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TA-21-57 Aboveground Storage Tank Diesel Fuel Oil Environmental Assessment and Characterization

Author(s):

Bruce Baumgartner (KSL-AENV)
Florie Caporuscio (Eberline Services)
Philip Stauffer (LANL EES-6)
Mark Haagenstad (RRES-WQH)

Submitted to:

Jerome Gonzales
Facility Waste Operations Utilities and Infrastructure
Los Alamos National Laboratory

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TA-21-57
ABOVEGROUND STORAGE TANK DIESEL FUEL OIL ENVIRONMENTAL ASSESSMENT AND CHARACTERIZATION

LA-UR-02-4007, Revision 1

December 2003

Prepared by:

Eberline Services/KSL-AENV
1900 Diamond Drive, Room 208
Los Alamos, New Mexico 87544

Bruce Baumgartner (KSL-AENV)
Florie Caporuscio (Eberline Services)
Philip Stauffer (LANL EES-6)
Mark Haagenstad (RRES-WQH)

Prepared for:

Los Alamos National Laboratory
Los Alamos, New Mexico 87545
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ACRONYMS

AST	aboveground storage tank
BGL	below ground level
BTEX	benzene, toluene, ethylbenzene, and xylenes
DOE	U.S. Department of Energy
DRO	diesel-range organics
EPA	U.S. Environmental Protection Agency
FWO-SWO	Facility Waste Operations–Solid Waste Operations
HENV	Health and Environmental
HSR-1	Health Safety and Radiation Protection
JCNNM	Johnson Controls Northern New Mexico
KSL	KBR-Shaw-LATA
LANL	Los Alamos National Laboratory
Ma	million annum or million years
MDL	Method Detection Limit
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
PSTB	Petroleum Storage Tank Bureau
ppm	parts per million
RRES-WQH	Risk Reduction and Environmental Stewardship–Water Quality and Hydrology
SAP	Sampling and Analysis Plan
SVOC	Semi-Volatile Organic Compounds
TA	Technical Area
TCLP	toxicity characteristic leaching procedure
TPH	total petroleum hydrocarbons
UST	underground storage tank
VOC	volatile organic compound

1.0 INTRODUCTION

This report is being prepared as a revision to LA-UR-02-4007 Revision 0. Results of additional characterization, requested by the New Mexico Environment Department (NMED), were incorporated into LA-UR-02-4007 to produce this report. Eberline Services/KSL Health and Environmental (KSL-AENV) have prepared this summary of results from the environmental assessment associated with soil contamination from leaking underground fuel-oil lines connecting the aboveground storage tank (AST) at Technical Area (TA)-21-57 with the TA-21-357 Steam Plant at Los Alamos National Laboratory (LANL) (see Figure 1 below and Appendix 1, Figure 1). Up to approximately 48,000 gallons of fuel oil from the AST was unaccounted for on January 16, 2002. An assessment into the potential for fuel oil leaking into the surrounding soil and environment has been completed. Soil removal and sampling were performed in accordance with the requirements of LANL, the U.S. Department of Energy (DOE), the NMED, and the U.S. Environmental Protection Agency (EPA) to determine the presence and extent of the leak from underground fuel-oil supply and return lines from the AST.

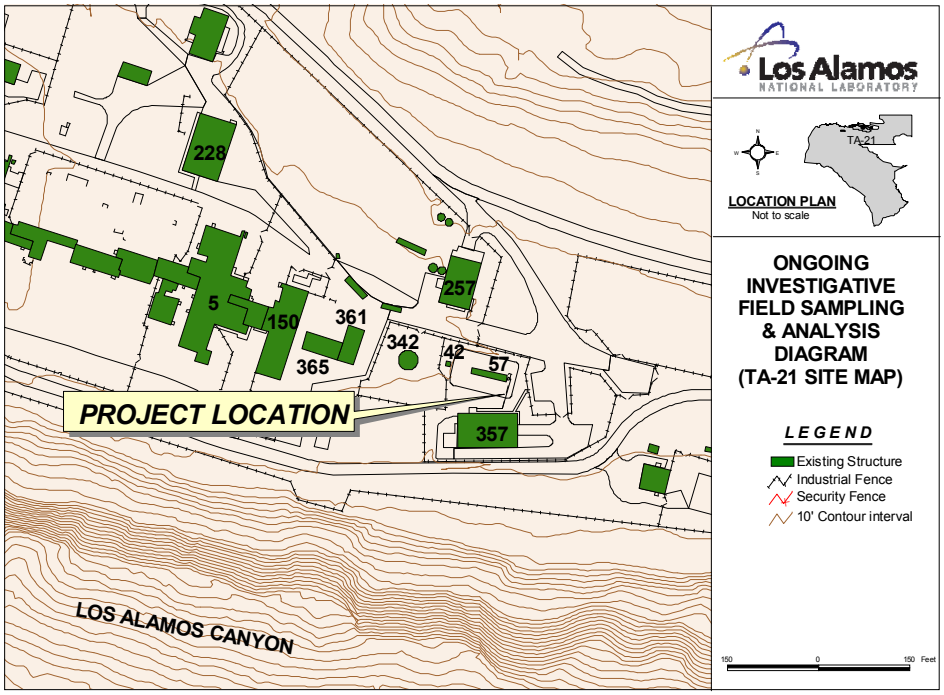

Figure 1. Overview of the TA-21 Building 357 Site

2.0 SCOPE OF WORK

The scope of work for this assessment is described in detail in the *Sampling and Analysis Plan, Assessment of Fuel Oil Contamination, TA-21-57 Fuel Storage Tank Release Investigation* (Benchmark Environmental/JCNNM-HENV, March 7, 2002), Amendments 1 through 4 thereof, and *Addendum 1, Additional Sampling and Analysis Plan, Assessment of Fuel Oil Contamination, TA-21-57 Fuel Storage Tank Release Investigation* (Eberline Services/KSL-HENV, July 30, 2003). These documents collectively will be hereinafter referred to as the SAP. The following description is a summary of this scope of work.

The purpose of the SAP is to document the objectives, rationale, and procedures for collecting, analyzing, and managing environmental samples taken from this site. Sampling methods for the investigation of the fuel-oil lines are in accordance with the objectives and procedures described in *Reporting and Investigation of Suspected and Confirmed Releases* (20 NMAC 5.7, 1995), *Corrective Actions for UST Systems Containing Petroleum Products* (20 NMAC 5.12, 2000), *Guidelines For Corrective Action* (NMED Petroleum Storage Tank Bureau [PSTB], March 13, 2003), and comments on the initial characterization activities received from the NMED in a letter dated May 28, 2003. The SAP outlines the methods and procedures proposed to collect samples and gather data of sufficient quality and quantity to adequately verify the presence and extent of the release that occurred from the associated underground fuel lines. It provides information necessary to identify the quantity of contaminated soil present at the site. The project received appropriate LANL reviews and was performed in accordance with approved site health and safety plans and emergency response plans. The project was performed in accordance with applicable DOE, LANL, and State of New Mexico requirements. The primary investigations performed during the initial assessment included ten potholes, trenching to inspect the pipelines, 23 GeoProbe samples, and ten continuously cored boreholes. The additional investigation involved advancing four additional boreholes to further establish the vertical and horizontal extent of the contamination and the role of fractures in potential contaminant transport.

3.0 HISTORY OF STEAM PLANTS AND FUEL TANK

The TA-21-57 fuel oil AST is a 50,000-gallon, one-section, nonbaffled tank that was installed in early 1945 to store fuel oil to supply the old Central Steam Plant, TA-21-9. In 1986 the new Steam Plant, TA-21-357, was commissioned. Fuel oil reached the new Steam Plant boilers via an aboveground pumping system located inside the building and through underground supply and return lines from the AST. The underground fuel lines leading to the old Steam Plant have been decommissioned and capped. The fuel lines between the new Steam Plant and the AST have now been removed and the AST is out of service.

The AST provided fuel oil as a backup source to fire boilers at TA-21-357. The normal source is natural gas. The tank was filled through an aboveground line and the supply and return lines to the TA-21-357 boilers were buried between the AST and the Steam Plant (a distance of about 80 ft.). The tank supply line has a 3-inch standpipe inside the tank with a 9-inch strainer, and the return line penetrates the tank at the top. The tank contained fuel oil.

On January 16, 2002, Steam Plant personnel tried to start using fuel oil. This attempt failed because no fuel was available at the boiler. Plant operators checked the pumps and filters, which were found to be functioning. The plant operators then pumped air to the tank to check for gelling of fuel. It was discovered at that time that there were only three inches of fuel in the tank whereas previous inventory readings had indicated a level of 128 inches (48,357 gallons) in the tank. Subsequently, pressurized air testing detected small leaks in the supply fuel-oil pipeline between the tank and the plant. On February 21, the Laboratory's Risk Reduction and Environmental Stewardship–Water Quality and Hydrology (RRES-WQH) notified NMED, EPA, and the National Response Center that a potential spill had occurred. Below is the scope of work to determine the extent of fuel oil contamination in the soil and underlying tuff in the region of the TA-21 Steam Plant.

4.0 SITE-SPECIFIC GEOLOGY AND GROUNDWATER

4.1 Regional Geology

The stratigraphic unit nomenclature of the Bandelier Tuff described in this report are largely according to Broxton and Reneau (1995). The Bandelier Tuff is dominantly composed of a complex sequence of nonwelded to welded ignimbrites that were erupted from the Valles-Toledo cauldera complex (Smith and Bailey 1966; Gardner et al. 1986). In the region of Los Alamos, the Bandelier Tuff consists of two members: the lower Otowi member (1.61 Ma) and the upper Tshirege member (1.22 Ma) (Izett and Obradovich 1994), separated by a unit of volcaniclastic rocks and tuffs of the Cerro Toledo interval, which is approximately 300 ft. below TA-21-357 (Heiken et al. 1986; Broxton and Reneau 1995; Lavine et al. 1997). The Tshirage member consists of four identified units (Units 1 through 4). The bottommost portion of Unit 1 is the Tsankawi pumice bed, which is the basal pumice fall of the Tshirege member. The two units of the Tshirage Tuff positively encountered at the TA-21 Steam Plant site are Unit 3 (the top layer) and Unit 2 (the lower layer).

4.2 Site-Specific Lithologic Descriptions

All descriptions were performed at the drill site with the help of a 10X hand lens. With the exception of differences in texture and induration brought about by the variations in welding (which were qualitatively determined by the degree of pumice flattening), the lithologic descriptions of Units 3 and 2 are consistent from borehole to borehole. The lithologic descriptions are arranged from youngest to oldest rocks. Specific stratigraphic unit characteristics for each borehole are depicted in Appendix 1, Figures 3 and 4.

4.2.1 Unit 3

Unit 3 is a nonwelded to moderately welded, phenocryst-rich, moderate pumice-bearing, devitrified tuff. This unit has been penetrated to its lower contact with Unit 2 in nine of the ten boreholes.

Phenocrysts in Unit 3 are abundant at 15 to 25 volume percent, with quartz and alkali feldspar in subequal amounts. The quartz and feldspar phenocrysts have distinctive physical characteristics. The quartz has a bipyramidal shape, and the alkali feldspar is chatoyant (flash of blue color observed). Plagioclase and mafic phenocrysts are extremely rare.

Pumice lapilli in the Unit 3 ash flow range from 10 to 20 percent by volume. Unit 3 is nonwelded to slightly welded at the top, but rapidly grades downward to partly welded tuff over a short interval (approximately 10 ft.). The pumices are fully inflated and vesicular at the top of the ash flow, but with increased welding, the tubular pumice structures become progressively more flattened and deformed. All pumices are devitrified in this unit. Colors of the pumice are of three modes. At the top of the flow, they are predominantly dark gray or brown with white stripes. Progressing down section, the brown lapilli gradually disappear and are replaced by large white pumice. The pumice ranged in size from 5 mm to over 10 cm.

The matrix of Unit 3 is composed of ash, devitrified glass shards, crystal fragments, and very small pumice fragments. The matrix color of this unit ranges from purple gray to medium gray, and the matrix makes up approximately 65 percent by volume of the ash flow.

4.2.2 Unit 2

Unit 2 is a nonwelded to densely welded, very phenocryst-rich, moderate pumice-bearing, devitrified tuff. The contact between Unit 3 and Unit 2 was determined by the abrupt increase in phenocryst content. In most boreholes, coring was continued through the nonwelded portion of Unit 2 until there was an increase in welding at 100 ft. below ground level (BGL). These four vertical assessment holes were finished at 155 ft. BGL

However, three holes were extended to greater depths in Unit 2. Borehole V2 went to 110 ft. BGL, where Unit 2 was partly welded. Borehole V5 was drilled to 125 BGL, where Unit 2 was densely welded. The deepest borehole, Borehole V1, was drilled to 175 ft. BGL and probably went below the bottom of Unit 2 and penetrated Unit 1. The Unit 2/Unit 1 contact was impossible to locate precisely, due to high core losses in the sampling. The assumption that the contact was passed (at approximately 165 ft. BGL) is dependent on three factors: the regional stratigraphy delineated by Broxton and Reneau (1995), the change from densely welded to nonwelded tuff in the 150- to 155-ft. interval, and a Plinian air fall pumice deposit observed in this borehole from 165–170 ft. BGL. It should be noted that in five Boreholes (V1, V-2A, V-4A, V-6A, and V-8A) the densely welded portion of Unit 2 extends from 110–150 ft. BGL.

Phenocrysts in Unit 2 are abundant at 35 to 45 volume percent, with quartz and alkali feldspar in subequal amounts. The quartz and feldspar phenocrysts have the same distinctive physical characteristics as described in Unit 3 (bipyramidal quartz and chatoyant alkali feldspar).

Pumices in Unit 2 range in volume from 10 to 20 percent. The color of these devitrified pumice range from white to gray. The gray pumice darkened in color as the degree of welding increased. The white pumice was not observed in the densely welded portion of the unit (110–150 ft. BGL). The pumice varied in size from 1 cm to more than 10 cm. The larger pumice are common in the upper nonwelded portion.

The matrix of Unit 2 is composed of ash, devitrified glass shards, crystal fragments, and very small pumice fragments. The matrix color of this unit ranges from light gray to dark gray, and the matrix makes up approximately 45 percent by volume of the ash flow.

4.2.3 Fractures

During the initial assessment phase (2002), twenty-eight fractures were identified in the original ten boreholes. Of those fractures, 25 (90 percent) were encountered in the upper 35 ft. of Unit 3 of the Tshirege member. The remaining three fractures were identified in the lower portion of Unit 3 (52 ft. and 56 ft. BGL) and the very top of Unit 2 (68 ft. BGL). The fractures observed were dominantly high angle, that is, 18 (67 percent) of the fractures were 70 degrees or more. Another two were fractures with 45-degree angles. The third major subset included fractures with 0-degree angle (i.e., horizontal), which accounted for seven (25 percent) of the observed set.

The petrography of the fracture linings and surrounding wall rock is extremely varied. Some of the fractures show no fill material and unaltered surrounding ash flow. Other fractures are lined with red-brown clay, often with caliche veinlets included, and also with unaltered wall rock. A third common fracture type is one in which the fracture walls are lined with iron-oxides. There is no obvious fill material in these, but the wall rock is oxidized for up to 2 cm beyond the fracture wall.

