7.0 THE CHEMICAL AGENT MUNITIONS DISPOSAL SYSTEM, SWMU 13

This section discusses the results of both the previous and current investigations for SWMU 13. Previous and Phase II RFI sampling results, a contamination assessment, a human health and ecological risk assessment, conclusions, and recommendations are presented for each site within the SWMU. The general soil and hydrological conditions for SWMU 13, based on this investigation and previous investigations, are presented in Section 7.1. The remaining sections (i.e., Sections 7.2 through 7.11) address each site at SWMU 13 and the groundwater regime for the entire CAMDS facility. These sections include the Fuel Spill Site (7.2), Underground Storage Tank Site (7.3), 3X Yard (7.4), Boiler Blowdown Discharge Site (7.5), Drainage Ditch Site (7.6), Chemical Unload Site (7.7), Pavement Perimeter Site (7.8), Sodium Hydroxide Spill Site (7.9), Wastewater Lagoons Site (7.10), and the CAMDS groundwater assessment (7.11).

Summaries of the analytical results for the sampling conducted during this Phase II investigation and previous investigations are presented in tables and figures. Complete analytical results for this Phase II investigation (including non-detects) are presented in Appendix D.

7.1 HYDROGEOLOGIC INVESTIGATION

7.1.1 Geology

The CAMDS facility rests at the toe of encroaching coalescing alluvial fan deposits where they emerge onto the Rush Valley floor and override older Ancient Lake Bonneville bed sediments. The sedimentation features at the CAMDS facility area are in the form of interfingering lenses, lobes, stringers, channels, blankets, bars, levees, wedges, and filled depressions that have eroded into and overlain preexisting lake-bed-type clay deposits. The deposits from these fans are cross-bedded thin sheets of sand-silt-clay lenses combined with flood-type gravel channels and mid-valley playa evaporites typical of arid alluvial fan sediments. These deposits unconformably overlay lacustrine clay-silt-sand facies and have formed a thin veneer, ranging from 5 to 20 feet thick. These eroded lake sediments contain subsurface clay lenses of varying thickness that underlie much of the southwestern corner of the TEAD-S Facility. Figure 7-1 is the geologic cross section support map for the cross sections provided in Figures 7-2, 7-3, 7-4, 7-5, 7-6, and 7-7. These cross sections were derived from previous investigation and Phase II RFI boring logs.

7.1.2 Hydrogeology

Prior to 1991, previous investigations resulted in the installation of 16 shallow groundwater monitoring wells around the CAMDS facility. During May and June 1991, Rust E&I installed an additional 14 groundwater monitoring wells (S-76-91 through S-87-91, S-91-91, and S-92-91) in the vicinity of the CAMDS facility as part of the 1991 field effort (Round I). Each of

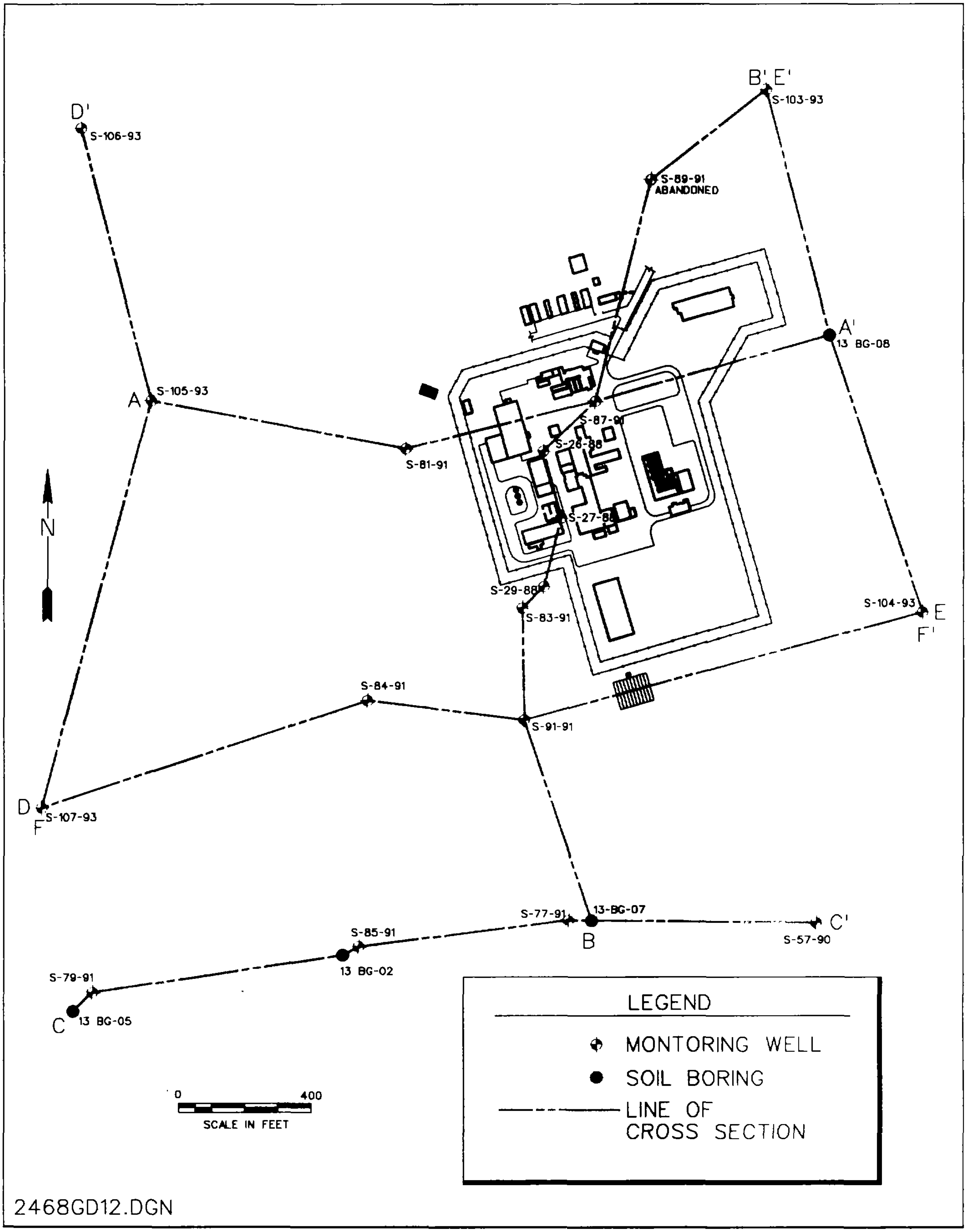

Figure 7-1. SWMU 13 Geological Cross Section Support Map

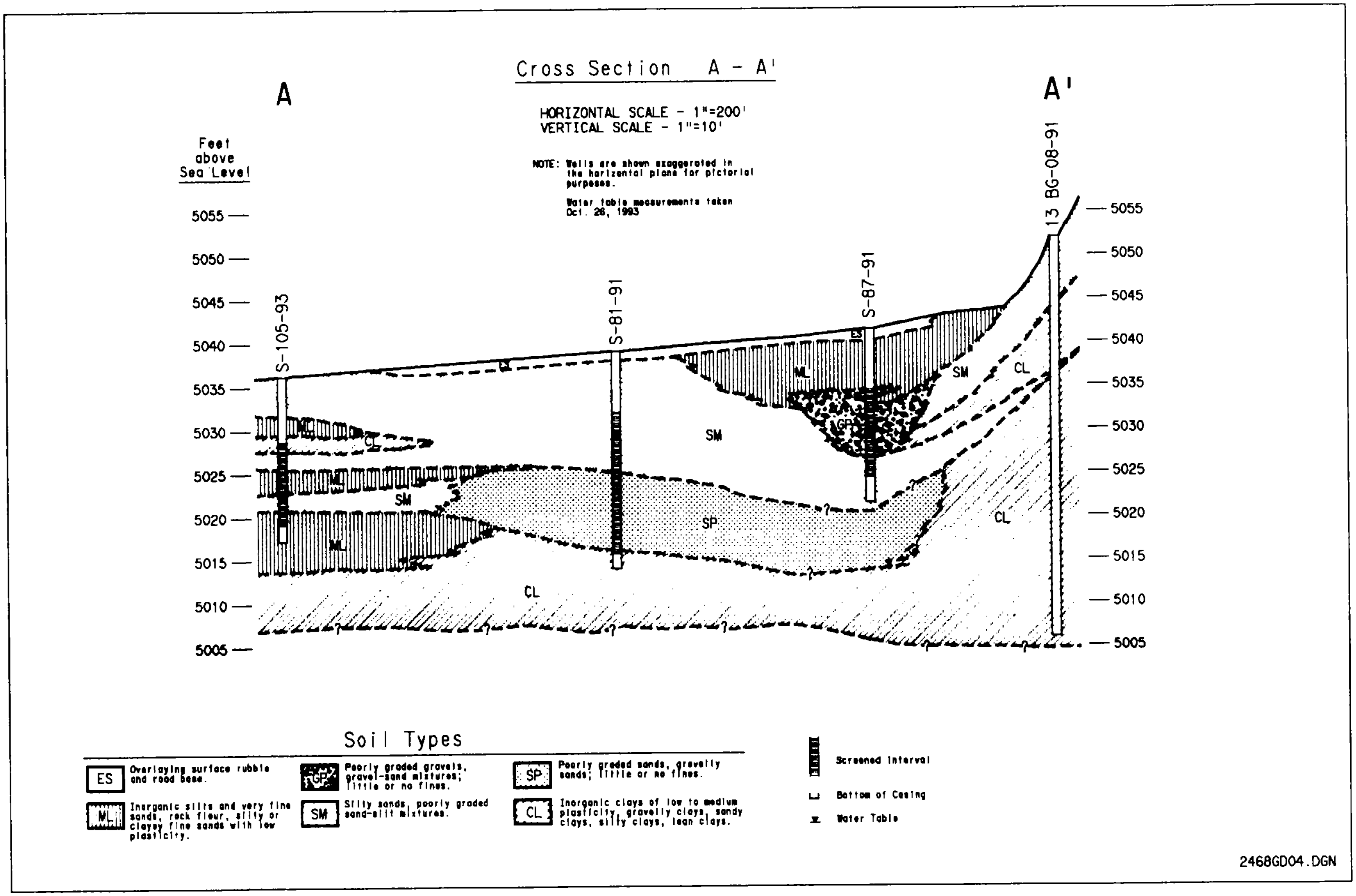

Figure 7-2. SWMU 13 Geologic Cross Section A-A'

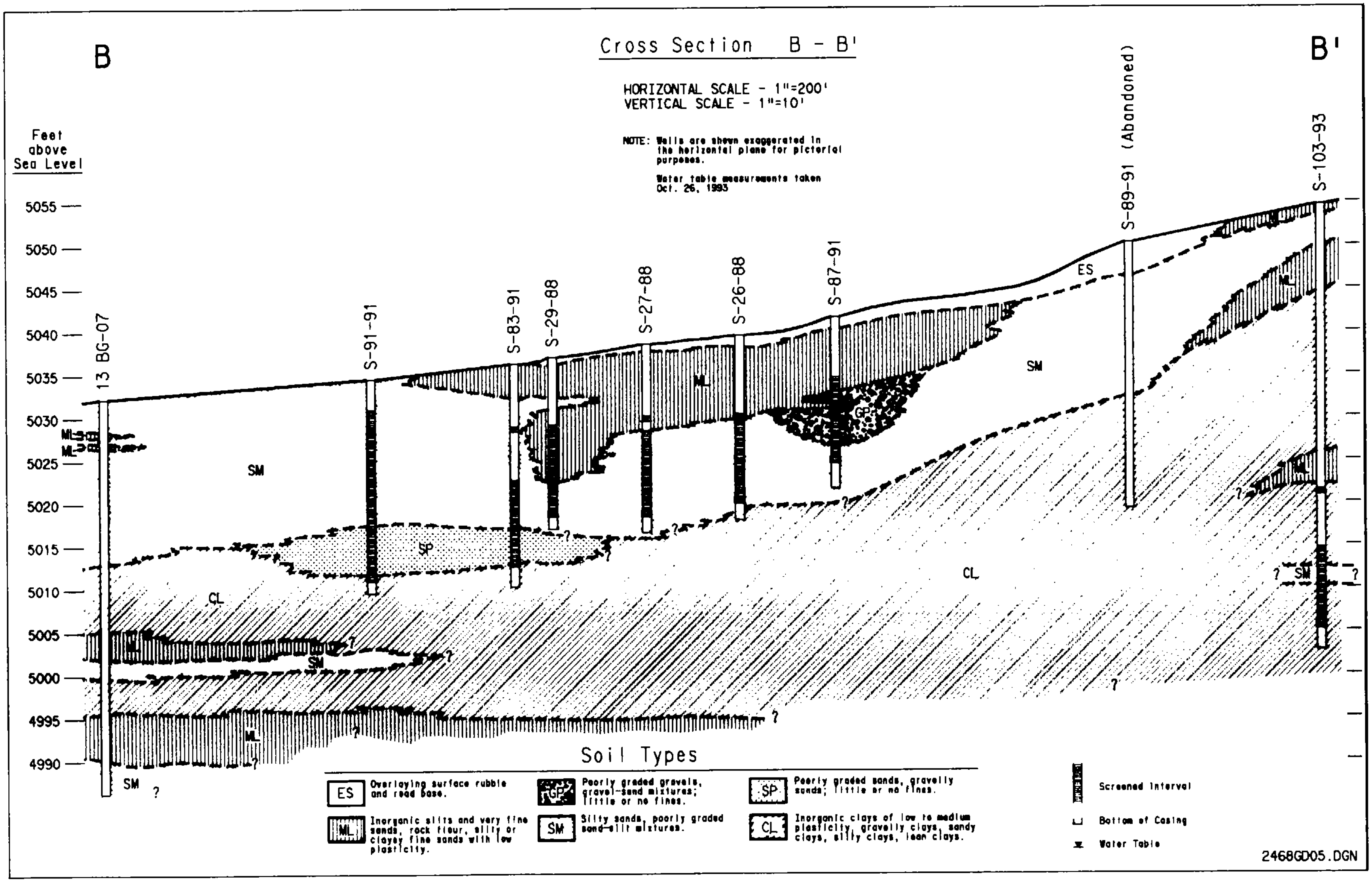

Figure 7-3. SWMU 13 Geologic Cross Section B-B'

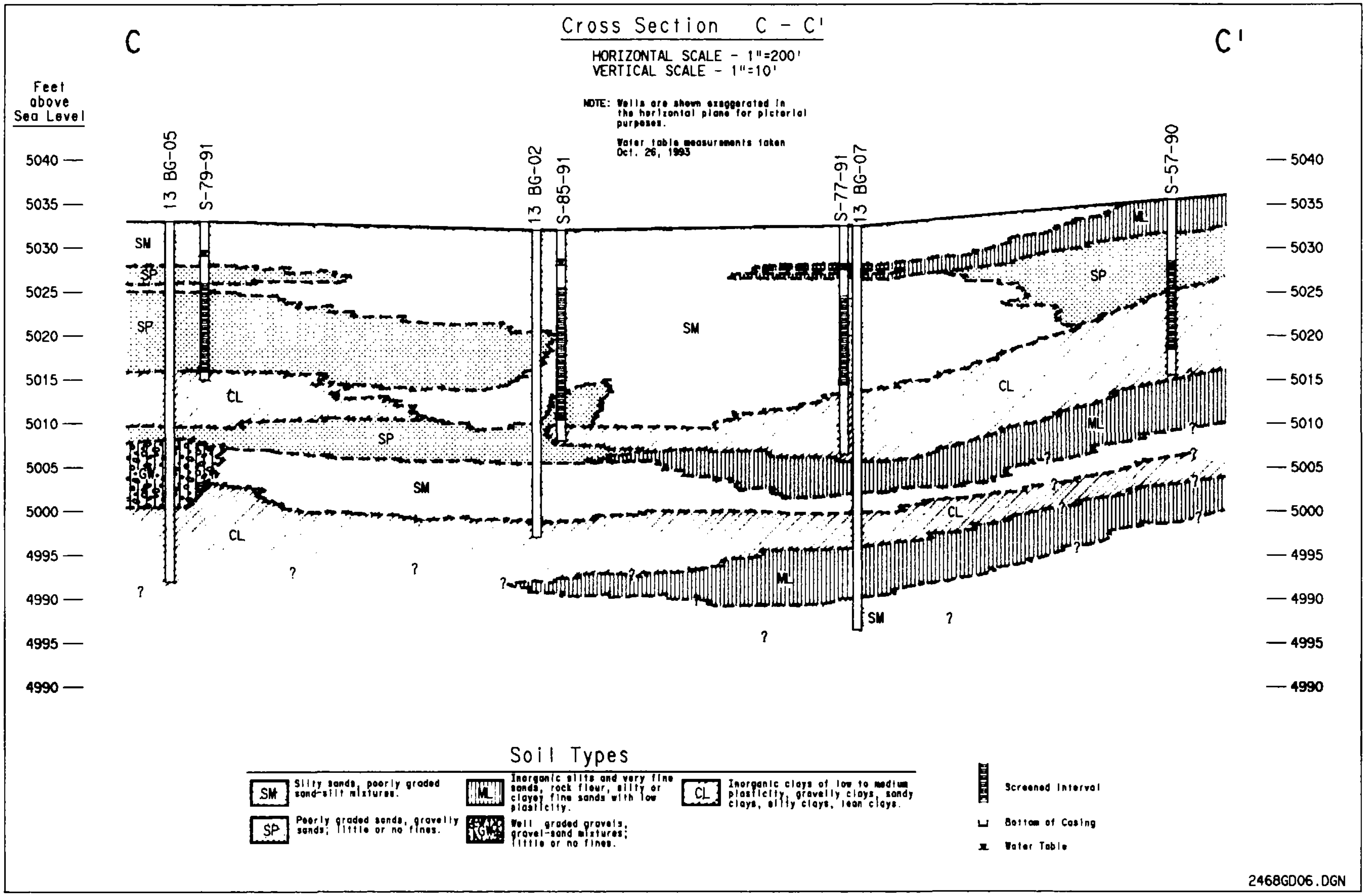

Figure 7-4. SWMU 13 Geologic Cross Section C-C'

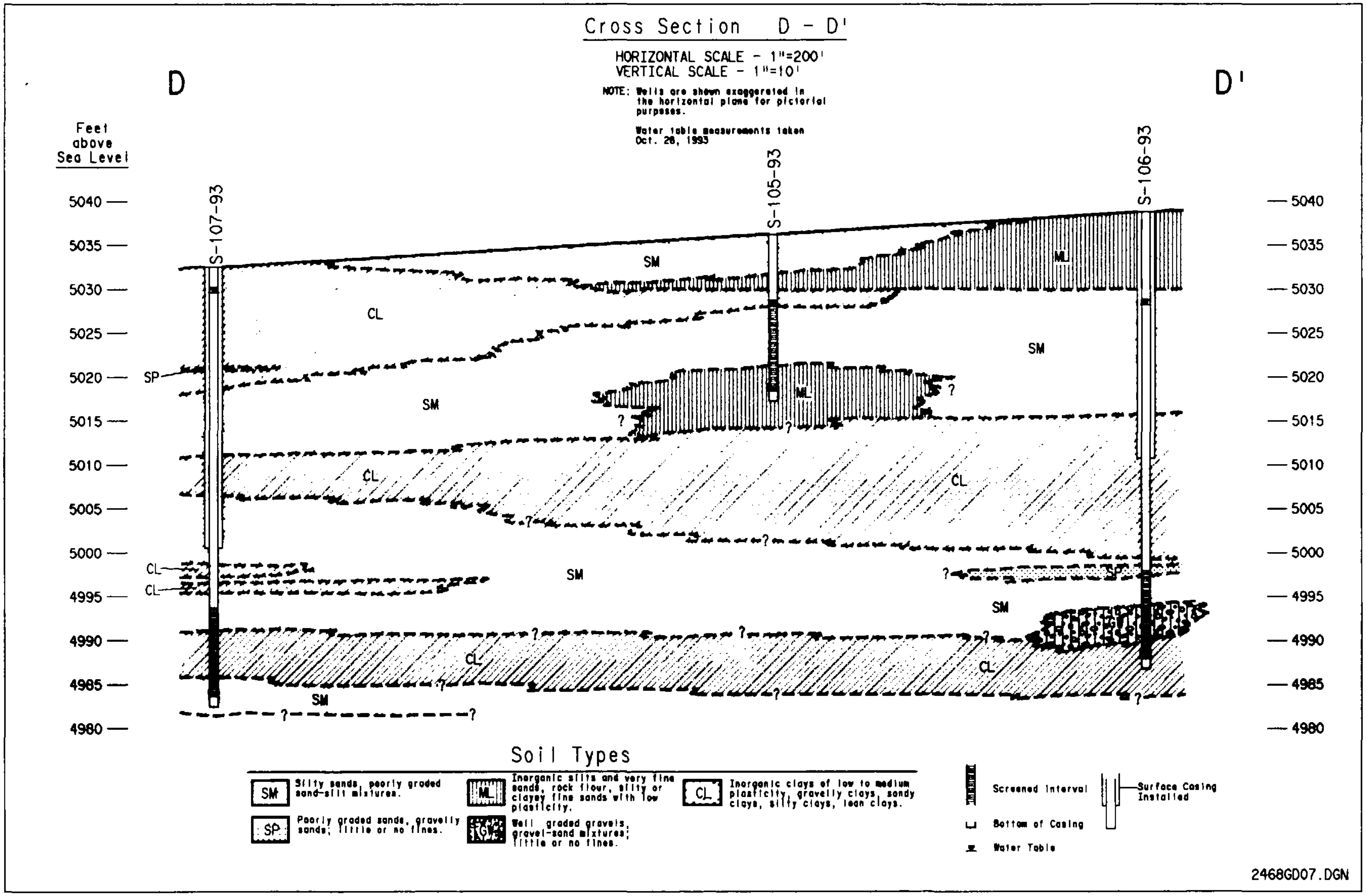

Figure 7-5. SWMU 13 Geologic Cross Section D-D'

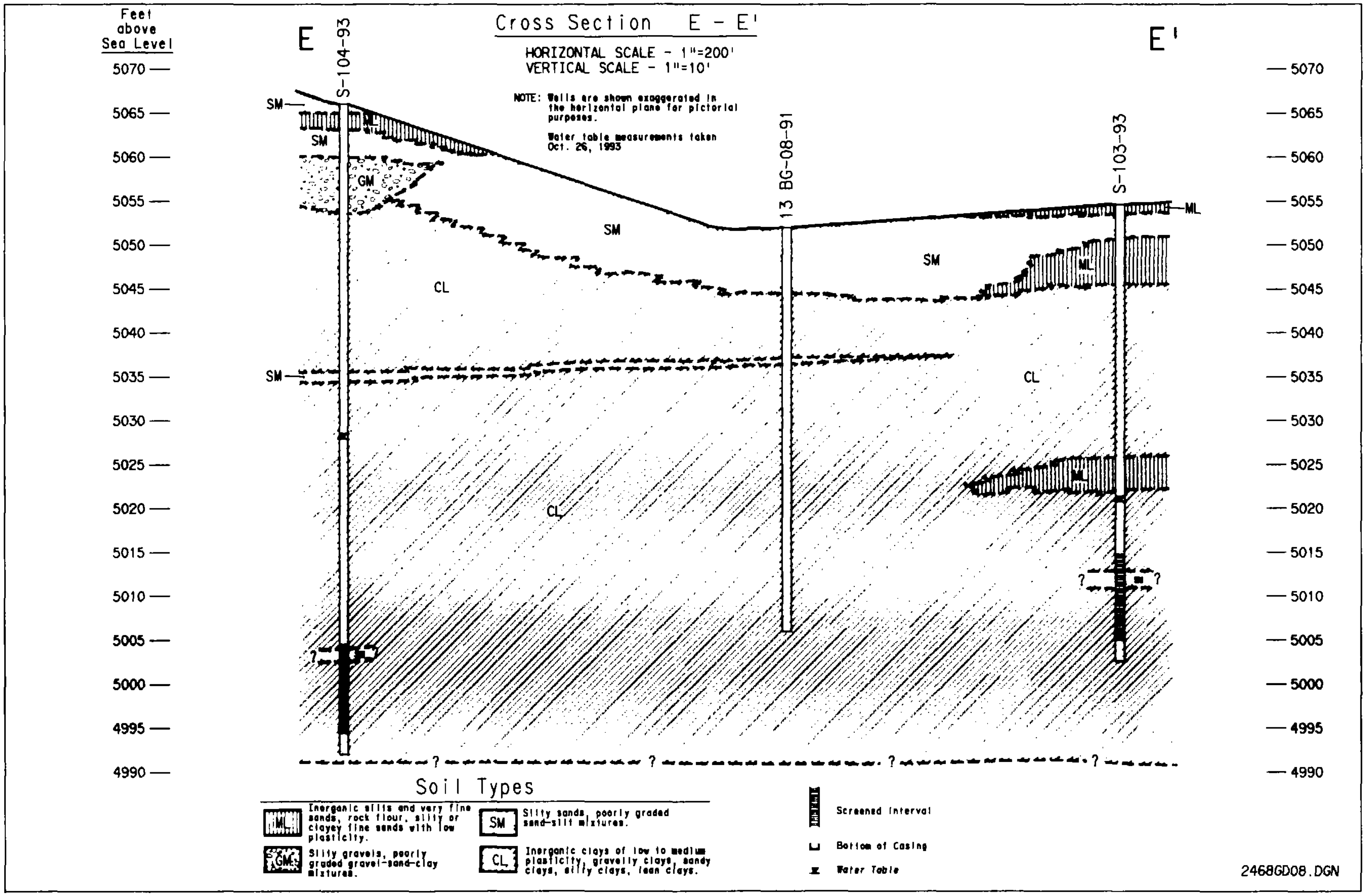

Figure 7-6. SWMU 13 Geologic Cross Section E-E'

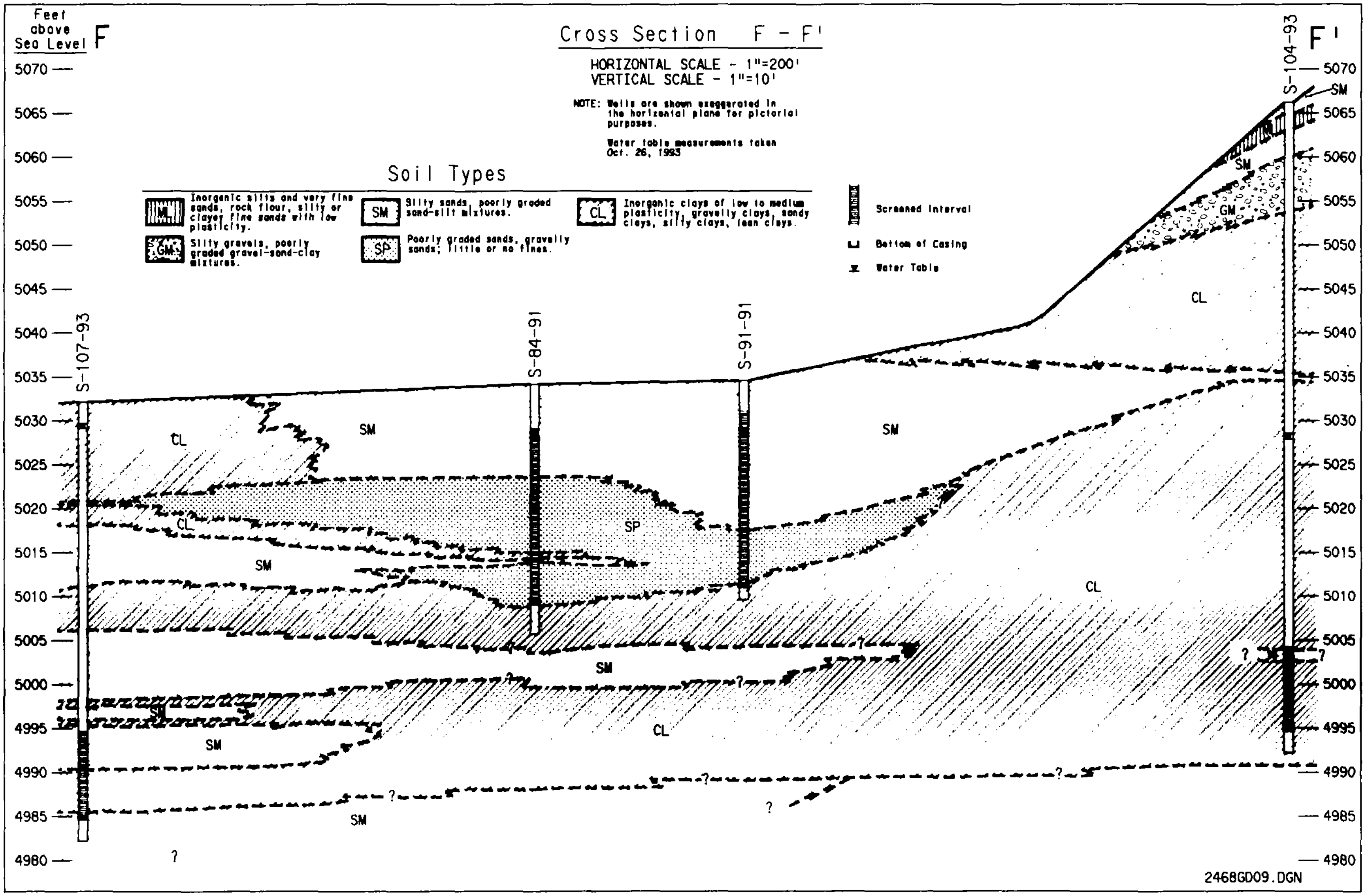

Figure 7-7. SWMU 13 Geologic Cross Section F-F'

these wells was screened in the upper shallow water-bearing zone. These wells were distributed around the facility as follows: S-87-91 was installed inside the CAMDS gates; S-76-91, S-78-91, S-80-91, S-81-91, S-82-91, S-83-91, and S-84-91 to the west; S-79-91, S-85-91, S-91-91 southwest of CAMDS; S-77-91 to the south; and S-86-91 and S-92-91 to the north (Figure 7-8). Proposed wells S-88-91 and S-89-91 were initially drilled inside the facility and to the north, respectively, but did not encounter groundwater and were subsequently abandoned. Well S-90-91 was proposed to be installed east of the facility; however, this well was never drilled. The background soil boring 13-BG-08 was drilled at this location instead.

