water	Date Received:	June 8, 1992
Dilution Factor:	1	Date Analyzed:	June 11, 1992

CAS Number	Compound Name	Result ug/l	PQL ug/l	Note
78933	2-Butanone	BQL	20	
71432	Benzene	BQL	1	
108101	4-Methyl-2-pentanone	BQL	10	
64175	Ethanol	BQL	2000	
60297	Diethylether	BQL	10	
108883	Toluene	1	1	
100414	Ethylbenzene	BQL	1	
1330207	Xylene (total)	1	1	*
123637	Paraldehyde ** #	ND	NA	
79061	Acrylamide ** #	ND	NA	

NA = Not Applicable

PQL = Practical Quantitation Limit

BQL = Below Quantitation Limit

* = Indicates an estimated value when the mass spectral data indicate the presence of a compound that meets the identification criteria in which the result is less than the practical quantitation limit but greater than zero.

B = This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable contamination and warns the data user to take appropriate action.

= See Case Narrative

** = Analysis for this analyte by EICP (Extracted Ion Current Profile)

ND = Not Determined

EcoTek LSI
EcoTek Laboratory Services Incorporated

Volatile Surrogate Recovery Data

Lab Sample ID: *248304* *Client Sample No.:* *B24T*

Surrogate Compound	*% Recovery*	*QC Limits*	*Notes*
Toluene-d8	*89*	*88-110*	
Bromofluorobenzene	*104*	*86-115*	
1,2-Dichloroethane-d4	*119*	*76-114*	***

D = Surrogate diluted out
**** = Surrogate recovery outside QC Limits*

Surrogates are compounds added to the sample prior to purging to monitor the purge efficiency. Lower surrogate recoveries may indicate possible matrix effect and/or lower purge efficiency.

Attachment A

EcoTek LSI
EcoTek Laboratory Services Incorporated

Volatile Organic Analytical Results
SW-846 Method 8240

Client:	*Martin Marietta*	*Client Sample No.:*	*Method Blank*
Lab Sample ID:	*VBLKWA*	*Client Reference No.:*	*SOW MAD/AS-01*
Matrix:	*Water*	*Date Received:*	*June 8, 1992*
Dilution Factor:	*1*	*Date Analyzed:*	*June 11, 1992*

CAS Number	*Compound Name*	*Result ug/l*	*PQL ug/l*	*Note*
78933	*2-Butanone*	*BQL*	*20*	
71432	*Benzene*	*BQL*	*1*	
108101	*4-Methyl-2-pentanone*	*BQL*	*10*	
64175	*Ethanol*	*BQL*	*2000*	
60297	*Diethylether*	*BQL*	*10*	
108883	*Toluene*	*BQL*	*1*	
100414	*Ethylbenzene*	*BQL*	*1*	
1330207	*Xylene (total)*	*BQL*	*1*	
123637	*Paraldehyde ** #*	*ND*	*NA*	
79061	*Acrylamide ** #*	*ND*	*NA*	

NA = Not Applicable

PQL = Practical Quantitation Limit

BQL = Below Quantitation Limit

* = *Indicates an estimated value when the mass spectral data indicate the presence of a compound that meets the identification criteria in which the result is less than the practical quantitation limit but greater than zero.*

B = This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable contamination and warns the data user to take appropriate action.

 # = See Case Narrative

*** = Analysis for this analyte by EICP (Extracted Ion Current Profile)*

ND = Not Determined

Volatile Surrogate Recovery Data

Lab Sample ID: VBLKWA Client Sample No.: Method Blank

Surrogate Compound	% Recovery	QC Limits	Notes
Toluene-d8	100	88-110	
Bromofluorobenzene	103	86-115	
1,2-Dichloroethane-d4	111	76-114	

D = Surrogate diluted out
***** = Surrogate recovery outside QC Limits*

Surrogates are compounds added to the sample prior to purging to monitor the purge efficiency. Lower surrogate recoveries may indicate possible matrix effect and/or lower purge efficiency.

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CASE NARRATIVE FOR SEMI-VOLATILE ANALYSIS USING CLP OLM01.8 SOW

CLIENT:	Martin Marietta Environmental Services
LSDG:	2483
PROJECT:	7500 Area Contamination/SOW MAD/AS-01

* All semi-volatile organics were analyzed by GC/MS on Hewlett-Packard GC/MSD HP5890/5970 Inst. ID. 7001 Inst. ID. 7004.

* Chromatography was performed on a 30m fused silica DB-5 capillary column using a temperature program capable of separating the compounds of interest.

* Extraction was performed on approximately 30 grams or 1 liter of sample unless stated otherwise.

* For soils, the intermediate extract concentration was taken to a final volume of 10 ml. Five (5) ml of this was cleaned via the GPC and subsequently taken to a final volume of 0.5 ml unless stated otherwise. Water extracts were taken to a final volume of 1.0 mls. Two (2) μl was injected onto the column for analysis.

* The reports of the TCL analytes and tentatively identified compounds (TIC) identified and quantified in the samples are contained in the following sections of the data package. The soil CRQLs and final results have been factored for initial sample volume, final extract volume, any necessary dilutions, and percent moisture. Also included are the appropriate calibration and quality control data where applicable.

* The following exceptions and/or considerations should be noted for the sample group contained within.

- Surrogate recoveries for all samples spikes and blanks were within acceptable limits.

- Sample BS24S was used for the matrix spike and matrix spike duplicate. Precision and accuracy were acceptable.

GC/MS Section Supervisor (designee)

6/25/92
Date

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EcoTek Laboratory Services Incorporated

Semivolatile TCL Organic Analytical Results
CLP SOW OLM01.8

Client:	Martin Marietta	Client Sample No.:	B24S
Lab Sample ID:	248301	Client Reference No.:	SOW MAD/AS-0!
Matrix:	Soil	Date Received:	June 8, 1992
Dilution Factor:	1	Date Extracted:	June 12, 1992

CAS Number	Compound Name	Result ug/kg	PQL ug/kg	Note
108952	Phenol	BQL	370	
111444	bis(2-Chloroethyl)ether	BQL	370	
95578	2-Chlorophenol	BQL	370	
541731	1,3-Dichlorobenzene	BQL	370	
106467	1,4-Dichlorobenzene	BQL	370	
95501	1,2-Dichlorobenzene	BQL	370	
95487	2-Methylphenol	BQL	370	
108601	2,2'-oxybis(1-Chloropropane)	BQL	370	
106445	4-Methylphenol	BQL	370	
621647	N-Nitroso-di-n-propylamine	BQL	370	
67721	Hexachloroethane	BQL	370	
98953	Nitrobenzene	BQL	370	
78591	Isophorone	BQL	370	
88755	2-Nitrophenol	BQL	370	
105679	2,4-Dimethylphenol	BQL	370	
111911	bis(2-Chloroethoxy)methane	BQL	370	
120832	2,4-Dichlorophenol	BQL	370	
120821	1,2,4-Trichlorobenzene	BQL	370	
91203	Naphthalene	BQL	370	
106478	4-Chloroaniline	BQL	370	
87683	Hexachlorobutadiene	BQL	370	

Lab Sample ID: 248301 *Client Sample No.:* B24S

CAS Number	Compound Name	Result ug/kg	PQL ug/kg	Note
59507	4-Chloro-3-methylphenol	BQL	370	
91576	2-Methylnaphthalene	BQL	370	
77474	Hexachlorocyclopentadiene	BQL	370	
88062	2,4,6-Trichlorophenol	BQL	370	
95954	2,4,5-Trichlorophenol	BQL	940	
91587	2-Chloronaphthalene	BQL	370	
88744	2-Nitroaniline	BQL	940	
131113	Dimethylphthalate	BQL	370	
208968	Acenaphthylene	BQL	370	
606202	2,6-Dinitrotoluene	BQL	370	
99092	3-Nitroaniline	BQL	940	
83329	Acenaphthene	BQL	370	
51285	2,4-Dinitrophenol	BQL	940	
100027	4-Nitrophenol	BQL	940	
132649	Dibenzofuran	BQL	370	
121142	2,4-Dinitrotoluene	BQL	370	
84662	Diethylphthalate	BQL	370	
7005723	4-Chlorophenyl-phenylether	BQL	370	
86737	Fluorene	BQL	370	
100016	4-Nitroaniline	BQL	940	
534521	4,6-Dinitro-2-methylphenol	BQL	940	
86306	N-Nitrosodiphenylamine	BQL	370	
101553	4-Bromophenyl-phenylether	BQL	370	
118741	Hexachlorobenzene	BQL	370	
87865	Pentachlorophenol	BQL	940	
85018	Phenanthrene	BQL	370	
120127	Anthracene	BQL	370	
86748	Carbazole	BQL	370	

Lab Sample ID: 248301 *Client Sample No.: B24S*

CAS Number	Compound Name	Result ug/kg	PQL ug/kg	Note
84742	Di-n-butylphthalate	BQL	370	
206440	Fluoranthene	BQL	370	
129000	Pyrene	BQL	370	
85687	Butylbenzylphthalate	BQL	370	
91941	3,3'-Dichlorobenzidine	BQL	370	
56553	Benzo(a)anthracene	BQL	370	
218019	Chrysene	BQL	370	
117817	bis(2-Ethylhexyl)phthalate	72	370	*
117840	Di-n-octylphthalate	BQL	370	
205992	Benzo(b)fluoranthene	BQL	370	
207089	Benzo(k)fluoranthene	BQL	370	
50328	Benzo(a)pyrene	BQL	370	
193395	Indeno(1,2,3-cd)pyrene	BQL	370	
53703	Dibenzo(a,h)anthracene	BQL	370	
191242	Benzo(g,h,i)perylene	BQL	370	

PQL = Practical Quantitation Limit

BQL = Below Quantitation Limit

** = Indicates an estimated value when the mass spectral data indicate the presence of a compound that meets the identification criteria in which the result is less than the practical quantitation limit but greater than zero.*

B = This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable contamination and warns the data user to take appropriate action.

Semivolatile Surrogate Recovery Data

Lab Sample ID: 248301 *Client Sample No.: B24S*

Surrogate Compound	*% Recovery*	*QC Limits*	*Note*
Nitrobenzene-d5	*41*	*23-120*	
2-Fluorobiphenyl	*46*	*30-115*	
Terphenyl-d14	*56*	*18-137*	
Phenol-d6	*41*	*24-113*	
2-Fluorophenol	*31*	*25-121*	
2,4,6-Tribromophenol	*42*	*19-122*	
2-Chlorophenol-d4	*39*	*20-130*	
1,2-Dichlorobenzene-d4	*44*	*20-130*	

D = Surrogate diluted out
**** = Surrogate recovery outside QC Limits*

Surrogates are compounds added to the sample prior to extraction to monitor the extraction efficiency. Lower surrogate recoveries may indicate possible matrix effect on the extraction procedure.

Tentatively Identified Compounds

Lab Sample ID: 248301 *Client Sample No.: B24S*

Compound	*Retention Time*	*Result ug/kg*	*Notes*
Unknown	*9.83*	*300*	
Unknown	*10.5*	*1700*	
Unknown	*10.72*	*130*	
Octamethylcyclotetrasiloxane	*11.07*	*700*	
Unknown	*12.75*	*530*	
Unknown (Hydrocarbon)	*28.54*	*130*	
Unknown	*29.67*	*5300*	
Unknown (Hydrocarbon)	*31.04*	*200*	
Unknown (Hydrocarbon)	*32.66*	*170*	
Unknown (Hydrocarbon)	*34.67*	*100*	
Unknown (Hydrocarbon)	*36.54*	*100*	
Unknown (Hydrocarbon)	*38.31*	*100*	

B = This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable contamination and warns the data user to take appropriate action.