During the supplementary characterization drilling, two fractures were encountered. Borehole V-2A had a 2-foot fracture from 148’ to 150’ in Unit 2. This high angle fracture was lined with a 1/8” red-brown clay seam and was constrained by unaltered wall rock. The second fracture, located in borehole V-6A (107’10” to 108’2”), showed no fill material and unaltered ash flow surrounded the fracture. This fracture

was at a 45-degree angle. Neither fracture indicated any fuel oil contamination by either visual or olfactory identification.

A few fractures in the boreholes were noteworthy. In Unit 2, Borehole V8 had a 1.5-ft. fracture that extended from 68 ft. to 69 ft. 6 inches BGL, and had both wall-rock and fracture-face oxidation. In Unit 3, Borehole A1 had a 2-ft. 1-inch fracture from 24 ft. 6 inches to 26 ft. 7 inches BGL, and a 4-inch-thick clay filling that was saturated with water. This borehole had six distinct fractures from 17 inches to 33 inches BGL.

Borehole V5 has a fracture with unusual characteristics (both visual and olfactory) that is believed to have fuel oil transport restriction implications. The fracture is located from 25 ft. 6 inches to 25 ft. 8 inches and has a dip of 45 degrees. The fracture is heavily discolored, as is the ash-flow material below the fracture. Samples above the fracture contain no fuel oil odor, but the sample directly below the fracture (35 ft. BGL) has a very strong fuel oil contamination smell. These observations indicate that the fuel oil flow to the west is being constrained above 25ft. 6 inches by this particular fracture in borehole V5. Furthermore, fuel oil contamination was not observed at depth further to the west in borehole V-6A.

4.3 Site-Specific Groundwater

The regional aquifer is typically separated from the alluvial groundwater and intermediate perched zone groundwater by 350–620 ft. of tuff, basalt, and sediments (LANL 1993). The regional aquifer beneath TA-21 is at an elevation of approximately 5,900 ft. or approximately 1,100 ft. BGL and is located chiefly within sediments of the Puye and Tesuque Formations (Broxton and Eller 1995). Thus, for mesa-top sites at TA-21, more than 1,100 ft. of tuff and volcaniclastic sediments separate the surface from the regional aquifer. The aquifer is generally believed to flow easterly toward the Rio Grande (Birdsell 2002, personal communication).

5.0 STATUTORY REQUIREMENTS

Sampling methods for the initial assessment of the fuel oil lines were done in accordance with the objectives and procedures described in *Reporting and Investigation of Suspected and Confirmed Releases* (20 NMAC 5.7, 1995) and *Corrective Actions for UST Systems Containing Petroleum Products* (20 NMAC 5.12, 2000). Sampling methods for the additional characterization were done in accordance with *Chapter 1, Soil and Groundwater, Sampling and Disposal* of the *Guidelines For Corrective Action* (NMED PSTB March 13, 2003)

5.1 Soil Collection Methodology and Sampling Protocols

In the case of this assessment, under requirements of the UST regulations, soils were sampled where holes or releases had occurred in tanks and underground piping, or where overfills/spills had occurred. Characterization of the contamination boundary was defined as levels of total petroleum hydrocarbons (TPH) less than 880 mg/kg; total benzene, toluene, ethylbenzene, and xylenes (BTEX) less than 50 mg/kg (or benzene alone less than 10 mg/kg); and hazardous constituents less than regulatory limits for metals, polynuclear aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), and semivolatile organic compounds SVOCs). For the purpose of this assessment, samples were taken at a minimum of 10 ft. below the contamination boundary from field measurements for verification.

For fuel oil contaminated soils, samples were collected in 4-ounce or larger jars. Jars were filled completely, leaving no headspace in the jar. Jars were placed on ice and shipped to a certified laboratory for analysis. Amber glass jars with Teflon® seals were required as containers for analytical purposes. Data

generated by certified laboratory analysis are the only data accepted by the UST Bureau. Acceptable laboratory analyses are:

- Analyzed for TPH by infrared spectrophotometry; freon extraction (for waste oil or diesel) (EPA Method 8015 modified by methylene chloride extraction)
- Analyzed for aromatic VOCs by gas chromatograph and a photo-ionization detector (EPA Method 8020)
- Analyzed for VOCs by gas chromatograph and mass spectrophotometry (EPA Method 8240)
- Analyzed for nonhalogenated VOCs by gas chromatograph and a flame-ionization detector (EPA Method 8015 modified by purge-and-trap sample preparation)

5.2 Handling and Disposal of Contaminated Soil

During the assessment process, all soil was segregated (contaminated versus uncontaminated) during soil removal and placed in covered roll-off bins or 55-gallon drums. Uncontaminated soil was managed as reusable fill material. Excavated soil was sampled and analyzed for characterizations of TPH, PAH, BTEX and TCLP metals. Contaminated soil with TPH levels higher than 1,000 mg/kg was managed as New Mexico Special Waste. None of the soil removed was categorized as hazardous waste. All soil removed during this assessment was properly characterized (waste profiles) and disposed of in accordance with LANL, NMED, and DOE requirements through Facility Waste Operations–Solid Waste Operations (FWO-SWO).

6.0 ASSESSMENT AND CHARACTERIZATION (POTHOLES, TRENCH, GEOPROBE, VERTICAL AND ANGLED CORE DRILLING, GROUNDWATER WELLS, AND AIR QUALITY)

6.1 Pothole Assessment

The first assessment method used was a series of ten potholes excavated on February 21, 2002 along the underground fuel supply and return lines. The locations of the potholes are depicted in Figure 2 (see also Appendix 1, Figure 5a). Potholes were distributed along the line in varying intervals for initial assessment of the extent of contamination. Grab samples were taken at a depth of six inches below and between the fuel-oil supply and return lines to determine the extent of fuel oil contamination near and under the fuel lines in each pothole. Soil samples were analyzed using Petroflag to measure levels of total petroleum hydrocarbons—diesel-range organics (TPH-DRO), and verification samples were sent to a state-certified laboratory (Assaigai Analytical Laboratory) for analysis. Two samples (Pothole #5 and Pothole #8) indicated hydrocarbon contamination at 120 parts per million (ppm) and 280 ppm.

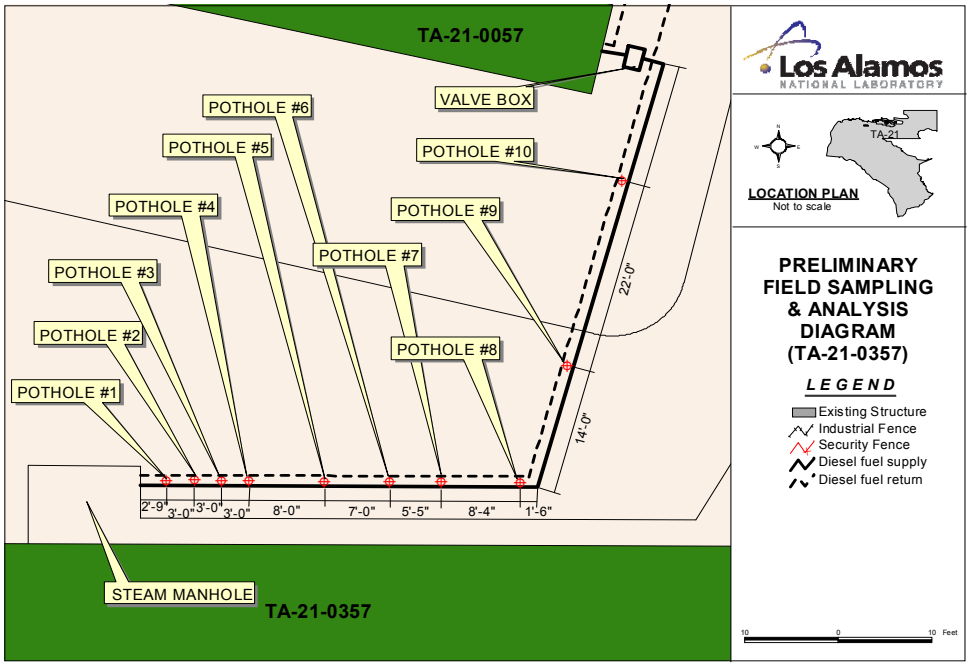

Figure 2. Sample Locations Taken from Potholes During Preliminary Sampling and Analysis

6.2 Trench Assessment

On February 23, 2002, an excavation was completed to expose the pipeline from the tank to the Steam Plant. Sixteen soil samples were taken from different points along the trench (see Appendix 1, Figure 5b). In the valve pit area (S/R-9), sampling and analyses from the trench indicated TPH-DRO levels at 1,100 mg/kg TPH-DRO. At approximately 10 ft. along the line from the valve pit (S/R-10), sampling and analysis indicated TPH-DRO levels at 29 mg/kg. The highest levels (26,000 mg/kg) of TPH-DRO was found about halfway between the elbow and the manhole (S/R-5). The higher value sample was taken from an area of visible contamination approximately 36 inches in diameter near a series of pinholes in the pipeline.

6.3 GeoProbe Assessment

On March 13, 2002, a GeoProbe unit was used to collect subsurface samples at the tuff/topsoil interface. The GeoProbe was advanced until rejection was reached, at which point a sample was collected. The samples were retrieved, packaged, and shipped to an independent laboratory (General Engineering Laboratories) for analysis. Photoionization-detection field analyses were used to establish contamination levels of the volatile fuel oil organics. These data helped provide immediate indications of contamination and were used to guide the depth of coring. This sampling scheme provided data that would encircle the tank and all associated piping, bounding the fuel-oil leak of concern. The 23 GeoProbe hole locations are illustrated in Figure 3 (see also Appendix 1, Figure 6). Primarily, contamination greater than 1,000 mg/kg diesel-range organics was found in the sample locations C, D, U, and V (see Table 1). Some contamination was found in sample location J, which is an historic spill unrelated to this assessment. Further characterization of sample location J is summarized in Appendix 2.

These sampling investigations led to the determination to bring in Sampling and analyses from the GeoProbe assessment indicated the need to further define the contamination with a hollow-stem auger drill rig. The drill rig would provide continuous core and allow systematic sampling to be conducted.

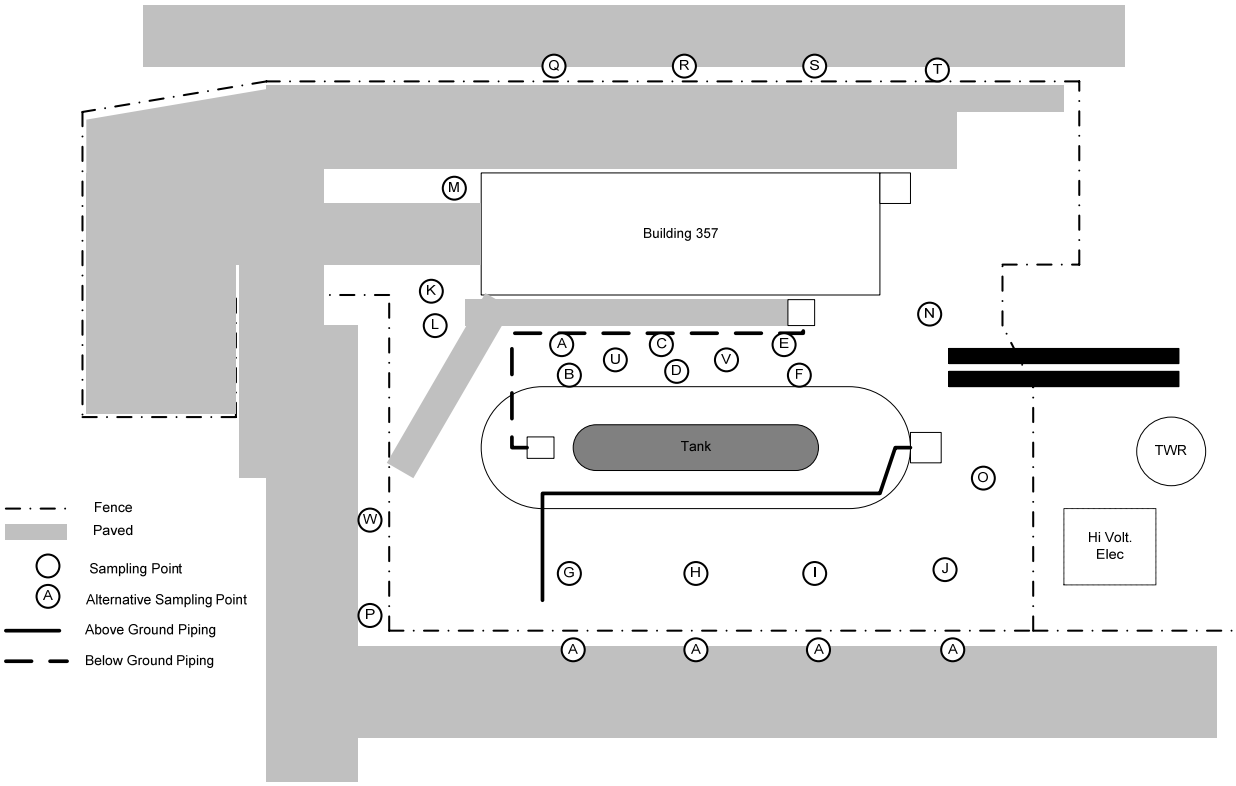

Figure 3. GeoProbe Sample and Analyses Locations and Layout

Table 1. Analytical Data from GeoProbing Assessment

Sample Point	Sample Depth Range (feet)	General Engineering Laboratories Analytical Data (TPH Diesel-Range Organics [mg/kg])
A	2 to 4	1.690
B	4 to 6	0.906
C	2 to 4.3	1,170.000
D	6 to 8	8,140.000
	8 to 12	1,260.000
	14 to 16	15,400.000
E	2 to 6.2	2.070
F	0 to 2.2	23.300
G	4 to 6	1.750
H	0 to 2	0.881
I	2 to 4	0.637
J	0 to 2	196.000
	2 to 5	1,080.000
K	0 to 3	36.800
L	2 to 4	0.763
M	2 to 4	2.920
N	2 to 4	1.310
O	0 to 2	1.340
P	2 to 4	2.080
Q	0 to 2	13.600
R	2 to 4	38.200
S	2 to 4	4.060
T	2 to 4	4.450
U	2 to 4	9.840
	4 to 6	15,500.000
	6 to 8	30,900.000
	8 to 10	51,500.000
	10 to 12	45,000.000
V	0 to 4	595.000
W	2 to 4	9.670

6.4 Vertical and Angled Core Drilling Assessment

On March 29, 2002, drilling at the TA-21-357 site commenced with a Central Mine Equipment 75 hollow-stem auger unit. During a three-week interval, ten continuous-core boreholes were completed. Four additional boreholes were completed during the additional characterization, which is described in Section 6.5The core was obtained by two different methods, depending on the degree of welding of the tuffs and the depth involved.

The first method of sample collection for shallow rocks was by 4-inch hollow-tube split spoons driven by gravity. For samples over 110 ft. in depth, which coincided with the densely welded portion of Unit 2, samples were collected by 2-inch hollow-tube split spoons driven by hammer. Borings were advanced through the area identified with the highest levels of contamination from the GeoProbe sampling and analytical results. Borings were advanced through the contaminated area, the first near the trench, and additional core sampling was stepped out toward the tank and parallel to the Steam Plant building (TA-21-357) in intervals that were based on previous boreholes (10–20 ft.). Coring commenced in a numerical sequence (see Figure 4 and Appendix 1, Figure 2) to assess the horizontal and vertical extent of the contamination. Samples were taken at depth intervals of 5–15 ft., depending on the contamination encountered, using photo-ionization-detector field-screening methods. The vertical holes provided data on the depth and horizontal extent of contamination in the most contaminated area between the AST and the Steam Plant.