The Round II field effort, completed in August 1993, included the installation of five more groundwater monitoring wells, S-103-93 through S-107-93. Wells S-103-93, S-104-93, and S-105-93 were installed with the screen in the most shallow water-bearing zone; S-106-93 and S-107-93 were designed to seal off the most shallow water bearing zone; and the screen was set in the next deepest water-producing unit. Wells S-106-93 and S-103-93 are located to the north of the CAMDS facility, S-104-93 was installed to the east, and S-105-93 and S-106-93 to the west.

Locations of all the CAMDS facility wells are presented in Figure 7-8. Well construction details for the wells that were installed by Rust E&I are included in Appendix C; a summary of well construction data from all 35 wells associated with the CAMDS facility is provided in Table 7-1.

7.1.2.1 *Groundwater Elevations*

As shown in Figures 7-2 through 7-7, the subsurface consists of interbedded clays, silts, sands, and gravels. Most importantly, there is no continuous, shallow water-bearing unit underlying the CAMDS facility and immediate surrounding area. The groundwater monitoring wells installed at this site are completed in various units, and the groundwater is encountered under variable conditions. Specifically, the groundwater associated with these monitoring wells is either confined, semi-confined, or unconfined. Table 7-2 lists the monitoring wells associated with the CAMDS facility, the groundwater elevation data collected during December 1992 and October 1993, and the corresponding groundwater conditions.

Depth to groundwater for the wells screened in confined units ranges from approximately 5 (S-107-93) to 40 (S-104-93) feet bgs. For wells screened in semi-confined units, depth to groundwater ranges from approximately 6 (S-85-91) to 12 (S-28-88) feet bgs. Wells screened in unconfined shallow water-bearing units, which is the most common groundwater condition encountered near CAMDS, the depth to groundwater ranges from approximately 8 (S-84-91) to 15 (S-86-91) feet bgs.

Figures 7-9 and 7-10 present groundwater contour maps based on data collected in December 18, 1992, and October 26, 1993, respectively. It is not practical to incorporate water level data collected from all of the wells into a single groundwater contour map. Each map represents only wells containing unconfined groundwater, which is the group of wells that

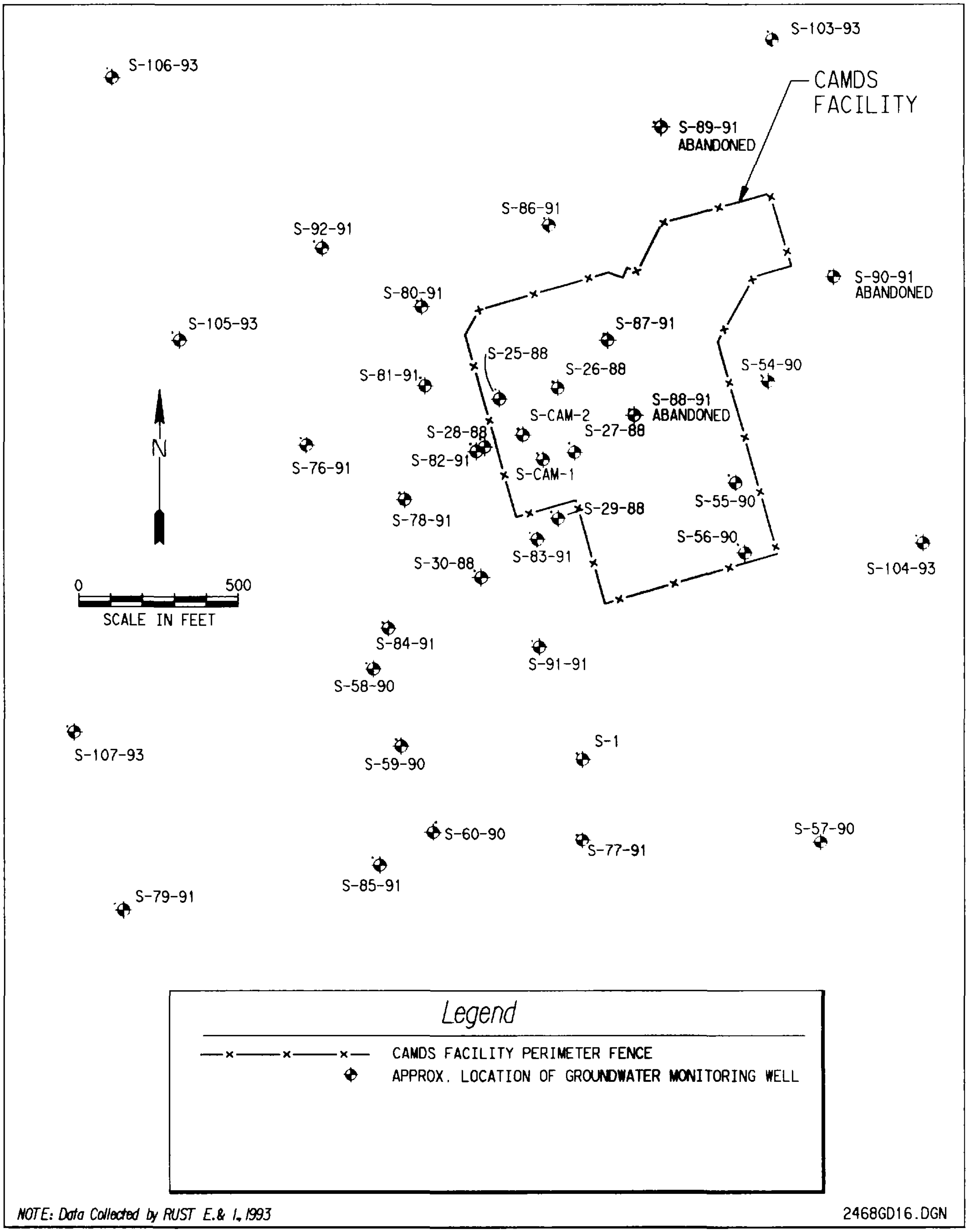

Figure 7-8. SWMU 13 Groundwater Monitoring Well Location Map

Table 7-1. SWMU 13 Monitoring Well Construction Data

Well No.	Date Installed	Total Depth BGS (ft)	Depth Top of Screen BGS (ft)	Screen Length (ft)	Casing Diameter (in)	TOC Elevation
S-1	5-27-82	26	10.3	10	4	5040.01
S-CAM-1	7-10-86	21.6	5.6	16	2	5038.9
S-CAM-2	7-14-86	23.5	5.5	18	2	5039.53
S-25-88	3-22-88	19.5	9.5	10	4	5039.04
S-26-88	3-23-88	19.4	9.4	10	4	5039.64
S-27-88	3-29-88	20.6	10.1	10	4	5038.97
S-28-88	3-31-88	18	7.5	10	4	5041.09
S-29-88	4-1-88	19.3	8.3	10	4	5038.79
S-30-88	4-7-88	18.2	7.7	10	4	5037.67
S-54-90	6-15-90	29	17.5	10	4	5050.63
S-55-90	6-16-90	19	8	10	4	5042.4
S-56-90	6-20-90	50	39	10	4	5052.69
S-57-90	6-28-90	20	7	10	4	5037.94
S-58-90	6-3-90	16	4	10	4	5036.53
S-59-90	6-6-90	16	5	10	4	5035.72
S-60-90	6-13-90	18	7	10	4	5034.91
S-76-91	6-18-91	23.4	8	15	4	5038.89
S-77-91	6-23-91	18.4	8	10	4	5034.14
S-78-91	5-29-91	23.1	7.7	15	4	5038.34
S-79-91	6-17-91	17.4	7	10	4	5035.2
S-80-91	5-28-91	23	7.7	15	4	5041.52
S-81-91	5-28-91	23	7.7	15	4	5040.87
S-82-91	5-16-91	23.4	13	10	4	5040.35
S-83-91	5-17-91	23.9	13.5	10	4	5037.97
S-84-91	5-18-91	25.7	5.4	20	4	5036.24
S-85-91	5-20-91	22	6.7	15	4	5034.12
S-86-91	6-21-91	17	11.7	5	4	5045.9
S-87-91	5-14-91	17.4	7	10	4	5041.69
S-91-91	5-19-91	24	3.7	20	4	5036.55
S-92-91	6-20-91	26	10.7	15	4	5041.41
S-103-93	8-19-93	49.4	40.1	10	4	5056.52
S-104-93	8-8-93	71.4	62.1	10	4	5068.26
S-105-93	8-5-93	17.4	8.1	10	4	5038.37

Table 7-1. SWMU 13 Monitoring Well Construction Data (continued)

Well No.	Date Installed	Total Depth BGS (ft)	Depth Top of Screen BGS (ft)	Screen Length (ft)	Casing Diameter (in)	TOC Elevation
S-106-93	8-20-93	51	41	10	4	5040.61
S-107-93	8-21-93	48.8	38.7	10	4	5034.61

Table 7-2. SWMU 13 Groundwater Elevation Data, December 1992 and October 1993, Phase II RFI

Well Number	TOC Elev[a] (ft)	December 1992 DTW[b] (ft)	December 1992 GW Elev[c] (ft)	October 1993 DTW (ft)	October 1993 GW Elev (ft)	Aquifer Type (C,U,SC)[d]
S-CAM-1	5038.9	12.48	5026.42	10.48	5028.42	SC
S-CAM-2	5039.53	14.17	5025.36	12.45	5027.08	SC
S-1	5040.01	8.5	5031.51	7.87	5032.14	SC
S-25-88	5039.04	10.95	5028.09	9.86	5029.18	SC
S-26-88	5039.64	NA[e]	NA	9.85	5029.79	U
S-27-88	5038.97	10.57	5028.4	9.41	5029.56	SC
S-28-88	5041.09	13.78	5027.31	12.6	5028.49	SC
S-29-88	5038.79	11.03	5027.76	10.21	5028.58	U
S-30-88	5037.67	10.03	5027.64	9.47	5028.2	SC
S-54-90	5050.63	20.12	5030.51	18.41	5032.22	C
S-55-90	5042.40	12.1	5030.3	9.92	5032.48	C
S-56-90	5052.69	12.49	5040.2	20.51	5032.18	C
S-57-90	5037.94	11.13	5026.81	10.41	5027.53	U
S-58-90	5036.53	8.04	5028.49	7.71	5028.82	U
S-59-90	5035.72	7.22	5028.5	6.88	5028.84	U
S-60-90	5034.91	6.57	5028.34	6.23	5028.68	U
S-76-91	5038.89	11.13	5027.76	10.37	5028.52	U
S-77-91	5034.14	6.97	5027.17	6.57	5027.57	SC
S-78-91	5038.34	10.72	5027.62	10.1	5028.24	U
S-79-91	5035.20	6.29	5028.91	6.06	5029.14	SC
S-80-91	5041.52	13.6	5027.92	12.6	5028.92	U
S-81-91	5040.87	12.98	5027.89	11.99	5028.88	U
S-82-91	5040.35	12.55	5027.8	11.65	5028.7	C
S-83-91	5037.97	10.3	5027.67	9.57	5028.4	U
S-84-91	5036.24	8.54	5027.7	8.13	5028.11	U

Table 7-2. SWMU 13 Groundwater Elevation Data, December 1992 and October 1993, Phase II RFI (continued)

		December 1992		October 1993		Aquifer
Well Number	TOC Elev[a] (ft)	DTW[b] (ft)	GW Elev[c] (ft)	DTW (ft)	GW Elev (ft)	Type (C,U,SC)[d]
S-85-91	5034.12	6.4	5027.72	6.05	5028.07	SC
S-86-91	5045.90	17.34	5028.56	15.43	5030.47	U
S-87-91	5041.69	13.07	5028.62	11.73	5029.96	U
S-91-91	5036.55	8.88	5027.67	8.35	5028.2	U
S-92-91	5041.41	13.76	5027.65	12.84	5028.57	U
S-103-93	5056.52	NA	NA	35.7	5020.82	C
S-104-93	5068.26	NA	NA	40.3	5027.96	C
S-105-93	5038.37	NA	NA	10.25	5028.12	U
S-106-93	5040.61	NA	NA	12.39	5028.22	C
S-107-93	5034.61	NA	NA	5.57	5029.04	C

Note.—Water level data collected December 18, 1992, and October 26, 1993. **Data affected by floating product in well.**
[a]TOC Elev=Top of casing elevation, above sea level.
[b]DTW=Depth to water, measured from top of casing.
[c]GW Elev=Groundwater elevation above sea level.
[d]C, U, SC=Confined, unconfined, semi-confined.
[e]NA=Data not available.

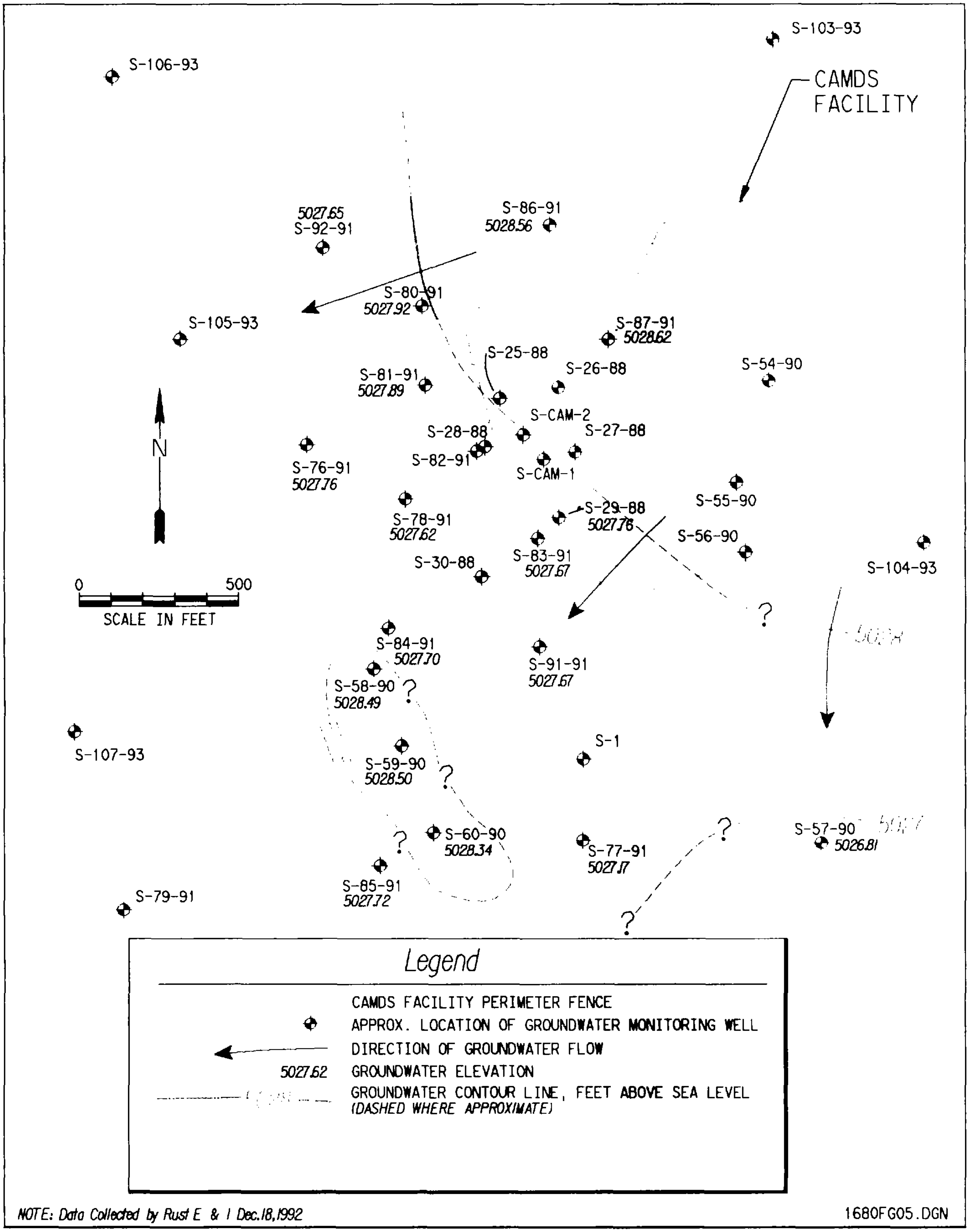

Figure 7-9. SWMU 13 Groundwater Contour Map for December 1992

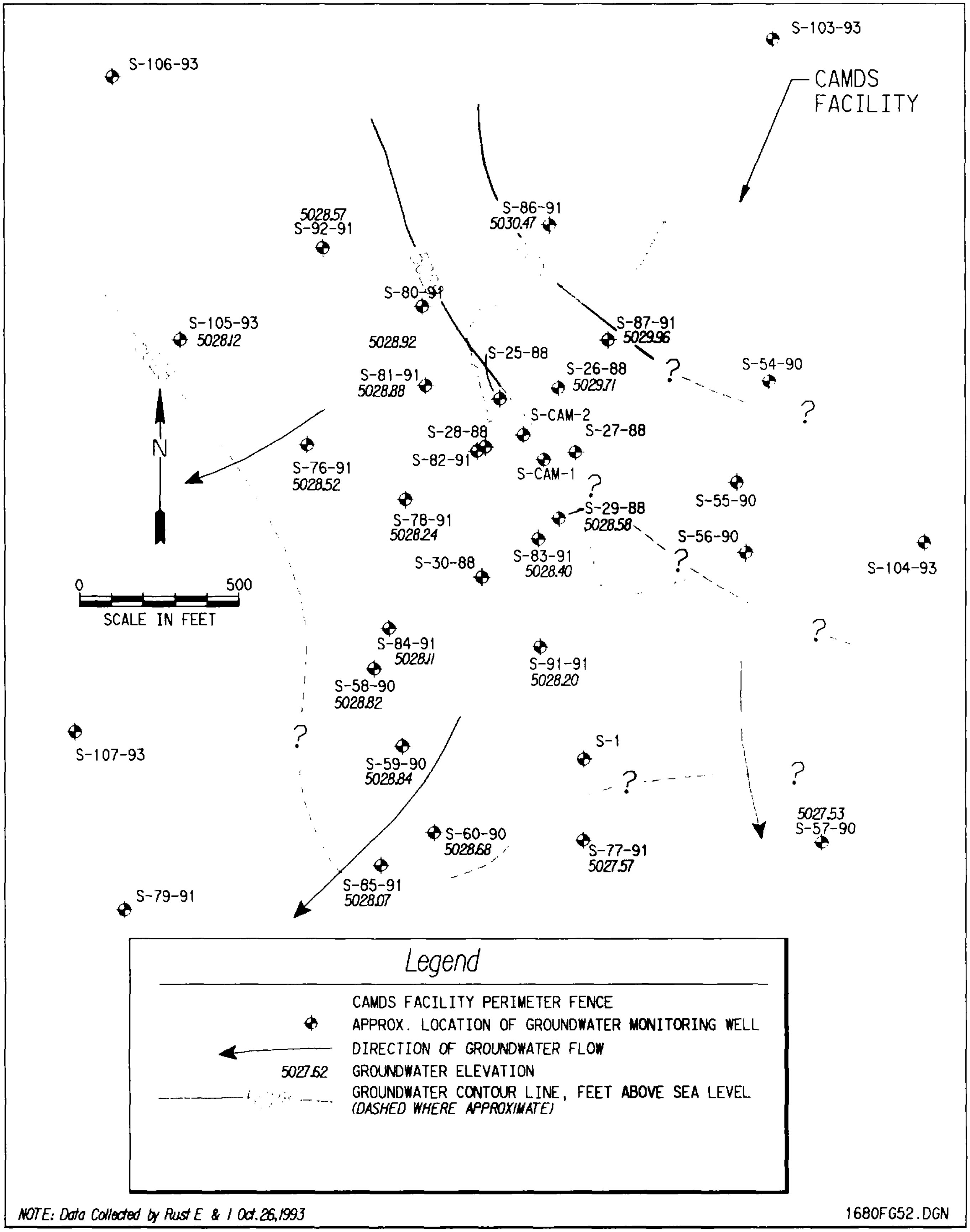

Figure 7-10. SWMU 13 Groundwater Contour Map for October 1993

provides sufficient data. As shown in Figure 7-9, groundwater flow trends to the west-southwest. There appears to be a groundwater mound to the southwest of the facility in the vicinity of Wells S-58-90, S-59-90, and S-60-90. According to information contained in the boring logs for these wells, a clayey sand unit was encountered approximately 7 feet bgs, causing a localized perched water table in this vicinity. As Figure 7-10 shows, the unconfined groundwater flow direction is similar to that shown on the December 1992 contour map, with the October 1993 data resulting in an average groundwater gradient of 0.001 foot/foot.

7.1.2.2 *Slug Tests*

Estimated hydraulic conductivities from wells installed prior to 1991 for the CAMDS facility ranged from 1.41×10^{-3} to 1.02×10^{-2} cm/sec (Weston 1991). To gain a better understanding of the hydrogeologic parameters at the CAMDS facility, slug tests were also performed at each of the Round I wells during June 1991 and on the Round II wells in October 1993. Data collected from these tests were used to estimate the hydraulic conductivity of the subsurface material at each location.

Where conditions allowed (i.e., the groundwater was semi-confined or unconfined), the test data were analyzed using two different methods: the Hvorslev Method and the Bouwer and Rice Method. Results of slug tests for the Round I and II wells ranged from 9.01×10^{-4} (Well S-84-91) to 1.87×10^{-1} (Well S-87-91) cm/sec for tests analyzed using the Hvorslev Method. For test data analyzed using the Bouwer and Rice Method, estimated hydraulic conductivities ranged from 7.34×10^{-5} (Well S-86-91) to 1.72×10^{-2} (Well S-106-93) cm/sec. Test results for all wells are included in Table 7-3. Test procedures, details of the data analysis methods used, and graphical representations of the data are included in Appendix A.

7.1.2.3 *Free-Product Recovery Test*

On July 8, 1991, during the collection of water level data, a floating, light-weight petroleum product (i.e., diesel fuel) was detected in five wells. The following is a list of wells containing free product and corresponding thickness (the distance from the top of the free product to the product-water interface): Well S-CAM-1, 0.49 foot; Well S-CAM-2, 0.52 foot; Well S-26-88, 0.16 foot; and Well S-28-88, 0.35 foot. A trace of product (less than 0.05 foot) was detected in Well S-27-88.

On July 10, 1991, a product recovery test was performed on Well S-28-88. This test was designed to determine the volume of product recharging into the well once both water and product were removed. Determination of how the well responds to this test provides qualitative information for the design of a preliminary product recovery system.

Well S-28-88 is a 4-inch well, 18.2 feet deep, and contains 10 feet of screen, starting 7.5 feet bgs. As a result, both the top of the product and the product-water interface (12.00 and 12.35 feet bgs, respectively) were within the screened interval of the well. After initial

Table 7-3. SWMU 13 Slug Test Results, Phase II RFI

Well Number	Method Hvorslev K (cm/sec)[a]	 Bouwer and Rice K (cm/sec)
S-76-91	1.90E-02	2.42E-03
S-77-91	NA[b]	2.27E-03
S-78-91	8.68E-03	3.43E-03
S-79-91	6.83E-03	2.87E-03
S-80-91	NA	2.85E-03
S-81-91	8.13E-03	2.76E-03
S-82-91	1.13E-02	2.55E-03
S-83-91	8.46E-03	3.15E-03
S-84-91	9.01E-04	3.67E-04
S-85-91	NA	2.37E-03
S-86-91	7.94E-04	7.34E-05
S-86-91*	1.46E-03	6.09E-05
S-87-91	1.87E-01	8.99E-02
S-87-91*	2.46E-01	8.15E-02
S-91-91	5.84E-03	1.36E-03
S-92-91	2.46E-02	2.17E-03
S-103-93	NA	6.33E-05
S-104-93	NA	2.13E-05
S-105-93	NA	2.18E-03
S-105-93*	NA	1.94E-03
S-106-93	NA	1.72E-02
S-107-93	NA	4.09E-04

*Duplicate test.
[a]Centimeters per second.
[b]Data not applicable to analysis method.

measurements of product and groundwater levels were recorded, both the product and groundwater were removed from the well using a bailer. Recovery data (of both the product and groundwater levels) were collected over the next 160 minutes. Appendix A contains the raw data generated from this test.

At the end of 160 minutes, only 0.17 foot of product was measured inside the well. This slow rate of recovery suggests that installing product-skimming pumps for removal of product may not be a feasible option.

7.1.2.4 *Groundwater Geochemistry*

Ebasco (1991) previously evaluated the general water characteristics of the shallow alluvial aquifer underlying the TEAD facility. As a result, three groundwater zones were identified (see Figure 5-2), ranging from relatively low TDS in groundwater to the northeast and grading to brackish groundwater to the southwest. Generally, this evolution of groundwater chemistry corresponds to a sedimentary facies change from alluvial fan type deposits in the northeastern portion of the project area to predominately lacustrine deposits to the southwest. SWMU 13 is located in the transition zone (Zone II, see Figure 5-2). Strata in Zone II are comprised of interfingering alluvial fan deposits and lacustrine deposits. The groundwater in Zone II is characterized by relatively low TDS to moderately saline TDS concentrations. This type of groundwater evolution from low TDS to brackish or brine TDS concentrations is common in the semi-arid basin and range province.

Generally, the surficial groundwater along the basin margin is lower in TDS because of its proximity to the recharge area. Subsequently, as the groundwater migrates toward the basin axis, it reacts with various mineral phases in the sediments, resulting in mineral dissolution and consequent increase in TDS. Eventually, as the groundwater approaches saturation with respect to various mineral phases, precipitation of calcite, anhydride, and gypsum becomes a common process. The groundwater and minerals may go through many cycles of dissolution and precipitation in this late stage of evolution. This conceptual model for the groundwater geochemistry provides a basis for interpreting the subsequent analytical data.

7.2 FUEL SPILL SITE

7.2.1 Previous Sampling and Phase II RFI Sampling Results

Previous investigations of the Fuel Spill Site were conducted by EA (1988) and Weston (1991). Rust E&I also investigated the site as part of this Phase II RFI.

EA, 1988. Following several diesel fuel spills from the three above-ground storage tanks, EA installed three monitoring wells (S-CAM-1, S-CAM-2, and S-CAM-3) in the area of the spill (Figure 7-11) in the summer of 1986. Visible floating product and a diesel fuel odor were apparent in wells S-CAM-1 and S-CAM-2 at the time of sampling. As a result, it was

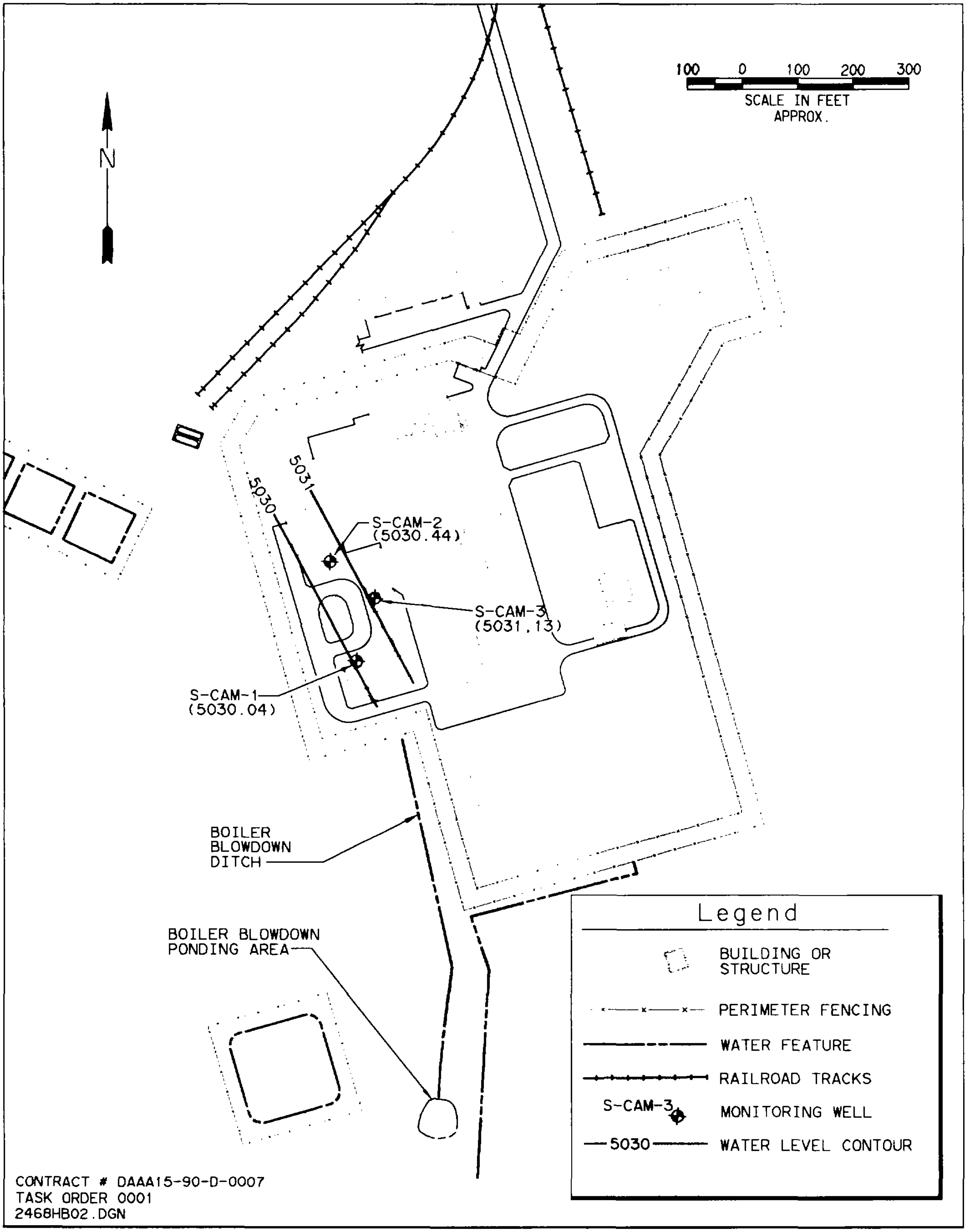

Figure 7-11. SWMU 13 Groundwater Sample Locations for the PA/SI, 1988

determined that samples would not be collected from these two wells. However, a sample was collected from S-CAM-3 and was analyzed for explosives, agent breakdown products, VOCs, SVOCs, metals, inorganics, and gross alpha/beta. The analytical results for this sample are shown in Table 7-4. As indicated in Table 7-4, eight SVOCs were detected in the groundwater with napthalenes present in the highest concentrations (100 to 200 μg/L). Benzene and ethylbenzene were also detected at concentrations of 20 μg/L and 6 μg/L, respectively. In addition, the explosive 2,4,6-trinitrotoluene was detected at a concentration of 14.2 μg/L. Eight metals were detected, but only arsenic (400 μg/L) exceeded federal drinking water standards. Gross alpha and beta radionuclides were detected, with gross alpha being twice the primary drinking water standards. No agent breakdown products were detected.