Semivolatile QC Spike Data

Client: *Martin Marietta*
Lab Sample ID: *248301MS/MSD*
Method: *CLP SOW OLM01.8*
Client Sample ID: *B24S*
Client Reference No.: *SOW MAD/AS-01*

Compound	*Matrix Spike % Recovery*	*Matrix Spike Duplicate % Recovery*	*% Recovery QC Lmits **	*Relative Percent Difference RPD*
Phenol	49.4	55.4	12-110	11.4
2-Chlorophenol	45.1	53.3	27-123	16.7
1,4-Dichlorobenzene	41.0	48.1	36-97	15.9
N-Nitroso-di-n-propylamine	52.6	62.6	41-116	17.3
1,2,4-Trichlorobenzene	47.2	55.9	39-98	16.8
4-Chloro-3-methylphenol	52.3	56.0	23-97	6.8
Acenaphthene	56.4	63.6	46-118	11.9
4-Nitrophenol	79.1	88.1	29495.0	10.7
2,4-Dinitrotoluene	55.9	65.2	24-96	15.3
Pentachlorophenol	94.0	111.1	9-103	16.6
Pyrene	57.1	70.8	26-127	21.5

* *EPA CLP SOW OLMO1.8 Form III SV-1*
D = Detected

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Semivolatile TCL Organic Analytical Results
CLP SOW OLM01.8

Client: Martin Marietta
Lab Sample ID: 248302
Matrix: Water
Dilution Factor: 1

Client Sample No.: B24B
Client Reference No.: SOW MAD/AS-01
Date Received: June 8, 1992
Date Extracted: June 10, 1992

CAS Number	Compound Name	Result ug/l	PQL ug/l	Note
108952	Phenol	BQL	10	
111444	bis(2-Chloroethyl)ether	BQL	10	
95578	2-Chlorophenol	BQL	10	
541731	1,3-Dichlorobenzene	BQL	10	
106467	1,4-Dichlorobenzene	BQL	10	
95501	1,2-Dichlorobenzene	BQL	10	
95487	2-Methylphenol	BQL	10	
108601	2,2'-oxybis(1-Chloropropane)	BQL	10	
106445	4-Methylphenol	BQL	10	
621647	N-Nitroso-di-n-propylamine	BQL	10	
67721	Hexachloroethane	BQL	10	
98953	Nitrobenzene	BQL	10	
78591	Isophorone	BQL	10	
88755	2-Nitrophenol	BQL	10	
105679	2,4-Dimethylphenol	BQL	10	
111911	bis(2-Chloroethoxy)methane	BQL	10	
120832	2,4-Dichlorophenol	BQL	10	
120821	1,2,4-Trichlorobenzene	BQL	10	
91203	Naphthalene	BQL	10	
106478	4-Chloroaniline	BQL	10	
87683	Hexachlorobutadiene	BQL	10	

Lab Sample ID: 248302 *Client Sample No.:* B24B

CAS Number	Compound Name	Result ug/l	PQL ug/l	Note
59507	4-Chloro-3-methylphenol	BQL	10	
91576	2-Methylnaphthalene	BQL	10	
77474	Hexachlorocyclopentadiene	BQL	10	
88062	2,4,6-Trichlorophenol	BQL	10	
95954	2,4,5-Trichlorophenol	BQL	25	
91587	2-Chloronaphthalene	BQL	10	
88744	2-Nitroaniline	BQL	25	
131113	Dimethylphthalate	BQL	10	
208968	Acenaphthylene	BQL	10	
606202	2,6-Dinitrotoluene	BQL	10	
99092	3-Nitroaniline	BQL	25	
83329	Acenaphthene	BQL	10	
51285	2,4-Dinitrophenol	BQL	25	
100027	4-Nitrophenol	BQL	25	
132649	Dibenzofuran	BQL	10	
121142	2,4-Dinitrotoluene	BQL	10	
84662	Diethylphthalate	1	10	*
7005723	4-Chlorophenyl-phenylether	BQL	10	
86737	Fluorene	BQL	10	
100016	4-Nitroaniline	BQL	25	
534521	4,6-Dinitro-2-methylphenol	BQL	25	
86306	N-Nitrosodiphenylamine	BQL	10	
101553	4-Bromophenyl-phenylether	BQL	10	
118741	Hexachlorobenzene	BQL	10	
87865	Pentachlorophenol	BQL	25	
85018	Phenanthrene	BQL	10	
120127	Anthracene	BQL	10	
86748	Carbazole	BQL	10	

Lab Sample ID: 248302		*Client Sample No.: B24B*		
CAS Number	*Compound Name*	*Result ug/l*	*PQL ug/l*	*Note*
84742	Di-n-butylphthalate	2	10	*
206440	Fluoranthene	BQL	10	
129000	Pyrene	BQL	10	
85687	Butylbenzylphthalate	BQL	10	
91941	3,3'-Dichlorobenzidine	BQL	10	
56553	Benzo(a)anthracene	BQL	10	
218019	Chrysene	BQL	10	
117817	bis(2-Ethylhexyl)phthalate	14	10	
117840	Di-n-octylphthalate	BQL	10	
205992	Benzo(b)fluoranthene	BQL	10	
207089	Benzo(k)fluoranthene	BQL	10	
50328	Benzo(a)pyrene	BQL	10	
193395	Indeno(1,2,3-cd)pyrene	BQL	10	
53703	Dibenzo(a,h)anthracene	BQL	10	
191242	Benzo(g,h,i)perylene	BQL	10	

PQL = Practical Quantitation Limit

BQL = Below Quantitation Limit

** = Indicates an estimated value when the mass spectral data indicate the presence of a compound that meets the identification criteria in which the result is less than the practical quantitation limit but greater than zero.*

B = This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable contamination and warns the data user to take appropriate action.

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Semivolatile Surrogate Recovery Data

Lab Sample ID: 248302   *Client Sample No.:* B24B

Surrogate Compound	*% Recovery*	*QC Limits*	*Note*
Nitrobenzene-d5	65	35-114	
2-Fluorobiphenyl	66	43-116	
Terphenyl-d14	91	33-141	
Phenol-d6	67	10- 110	
2-Fluorophenol	56	21-110	
2,4,6-Tribromophenol	95	10-123	
2-Chlorophenol-d4	61	33-110	
1,2-Dichlorobenzene-d4	60	16-110	

D = Surrogate diluted out
**** = Surrogate recovery outside QC Limits*

Surrogates are compounds added to the sample prior to extraction to monitor the extraction efficiency. Lower surrogate recoveries may indicate possible matrix effect on the extraction procedure.

Attachment A

EcoTek LSI
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Tentatively Identified Compounds

Lab Sample ID: 248302 *Client Sample No.: B24B*

Compound	*Retention Time*	*Result ug/l*	*Notes*
Unknown	*11.06*	*3*	
Unknown	*13.16*	*3*	
2-(2-butoxyethoxyl)-Ethanol	*15.09*	*11*	*B*
Unknown	*16.02*	*5*	
Unknown	*16.4*	*3*	
Unknown	*17.73*	*4*	*B*
Unknown	*20.07*	*3*	
Unknown	*23.67*	*2*	
Unknown	*27.65*	*3*	
Unknown	*27.77*	*9*	
Unknown (Hydrocarbon)	*28.7*	*2*	
Unknown (Hydrocarbon)	*29.89*	*4*	
Unknown	*30.26*	*3*	
Unknown (Hydrocarbon)	*31.26*	*5*	
Unknown (Hydrocarbon)	*32.95*	*4*	
Unknown (Hydrocarbon)	*34.98*	*2*	
Unknown	*36.08*	*5*	
Unknown	*36.99*	*3*	
Unknown	*41.21*	*3*	

B = This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable contamination and warns the data user to take appropriate action.

Attachment B

EcoTek LSI
EcoTek Laboratory Services Incorporated

Semivolatile TCL Organic Analytical Results
CLP SOW OLM01.8

Client:	*Martin Marietta*	*Client Sample No.:*	*B24E*
Lab Sample ID:	*248303*	*Client Reference No.:*	*SOW MAD/AS-01*
Matrix:	*Water*	*Date Received:*	*June 8, 1992*
Dilution Factor:	*1*	*Date Extracted:*	*June 10, 1992*

CAS Number	Compound Name	Result ug/l	PQL ug/l	Note
108952	Phenol	BQL	9	
111444	bis(2-Chloroethyl)ether	BQL	9	
95578	2-Chlorophenol	BQL	9	
541731	1,3-Dichlorobenzene	BQL	9	
106467	1,4-Dichlorobenzene	BQL	9	
95501	1,2-Dichlorobenzene	BQL	9	
95487	2-Methylphenol	BQL	9	
108601	2,2'-oxybis(1-Chloropropane)	BQL	9	
106445	4-Methylphenol	BQL	9	
621647	N-Nitroso-di-n-propylamine	BQL	9	
67721	Hexachloroethane	BQL	9	
98953	Nitrobenzene	BQL	9	
78591	Isophorone	BQL	9	
88755	2-Nitrophenol	BQL	9	
105679	2,4-Dimethylphenol	BQL	9	
111911	bis(2-Chloroethoxy)methane	BQL	9	
120832	2,4-Dichlorophenol	BQL	9	
120821	1,2,4-Trichlorobenzene	BQL	9	
91203	Naphthalene	BQL	9	
106478	4-Chloroaniline	BQL	9	
87683	Hexachlorobutadiene	BQL	9	

Lab Sample ID: 248303 *Client Sample No.: B24E*

CAS Number	Compound Name	Result ug/l	PQL ug/l	Note
59507	4-Chloro-3-methylphenol	BQL	9	
91576	2-Methylnaphthalene	BQL	9	
77474	Hexachlorocyclopentadiene	BQL	9	
88062	2,4,6-Trichlorophenol	BQL	9	
95954	2,4,5-Trichlorophenol	BQL	23	
91587	2-Chloronaphthalene	BQL	9	
88744	2-Nitroaniline	BQL	23	
131113	Dimethylphthalate	BQL	9	
208968	Acenaphthylene	BQL	9	
606202	2,6-Dinitrotoluene	BQL	9	
99092	3-Nitroaniline	BQL	23	
83329	Acenaphthene	BQL	9	
51285	2,4-Dinitrophenol	BQL	23	
100027	4-Nitrophenol	BQL	23	
132649	Dibenzofuran	BQL	9	
121142	2,4-Dinitrotoluene	BQL	9	
84662	Diethylphthalate	2	9	*
7005723	4-Chlorophenyl-phenylether	BQL	9	
86737	Fluorene	BQL	9	
100016	4-Nitroaniline	BQL	23	
534521	4,6-Dinitro-2-methylphenol	BQL	23	
86306	N-Nitrosodiphenylamine	BQL	9	
101553	4-Bromophenyl-phenylether	BQL	9	
118741	Hexachlorobenzene	BQL	9	
87865	Pentachlorophenol	BQL	23	
85018	Phenanthrene	BQL	9	
120127	Anthracene	BQL	9	
86748	Carbazole	BQL	9	

Lab Sample ID: 248303 *Client Sample No.: B24E*

CAS Number	*Compound Name*	*Result ug/l*	*PQL ug/l*	*Note*
84742	Di-n-butylphthalate	1	9	*
206440	Fluoranthene	BQL	9	
129000	Pyrene	BQL	9	
85687	Butylbenzylphthalate	BQL	9	
91941	3,3'-Dichlorobenzidine	BQL	9	
56553	Benzo(a)anthracene	BQL	9	
218019	Chrysene	BQL	9	
117817	bis(2-Ethylhexyl)phthalate	3	9	*
117840	Di-n-octylphthalate	BQL	9	
205992	Benzo(b)fluoranthene	BQL	9	
207089	Benzo(k)fluoranthene	BQL	9	
50328	Benzo(a)pyrene	BQL	9	
193395	Indeno(1,2,3-cd)pyrene	BQL	9	
53703	Dibenzo(a,h)anthracene	BQL	9	
191242	Benzo(g,h,i)perylene	BQL	9	

PQL = Practical Quantitation Limit

BQL = Below Quantitation Limit

** = Indicates an estimated value when the mass spectral data indicate the presence of a compound that meets the identification criteria in which the result is less than the practical quantitation limit but greater than zero.*

B = This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable contamination and warns the data user to take appropriate action.

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Semivolatile Surrogate Recovery Data

Lab Sample ID: *248303*

Client Sample No.: *B24E*

Surrogate Compound	*% Recovery*	*QC Limits*	*Note*
Nitrobenzene-d5	*76*	*35-114*	
2-Fluorobiphenyl	*69*	*43-116*	
Terphenyl-d14	*79*	*33-141*	
Phenol-d6	*78*	*10- 110*	
2-Fluorophenol	*70*	*21-110*	
2,4,6-Tribromophenol	*86*	*10-123*	
2-Chlorophenol-d4	*70*	*33-110*	
1,2-Dichlorobenzene-d4	*71*	*16-110*	

D = Surrogate diluted out
**** = Surrogate recovery outside QC Limits*

Surrogates are compounds added to the sample prior to extraction to monitor the extraction efficiency. Lower surrogate recoveries may indicate possible matrix effect on the extraction procedure.