A total of eight vertical holes were bored during the initial characterization (V1 through V8). Boreholes V1 through V7 were located on the north side of Building TA-21-357. Borehole V8 was drilled on the south side of the building. The depths of these boreholes are shown in Table 2. Two angled boreholes (A1 and A2) were drilled on the north side of the building. The intent of these boreholes was to penetrate the tuffs beneath the building and intercept the fuel oil plume. Borehole A1 was drilled to the south at 35 degrees from vertical and reached a drill length of 40 ft. Borehole A2 was also drilled to the south, but with an angle of 25 degrees from vertical, and was drilled to a length of 95 ft.

Table 2. Pertinent Information on Initial Assessment Hollow-Stem Auger Boreholes

	Hole Number									
Contact Feet Below Ground Level	**V1**	**V2**	**V3**	**V4**	**V5**	**V6**	**V7**	**V8**	**A1**	**A2**
Soil/Unit 3	3	5	3.4	5	4.5	4.5	4.5	3	*	4
Unit 3/Unit 2	65	65	61*	65	65	63	63	65		67
Unit 2/Unit 1	165*									
Termination Depth	175	110	105	105	125	105	105	105	33	86

* = Contact identification imprecise due to core loss in relevant interval

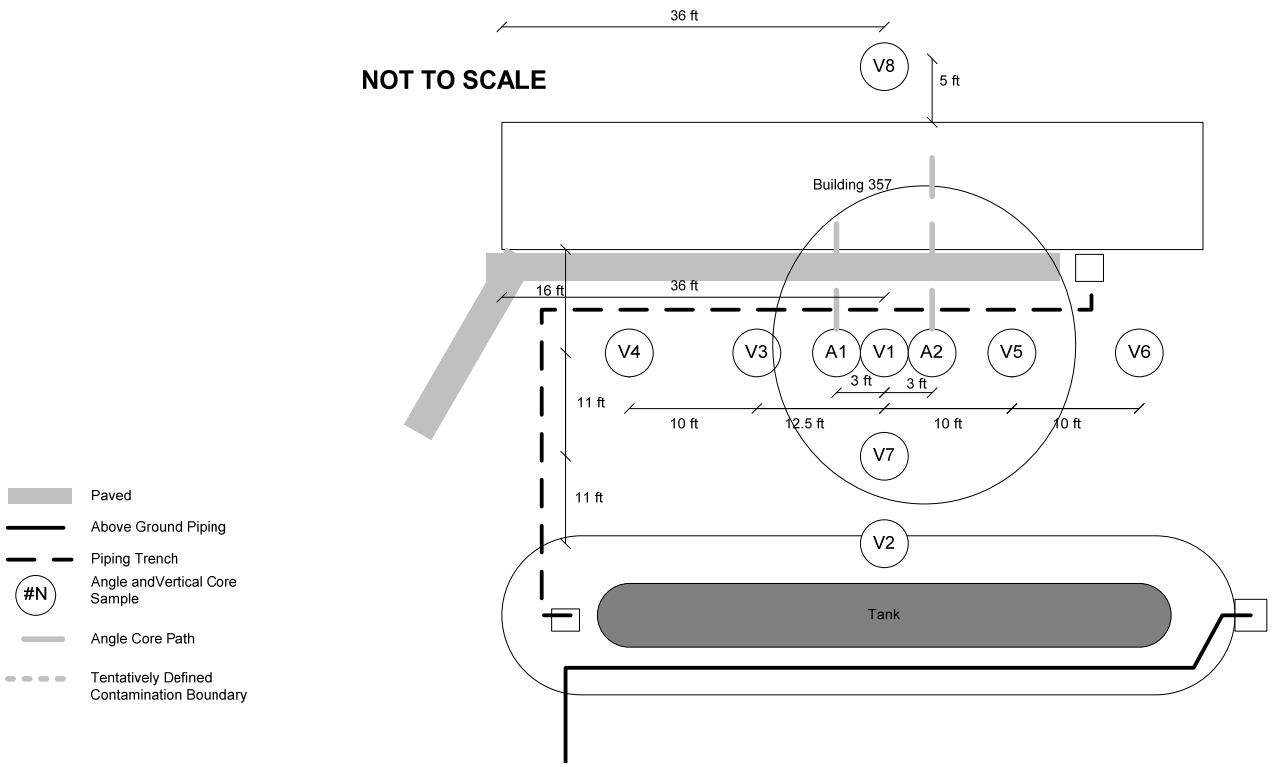

Figure 4. Vertical and Angled Borehole Core Sampling and Analyses Locations

6.5 Additional Characterization

Based on comments in a letter from the NMED (*Response and Comments for Diesel Spill Located at Technical Area 21-57*, dated May 28, 2003) on the initial characterization work, the auger rig was re-deployed on September 23, 2003 to complete four additional boreholes to better define the bounds of the vertical and horizontal extent of the contamination. The locations of the boreholes are shown in Appendix 1 Figure 2). Boreholes V-2A, -4A, and –6A were located on the north side of Building TA-21-357. Borehole V-8A was drilled on the south side of the building. The boreholes were placed adjacent to previous vertical boreholes and were intended to provide additional characterization at depth. A depth profile for the four boreholes is provided in Appendix 1 Figures 7a (WE) and 7b (SE). Each borehole was advanced to the initial sampling point without core retrieval. A PetroFLAG TPH field test kit was used to guide sampling and analysis activities. The initial sampling point at each borehole was sampled to collect BTEX and PAH data at the point most likely to be contaminated based on the original contamination zone profile. After collection of the initial sample, each borehole was then advanced, collecting continuous core, to a final depth of 155'. Samples were collected at 5-foot intervals from the continuously cored zone of each borehole.

Table 3. Additional Borehole Sampling Locations

Borehole	Initial Sampling	Continuous Core Sampling
V-2A	95'	5-foot intervals from 110'-155'
V-4A	95'	5-foot intervals from 105'-155'
V-6A	95'	5-foot intervals from 105'-155'
V-8A	95'	5-foot intervals from 105'-155'

Table 4. Pertinent Information on Additional Hollow-Stem Auger Boreholes

	Hole Number			
	V-2A	**V-4A**	**V6A**	**V8A**
Unit 3/Unit 2	65*	65*	63*	65*
Termination Depth	155	155	155	155

* Inferred from previous drilling program

6.6 Groundwater Assessment

As part of the preliminary assessment for this site characterization, RRES-WQH is conducting sampling and analyses in the nearest groundwater wells. Copies of the analytical reports can be accessed in the RRES-WQH Water Quality Data Base. DRO results are summarized in Appendix 4 for the April – June 2003 sampling events. All results except two were nondetect for DRO compounds. A sample from well PM-1 collected in February 2002 had 0.2 mg/L DRO. All subsequent monthly DRO sample results for

this well have been below the detection limit of 0.05 mg/L. A sample from well O-1 collected in May 2002 had 0.076 mg/L DRO. All subsequent monthly DRO sample results for this well have been below the detection limit of 0.05 mg/L. Monthly sampling has continued at these four water-supply wells for DRO compounds. No DRO compounds have been detected in any of the monthly samples since May of 2002.

6.7 Air Quality Assessment

Personal and area air sampling for total hydrocarbons was conducted at the TA-21 Steam Plant between May 21, 2002 and August 20, 2002. Sampling consisted of employees wearing a passive organic vapor badge in their breathing zone throughout their entire work shift. In addition, one badge was placed on a tree branch several hundred yards away from the Steam Plant during the same work shift. This served as an area/background sample. All samples were analyzed for total hydrocarbons (as hexane), by NATLSCO Laboratory. Hexane is used as a reference because it has chemical properties that are very similar to many other hydrocarbons such as benzene, ehthylbenzene, toluene, and xylene. High hexane levels would indicate that sampling for individual hydrocarbons might be necessary. Low levels of hexane (below 10 ppm) would indicate that hydrocarbon concentrations are not a health issue.

All personal samples were well below 1 ppm (see Appendix 4). Furthermore, area samples located several hundred yards away from the TA-21 Steam Plant have resulted in similar concentrations, suggesting that workers have only been exposed to hydrocarbon concentrations that occur naturally. Detection limits resulting from sample analyses have ranged from 0.054–0.099 ppm.

6.8 Analytical Results

All analytical results for TPH-DRO are compiled in Appendix 3. The data received Level-4 verification and validation and can be accessed through LANL's RRES-WQH information management systems (the RRES-WQH Water Quality Database). TPH-DRO analyses were requested for both the GeoProbe samples and the hollow-stem auger core samples.

Most of the GeoProbe results were lower than 50 mg/kg; however, five of the GeoProbe locations had significantly higher levels of TPH-DRO readings. Higher TPH-DRO levels were found in GeoProbe locations C, D, U, and V (see Figure 3 or Appendix 1 Figure 6). The four locations were in the vicinity of the pinhole leaks in the underground fuel lines. GeoProbe hole U had the highest sample value of the four, at 51,500 mg/kg TPH-DRO, while probe hole V had the lowest sample value of the four, at 595 mg/kg TPH-DRO. Some contamination (approximately 1,080 mg/kg TPH-DRO) was also found in sample location J. Further characterization was conducted for sample location J, and is summarized in Appendix 2.

At no point during the characterization did soils/rock cuttings show visible evidence of contaminant-saturated soil as described in the NMED regulations (20 NMAC 5 Petroleum Storage Tank Regulations). Analytical results of the vertical boreholes were used to establish the extent of the plume. Vertical Boreholes V3 and V7 (see Figure 4) did not register TPH-DRO values above 80 mg/kg, and vertical Boreholes V2, V2A, V4, V4A, V6, V6A, V8 and V8A did not indicate TPH-DRO values above 100 mg/kg. Of the twelve vertical holes, V1 and V5 had higher TPH-DRO analytical result values. The highest recorded TPH-DRO analytical results in boreholes V1 and V5 were 141,000 mg/kg at 85 ft. (Borehole V1) and 25,200 mg/kg at 45 ft. (Borehole V5). The angled boreholes (A1 and A2) had highest recorded TPH values at 30 ft. (25,000 mg/kg) and 25 ft. (27,300 mg/kg), respectively. These results indicate that there is some fraction of fuel oil located under the northern portion of Building TA-21-357. Based on the borehole TPH-DRO concentration data and a plume volume estimate model, the entire tank

volume of 48,357 gallons leaked into the subsurface and remains in the geological formations at this site (Stauffer 2002).

Other analytes that were sampled in the assessment (as a subset of the TPH analyses) included TCLP metals, PAHs, VOCs, and semivolatile organic compounds (SVOCs). Maximum hazardous constituents levels detected during sampling activities are presented in Table 3. Naphthalene was detected in Borehole V1 (24.2 mg/kg at 8 ft. deep) and in Borehole A2 (25.4 mg/kg at 10 ft. deep), as well as Fluorene in A2 (8.450 mg/kg at 20 ft. deep). There was also detection of Phenanthrene (13.2 mg/kg) and Acenaphthene (5.85 mg/kg) in Borehole A2 at 10 ft.

Table 5. Maximum Hazardous Constituents Concentrations Detected During Characterization Activities

Contaminant of Concern	NMED DAF 20 GW Protection Screening Guideline (mg/kg)	Maximum Site Concentration Detected (mg/kg)
Benzene	0.06	0.311
Ethyl benzene	8	7.570
Naphthalene	0.2	25.400
Toluene	5	5.670
Xylene	100	24.500
Acenaphthene	NL	5.850
Acenaphthylene	NL	0.975
Anthracene	NL	1.920
Benzo(a)anthracene	40	0.544
Benzo(a)pyrene	100	ND
Benzo(b)fluoranthene	20	6.88
Benzo(ghi)perylene	NL	ND
Benzo(k)fluoranthene	200	4.38
Chrysene	1000	ND
Dibenzo(a,h)anthracene	9	ND
Fluoranthene	NL	1.44
Fluorene	NL	8.450
Indeno(1,2,3-cd)pyrene	40	2.37
Phenanthrene	NL	13.200
Pyrene	NL	3.88

NL – Substance not listed in NMED Petroleum-Related Contaminants Screening Guidelines.

7.0 RADIATION REPORTS

Because of the proximity to material disposal areas at TA-21 (approximately 400 yards to MDA-A), radiation surveys were performed on the borehole spoils. Surveys were conducted from March 11 through March 20, 2002, and again on April 2 and 3, 2002. Direct surveys were taken for alpha, beta, and gamma

radiation using Ludlum model #139 and Health Safety and Radiation Protection (HSR-1) instruments. In addition, some of the cuttings were submitted to the HSR-1 laboratory for further analysis. Sampling and analysis values for radioactivity were at background levels. The analytical information is presented in Appendix 4 as part of the radiation survey documentation. The documentation includes emails and radiation survey reports. All surveys and analyses indicated radiation levels were below the natural background levels established for the area.

8.0 DISCUSSION

The combination of geology, analytical results for TPH-DRO at the TA-21 Steam Plant, and the plume volume estimate provide interesting points for discussion. Items that will be covered in this discussion are as follows: the relationship between fuel oil flow and saturation in tuffs; the role that fractures play in directing fuel oil transport; the role of capillary barriers in the Bandelier Tuff; and predictions on the final volume of rock necessary to contain the plume.

8.1 Saturation with Respect to Fuel Oil Flow

To understand what the measured fuel oil concentrations mean with respect to transport, we must examine the interaction between fuel oil saturation and flow. The mean saturated fuel oil conductivity for Unit 3 is on the order of 500 ft./yr (using an estimated fuel oil viscosity and density) (Rogers and Gallaher 1995). Because the rock is not fully saturated with fuel oil, the in-situ conductivity is unknown, but generally drops to between 10–20 percent of the saturated value at 50 percent fuel oil saturation (Testa 1994). As the residual saturation is approached, conductivity approaches zero and the remaining fuel oil is trapped as unconnected clumps. Flow of fuel oil in the subsurface may occur until the residual saturation is achieved (Fetter 1999). Residual fuel oil saturation for these rocks is not known; however, typical values from the literature suggest a value as high as 20 percent (Fetter 1999; Cohen and Mercer 1993). Assuming a grain density of 2.65 g/cm^3 and a fuel oil density of 0.85 g/cm^3, the saturation of fuel oil at 85 ft. BGL (141,000 mg/kg) is approximately 44 percent. In the densely welded portion of Unit 2, the maximum saturation is predicted to be approximately 40 percent at 105 ft. BGL (44,500 mg/kg). Concentrations of TPH below 145 ft BGL rapidly decreases from 22,000 mg/kg to 1.7 mg/kg over the last 35 ft. of Borehole V1. Thus, the leading edge of the plume has migrated to approximately 145 ft. BGL. Some portion of the plume has been detected in Borehole V5, where the bulk of the plume lies in the 85-ft. to 105-ft. depth range, within a few feet of Borehole V1.

8.2 Role of Fractures

Fractures in Unit 3 can act as conduits through which fuel oil can move, and this transport pathway has been shown to be active at potential release site PRS-21-029 (DP Tank Farm), located just west of the current site (LANL 2001). Wholetz (1995a & b) confirmed by fracture mapping that there was a high fracture density in the vicinity of the DP Tank Farm due to the Guaje Mountain Fault system. The fractures at the DP Tank Farms allow lateral spreading, providing sub-vertical pathways away from the main plume.

However, fracture mapping by Wholetz (1995a) on the north side of Los Alamos Canyon near the TA-21 Power Plant indicated a very low fracture density, approximately an order of magnitude lower than at the DP Tank Farm location.