Weston, 1991. In the spring and summer of 1988, Weston (Weston 1991) conducted, as part of their RI at TEAD-S, a drilling and sampling program to further define the diesel fuel plume identified by EA. Six boreholes (later converted to wells) were drilled in the area of the diesel fuel spill. These borings (S-25-88 through S-30-88) were located near the main diesel fuel tank farm (Figure 7-12). Soil samples were collected at 5-foot intervals beginning 5 feet below the surface and continuing to the bottom of the hole. Total depths ranged from approximately 18 to 22 feet. These samples assisted in characterizing the lithology at the sites. A sample was also collected from the saturated zone for laboratory analysis. This zone was to be screened when its respective boring was converted to a monitoring well.

The six samples (one per boring) from this zone were analyzed for VOCs, SVOCs, explosives, petroleum hydrocarbons, and anions. An additional sample was collected from S-27-88 and S-28-88 on the basis of elevated organic vapor monitoring results (Weston, 1991). The results of these eight subsurface soil samples are shown in Table 7-5. No positively identified VOCs were detected from the eight soil samples. However, 10 μg/g of tentatively identified xylenes were detected in a sample from S-27-88, and 11 μg/g of unknown VOCs were found in a soil sample from S-28-88.

Several positively identified SVOCs were identified along with some unknown SVOCs. Soil boring results from S-27-88 showed acenaphthene, di-n-butyl phthalate, fluorene, naphthalene, and phenanthrene (2.5 μg/g total concentration). Tentatively identified SVOCs were also found in the soil samples from S-25-88, S-27-88, and S-30-88, including unknowns, 1,1-dimethyl hydroperoxide, methyl ketone (1.0 μg/g of a ketone was also detected in a blank), and organic acid (Table 7-5). The presence of SVOCs such as the analytes discussed above are indicative of fuel-contaminated soil (Weston 1991).

Another indication that the fuel spill affected soil in the area is the presence of TPHCs. TPHCs were detected in all eight subsurface soil samples with the highest levels being in boring S-27-88 at a depth of 10 feet (380 μg/g), boring S-28-88 at a depth of 12.5 feet (70 μg/g), and boring S-25-88 at a depth of 16 feet (25 μg/g). Weston concluded that the fuel-related contamination in soils was a result of groundwater migration and seasonal water-table fluctuation that resulted in residual petroleum hydrocarbons adsorbing in the soils above the water table.

Table 7-4. SWMU 13 Groundwater Sampling Results for Monitoring Well S-CAM-3, PA/SI, 1988

Parameter	Results (μg/L unless otherwise noted)
Volatiles	
Benzene	20
Ethylbenzene	6
Semi-Volatiles	
Naphthalene	100
2-Methylnaphthalene	200
Acenaphthene	40
DibenzoFuran	10
Fluorene	20
Phenanthrene	60
Bis(2-ethylhexyl)phthalate	2[a]
Anthracene	3
Agent Breakdown Products	Below the CRL[b]
Explosives	
2,4,6-TNT	14.2
Metals (total)	
Arsenic	400
Barium	>200
Beryllium	1.20
Chromium	21
Lead	31

Footnotes on next page.

Table 7-4. SWMU 13 Groundwater Sampling Results for Monitoring Well S-CAM-3, PA/SI, 1988 (continued)

Parameter	Results (μg/L unless otherwise noted)
Silver	0.42
Sodium (mg/L)	173
Zinc (mg/L)	114
Inorganics	
Chloride (mg/L)	83.5
Fluoride	3,100
N02+N03 Nitrogen	30
Orthophosphate	120
Sulfate (mg/L)	250
Gross Alpha (pCi/L)	34±11
Gross Beta (pCi/L)	36±13

Note.—The agent breakdown product suite consisted of thiodiglycol. The detection limit was 720 μg/L. No agent compounds were sampled or analyzed for.

[a]Probably due to laboratory contamination.

[b]Below the CRL=below certified reporting limits.

Source: EA, 1988 (Laboratory analysis performed by EA Engineering Science)

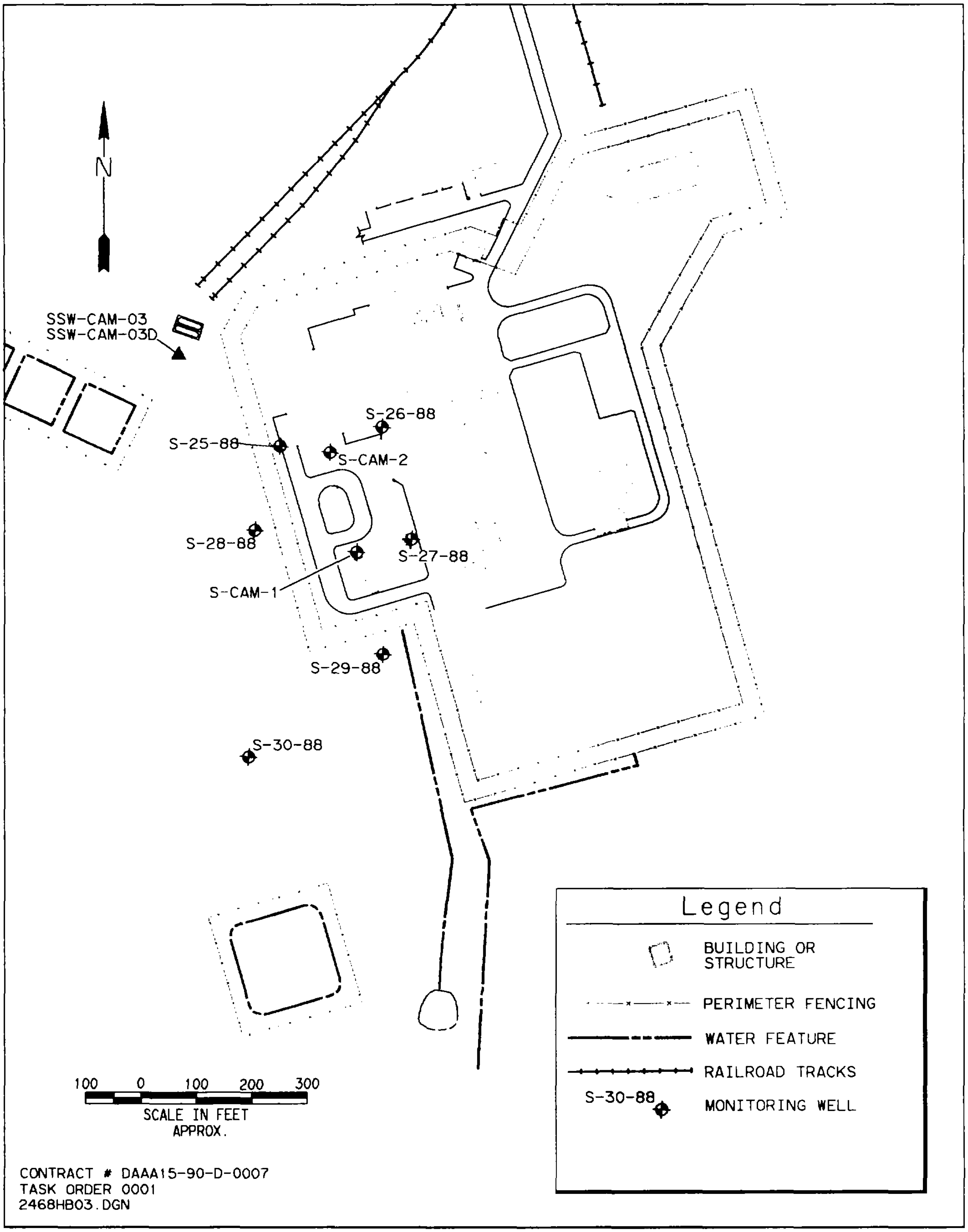

Figure 7-12. SWMU 13 Soil and Groundwater Sample Locations for the RI, 1991

Table 7-5. SWMU 13 Soil Boring Sample Results, RI, 1991

Parameter	S-25-88-08	S-26-88-01	S-27-88-03	S-27-88-07	S-28-88-05	S-28-88-07	S-29-88-04	S-30-88
				(Concentrations in μg/g)				
Depth (ft)[(a)]	16	19	10	15	12.5	18	19	13
Volatile Organics	ND[(b)]	ND	ND	ND		ND	ND	
Xylenes				10[1]				
Unknowns						11[1]		
Semivolatile Organics		ND			ND	ND	ND	
Acenaphthene			0.16					
Di-n-Butyl Phthalate			0.7					
Fluorene			0.21					
Naphthalene			0.55					
Phenanthrene			0.88					
BDAE[(c)]								0.28
1,1-Dimethyl Hydroperoxide								2.53[1]
Methyl Ketone[(d)]								3.73[1]
Organic Acid				14[1][(e)]				
Unknowns	1[1]							1.94[1]
Explosives	ND	ND	ND	ND	ND	ND	ND	ND
Petroleum Hydrocarbons	25	11	380	2.0	70	2.0	4.0	9.0

Table 7-5. SWMU 13 Soil Boring Sample Results, RI, 1991 (continued)

Parameter	S-25-88-08	S-26-88-01	S-27-88-03	S-27-88-07	S-28-88-05	S-28-88-07	S-29-88-04	S-30-88
	(Concentrations In µg/g)							
Anions								
Bromide	LT[f]	LT	LT	LT	LT	LT	LT	LT
Chloride	12,900[g]	10,300	14,500	21,400	20,300	65,000	6,640	LT
Fluoride	4.39	28.2	LT	21.1	25.5	24.8	23.3	11.2
Nitrate/Nitrite	LT	LT	LT	LT	LT	LT	1,160	LT
Sulfate	19,150[g]	55,300	LT	LT	33,100	LT	LT	LT

Note.—Samples analyzed for all parameters. A revision of moisture contents factors was made to the Installation Restoration Data Management System (IRDMIS), which may affect some of the values in this table. In most cases, the variation is 1 percent to 5 percent.

[a]Depths are to top of sample. Samples collected over a 1.5 -foot range.

[b]ND=not detected.

[c]BDAE=unknown benzenedicarboxylic acid ester derivative.

[d]A ketone was also found in a blank sample at a concentration of 1.0 µg.g.

[e][ ]=number of unknowns or TICs.

[f]LT (or blank)=less than CRL or SRL.

[g]Average of laboratory duplicates.

Source: Weston, 1991.

Several anions were detected in the soil samples from S-25-88 through S-30-88. Chloride and fluoride were the most prominent with detections in all but one sample each (S-30-88 and S-27-88, respectively). Chloride concentrations ranged from 6,640 μg/g in S-29-88 to 65,000 μg/g in S-28-88, and fluoride concentrations ranged from 4.39 μg/g in S-25-88 to 28.2 μg/g in S-26-88. Sulfate was detected in three of the borings (up to 55,300 μg/g), while nitrates and nitrites were only detected in S-29-88 at 1,160 μg/g. Bromide was not found in any of the eight samples.

Additionally, analytical results to determine the presence of explosives in the six boring locations reported non-detects in all samples.

The six borings were converted to monitoring wells and subsequently sampled. Four existing wells installed by ERTEC and EA were also sampled by Weston (1991). The samples were analyzed for VOCs, SVOCs, explosives, metals, anions, agent breakdown products, and radionuclides. The results of this sampling are presented in Table 7-6.

Petroleum hydrocarbons in well S-CAM-1 were at a level of 190,000 μg/L, which was two orders of magnitude higher than most other wells. This well was not sampled previously by EA because of the presence of floating product. S-CAM-1 also contained the highest level of explosives (30 μg/L of 2,4,6-trinitrotoluene) and SVOCs (total of 646 μg/L). Of the SVOCs naphthalene was the only compound conclusively identified (79.6 μg/L). The other wells (S-25-88, S-26-88, and S-27-88) showed similar petroleum hydrocarbon contamination but with decreasing levels similar to those in S-CAM-2 (8,500 μg/L).

VOCs were detected in well S-25-88 with the primary compounds being carbon tetrachloride (69 μg/L), trichloroethylene (9.01 μg/L), and benzene (4.51 μg/L). Well S-27-88 contained 17 μg/L of trichloroethylene. The explosive 2,4,6-trinitrotoluene was found in four of the wells ranging in concentration from 1.65 to 30 μg/L. A trace (0.88 μg/L) of 2,4-dinitrotoluene was detected in well S-26-88. Chemical agent breakdown product (IMPA) was detected in all wells except S-25-88 and S-26-88. Concentrations ranged from 11 μg/L to 30 μg/L.

Arsenic and nickel were present in all wells. Silver (total), copper (dissolved), lead (dissolved), and antimony (total and dissolved) also exceeded background concentrations in each of the wells. The highest levels of gross alpha, gross beta, and uranium were detected in well S-27-88. All of the wells contained various levels of radionuclides, but Weston could not determine if the concentrations represented background levels or whether there was a local source for the radionuclides. Chloride and sulfate were also found to be above background levels in all wells from this area of CAMDS. Weston interpreted this to represent brackish water.

Rust E&I, 1991. During the spring and summer of 1991, Rust E&I conducted a phased approach to the field investigation portion of the Phase II RFI at CAMDS. To further define the extent of diesel-fuel-related contamination, the first investigation performed was a soil-gas survey. Samples were collected at an approximate depth of 5 feet along nine lines, which

Table 7-6. SWMU 13 Groundwater Sample Results, RI, 1991

	Sample Location									
	Within CAMDS					Outside CAMDS				
Parameter	S-CAM-1	S-CAM-2	S-25-88	S-26-88	S-27-88	S-28-88	S-29-88	S-30-88	S-1	S-3
	(Concentrations in μg/L or as noted)									
Volatile Organics		ND[a]					ND	ND	NA[b]	ND
Benzene	41.9		4.51			37.8				
Carbon Tetrachloride			69		17					
Trlchloroethylene			9.01	0.801		8.93				
Semivolatile Organics							ND		ND	ND
Naphthalene	79.6	98.7	67.5	89	122	50.1				
Alkane		71[4][c]								
Benzene or Benzene Derivatives		55[2]	71[3]	49[2]	151[4]	61[3]				
Benzene Acetic Acid	20[1]									
Bromacil					20[1]					
Decane		18[1]	15[1]							
Dihydro-Methyl-IH-Indene	11[1]	12[1]		23[1]	12[1]					
Dimethyl Benzoic Acid			12[1]							
Naphthalene or Alkylated Naththalene	307[7]	334[7]	176[6]	88[3]	187[4]	17[1]				
Naphthalene Acetic Acid	11[1]									
Propenoic Acid Ehtyl Hexyl Ester	17[1]									
Unknown	87[5]	46[3]	11[1]	13[1]	19[1]	178[3]		12[1]		

Table 7-6. SWMU 13 Groundwater Sample Results, RI, 1991 (continued)

	Sample Location									
	Within CAMDS					Outside CAMDS				
Parameter	S-CAM-1	S-CAM-2	S-25-88	S-26-88	S-27-88	S-28-88	S-29-88	S-30-88	S-1	S-3
	(Concentrations in µg/L or as noted)									
Explosives					ND				ND	
2,4-Dinitrotoluene				0.88						
1,3,5-Trinitrobenzene						9.8				
2,4,6-Trinitrotoluene	30	20	1.65	2.57		14	5.27	3.15		3.25
IMPA	27	30			15	15	18	11	16	13
Petroleum Hydrocarbons	190,000	8,900	5,600	5,600	5,400	3,700	1,800	1,200	1,000	560
Metals, Total/Dissolved										
Silver	0.426/0.426	0.319/0.426	0.319/LT	0.319/0.426	0.426/0.639	1.38/0.532	0.53/0.43	0.74/2.66		0.74/0.74
Arsenic	720/590	1,100/1,500	1,300/1,100	490/370	1,500/1,600	370/370	410/470	72/150	320/330	20.9/19.5
Beryllium						0.201/LT[d]		1.01LT	0.503/LT	
Cadmium								6.44/LT		
Chromium						1,600/1,900				
Copper	6.22/27.9	5.36/18.5	14.5/13.9	5.25/8.90	7.93/8.36	18.5/7.72	17.6/LT	36.1/12.1	10.9/14.5	10.6/3/32
Nickel	46.7/176	58.3/80.6	78.3/175	42.5/42.4	63.2/33.1	23.1/LT	12.5/LT	16.0/LT	12.4/LT	
Lead	6.57/15.8	4.25/4.95	3.13/4.15	2.73/2.73	7.28/7.68	11.9/LT	7.58/LT	9.91/LT	12.4/LT	2.73/LT
Antimony	8.07/4.89	5.57/LT	10.7/4.43	7.05/LT	5.80/4.55	10.6/3.98	8.64/LT	9.09/8.18		
Selenium					LT/40.8					
Thallium										
Zinc	48.7/69.0	28.8/84.7	31.3/41.3	19.7/LT	18.8/46.0	127/LT	72.2/LT	82.0/23.3	35.2/96.0	69.9/19.1

Table 7-6. SWMU 13 Groundwater Sample Results, RI, 1991 (continued)

	Sample Location									
	Within CAMDS					Outside CAMDS				
Parameter	CAM-1	CAM-2	S-25-88	S-26-88	S-27-88	S-28-88	S-29-88	S-30-88	S-1	S-3
	(Concentrations in µg/L or as noted)									
Anions mg/L										
Bromide	LT	LT	LT	LT	LT	LT	LT	LT	0.128	LT
Chloride	969	747.5*	1,780	237	927	3,950	1,560	7,830	380	3.040
Nitrite/Nitrate	LT	LT	LT	LT	16	LT	LT	27,000	LT	LT
Sulfate	3,300	1,655*	1,720	2,050	4,800	4,800	2,490	4,200	140	840
Fluoride	LT	LT	LT	LT	LT	LT	LT	LT	0.965	LT
Radionuclides, pCi/L										
Gross Alpha	LT58	51±33	120±60	39±36	130±70	LT 86	LT 54	210±130	15±9	LT 67
Gross Beta	59±29	48±22	LT 47	30±17	92±39	79±39	56±29	140±70	26±7	LT 47
Uranium	26	19	35	23	41	29	18	18	13	12

*=Average of laboratory duplicates.
[a]ND=compounds of this class were not detected.
[b]Samples analyzed for all parameters shown unless noted by NA.
[c][ ]=number of unknown or TICs.
[d]LT or blank=below CRL, SRL, or stated value.

Source: Weston, 1991.

were established on the basis of suspected sources, and on the estimated extent of contamination, which was based on previous investigation results. Because the types of contaminants were known, benzene, toluene, xylene, carbon tetrachloride, methylene chloride, and trichloroethylene were selected for analysis using a portable field gas chromatograph. The results of this survey are presented in Table 7-7 and are shown in Figure 7-13.

The results of the soil-gas survey showed that line 2 west of CAMDS contained only one detectable contaminant (ethylbenzene at 0.15 parts per million (ppm)). Elevated concentrations of benzene, toluene, and xylene were detected along sample line 3, located just to the west of the Fuel Spill Site, indicating detection of fuel-related contamination. Also associated with line 3 were elevated levels of carbon tetrachloride. Two points along line 4 contained all but one of the contaminants analyzed for—trichloroethylene—with carbon tetrachloride being detected in concentrations of 240 and 150 ppm. Only minor amounts of contaminants were detected in lines 5, 6, and 8, and no contaminants were detected along lines 7 and 10. One exception was found on line 6 where 19 ppm of toluene was detected at sample point 6-7. This point is located just west of the diesel fuel tank farm. Line 9 showed 0.4 ppm methylene chloride at sample points 9-1 and 9-2. This, however, is believed to be due to laboratory contamination and not a contaminant release.

On the basis of the soil-gas survey and previous investigation results, 23 soil borings were drilled and sampled to characterize the fuel-related contamination at the Fuel Spill Site. These included soil borings 13FS-01 through 13FS-10, 13FS-12 through 13FS-15, and 13FS-18 through 13FS-26 (Figure 7-14). The borings were drilled to a depth of 10 feet, and samples were collected at 1-to-2, 4-to-5, 8-to-9, and 9-to-10-foot intervals (Appendix D). The analyte suite consisted of VOCs, SVOCs, and TPHCs. Soil boring samples 13FS-23-3 and 13FS-23-4 were also analyzed for explosives. No explosives were detected in these two samples. Figures 7-15 through 7-22 present the lateral extent for VOCs (8 to 9 and 9 to 10 feet), SVOCs (8 to 9 and 9 to 10 feet), and TPHCs (1 to 2, 4 to 5, 8 to 9, and 9 to 10 feet). Individual analyte information is included in Table 7-8. It is important to note that the VOC and SVOC maps for 1 to 2 feet and 4 to 5 feet are not included because, with the exception of 13FS-26, samples were not collected for these analyte groups at these depths. (No organic analytes were detected in 13FS-26 at the 1-to-2-foot or 4-to-5-foot sample intervals.)

SVOCs were detected in soil samples from 14 of the 23 soil borings drilled at the Fuel Spill Site. Analytes detected include naphthalene, 2-methylnaphthalene, acenapthene, anthracene, fluorene, phenanthrene, dimethylnaphthalenes, trimethylnaphthalenes, N-nitrosodiphenyl-amine, and methylnaphthalenes. The highest concentrations of SVOCs were detected in borings adjacent to the three above-ground tanks. Total SVOC contamination (total of all SVOC analytes detected) was 968 μg/g in 13FS-18-3 (8 to 9 feet) and 830 μg/g in 13FS-18-4 (9 to 10 feet). Soil boring 13FS-14-3 (8 to 9 feet) contained 732.46 μg/g of SVOCs, and 13FS-14-4 (9 to 10 feet) showed 601.9 μg/g of SVOC contamination. Total SVOC concentrations ranged from 69.4 μg/g in 13FS-04-3 to 968 μg/g in 13FS-18-3 in the 8-to-9-foot sampled interval, while concentrations in the 9-to-10-foot interval ranged from 127.3 μg/g in 13FS-22-4 to 830 μg/g in 13FS-18-4.

Table 7-7. TEAD-S Soil-Gas Survey, Phase II RFI

Sample Location Number	Benzene	Toluene	Ethyl Benzene	Xylene	Carbon Tetrachloride	Methylene Chloride	Trichloroethene
2-1	--[a]	--	--	--	--	--	--
2-2	--	--	--	--	--	--	--
2-3	--	--	--	--	--	--	--
2-4	--	--	--	--	--	--	--
2-5	--	--	--	--	--	--	--
2-6	--	--	--	--	--	--	--
2-7	--	--	--	--	--	--	--
2-8	--	--	--	--	--	--	--
2-9	--	--	--	--	--	--	--
2-10	--	--	--	--	--	--	--
2-11	--	--	--	--	--	--	--
2-12	--	--	--	--	--	--	--
2-13	--	--	--	--	--	--	--
2-14	--	--	--	--	--	--	--
2-15	--	--	--	--	--	--	--
2-16	--	--	--	--	--	--	--
2-17	--	--	--	--	--	--	--
2-18	--	--	--	--	--	--	--
2-19	--	--	--	--	--	--	--
2-20	--	--	--	--	--	--	--
2-21	--	--	--	--	--	--	--
2-22	NA[b]	NA	NA	NA	NA	NA	NA
2-23	--	--	--	--	--	--	--
2-24	--	--	--	--	--	--	--
2-25	--	--	--	--	--	--	--
2-26	--	--	--	--	--	--	--
2-27	--	--	--	--	--	--	--
2-28	--	--	--	--	--	--	--

Footnotes at end of table.

Table 7-7. *TEAD-S Soil-Gas Survey, Phase II RFI (continued)*

Sample Location Number	Benzene	Toluene	Ethyl Benzene	Xylene	Carbon Tetrachloride	Methylene Chloride	Trichloroethene
2-29	--	--	--	--	--	--	--
2-30	--	--	--	--	--	--	--
2-31	--	--	--	--	--	--	--
2-32	--	--	--	--	--	--	--
2-33	--	--	--	--	--	--	--
2-34	--	--	--	--	--	--	--
2-35	--	--	0.15	--	--	--	--
3-1	--	--	--	--	--	--	--
3-2	0.1	--	--	--	--	--	--
3-3	0.1	--	--	--	1.4	--	--
3-4	0.1	--	--	--	--	--	--
3-5	0.1	--	--	--	--	--	--
3-6	3.0	1.2	0.8	3.3	--	--	--
3-7	3.6	1.4	1.7	5.1	2.8	--	--
3-8	1.0	0.3	0.3	1.1	12	--	--
3-9	0.3	0.1	1.3	1.2	--	--	--
3-10	1.0	0.5	0.5	1.6	--	--	--
3-11	0.8	0.4	0.5	1.6	--	--	--
3-12	0.1	--	--	--	--	--	--
3-13	0.3	--	--	--	--	--	--
3-14	0.1	--	--	--	--	--	--
3-15	0.2	--	--	--	--	--	--
3-16	--	0.3	--	--	--	--	--
3-17	--	--	--	--	--	--	--
3-18	--	--	--	--	--	--	--
3-19	--	--	--	--	--	--	--
3-20	--	--	--	--	--	--	--
3-21	--	--	--	--	--	--	--

Footnotes at end of table.

Table 7-7. TEAD-S Soil-Gas Survey, Phase II RFI (continued)

Sample Location Number	Benzene	Toluene	Ethyl Benzene	Xylene	Carbon Tetrachloride	Methylene Chloride	Trichloroethene
3-22	--	--	--	--	--	--	--
3-23	--	--	--	--	--	--	--
3-24	--	--	--	--	--	--	--
3-25	--	--	--	--	--	--	--
3-26	--	--	--	--	--	--	--
3-27	--	--	--	--	--	--	--
3-28	--	--	--	--	--	--	--
3-29	--	--	--	--	--	--	--
3-30	--	--	--	--	--	--	--
4-1	NA	NA	NA	NA	NA	NA	NA
4-2	--	--	--	--	1.9	1.8	--
4-3	--	--	--	--	--	0.8	--
4-4	--	--	--	--	--	0.6	--
4-5	--	--	--	--	--	0.5	--
4-6	0.3	--	--	--	--	--	--
4-7	0.6	--	--	--	--	2.2	0.3
4-8	--	--	--	--	0.9	--	--
4-9	--	--	--	--	--	--	--
4-10	--	--	--	--	--	--	--
4-11	33	18	11	76	240	9.8	--
4-12	17	14	12	69	150	56	--
4-13	--	--	--	--	--	--	--
4-14	--	--	--	--	--	--	--
4-15	--	--	--	--	--	--	--
4-16	--	--	--	--	--	--	--
4-17	--	--	--	--	--	--	--
4-18	--	--	--	--	--	--	--

Footnotes at end of table.

Table 7-7. TEAD-S Soil-Gas Survey, Phase II RFI (continued)

Sample Location Number	Benzene	Toluene	Ethyl Benzene	Xylene	Carbon Tetrachloride	Methylene Chloride	Trichloroethene
5-1	0.4	--	--	--	2.8	--	--
5-2	--	1.0	--	--	--	5.7	--
5-3	0.4	--	--	--	--	1.4	--
6-1	--	--	--	--	1.9	0.6	--
6-2	--	--	--	--	--	0.8	--
6-3	--	--	--	--	--	--	--
6-4	--	--	--	--	--	--	--
6-5	0.2	--	--	--	--	--	--
6-6	--	--	--	--	--	--	--
6-7	0.1	19	--	--	--	2.5	--
6-8	--	3	--	--	--	--	--
6-9	--	--	--	--	--	--	--
7-1	--	--	--	--	--	--	--
7-2	--	--	--	--	--	--	--
7-3	--	--	--	--	--	--	--
7-4	--	--	--	--	--	--	--
7-5	--	--	--	--	--	--	--
7-6	--	--	--	--	--	--	--
8-1	--	--	--	--	--	--	--
8-2	--	--	--	--	--	--	--
8-3	--	--	--	--	--	--	--
8-4	--	--	--	--	--	--	--
8-5	--	--	--	--	--	0.4	--
8-6	--	--	--	--	--	0.4	--
9-1	--	--	--	--	--	0.4	--
9-2	--	--	--	--	--	0.4	--
9-3	--	--	--	--	--	--	--
10-1	--	--	--	--	--	--	--
10-2	--	--	--	--	--	--	--

Note.—Units in mg/L

[a]"--" = analyte not detected.