EcoTek LSI
EcoTek Laboratory Services Incorporated

Tentatively Identified Compounds

Lab Sample ID: 248303 *Client Sample No.:* B24E

Compound	Retention Time	Result ug/l	Notes
Unknown	9.36	3	B
Unknown	9.66	3	B
Unknown	10.33	3	B
Unknown	11.08	6	
Unknown	11.72	5	B
Unknown	13.16	3	
Unknown	14.76	3	
2-(2-butoxyethoxyl)-Ethanol	15.1	15	B
Unknown	16.02	7	
Unknown	16.34	3	
Unknown	16.4	3	
Unknown	17.74	6	B
Unknown	20.07	4	
Unknown	23.5	2	
Unknown	23.67	2	
Unknown	27.76	13	
Unknown	31.18	3	
Unknown	36.1	6	
Unknown	41.21	5	

B = *This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable contamination and warns the data user to take appropriate action.*

Semivolatile TCL Organic Analytical Results
CLP SOW OLM01.8

Client:	Martin Marietta	Client Sample No.:	Method Blank
Lab Sample ID:	Q1261201	Client Reference No.:	SOW MAD/AS-01
Matrix:	Soil	Date Received:	N/A
Dilution Factor:	1	Date Extracted:	June 12, 1992

CAS Number	Compound Name	Result ug/kg	PQL ug/kg	Note
108952	Phenol	BQL	330	
111444	bis(2-Chloroethyl)ether	BQL	330	
95578	2-Chlorophenol	BQL	330	
541731	1,3-Dichlorobenzene	BQL	330	
106467	1,4-Dichlorobenzene	BQL	330	
95501	1,2-Dichlorobenzene	BQL	330	
95487	2-Methylphenol	BQL	330	
108601	2,2'-oxybis(1-Chloropropane)	BQL	330	
106445	4-Methylphenol	BQL	330	
621647	N-Nitroso-di-n-propylamine	BQL	330	
67721	Hexachloroethane	BQL	330	
98953	Nitrobenzene	BQL	330	
78591	Isophorone	BQL	330	
88755	2-Nitrophenol	BQL	330	
105679	2,4-Dimethylphenol	BQL	330	
111911	bis(2-Chloroethoxy)methane	BQL	330	
120832	2,4-Dichlorophenol	BQL	330	
120821	1,2,4-Trichlorobenzene	BQL	330	
91203	Naphthalene	BQL	330	
106478	4-Chloroaniline	BQL	330	
87683	Hexachlorobutadiene	BQL	330	

Lab Sample ID: Q1261201 *Client Sample No.: Method Blank*

CAS Number	*Compound Name*	*Result ug/kg*	*PQL ug/kg*	*Note*
59507	4-Chloro-3-methylphenol	BQL	330	
91576	2-Methylnaphthalene	BQL	330	
77474	Hexachlorocyclopentadiene	BQL	330	
88062	2,4,6-Trichlorophenol	BQL	330	
95954	2,4,5-Trichlorophenol	BQL	830	
91587	2-Chloronaphthalene	BQL	330	
88744	2-Nitroaniline	BQL	830	
131113	Dimethylphthalate	BQL	330	
208968	Acenaphthylene	BQL	330	
606202	2,6-Dinitrotoluene	BQL	330	
99092	3-Nitroaniline	BQL	830	
83329	Acenaphthene	BQL	330	
51285	2,4-Dinitrophenol	BQL	830	
100027	4-Nitrophenol	BQL	830	
132649	Dibenzofuran	BQL	330	
121142	2,4-Dinitrotoluene	BQL	330	
84662	Diethylphthalate	BQL	330	
7005723	4-Chlorophenyl-phenylether	BQL	330	
86737	Fluorene	BQL	330	
100016	4-Nitroaniline	BQL	830	
534521	4,6-Dinitro-2-methylphenol	BQL	830	
86306	N-Nitrosodiphenylamine	BQL	330	
101553	4-Bromophenyl-phenylether	BQL	330	
118741	Hexachlorobenzene	BQL	330	
87865	Pentachlorophenol	BQL	830	
85018	Phenanthrene	BQL	330	
120127	Anthracene	BQL	330	
86748	Carbazole	BQL	330	

Lab Sample ID: Q1261201 *Client Sample No.: Method Blank*

CAS Number	*Compound Name*	*Result ug/kg*	*PQL ug/kg*	*Note*
84742	Di-n-butylphthalate	BQL	330	
206440	Fluoranthene	BQL	330	
129000	Pyrene	BQL	330	
85687	Butylbenzylphthalate	BQL	330	
91941	3,3'-Dichlorobenzidine	BQL	330	
56553	Benzo(a)anthracene	BQL	330	
218019	Chrysene	BQL	330	
117817	bis(2-Ethylhexyl)phthalate	BQL	330	
117840	Di-n-octylphthalate	BQL	330	
205992	Benzo(b)fluoranthene	BQL	330	
207089	Benzo(k)fluoranthene	BQL	330	
50328	Benzo(a)pyrene	BQL	330	
193395	Indeno(1,2,3-cd)pyrene	BQL	330	
53703	Dibenzo(a,h)anthracene	BQL	330	
191242	Benzo(g,h,i)perylene	BQL	330	

PQL = Practical Quantitation Limit

BQL = Below Quantitation Limit

* = *Indicates an estimated value when the mass spectral data indicate the presence of a compound that meets the identification criteria in which the result is less than the practical quantitation limit but greater than zero.*

B = This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable contamination and warns the data user to take appropriate action.

Semivolatile Surrogate Recovery Data

Lab Sample ID: *Q1261201* *Client Sample No.:* *Method Blank*

Surrogate Compound	*% Recovery*	*QC Limits*	*Note*
Nitrobenzene-d5	*63*	*23-120*	
2-Fluorobiphenyl	*63*	*30-115*	
Terphenyl-d14	*75*	*18-137*	
Phenol-d6	*67*	*24-113*	
2-Fluorophenol	*53*	*25-121*	
2,4,6-Tribromophenol	*70*	*19-122*	
2-Chlorophenol-d4	*59*	*20-130*	
1,2-Dichlorobenzene-d4	*66*	*20-130*	

D = Surrogate diluted out
**** = Surrogate recovery outside QC Limits*

Surrogates are compounds added to the sample prior to extraction to monitor the extraction efficiency. Lower surrogate recoveries may indicate possible matrix effect on the extraction procedure.

Tentatively Identified Compounds

Lab Sample ID: Q1261201

Client Sample No.: Method Blank

Compound	**Result** ug/kg	**Notes**
Sample was searched for TIC's. No peaks found.	N/A	

B = This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable contamination and warns the data user to take appropriate action.

N/A = Not Applicable

Attachment B

EcoTek LSI
EcoTek Laboratory Services Incorporated

Semivolatile TCL Organic Analytical Results
CLP SOW OLM01.8

Client:	Martin Marietta	Client Sample No.:	Method Blank
Lab Sample ID:	Q1261005	Client Reference No.:	SOW MAD/AS-01
Matrix:	Water	Date Received:	N/A
Dilution Factor:	1	Date Extracted:	June 10, 1992

CAS Number	Compound Name	Result ug/l	PQL ug/l	Note
108952	Phenol	BQL	10	
111444	bis(2-Chloroethyl)ether	BQL	10	
95578	2-Chlorophenol	BQL	10	
541731	1,3-Dichlorobenzene	BQL	10	
106467	1,4-Dichlorobenzene	BQL	10	
95501	1,2-Dichlorobenzene	BQL	10	
95487	2-Methylphenol	BQL	10	
108601	2,2'-oxybis(1-Chloropropane)	BQL	10	
106445	4-Methylphenol	BQL	10	
621647	N-Nitroso-di-n-propylamine	BQL	10	
67721	Hexachloroethane	BQL	10	
98953	Nitrobenzene	BQL	10	
78591	Isophorone	BQL	10	
88755	2-Nitrophenol	BQL	10	
105679	2,4-Dimethylphenol	BQL	10	
111911	bis(2-Chloroethoxy)methane	BQL	10	
120832	2,4-Dichlorophenol	BQL	10	
120821	1,2,4-Trichlorobenzene	BQL	10	
91203	Naphthalene	BQL	10	
106478	4-Chloroaniline	BQL	10	
87683	Hexachlorobutadiene	BQL	10	

Lab Sample ID: Q1261005 *Client Sample No.: Method Blank*

CAS Number	Compound Name	Result ug/l	PQL ug/l	Note
59507	4-Chloro-3-methylphenol	BQL	10	
91576	2-Methylnaphthalene	BQL	10	
77474	Hexachlorocyclopentadiene	BQL	10	
88062	2,4,6-Trichlorophenol	BQL	10	
95954	2,4,5-Trichlorophenol	BQL	25	
91587	2-Chloronaphthalene	BQL	10	
88744	2-Nitroaniline	BQL	25	
131113	Dimethylphthalate	BQL	10	
208968	Acenaphthylene	BQL	10	
606202	2,6-Dinitrotoluene	BQL	10	
99092	3-Nitroaniline	BQL	25	
83329	Acenaphthene	BQL	10	
51285	2,4-Dinitrophenol	BQL	25	
100027	4-Nitrophenol	BQL	25	
132649	Dibenzofuran	BQL	10	
121142	2,4-Dinitrotoluene	BQL	10	
84662	Diethylphthalate	BQL	10	
7005723	4-Chlorophenyl-phenylether	BQL	10	
86737	Fluorene	BQL	10	
100016	4-Nitroaniline	BQL	25	
534521	4,6-Dinitro-2-methylphenol	BQL	25	
86306	N-Nitrosodiphenylamine	BQL	10	
101553	4-Bromophenyl-phenylether	BQL	10	
118741	Hexachlorobenzene	BQL	10	
87865	Pentachlorophenol	BQL	25	
85018	Phenanthrene	BQL	10	
120127	Anthracene	BQL	10	
86748	Carbazole	BQL	10	

Lab Sample ID: Q1261005		Client Sample No.: Method Blank		
CAS Number	**Compound Name**	**Result ug/l**	**PQL ug/l**	**Note**
84742	Di-n-butylphthalate	BQL	10	
206440	Fluoranthene	BQL	10	
129000	Pyrene	BQL	10	
85687	Butylbenzylphthalate	BQL	10	
91941	3,3'-Dichlorobenzidine	BQL	10	
56553	Benzo(a)anthracene	BQL	10	
218019	Chrysene	BQL	10	
117817	bis(2-Ethylhexyl)phthalate	BQL	10	
117840	Di-n-octylphthalate	BQL	10	
205992	Benzo(b)fluoranthene	BQL	10	
207089	Benzo(k)fluoranthene	BQL	10	
50328	Benzo(a)pyrene	BQL	10	
193395	Indeno(1,2,3-cd)pyrene	BQL	10	
53703	Dibenzo(a,h)anthracene	BQL	10	
191242	Benzo(g,h,i)perylene	BQL	10	

PQL = Practical Quantitation Limit

BQL = Below Quantitation Limit

** = Indicates an estimated value when the mass spectral data indicate the presence of a compound that meets the identification criteria in which the result is less than the practical quantitation limit but greater than zero.*

B = This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable contamination and warns the data user to take appropriate action.

EcoTek LSI
EcoTek Laboratory Services Incorporated

Semivolatile Surrogate Recovery Data

Lab Sample ID: Q1261005 *Client Sample No.: Method Blank*

Surrogate Compound	*% Recovery*	*QC Limits*	*Note*
Nitrobenzene-d5	80	35-114	
2-Fluorobiphenyl	75	43-116	
Terphenyl-d14	92	33-141	
Phenol-d6	79	10-110	
2-Fluorophenol	74	21-110	
2,4,6-Tribromophenol	78	10-123	
2-Chlorophenol-d4	73	33-110	
1,2-Dichlorobenzene-d4	76	16-110	

D = Surrogate diluted out
**** = Surrogate recovery outside QC Limits*

Surrogates are compounds added to the sample prior to extraction to monitor the extraction efficiency. Lower surrogate recoveries may indicate possible matrix effect on the extraction procedure.