The fractures at the Power Plant limit lateral spreading. One fracture of interest was observed in Borehole V5. The fracture had a dip of 45 degrees and was located from 25 ft. 6 inches to 25 ft. 8 inches. The fracture was heavily discolored, as was the ash-flow material below the fracture. Samples taken above the fracture indicated negligible fuel oil contamination. Directly below the fracture at a depth of 35 ft. BGL, the sample taken for fuel oil was highly contaminated (12,900 mg/kg). This geometry of contamination suggests that the fracture dipped to the west, and that the material below the fracture was contaminated from the leak point to the east. Therefore, this particular fracture is acting as a barrier for migration across the fracture.

A fracture at borehole V-2A was observed at 148-150 ft. depth BGL and had a 1/6 inch clay lining. The fracture was sampled with PetroFlag and was low (48 mg/kg). The fracture was also sampled for TPH-DRO and lab results were undetected at the MDL level (1.8 mg/kg). These results indicate that the fracture observed in V-2A did not act as a conduit for fuel oil transport.

A fracture in V-6A at 108' showed no visible staining or fuel oil odor. PetroFlag samples at 105 ft. and 110 ft. were 34 and 38 mg/kg respectively. Laboratory samples taken from core in this borehole at 105 ft. and 115 ft. were nondetect at the MDL level (1.3 and 1.8 mg/kg, respectively). In a similar fashion, these chemical results indicate that the fracture observed in V-6A did not act as a conduit for fuel oil transport.

Fractures in Unit 2 rarely continue more than a few feet into Unit 1 (Broxton and Reneau 1995), leading to the conclusion that any fractures should be limited to the upper 150 ft. of the unsaturated zone at this site.

Absence of fuel oil contamination at the four new perimeter boreholes (V-2A, -4A, -6A, and –8A), and lack of fuel oil in the observed fractures of this study, indicate that fractures in the initial characterization did not play a role in allowing fuel oil to migrate away from the plume.

8.3 Capillary Barriers within the Bandelier Tuff

The PRS 21-029 study showed that the subsurface fuel oil was laterally diverted at a clay-rich contact within Unit 3 (LANL 2001). This diversion can be explained by a change in material properties that results in a capillary discontinuity. Such a discontinuity would necessitate a large pressure (head) to force the fuel oil into the underlying unit. With small increases in pressure due to slow downward flow, the tendency of the fuel oil is to move laterally at such a capillary boundary. The absence of fuel oil ponding at the estimated Unit3/Unit 2 contact indicates that this horizon is not marked by a capillary barrier.

Because the data of this study show virtually no fuel oil below 150 ft., the capillary gradient between the welded base of Unit 2 and the underlying nonwelded Unit 1 may be causing such a diversion above 150 ft. at this site. The presence of a capillary barrier can be used to for estimate both the current plume shape and the future behavior of the fuel oil plume. The expected depth of migration is more well constrained if such a barrier exists. The issue of lateral transport was addressed in the addendum SAP for additional characterization. The extension of Boreholes V-2A, V-4A, V-6A, and V-8A and the subsequent evaluation that fuel oil contamination does not occur at depth indicate that any lateral transport has not extended to these boreholes.

8.4 Final Plume Configuration

Transport of fuel oil in the Bandelier Tuff at this site is controlled by four physical factors including: 1) gravity, 2) capillary barriers, 3) residual saturation, and 4) fractures in the ash-flows. Originally, it was believed that gravity was the major transport mechanism. Effectively, gravity moved the fuel oil down to the capillary barrier at the Unit 2 / Unit 1 contact (165 ft. BGL). The barrier, created by the pore size

differential at the contact, allowed upper portions of the tuff (interval 85 to 105 ft. BGL) to exceed the residual saturation of the rocks and allow the fuel oil to spread laterally. The lateral spread of the fuel oil has been constrained by fractures in some areas of the site. Evidence for this is seen in borehole V5 at 25 ft BGL (as described in Section 8.3), and the absence of the contamination plume in borehole V3. Additionally, sampling and analysis in boreholes V-2A, V-4A, V-6A, and V-8A indicate lateral spreading of the fuel oil is contained.

A calculation was performed to estimate the plume volume when residual fuel oil saturation is achieved everywhere and the plume stops moving by either gravitational or capillary forces. If we take the total plume estimate of 50,000 gallons, an average Bandelier Tuff porosity of 50 percent, and residual fuel oil saturation of 20 percent, the volume of rock necessary to contain the plume is calculated to be on the order of 2,000 m^3 (70,000 $ft.^3$). The estimate corresponds to a block of tuff that is 145 ft deep by 22 ft x 22 ft at the surface.

9.0 CONCLUSIONS

From February to April of 2002, an assessment was conducted regarding a potential fuel-oil leak into the soil and environment surrounding the underground fuel-oil pipelines from the TA-21-57 AST. The assessment was performed in a stepwise fashion, starting with ten potholes and PetroFlag spot analyses, followed by excavation of the pipelines and sampling within the excavated trenches. After this initial analysis, a decision was made to perform 23 GeoProbe samples, followed by eight vertical and two angled continuous-core, hollow-stem auger boreholes. Additional characterization to install four more boreholes was performed in September 2003 to address NMED's concerns for defining nature and extent of the fuel oil contamination (*Response and Comments for Diesel Spill Located at Technical Area 21-57*, dated May 28, 2003). Soil removal and sampling were performed in accordance with LANL, DOE, NMED, and EPA requirements to determine the presence and extent of the leak.

Based on borehole TPH-DRO concentration data and plume volume estimates strongly indicate that the entire tank volume of 48,357 gallons has leaked into the subsurface Tshirage Unit at this site (Stauffer 2002). Plume volume calculations, visual and olfactory inspection of fractures, field test results, and laboratory analytical data all indicate that contaminant transport through fractures does not appear to be occurring at this site. Characterization activities and sampling and analysis also reveal that fuel oil contamination in contained within the Tshirage Unit at the site. Other than the fuel oil contamination in the Tshirage Unit, additional air and water sampling indicate that there are no other hazardous conditions related to this fuel oil release.

Additionally, a Tier 1 Evaluation was completed in February 2003 in accordance with New Mexico Underground Storage Tank Bureau Guidelines for Corrective Action (20 NMAC 5.12, 2000). Results from the evaluation indicate that the site has met the applicable Tier 1 RBSLs, and no further remedial action is required according to NMED regulations. The Tier 1 Evaluation, TA-21-57 Aboveground Storage Tank Diesel Fuel oil Release (Shaw Environmental Inc., 2003) was submitted to NMED on March 21, 2003. Data obtained during the additional characterization did not alter the conclusions of the Tier 1 Evaluation. Characterization methods, activities, evaluations, and associated results and conclusions indicate that the nature and extent of fuel oil contamination at this site has been fully defined.

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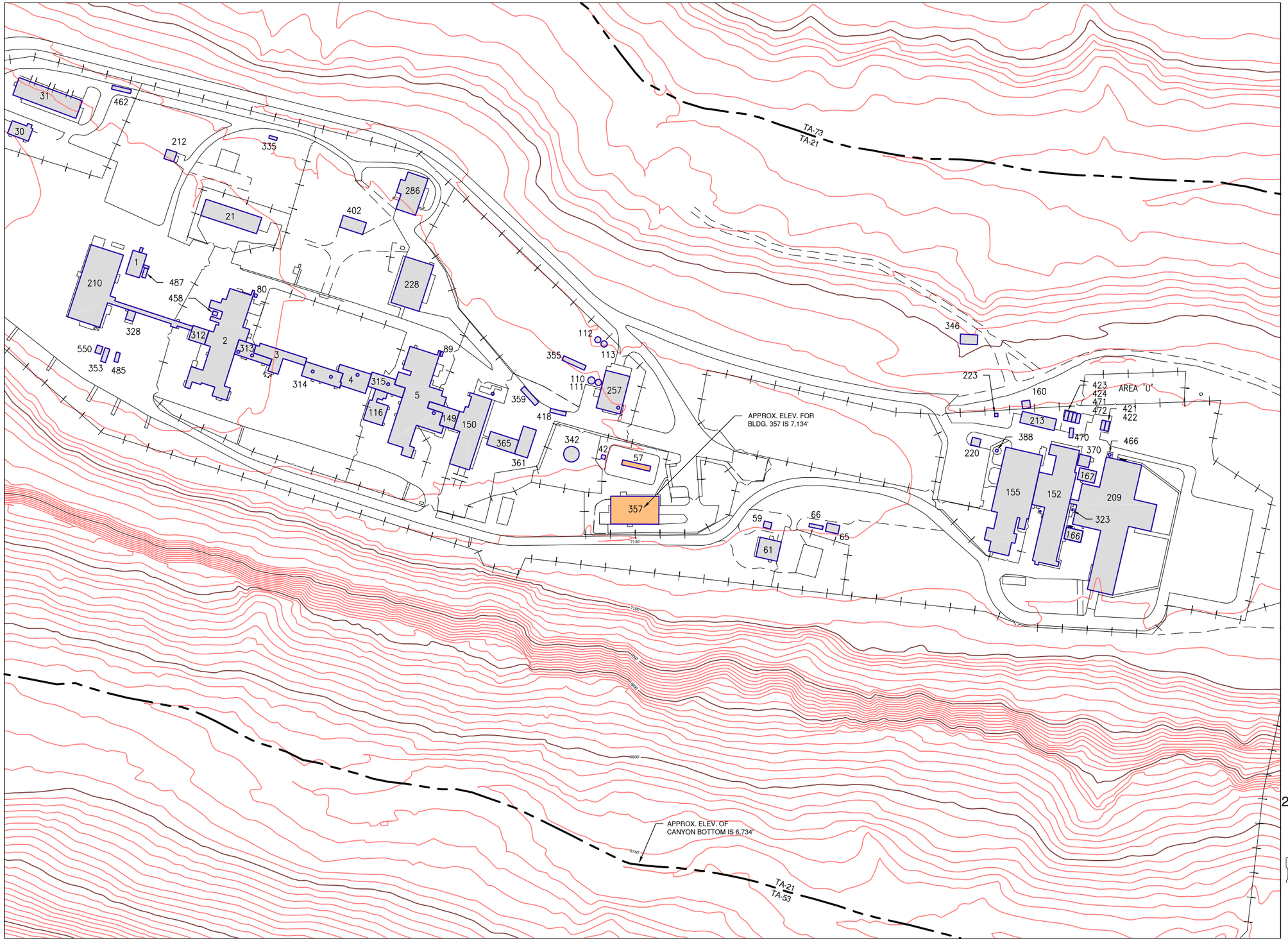
Figure 1 - BASE MAP W/CONTOURS
TA-21 DP SITE - OVERVIEW OF THE TA-21 BUILDING 357 AND 57 SITE



Prepared For:
Los Alamos National Lab

Prepared by:
Johnson Controls Northern New Mexico

UTILITY MAPPING

LEGEND

- XXX — Featured Building
- XXX — Building With Number
- Paved Road
- Dirt/Gravel Road
- Security Fence
- Industrial Fence
- TA Boundary Line
- 100' Contours
- 10' Contours

Data obtained from JCNNM Utility Mapping and Location Section. Data was collected using GPS units and located using conventional locating equipment. Data should be field verified prior to using the information for any design, planning, construction or otherwise.

N
W E
S

Scale 1"= 200'

200 0 400 600

Johnson Controls
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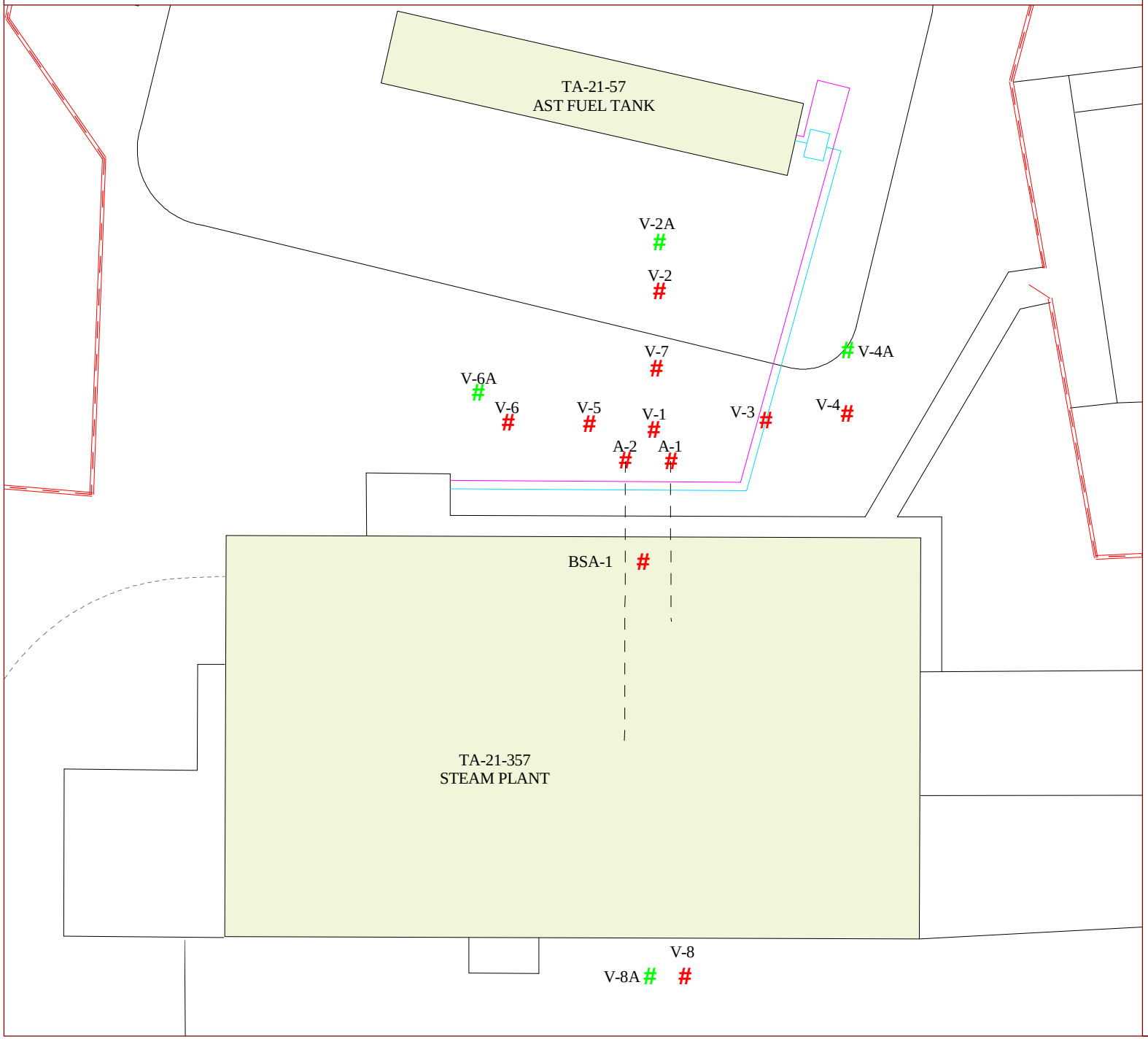
Los Alamos, NM 87544

Drawing Number: U02039_A rev1
Dated: August 23, 2002
Produced by: D. Sauer

Figure 2 - Vertical & Angle Core Sampling and Analyses Locations



KSL
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Legend

- # Vertical Points W/#
- Structures
- Diesel Fuel Supply
- Diesel Fuel Return
- Paved Roads
- Dirt Roads
- Fences
- # Additonal Borehole Locations