[b]NA = not analyzed, unable to obtain UXO clearance.

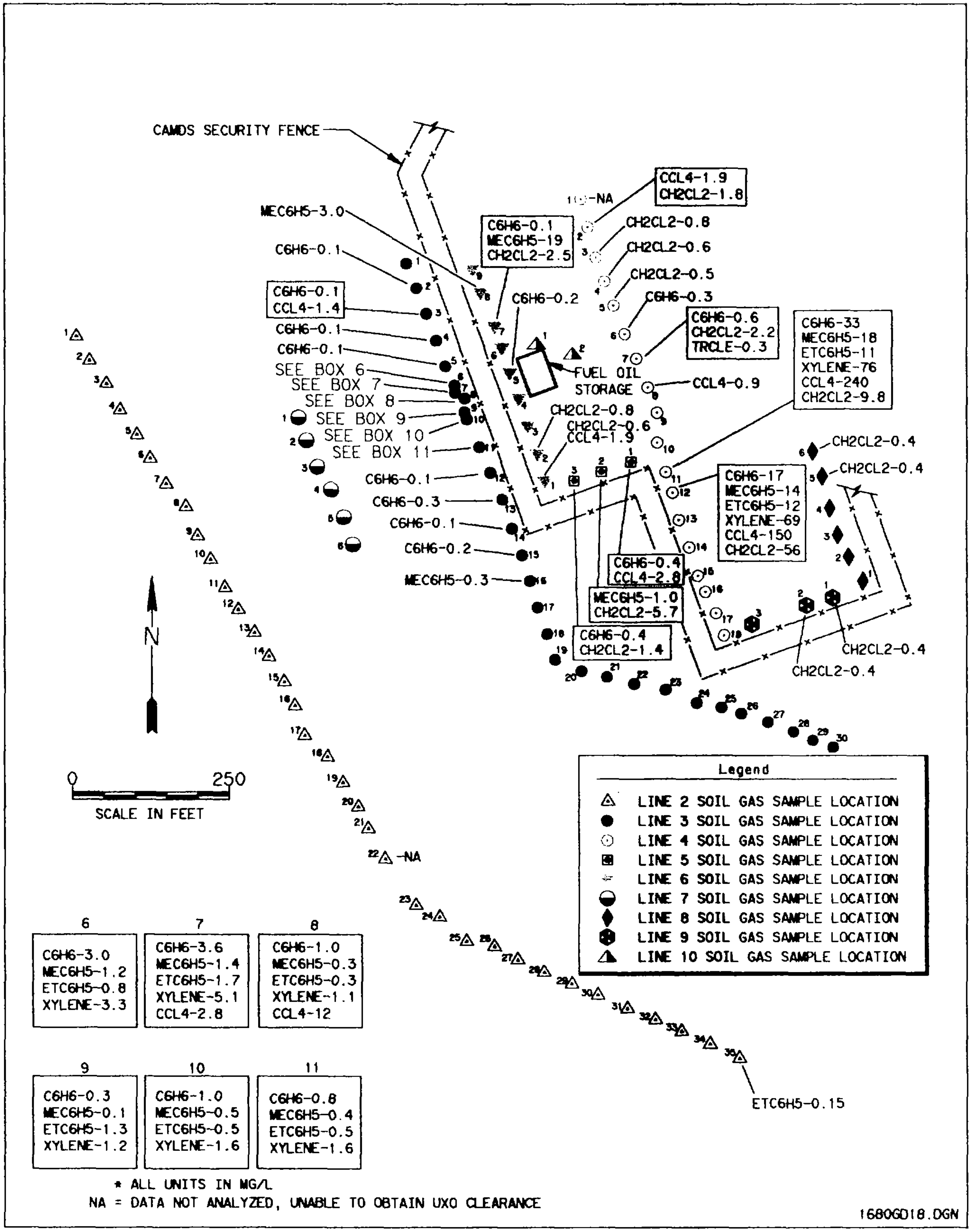

Figure 7-13. SWMU 13 Soil-Gas Survey Sample Locations, Phase II RFI

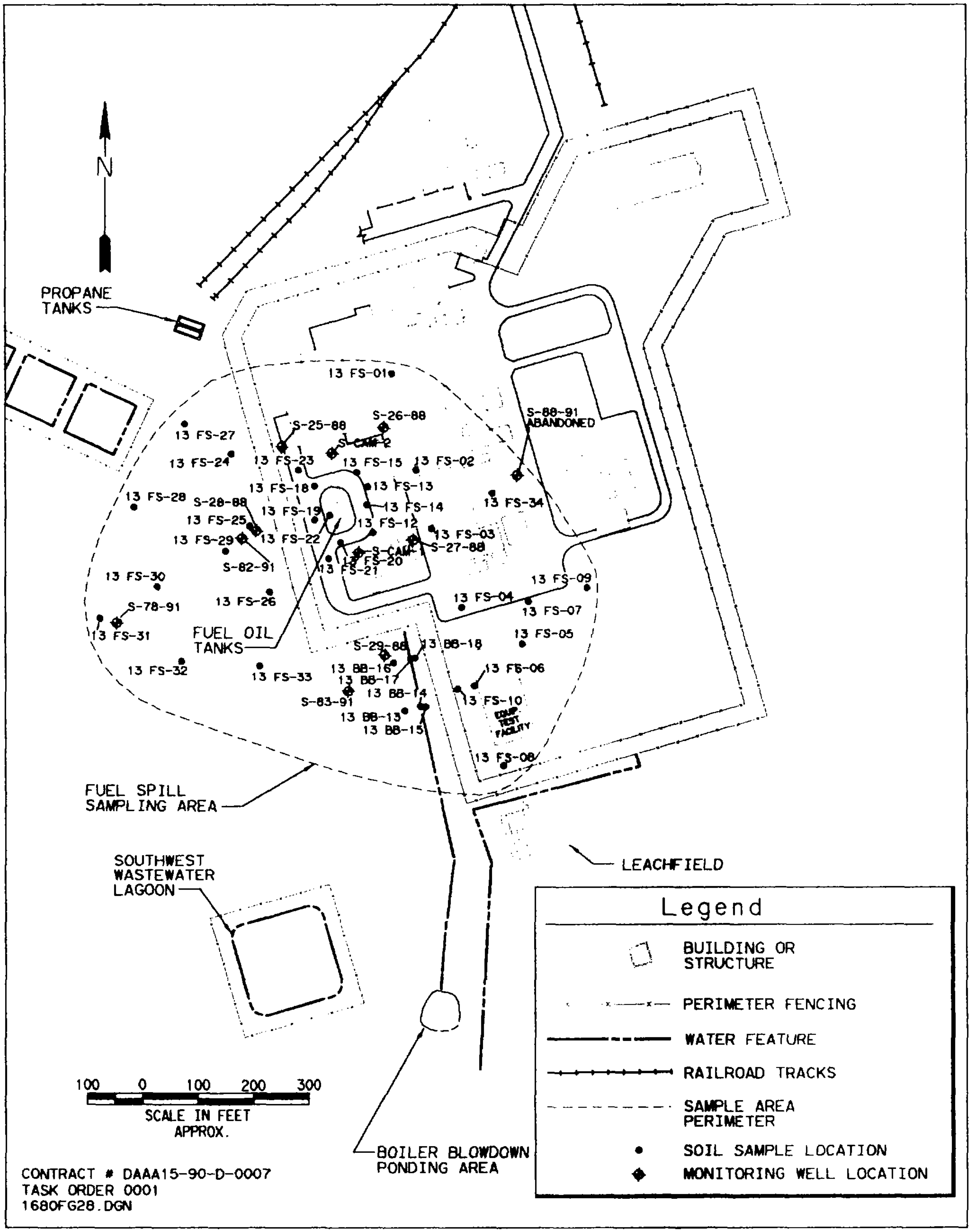

Figure 7-14. SWMU 13 Soil Boring Sample Locations at the Fuel Spill Site, Phase II RFI

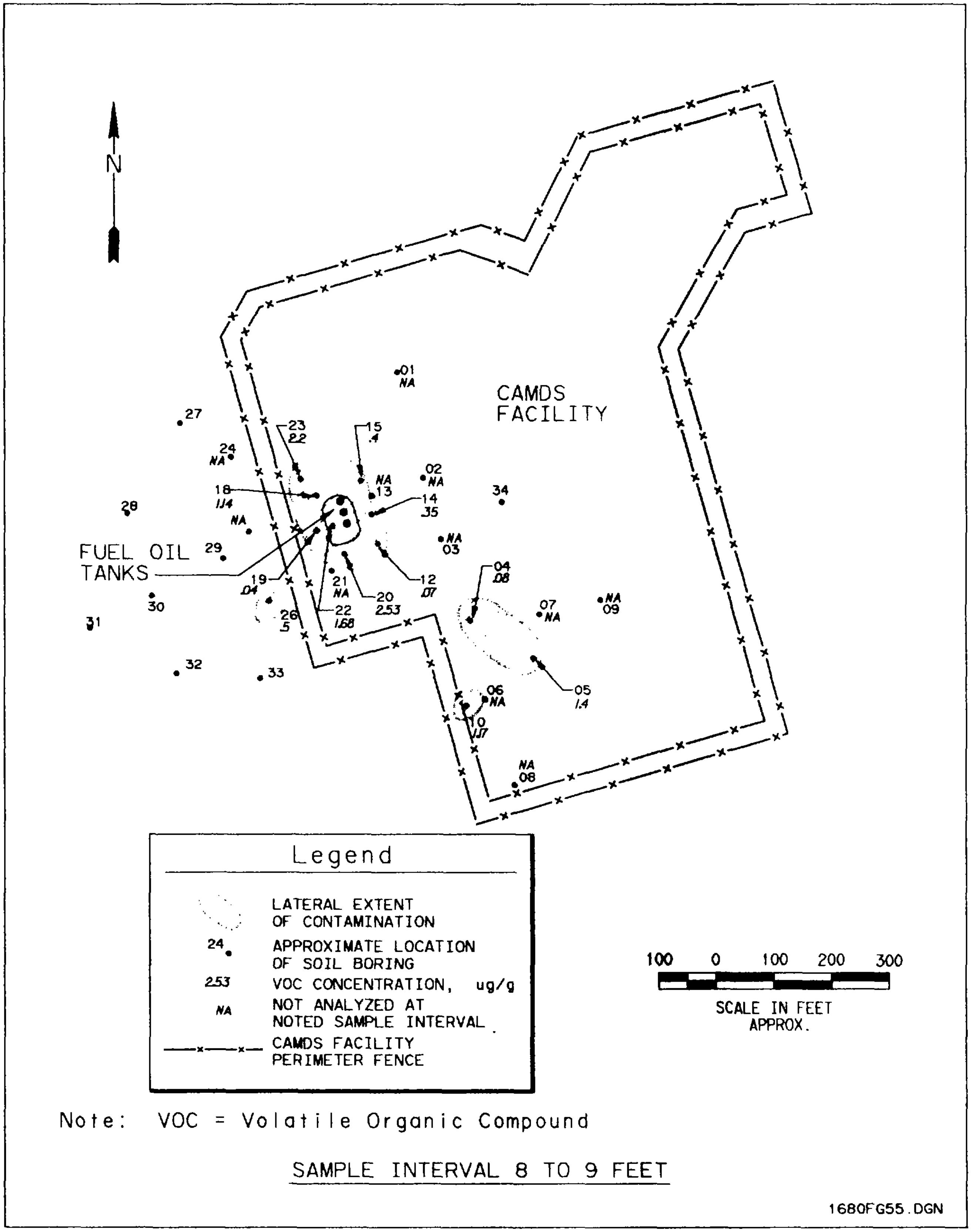

Figure 7-15. SWMU 13 Lateral Extent of Volatile Organic Compounds at the Fuel Spill Site at the 8-to-9-Foot Sample Interval, Phase II RFI

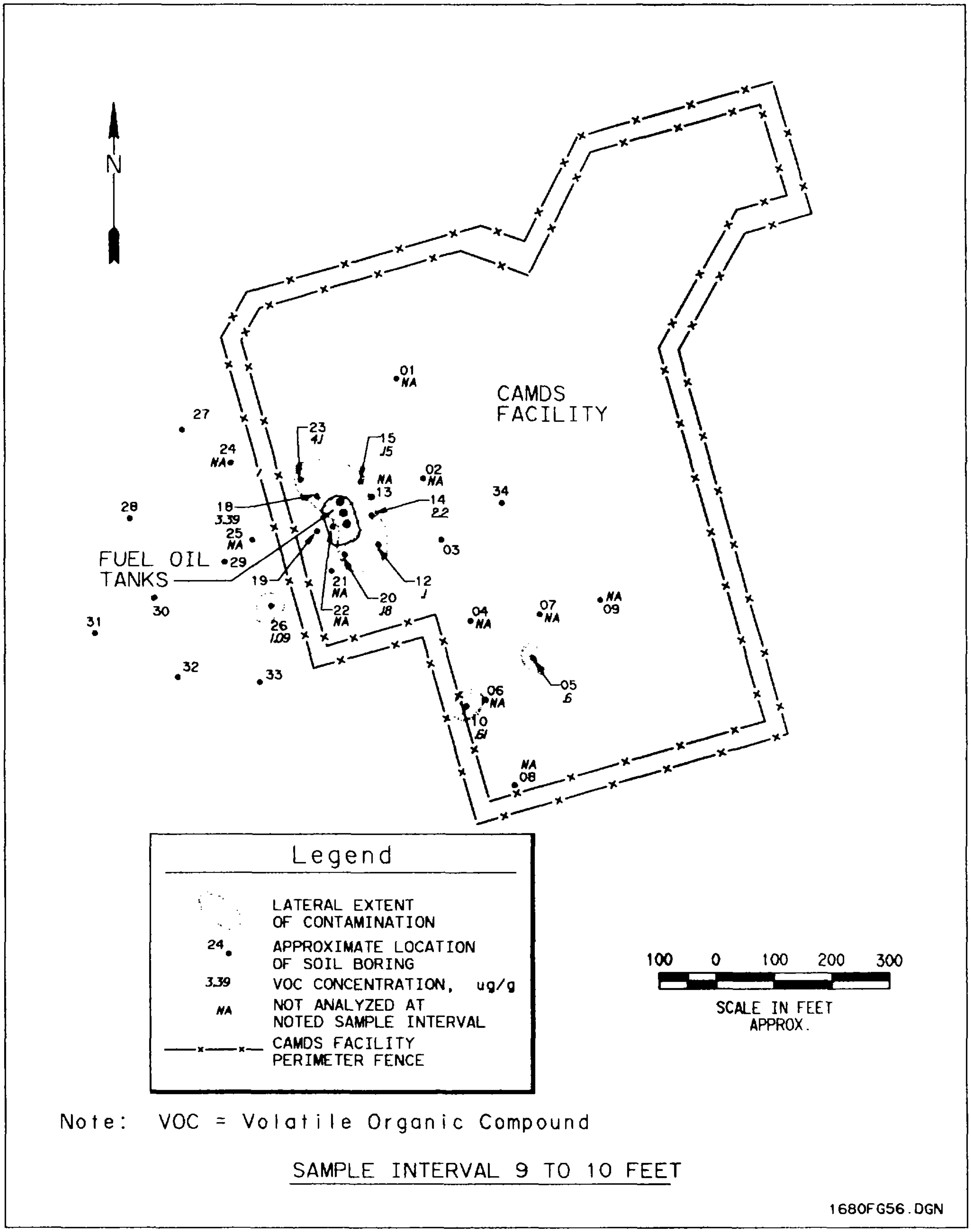

Figure 7-16. SWMU 13 Lateral Extent of Volatile Organic Compounds at the Fuel Spill Site at the 9-to-10-Foot Sample Interval, Phase II RFI

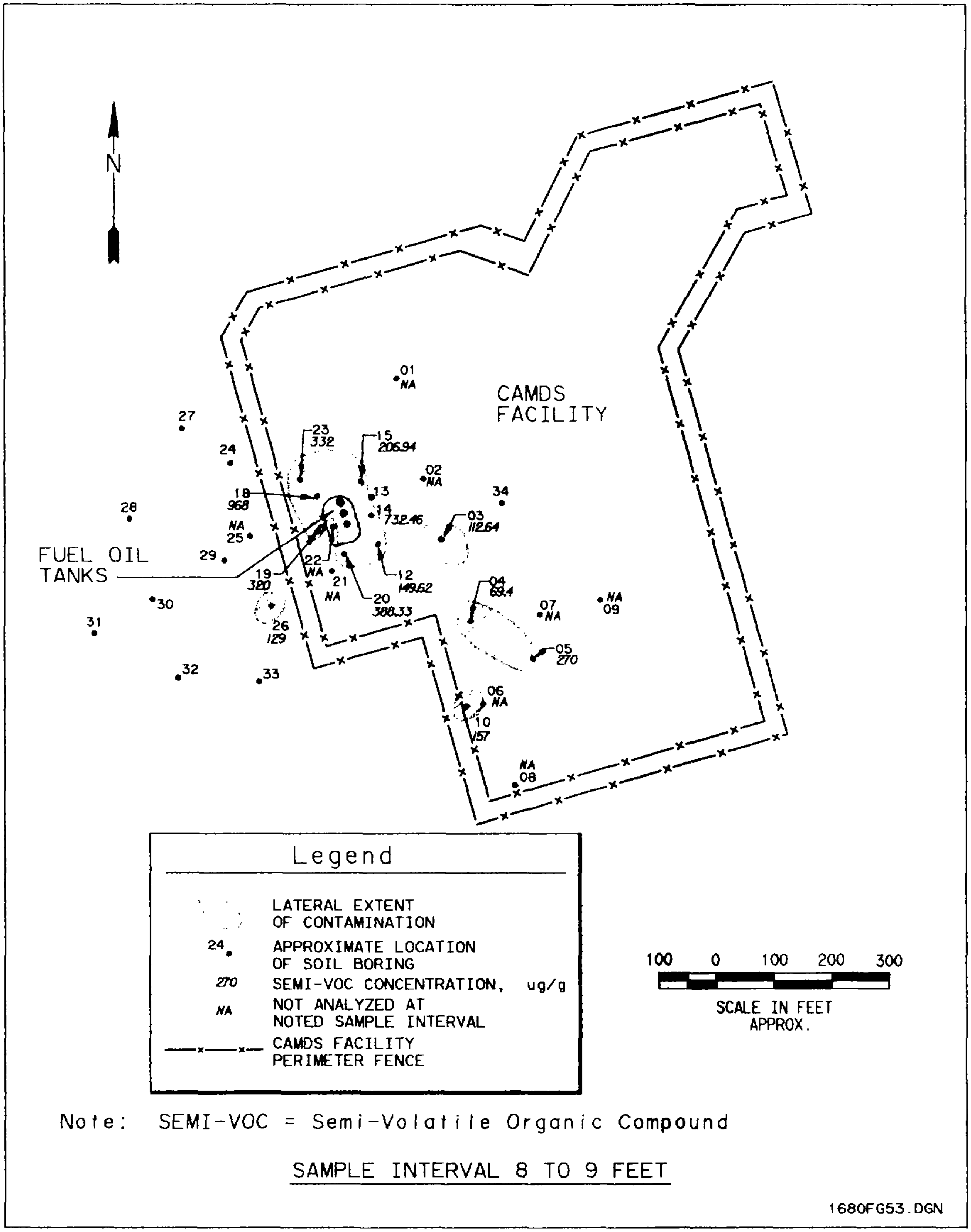

Figure 7-17. SWMU 13 Lateral Extent of Semi-Volatile Organic Compounds at the Fuel Spill Site at the 8-to-9-Foot Sample Interval, Phase II RFI

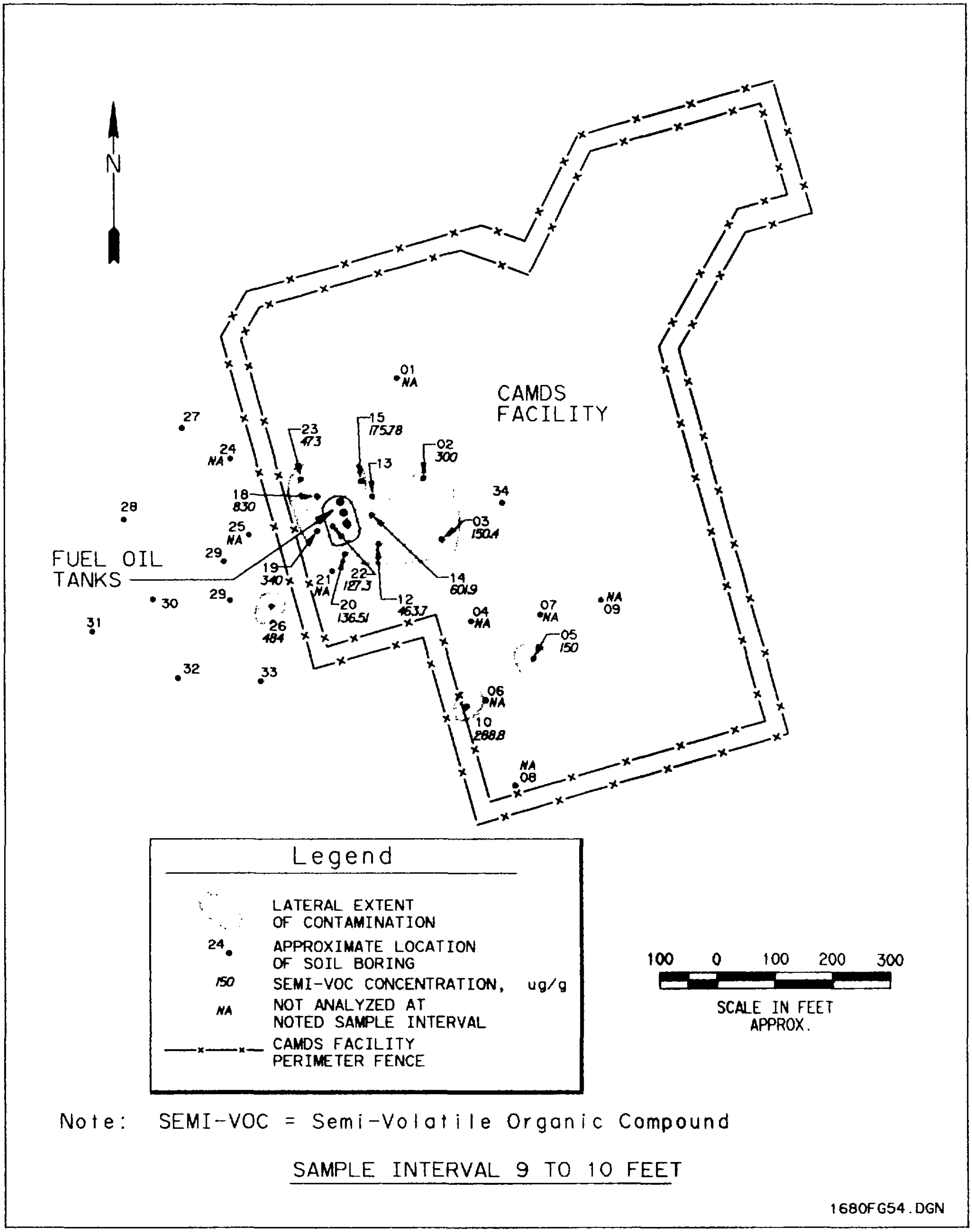

Figure 7-18. SWMU 13 Lateral Extent of Semi-Volatile Organic Compounds at the Fuel Spill Site at the 9-to-10-Foot Sample Interval, Phase II RFI

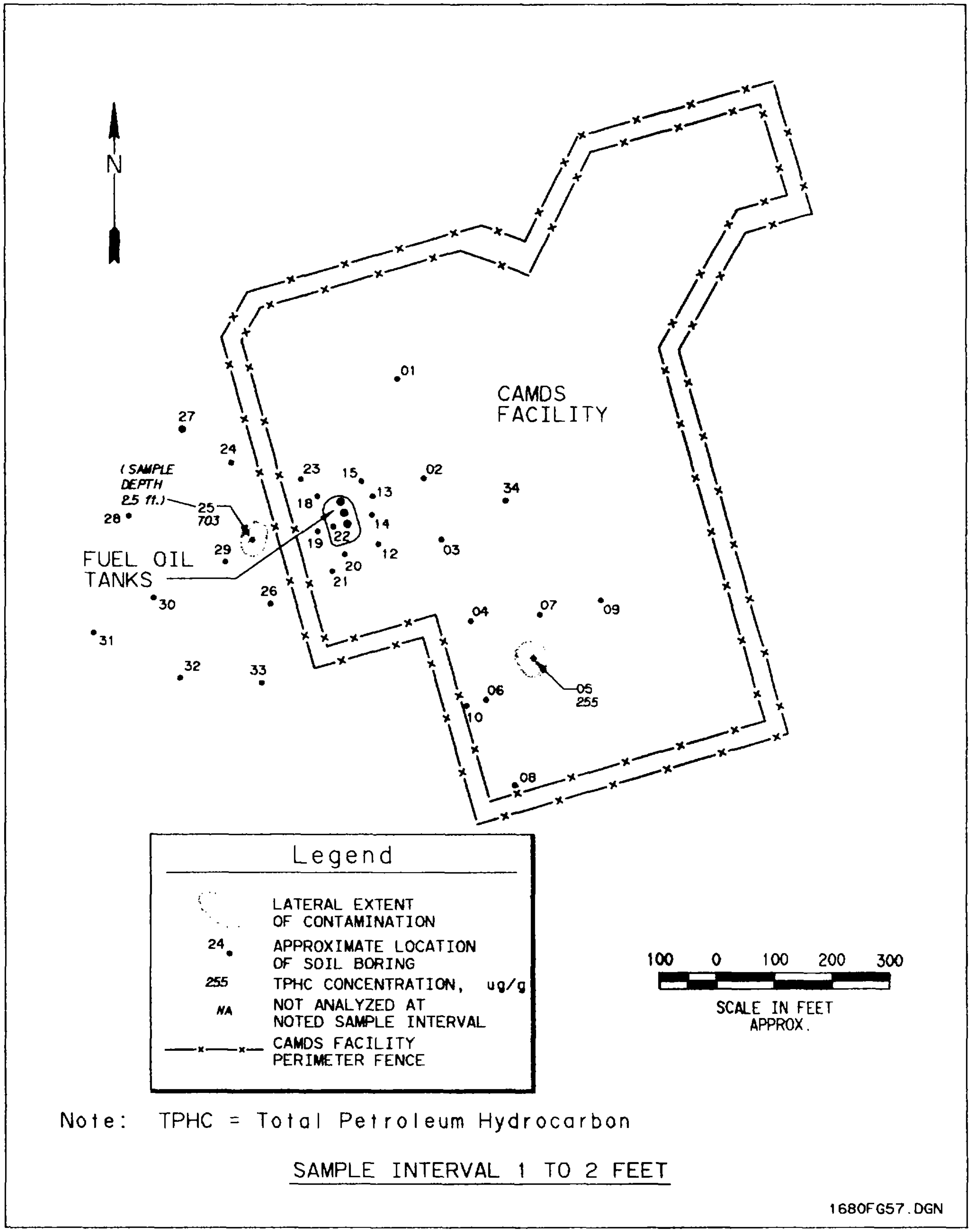

Figure 7-19. SWMU 13 Lateral Extent for Total Petroleum Hydrocarbons at the Fuel Spill Site at the 1-to-2-Foot Sample Interval, Phase II RFI

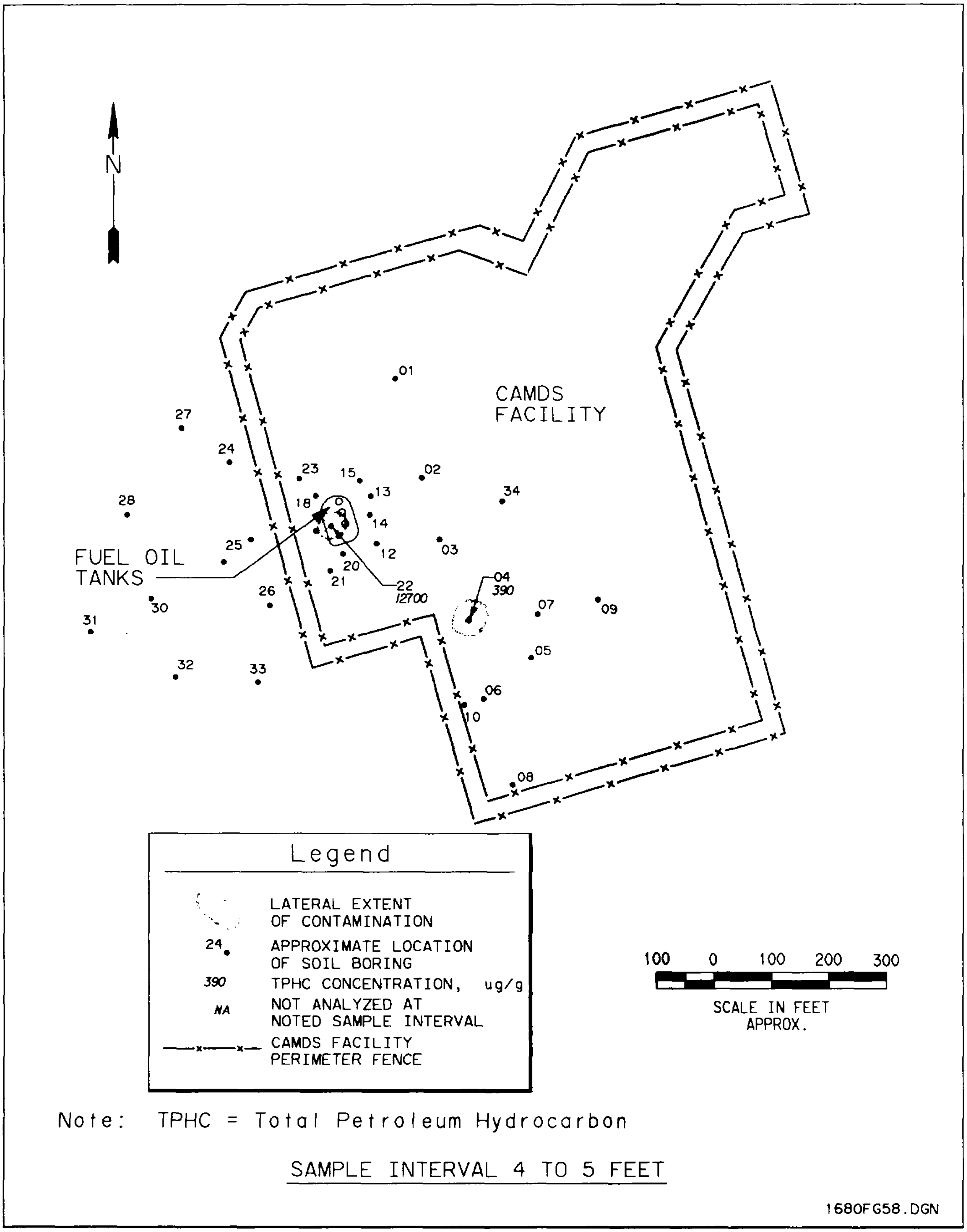

Figure 7-20. SWMU 13 Lateral Extent for Total Petroleum Hydrocarbons at the Fuel Spill Site at the 4-to-5-Foot Sample Interval, Phase II RFI