Tentatively Identified Compounds

Lab Sample ID: Q1261005 *Client Sample No.: Method Blank*

Compound	*Retention Time*	*Result ug/l*	*Notes*
Unknown	*9.35*	*2*	
Unknown	*9.67*	*3*	
Unknown	*10.33*	*4*	
Unknown	*11.71*	*3*	
2-(2-butoxyethoxyl)-Ethanol	*15.09*	*15*	
Unknown	*17.73*	*6*	

B = This flag is used when the analyte is found in the associated blank as well as in the sample. It indicates possible/probable contamination and warns the data user to take appropriate action.

Attachment B

EcoTek LSI
EcoTek Laboratory Services Incorporated

CASE NARRATIVE FOR TOTAL PETROLEUM HYDROCARBONS BY CA-DHS METHOD GC/FID

Client: Martin Marietta

LSDG: 2483

Samples(s): B24S, B24B, B24E from 7500 Area Contamination

- The sample batch was analyzed using a Hewlett-Packard gas chromatograph equipped with a flame ionization detector.
- Chromatography was performed on a RTx-5 column using a temperature program suitable for resolving the target analytes. Quantitation of sample concentrations was performed using a three to five level calibration. All appropriate quality control samples were analyzed with the sample batch.
- The initial sample amount was approximately 1000 ml for aqueous samples and 20 grams for soil matrices unless noted otherwise. The final extract volume was 5 ml.
- Practical Quantitation Limits (PQLs) are based upon the lowest standard and then factored for the initial sample amount, final sample extract volume, any necessary dilutions, and percent moisture (for soils).
- The following exceptions and/or considerations should be noted for the sample group contained within:

  - Only kerosene was analyzed and reported per the request.

EcoTek LSI
EcoTek Laboratory Services Incorporated

Petroleum Hydrocarbons Analytical Results
CA-DHS Extractable Petroleum Hydrocarbons

Client: *Martin Marietta*
Client Sample No.: *B24S*
Lab Sample ID: *248301*
Client Reference No.: *SOW MAD/AS-01*
Matrix: *Soil*
Date Received: *June 5, 1992*
Dilution Factor: *1*
Date Extracted: *June 12, 1992*

CAS Number	*Compound Name*	*Result mg/kg*	*PQL mg/kg*	*Note*
NA	*Kerosene*	*BQL*	*14*	

PQL = Practical Quantitation Limit
BQL = Below Quantitation Limit

EcoTek LSI
EcoTek Laboratory Services Incorporated

Petroleum Hydrocarbons Analytical Results
CA-DHS Extractable Petroleum Hydrocarbons

Client:	Martin Marietta	**Client Sample No.:**	B24S Duplicate
Lab Sample ID:	248301D	**Client Reference No.:**	SOW MAD/AS-01
Matrix:	Soil	**Date Received:**	June 5, 1992
Dilution Factor:	1	**Date Extracted:**	June 12, 1992

CAS Number	Compound Name	Result mg/kg	PQL mg/kg	Note
NA	Kerosene	BQL	14	

PQL = Practical Quantitation Limit
BQL = Below Quantitation Limit

EcoTek LSI
EcoTek Laboratory Services Incorporated

Petroleum Hydrocarbons Analytical Results
CA-DHS Extractable Petroleum Hydrocarbons

Client:	Martin Marietta	Client Sample No.:	Extraction Blank
Lab Sample ID:	Q1261202	Client Reference No.:	SOW MADD/AS-01
Matrix:	Soil	Date Received:	NA
Dilution Factor:	1	Date Extracted:	June 12, 1992

CAS Number	Compound Name	Result mg/kg	PQL mg/kg	Note
NA	Kerosene	BQL	13	

PQL = Practical Quantitation Limit
BQL = Below Quantitation Limit

Client: Martin Marietta
LSDG: 2483
Method: CA-DHS Extractable Petroleum Hydrocarbons

Date of Extraction: June 12, 1992
Date of Analysis: June 23, 1992
Client Reference No.: SOW MAD/AS-01

BS/BSD ANALYTICAL RESULTS

CA-DHS Extractable Petroleum Hydrocarbons

Matrix: Soil
Lab Sample ID: Q1261203/204
Client Sample ID: Blank Blank Spike and Duplicate

Spike Compound	% Recovery QC Limits	Spike Amount mg/kg	Unspiked Sample Result mg/kg	Spiked Sample Result mg/kg (BS)	% Spike Recovery (BS)	Duplicate Spike Sample Result mg/kg (BSD)	% Spike Recovery (BSD)	%RPD
Kerosene	#	100	0	62	62	87	87	33.3

QC limits are currently under development

Client: Martin Marietta
LSDG: 2483
Method: CA-DHS Extractable Petroleum Hydrocarbons
Client Reference No.: SOW MAD/AS-01

Sample Receipt Date: June 5, 1992
Date of Collection: May 31, 1992
Date of Extraction: June 12, 1992
Date of Analysis: June 23, 1992

MS/MSD ANALYTICAL RESULTS
CA-DHS Extractable Petroleum Hydrocarbons

Matrix: Soil
Lab Sample ID: 248301
Client Sample ID: B24S

Spike Compound	*% Recovery QC Limits*	*Spike Amount mg/kg*	*Unspiked Sample Result mg/kg*	*Spiked Sample Result mg/kg (MS)*	*% Spike Recovery (MS)*	*Duplicate Spike Sample Result mg/kg (MSD)*	*% Spike Recovery (MSD)*	*%RPD*
Kerosene	*#*	*100*	*0*	*80*	*80*	*77*	*77*	*3.9*

 # QC limits are currently under development

EcoTek LSI
EcoTek Laboratory Services Incorporated

Petroleum Hydrocarbons Analytical Results
CA-DHS Extractable Petroleum Hydrocarbons

Client:	*Martin Marietta*	*Client Sample No.:*	*Extraction Blank*
Lab Sample ID:	*Q1261006*	*Client Reference No.:*	*SOW MAD/AS-01*
Matrix:	*Water*	*Date Received:*	*NA*
Dilution Factor:	*1*	*Date Extracted:*	*June 10, 1992*

CAS Number	*Compound Name*	*Result mg/l*	*PQL mg/l*	*Note*
NA	*Kerosene*	*BQL*	*0.25*	

PQL = Practical Quantitation Limit
BQL = Below Quantitation Limit

EcoTek LSI
EcoTek Laboratory Services Incorporated

Petroleum Hydrocarbons Analytical Results
CA-DHS Extractable Petroleum Hydrocarbons

Client:	Martin Marietta	Client Sample No.:	B24B
Lab Sample ID:	248302	Client Reference No.:	SOW MAD/AS-01
Matrix:	Water	Date Received:	June 5, 1992
Dilution Factor:	1	Date Extracted:	June 10, 1992

CAS Number	Compound Name	Result mg/l	PQL mg/l	Note
NA	Kerosene	BQL	0.24	

PQL = Practical Quantitation Limit
BQL = Below Quantitation Limit

EcoTek LSI
EcoTek Laboratory Services Incorporated

Petroleum Hydrocarbons Analytical Results
CA-DHS Extractable Petroleum Hydrocarbons

Client:	*Martin Marietta*	*Client Sample No.:*	*B24E*
Lab Sample ID:	*248303*	*Client Reference No.:*	*SOW MAD/AS-01*
Matrix:	*Water*	*Date Received:*	*June 5, 1992*
Dilution Factor:	*1*	*Date Extracted:*	*June 10, 1992*

CAS Number	*Compound Name*	*Result mg/l*	*PQL mg/l*	*Note*
NA	*Kerosene*	*BQL*	*0.26*	

PQL = Practical Quantitation Limit
BQL = Below Quantitation Limit

Client: *Martin Marietta*
LSDG: *2483*
Method: *CA-DHS Extractable Petroleum Hydrocarbons*

Date of Extraction: *June 10, 1992*
Date of Analysis: *June 23, 1992*
Client Reference No.: *SOW MAD/AS-01*

BS/BSD ANALYTICAL RESULTS
CA-DHS Extractable Petroleum Hydrocarbons

Matrix: *Water*
Lab Sample ID: *Q1261007/008*
Client Sample ID: *Blank Spike and Duplicate*

Spike Compound	% Recovery QC Limits	Spike Amount mg/l	Unspiked Sample Result mg/l	Spiked Sample Result mg/l (BS)	% Spike Recovery (BS)	Duplicate Spike Sample Result mg/l (BSD)	% Spike Recovery (BSD)	%RPD
Kerosene	#	2.00	0	1.62	81	1.38	69	15.8

 # QC limits are currently under development

EcoTek LSI
EcoTek Laboratory Services Incorporated

CASE NARRATIVE FOR METALS ANALYSIS
Method SW-846

Client: Martin Marietta
Case: SOW MAD/AS-01
LSDG: 2483

- **Analysis** - Metals analysis was performed on one soil and two water samples. Samples were prepared and analyzed according to SW-846. The following methods and instruments were used for analysis:

Analysis	Instrument	Method
ICP	TJA ICAP 61E	6010
CVAA	TJA CVAA S-12	7470, 7471
GFAA-As	TJA SH-4000	7060
GFAA-Pb	TJA SH-22	7421
GFAA-Se	TJA SH-4000	7740
GFAA-Tl	TJA SH-4000	7841

- **QA/QC** - All appropriate QC data was within acceptable control limits with the following exceptions:

  - The sample matrix duplicate relative percent difference (RPD) was outside the 20 % control limits for Iron and Potassium in the soil sample. The most probable cause of these failures is the nonhomogenous nature of soil samples.

  - The sample matrix duplicate relative percent difference (RPD) was outside the 20 % control limits for Iron in the water samples. The most probable cause of this failure is a matrix interference.

  - The sample matrix spike percent recovery was outside the 25 % control limits for Aluminum, Calcium, Iron, Lead, Magnesium, Manganese, and Potassium for sample B24S as a result of the high concentrations of these analytes relative to the spike concentration. The sample matrix spike percent recovery was also outside the 25 % control limits for Antimony and Selenium. Antimony's poor spike recovery was probably due to the volitalization of Antimony that can occur during acid digestion. Selenium's poor spike recovery was probably due to a matrix interference. A post digestion spike was performed for Antimony and Potassium with acceptable results.

- **General Discussion** - A sample predigestion matrix spike was not performed for Lithium and Strontium. A post digestion spike for these analytes gave acceptable results.

  Iron was present in sample B24S at a concentration over the linear range of the ICP, therefore, the concentration of Iron was determined at a five fold dilution in sample B24S.