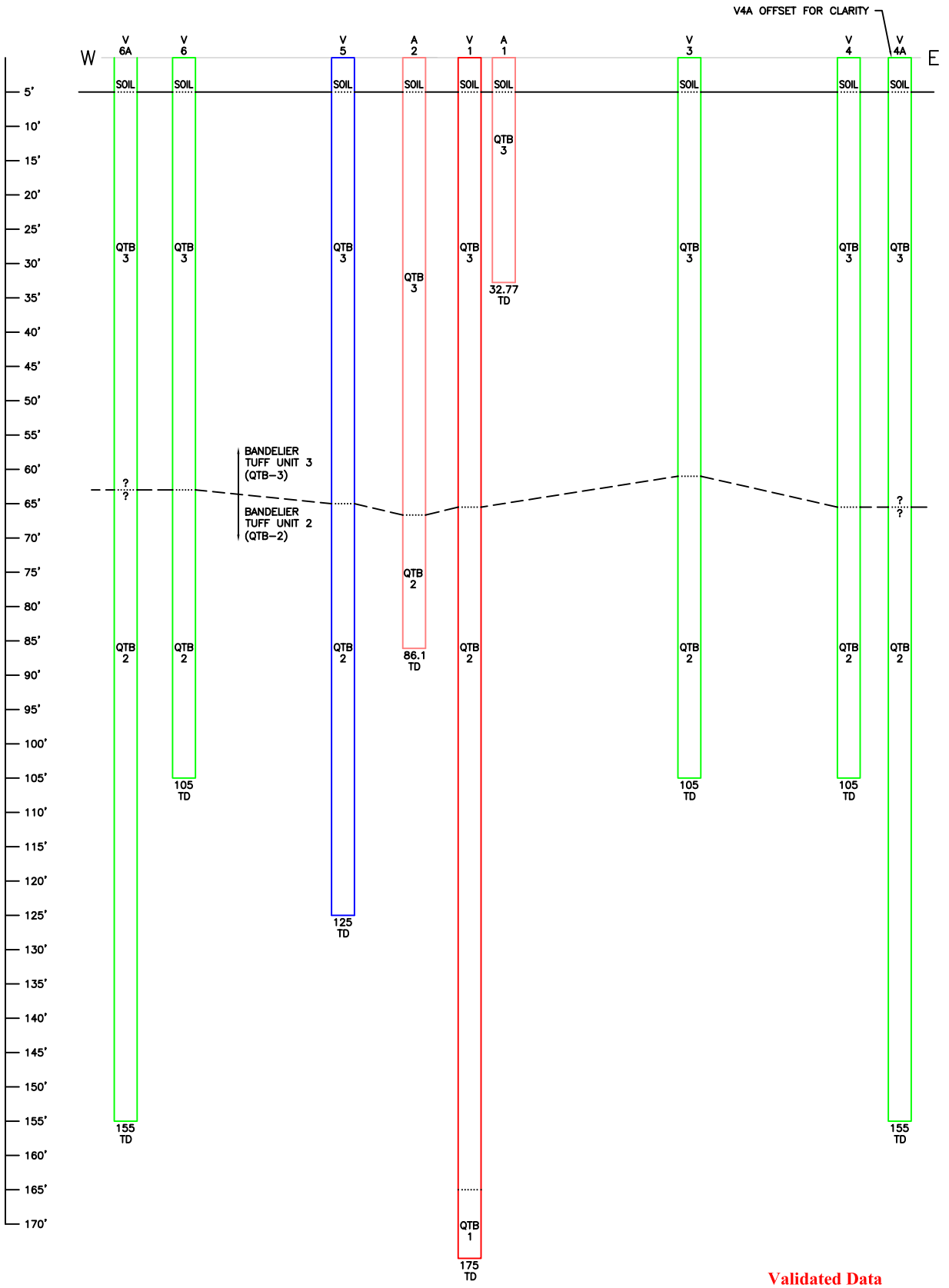
N
W E
S

Scale: 1" = 20' ft

10 0 10 20 Feet

November 19 2003

Figure 3
TA-21 STRATIGRAPHIC CORRELATIONS (NORTH ELEVATION)



Validated Data

NORTH ELEVATION
VERTICAL HOLES

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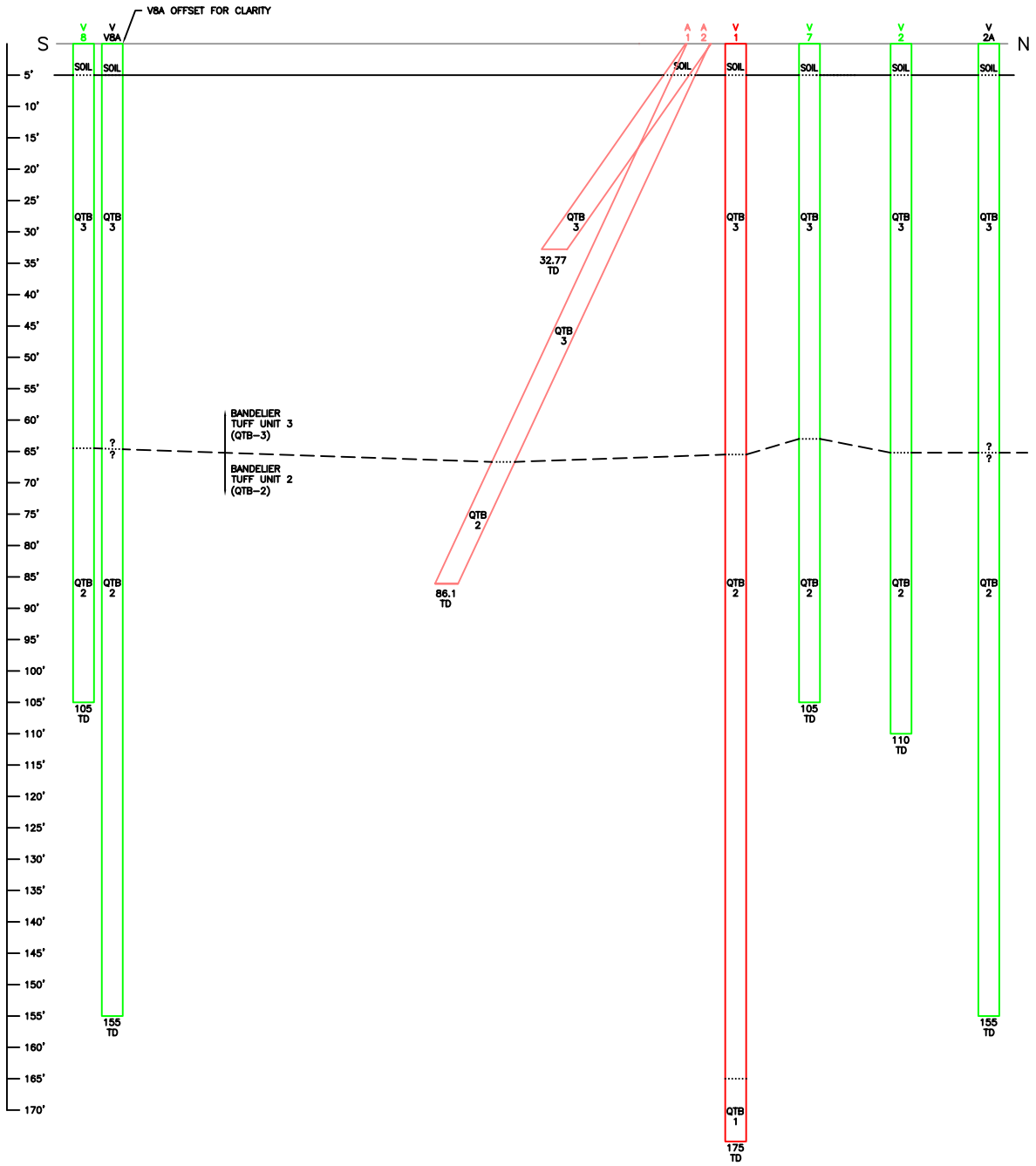
UTILITIES GIS AND DATA MANAGEMENT
DECEMBER 03, 2003

Figure 4
TA-21 STRATIGRAPHIC CORRELATIONS (WEST ELEVATION)



Validated Data

WEST ELEVATION
VERTICAL HOLES

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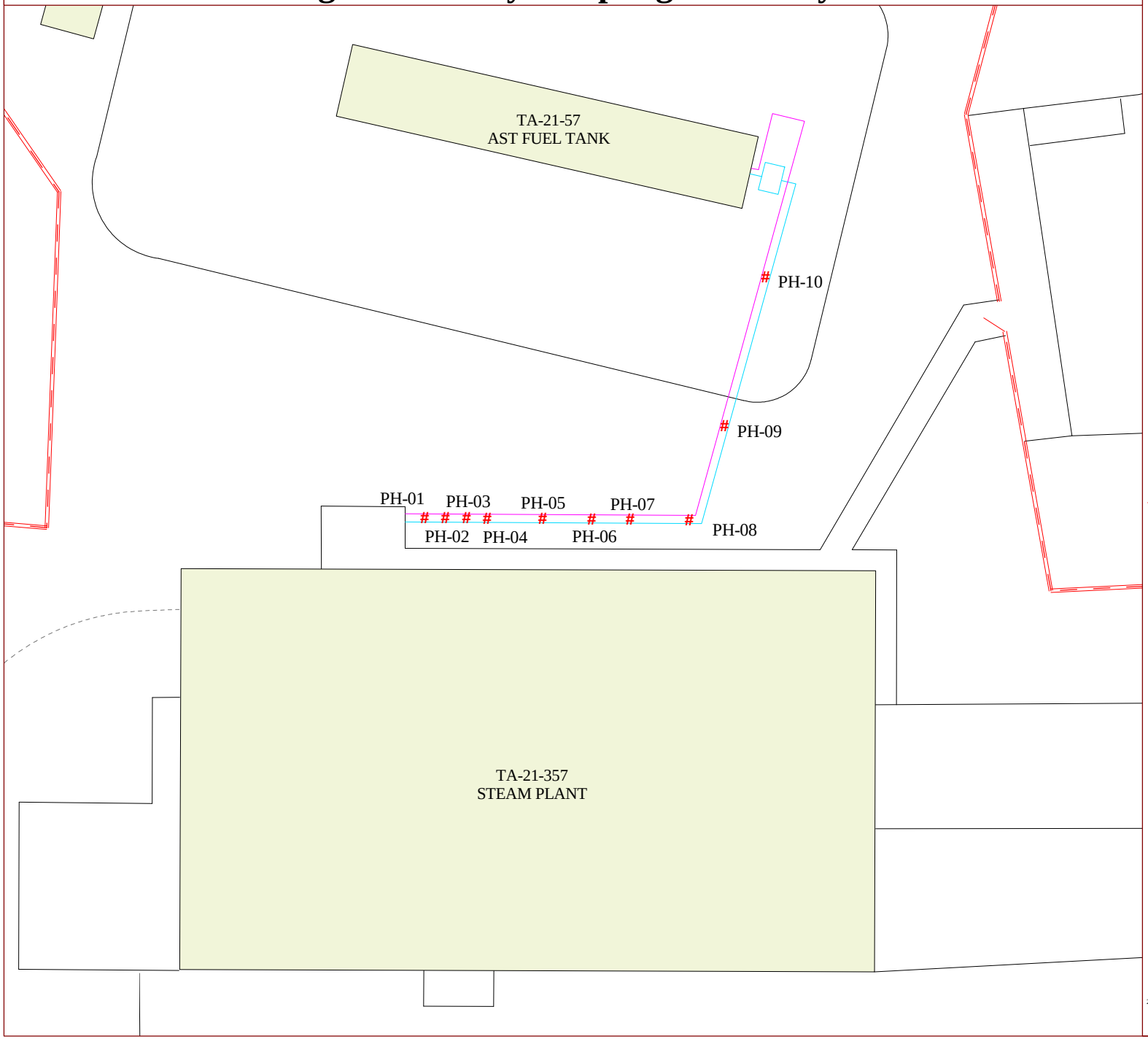
DECEMBER 03, 2003

Figure 5a Sample Locations Taken from Potholes During Preliminary Sampling and Analyses



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UTILITIES GIS AND DATA MANAGEMENT

Legend

- # PH Points W/#
- Structures
- Diesel Fuel Supply
- Diesel Fuel Return
- Paved Roads
- Dirt Roads
- Fences

Provisional Data

- DR - Detected Reading
- ND - Not Detected
- QA/QC In Progress
- Assaigai Analytical LABS Data
- Date Measures Diesel Range Organics

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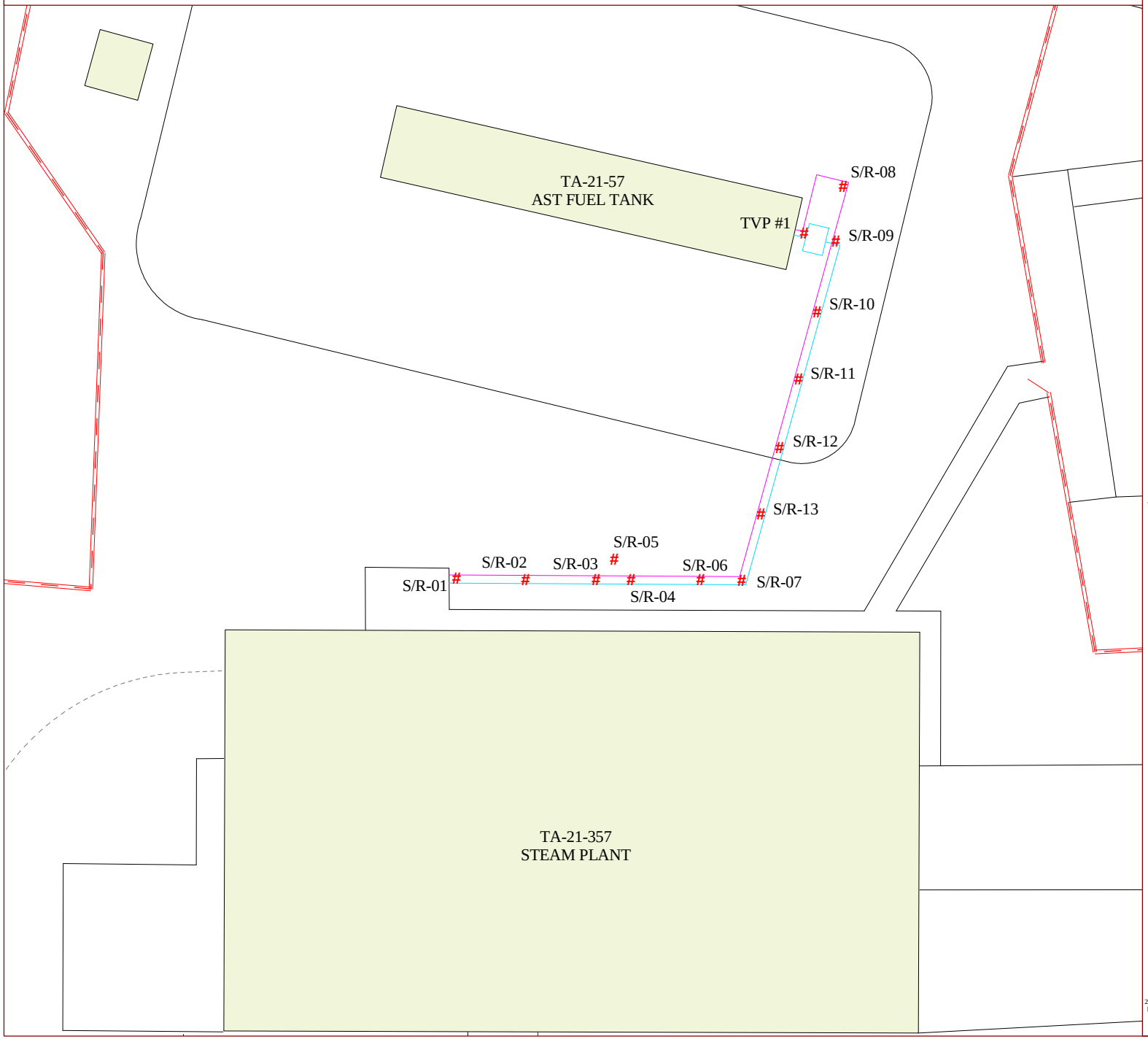
Scale: 1" = 20' ft