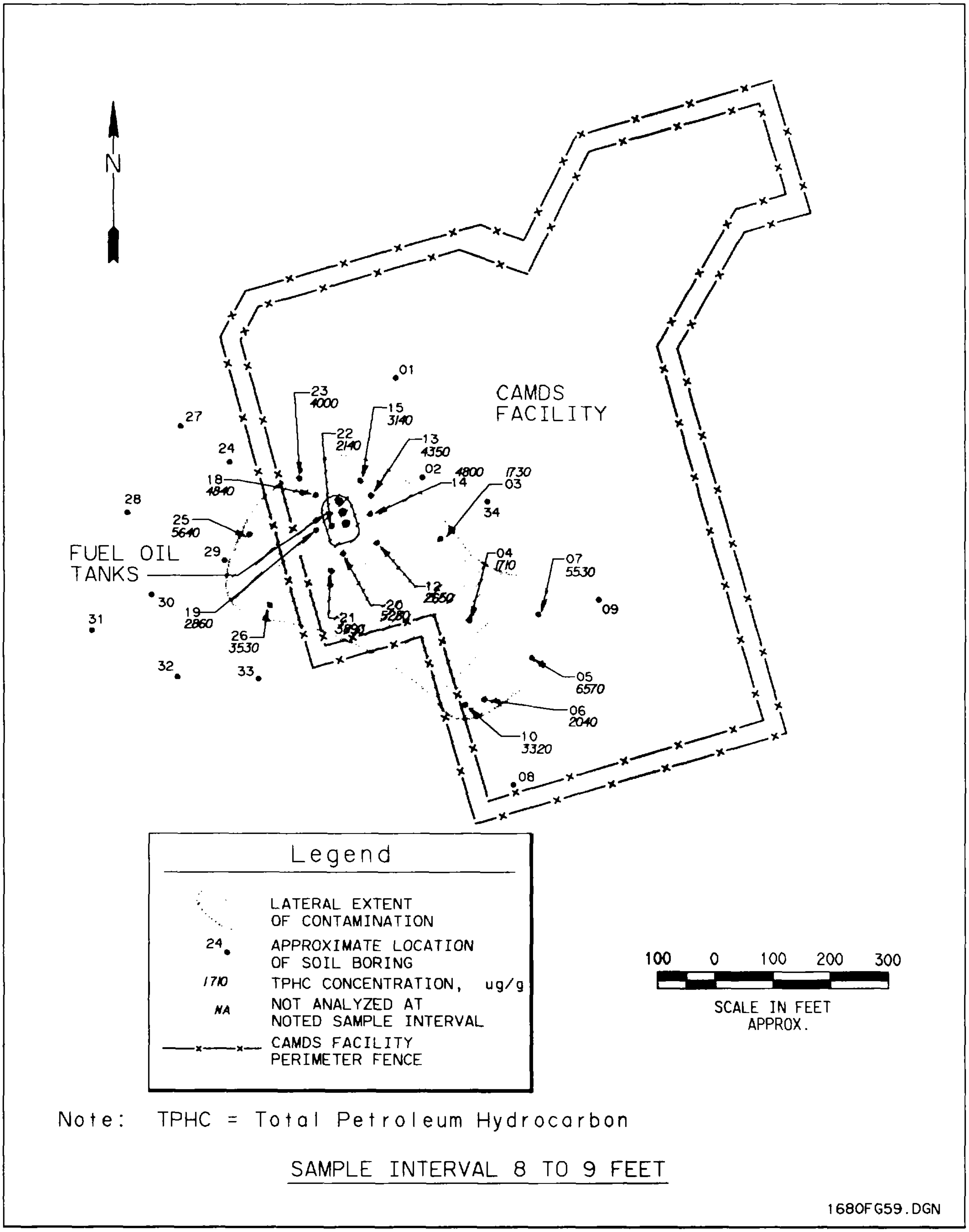

Figure 7-21. SWMU 13 Lateral Extent for Total Petroleum Hydrocarbons at the Fuel Spill Site at the 8-to-9-Foot Sample Interval, Phase II RFI

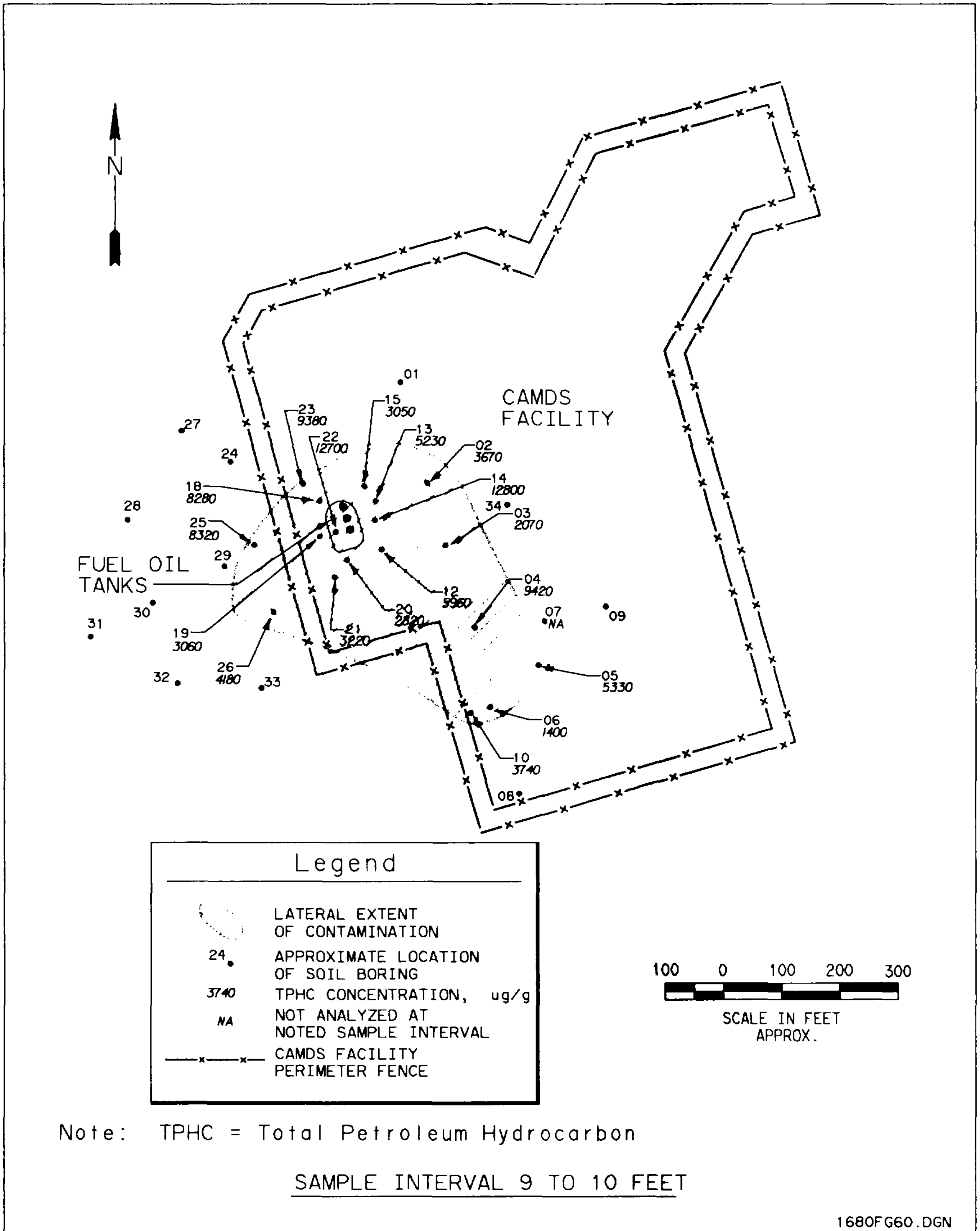

Figure 7-22. SWMU 13 Lateral Extent for Total Petroleum Hydrocarbons at the Fuel Spill Site at the 9-to-10-Foot Sample Interval, Phase II RFI

Table 7-8. SWMU 13 Soil Sample Results for the Fuel Spill Site, Phase II RFI

		VOCs (µg/g)						SVOCs (µg/g)										TPHC µg/g)	Anions µg/g)			pH	TOC (µg/g)
Sample ID	Depth	1,1,2,2-Tetrachloroethane	1,2-Dimethylbenzene	1,3-Dimethylbenzene	Benzene	Ethylbenzene	Methylene Chloride	2-Methylnaphthalene	Acenaphthene	Anthracene	Dimethylnaphthalenes	Fluorene	Methylnaphthalenes	N-Nitroso Diphenylamine	Naphthalene	Phenanthrene	Trimethylnaphthalenes	Total Petroleum Hydrocarbons	Chloride (BKGD (a) - 596)	Nitrate (BKGD - 4.67)	Sulfate (BKGD - 1,697)	pH	Total Organic Carbon
13FS-02-4	9.5	--(b)	--	--	--	--	--	40	ND(c)	ND	100	ND	40	ND	ND	20	100	3,670	--	--	--	--	--
13FS-03-3	8.5	--	--	--	--	--	--	10	1.3	ND	25	0.64	13	ND	7	5.7	50	1,730	--	--	--	--	--
13FS-03-4	9.5	--	--	--	--	--	--	20	1.6	ND	62	0.8	12	ND	9	8	37	2,070	--	--	--	--	--
13FS-04-2	4.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	390	--	--	--	--	--
13FS-04-3	8.5	ND	ND	0.08	ND	ND	ND	10	1.2	ND	25	1.2	12	ND	2.8	5.2	12	1,710	--	--	--	--	--
13FS-04-4	9.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	9,420	--	--	--	--	--
13FS-05-1	1.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	255	--	--	--	--	--
13FS-05-3	8.5	ND	0.8	0.3	ND	0.3	ND	50	ND	ND	100	ND	--	ND	20	20	80	6,570	--	--	--	--	--
13FS-05-4	9.5	ND	0.4	0.1	ND	0.1	ND	40	ND	ND	40	ND	--	ND	10	10	50	5,330	--	--	--	--	--
13FS-06-3	8.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2,040	--	--	--	--	--
13FS-06-4	10.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1,400	--	--	--	--	--
13FS-07-3	9.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5,530	--	--	--	--	--
13FS-10-3	8.5	ND	ND	ND	ND	0.083	0.094	30	ND	ND	60	ND	20	ND	7	10	30	3,320	--	--	--	--	--
13FS-10-4	9.5	ND	ND	ND	0.0057	0.6	DS(d)	30	ND	ND	100	2	40	ND	6	10	100	3,740	--	--	--	--	--
13FS-12-3	8.5	ND	ND	0.07	ND	ND	ND	24.9	1.49	0.759	62.2	ND	12.4	0.808	3.11	7.46	37.3	2,650	--	--	--	--	--
13FS-12-4	9.5	ND	ND	ND	0.03	0.07	ND	49.3	7.4	ND	247	ND	--	ND	12.3	24.7	123	5,960	--	--	--	--	--
13FS-13-3	8.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4,350	--	--	--	--	--
13FS-13-4	9.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5,230	--	--	--	--	--
13FS-14-3	8.5	ND	ND	ND	0.05	0.3	ND	77.1	6.43	ND	386	6.43	90	ND	12.8	25.7	128	4,800	--	--	--	--	--
13FS-14-4	9.5	ND	ND	ND	0.2	2.0	ND	24.6	11.1	ND	369	12.3	111	ND	24.6	49.3	--	12,800	--	--	--	--	--
13FS-15-3	8.5	ND	0.2	0.2	ND	ND	ND	37.2	2.48	1	62	ND	86.8	ND	4.96	12.4	--	3,140	--	--	--	--	--
13FS-15-4	9.5	ND	0.07	0.08	ND	ND	ND	38.3	2.04	1.01	25.5	0.446	51	ND	6.38	12.8	38.3	3,050	--	--	--	--	--
13FS-18-3	8.5	ND	0.5	0.5	0.04	0.1	ND	90	9	ND	400	9	100	ND	20	40	300	4,840	--	--	--	--	--
13FS-18-4	9.5	ND	2.0	1.0	0.09	0.3	ND	100	20	ND	400	10	100	ND	40	60	100	8,280	--	--	--	--	--
13FS-19-3	8.5	ND	ND	ND	ND	0.04	ND	50	ND	ND	100	ND	50	ND	10	20	90	2,860	--	--	--	--	--
13FS-19-4	9.5	ND	ND	ND	ND	ND	ND	60	ND	ND	100	ND	50	ND	10	20	100	3,060	--	--	--	--	--
13FS-20-3	8.5	0.3	1.0	1.0	0.03	0.2	ND	62.6	ND	ND	125	5.01	50.1	ND	7.52	25.1	113	5,280	--	--	--	--	--
13FS-20-4	9.5	ND	0.08	0.1	ND	ND	ND	25.4	1.91	1.12	25.4	1.4	63.5	ND	5.08	12.7	--	2,820	--	--	--	--	--
13FS-21-3	8.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3,890	--	--	--	--	--
13FS-21-4	9.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3,220	--	--	--	--	--

Table 7-8. SWMU 13 Soil Sample Results for the Fuel Spill Site, Phase II RFI (continued)

		VOCs (µg/g)						SVOCs (µg/g)										TPHC µg/g)	Anions µg/g)			pH	TOC (µg/g)
Sample ID	Depth	1,1,2,2-Tetrachloroethane	1,2-Dimethylbenzene	1,3-Dimethylbenzene	Benzene	Ethylbenzene	Methylene Chloride	2-Methylnaphthalene	Acenaphthene	Anthracene	Dimethylnaphthalenes	Fluorene	Methylnaphthalenes	N-Nitroso Diphenylamine	Naphthalene	Phenanthrene	Trimethylnaphthalenes	Total Petroleum Hydrocarbons	Chloride (BKGD [a] - 596)	Nitrate (BKGD - 4.67)	Sulfate (BKGD - 1,697)	pH	Total Organic Carbon
13FS-22-2	4.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	12,700	--	--	--	--	--
13FS-22-3	8.5	ND	0.5	0.8	0.08	0.3	ND	--	--	--	--	--	--	--	--	--	--	2,140	--	--	--	--	--
13FS-22-4	9.5	--	--	--	--	--	--	5.1	10	1.4	64	5	--	ND	5.8	10	26	12,700	--	--	--	--	--
13FS-23-2	4.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2,150	--	--	--	10.8	--
13FS-23-3	8.5	ND	1.0	1.0	ND	0.2	ND	20	7	ND	60	6	--	ND	9	30	200	4,000	--	--	--	--	20,900
13FS-23-4	9.5	ND	2.0	2.0	ND	0.1	ND	20	7	ND	200	6	--	ND	10	30	200	9,380	--	--	--	--	--
13FS-24-3	8.5	--	--	--	--	--	--	ND	ND	ND	--	ND	--	ND	ND	ND	--	ND	--	--	--	--	11,000
13FS-25-1	1.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	703	--	--	--	--	--
13FS-25-3	8.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5,640	--	--	--	--	--
13FS-25-4	9.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	8,320	--	--	--	--	--
13FS-26-3	8.5	ND	0.5	ND	ND	ND	0.0098	30	7	ND	--	4	--	ND	8	20	60	3,530	--	--	--	--	--
13FS-26-4	9.5	ND	1.0	0.05	0.018	0.023	DS	30	6	ND	70	ND	50	ND	8	20	300	4,180	--	--	--	--	--
S-88-91-1	3.0	--	--	--	--	--	--	ND	ND	ND	--	ND	--	ND	ND	ND	--	ND	1,400	98	2,200	--	--
S-88-91-2	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	ND	--	ND	ND	ND	--	ND	3,000	ND	17,000	--	--
S-88-91-3	9.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	--	ND	--	ND	ND	ND	--	ND	DS	12.7	DS	--	--
13FS-01-1*	1.5																						
13FS-01-2	4.5																						
13FS-01-3	8.5																						
13FS-01-4	9.5																						
13FS-02-1	1.5																						
13FS-02-2	4.5																						
13FS-02-3	8.5																						
13FS-03-1	1.5																						
13FS-03-2	4.5																						
13FS-04-1	1.5																						
13FS-05-2	4.5																						
13FS-06-1	1.0																						
13FS-06-2	4.5																						
13FS-07-1	1.5																						
13FS-07-2	4.5																						
13FS-08-1	1.0																						
13FS-08-2	4.5																						

Table 7-8. SWMU 13 Soil Sample Results for the Fuel Spill Site, Phase II RFI (continued)

		VOCs (µg/g)						SVOCs (µg/g)										TPHC µg/g)	Anions µg/g)			pH	TOC (µg/g)
Sample ID	Depth	1,1,2,2-Tetrachloroethane	1,2-Dimethylbenzene	1,3-Dimethylbenzene	Benzene	Ethylbenzene	Methylene Chloride	2-Methylnaphthalene	Acenaphthene	Anthracene	Dimethylnaphthalenes	Fluorene	Methylnaphthalenes	N-Nitroso Diphenylamine	Naphthalene	Phenanthrene	Trimethylnaphthalenes	Total Petroleum Hydrocarbons	Chloride (BKGD (a) - 596)	Nitrate (BKGD - 4.67)	Sulfate (BKGD - 1,697)	pH	Total Organic Carbon
13FS-08-3	8.5																						
13FS-08-4	9.5																						
13FS-09-1	1.5																						
13FS-09-2	4.5																						
13FS-09-3	8.5																						
13FS-09-4	9.5																						
13FS-10-1	2.5																						
13FS-10-2	4.5																						
13FS-12-1	2.5																						
13FS-12-2	4.5																						
13FS-13-1	2.5																						
13FS-13-2	4.5																						
13FS-14-1	2.5																						
13FS-14-2	4.5																						
13FS-15-1	2.5																						
13FS-15-2	4.5																						
13FS-18-1	1.5																						
13FS-18-2	4.5																						
13FS-19-1	1.5																						
13FS-19-2	4.5																						
13FS-20-1	1.5																						
13FS-20-2	4.5																						
13FS-21-1	1.5																						
13FS-21-2	4.5																						
13FS-22-1	1.5																						
13FS-23-1	2.5																						
13FS-24-1	1.5																						
13FS-24-2	4.5																						
13FS-24-4	9.5																						
13FS-25-2	4.5																						
13FS-26-1	0.5																						

Table 7-8. SWMU 13 Soil Sample Results for the Fuel Spill Site, Phase II RFI (continued)

		VOCs (µg/g)						SVOCs (µg/g)										TPHC µg/g)	Anions µg/g)			pH	TOC (µg/g)
Sample ID	Depth	1,1,2,2-Tetrachloroethane	1,2-Dimethylbenzene	1,3-Dimethylbenzene	Benzene	Ethylbenzene	Methylene Chloride	2-Methylnaphthalene	Acenaphthene	Anthracene	Dimethylnaphthalenes	Fluorene	Methylnaphthalenes	N-Nitroso Diphenylamine	Naphthalene	Phenanthrene	Trimethylnaphthalenes	Total Petroleum Hydrocarbons	Chloride (BKGD [a] - 596)	Nitrate (BKGD - 4.67)	Sulfate (BKGD - 1,697)	pH	Total Organic Carbon
13FS-26-2	4.5																						
13FS-27	9.0																						
13FS-28	9.0																						
13FS-29	9.0																						
13FS-30	9.0																						
13FS-31	9.0																						
13FS-32	9.0																						
13FS-33	9.0																						
13FS-34	9.0																						

[a]Bkgd=Background value for specified analyte.

[b]--=Analysis not performed.

[c]ND=Analyte not detected at or above the certified reporting limit (CRL), standard reporting limit (SRL), or method detection limit (MDL).

[d]DS=Data screened due to the 5 times or 10 times rule or did not exceed background values where applicable (see Section 6 for data screening methodologies).

[e]The following sample IDs, where there were no detected contaminants, are included in the remainder of this table. A comprehensive listing of all the data is presented in Appendix D.

SVOC contamination was also detected in the area north and northeast of the Equipment Test Facility (ETF) (Figure 7-14). Soil boring 13FS-05-3 (8 to 9 feet) contained 270 μg/g SVOCs, and 13FS-05-4 (9 to 10 feet) had 150 μg/g SVOC contamination. VOCs were detected in the soil samples from 12 of the 23 soil borings. Analytes detected include 1,2-dimethylbenzene, 1,3-dimethylbenzene, benzene, ethylbenzene, methylene chloride, and 1,1,2,2-tetrachloroethane (1,1,2,2-tetrachloroethane and methylene chloride were detected in only one sample each and are not related to petroleum products). As with the SVOC contamination, the highest VOC concentrations were detected in soil borings adjacent to the tanks. Total VOC contamination (total of all volatile organic analytes detected) was the highest in 13FS-20-3 at the 8-to-9-foot interval (2.53 μg/g) and in sample 13-FS-23-4 at the 9-to-10-foot interval (4.1 μg/g). Total VOC concentrations ranged from 0.04 μg/g in 13FS-19-3 to 2.53 μg/g in 13FS-20-3 in the 8-to-9-foot interval, while concentrations in the 9-to-10-foot interval ranged from 0.1 μg/g in 13FS-12-4 to 4.1 μg/g in 13FS-23-4. VOCs were also detected in the vicinity of the ETF (up to 1.4 μg/g in sample 13FS-05-3, at 8 to 9 feet).

TPHCs were detected in the soil samples from 19 of the 23 soil borings from this site. Once again, the highest concentrations are adjacent to the above-ground tanks; 13FS-22-2 contained 12,700 μg/g at the 4-to-5-foot interval. Soil boring 13FS-25-3 contained the highest TPHC concentrations at the 8-to-9-foot interval (5,640 μg/g) while the highest TPHC contamination at the 9-to-10-foot sample interval was detected in 13FS-14-4 at 12,800 μg/g. TPHC contamination was detected at all four sample depths (1 to 2, 4 to 5, 8 to 9, and 9 to 10 feet). Concentration and lateral extent increased with depth. The greatest concentration at 1 to 2 feet was 703 μg/g, while 12,800 μg/g was detected in one of the 9-to-10-foot samples (13FS-14-4). TPHCs were also detected in the vicinity of the ETF, up to 9,420 μg/g in the sample collected at 9 to 10 feet in 13FS-04-4.

Although monitoring well S-88-91 was not installed to evaluate the soils at the Fuel Spill Site, results from the soil samples that were collected during the drilling of this well are discussed here because of the well's proximity to the site (Figure 7-8). These soil samples were collected from the approximate depths of 3, 5, and 9 feet. The analyte suite consisted of VOCs, SVOCs, TPHCs, explosives, metals, and anions. No organic compounds were detected and no metals were detected above background. Three anions (chloride, nitrate, and sulfate) were detected in these samples. Chloride values ranged from 1,400 to 3,000 μg/g, nitrate values ranged from 12.7 to 98 μg/g, and sulfate was detected above background at 2,200 and 17,000 μg/g.

Rust E&I 1993. During the summer of 1993, Rust E&I returned to the Fuel Spill Site to more accurately define the extent of the fuel-contaminated soils at this site. Eight additional soil borings (13FS-27 through 13FS-34) (Figure 7-14) were drilled to a depth of approximately 10 feet. Soil samples were collected from the 8-10 foot interval and analyzed for TPHCs. This TPHC analysis targeted gas- and diesel-related hydrocarbons along with benzene, toluene, ethylbenzene, and total xylenes. No TPHCs were detected in any of these eight borings. Appendix D presents all of the analytical data for the Fuel Spill Site.

7.2.2 Nature and Extent of Contamination

The soil-gas survey conducted by Rust E&I generally defined a broad area of fuel-related contamination to the west of the three above-ground tanks. This area corresponded well with the area of known groundwater contamination from previous investigations. In addition, a second area of contamination to the south of the known spill area was identified in the vicinity of the ETF. The placement of many of the soil borings was based on the soil-gas results.

After evaluating the data collected during this Phase II investigation, it is likely that the TPHC contamination detected in the vicinity of the three above-ground tanks and the ETF is associated with the operations at the Fuel Spill Site. The majority of the TPHC-contaminated soil was detected near the top of the water table (8 to 10 feet). Figures 7-21 and 7-22 present the lateral extent of the TPHC contamination in the vicinity of the Fuel Spill Site. The soil samples collected from the 1993 soil borings (13FS-27 through 13FS-34) helped define the lateral extent of the TPHC contamination at the Fuel Spill Site.

Generally, the TPHC concentrations decrease upwards from the water table, resulting in only two samples collected at the 1-to-2-foot interval that contained TPHC contamination (255 $\mu g/g$ in 13FS-05 and 703 $\mu g/g$ in 13FS-25) (Figure 7-19). Typically, fuel-related compounds such as TPHCs tend to migrate vertically through the soils to the water table. It is not uncommon for most of the fuel-related compounds to follow this migration, while at the same time some of the lighter fuel fractions will volatilize near the ground surface. This scenario would leave a contamination "fingerprint" similar to what is presented in Figures 7-19 through 7-22. Once these fuel-related compounds reach the water table, the majority of the vertical migration ceases as these compounds have a lower specific gravity, relative to water, and tend to "float" on the water table.

Figures 7-15 through 7-18 present the areas of known VOC and SVOC contamination at the Fuel Spill Site. Soil sample results from the 1991 Fuel Spill Site soil borings indicated that the majority of the VOCs and SVOCs were fuel-related. (Note: Methylene chloride was detected in only one sample at 0.094 $\mu g/g$. Although this detection was more than 10 times what was detected in the method blank, this VOC is a common laboratory contaminant and the detection may still be due to laboratory operations. The compound 1,1,2,2-tetrachloroethane was detected in only one sample at 0.3 $\mu g/g$. Quality control data were not available; therefore, no screening was possible to determine whether this VOC is an actual detect. N-nitrosodiphenylamine was also detected in only one sample at 0.808 $\mu g/g$. As with the 1,1,2,2-tetrachloroethane, quality control data were not available for this SVOC.) The nature and extent of the VOC and SVOC contamination is similar to that of the TPHC nature and extent described above, even though fewer samples were analyzed for VOCs and SVOCs. Indeed, these detected TPHCs, VOCs, and SVOCs are primarily fuel-related and behave similarly under the conditions present at this site.

Although the soil samples collected from monitoring well S-88-91 contained the anions chloride, nitrate, and sulfate in excess of background concentrations, it is not likely that these detections represent soil contamination. For example, some of the values used to determine background concentrations for chloride are higher than what was detected in the soil samples from S-88-91. Additionally, only 12 data points were available for background calculations for anions (see Section 5.0). Nevertheless, these three anions were carried through the risk assessment process as contaminants.

7.2.3 Risk Assessment Results

7.2.3.1 *Baseline Human Health Risk Assessment*

This section presents the results of the sample data screening approach previously described in Section 6.1.1 that led to (1) the selection of the COPCs, (2) the exposure pathways that are labeled in the conceptual site model as being complete, (3) the exposure point concentrations in each respective environmental medium for those COPCs that have published health criteria, and (4) the carcinogenic and noncarcinogenic risk estimates for each receptor population under current and future land use scenarios.

This section of the report evaluates exposure to COPCs detected in site soils as well as those contaminants measured or modeled in various media from SWMU-wide or depot-wide sources. The direct soil-contact pathway (e.g., ingestion and dermal exposure) is associated with site-specific chemicals. Similarly, ingestion of homegrown produce by future on-site residents is based on those contaminants (if any) measured in surface soil within this site. Site-specific contaminants in soil are also used as model inputs to the air pathway for current off-site residents and the future on-site construction worker.

Current on-site workers and future on-site residents, however, are assumed to be potentially exposed to SWMU-wide chemicals in air (i.e., those chemicals detected in surface media at all of the sites evaluated within SWMU 13). Exposure to SWMU-wide chemicals was also the approach selected for the groundwater pathway. Thus, future on-site residents are assumed to be potentially exposed to groundwater contaminants measured in monitoring wells located across SWMU 13. The results of the groundwater evaluation are also presented separately in Section 7.11.3.1. Finally, ingestion of beef and dairy products by future on-site residents is based on modeling contaminants detected in base-wide surface soils; cattle are assumed to graze at contaminated sites within SWMU 13 and SWMU 17. Thus, the total cancer risk and noncarcinogenic hazards to the future on-site resident (adult and child) presented in the sections below include those contributions associated with exposures to SWMU-wide contamination in air and groundwater and to depot-wide chemicals in beef and milk.