EcoTek LSI
EcoTek Laboratory Services Incorporated

Trace Metals Analytical Results
Method SW-846

Client:	*Martin Marietta*	*Client Sample No.:*	*B24S*
Lab Sample ID:	*248301*	*Client Reference No.:*	*SOW MAD/AS-01*
Matrix:	*Soil*	*Date Received:*	*June 8, 1992*

Analyte	*Date Analyzed*	*Dilution Factor*	*Result mg/kg*	*Detection Limit mg/kg*	*Note*
Aluminum	*6/23/92*	*1*	*23000*	*1.34*	*N*
Antimony	*6/23/92*	*1*	*< 1.12*	*1.12*	*N*
Arsenic	*6/24/92*	*5*	*6.78*	*0.54*	
Barium	*6/23/92*	*1*	*93.2*	*0.11*	
Beryllium	*6/23/92*	*1*	*1.03*	*0.11*	
Cadmium	*6/23/92*	*1*	*< 0.11*	*0.11*	
Calcium	*6/23/92*	*1*	*927*	*0.44*	*N*
Chromium	*6/23/92*	*1*	*33.6*	*0.22*	
Cobalt	*6/23/92*	*1*	*22.6*	*0.34*	
Copper	*6/23/92*	*1*	*15.6*	*0.22*	
Iron	*6/23/92*	*5*	*55800*	*1.12*	*N,**
Lead	*6/24/92*	*20*	*13.8*	*2.18*	*N*
Lithium	*6/23/92*	*1*	*25.6*	*0.11*	
Magnesium	*6/23/92*	*1*	*2730*	*1.91*	*N*
Manganese	*6/23/92*	*1*	*656*	*0.11*	*N*
Mercury	*6/23/92*	*1*	*0.03*	*0.01*	
Nickel	*6/23/92*	*1*	*23.6*	*0.34*	
Potassium	*6/23/92*	*1*	*3820*	*31.7*	*N,**
Selenium	*6/24/92*	*1*	*< 0.10*	*0.10*	*N*
Silver	*6/23/92*	*1*	*< 0.44*	*0.44*	
Sodium	*6/23/92*	*1*	*64.4*	*0.90*	
Strontium	*6/23/92*	*1*	*6.54*	*0.11*	
Thallium	*6/25/92*	*1*	*< 0.10*	*0.10*	
Vanadium	*6/23/92*	*1*	*30.1*	*0.22*	
Zinc	*6/23/92*	*1*	*48.5*	*0.11*	

* = *The Duplicate analysis not within control limits.*
N = *The Matrix spike sample recovery was outside of control limits.*

Trace Metals Analytical Results
Method SW-846

Client:	*Martin Marietta*	*Client Sample No.:*	*B24B*
Lab Sample ID:	*248302*	*Client Reference No.:*	*SOW MAD/AS-01*
Matrix:	*Water*	*Date Received:*	*June 8, 1992*

Analyte	*Date Analyzed*	*Dilution Factor*	*Result ug/l*	*Detection Limit ug/l*	*Note*
Aluminum	*6/22/92*	*1*	*28.1*	*12.0*	
Antimony	*6/22/92*	*1*	*<10.0*	*10.0*	
Arsenic	*6/23/92*	*1*	*<1.00*	*1.00*	
Barium	*6/22/92*	*1*	*<1.00*	*1.00*	
Beryllium	*6/22/92*	*1*	*<1.00*	*1.00*	
Cadmium	*6/22/92*	*1*	*<1.00*	*1.00*	
Calcium	*6/22/92*	*1*	*39.3*	*4.00*	
Chromium	*6/22/92*	*1*	*<2.00*	*2.00*	
Cobalt	*6/22/92*	*1*	*<3.00*	*3.00*	
Copper	*6/22/92*	*1*	*110*	*2.00*	
Iron	*6/22/92*	*1*	*25.2*	*2.00*	*
Lead	*6/22/92*	*1*	*7.41*	*1.00*	
Lithium	*6/22/92*	*1*	*<1.00*	*1.00*	
Magnesium	*6/22/92*	*1*	*<17.0*	*17.0*	
Manganese	*6/22/92*	*1*	*<1.00*	*1.00*	
Mercury	*6/18/92*	*4*	*1.20*	*0.48*	
Nickel	*6/22/92*	*1*	*<3.00*	*3.00*	
Potassium	*6/22/92*	*1*	*<282*	*282*	
Selenium	*6/24/92*	*1*	*<1.00*	*1.00*	
Silver	*6/22/92*	*1*	*<4.00*	*4.00*	
Sodium	*6/22/92*	*1*	*66.7*	*8.00*	
Strontium	*6/22/92*	*1*	*<1.00*	*1.00*	
Thallium	*6/22/92*	*1*	*1.05*	*1.00*	
Vanadium	*6/22/92*	*1*	*<2.00*	*2.00*	
Zinc	*6/22/92*	*1*	*128*	*1.00*	

* = *The Duplicate analysis not within control limits.*
N = *The Matrix spike sample recovery was outside of control limits.*

EcoTek LSI
EcoTek Laboratory Services Incorporated

Trace Metals Analytical Results
Method SW-846

Client: Martin Marietta
Lab Sample ID: 248303
Matrix: Water
Client Sample No.: B24E
Client Reference No.: SOW MAD/AS-01
Date Received: June 8, 1992

Analyte	Date Analyzed	Dilution Factor	Result ug/l	Detection Limit ug/l	Note
Aluminum	6/22/92	1	40.0	12.0	
Antimony	6/22/92	1	< 10.0	10.0	
Arsenic	6/23/92	1	< 1.00	1.00	
Barium	6/22/92	1	< 1.00	1.00	
Beryllium	6/22/92	1	< 1.00	1.00	
Cadmium	6/22/92	1	< 1.00	1.00	
Calcium	6/22/92	1	60.8	4.00	
Chromium	6/22/92	1	2.16	2.00	
Cobalt	6/22/92	1	< 3.00	3.00	
Copper	6/22/92	1	115	2.00	
Iron	6/22/92	1	39.6	2.00	*
Lead	6/22/92	1	5.83	1.00	
Lithium	6/22/92	1	< 1.00	1.00	
Magnesium	6/22/92	1	< 17.0	17.0	
Manganese	6/22/92	1	1.32	1.00	
Mercury	6/18/92	4	1.06	0.48	
Nickel	6/22/92	1	< 3.00	3.00	
Potassium	6/22/92	1	< 282	282	
Selenium	6/24/92	1	< 1.00	1.00	
Silver	6/22/92	1	< 4.00	4.00	
Sodium	6/22/92	1	72.7	8.00	
Strontium	6/22/92	1	5.60	1.00	
Thallium	6/22/92	1	1.59	1.00	
Vanadium	6/22/92	1	< 2.00	2.00	
Zinc	6/22/92	1	121	1.00	

* = *The Duplicate analysis not within control limits.*
N = *The Matrix spike sample recovery was outside of control limits.*

Trace Metals Analytical Results
Soil Preparation Blank

Client: Martin Marietta
Client Reference No.: SOW MAD/AS-01
Lab Sample ID: PBS 2483
Date Received: June 8, 1992

Analyte	Date Analyzed	Dilution Factor	Result mg/kg	Detection Limit mg/kg	Note
Aluminum	6/23/92	1	2.28	1.20	
Antimony	6/23/92	1	< 1.00	1.00	
Arsenic	6/24/92	1	0.19	0.10	
Barium	6/23/92	1	< 0.10	0.10	
Beryllium	6/23/92	1	< 0.10	0.10	
Cadmium	6/23/92	1	< 0.10	0.10	
Calcium	6/23/92	1	3.48	0.40	
Chromium	6/23/92	1	< 0.20	0.20	
Cobalt	6/23/92	1	< 0.30	0.30	
Copper	6/23/92	1	< 0.20	0.20	
Iron	6/23/92	1	3.52	0.20	
Lead	6/24/92	1	0.11	0.10	
Lithium	6/23/92	1	< 0.10	0.10	
Magnesium	6/23/92	1	< 1.70	1.70	
Manganese	6/23/92	1	< 0.10	0.10	
Mercury	6/23/92	1	0.02	0.02	
Nickel	6/23/92	1	< 0.30	0.30	
Potassium	6/23/92	1	< 28.2	28.2	
Selenium	6/24/92	1	< 0.10	0.10	
Silver	6/23/92	1	< 0.40	0.40	
Sodium	6/23/92	1	12.0	0.80	
Strontium	6/23/92	1	< 0.10	0.10	
Thallium	6/25/92	1	< 0.10	0.10	
Vanadium	6/23/92	1	< 0.20	0.20	
Zinc	6/23/92	1	1.40	0.10	

EcoTek LSI
EcoTek Laboratory Services Incorporated

Trace Metals Analytical Results
Water Preparation Blank

Client: Martin Marietta
Client Reference No.: SOW MAD/AS-01
Lab Sample ID: PBW 2483
Date Received: June 8, 1992

Analyte	Date Analyzed	Dilution Factor	Result ug/l	Detection Limit ug/l	Note
Aluminum	6/23/92	1	18.8	12.0	
Antimony	6/23/92	1	< 10.0	10.0	
Arsenic	6/24/92	1	< 1.00	1.00	
Barium	6/23/92	1	< 1.00	1.00	
Beryllium	6/23/92	1	< 1.00	1.00	
Cadmium	6/23/92	1	< 1.00	1.00	
Calcium	6/23/92	1	16.5	4.00	
Chromium	6/23/92	1	< 2.00	2.00	
Cobalt	6/23/92	1	< 3.00	3.00	
Copper	6/23/92	1	< 2.00	2.00	
Iron	6/23/92	1	6.29	2.00	
Lead	6/24/92	1	2.17	1.00	
Lithium	6/23/92	1	< 1.00	1.00	
Magnesium	6/23/92	1	< 17.0	17.0	
Manganese	6/23/92	1	< 1.00	1.00	
Mercury	6/23/92	1	0.06	0.03	
Nickel	6/23/92	1	< 3.00	3.00	
Potassium	6/23/92	1	< 282	282	
Selenium	6/24/92	1	< 1.00	1.00	
Silver	6/23/92	1	< 4.00	4.00	
Sodium	6/23/92	1	71.4	8.00	
Strontium	6/23/92	1	< 1.00	1.00	
Thallium	6/25/92	1	< 1.00	1.00	
Vanadium	6/23/92	1	< 2.00	2.00	
Zinc	6/23/92	1	2.21	1.00	

Trace Metals Analytical Results

Soil Duplicate and Spike

Client: *Martin Marietta*
Lab Sample ID: *248301*
Client Sample No.: *B24S*
Client Reference No.: *SOW MAD/AS-01*

Analyte	Sample Result mg/kg	Duplicate Result mg/kg	% RPD	Spike Result mg/kg	Spike Added mg/kg	% Recovery
Aluminum	23000	20300	12.5	22900	103	0.0
Antimony	<1.12	1.36	NA	19.6	103	19.1
Arsenic	6.78	7.25	6.7	12.2	4.47	121.2
Barium	93.2	83.1	11.5	191	103	95.1
Beryllium	1.03	1.02	1.0	100	103	96.3
Cadmium	<0.11	<0.10	NA	96.6	103	93.9
Calcium	927	983	5.9	1220	103	285.0
Chromium	33.6	32.4	3.6	128	103	91.8
Cobalt	22.6	23.8	5.2	128	103	102.5
Copper	15.6	18.2	15.4	115	103	96.7
Iron	55800	43100	25.7	30000	103	0.0
Lead	13.8	16.1	15.4	19.7	2.24	263.8
Lithium	25.6	25.1	2.0	119	103	90.8
Magnesium	2730	2800	2.5	2680	103	0.0
Manganese	656	656	0.0	1360	103	684.7
Mercury	0.03	0.05	NA	0.48	0.469	96.0
Nickel	23.6	25.6	8.1	120	103	93.8
Potassium	3820	2920	26.7	4310	1030	47.6
Selenium	<0.10	0.18	NA	0.58	1.12	51.9
Silver	<0.44	<0.42	NA	96.0	103	93.4
Sodium	64.4	66.3	2.9	155	103	88.1
Strontium	6.54	5.56	16.2	114	103	104.5
Thallium	<0.10	<0.11	NA	4.86	5.59	86.9
Vanadium	30.1	28.7	4.8	125	103	92.3
Zinc	48.5	49.4	1.8	140	103	89.0

NA = Not Applicable
Duplicate Limits = 20%
Spike Limits = 25%

Trace Metals Analytical Results

Water Duplicate and Spike

Client: Martin Marietta
Client Sample No.: B24B, B24E
Lab Sample ID: 248302, 03
Client Reference No.: SOW MAD/AS-01

Analyte	Sample Result ug/l	Duplicatte Result ug/l	% RPD	Spike Result ug/l	Spike Added ug/l	% Recovery
Aluminum	28.1	46.9	NA	955.17	1000	92.7
Antimony	< 10.0	< 10.0	NA	973.5	1000	97.4
Arsenic	< 1.00	< 1.00	NA	45.47	40	113.7
Barium	< 1.00	1.09	NA	967.44	1000	96.7
Beryllium	< 1.00	< 1.00	NA	976.58	1000	97.7
Cadmium	< 1.00	< 1.00	NA	950.05	1000	95.0
Calcium	39.3	53.0	NA	1030.9	1000	99.2
Chromium	< 2.00	4.44	NA	972.13	1000	97.2
Cobalt	< 3.00	< 3.00	NA	955.11	1000	95.5
Copper	110	112	1.8	1069.2	1000	95.9
Iron	25.2	65.5	88.9	1013.7	1000	98.9
Lead	7.41	7.79	5.0	26.07	20	93.3
Lithium	< 1.00	1.18	NA	1030.4	1000	103.0
Magnesium	< 17.0	< 17.0	NA	915.22	1000	91.5
Manganese	< 1.00	1.17	NA	947.65	1000	94.8
Mercury	0.27	0.40	NA	4.452	4	104.6
Nickel	< 3.00	< 3.00	NA	962	1000	96.2
Potassium	< 282	< 282	NA	9166.4	10000	91.7
Selenium	< 1.00	< 1.00	NA	9.891	10	98.9
Silver	< 4.00	< 4.00	NA	942.14	1000	94.2
Sodium	66.7	71.7	7.2	1035.5	1000	96.9
Strontium	< 1.00	< 1.00	NA	908.1	1000	90.8
Thallium	1.59	1.10	NA	46.83	50	90.5
Vanadium	< 2.00	< 2.00	NA	970.71	1000	97.1
Zinc	128	131	2.3	1084	1000	95.6

NA = Not Applicable
Duplicate Limits = 20%
Spike Limits = 25%

EcoTek LSI
EcoTek Laboratory Services Incorporated

3342 International Park Drive, S.E.
Atlanta, Georgia 30316
(404) 244-0827
Fax # (404) 243-5355

August 10, 1992

Dr. Charlotte Kimbrough
Martin Marietta Energy Systems
P. O. Box 2003
Hwy. 58, Blair Road
Oak Ridge, TN 37831-7169

References: SOW MAD/AS-01

Dear Dr. Kimbrough:

Enclosed along with this letter are the Gamma, Strontium-90, and Gross Alpha/Beta for the sample(s) received June 5, 1992. The remaining results will follow as soon as possible.