20 0 20 Feet

August 23, 2002

Figure 5b - Trench Assessment Sampling and Analyses Locations



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UTILITIES GIS AND DATA MANAGEMENT

Legend

- # SR Points W/#
- Structures
- Diesel Fuel Supply
- Diesel Fuel Return
- Paved Roads
- Dirt Roads
- Fences

Provisional Data

- DR - Detected Reading
- ND - Not Detected
- QA/QC In Progress
- Assaigai Analytical LABS Data
- Date Measures Diesel Range Organics

N
W E
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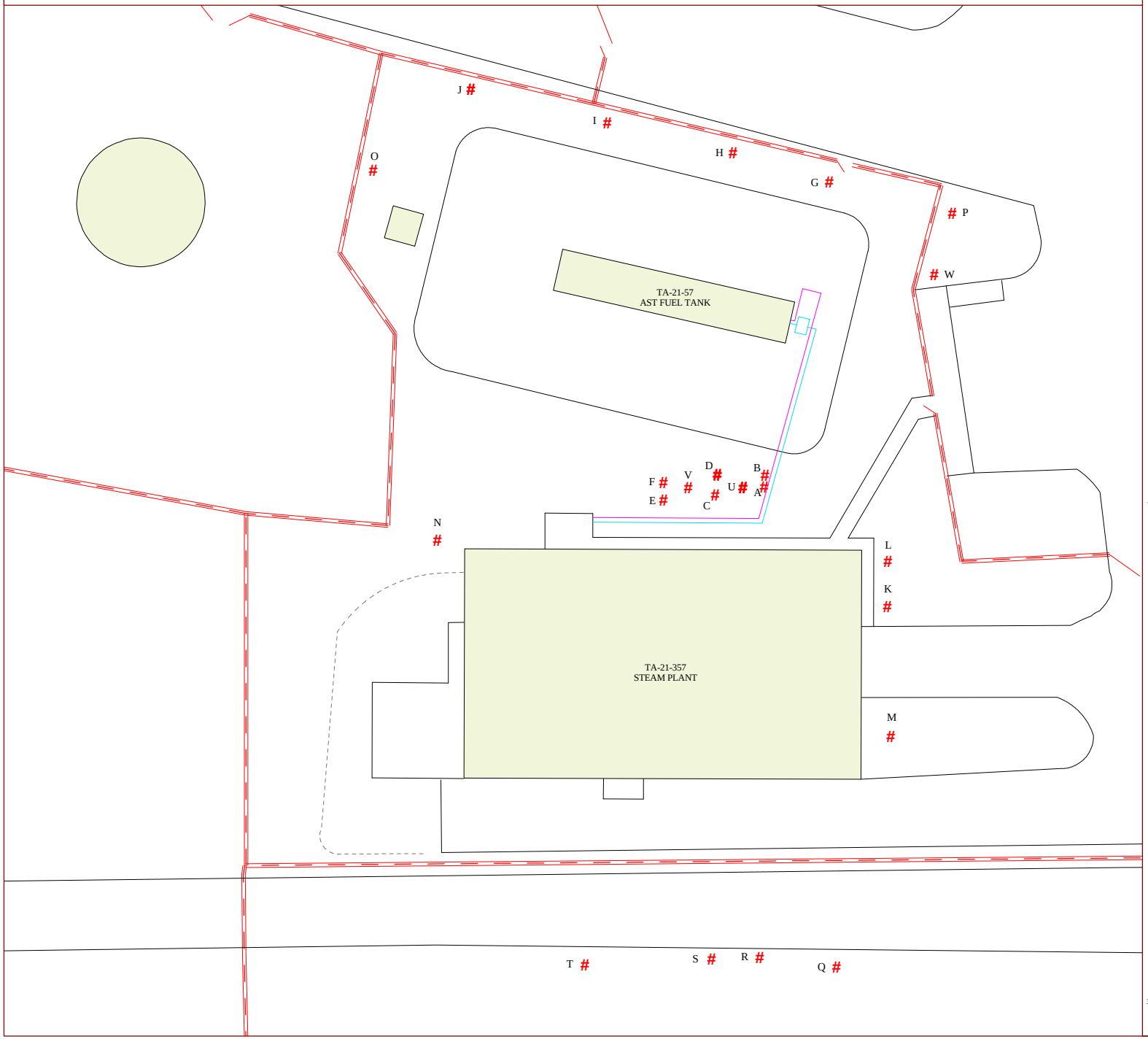
Scale: 1" = 20' ft

20 0 20 Feet

August 23, 2002

Figure 6 - Geoprobe Sample and Analyses Locations and Layouts



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Legend

- # Geoprobe Points W/#
- Structures
- Diesel Fuel Supply
- Diesel Fuel Return
- Paved Roads
- Dirt Roads
- Fences

Provisional Data

- DR - Detected Reading
- ND - Not Detected
- QA/QC In Progress
- Assaigai Analytical LABS Data
- Date Measures Diesel Range Organics

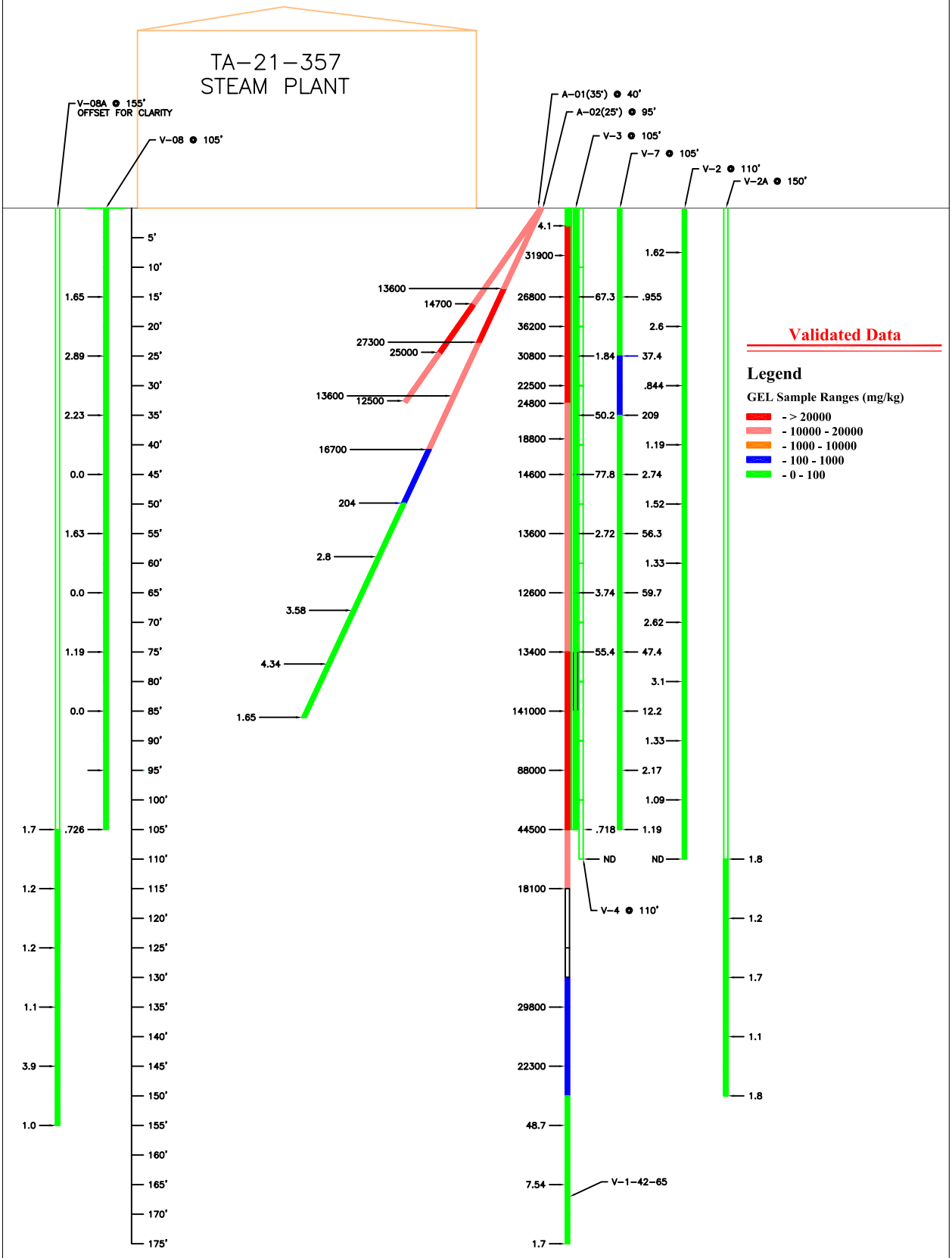
N
W E
S

Scale: 1" = 35' ft

35 0 35 Feet

August 23, 2002

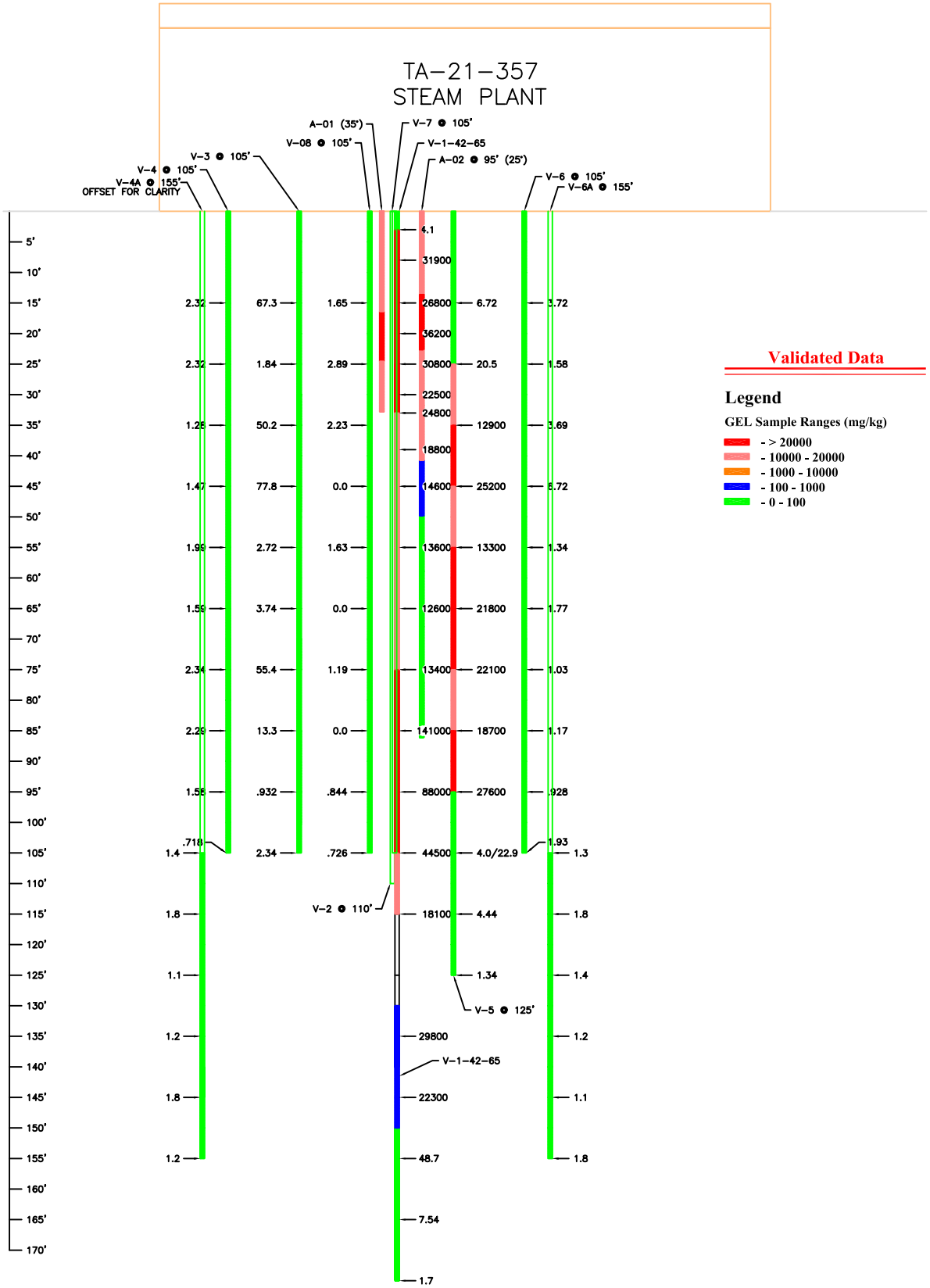
Figure 7A (WE)
DIESEL FUEL OIL #2 CONTAMINATION EXTENT



WEST ELEVATION
VERTICAL HOLES
GEL READINGS

KSL KBR • SHAW • LATA
UTILITIES GIS AND DATA MANAGEMENT
DECEMBER 03, 2003

Figure 7B (SE)
DIESEL FUEL OIL #2 CONTAMINATION EXTENT



SOUTH ELEVATION
VERTICAL HOLES
GEL READINGS

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DECEMBER 03, 2003

APPENDIX 2

Point J Characterization

POINT J CHARACTERIZATION

Overview

During the Geoprobe characterization activities of the TA-21-57 Above Ground Storage Tank Diesel Fuel Oil Environmental Assessment and Characterization sampling and analyses of Point J resulted in Total Petroleum Hydrocarbons (TPH)-Diesel Range Organics (DRO) contamination levels of 1,080 mg/kg. The composite sample was taken near the tuff/topsoil interface between 2-ft. and 5-ft. depths. Although only slightly higher than New Mexico Special Waste Limits (1,000 mg/kg TPH), further characterization of the area was conducted.

Excavation and Sampling and Analyses Characterization

To further characterize the extent of contamination near Point J, a 5 ft. x 5 ft. x 5 ft. section of soil was removed directly over the original Geoprobe point. Four composite samples were taken (JPA-1 through JPA-4) in a 2 ft. radius on four sides of the excavated region at depths of 4.5 ft. to 5 ft. (see Figure 1). Field sampling using PetroFlag was used to determine the extent of contamination in all four of the sampling locations. Immediate field sampling provided only one indication of contamination at point JPA-2 (5 ppm TPH-DRO). The samples were sent to General Engineering Laboratory to be analyzed for TPH Diesel Range Organics.