7.2.3.1.1 ***Chemicals of Potential Concern.*** Site-related chemicals were not encountered in the surface soils within this site (0 to 1 foot). The COPCs measured in the subsurface (1.5 to 10.0 feet) soil are summarized in Table 7-9. This table does not include TPHC, which was measured in the subsurface soil at concentrations ranging between 255 and 12,800 μg/g. Chloride and sulfate were also measured at levels as high as 3,000 and 17,000 μg/g, respectively. These two anions and TPHC lack USEPA Health Criteria and, thus, were not evaluated further.

Table 7-9. SWMU 13 Summary of Concentrations of Chemicals of Potential Concern in Subsurface Soil at the Fuel Spill Site, Phase II RFI

Chemical	Background Concentration (mg/kg)	Frequency of Detection	Range of Detects (mg/kg)	Arithmetic Mean Concentration (mg/kg)	95% UCL (mg/kg)
VOCs					
Benzene	NA	8/23	0.018-0.2	0.031	**0.046**
1,2-Dimethylbenzene (O-xylene)	NA	13/23	0.07-2.0	0.44	**0.66**
1,3-Dimethylbenzene (M-xylene)	NA	14/23	0.05-2.0	0.32	**0.50**
Ethylbenzene	NA	15/23	0.023-2.0	0.21	**0.36**
Methylene chloride	NA	1/23	0.094	0.028	**0.035**
1,1,2,2-Tetrachloroethane	NA	1/23	0.30	0.021	**0.043**
Anions					
Nitrate	4.67	2/2	12.7-**98.0**	55.4	321.6
SVOCs					
Acenaphthene	NA	17/27	1.2-20.0	4.35	**5.82**
Anthracene	NA	5/10	0.759-1.4	0.66	**0.92**
Dimethylnaphthalenes	NA	24/24	25.0-400.0	133.7	**178.3**
Fluorene	NA	15/27	0.446-12.3	3.04	**4.13**
2-Methylnaphthalene	NA	25/27	5.1-100.0	36.1	**44.4**
Methylnaphthalenes	NA	18/18	12.0-111.0	52.9	**66.4**
N-nitroso diphenylamine	NA	1/10	0.808	0.23	**0.35**
Naphthalene	NA	24/27	2.8-40.0	9.7	**12.43**
Phenanthrene	NA	25/27	5.2-60.0	18.9	**23.5**
Trimethylnaphthalenes	NA	22/22	12.0-300.0	103.4	**133.2**

Notes.—NA denotes Not Applicable. TPHC, chloride, and sulfate were also detected but were not evaluated further due to the lack of USEPA Health Criteria. **Bold** type designates the exposure point concentration selected for these media.

7.2.3.1.2 *Complete Exposure Pathways*. The pathways that were assumed complete at this site are shown on the conceptual site model in Figure 7-23. Site-related chemicals were not detected in the surface soil within this site and, thus, all exposure pathways associated with this medium for the current on-site worker (ingestion and dermal), off-site resident (inhalation), and potential future on-site resident (ingestion, dermal, and consumption of homegrown produce) were assumed to be incomplete. Exposure by future on-site construction workers from ingestion of and dermal contact with site-related chemicals in subsurface soil, however, was evaluated. Their exposure due to inhalation of fugitive dust and soil vapor emissions were also evaluated. Evaluation of exposure to SWMU-wide chemicals in groundwater by potential future on-site residents is described in Section 7.11.3.1.

The sites within SWMU 13 either overlap or are adjacent to each other so that it was practical to estimate air chemical levels as SWMU-wide concentrations instead of on a site-specific basis. Therefore, exposure from inhalation of SWMU-wide chemical concentrations by the on-site worker during daily visits to this site were included despite the fact that these chemicals were not found in the surficial soil at this location. The modeling approach is presented in detail in Section 6.1.2.3.3. Exposure to air contaminants by the future resident was also based on SWMU-wide modeling. Similarly, exposure by potential future on-site residents from ingestion of chemicals in beef and milk, derived as depot-wide averages using data collected from SWMUs 13 and 17, was also evaluated.

7.2.3.1.3 *Exposure Point Concentrations*. Only the inhalation pathway was considered complete for current on-site workers, and exposure was evaluated based on chemical concentrations modeled over SWMU 13. Exposures to site-specific chemicals by the future on-site construction worker from all complete pathways were evaluated based on the exposure point concentrations in Table 7-10. These values represent chemical concentrations measured in subsurface soil to a depth of 10 feet bgs. This table also includes average values for chemicals in beef and milk that were estimated based on data from sites within both SWMUs 13 and 17 and used to calculate exposure by future on-site residents. Exposure to chemicals in air and in groundwater by the potential future on-site resident are based on the SWMU-wide exposure point concentrations in Tables 7-10 and 7-68, respectively.

7.2.3.1.4 *Risk Estimates*. The receptor populations evaluated at this site include the on-site worker, future construction worker, and the potential future on-site resident. Risk to the current on-site worker was evaluated from inhalation of airborne chemicals from other site locations within SWMU 13. Risk to the future construction worker was estimated for potential exposure due to inhalation of, ingestion of, and dermal contact with chemicals in Fuel Spill Site subsurface soils. Risk to the potential future on-site resident was estimated for inhalation of particulates and vapors (from other sites within SWMU 13); ingestion of beef and milk (depot-wide evaluation); and inhalation, ingestion of, and dermal contact with SWMU-wide chemicals in groundwater. These results are summarized for each pathway in Tables 7-11 and 7-12. Actual risk calculations are presented in Appendix H. Tables 7-11 and 7-12 show in bold font those risks and hazards which are site-specific (i.e., related to chemicals detected specifically in this site's soils).

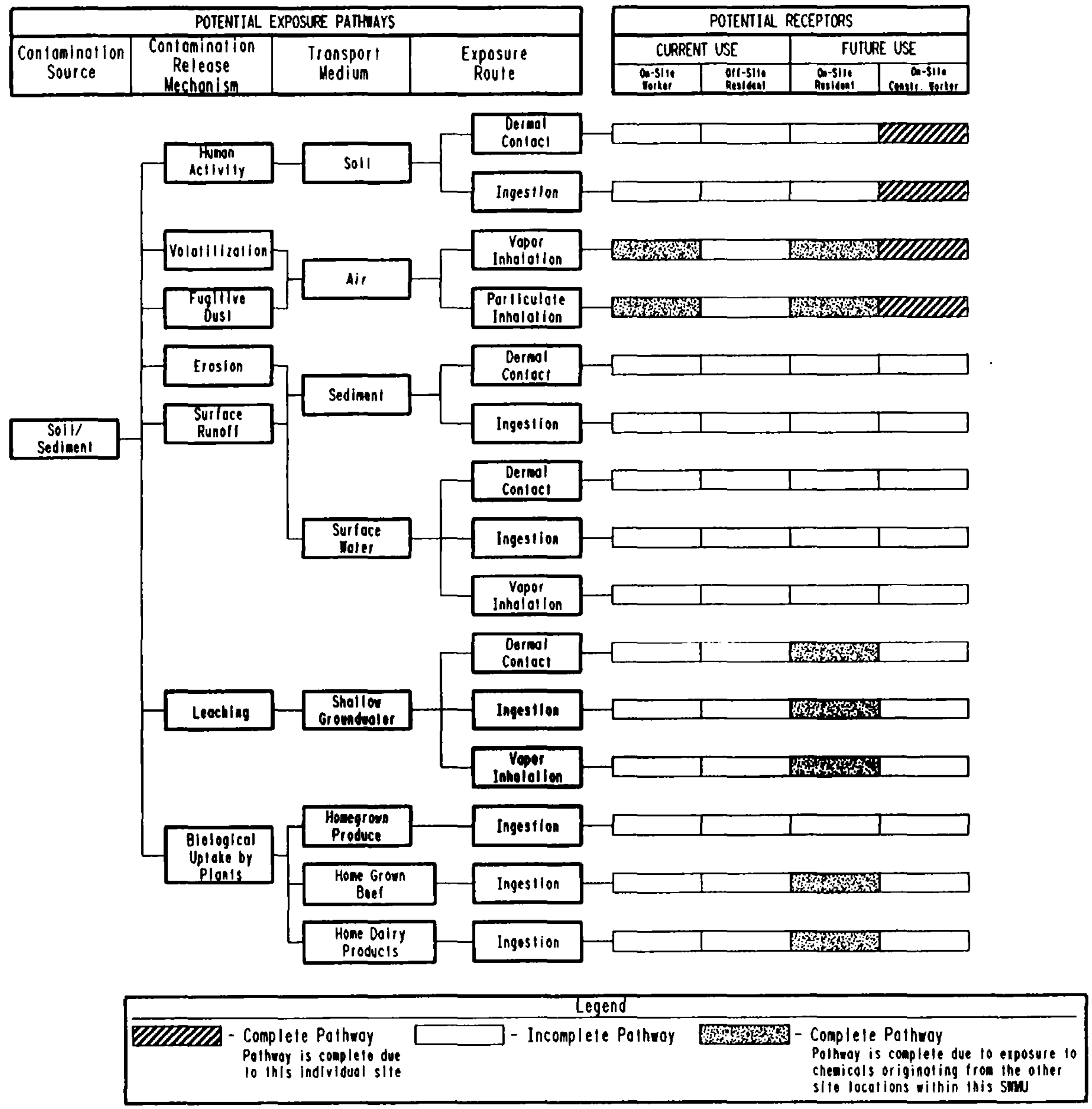

Figure 7-23. SWMU 13 Potential Human Exposure Pathway Conceptual Model for the Fuel Spill Site, Phase II RFI

Table 7-10. SWMU 13 Exposure Point Concentrations for the Chemicals of Potential Concern at the Fuel Spill Site, Phase II RFI

Receptor	Chemical	EXPOSURE POINT CONCENTRATIONS								
		Air[a] (mg/m³)	Soil (mg/kg)	Milk[b] (mg/L)	Beef[b] (mg/g)	Potato (mg/g)	Tomato (mg/g)	Carrot (mg/g)	Lettuce (mg/g)	Beans (mg/g)
On-Site Worker	Arsenic	2.15E-07	NA	---	---	---	---	---	---	---
	Beryllium	7.76E-09	NA	---	---	---	---	---	---	---
	Chromium	5.60E-07	NA	---	---	---	---	---	---	---
	Copper	2.01E-07	NA	---	---	---	---	---	---	---
	Lead	8.33E-08	NA	---	---	---	---	---	---	---
	Mercury	1.27E-10	NA	---	---	---	---	---	---	---
	Nickel	1.21E-08	NA	---	---	---	---	---	---	---
	Nitrate	5.00E-07	NA	---	---	---	---	---	---	---
	Uranium	2.64E-09	NA	---	---	---	---	---	---	---
	Zinc	1.31E-06	NA	---	---	---	---	---	---	---
	Acetone	1.30E-05	ND	---	---	---	---	---	---	---
	Chloromethane	1.60E-06	ND	---	---	---	---	---	---	---
	Methylene chloride	2.35E-06	ND	---	---	---	---	---	---	---
	4-Methylphenol	3.16E-10	ND	---	---	---	---	---	---	---
	Methyl isobutyl ketone	1.50E-09	ND	---	---	---	---	---	---	---
	Methyl-n-butyl ketone	7.30E-10	NA	---	---	---	---	---	---	---
Future On-Site Resident	Arsenic	2.1E-06 (3.49E-06)	NA	9.8E-08	1.63E-09	---	---	---	---	---
	Beryllium	4.81E-08 (7.4E-08)	NA	9.32E-11	3.99E-11	---	---	---	---	---
	Chromium	5.9E-06 (1.1E-05)	NA	7.65E-08	4.0E-09	---	---	---	---	---

Table 7-10. SWMU 13 Exposure Point Concentrations for the Chemicals of Potential Concern at the Fuel Spill Site, Phase II RFI (continued)

Receptor	Chemical	EXPOSURE POINT CONCENTRATIONS								
		Air[a] (mg/m^3)	Soil (mg/kg)	Milk[b] (mg/L)	Beef[b] (mg/g)	Potato (mg/g)	Tomato (mg/g)	Carrot (mg/g)	Lettuce (mg/g)	Beans (mg/g)
Future On-Site Resident (cont.)	Copper	1.7E-06 (1.0E-05)	NA	4.41E-05	1.13E-07	---	---	---	---	---
	Lead	1.47E-06 (2.99E-06)	NA	1.55E-07	8.16E-11	---	---	---	---	---
	Mercury	6.17E-09 (1.24E-08)	NA	1.03E-09	1.26E-11	---	---	---	---	---
	Nickel	6.02E-07 (1.2E-06)	NA	8.52E-08	7.29E-09	---	---	---	---	---
	Nitrate	4.89E-07 (6.64E-07)	NA	NA	NA	---	---	---	---	---
	Uranium	1.18E-07 (2.35E-07)	NA	2.0E-09	7.71E-12	---	---	---	---	---
	Zinc	1.03E-05 (1.73E-05)	NA	4.63E-03	1.78E-05	---	---	---	---	---
	Bis(2-ethylhexyl) phthalate	---	ND	1.24E-09	1.51E-12	---	---	---	---	---
	1,2-Dimethylbenzene	---	ND	3.49E-12	4.25E-15	---	---	---	---	---
	4-Methylphenol	1.26E-08 (2.53E-08)	ND	4.07E-10	4.96E-13	---	---	---	---	---
	Methyl isobutyl ketone	8.0E-09 (9.50E-09)	ND	6.5E-12	7.92E-15	---	---	---	---	---
	Methyl-n-butyl ketone	4.00E-09 (4.80E-09)	ND	---	---	---	---	---	---	---
	Toluene	---	ND	2.48E-12	3.02E-15	---	---	---	---	---
Future Construction Worker	Benzene	4.2E-07	0.046	---	---	---	---	---	---	---
	1,2-Dimethylbenzene (O-xylene)	1.6E-07	0.66	---	---	---	---	---	---	---
	1,3-Dimethylbenzene (M-xylene)	1.2E-06	0.50	---	---	---	---	---	---	---

Table 7-10. SWMU 13 Exposure Point Concentrations for the Chemicals of Potential Concern at the Fuel Spill Site, Phase II RFI (continued)

Receptor	Chemical	EXPOSURE POINT CONCENTRATIONS								
		Air[a] (mg/m^3)	Soil (mg/kg)	Milk[b] (mg/L)	Beef[b] (mg/g)	Potato (mg/g)	Tomato (mg/g)	Carrot (mg/g)	Lettuce (mg/g)	Beans (mg/g)
Future Construction Worker (cont.)	Ethylbenzene	9.8E-07	0.36	---	---	---	---	---	---	---
	Methylene chloride	7.3E-07	0.035	---	---	---	---	---	---	---
	Nitrate	4.31E-06	98.0	---	---	---	---	---	---	---
	1,1,2,2-Tetrachloroethane	9.2E-07	0.043	---	---	---	---	---	---	---
	Acenaphthene	2.56E-07	5.82	---	---	---	---	---	---	---
	Anthracene	4.05E-08	0.92	---	---	---	---	---	---	---
	Dimethylnaphthalenes	7.85E-06	178.3	---	---	---	---	---	---	---
	Fluorene	1.82E-07	4.13	---	---	---	---	---	---	---
	2-Methylnaphthalene	1.95E-06	44.4	---	---	---	---	---	---	---
	Methylnaphthalenes	2.92E-06	66.4	---	---	---	---	---	---	---
	N-nitroso diphenylamine	1.54E-08	0.35	---	---	---	---	---	---	---
	Naphthalene	5.47E-07	12.43	---	---	---	---	---	---	---
	Phenanthrene	1.03E-06	23.5	---	---	---	---	---	---	---
	Trimethylnaphthalenes	5.86E-06	133.2	---	---	---	---	---	---	---

Notes.—--- denotes not applicable. ND denotes chemical was not detected in site soil. ND denotes not analyzed.

[a]Air values represent average level for worker and maximum for future resident. For construction worker air values are based on corresponding subsurface concentrations. Value in parentheses is for child.

[b]Milk and beef concentrations represent average values based on data collected from SWMUs 13 and 17.

Table 7-11. SWMU 13 Summary of Carcinogenic Risks for the Fuel Spill Site, Phase II RFI

Potential Exposure Pathways		Current Use		Future Use	
Environmental Medium	**Potential Exposure Route**	**On-Site Worker[a]**	**Off-Site Resident Adult (Child)**	**Construction Worker**	**On-Site Resident Adult (Child)[b]**
Subsurface Soil	Dermal Contact	NA	NA	**1.17E-11**	NA
	Ingestion	NA	NA	**4.80E-10**	NA
Air	Particulate Inhalation	2.12E-07	NA	**NE**	3.09E-05[c](3.98E-05)[d]
	Vapor Inhalation	1.12E-10	NA	**4.14E-10**	NE
Groundwater	Dermal Contact	NA	NA	NA	1.55E-04(4.79E-05)
	Ingestion	NA	NA	NA	5.79E-03[e](2.70E-03)[e]
	Vapor Inhalation	NA	NA	NA	3.00E-07(2.10E-07)
Homegrown Produce	Ingestion	NA	NA	NA	NA
Homegrown Beef	Ingestion	NA	NA	NA	1.35E-09 (5.55E-10)
Homegrown Dairy Products	Ingestion	NA	NA	NA	5.73E-10 (6.54E-10)
	Total Cancer Risk	2.12E-07	NA	**9.06E-10**	5.98E-03 (2.79E-03)

Notes.—NA denotes not applicable. NE denotes not evaluated due to lack of USEPA Health Criteria for site-related chemicals within this pathway. Bold type designates site-specific risks (i.e., those potential risks that are attributed to chemicals detected at this site).

[a]Exposure to workers was evaluated based on the time spent at each site during assumed daily visits to each site within SWMU 13. Exposure to airborne chemicals was evaluated based on chemicals measured in surface soil and surface water within this SWMU. The concentrations used for this medium represent SWMU-wide values. Therefore, even if site-specific contamination is absent from surficial soil, exposure from inhalation of particulates and vapors from other sites was assumed to occur.

[b]Beef and milk chemical concentrations represent depot-wide values for TEAD-S. Therefore, the future resident at each site may be exposed to site-specific chemicals and also to those associated with other site locations within SWMU 13 and 17.

[c]Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, and the Pavement Perimeter Site is responsible for almost 90 percent of the total air pathway risk.

[d]Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, the Southwest Wastewater Lagoon, and the Pavement Perimeter Site is responsible for over 90 percent of the total air pathway risk.

[e]Ingestion of arsenic detected in SWMU-wide monitoring wells is responsible for at least 90 percent of the total groundwater pathway risks.

Table 7-12. SWMU 13 Summary of Noncarcinogenic Hazards for the Fuel Spill Site, Phase II RFI

Potential Exposure Pathways		Current Use		Future Use	
Environmental Medium	**Potential Exposure Route**	**On-Site Worker[a]**	**Off-Site Resident Adult (Child)**	**Construction Worker**	**On-Site Resident Adult (Child)[b]**
Subsurface Soil	Dermal Contact	NA	NA	**5.31E-04**	NA
	Ingestion	NA	NA	**5.57E-03**	NA
Air	Particulate Inhalation	1.15E-02	NA	**1.38E-03**	1.41E+00(9.21E+00)[c]
	Vapor Inhalation	4.96E-07	NA	**8.49E-07**	8.57E-07(2.67E-06)
Groundwater	Dermal Contact	NA	NA	NA	5.02E-01(2.81E-01)
	Ingestion	NA	NA	NA	7.35E+01[d](9.61E+01)[d]
	Vapor Inhalation	NA	NA	NA	1.38E-02(5.45E-03)
Homegrown Produce	Ingestion	NA	NA	NA	NA
Homegrown Beef	Ingestion	NA	NA	NA	8.30E-05 (1.70E-04)
Homegrown Dairy Products	Ingestion	NA	NA	NA	1.57E-04 (8.97E-04)
	Total Hazard	1.15E-02	NA	**7.48E-03**	7.54E+01(1.06E+02)

Notes.—NA denotes not applicable. NE denotes not evaluated due to lack of USEPA Health Criteria for site-related chemicals within this pathway. Bold type designates site-specific hazards (i.e., those potential hazards that are attributed to chemicals detected at this site).

[a]Exposure to workers was evaluated based on the time spent at each site during assumed daily visits to each site within SWMU 13. Exposure to airborne chemicals was evaluated based on chemicals measured in surface soil and surface water within this SWMU. The concentrations used for this medium were derived as average values for this SWMU. Therefore, even if site-specific contamination is absent from surficial soil, exposure from inhalation of particulate and vapors from other site locations was assumed to occur.

[b]Beef and milk chemical concentrations were derived as average values over TEAD-S. Therefore, the future resident at each site is exposed to site-related chemicals and also to those associated with other site locations within SWMU 13 and 17.

[c]Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, and the Southwest Wastewater Lagoon is responsible for at least 90 percent of the total air pathway hazard.

[d]Ingestion of arsenic, thallium, and fluoride detected in SWMU-wide monitoring wells is responsible for over 90 percent of the total groundwater pathway hazards.

Current Land Use

Cancer risk and noncarcinogenic hazard to the current on-site worker from inhalation of SWMU-wide 13 chemicals were estimated to be 2.12E-07 and 1.15E-02, respectively.

Future Land Use

Total cancer risk and noncarcinogenic hazard to the future construction worker resulting from exposure to site-specific chemicals in subsurface soil and air were estimated to be 9.06E-10 and 7.48E-03, respectively. Total cancer risks to the potential future on-site adult and child from exposure to SWMU-wide chemicals in groundwater and air, and to depot-wide chemicals in beef/milk were estimated to be 5.98E-03 and 2.79E-03. Total noncarcinogenic hazards to these receptors were estimated to be 7.54E+01 and 1.06E+02, respectively.

7.2.3.1.5 ***Conclusions.*** The results of the human health risk assessment under the current land use exposure scenario at this site indicate that the estimated cancer risk to the on-site worker of 2.12E-08 is below the 1E-06 State of Utah recommended threshold limit of allowable risk. Noncarcinogenic hazards to this receptor under current land use conditions was estimated to be well below the State of Utah recommended value of 1. This site does not contribute to the total risk or hazard to the off-site resident.

The results of the human health risk assessment under future land use conditions indicate that the estimated total cancer risk to the potential future on-site adult and child resident of 5.98E-03 and 2.79E-03, respectively, exceed the State of Utah recommended threshold limit of allowable risk. Total cancer risk to the future construction worker was found to be below this limit. Total noncarcinogenic hazards to the potential future on-site adult and child resident of 75.4 and 106, respectively, were found to be well above the State of Utah recommended value of 1. Total noncarcinogenic hazard to the future construction worker was found to be below this value.

Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, and the Pavement Perimeter Site is responsible for almost 90 percent of the total air pathway cancer risk to the future on-site adult resident. Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, the Southwest Wastewater Lagoon, and the Pavement Perimeter Site is responsible for approximately 90 percent of the cancer risk to the future on-site child resident. These latter sites, with the exception of the Pavement Perimeter Site, are also responsible for over 90 percent of the total noncancer air-pathway hazard to the future on-site child resident. Ingestion of arsenic detected in SWMU-wide monitoring wells is responsible for over 90 percent of the total groundwater pathway risks and hazards (with thallium and fluoride) to future on-site residents (adults and children).

In summary, the only potential risks/hazards that can be attributed to chemicals detected specifically in soils at this site are those associated with the future on-site construction worker.

As stated previously (above), the total risk and hazard to this receptor were found to be well below the threshold limits, recommended by the State of Utah, of 1E-06 (for cancer risk) and 1 (for noncancer hazard).

7.2.3.2 *Ecological Risk Assessment*

7.2.3.2.1 *Site Characterization.* The ecological assessment for the Fuel Spill Site included a survey of vegetation and wildlife, and a qualitative habitat evaluation. This assessment did not include collection of either vegetation or wildlife samples for analysis. Human activity at this site is frequent. The potential wildlife inhabitants include small and large mammals, birds, and several of the raptor species. There is no indication that this area is a critical habitat for any endangered or threatened species. All contaminant detects for this site were below the surface. TPHC was detected in two samples at 1.5 feet in depth. Most other COPC detects were from 8.5 to 9.5 feet in depth. Species of vegetation observed in the vicinity of the Fuel Spill site include Russian thistle, shadscale, rabbitbrush, bottlebrush, and squirreltail grass. Wildlife species observed include antelope, mule deer, jackrabbits, deer mice, the Great Basin gopher snake, and the redtailed hawk.

No evidence of surface water was observed during the field investigation, and it is unlikely that significant surface water ever accumulates on this site as the result of storm episodes or snow melt.

7.2.3.2.2 *Conclusions.* All contaminants that might be of concern to ecological receptors were detected well below the surface. Because of the depth of contaminants, minimal uptake by plants is expected. In addition, all of the contaminants are VOCs and SVOCs, and accumulation in terrestrial plants is not likely. Furthermore, since human activity at the site, which is located within a fence, is projected to continue, no adverse impacts to ecological receptors should occur.

7.2.4 Conclusions and Recommendations

The primary contaminants in the soils at the Fuel Spill Site are fuel-related VOCs, SVOCs, and TPHCs. TPHCs are the most prevalent. The soil borings drilled during the 1993 field effort define the lateral extent as presented in Figures 7-15 through 7-22, while the vertical extent can be approximated by the water table (8 to 10 feet). Generally, contaminant concentrations and extent increase with depth until the water table is encountered.

Although the soil samples from S-88-91 contained the anions chloride, nitrate, and sulfate in excess of background, it is believed that these detections do not represent a contamination problem (see Section 7.2.2).

The human health risk assessment evaluated both the current and future use scenarios at this site. Results under the current use scenario indicate that the carcinogenic risk to the on-site worker is well below the State of Utah limit and the noncarcinogenic hazard to this receptor is also well below State of Utah goal of unity.

Under the future use scenarios, the cancer risk and the noncarcinogenic hazard to the construction worker were both below State of Utah criteria. While the cancer risk and the noncarcinogenic hazard to the on-site resident were both above these criteria, they were due to SWMU-wide chemicals in air and groundwater and are not related to site-specific contaminants.

Because COPCs are well below the surface and because frequent human activity is expected to continue, it was concluded that no adverse impacts to the key ecological receptor species or habitat should occur at the Fuel Spill Site.

In summary, all available data were used to determine whether past operations at the Fuel Spill Site have created an environment that could result in any adverse effects to human health or to the local ecology. Results from the human health and ecological risk assessments indicate that no adverse effects will occur under any of the scenarios evaluated except the future on-site resident. Results from this exposure scenario should not be used to evaluate potential risk-based cleanup options as it is unlikely that a residential scenario will occur at this site (see Section 6.0).

Because TPHCs could not be quantitatively evaluated under the human health risk assessment and because some of the TPHC concentrations detected at this site exceed cleanup standards for the State of Utah (30 μg/g for gasoline-related TPHCs and 100 μg/g for diesel-related TPHCs in soil), it is recommended that the Fuel Spill Site be carried through the CMS process to further evaluate the TPHC-contaminated soils above the vadose zone (approximately 8 feet). Additionally, it is possible that these soils could contribute to the current groundwater contamination, violating the Principle of Non-Degradation requirements as outlined in the Utah cleanup action and risk based closure standards. The soils in the vadose zone, along with saturated soils (soils at and below the water table), are also contaminated with TPHCs but cannot be separated from the groundwater, as it also contains TPHCs. Under current-use scenarios, the groundwater is not available and does not create a risk to human health or to the local ecology (see Section 7.11). Therefore, both vadose zone soils and saturated zone soils that are associated with the groundwater at the Fuel Spill Site are not currently creating any adverse effects to human health or to the local ecology.

7.3 UNDERGROUND STORAGE TANK SITE

7.3.1 Previous Sampling and Phase II RFI Sampling Results

No previous investigations have been conducted at this site prior to this Phase II RFI.

Rust E&I, 1991. Rust E&I drilled and sampled soil borings in the area of the reported spills/leaks to assess the extent, if any, of fuel-related contamination in subsurface soils. Figure 7-24 shows the locations of the 1991 soil borings (13US-03 through 13US-15). The borings were drilled to a depth of 10 feet, and soil samples were collected at depths of 0 to 2, 4 to 5, and 9 to 10 feet. Only one sample was collected from boring number 5 because of drilling problems encountered at this location. The samples were analyzed for TPHCs. Table 7-13 summarizes the analytical results, and a complete listing of all of the data is presented in Appendix D. None of the samples showed detections of TPHCs. As a result, no further sampling was conducted during the 1993 field effort.

Monitoring well S-87-91 was not installed to evaluate the soils at the Underground Storage Tank Site. However, the results from the soil samples that were collected during the drilling of this 1991 well are discussed here because of the well's proximity to the site (Figure 7-24). These soil samples were collected from the approximate depths of 2, 5, and 9 feet. The analyte suite consisted of VOCs, SVOCs, TPHCs, explosives, metals, and anions. No organic compounds were detected, and no metals were detected above background. Three anions (chloride, nitrate, and sulfate) were detected in these samples. Chloride values ranged from 1,600 to 2,000 μg/g; nitrate values ranged from 9.8 to 57 μg/g; and sulfate was detected above background at 6,700 and 21,000 μg/g.

7.3.2 Nature and Extent of Contamination

Although previous fuel spills have been reported in the two underground storage tank areas, Rust E&I found no evidence of residual contamination in the subsurface soils surrounding the tanks. The soil borings were drilled on all sides of the tank sites to ensure that any migration of the suspected fuel-related contaminants would be detected. On the basis of these sampling results, it appears that no contamination exists at this site.