Please contact Craig Johnson at (404)244-0827 if you have any questions. Also, please refer to LSDG number 2483 in future correspondence.

Sincerely,

ECOTEK LABORATORY SERVICES, INC.

Donald L. Dihel
Quality Assurance Manager

Craig Johnson

Craig Johnson
Senior Project Manager

Enclosures.
DLD/CCJ/crb

EcoTek LSI
EcoTek Laboratory Services Incorporated

3342 International Park Drive, S.E.
Atlanta, Georgia 30316
(404) 244-0827
Fax # (404) 243-5355

August 18, 1992

Mr. Terry Hatmaker
Oak Ridge National Laboratory
Building 7503, Room 16, Mail Stop 6382
Bethel Valley Road
Oak Ridge, TN 37831

Reference: (SOW MAD AS-01)
SOW-12 APO# ER-060392-01-03-ET 8-19-92

Dear Mr. Hatmaker:

Enclosed along with this letter are the remaining hard copy results for the sample(s) received June 5, 1992. This report includes Technetium-99, Isotopic Plutonium, Americium-241, Curium-243, 245, 247, and preliminary Isotopic Uranium results. The revised Isotopic Uranium results will follow as soon as possible.

Please contact Craig Johnson at (404)244-0827 if you have any questions. Also, please refer to LSDG number 2483 in future correspondence.

Sincerely,

ECOTEK LABORATORY SERVICES, INC.

Donald L. Dihel
Quality Assurance Manager

Craig Johnson
Craig Johnson
Senior Project Manager

Enclosures.
DLD/CCJ/crb

EcoTek LSI
EcoTek Laboratory Services Incorporated

3342 International Park Drive, S.E.
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Fax # (404) 243-5355

AUG 31 3 09 PM '92

August 28, 1992

Dr. Charlotte Kimbrough
Martin Marietta Energy Systems
P. O. Box 2003
Hwy. 58, Blair Road
Oak Ridge, TN 37831

Reference: SOW: MAD AS-01
APO #: ER 060392-01-03-ET

Dear Dr. Kimbrough:

Enclosed along with this letter are the finalized Isotopic Uranium results for the sample(s) received June 5, 1992.

Please contact Craig Johnson at (404)244-0827 if you have any questions. Also, please refer to LSDG number 2483 in future correspondence.

Sincerely,

ECOTEK LABORATORY SERVICES, INC.

Donald L. Dihel
Quality Assurance Manager

Craig Johnson

Craig Johnson
Senior Project Manager

Enclosures.
DLD/CCJ/crb

RADIOCHEMISTRY

Gamma Isotopic

EcoTek LSI
EcoTek Laboratory Services Incorporated

CASE NARRATIVE FOR GAMMA ISOTOPICS

Client: Martin Marietta Energy Systems

LSDG: 2483 (soil)

* The prepared sample is placed in a container and counted on a gamma spectrometry system which is calibrated with NIST traceable standards. A spectrum is collected and analyzed for the presence of gamma emitting radionuclides. The peaks present in the sample spectrum are compared to a nuclide library and the gamma emitters identified. The identified peaks are then quantified and isotopic concentrations calculated. MDA's are then calculated for isotopes not identified in the sample.

* The detection limit for this analysis (MDA) is dependent on sample size, detector efficiency, detector background, and count time.

* The following exceptions and/or considerations should be noted for the sample group contained within:

- The gamma scan for sample 248301 was reprocessed to determine the Cm-243, Cm-245, and Cm-247 activity in the sample.

EcoTek LSI
EcoTek Laboratory Services Incorporated

CASE NARRATIVE FOR GAMMA ISOTOPICS

Client: Martin Marietta Energy Systems

LSDG: 2483 (Water)

- The prepared sample is placed in a container and counted on a gamma spectrometry system which is calibrated with NIST traceable standards. A spectrum is collected and analyzed for the presence of gamma emitting radionuclides. The peaks present in the sample spectrum are compared to a nuclide library and the gamma emitters identified. The identified peaks are then quantified and isotopic concentrations calculated. A Minimum Detectable Activity (MDA) is then calculated for isotopes not identified in the sample.

- The detection limit, or MDA, for this analysis is dependent on sample size, detector efficiency, detector background, and count time.

- The following exceptions and/or considerations should be noted for the sample group contained within:

The duplicate Relative Percent Difference (RPD) was within the laboratory control limits. No blank spike or reagent blank was analyzed with this data set.

RADIOCHEMISTRY

Isotopic Plutonium

EcoTek LSI
EcoTek Laboratory Services Incorporated

CASE NARRATIVE FOR ISOTOPIC PLUTONIUM

Client: Martin Marietta Energy Systems

LSDG: 2483 (soil)

* Aliquots of sample are traced with Plutonium-236 and analyzed for isotopic Plutonium (238, 239/240, and 242). The samples are loaded onto an anion exchange column using 8N nitric acid. After rinsing the column, the plutonium is selectively stripped from the column using a solution of 9M hydrochloric acid and ammonium iodide. One half of the solution is electroplated and analyzed for alpha emitting plutonium isotopes by an alpha spectrometry system.

* Quantification of each of the alpha emitting isotopes is done by quantifying the observed peak area(s) of the isotope(s) of interest and the peak area of the tracer isotope added to the sample. The observed peak area of the tracer isotope is then used to calculate the chemical recovery of the sample. This chemical recovery is then applied to the peaks of interest, with the detector efficiency, count time, and sample volume/weight to calculate the isotopic concentration of each of the plutonium isotopes detected.

* The detection limit, or Minimum Detectable Activity (MDA), of this analysis is affected by many analysis parameters, including sample volume/weight, chemical recovery, detector efficiency, sample count time, and instrument background.

* The following exceptions and/or considerations should be noted for the sample group contained within:

The blank spike and matrix spike recoveries were within laboratory control limits. The reagent blank contained no measurable amounts of activity greater than the MDA. The duplicate Relative Percent Difference (RPD) is not applicable since MDA's were used in the calculations.

RADIOCHEMISTRY

Curium

EcoTek LSI
EcoTek Laboratory Services Incorporated

CASE NARRATIVE FOR ISOTOPIC CURIUM

Client: Martin Marietta Energy Systems

LSDG: 2483 (soil)

- The prepared sample is placed in a container and counted on a gamma spectrometry system which is calibrated with NIST traceable standards. A spectrum is collected and analyzed for the presence of gamma emitting radionuclides. The peaks present in the sample spectrum are compared to a nuclide library and the gamma emitters identified. The identified peaks are then quantified and isotopic concentrations calculated. The Minimum Detectable Activity (MDA) is then calculated for isotopes not identified in the sample.
- The detection limit, or MDA, for this analysis is dependent on sample size, detector efficiency, detector background, and count time.
- The following exceptions and/or considerations should be noted for the sample group contained within:

  The gamma scan for sample 2483-01 was reprocessed to determine the Cm-243, Cm-245, and Cm-247 activity in the sample.

RADIOCHEMISTRY

Isotopic Uranium

EcoTek LSI
EcoTek Laboratory Services Incorporated

CASE NARRATIVE FOR ISOTOPIC URANIUM

Client: Martin Marietta Energy Systems

LSDG: 2483 (soil)

- Aliquots of sample(s) are traced with Uranium-232 and analyzed for Isotopic Uranium (234,235, and 238). The samples are converted to a chloride form and loaded onto an anion exchange column using 12N hydrochloric acid. After rinsing the column, the uranium is selectively stripped from the column using a solution of 1M hydrochloric acid. The solution is electroplated and analyzed for uranium isotopes by alpha spectrometry using pulse height analysis. All alpha spectrometers are calibrated with NIST traceable standards.

- Quantification of each isotope is done by quantifying the observed peak area(s) of the isotope(s) of interest and the peak area of the tracer isotope added to the sample. The observed peak area of the tracer isotope is then used to calculate the chemical recovery of the sample. This chemical recovery is then applied to the peaks of interest, with the detector efficiency, count time, and sample volume/weight to calculate the isotopic concentration of each of the uranium isotopes detected.

- The detection limit, or Minimum Detectable Activity (MDA), of this analysis is affected by many analysis parameters, including sample volume/weight, chemical recovery, detector efficiency, sample count time, and instrument background.

- The following exceptions and/or considerations should be noted for the sample group contained within:

  The blank spike recovery and duplicate Relative Percent Difference (RPD) were within the laboratory control limits. MDA's were used to calculate the duplicate RPD for U-235 making the RPD not applicable. Also, the matrix spike (MS) and matrix spike duplicate (MSD) recoveries and the MS/MSD reproducibility were judged to be acceptable.

  The reagent blank contained U-234 and U-238 contamination at 21% and 43%, respectively, of the sample activity. This contamination is similar to that obtained in the two previous sample analyses performed on August 5 and 13, 1992. The batch of samples were prepared together, and the presence of activity in the blank is believed to be the results of cross-contamination during preparation.

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10-13-92

RADIOCHEMISTRY

Isotopic Americium

EcoTek LSI
EcoTek Laboratory Services Incorporated

CASE NARRATIVE FOR ISOTOPIC AMERICIUM

Client: Martin Marietta Energy Systems

LSDG: 2483 (soil)

- Aliquots of sample were traced with Americium-243 (or Curium-244 if Am-243 analysis is required) and analyzed for isotopic Am-241 (and Am-243). The americium and curium present in the samples is removed by extraction into DDCP and then back extracted into a dilute nitric acid solution. Trace metals and organic contaminants are removed by precipitation with yttrium flouride. Americium and curium are finally purified by ion exchange chromatography and electroplated for analysis using an alpha spectrometry system, using pulse height analysis. All alpha spectrometers are calibrated with NIST traceable standards.

- Quantification of each isotope is done by quantifying the observed peak area(s) of the isotope(s) of interest and the peak area of the tracer isotope added to the sample. The observed peak area of the tracer is then used to calculate the chemical recovery of the sample. This chemical reco en applied to the peaks of interest, with the detector efficiency, count time, and mple volume/weight to calculate the isotopic concentration of each of the americum isotopes detected.

- The detection limit, or Minimum Detectable Activity (MDA), of this analysis is affected by many analysis parameters, including sample volume/weight, chemical recovery, detector efficiency, sample count time, and instrument background.

- The following exceptions and/or considerations should be noted for the sample group contained within:

  The Am-241 was performed by alpha spectrometry to confirm the gamma spectroscopy results. The results obtained by alpha spectrometry were in agreement with the gamma results, with all results less than the MDA.

  The blank spike and matrix spike percent recoveries were within the laboratory control limits. The reagent blank contained no measurable amounts of activity greater than the MDA. The duplicate Relative Percent Difference (RPD) is not applicable due to the use of MDA's in the calculation.