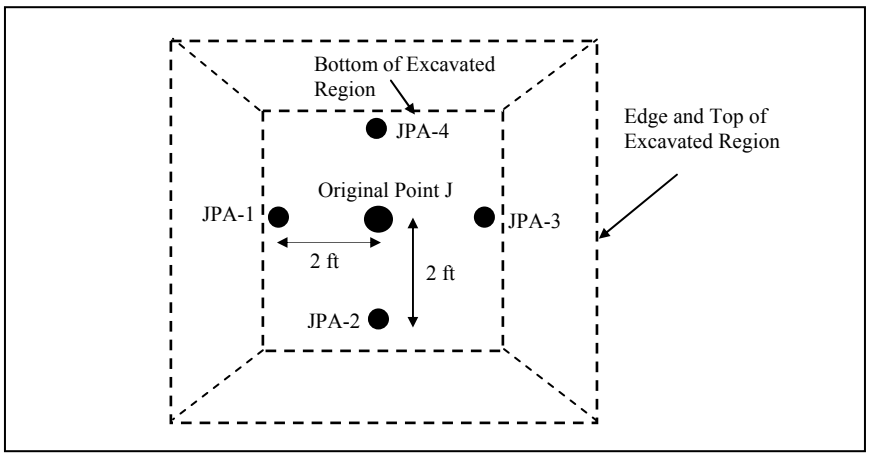

Figure 1. Sampling Layout of Point J

Analytical Result and Conclusions

Analytical results from GEL reflected low levels of TPH-DRO ranging from 79 mg/kg to 287 mg/kg (see Table 1). These levels are considerably lower than the original reading at point J of 1,080 mg/kg TPH-DRO. The TPH-DRO levels suggest that the contamination is bound within the area that was excavated. These TPH-DRO levels also indicate that the contamination of the area is very minor and well below New Mexico Special Waste levels of concern.

There are several utility lines (water and gas) within 18 inches of Point J. Contamination may have been an artifact of a small historical spill that occurred during the placement of these utility lines.

All soil excavated from the area was placed back into the ground until remediation activities have been established.

Table 1. General Engineering Laboratories Analytical Results (TPH-DRO) of Point J Characterization

Sample ID	TPH-DRO (mg/kg)
JPA-1	119
JPA-2	287
JPA-3	79
JPA-4	103

APPENDIX 3

Analytical Results

Results from Vertical Coring Holes at TA-21-357 Fuel Oil Assessment
Provisional Analytical Data from General Engineering Laboratories

Sample Name	Depth (ft)	General Engineering Laboratories Analytical Data (TPH-Diesel Range Organics [mg/kg])
Vertical Hole #1	3	4.100
	8	31900.000
	15	26800.000
	20	36200.000
	25	30800.000
	30	22500.000
	33	24800.000
	39	18800.000
	45	14600.000
	55	13600.000
	65	12600.000
	75	13400.000
	85	141000.000
	95	88000.000
	105	44500.000
	115	18100.000
	125	170.000
	135	29800.000
	145	22300.000
	155	48.700
	165	7.540
	175	1.700
Vertical Hole #2	7.5	1.620
	20	2.600
	30	0.844
	40	1.190
	50	1.520
	60	1.330
	70	2.620
	80	3.100
	90	1.330
	100	1.090
Vertical Hole #2A	110	ND
	120	1.2
	130	1.7
	140	1.1
	150	1.8

Sample Name	Depth (ft)	General Engineering Laboratories Analytical Data (TPH-Diesel Range Organics [mg/kg])
Vertical Hole #3	15	67.300
	25	1.840
	35	50.200
	45	77.800
	55	2.720
	65	3.740
	75	55.400
	85	13.300
	95	0.932
	105	2.340
Vertical Hole #4	15	2.320
	25	2.320
	35	1.280
	45	1.470
	55	1.990
	65	1.590
	75	2.340
	85	2.290
	95	1.580
	105	0.718
	105 (dup.)	ND
Vertical Hole #4A	115	1.8
	125	1.1
	135	1.2
	145	1.8
	155	1.2
Vertical Hole #5	15	6.720
	25	20.500
	35	12900.000
	45	25200.000
	55	13300.000
	65	21800.000
	75	22100.000
	85	18700.000
	95	27600.000
	105	4.000
	105 (duplicate)	22.900
	115	4.440
	125	1.340

Sample Name	Depth (ft)	General Engineering Laboratories Analytical Data (TPH-Diesel Range Organics [mg/kg])
Vertical Hole #6	15	3.72
	25	1.58
	35	3.69
	45	6.72
	55	1.34
	65	1.77
	75	1.03
	85	1.17
	95	0.928
	105	1.93
Vertical Hole #6A	115	1.8
	125	1.4
	135	1.2
	145	1.1
	155	1.8
Vertical Hole #7	15	0.955
	25	37.4
	35	209
	45	2.74
	55	56.3
	65	59.7
	75	47.4
	85	12.2
	95	2.17
	105	1.19
Vertical Hole #8	15	1.650
	25	2.890
	35	2.230
	45	0.000
	55	1.630
	65	0.000
	75	1.190
	85	0.000
	95	0.844
	105	0.726
Vertical Hole # 8A	115	1.2
	125	1.2
	135	1.1
	145	3.9
	155	1.0

Sample Name	Depth (ft)	General Engineering Laboratories Analytical Data (TPH-Diesel Range Organics [mg/kg])
Angle Hole #1at 35 degrees	20	14700.000
	30	25000.000
	40	12500.000
Horizontal Extent	11.47	14700.000
	17.21	25000.000
	22.94	12500.000
Vertical Extent	16.38	14700.000
	24.57	25000.000
	32.77	12500.000
Angle Hole #2 at 25 degrees	15	13600.000
	25	27300.000
	35	13600.000
	45	16700.000
	55	204.000
	65	2.800
	75	3.580
	85	4.340
	95	1.650
Horizontal Extent	6.33	13600.000
	10.57	27300.000
	14.79	13600.000
	19.02	16700.000
	23.24	204.000
	27.47	2.800
	31.70	3.580
	35.92	4.340
	40.15	1.650
Vertical Extent	13.59	13600.000
	22.66	27300.000
	31.72	13600.000
	40.78	16700.000
	49.85	204.000
	58.91	2.800
	67.97	3.580
	77.04	4.340
	86.10	1.650
Point J Re-Characterization		
JPA-1	4.5 to 5	119
JPA-2	4.5 to 5	287

Sample Name	Depth (ft)	General Engineering Laboratories Analytical Data (TPH-Diesel Range Organics [mg/kg])
JPA-3	4.5 to 5	79
JPA-4	4.5 to 5	103

APPENDIX 4

Radiation, Water Quality, and Air Quality Survey Documentation

HPAL SUBMITTAL FORM

SAMPLE DESCRIPTION

Sample Date/Time: 4-3-02 No. Of Samples: 1
TA: 21 Bldg: 357
RCT: Don Gibbons Z Number: 021631
RCT Signature: Don Gibbon MS: K-988
Phone/Fax: 5-4926

SAMPLE TRACKING NUMBER

ESH-1 SAMPLE TRACKING

22001713

TYPE OF SAMPLE

☐ Smear ☐ Tritium Smears ☐ Oils ☐ Liquid ☒ Soil
☐ CAM ☐ Air Sampler ☐ Nasal Swipe ☐ Solid
☐ Special / Type:

COMMENTS

Soil From
TA-21 357
Drill Hole

ANALYSIS REQUESTED

Gross: ☐ Alpha ☐ Beta ☒ Gamma

☐ Alpha Spec ☐ Beta Analysis ☒ Gamma Spec. ☐ Liquid Scintillation Counting
☐ Nuclide:

Occurrence No.:
Incident No.:
RWP No.:

NASAL SWIPES

Name	Z Number	Group	Respirator Yes/No	Date	Time
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

LIQUID / WOUND / OTHER SAMPLES

Description	Sample ID No.
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

CAM FILTERS / AIR SAMPLES

Location	Sample On		Sample Off	
	Date	Time	Date	Time
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

HPAL Submittal Form 4/22/99

ESH-1 SMEAR SURVEY FORM

SAMPLE DESCRIPTION

Sample Date/Time: 4-3 No. Of Samples: 1
TA: 21 Bldg: 357
RCT: Don Gibbons Z Number: 071631
Phone/Fax: 5-4926

SAMPLE TRACKING NUMBER

ESH-1 SAMPLE TRACKING
22001713

PURPOSE OF SURVEY

☐ ROUTINE ☐ PRE-JOB ☐ POST-JOB ☐ HOT-JOB
☐ ITEM RELEASE ☐ OFFSITE SHIPMENT ☐ ONSITE SHIPMENT
☒ NON-ROUTINE/OTHER: Soil FROM DRILL SITE

INSTRUMENTATION

TYPE	HSE No.	CAL DUE	% EFF	BKG
Ludlum 139	3794	1-23-03	50	NDA
BSP-1	0199	7-16-02	50	200

ADDITIONAL INFORMATION

☐ Occurrence No.:
☐ Incident No.:
☐ RWP No.:

Smear No.	Location	Alpha*	Beta*	Gamma*
1	BOTTLE	NDA	NDA	NDA

Smear No.	Location	Alpha*	Beta*	Gamma*

* dpm/100 cm2
E:\CORELDRW\HPALMST.CDR

PAGE 1 OF ____

Rev: 10 9

ESH-1 DIRECT SURVEY FORM

SAMPLE DESCRIPTION

Sample Date/Time: 4-3-02 No. Of Samples: 1
TA: 21 Bldg: 357
RCT: DON GIBBONS Z Number: 071631
RCT Signature: Don Gibbons MS: K-988
Phone/Fax: 5-4926

PURPOSE OF SURVEY

☐ Routine ☐ Pre-Job ☐ Post-Job ☐ Hot-Job
☐ Item Release ☐ Offsite Shipment ☐ Onsite Shipment
☒ Non-Routine / Other: SOIL FROM DRILL HOLE

ADDITIONAL INFORMATION

Occurrence No.:
Incident No.:
RWP No.:

INSTRUMENTATION

TYPE	HSE No.	CAL Due	% EFF	BKG
LUD 139	3794	6-23-03	50	NDA
ESP-1	6199	7-26-02	50	200

REMARKS

ESH-1 REVIEW BY

Item/Area	Alpha		Beta/Gamma		Remarks
	cpm	dpm*	cpm	dpm*	
SAMPLE BOTTLE	NDA	NDA	NDA	NDA	

*dpm/100 cm^2

DIRECT SURVEY FORM 1 of ____ 3/11/99

Los Alamos
NATIONAL LABORATORY
memorandum

Health & Safety Division
ESH-4 Health Physics Measurements
Analytical Laboratories Section

To/MS: **Don Gibbons, ESH-1, MS G749**
Analyst: **Michael Martinez, ESH-4, MS G757**
Reviewer: **Bob Martin, ESH-4, MS G757**
Phone/FAX: **5-8888/7-7246**
Symbol: **ESH-4-HPAL-REP-797**
Date: **April 9, 2002**

ANALYSIS REPORTS FOR SAMPLES SUBMITTED TO THE HEALTH PHYSICS ANALYTICAL LABORATORY FROM TA-21 (BC22001713)

The following samples were submitted to ESH-4's HPAL from TA-21, for analysis. The reported activities, in µCi, are the total activities on the samples and are decay corrected to the stop date and time indicated. The samples were analyzed utilizing a HpGe detector and ADCAM Multi-Channel Analyzer.

The analysis results are shown in the table below:

Sample Id	Reference #	Collected Date	Collected Time	Analyzed Date	Analyzed Time	Nuclide(s)	Activity (µCi)	2s (%)
Soil	22001713	04/03/02	1200	04/08/02	1429	-------	<MDA	---

MV:sm

Cy: File

HPAL SUBMITTAL FORM

SAMPLE DESCRIPTION

Sample Date/Time: 4-2-02 No. Of Samples: 1
TA: 21 Bldg: STEAM PLANT
RCT: DON GIBBONS Z Number: 071631
RCT Signature: Don Gibbons MS: K-888
Phone/Fax: 5-4926

SAMPLE TRACKING NUMBER

ESH-1 SAMPLE TRACKING
22001650

TYPE OF SAMPLE

☐ Smear ☐ Tritium Smears ☐ Oils ☐ Liquid ☒ Soil
☐ CAM ☐ Air Sampler ☐ Nasal Swipe ☐ Solid
☐ Special / Type:

COMMENTS

SOIL FROM DRILL HOLE NEAR DIESEL TANK

ANALYSIS REQUESTED

Gross: ☒ Alpha ☒ Beta ☐ Gamma
☐ Alpha Spec ☐ Beta Analysis ☐ Gamma Spec. ☐ Liquid Scintillation Counting
☐ Nuclide:

Occurrence No.:
Incident No.:
RWP No.:

NASAL SWIPES

	Name	Z Number	Group	Respirator Yes/No	Date	Time
1						
2						
3						
4						
6						
7						
8						
9						
10						

LIQUID / WOUND / OTHER SAMPLES

	Description	Sample ID No.
1		
2		
3		
4		
5		
6		
7		
9		
10		

CAM FILTERS / AIR SAMPLES

	Location	Sample On Date	Sample On Time	Sample Off Date	Sample Off Time
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

HPAL Submittal Form 4/22/99

ESH-1 DIRECT SURVEY FORM

SAMPLE DESCRIPTION

Sample Date/Time: 4-2-02 No. Of Samples: 1
TA: 21 Bldg:
RCT: DON GIBBONS Z Number: 071631
RCT Signature: Don Gibbons MS: M-988
Phone/Fax: 5-4926

INSTRUMENTATION

TYPE	HSE No.	CAL Due	% EFF	BKG
LUD 139			50	NDA
ESP-1	6313	12-17-02	50	200

PURPOSE OF SURVEY

☐ Routine ☐ Pre-Job ☐ Post-Job ☐ Hot-Job
☐ Item Release ☐ Offsite Shipment ☐ Onsite Shipment
☒ Non-Routine / Other: SOIL FROM 55' DRILL HOLE BY DIESEL TANK

REMARKS

ADDITIONAL INFORMATION

Occurrence No.:
Incident No.:
RWP No.:

ESH-1 REVIEW BY

Item/Area	Alpha		Beta/Gamma		Remarks
	cpm	dpm*	cpm	dpm*	

*dpm/100 cm^2

DIRECT SURVEY FORM 1 of ____ 3/11/99

ESH-1 SMEAR SURVEY FORM

SAMPLE DESCRIPTION

Sample Date/Time: _____ No. Of Samples: _____

TA: _____ Bldg: _____

RCT: _____ Z Number: _____

Phone/Fax: _____

SAMPLE TRACKING NUMBER

ESH-1 SAMPLE TRACKING

22001650

PURPOSE OF SURVEY

☐ ROUTINE ☐ PRE-JOB ☐ POST-JOB ☐ HOT-JOB

☐ ITEM RELEASE ☐ OFFSITE SHIPMENT ☐ ONSITE SHIPMENT

☐ NON-ROUTINE/OTHER: _____

INSTRUMENTATION

TYPE	HSE No.	CAL DUE	% EFF	BKG

ADDITIONAL INFORMATION

☐ Occurrence No.: _____

☐ Incident No.: _____

☐ RWP No.: _____

Smear No.	Location	Alpha*	Beta*	Gamma*
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
14				
15				

Smear No.	Location	Alpha*	Beta*	Gamma*
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				

* dpm/100 cm2

PAGE 1 OF 2

Rev. 12/94

Los Alamos
NATIONAL LABORATORY
memorandum

Health & Safety Division
ESH-4 Health Physics Measurements
Analytical Laboratories Section

To/MS: **Don Gibbons, ESH-1, MS G749**
Analyst: **Mike Jensen, ESH-4, MS G757**
Reviewer: **Bob Martin, ESH-4, MS G757**
Phone/FAX: **5-8888/7-7246**
Symbol: **ESH-4-HPAL-REP-788**
Date: **April 3, 2002**

ANALYSIS REPORTS FOR SAMPLES SUBMITTED TO THE HEALTH PHYSICS ANALYTICAL LABORATORY FROM TA-21 (BC22001650)

The following samples were submitted to ESH-4's HPAL from TA-21, for analysis. The reported activities, in μCi, are the total activities on the samples and are decay corrected to the stop date and time indicated. The samples were analyzed utilizing a HpGe detector and ADCAM Multi-Channel Analyzer.