Although the soil samples collected from monitoring well S-87-91 contained the anions chloride, nitrate, and sulfate in excess of background, it is not likely that these detections represent soil contamination. Nevertheless, these three anions were carried through the risk assessment process, which is presented in the following section.

7.3.3 Risk Assessment Results

7.3.3.1 *Baseline Human Health Risk Assessment*

This section presents the results of the sample data screening approach previously described in Section 6.1.1 that led to (1) the selection of the COPCs, (2) the exposure pathways that are labeled in the conceptual site model as being complete, (3) the exposure-point concentrations in each respective environmental medium for those COPCs that have published health criteria, and (4) the carcinogenic and noncarcinogenic risk estimates for each receptor population under current and future land use scenarios.

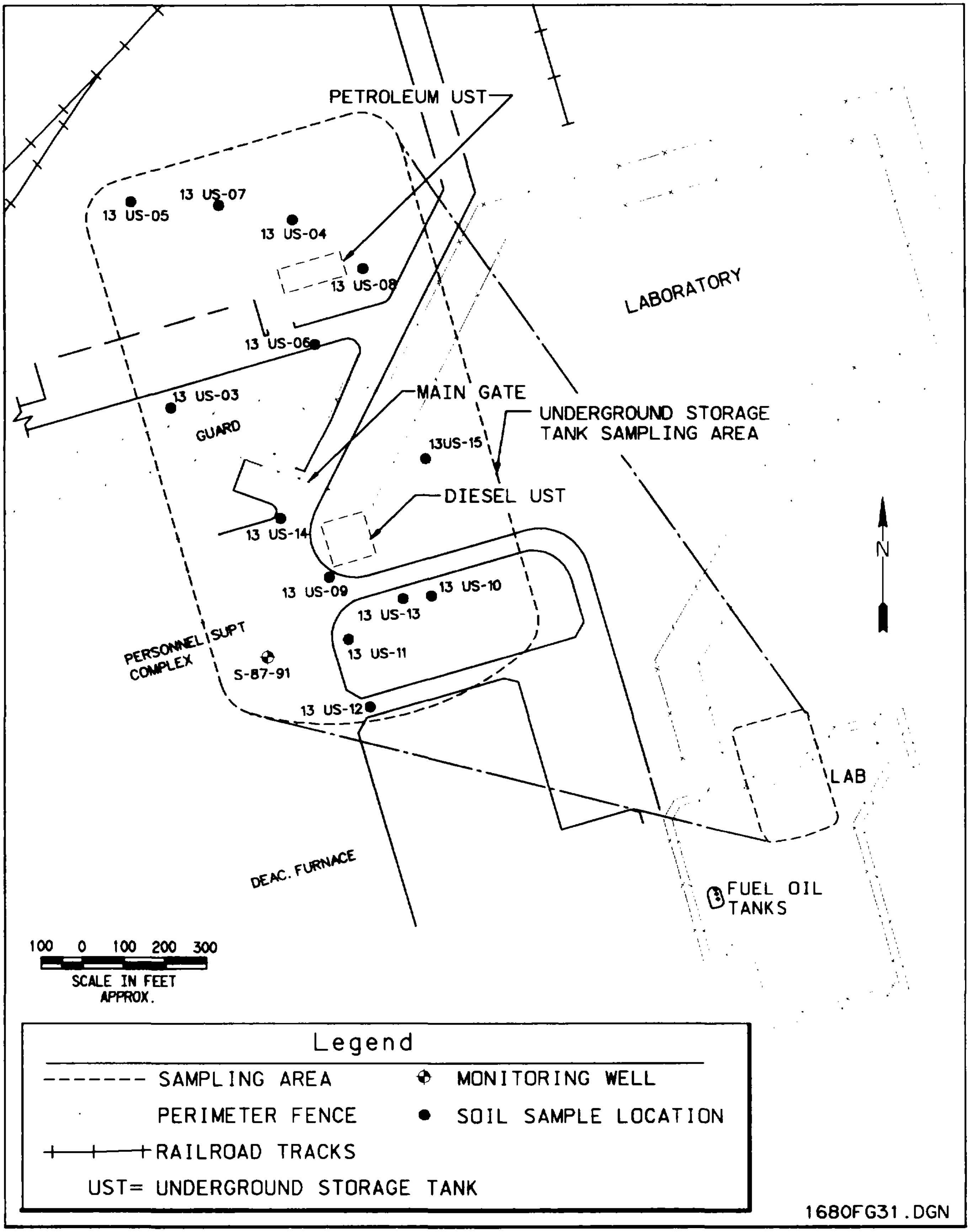

Figure 7-24. SWMU 13 Soil Boring Sample Locations at the Underground Storage Tank Site, Phase II RFI

Table 7-13. SWMU 13 Soil Sample Results for the Underground Storage Tank Site, Phase II RFI

		Anions (μg/g)			pH
Sample ID	**Depth**	**Chloride (BKGD[a] 596)**	**Nitrate (BKGD 4.67)**	**Sulfate (BKGD 1,697)**	
13US-04-2	5	--[b]	--	--	9.33
S-87-91-1	2	ND[c]	57.0	DS[d]	--
S-87-91-2	5	1,600	16.9	6,700	--
S-87-91-3	9	2,000	9.8	21,000	--
13US-03-1[e]	1.0				
13US-03-2	4.5				
13US-03-3	9.5				
13US-04-1	1.0				
13US-04-3	9.5				
13US-05-1	1.0				
13US-06-1	1.0				
13US-06-2	4.5				
13US-06-3	9.5				
13US-07-1	1.0				
13US-07-2	4.5				
13US-07-3	9.5				
13US-08-1	1.0				
13US-08-2	4.5				
13US-08-3	9.5				
13US-09-1	1.0				
13US-09-2	4.5				
13US-09-3	9.0				
13US-10-1	0.5				

Table 7-13. SWMU 13 Soil Sample Results for the Underground Storage Tank Site, Phase II RFI (continued)

		Anions (μg/g)			pH
Sample ID	**Depth**	**Chloride (BKGD[a] 596)**	**Nitrate (BKGD 4.67)**	**Sulfate (BKGD 1,697)**	
13US-10-2	4.0				
13US-10-3	9.5				
13US-11-1	1.0				
13US-11-2	4.5				
13US-11-3	9.5				
13US-12-1	1.0				
13US-12-2	4.5				
13US-12-3	9.5				
13US-13-1	1.0				
13US-13-2	4.5				
13US-13-3	9.5				
13US-14-1	1.0				
13US-14-2	4.5				
13US-14-3	9.5				
13US-15-1	1.0				
13US-15-2	4.5				
13US-15-3	9.5				

[a]BKGD = Background value for specified analyte.

[b]— = Analysis not performed.

[c]ND = Analyte not detected at or above the CRL, SRL, or MDL.

[d]DS = Data screened due to the 5 times or 10 times rule or did not exceed background values where applicable (see Section 6 for data screening methodologies).

[e]The following sample IDs, where there were no detected contaminants, are included in the remainder of this table. A comprehensive listing of all the data is presented in Appendix D.

This section of the report evaluates exposure to COPCs detected in site soils as well as those contaminants measured or modeled in various media from SWMU-wide or depot-wide sources. The direct soil-contact pathway (e.g., ingestion and dermal exposure) is associated with site-specific chemicals. Similarly, ingestion of homegrown produce by future on-site residents is based on those contaminants (if any) measured in surface soil within this site. Site-specific contaminants in soil are also used as model inputs to the air pathway for current off-site residents and the future on-site construction worker.

Current on-site workers and future on-site residents, however, are assumed to be potentially exposed to SWMU-wide chemicals in air (i.e., those chemicals detected in surface media at all of the sites evaluated within SWMU 13). Exposure to SWMU-wide chemicals was also the approach selected for the groundwater pathway. Thus, future on-site residents are assumed to be potentially exposed to groundwater contaminants measured in monitoring wells located across SWMU 13. The results of the groundwater evaluation are also presented separately in Section 7.11.3.1. Finally, ingestion of beef and dairy products by future on-site residents is based on modeling contaminants detected in depot-wide surface soils; cattle are assumed to graze at contaminated sites within SWMU 13 and SWMU 17. Thus, the total cancer risk and noncarcinogenic hazards to the future on-site resident (adult and child) presented in the sections below include those contributions associated with exposures to SWMU-wide contamination in air and groundwater and to depot-wide chemicals in beef and milk.

7.3.3.1.1 ***Chemicals of Potential Concern.*** Site-related chemicals were not encountered in the surface soils within this site. In the subsurface soil only chloride, sulfate, and nitrate were measured at levels above background. Chloride and sulfate were measured at levels as high as 2,000 and 21,000 μg/g, respectively. These chemicals lack USEPA Health Criteria and, thus, were not evaluated further. Therefore, the only COPC in soil evaluated at this site is nitrate. Subsurface soil nitrate concentrations ranged between 9.8 and 57.0 μg/g. The 95% UCL on the mean of the nitrate levels was estimated to be 70.8 μg/g.

7.3.3.1.2 ***Complete Exposure Pathways.*** The pathways that were assumed complete at this site are shown on the conceptual site model in Figure 7-25. Site-related chemicals were not detected in the surface soil within this site and, thus, all exposure pathways associated with this medium for the current on-site worker (ingestion and dermal), off-site resident (inhalation), and potential future on-site resident (ingestion, dermal, and consumption of homegrown produce) were assumed to be incomplete. Exposure by future on-site construction workers from ingestion of and dermal contact with nitrate in subsurface soil, however, was evaluated. Their exposure due to fugitive dust emissions was also evaluated. Evaluation of exposure to SWMU-wide chemicals in groundwater by potential future on-site residents is described in Section 7.11.3.1.

The sites within SWMU 13 either overlap or are adjacent to each other so that it was practical to estimate air chemical levels as SWMU-wide concentrations instead of on a site-specific basis. Therefore, exposure from inhalation of SWMU-wide chemical concentrations by the

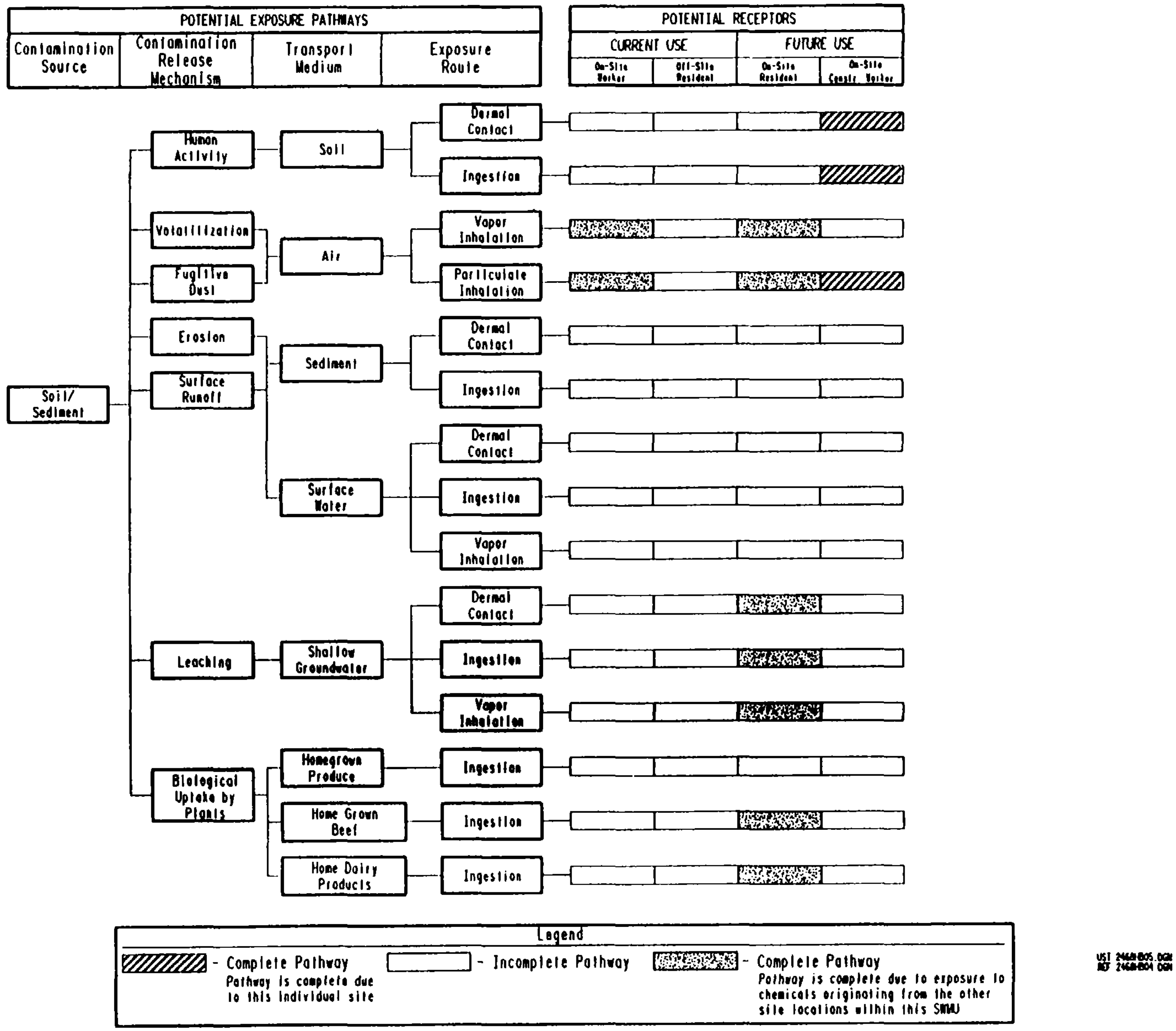

Figure 7-25. Potential Human Exposure Pathway Conceptual Model for the Underground Storage Tank Site, SWMU 13

on-site worker during daily visits to this site were included despite the fact that these chemicals were not found in the surficial soil at this location. The modeling approach is presented in detail in Section 6.1.2.3.3. Exposure to air contaminants by future residents was also based on SWMU-wide modeling. Similarly, exposure by potential future on-site residents from ingestion of chemicals in beef and milk, derived as depot-wide averages using data collected at SWMUs 13 and 17, was also evaluated.

7.3.3.1.3 *Exposure Point Concentrations*. Only the inhalation pathway was considered complete for the current on-site worker, and exposure was based on chemical concentrations modeled over SWMU 13. Exposure to chemicals in beef and milk by potential future on-site residents was based on average values derived for all of TEAD-S using data collected from sites within SWMU 13 and 17. These exposure point concentrations were not summarized for this site since they are not unique to this location and may actually be viewed from the same table at any other site within SWMU 13 (see Table 7-10). Exposures associated with ingestion and dermal contact with nitrate in subsurface soil by the future on-site construction worker were estimated based on a soil concentration value of 57.0 ppm. Exposure associated with inhalation by the construction worker of dust contaminated by nitrate is estimated based on a modeled monthly maximum air concentration of 3.8E-06 mg/m^3 for nitrate. Exposure to chemicals in air and groundwater by potential future on-site residents are based on the SWMU-wide exposure point concentrations in Tables 7-10 and 7-68, respectively.

7.3.3.1.4 *Risk Estimates*. The receptor populations evaluated at this site include the current on-site worker, the future construction worker, and the potential future on-site resident. Risk to the current on-site worker was evaluated from inhalation of airborne chemicals from other site locations within SWMU 13. Risk to the future construction worker was estimated for potential exposure due to inhalation of, ingestion of, and dermal contact with chemicals in Underground Storage Tank Site subsurface soils. Risk to the potential future on-site resident was estimated for inhalation of particulates and vapors (from other sites within SWMU 13); ingestion of beef and milk (depot-wide evaluation); and inhalation, ingestion of, and dermal contact with SWMU-wide chemicals in groundwater.

The results of this evaluation under current and future land use are presented below. These results are summarized for each exposure pathway in Tables 7-14 and 7-15. Actual risk calculations are presented in Appendix H. Tables 7-14 and 7-15 show in bold font those risks and hazards that are site-specific (i.e., related to chemicals detected specifically in this site's soils).

Current Land Use

Cancer risk to the current on-site worker from exposure to SWMU-wide chemicals in air was estimated to be 2.12E-07. Noncarcinogenic hazard to this receptor was estimated to be 1.15E-02.

Table 7-14. SWMU 13 Summary of Carcinogenic Risks for the Underground Storage Tank Site, Phase II RFI

Potential Exposure Pathways		**Current Use**		**Future Use**	
Environmental Medium	**Potential Exposure Route**	**On-Site Worker[a]**	**Off-Site Resident Adult (Child)**	**Construction Worker**	**On-Site Resident Adult (Child)[b]**
Subsurface Soil	Dermal Contact	NA	NA	NE	NA
	Ingestion	NA	NA	NE	NA
Air	Particulate Inhalation	2.12E-07	NA	NE	3.09E-05[c](3.98E-05)[d]
	Vapor Inhalation	1.12E-10	NA	NA	NE
Groundwater	Dermal Contact	NA	NA	NA	1.55E-04(4.79E-05)
	Ingestion	NA	NA	NA	5.79E-03[e](2.70E-03)[e]
	Vapor Inhalation	NA	NA	NA	3.00E-07(2.10E-07)
Homegrown Produce	Ingestion	NA	NA	NA	NA
Homegrown Beef	Ingestion	NA	NA	NA	1.35E-09 (5.55E-10)
Homegrown Dairy Products	Ingestion	NA	NA	NA	5.73E-10 (6.54E-10)
	Total Cancer Risk	**2.12E-07**	**NA**	**NE**	**5.98E-03 (2.79E-03)**

Notes.—NA denotes not applicable. NE denotes not evaluated due to lack of USEPA Health Criteria for site-related chemicals within this pathway.

[a]Exposure to workers was evaluated based on the time spent at each site during assumed daily visits to each site within SWMU 13. Exposure to airborne chemicals was evaluated based on chemicals measured in surface soil and surface water within this SWMU. The concentrations used for this medium represent SWMU-wide values. Therefore, even if site-specific contamination is absent from surficial soil, exposure from inhalation of particulates and vapors from other sites was assumed to occur.

[b]Beef and milk chemical concentrations represent depot-wide values for TEAD-S. Therefore, the future resident at each site may be exposed to site-specific chemicals and also to those associated with other site locations within SWMU 13 and 17.

[c]Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, and the Pavement Perimeter Site is responsible for almost 90 percent of the total air pathway risk.

[d]Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, the Southwest Wastewater Lagoon, and the Pavement Perimeter Site is responsible for over 90 percent of the total air pathway risk.

[e]Ingestion of arsenic detected in SWMU-wide monitoring wells is responsible for at least 90 percent of the total groundwater pathway risks.

Table 7-15. SWMU 13 Summary of Noncarcinogenic Hazards for the Underground Storage Tank Site, Phase II RFI

Potential Exposure Pathways		Current Use		Future Use	
Environmental Medium	**Potential Exposure Route**	**On-Site Worker[a]**	**Off-Site Resident Adult (Child)**	**Construction Worker**	**On-Site Resident Adult (Child)[b]**
Subsurface Soil	Dermal Contact	NA	NA	**4.39E-08**	NA
	Ingestion	NA	NA	**4.59E-06**	NA
Air	Particulate Inhalation	1.15E-02	NA	NE	1.41E+00(9.21E+00)[c]
	Vapor Inhalation	4.96E-07	NA	NA	8.57E-07(2.67E-06)
Groundwater	Dermal Contact	NA	NA	NA	5.02E-01(2.81E-01)
	Ingestion	NA	NA	NA	7.75E+01[d](9.61E+01)[d]
	Vapor Inhalation	NA	NA	NA	1.38E-02(5.45E-03)
Homegrown Produce	Ingestion	NA	NA	NA	NA
Homegrown Beef	Ingestion	NA	NA	NA	8.30E-05(1.70E-04)
Homegrown Dairy Products	Ingestion	NA	NA	NA	1.57E-04(8.97E-04)
	Total Hazard	1.15E-02	NA	**4.63E-06**	7.54E+01(1.06E+02)

Notes.—NA denotes not applicable. NE denotes not evaluated due to lack of USEPA Health Criteria for site-related chemicals within this pathway. **Bold** type designates site-specific risks (i.e., those potential risks that are attributed to chemicals detected at this site).

[a]Exposure to workers was evaluated based on the time spent at each site during assumed daily visits to each site within SWMU 13. Exposure to airborne chemicals was evaluated based on chemicals measured in surface soil and surface water within this SWMU. The concentrations used for this medium represent SWMU-wide values. Therefore, even if site-specific contamination is absent from surficial soil, exposure from inhalation of particulates and vapors from other sites was assumed to occur.

[b]Beef and milk chemical concentrations represent depot-wide values for TEAD-S. Therefore, the future resident at each site may be exposed to site-specific chemicals and also to those associated with other site locations within SWMU 13 and 17.

[c]Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, and the Southwest Wastewater Lagoon is responsible for over 90 percent of the total air pathway hazard.

[d]Ingestion of arsenic, thallium, and fluoride detected in SWMU-wide monitoring wells is responsible for over 90 percent of the total groundwater pathway hazards.

Future Land Use

Total cancer risk to the construction worker from exposure to site-related chemicals in subsurface soil and air was not estimated because no carcinogens were detected in subsurface soil. Total noncarcinogenic hazard to this receptor was estimated to be 4.63E-06. Total carcinogenic risks to the potential future on-site adult and child resident from exposure to SWMU-wide chemicals in groundwater and air, and to depot-wide chemicals in beef and milk were estimated to be 5.98E-03 and 2.79E-03, respectively. Total noncarcinogenic hazards to these receptors were estimated to be 7.54E+01 and 1.06E+02.

7.3.3.1.5 ***Conclusions.*** The results of the human health risk assessment under the current land use exposure scenario at this site indicate that the estimated cancer risk to the on-site worker of 2.12E-07 is below the 1E-06 State of Utah recommended limit of allowable risk. The total noncarcinogenic hazard to this worker is well below the State of Utah recommended value of 1. This site does not contribute to the total risk or hazard to the off-site resident.

The results of the human health risk assessment under future land use conditions indicate that total noncarcinogenic hazard to a future construction worker is below the State's recommended value of 1. The estimated total cancer risks to the potential future on-site adult and child resident of 5.98E-03 and 2.79E-03, respectively, exceed the State of Utah recommended threshold limit of allowable risk. Total noncarcinogenic hazards to the potential future on-site adult and child resident of 75.4 and 106, respectively, were found to be well above the State of Utah recommended value of 1. Most of this risk/hazard is related to potential ingestion of contaminated groundwater by future on-site residents.

Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, and the Pavement Perimeter Site is responsible for almost 90 percent of the total air pathway cancer risk to the future on-site adult resident. Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, the Southwest Wastewater Lagoon, and the Pavement Perimeter Site is responsible for approximately 90 percent of the cancer risk to the future on-site child resident. These latter sites, with the exception of the Pavement Perimeter Site, are also responsible for over 90 percent of the total noncancer air-pathway hazard to future on-site residents (adults and children). Ingestion of arsenic detected in SWMU-wide monitoring wells is responsible for over 90 percent of the total groundwater pathway risks to future on-site residents (adults and children).

In summary, the only potential risks/hazards that can be attributed to chemicals detected specifically in soils at this site are those associated with the future on-site construction worker. As stated previously (above), no carcinogens were detected in site soils. The total noncarcinogenic hazard to this receptor was found to be well below the State's recommended threshold limit of 1 (for noncancer hazard).

7.3.3.2 *Ecological Risk Assessment*

7.3.3.2.1 *Site Characterization.* The ecological assessment for the Underground Storage Tank Site did not include a survey of vegetation and wildlife, nor a qualitative habitat evaluation. Human activity at this site is frequent. Also, the immediate area of the underground storage tanks is covered with asphalt, concrete, and gravel. The potential wildlife inhabitants include small mammals and birds. This site is not a critical habitat for any endangered or threatened species. No evidence of surface water was observed during the field investigation, and it is unlikely that significant surface water ever accumulates on this site as the result of storm episodes or snow melt. Because of the site condition, locale, and contaminants detected, there appear to be no pathways available for ecological risk.

7.3.3.2.2 *Conclusions.* All COPCs (chlorides, sulfates, and nitrates) to ecological receptors were detected well below the surface (minimum depth of detection was 2 feet). The site is frequently used by humans, is mostly covered with paving or gravel, and is generally fenced. The future use of the site is not projected to change. Because of these reasons, no adverse impacts to ecological receptors should occur.

7.3.4 Conclusions and Recommendations

COPCs associated with the Underground Storage Tank Site are the anions chloride, nitrate, and sulfate in subsurface soils. Although, chloride, nitrate, and sulfate exceed background, it is not likely that these detections represent soil contamination. Chloride and sulfate lack USEPA Health Criteria and, thus, were not evaluated further in the human health risk assessment. These anions are low in toxicity and are unlikely to be of concern.

The human health risk assessment evaluated both the current and future use exposure scenarios at the site. Results of the human health risk assessment under the current land use exposure scenario indicate that carcinogenic risk to the on-site worker is below the State of Utah recommended threshold limit of allowable risk. This site does not include contributions to the total carcinogenic risk to the off-site resident. Total noncarcinogenic hazards to all receptors under the current use conditions were found to be below State of Utah criteria.

Results of the human health risk assessment under future use conditions indicated that carcinogenic risk to the future on-site resident (adult and child) exceed the State of Utah recommended threshold limit for allowable risk. Total noncarcinogenic hazards exceed State of Utah criteria for the future on-site resident but not for the future on-site construction worker. These potential residential risks/hazards were due to SWMU-wide chemicals in air and groundwater and are not related to site-specific contamination.

It is important to emphasize that the exposure point concentrations for air and for beef and milk used in the human health risk assessment were estimated as SWMU-wide and area-wide (over TEAD-S) values, respectively. In so doing, it is possible to estimate an exposure to a receptor at a particular site despite the absence of site-related chemicals in surfical soil. This occurs because it has been assumed that exposure can take place to chemicals originating from other sites within SWMU 13 and/or SWMU 17 via the air pathway and through consumption of homegrown beef and milk products. Similarly, the groundwater exposure point concentrations were also derived as a SWMU-wide average for each chemical. Therefore, to avoid misrepresenting the results of the risk assessment, it is important to distinguish the portion of the risk and hazard estimates that are due to site-related contamination from that due to SWMU-wide and/or area-wide contributions. Recommendations for each site within both SWMUs will be made pursuant to the provisions of Section R315-101-6 of the Utah Hazardous Waste Rules. Since the groundwater medium at SWMU 13 is already being recommended to the CMS (Site Management Plan), the site-specific recommendations will be based on the results of the risk assessment without the groundwater contribution.

The ecological assessment concluded that no adverse impacts should occur to ecological receptors at this site. Lack of suitable habitat, high frequency of human activity, and lack of exposure pathways support this conclusion.

In summary, all available data were used to determine whether past operations at the Underground Storage Tank Site have created an environment that could result in any adverse effects to human health or to the local ecology. Results from the human health assessment indicate that adverse impacts to the future on-site resident at the site may occur primarily as a result of ingestion of contaminated groundwater. However, for reasons explained above and because of the absence of site-related contamination in surface soils, the risk and hazard contributions due to groundwater and airborne chemicals originating from other site locations could be removed to demonstrate that the site-specific risk and hazard are below 1E-06 and 1.0, respectively. In so doing, the criteria in item (c) (1) of R315-101-6 could be met and, therefore, a recommendation for no further action may be made.

7.4 THE 3X YARD

7.4.1 Previous Sampling and Phase II RFI Sampling Results

No formal previous investigation has been conducted at the 3X Yard prior to this Phase II RFI. However, TEAD personnel did collect a soil sample from this site in 1988. Rust E&I investigated this site as part of this Phase II RFI.

TEAD, 1988. A soil sample from the 3X Yard was collected near the SAF Laboratory (Figure 7-26) by TEAD Environmental Management Office personnel in 1988 (Weston 1991). The results from this sample are presented in Table 7-16. They show that chromium was present at a concentration of 70,000 μg/g, mercury at 200 μg/g, cadmium at 13.5 μg/g, and lead at 37 μg/g. All of these contaminants exceeded the estimated background concentration range for the CAMDS area determined in 1988. These four analytes were also detected in the EP extract. Only chromium (2,300 mg/L) exceeded the maximum allowable concentration of 5.0 mg/L (EP toxicity concentration) (Weston 1991).