RADIOCHEMISTRY

Technetium-99

EcoTek LSI
EcoTek Laboratory Services Incorporated

CASE NARRATIVE FOR TECHNETIUM-99

Client: Martin Marietta Energy Systems

LSDG: 2483 (soil)

* Aliquots of sample are prepared in a 9N sulfuric acid solution, traced with Technetium-99m and separated from the sample matrix by extraction into tributyl phosphate. A portion of the orgainic phase is transferred to a liquid scintillation vial and scintillation cocktail added. The vial is first gamma counted, measuring the Tc-99m concentration, to determine the chemical recovery. The sample vial is stored to allow for decay of the Tc-99m. After sufficient decay of the 6 hour half-life Tc-99m the vial is beta counted in a liquid scintillation counter to determine the Tc-99 activity.

* Quantification of the Tc-99 is done by quantifying the observed peak area of the beta spectrum. the observed gamma activity of the tracer isotope is then used to calculate the chemical recovery of the sample. This chemical recovery is then applied to the measured Tc-99 activity using the detector efficiency, count time, and sample volume/weight to calculate the isotopic concentration of Tc-99.

* The detection limits, or Minimum Detectable Activity (MDA), of this analysis are affected by many analysis parameters, including sample volume/weight, chemical recovery, detector efficiency, sample count time, and instrument background.

* The following exceptions and/or considerations should be noted for the sample group contained within.

The blank spike recovery, matrix spike recovery, and duplicate Relative Percent Difference (RPD) were within the laboratory control limits. The reagent blank contained no measureable amounts of activity greater than the MDA.

RADIOCHEMISTRY

Strontium-90

EcoTek LSI
EcoTek Laboratory Services Incorporated

CASE NARRATIVE FOR STRONTIUM-90

Client: Martin Marietta Energy Systems

LSDG: 2483 (soil)

- Stable carriers are added to aliquots of sample to aid in the separation of interfering isotopes from the strontium isotopes. Interferences from calcium and other radionuclides are removed by one or more precipitations of the strontium carrier as strontium nitrate. Barium and radium interferences are removed as a chromate. The sample is counted for beta activity, on a Canberra HT1000 Gas Flow Proportional Counter, to determine the total strontium activity present. After an appropriate ingrowth period, the Y-90 is milked from the sample and counted on a Canberra HT1000 Gas Flow Proportional Counter. The Sr-90 activity is determined from the Y-90 activity, and the Sr-89 is determined by subtracting the Sr-90 activity from the total Sr activity.

- The detection limits, or Minimum Detectable Activity (MDA), of this analysis are dependent on sample size, detector efficiency, detector background, count time, and chemical recovery.

- The following exceptions and/or considerations should be noted for the sample group contained within:

  The blank spike recovery and duplicate Relative Percent Difference (RPD) were within the laboratory control limits. The reagent blank contained minor contamination less than 1% of the sample activities. The matrix spike recovery is not distinguishable due the ratio of sample activity to the amount of matrix spike added (~200/1). Therefore, the matrix spike percent recovery is not applicable.

CASE NARRATIVE FOR STRONTIUM-90

Client: Martin Marietta Energy Systems

LSDG: 2483 (Water)

* Stable carriers are added to aliquots of sample to aid in the separation of interfering isotopes from the strontium isotopes. Interferences from calcium and other radionuclides are removed by one or more precipitations of the strontium carrier as strontium nitrate. Barium and radium interferences are removed as a chromate. The sample is counted for beta activity, on a Canberra HT1000 Gas Flow Proportional Counter, to determine the total strontium activity present. After an appropriate ingrowth period, the Y-90 is milked from the sample and counted on a Canberra HT1000 Gas Flow Proportional Counter. The Sr-90 activity is determined from the Y-90 activity, and the Sr-89 is determined by subtracting the Sr-90 activity from the total Sr activity.

* The detection limits, or Minimum Detectable Activity (MDA), of this analysis are dependent on sample size, detector efficiency, detector background, count time, and chemical recovery.

* The following exceptions and/or considerations should be noted for the sample group contained within:

The blank spike recovery, matrix spike recoveries and duplicate Relative Percent Difference (RPD) were within the laboratory control limits. The reagent blank contained no measurable activity greater than the MDA.

RADIOCHEMISTRY

Gross Alpha/Gross Beta

EcoTek LSI
EcoTek Laboratory Services Incorporated

CASE NARRATIVE
GROSS ALPHA/GROSS BETA ANALYSIS

Client: Martin Marietta Energy Systems

LSDG: 2483 (Soil)

* The prepared sample is evaporated on a 5 cm stainless steel planchet. The activity of the deposited residue is then measured using a gas flow proportional counter which has been calibrated with NIST traceable standards.

* This analysis is applicable for the analysis of isotopes which emit alpha particles having energies above 3.9 MeV and maximum beta energies above 0.1 MeV. Radionuclides that are volatile under the sample preparation conditions of this method, such as radon, some technetium, cesium, and iodine compounds, are not measured.

* Gross alpha and gross beta determinations are expressed as an equivalency to Am-241 and Sr-90, respectively.

* The detection limits, or Minimum Detectable Activity (MDA), of this analysis are dependent on sample size, detector efficiency, detector background, count time, and sample solids content.

* The volume/weight of 1.000 listed on the data sheet for the method blank and method spike is an arbitrary number used for calculation purposes only.

* The following exceptions and/or considerations should be noted for the sample group contained within:

- The blank spike recovery and duplicate Relative Percent Difference (RPD) for both Gross Alpha were within the laboratory control limits. The reagent blank contained no measureable amounts of alpha activity greater than the MDA. Activity above the MDA was present in the beta scan. However, the blank activity was less than 10% of the sample activity which is required for a passing sample run.

A matrix spike was performed but was not detectable due to the high activity present in the sample, as compared to the matrix spike activity. Therefore, these numbers are not applicable.

The gross alpha results are flagged (J) as estimated, since it is believed that the results observed are due to the crosstalk of the beta channel into the alpha channel. During instrument setup for simultaneous counting the instrument discriminator is established at a level were the beta to alpha crosstalk is less than 1%. In reviewing the data, paying particular attention to the gross counts for both the gross alpha and gross beta, it can be seen that the alpha results observed are a false positive caused by the crosstalk from the extremely high levels of beta activity present in the sample.

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EcoTek LSI
EcoTek Laboratory Services Incorporated

CASE NARRATIVE
GROSS ALPHA / GROSS BETA ANALYSIS

Client: Martin Marietta Energy Systems

LSDG: 2483 (Water)

* The prepared sample is evaporated on a 5 cm stainless steel planchet. The activity of the deposited residue is then measured using a gas flow proportional counter which has been calibrated with NIST traceable standards.

* This analysis is applicable for the analysis of isotopes which emit alpha particles having energies above 3.9 MeV and maximum beta energies above 0.1 MeV. Radionuclides that are volatile under the sample preparation conditions of this method, such as radon, some Technetium, Cesium, and Iodine compounds, are not measured.

* Gross alpha and beta determinations are expressed as an equivalency to Am-241 and Sr-90, respectively.

* The detection limits of this analysis (MDA) are dependent on sample size, detector efficiency, detector background, count time, and sample solids content.

* The volume/weight of 1.000 listed on the data sheet for the method blank and method spike is an arbitrary number used for calculation purposes only.

* The following exceptions and/or considerations should be noted for the sample group contained within:

The gross alpha blank spike was above the upper laboratory control limit of 125%. The matrix spike (MS) percent recovery was 131%. The duplicate Relative Percent Difference (RPD) was within laboratory control limits, and the matrix spike duplicate (MSD) percent recovery and the MS/MSD reproducibility were judged to be acceptable. The reagent blank contained no measurable activity greater than the MDA.

The gross beta blank spike recovery and duplicate RPD were within laboratory control limits. The MS/MSD percent recoveries and the MS/MSD reproducibility were judged to be acceptable. The reagent blank contained no measurable activity greater than the MDA.

EcoTek LSI
EcoTek Laboratory Services Incorporated

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March 17, 1993

Terry L. Hatmaker
Analytical Project Office
Martin Marietta Energy Systems, Inc.
P.O. Box 2003
Oak Ridge, TN 37831-7169

Dear Mr. Hatmaker:

The following questions and answers represent our response to your recent inquiry regarding the radioanalytical data that was submitted under the Martin Marietta Energy Systems project description, "Investigation of the 7500 Area Contamination Site Sampling".

1. <u>Why was Es-253 and Bk-249 omitted from the sample analysis?</u>

   Es-253 is primarily an alpha emitter and decays to Bk-249 with a 20.5 day half-life. There are no significant gamma energies with sufficient abundance to enable detection by gamma spectroscopy as requested in the Statement of Work for this project. The primary decay of Bk-249 is by beta particle emission to Cf-249 with 99% abundance. This radionuclide would not be detected by gamma spectroscopy. The decay product of Cf-249 has associated gamma energies with sufficient abundance (66%) at 387keV and could be detected by gamma analysis if sufficient activity was present. Therefore, this radionuclide was used in the final report. In addition, Cf-249 was reported as the decay product and not the parent due to the fact that this radionuclide is not of environmental origin. Cf and Bk radionuclides are not naturally occurring and could be part of anthropogenic inputs to the surroundings, so to report the short lived parent from the longer lived daughter may not be applicable. Cf-252 was also requested, but there are no sufficient gamma-ray energies with significant abundance.

2. <u>Explain why Minimum Detectable Activities change.</u>

   In the MDA values that were verified, it was observed that there were slight differences between the initially reported values and the most recent submission of this data on January 15th. It appears that a combination of data entry and rounding errors in spreadsheet cell formatting were the contributing causes of these differences. The data for each of these samples have been re-checked and the correct MDA data for the isotopes is provided.

3. Explain the "J" qualifier for the Gross Alpha data.

The "J" flagged data corresponds to the analysis performed on the soil sample. The initial count data demonstrates approximately 1,700 pCi/G of alpha activity. Details of this flag are noted in the analysis case narrative found on page 127 of the initial report. Initial questions from the APO regarding the level of alpha activity in this sample were raised since there was no known alpha source at the surroundings and this result was not consistent with the natural background. The gas flow proportional counters employed at EcoTek LSI are set-up to count alpha and beta decays simultaneously. In this dual isotope counting method, there is up to a 3% spill up contribution of beta counts possible into the alpha counting channel. Upon investigation of the raw count data, it could be shown that the unexpectedly high alpha counts could be the result of a cross contribution during the measurement. The spill over of beta into alpha is suspected to have led to a false alpha positive result.

4. How can the Co-60 result change from a Non-Detect to a Detect back to a Non-Detect?

In the initial data submission, the Co-60 result for all samples was Non-Detect. The reported values for the waters has been consistent throughout all submittals. The soil sample was initially reported as a Non-Detect. The standard laboratory policy for reporting gamma spectroscopy data employs a limit of 45% at ±%2 sigma uncertainty. Based on this criteria, the Co-60 peak was considered a false positive, and hence, not reported in the final submission of analytical data. In the second release of this data, the original value of 0.092 ± 0.16 pc/gram (174% error) was entered into the spreadsheet. The value was reported in error as this peak was not present as indicated by the statistical limit criteria.

5. In addition to providing you this response, it was noted during the data review that the strontium counting efficiency used at the time of processing these samples was incorrect. As shown in the initial release of this data, the strontium-89 counting efficiency was approximately 70%. Upon re-calibration, the efficiency is approximately 45%. The difference in the counting efficiency yields different Sr-90 values because in the solution of the simultaneous equations used to compute both the Sr-89 and Sr-90 activities, the Sr-89 efficiency is used. This change does not significantly effect the data for the water samples, since the activity was less than MDA. In the soil sample the difference is approximately 1,500pCi/gram or 6% lower than initially reported.

I certainly hope that the information provided by our Radioanalytical Data Review Team will satisfactorily answer your questions. Please feel free to contact EcoTek LSI with any future questions regarding this project and the associated analytical results. Inquiries should be directed to Craig Johnson, Senior Project Manager.

Sincerely,

ECOTEK LABORATORY SERVICES, INC.