The analysis results are shown in the table below:

Sample Id	Reference #	Collected Date	Collected Time	Analyzed Date	Analyzed Time	Nuclide(s)	Activity (μCi)	2s (%)
Soil	22001650	04/02/02	1200	04/03/02	1017	-------	<MDA	---

BM:sm

Cy: File

"Jerome F. Gonzales" <jerome@lanl.gov>
04/15/2002 10:59 AM

To: fcaporuscio@eberlineservices.com
cc:
Subject: Fwd: TA-21 Rad Survey

```
>X-Sender: u108821@esh-mail.lanl.gov
>X-Mailer: QUALCOMM Windows Eudora Version 5.1
>Date: Mon, 25 Mar 2002 08:09:40 -0700
>To: jerome@lanl.gov
>From: "Martin J. Peifer" <peiferm@lanl.gov>
>Subject: Fwd: TA-21 EAST BOREHOLE
>
>Jerome,
>
>As you have requested, here is a brief report from Darril Stafford (ESH-1
>RCT) regarding radiation monitoring activities he performed at the drill
>site near TA-21-57.  Please let me or Darril know if you need any further
>information for your records.  Marty.
>
>
>
>
>
>Marty Peifer, Team Leader
>ESH-1, Health Physics Operations
>Los Alamos National Laboratory
>Los Alamos, New Mexico 87545  MS. M-769
>Phone:  (505) 665-4342
>Pager:          (505) 664-6649
>Cellular phone: (505) 699-1063
>Fax:            (505) 667-0189
>E-mail: peiferm@lanl.gov
>
>
>
>
>>X-Sender: u113569@esh-mail.lanl.gov
>>X-Mailer: QUALCOMM Windows Eudora Version 5.0
>>Date: Mon, 25 Mar 2002 08:20:49 -0700
>>To: peiferm@lanl.gov
>>From: Darril Stafford <darril@lanl.gov>
>>Subject: TA-21 EAST BOREHOLE
>>
>>Marty, on March 11 through March 20, ESH-1 provided RCT support for the
>>boreholes that were drilled around the diesel tank at DP EAST.  All
>>direct surveys were at background levels for Beta/Gamma and Alpha and
>>require no further action.  If you have any further questions in this
>>matter please feel free to contact me at 104-8421 or 699-1005.
>>
>>INSTRUMENTS USED:
>>

>>Eberline ESP-1/HP-260, HSE #5934, Cal Due,4/10/02
>>Ludlum 139, HSE # 7617, Cal Due, 8/14/02
>>
>>Thanks, Darril Stafford, ESH-1 RCT
```

"Jerome F. Gonzales" <jerome@lanl.gov>
04/15/2002 02:11 PM

To: fcaporuscio@eberlineservices.com
cc:
Subject: Fwd: Rad Survey Results

X-Sender: 182557@chaco.jci.lanl.gov
X-Mailer: QUALCOMM Windows Eudora Version 5.1
Date: Mon, 15 Apr 2002 14:08:42 -0600
To: "Jerome F. Gonzales" <jerome@lanl.gov>,
"Mell A. Smithour" <smithour_mell_a@lanl.gov>
From: "David L. Madrid" <dlmadrid@lanl.gov>
Subject: Fwd: Soil Sample Results

X-Sender: jami@esh-mail.lanl.gov
X-Mailer: QUALCOMM Windows Eudora Version 5.1
Date: Mon, 15 Apr 2002 13:27:08 -0600
To: dlmadrid@lanl.gov
From: Jami Morgan <jami@lanl.gov>
Subject: Soil Sample Results
Cc: lwpacheco@lanl.gov, jgeorge@lanl.gov

David, A per your request, I am e-mailing you with the results of soil samples taken at TA-21 diesel tank leak on 04/02/02, and 04/03/02. Direct Surveys taken with a Ludlum 139 #3794, and an ESP-1 #6199 revealed no Alpha, Beta, or Gamma contamination. Soil samples submitted to our analysis Laboratory also revealed the same results.
I will forward copies to you through inner-office mail.
If you have any more questions, please feel free to call us.

Don Gibbons, ESH-1 RCT 5-4926
Jami Morgan, ESH-1 RCT 5-4926

David L. Madrid
Project Manager

Johnson Controls Northern New Mexico
TA3-38 Room 108
P.O. Box 50
Los Alamos, New Mexico 87544

Tel: (505) 677-3751
Cell: (505) 699-1778
Pager: 104-3867
Fax: (505) 667-8151

WATER QUALITY SURVEY

Table 2. Special Drinking Water Monitoring Results for Diesel Range Organics (DRO) in 2002

Sample Date	Analytical Lab	PM-1 (mg/L)	PM-3 (mg/L)	O-1 (mg/L)	O-4 (mg/L)
2/23/2002	GEL	0.2	<0.05	<0.05	<0.05
2/23/2002	GEL-duplicate sample				<0.05
3/14/2002	GEL	<0.05	<0.05	<0.05	<0.05
3/14/2002	GEL-duplicate sample				<0.05
4/18/2002	GEL	<0.048	<0.048	<0.048	<0.048
4/18/2002	GEL-duplicate sample				<0.048
5/18/2002	GEL	<0.05	<0.05	0.076	<0.048
6/26/2002	GEL	<0.05	<0.05	<0.05	<0.05

GEL = General Engineering Laboratories

Notes: Monthly DRO sample results for all wells from 7/2002 through November 2003 have been non-detectable.

AIR QUALITY SAMPLING AND ANALYSES

Date	Location	Time On	Time Off	Sample Type	Monitor #	Empl. ID	Sample ID	Total Hydrocarbons		Total Time (min)	Detection Limit (ppm)
5/21/2002	TA-21	7:58	3:19	Personal	RC4695		02052101TM	<0.099		433	0.0820734
5/21/2002	TA-21	8:19	3:22	Area	RC4694		02052102TM	<0.1		423	0.0840137
5/21/2002	TA-21			Blank	RC4690		02052103TM	ND			
5/22/2002	TA-21	8:02	3:00	Personal	RC4607		02052201TM	<0.1		418	0.0850186
5/22/2001	TA-21	8:07	3:00	Personal	RC4544		02052202TM	<0.11		413	0.0860479
5/22/2002	TA-21	8:03	3:00	Personal	RC4655		02052203TM	<0.1		417	0.0852225
5/22/2002	TA-21			Blank	RC4527		02052204TM	ND			
5/30/2002	TA-21	7:38	3:40	Personal	QB3304		02053001TM	<0.089		478	0.0743468
5/30/2002	TA-21	7:39	3:40	Personal	QB3268		02053002TM	<0.089		479	0.0741916
5/30/2002	TA-21	7:40	3:40	Personal	QB3293		02053003TM	<0.089		480	0.0740371
5/30/2002	TA-21	8:00	7:00	Area	QB3395		02053004TM	<.06		660	0.0538451
5/30/2002	TA-21			Blank	QB3362		02053005TM	ND			
6/5/2002	TA-21	8:10	3:30	Area	QB3321		02060501TM	0.099		440	0.0807677
6/5/2002	TA-21	7:54	3:30	Personal	QB3234		02060502TM	0.27		456	0.0779338
6/5/2002	TA-21	8:00	3:00	Personal	QB3375		02060503TM	0.096		420	0.0846138
6/5/2002	TA-21			Blank	QB3358		02060504TM	ND			
6/11/2002	TA-21	9:00	3:40	Personal	QB3361		02061101TM	0.12		400	0.0888445
6/11/2002	TA-21	9:03	10:40	Personal	QB3395		02061102TM	0.11		97	0.366369
6/11/2002	TA-21	9:49	3:50	Area	QB3280		02061103TM	0.12		359	0.0989911
6/20/2002	TA-21	7:18	4:00	Personal	QB3283		02062001TM	< 0.087		522	0.0680801
6/20/2002	TA-21	7:19	4:00	Personal	QB3410		02062002TM	< 0.087		521	0.0682107
6/20/2002	TA-21	7:20	4:00	Personal	QB3263		02062003TM	0.57		520	0.0683419
6/20/2002	TA-21	7:27	4:30	Area	QB3339		02062004TM	< 0.085		537	0.0661784
6/20/2002	TA-21			Blank			02062005TM	ND			
6/25/2002	TA-21	8:00	3:40	Personal	QB3394		02062501TM	1.6		460	0.0772561
6/25/2002	TA-21	8:00	3:30	Personal	QB3727		02062502TM	0.17		450	0.0789729
6/25/2002	TA-21	8:08	3:45	Area	QB3231		02062503TM	0.95		457	0.0777632
7/2/2002	TA-21	8:28	3:36	Personal	QB3713		02070208TM	< 0.11		424	0.0838155
7/2/2002	TA-21	8:25	3:36	Personal	QB3596		0207029TM	0.13		421	0.0844128
7/2/2002	TA-21	8:30	3:38	Area	QB3800		02070210TM	< 0.11		428	0.0830322
7/10/2002	TA-21	9:08	3:36	Area	QB3981		02071001TM	0.26		388	0.0915922
7/10/2002	TA-21	9:00	3:30	Personal	QB3434		02071002TM	0.14		390	0.0911225
7/10/2002	TA-21	9:04	3:30	Personal	QB3739		02071003TM	< 0.11		386	0.0920668
7/10/2002	TA-21	9:01	3:30	Personal	QB4886		02071004TM	0.21		389	0.0913568
7/16/2002	TA-21	7:55	4:25	Personal	QB3525		02071601TM	0.16		510	0.0696819
7/16/2002	TA-21	8:00	4:28	Area	QB3679		02071602TM	< 0.087		508	0.0699563
7/23/2002	TA-21	7:55	3:45	Personal	QB3555		02072305TM	< 0.094		460	0.0772561
7/23/2002	TA-21	7:59	3:40	Personal	QB3570		02072306TM	< 0.1		451	0.0787978
7/23/2002	TA-21	8:04	3:39	Area	QB3841		02072307TM	< 0.097		457	0.0777632
7/23/2002	TA-21			Blank	QB4691		02072308TM	ND			
7/30/2002	TA-21	8:51	3:31	Personal	QB3701		02073004TM				
7/30/2002	TA-21	8:55	3:31	Personal	QB3677		02073005TM				
7/30/2002	TA-21	9:00	3:33	Area	QB3808		02073006TM				
8/6/2002	TA-21	8:04	3:22	Personal	QB3844		02080601TM				

Date	Location	Time On	Time Off	Sample Type	Monitor #	Empl. ID	Sample ID	Total Hydrocarbons		Total Time (min)	Detection Limit (ppm)
8/6/2002	TA-21	8:06	3:22	Personal	QB3748		02080602TM				
8/6/2002	TA-21	8:12	3:22	Personal	QB3591		02080603TM				
8/6/2002	TA-21	8:17	3:36	Area	QB3782		02080604TM				
8/13/2002	TA-21	7:55	3:44	Personal	QB3736		02081301TM				
8/13/2002	TA-21	7:57	3:44	Personal	QB3755		02081302TM				
8/13/2002	TA-21	7:59	3:44	Personal	QB3572		02081303TM				
8/13/2002	TA-21	8:04	3:47	Area	QB3600		02081304TM				
8/13/2002	TA-21			Blank	QB3710		02081305TM				
8/13/2002	TA-21			Blank	QB3571		02081306TM				
8/20/2002	TA-21	8:12	5:00	Personal	QB3541		02082001TM				
8/20/2002	TA-21	8:15	4:26	Personal	QB4896		02082002TM				
8/20/2002	TA-21	8:20	4:26	Personal	QB3852		02082003TM				
8/20/2002	TA-21	8:34	4:30	Area	QB3634		02082004TM				
9/25/2002	TA-21	8:06	3:20	Personal	QG2155		03092501TM	< 0.094		434	0.0820734
9/25/2002	TA-21	8:05	3:20	Personal	QG2040		03092502TM	0.32		435	0.0840137
9/25/2002	TA-21	8:08	3:20	Personal	QG1995		03092503TM	< 0.094		432	0.0860479
9/25/2002	TA-21	8:21	3:36	Area	QG2359		03092504TM	< 0.093		435	0.0850186
9/25/2002	TA-21			Blank	QG2317		03092505TM	ND			
9/25/2002	TA-21			Blank	QG2073		03092506TM	ND			
1/2/2003	TA-21	8:11	4:00	Personal	QG2289		03010702TM	< 0.09		469	0.0852225
1/2/2003	TA-21	8:15	4:00	Personal	QG2235		03010703TM	0.23		465	0.0743468
1/2/2003	TA-21	7:50	4:02	Area	QG2118		03010704TM	< 0.06		492	0.0741916
1/2/2003	TA-21	8:03	4:00	Blank	QG2144		03010705TM	ND			
2/4/2003	TA-21	8:08	3:37	Personal	QG2273		03020401TM	< 0.1		449	0.0538451
2/4/2003	TA-21	8:15	3:37	Personal	QG2263		03020402TM	< 0.11		442	0.0740371
2/4/2003	TA-21	8:36	3:38	Area	QG2273		03020403TM	< 0.11		422	0.0807677
2/4/2003	TA-21			Blank	QG2167		03020404TM	ND			
3/7/2003	TA-21	7:52	4:20	Personal	QG2303		03030701TM	0.34		508	0.0846138
3/7/2003	TA-21	7:49	4:20	Personal	QG2261		03030702TM	0.18		511	0.0538451
3/7/2003	TA-21	7:53	4:20	Personal	QG2221		03030703TM	0.24		507	0.0888445
3/7/2003	TA-21	7:57	4:22	Area	QG2341		03030704TM	0.62		501	0.366369
3/7/2003	TA-21			Blank	QG2156		03030705TM	ND			
5/8/2003	TA-21	8:11	3:30	Personal	QG1992		03050801TM	3.6		439	0.0680801
5/8/2003	TA-21	8:13	3:30	Personal	QG2038		03050802TM	< 0.093		437	0.0682107
5/8/2003	TA-21	8:15	3:30	Personal	QG2151		03050804TM	< 0.094		435	0.0683419
5/8/2003	TA-21	8:21	3:30	Area	QG2319		03050803TM	0.36		429	0.0850186
5/8/2003	TA-21			Blank	QG2280		03050805TM	ND			
7/29/2003	TA-21	8:30	4:00	Personal	QG1968		03072901TM	0.11		450	0.0852225
7/29/2003	TA-21	8:34	4:00	Personal	QG2052		03072902TM	0.14		446	0.0740371
7/29/2003	TA-21	8:41	4:00	Personal	QG2299		03072903TM	<0.089		449	0.0743468
7/29/2003	TA-21	8:55	4:02	Area	QG2232		03072904TM	0.098		417	0.0741916
7/29/2003	TA-21			Blank	QG2423		03072905TM	ND			
7/29/2003	TA-21			Blank	QG2369		03072906TM	ND			