Stan De Filippis

Stan De Filippis
Radiological Laboratory Manager

EcoTek LSI
EcoTek Laboratory Services Incorporated

Client: Martin Marietta
LSDG: 2483
Date Received: June 5, 1992

SOW#: 12
APO#: ER060392-01-03 (7500 Area Contamination)

Lab Sample ID	Client Sample ID	Date Analyzed	Analyte	Matrix	Qualifier	Units	Result	2 Sigma Error	Detection Limit
248301	B24S	6/23/92	Silver-110m	Soil		pCi/g	ND	NA	3.4E-1
248301	B24S	6/23/92	Americium-243	Soil		pCi/g	ND	NA	9.1E+1
248301	B24S	6/23/92	Barium-140	Soil		pCi/g	ND	NA	1.3E+0
248301	B24S	6/23/92	Cerium-141	Soil		pCi/g	ND	NA	1.1E+0
248301	B24S	6/23/92	Cerium-144	Soil		pCi/g	ND	NA	5.3E+0
248301	B24S	6/23/92	Californium-249	Soil		pCi/g	ND	NA	5.2E-1
248301	B24S	6/23/92	Curium-243	Soil		pCi/g	ND	NA	3.9E+0
248301	B24S	6/23/92	Curium-245	Soil		pCi/g	ND	NA	8.9E+0
248301	B24S	6/23/92	Curium-247	Soil		pCi/g	ND	NA	4.8E-1
248301	B24S	6/23/92	Cobalt-60	Soil		pCi/g	ND	NA	1.5E-1
248301	B24S	6/23/92	Cesium-134	Soil		pCi/g	ND	NA	3.0E-1
248301	B24S	6/23/92	Cesium-136	Soil		pCi/g	ND	NA	2.3E-1
248301	B24S	6/23/92	Cesium-137	Soil		pCi/g	1.6E+1	2.0E+0	4.3E-1
248301	B24S	6/23/92	Europium-156	Soil		pCi/g	ND	NA	2.4E+0
248301	B24S	6/23/92	Iodine-131	Soil		pCi/g	ND	NA	4.6E-1
248301	B24S	6/23/92	Lanthanum-140	Soil		pCi/g	ND	NA	1.1E-1
248301	B24S	6/23/92	Niobium-95	Soil		pCi/g	ND	NA	2.5E-1
248301	B24S	6/23/92	Ruthenium-103	Soil		pCi/g	ND	NA	3.7E-1
248301	B24S	6/23/92	Ruthenium-106	Soil		pCi/g	ND	NA	2.9E+0
248301	B24S	6/23/92	Zinc-65	Soil		pCi/g	ND	NA	3.6E-1
248301	B24S	6/23/92	Zirconium-95	Soil		pCi/g	ND	NA	4.5E-1
248301	B24S	6/23/92	Americium-241	Soil		pCi/g	ND	NA	2.3E+0
248301	B24S	6/23/92	Gross Alpha	Soil	J	pCi/g	1.7E+3	2.1E+2	1.6E+1
248301	B24S	6/23/92	Gross Beta	Soil		pCi/g	5.7E+4	5.9E+2	1.2E+1
248301	B24S	6/23/92	Plutonium-238	Soil		pCi/g	ND	NA	1.2E-1
248301	B24S	6/23/92	Plutonium-239/240	Soil		pCi/g	ND	NA	4.7E-2
248301	B24S	6/23/92	Plutonium-242	Soil		pCi/g	ND	NA	4.7E-2
248301	B24S	6/23/92	Strontium-90	Soil		pCi/g	2.5E+4	4.0E+1	7.7E-1

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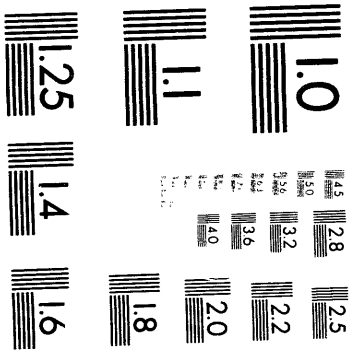
248301	B24S	6/23/92	Technetium-99	Soil		pCi/g	ND	NA	1.8E+0
248301	B24S	6/23/92	Uranium-234	Soil		pCi/g	3.5E+0	8.5E-1	4.5E-1
248301	B24S	6/23/92	Uranium-235	Soil		pCi/g	ND	NA	9.6E-2
248301	B24S	6/23/92	Uranium-238	Soil		pCi/g	2.1E+0	5.8E-1	3.0E-1
248301	B24S	6/23/92	Barium-133	Soil		pCi/g	ND	NA	5.9E-1
248301	B24S	6/23/92	Cobalt-57	Soil		pCi/g	ND	NA	7.3E-1
248301	B24S	6/23/92	Chromium-51	Soil		pCi/g	ND	NA	3.7E+0
248301	B24S	6/23/92	Europium-152	Soil		pCi/g	ND	NA	5.4E-1
248301	B24S	6/23/92	Europium-154	Soil		pCi/g	ND	NA	1.5E+0
248301	B24S	6/23/92	Europium-155	Soil		pCi/g	ND	NA	3.5E+0
248301	B24S	6/23/92	Hafnium-181	Soil		pCi/g	ND	NA	4.0E-1
248301	B24S	6/23/92	Iridium-192	Soil		pCi/g	ND	NA	4.4E-1
248301	B24S	6/23/92	Potassium-40	Soil		pCi/g	1.9E+1	3.1E+0	1.5E+0
248301	B24S	6/23/92	Radium-226	Soil		pCi/g	ND	NA	9.7E-1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Lab Sample ID	Client Sample ID	Date Analyzed	Analyte	Matrix	Qualifier	Units	Result	2 Sigma Error	Detection Limit
248302	B24B	6/24/92	Silver-110m	Water		pCi/l	ND	NA	2.2E+0
248302	B24B	6/24/92	Americium-243	Water		pCi/l	ND	NA	9.1E+1
248302	B24B	6/24/92	Barium-140	Water		pCi/l	ND	NA	8.0E+0
248302	B24B	6/24/92	Cerium-141	Water		pCi/l	ND	NA	3.2E+0
248302	B24B	6/24/92	Cerium-144	Water		pCi/l	ND	NA	1.4E+1
248302	B24B	6/24/92	Californium-249	Water		pCi/l	ND	NA	2.5E+0
248302	B24B	6/24/92	Curium-243	Water		pCi/l	ND	NA	1.4E+1
248302	B24B	6/24/92	Curium-245	Water		pCi/l	ND	NA	2.3E+1
248302	B24B	6/24/92	Curium-247	Water		pCi/l	ND	NA	2.4E+0
248302	B24B	6/24/92	Cobalt-60	Water		pCi/l	ND	NA	2.6E+0
248302	B24B	6/24/92	Cesium-134	Water		pCi/l	ND	NA	2.5E+0
248302	B24B	6/24/92	Cesium-136	Water		pCi/l	ND	NA	3.6E+0
248302	B24B	6/24/92	Cesium-137	Water		pCi/l	ND	NA	2.5E+0
248302	B24B	6/24/92	Europium-156	Water		pCi/l	ND	NA	2.3E+1
248302	B24B	6/23/92	Gross Alpha	Water		pCi/l	ND	NA	9.6E+0
248302	B24B	6/23/92	Gross Beta	Water		pCi/l	ND	NA	1.1E+1
248302	B24B	6/23/92	Iodine-131	Water		pCi/l	ND	NA	2.3E+0
248302	B24B	6/23/92	Lanthanum-140	Water		pCi/l	ND	NA	4.1E+0
248302	B24B	6/24/92	Niobium-95	Water		pCi/l	ND	NA	2.4E+0
248302	B24B	6/24/92	Ruthenium-103	Water		pCi/l	ND	NA	1.9E+0
248302	B24B	6/24/92	Ruthenium-106	Water		pCi/l	ND	NA	2.2E+1
248302	B24B	7/28/92	Strontium-90	Water		pCi/l	ND	NA	3.6E+0
248302	B24B	7/28/92	Uranium-235	Water		pCi/l	ND	NA	1.4E+1
248302	B24B	6/24/92	Zinc-65	Water		pCi/l	ND	NA	5.4E+0
248302	B24B	6/24/92	Zirconium-95	Water		pCi/l	ND	NA	4.3E+0
248302	B24B	6/22/92	Barium-133	Water		pCi/l	ND	NA	2.8E+0
248302	B24B	6/22/92	Cobalt-57	Water		pCi/l	ND	NA	1.7E+0
248302	B24B	6/22/92	Chromium-51	Water		pCi/l	ND	NA	1.6E+1

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248302	B24B	6/22/92	Europium-152	Water		pCi/l	ND	NA	1.2E+1
248302	B24B	6/22/92	Europium-154	Water		pCi/l	ND	NA	3.6E+0
248302	B24B	6/22/92	Europium-155	Water		pCi/l	ND	NA	7.5E+0
248302	B24B	6/22/92	Hafnium-181	Water		pCi/l	ND	NA	2.1E+0
248302	B24B	6/22/92	Iridium-192	Water		pCi/l	ND	NA	1.9E+0
248302	B24B	6/22/92	Potassium-40	Water		pCi/l	1.1E+2	3.5E+1	2.7E+1
248302	B24B	6/22/92	Radium-226	Water		pCi/l	ND	NA	5.0E+0

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248303	B24E	6/23/92	Silver-110m	Water		pCi/l	ND	NA	2.2E+0
248303	B24E	6/23/92	Americium-243	Water		pCi/l	ND	NA	8.9E+1
248303	B24E	6/23/92	Barium-140	Water		pCi/l	ND	NA	8.5E+0
248303	B24E	6/23/92	Cerium-141	Water		pCi/l	ND	NA	3.2E+0
248303	B24E	6/23/92	Cerium-144	Water		pCi/l	ND	NA	1.3E+1
248303	B24E	6/23/92	Curium-243	Water		pCi/l	ND	NA	1.4E+1
248303	B24E	6/23/92	Curium-245	Water		pCi/l	ND	NA	2.3E+1
248303	B24E	6/23/92	Curium-247	Water		pCi/l	ND	NA	2.4E+0
248303	B24E	6/23/92	Cobalt-60	Water		pCi/l	ND	NA	2.9E+0
248303	B24E	6/23/92	Cesium-134	Water		pCi/l	ND	NA	2.4E+0
248303	B24E	6/23/92	Cesium-136	Water		pCi/l	ND	NA	3.6E+0
248303	B24E	6/23/92	Cesium-137	Water		pCi/l	ND	NA	2.4E+0
248303	B24E	6/23/92	Californium-249	Water		pCi/l	ND	NA	2.6E+0
248303	B24E	6/23/92	Europium-156	Water		pCi/l	ND	NA	2.3E+1
248303	B24E	6/23/92	Gross Alpha	Water		pCi/l	ND	NA	8.2E+0
248303	B24E	6/23/92	Gross Beta	Water		pCi/l	ND	NA	1.1E+1
248303	B24E	6/23/92	Iodine-131	Water		pCi/l	ND	NA	2.2E+0
248303	B24E	6/23/92	Lanthanum-140	Water		pCi/l	ND	NA	4.0E+0
248303	B24E	6/23/92	Niobium-95	Water		pCi/l	ND	NA	2.4E+0
248303	B24E	6/23/92	Ruthenium-103	Water		pCi/l	ND	NA	2.0E+0
248303	B24E	6/23/92	Ruthenium-106	Water		pCi/l	ND	NA	2.2E+1
248303	B24E	7/28/92	Strontium-90	Water		pCi/l	ND	NA	3.5E+0
248303	B24E	7/28/92	Uranium-235	Water		pCi/l	ND	NA	1.5E+1
248303	B24E	6/23/92	Zinc-65	Water		pCi/l	ND	NA	4.4E+0
248303	B24E	6/23/92	Zirconium-95	Water		pCi/l	ND	NA	4.1E+0
248303	B24E	6/23/92	Barium-133	Water		pCi/l	ND	NA	2.7E+0
248303	B24E	6/23/92	Cobalt-57	Water		pCi/l	ND	NA	1.8E+0
248303	B24E	6/23/92	Chromium-51	Water		pCi/l	ND	NA	1.7E+1

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248303	B24E	6/23/92	Europium-154	Water		pCi/l	ND	NA	3.7E+0
248303	B24E	6/23/92	Europium-155	Water		pCi/l	ND	NA	7.9E+0
248303	B24E	6/23/92	Hafnium-181	Water		pCi/l	ND	NA	2.3E+0
248303	B24E	6/23/92	Iridium-192	Water		pCi/l	ND	NA	1.9E+0
248303	B24E	6/23/92	Potassium-40	Water		pCi/l	ND	NA	3.7E+1
248303	B24E	6/23/92	Radium-226	Water		pCi/l	ND	NA	5.0E+0

DATE

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