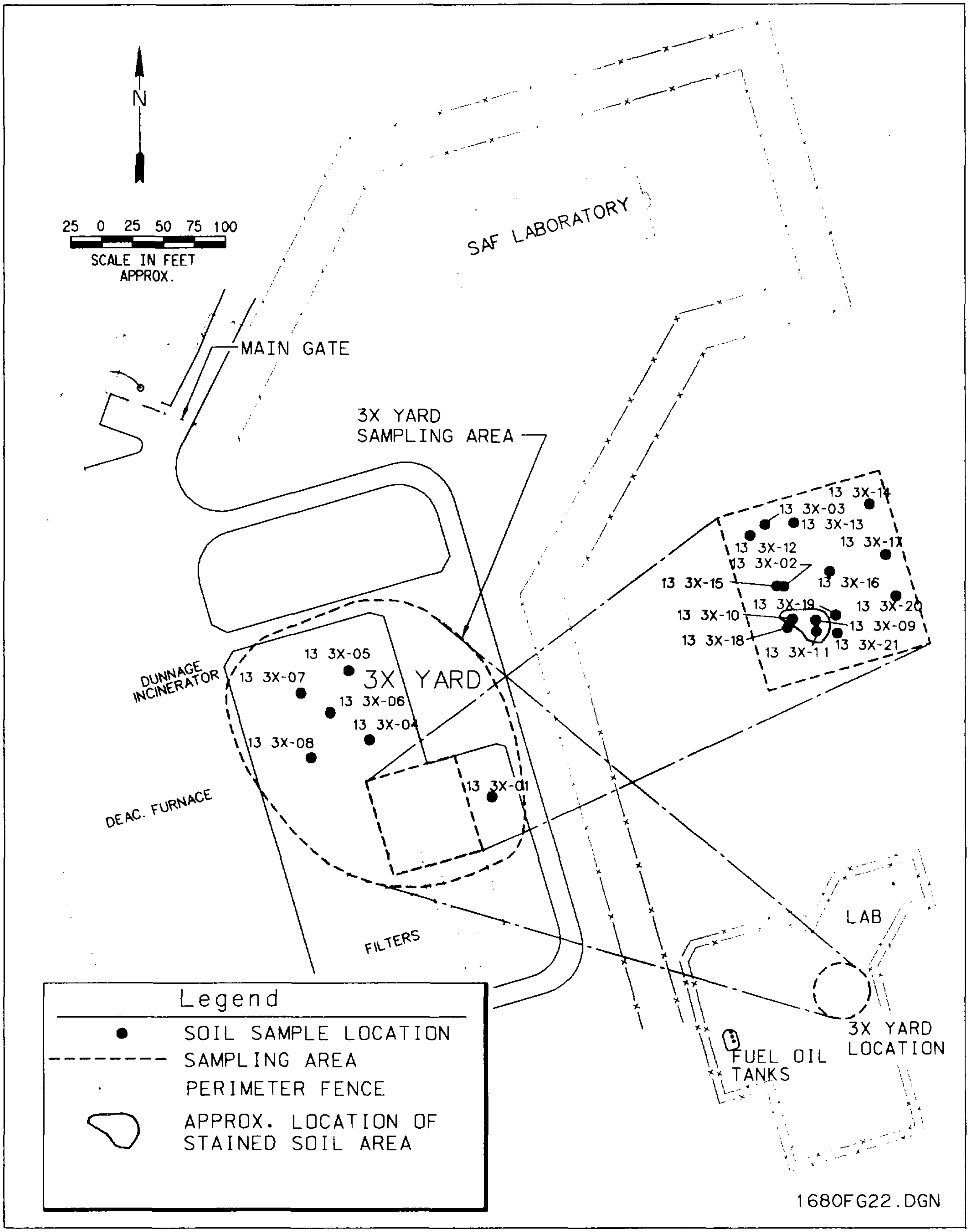

Figure 7-26. Soil Boring Sample Locations at the 3X Yard, SWMU 13

Table 7-16. SWMU 13 Soil Sample Results from a Sample Collected at the 3X Yard, RI, 1991

Analyte	**Soil Sample (μg/g)**	**EP[a] Toxicity[b] (mg/L)**	**Maximum Allowable Concentration (TCLP)[c] (mg/L)**
Arsenic	11.7	<0.01	5.0
Barium	<20	<0.20	100.0
Cadmium	13.5	0.47	1.0
Chromium	70,000	2,300	5.0
Lead	37	0.40	5.0
Mercury	200	0.081	0.2
Selenium	<0.5	<.005	1.0
Silver	<1	<0.01	5.0

[a]EP=extraction procedure.
[b]The EP Toxicity column has been added to Weston's table for comparison purposes.
[c]Toxicity Characteristic Leaching Procedure.

Sources: Weston (1991); 40 CFR 261.24

Rust E&I, 1991. Rust E&I conducted a surface- and subsurface-soil sampling program at the 3X Yard to determine the extent of metals contamination that resulted from the leaking barrels. Eight soil borings were drilled to a depth of 10 feet, and soil samples were collected at depths of 0 to 2, 4 to 5, and 9 to 10 feet from each boring. Samples were analyzed for metals, and one sample (133X-01-2) was analyzed for pH. Results of these sample analyses are presented in Table 7-17, and a complete listing of analytical data for the 3X Yard is presented in Appendix D. Additionally, two surface-soil samples (133X-09 and 133X-10) were collected from areas of obvious ground staining (yellow stain) located near the emergency generator housing (see Figure 7-26).

Arsenic was detected in three subsurface samples and one surface sample ranging from 42.4 to 180 μg/g. These arsenic detections exceeded the background threshold of 16.4 μg/g. Chromium detections exceeded the background threshold of 23.5 μg/g in seven subsurface samples ranging from 25.3 to 36.1 μg/g.

The two surface-soil samples from the stained areas (133X-09 and 133X-10) contained chromium in concentrations of 520 and 66 μg/g, respectively. Arsenic was detected at 42.4 μg/g in sample 133X-09-1.

Sample 133X-02-2, located just north of the stained areas, was analyzed using the Toxicity Characteristic Leaching Procedure (TCLP). The TCLP results for this sample are silver, 460 μg/L; barium, 970 μg/L; cadmium, 30 μg/L; and chromium, 110 μg/L. None of these detections exceed their respective RCRA maximum allowable TCLP concentrations.

Following evaluation of analytical data collected in 1991, it was determined that additional sampling for chromium was necessary in order to further define the horizontal and vertical extent of chromium contamination at the 3X Yard.

Rust E&I, 1993. Rust E&I returned to the 3X Yard as part of the 1993 field investigation in order to further define the extent of chromium contamination present at the site. One soil boring (133X-11) was drilled within the stained area to a depth of 10 feet with soil samples collected from 2-to-3, 4-to-6, and 9-to-10 feet (see Figure 7-26). These samples were analyzed for chromium and yielded no detectable concentrations.

Ten surface-soil samples were collected from a depth of 0-to-6 inches (133X-12 through 133X-21). Seven of these samples detected chromium above the background threshold, ranging from 25.6 μg/g (133X-12) to 758 μg/g (133X-21). Table 7-17 presents the analytical results, and Figure 7-26 shows the location of these samples.

Lower levels of chromium at or near background concentrations were detected at depths ranging from 0.2 to 9.5 feet from soil borings 133X-01, 133X-04, 133X-05, and 133X-06, all of which were located some distance north and east of the spill area. It does not appear that the chromium detected in these borings is related to the spill area, but it is more likely due to natural variation in the background chromium values found within the soils at the 3X Yard. Furthermore, some of the values used to derive background concentrations are higher than

Table 7-17. Soil Sample Results for the 3X Yard, SWMU 13, Phase II RFI

Sample ID	Depth	Metals (μg/g) Arsenic (BKGD[a] 16.4)	Metals (μg/g) Chromium (BKGD 23.5)	pH
133X-01-2	4.5	47.0	27.8	9.96
133X-01-3	9.5	180.0	25.7	--[b]
133X-02-1	1.5	ND[c]	170.0	--
133X-04-1	1.0	ND	24.5	--
133X-05-1	1.0	ND	25.3	--
133X-06-3	9.5	48.2	36.1	--
133X-07-1	1.0	ND	26.4	--
133X-09-1	0.2	42.4	520.0	--
133X-10-1	0.2	ND	66.0	--
133X-12	0.5	--	25.6	--
133X-13	0.5	--	26.8	--
133X-15	0.5	--	26.1	--
133X-16	0.5	--	26.8	--
133X-18	0.5	--	394.0	--
133X-19	0.5	--	71.1	--
133X-21	0.5	--	758.0	--
133X-01-1[d]	1.5			
133X-02-2	5.0			
133X-02-3	9.5			
133X-03-1	1.5			
133X-03-2	4.5			
133X-03-3	9.5			
133X-04-2	4.5			
133X-04-3	9.5			
133X-05-2	4.5			
133X-05-3	9.5			
133X-06-1	1.0			
133X-06-2	4.5			
133X-07-2	4.5			
133X-07-3	9.5			
133X-08-1	1.5			
133X-08-2	4.5			
133X-08-3	9.5			
133X-11-1	3.0			
133X-11-2	6.0			
133X-11-3	10			
133X-14	6.0			
133X-17	6.0			
133X-20	6.0			

[a]BKGD = Background value for specified analyte.
[b]-- = Analysis not performed.
[c]ND = Analyte not detected at or above the CRL, SRL, or MDL.
[d]The following sample IDs, where there were no detected contaminants, are included in the remainder of this table. A comprehensive listing of all the data is presented in Appendix D.

those detected in these borings. However, all chromium concentrations were evaluated through the risk assessment process presented in the following section.

7.4.2 Risk Assessment Results

7.4.2.1 *Baseline Human Health Risk Assessment*

This section presents the results of the sample data screening approach previously described in Section 6.1.1 that led to (1) the selection of the COPCs, (2) the exposure pathways that are labeled in the conceptual site model as being complete, (3) the exposure-point concentrations in each respective environmental medium for those COPCs that have published health criteria, and (4) the carcinogenic and noncarcinogenic risk estimates for each receptor population under current and future land use scenarios.

This section of the report evaluates exposure to COPCs detected in site soils as well as those contaminants measured or modeled in various media from SWMU-wide or depot-wide sources. The direct soil-contact pathway (e.g., ingestion and dermal exposure) is associated with site-specific chemicals. Similarly, ingestion of homegrown produce by future on-site residents is based on those contaminants (if any) measured in surface soil within this site. Site-specific contaminants in soil are also used as model inputs to the air pathway for current off-site residents and the future on-site construction worker.

Current on-site workers and future on-site residents, however, are assumed to be potentially exposed to SWMU-wide chemicals in air (i.e., those chemicals detected in surface media at all of the sites evaluated within SWMU 13). Exposure to SWMU-wide chemicals was also the approach selected for the groundwater pathway. Thus, future on-site residents are assumed to be potentially exposed to groundwater contaminants measured in monitoring wells located across SWMU 13. The results of the groundwater evaluation are also presented separately in Section 7.11.3.1. Finally, ingestion of beef and dairy products by future on-site residents is based on modeling contaminants detected in depot-wide surface soils; cattle are assumed to graze at contaminated sites within SWMU 13 and SWMU 17. Thus, the total cancer risk and noncarcinogenic hazards to the future on-site resident (adult and child) presented in the sections below include those contributions associated with exposures to SWMU-wide contamination in air and groundwater and to depot-wide chemicals in beef and milk.

7.4.2.1.1 ***Chemicals of Potential Concern.*** The soil data for this site were grouped by depth and evaluated in the human health risk assessment accordingly. The COPCs measured in the surface (0 to 1.0 foot) and subsurface (1.0 to 9.5 feet) soil are chromium and arsenic. The measured concentrations for both chemicals are summarized in Table 7-18.

7.4.2.1.2 ***Complete Exposure Pathways.*** The pathways assumed complete at this site are shown on the conceptual site model in Figure 7-18. Exposure by current on-site workers and

Table 7-18. SWMU 13 Summary of Concentrations of Chemicals of Potential Concern in Surface and Subsurface Soil at the 3X Yard, Phase II RFI

Chemical	Background Concentration (mg/kg)	Frequency of Detection	Range of Detects (mg/kg)	Arithmetic Mean Concentration (mg/kg)	95% UCL (mg/kg)
Surface Soil*					
Arsenic	16.4	1/2 (1/4)	**42.4**	NA (19.6)	NA **(37.5)**
Chromium	23.5	12/12 (15/16)	16.2-758.0	163.8 (128.9)	**293.8 (226.9)**
Subsurface Soil					
Arsenic	16.4	3/4	47.0-180.0	71.8	**159.1**
Chromium	23.5	8/23	12.2-170.0	26.9	**38.1**

Note.—NA denotes Not Applicable. **Bold** type designates the exposure point concentration selected for these media.

*Sample locations 13 3X-04-1, 05-1, 06-1, and 07-1 are currently covered with pavement and, thus, were not included in the evaluation under current land use. Under future land use, it was assumed the asphalt would not exist so these data were included in the evaluation. The values in parenthesis were used to evaluate the exposure by potential future on-site residents.

by potential future on-site residents from ingestion of and dermal contact with COPCs measured in surface soil was evaluated. Exposure by future construction workers from ingestion of and dermal contact with site-specific chemicals in subsurface soil was also evaluated. Their inhalation exposure to site-specific chemicals detected in subsurface soils was treated as a complete exposure pathway. Inhalation exposure by off-site residents of site-specific contaminants dispersed from surface soil in ambient air represents the only complete exposure pathway for these receptors. Exposure from inhalation of SWMU-wide airborne chemicals by current on-site workers and potential future on-site residents was also evaluated. This site does not include surface water or lagoon sediments and, thus, exposure pathways associated with these medium are incomplete. Chemicals measured in surface soil (0 to 1.0 foot) at this site were assumed to be available for plant uptake. Therefore, exposure by potential future on-site residents from consumption of vegetables grown at this site was evaluated. Exposure by potential future on-site residents from ingestion of chemicals in beef and milk, derived as depot-wide averages using data collected at SWMUs 13 and 17, was also evaluated. Evaluation of exposure to SWMU-wide chemicals in groundwater by potential future on-site residents is described in Section 7.11.3.1.

The sites within SWMU 13 either overlap or are adjacent to each other so that it was practical to estimate air chemical levels as SWMU-wide concentrations instead of on a site-specific basis. Therefore, exposure from inhalation of SWMU-wide chemical concentrations by the on-site worker during daily visits to this site were included despite the fact that these chemicals were not all present in surficial soil at this location. The modeling approach is presented in detail in Section 6.1.2.3.3. Exposure to air contaminants by future residents was also based on SWMU-wide modeling.

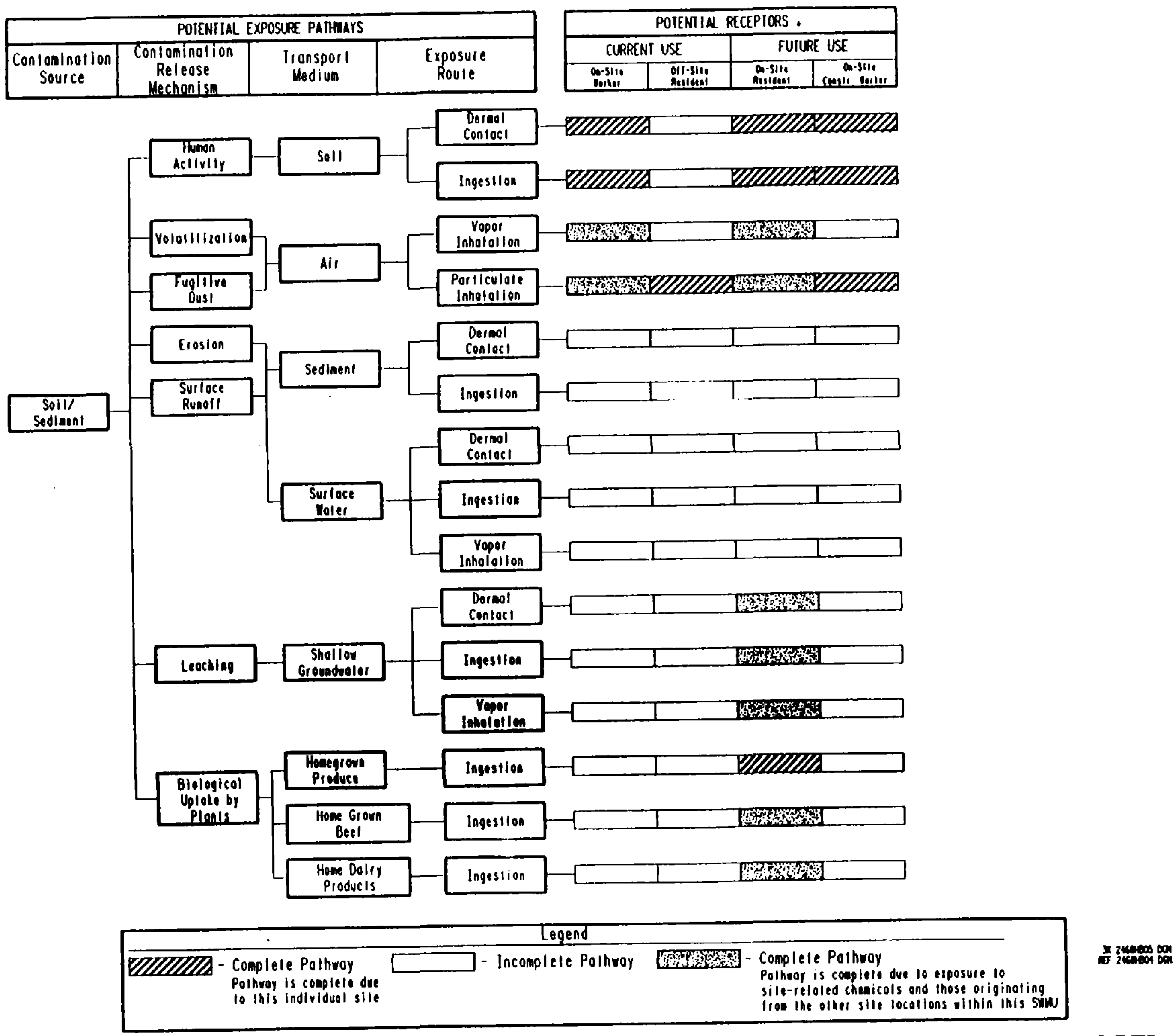

Figure 7-27. SWMU 13 Potential Human Exposure Pathway Conceptual Model for the 3X Yard, Phase II RFI

7.4.2.1.3 *Exposure Point Concentrations*. Exposures from all complete pathways by all the identified receptors are estimated from the exposure-point concentrations in Table 7-19. These values are based on soil chemical concentrations measured in surface and subsurface soil within this site. This table also includes airborne chemicals that originated from other sites within this SWMU that contribute to overall exposures to current workers and future residents, as well as average values for chemicals in beef and milk over all of TEAD-S (vis-à-vis future on-site residents). Exposure to chemicals in groundwater by potential future on-site residents are based on the SWMU-wide exposure point concentrations in Table 7-68.

7.4.2.1.4 *Risk Estimates*. The receptor populations evaluated at this site include the current on-site worker, off-site resident (adult and child), future construction worker, and the potential future on-site resident (adult and child). Cancer risks and noncarcinogenic hazards to these receptor populations were estimated based on exposure to site-specific chemicals in surface soil and subsurface soil (construction worker); SWMU-wide chemicals in air and groundwater; and/or depot-wide contaminants in beef and milk. The results of this evaluation under current and future land use are presented below. These results are also summarized for each exposure pathway in Tables 7-20 and 7-21. Actual risk calculations are presented in Appendix H. Tables 7-20 and 7-21 show in bold font those risks and hazards that are site-specific (i.e., related only to chemicals detected specifically in this site's soils).

<u>*Current Land Use*</u>

Cancer risk to the current on-site worker from direct exposure to site-specific chemicals in surface soil and indirect exposure to SWMU-wide chemicals in air was estimated to be 1.54E-06, and the noncarcinogenic hazard to this receptor was estimated to be 2.22E-02. The contribution of this location to the total cancer risk for the off-site adult was 1.07E-09, and the noncarcinogenic hazard, 5.27E-05. The contribution from this location to total cancer risk for the off-site child resident was 7.50E-10, and total noncarcinogenic hazard, 1.84E-04.

<u>*Future Land Use*</u>

Total cancer risk to the construction worker was estimated to be 9.81E-06, and the total noncarcinogenic hazard, 3.16E-01. These estimates for the construction worker are based entirely on site-specific contamination.

Total cancer risk to the potential future on-site adult and child from exposure to air, soil, beef, milk, produce, and groundwater was estimated to be 6.13E-03 and 2.91E-03, respectively. Total noncarcinogenic hazard to these receptors was estimated to be 7.59E+01 and 1.09E+02, respectively. Site-specific contamination in soil and produce, as well as SWMU-wide chemicals in other media, contributed to these total risks/hazards.

7.4.2.1.5 *Conclusions*. The results of the human health risk assessment under the current land use exposure scenario at this site indicate that the estimated cancer risk to the on-site worker of 1.54E-06 exceeds the recommended State of Utah threshold limit of 1E-06 for

Table 7-19. SWMU 13 Exposure Point Concentrations for the Chemicals of Potential Concern at the 3X Yard, Phase II RFI

Receptor	Chemical	EXPOSURE POINT CONCENTRATIONS								
		Air[a] (mg/m^3)	Soil (mg/kg)	Milk[b] (mg/L)	Beef[b] (mg/g)	Potato[c] (mg/g)	Tomato (mg/g)	Carrot (mg/g)	Lettuce (mg/g)	Beans (mg/g)
On-Site Worker	Arsenic	2.15E-07	42.4	---	---	---	---	---	---	---
	Beryllium	7.76E-09	<Bkgd	---	---	---	---	---	---	---
	Chromium	5.60E-07	293.8	---	---	---	---	---	---	---
	Copper	2.01E-07	<Bkgd	---	---	---	---	---	---	---
	Lead	8.33E-08	ND	---	---	---	---	---	---	---
	Mercury	1.27E-10	<Bkgd	---	---	---	---	---	---	---
	Nickel	1.24E-08	ND	---	---	---	---	---	---	---
	Nitrate	5.00E-07	ND	---	---	---	---	---	---	---
	Uranium	2.64E-09	ND	---	---	---	---	---	---	---
	Zinc	1.31E-06	ND	---	---	---	---	---	---	---
	Acetone	1.30E-05	NA	---	---	---	---	---	---	---
	Chloromethane	1.60E-06	NA	---	---	---	---	---	---	---
	Methylene chloride	2.35E-06	NA	---	---	---	---	---	---	---
	4-Methylphenol	3.16E-10	NA	---	---	---	---	---	---	---
	Methyl isobutyl ketone	1.50E-09	NA	---	---	---	---	---	---	---
	Methyl-n-butyl ketone	7.30E-10	NA	---	---	---	---	---	---	---
Off-Site Resident	Arsenic	3.18E-11	---	---	---	---	---	---	---	---
	Chromium	2.20E-10	---	---	---	---	---	---	---	---

Table 7-19. SWMU 13 Exposure Point Concentrations for the Chemicals of Potential Concern at the 3X Yard, Phase II RFI (continued)

		EXPOSURE POINT CONCENTRATIONS								
Receptor	Chemical	Air[a] (mg/m³)	Soil (mg/kg)	Milk[b] (mg/L)	Beef[b] (mg/g)	Potato[c] (mg/g)	Tomato (mg/g)	Carrot (mg/g)	Lettuce (mg/g)	Beans (mg/g)
Future On-Site Resident	Arsenic	2.1E-06(3.49E-06)	37.5	9.80E-08	1.63E-09	5.60E-05	1.40E-05	2.70E-05	7.50E-05	6.30E-05
	Beryllium	4.81E-08(7.4E-08)	<Bkgd	9.32E-11	3.99E-11	---	---	---	---	---
	Chromium	5.9E-06(1.1E-05)	226.9	7.65E-08	4.00E-09	2.60E-04	6.10E-05	1.20E-04	8.50E-06	2.90E-04
	Copper	1.70E-06(1.0E-05)	<Bkgd	4.41E-05	1.13E-07	---	---	---	---	---
	Lead	1.47E-06(2.94E-06)	ND	1.55E-07	8.16E-11	---	---	---	---	---
	Mercury	6.19E-09(1.24E-08)	<Bkgd	1.03E-09	1.26E-11	---	---	---	---	---
	Nickel	6.02E-07(1.2E-06)	ND	8.52E-08	7.29E-09	---	---	---	---	---
	Nitrate[d]	4.89E-07(6.64E-07)	ND	NA	NA	---	---	---	---	---
	Uranium	1.18E-07(2.35E-07)	ND	2.00E-09	7.71E-12	---	---	---	---	---
	Zinc	1.03E-05(1.73E-05)	ND	4.63E-03	1.78E-05	---	---	---	---	---
	Bis(2-ethylhexyl) phthalate	---	NA	1.24E-09	1.51E-12	---	---	---	---	---
	1,2-Dimethylbenzene	---	NA	3.49E-12	4.25E-15	---	---	---	---	---
	4-Methylphenol	1.26E-08(2.53E-08)	NA	4.07E-10	4.96E-13	---	---	---	---	---
	Methyl isobutyl ketone	8.0E-09(9.5E-09)	NA	6.50E-12	7.92E-15	---	---	---	---	---
	Methyl-n-butyl ketone	4.00E-09(4.80E-09)	NA	---	---	---	---	---	---	---
	Toluene	---	NA	2.48E-12	3.02E-15	---	---	---	---	---
Future Construction Worker	Arsenic	2.07E-06	159.1	---	---	---	---	---	---	---
	Chromium	4.95E-07	38.1	---	---	---	---	---	---	---

Notes.—ND denotes chemical was not detected in site soil. --- denotes not applicable. NA denotes not analyzed. <Bkgd denotes below background.

[a]Air values represent average values for on-site workers and maximum levels for future on-site residents. Values in parenthesis are for the child. Air chemical concentrations are based on corresponding subsurface soil values for the construction worker.

[b]Milk and beef concentrations were derived to evaluate exposure to potential future on-site residents, and represent average values based on data collected from SWMUs 13 and 17.

[c]Vegetable chemical concentrations are based on corresponding soil concentration.

[d]Transfer factors are not available for nitrate.

Table 7-20. SWMU 13 Summary of Carcinogenic Risks for the 3X Yard, Phase II RFI

Potential Exposure Pathways		Potential Receptors			
		Current Use		Future Use	
Environmental Medium	Potential Exposure Route	On-Site Worker[a]	Off-Site Resident Adult (Child)	Construction Worker	On-Site Resident Adult (Child)[b]
Soil	Dermal Contact	**9.43E-08**	NA	9.19E-08	**1.52E-06 (8.17E-07)**
	Ingestion	**1.23E-06**[c]	NA	9.61E-06[c]	**3.30E-05**[c]**(6.16E-05)**[c]
Air	Vapor Inhalation	1.12E-10	NA	NA	NE
	Particulate Inhalation	2.12E-07	**1.07E-09 (7.50E-10)**	**1.08E-07**	3.09E-05[d] (3.98E-05)[e]
Groundwater	Dermal Contact	NA	NA	NA	1.55E-04 (4.79E-05)
	Ingestion	NA	NA	NA	5.79E-03[f] (2.70E-03)[f]
	Vapor Inhalation	NA	NA	NA	3.00E-07 (2.10E-07)
Homegrown Produce	Ingestion	NA	NA	NA	**1.18E-04**[c] **(6.04E-05)**[c]
Homegrown Beef	Ingestion	NA	NA	NA	1.35E-09 (5.55E-10)
Homegrown Dairy Products	Ingestion	NA	NA	NA	5.73E-10 (6.54E-10)
	Total Cancer Risk	0.000002	**1.54E-06 (7.50E-10)**	**9.81E-06**	6.13E-03 (2.91E-03)

Notes.—NA denotes not applicable. NE denotes not evaluated due to lack of USEPA Health Criteria for site-related chemicals within this pathway. *Bold type designates site-specific risks* (i.e., those potential risks that are attributed to chemicals detected at this site).

[a]Exposure to workers was evaluated based on the time spent at each site during assumed daily visits to each site within SWMU 13. Exposure to airborne chemicals was evaluated based on chemicals measured in surface soil and surface water within this SWMU. The concentrations used for this medium represent SWMU-wide values. Therefore, even if site-specific contamination is absent from surficial soil, exposure from inhalation of particulates and vapors from other sites was assumed to occur.

[b]Beef and milk chemical concentrations represent depot-wide values for TEAD-S. Therefore, the future resident at each site may be exposed to site-specific chemicals and also to those associated with other site locations within SWMU 13 and 17.

[c]Ingestion of arsenic detected in this site's soil is responsible for most of the risk.

[d]Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, and the Pavement Perimeter Site is responsible for over 90 percent of the total air pathway risk.

[e]Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, the Southwest Wastewater Lagoon, and the Pavement Perimeter Site is responsible for over 90 percent of the total air pathway risk.

[f]Ingestion of arsenic detected in SWMU-wide monitoring wells is responsible for over 90 percent of the total groundwater pathway risks.

Table 7-21. SWMU 13 Summary of Noncarcinogenic Hazards for the 3X Yard, Phase II RFI

Potential Exposure Pathways		Potential Receptors			
		Current Use		Future Use	
Environmental Medium	Potential Exposure Route	On-Site Worker[a]	Off-Site Resident Adult (Child)	Construction Worker	On-Site Resident Adult (Child)[b]
Soil	Dermal Contact	**8.30E-04**	NA	**2.87E-03**	**1.07E-02 (2.31E-02)**
	Ingestion	**1.09E-02**	NA	**3.00E-01**	**2.33E-01 (1.74E+00)[c]**
Air	Vapor Inhalation	4.96E-07	NA	NA	8.57E-07 (2.67E-06)
	Particulate Inhalation	1.15E-02	**5.27E-05 (1.84E-04)**	**1.32E-02**	1.41E-00 (9.21E+00)[d]
Groundwater	Dermal Contact	NA	NA	NA	5.02E-01 (2.81E-01)
	Ingestion	NA	NA	NA	7.35E+01[e] (9.61E+01)[e]
	Vapor Inhalation	NA	NA	NA	1.38E-02 (5.45E-03)
Homegrown Produce	Ingestion	NA	NA	NA	**7.58E-01 (1.66E+00)[c]**
Homegrown Beef	Ingestion	NA	NA	NA	8.30E-05 (1.70E-04)
Homegrown Dairy Products	Ingestion	NA	NA	NA	1.57E-04 (8.97E-04)
	Total Hazard	2.32E-02	**5.27E-05 (1.84E-04)**	**3.16E-01**	7.59E+01 (1.09E+02)

Notes.—NA denotes not applicable. Bold type designates site-specific hazards (i.e., those potential hazards that are attributed to chemicals detected at this site).

[a]Exposure to workers was evaluated based on the time spent at each site during assumed daily visits to each site within SWMU 13. Exposure to airborne chemicals was evaluated based on chemicals measured in surface soil and surface water within this SWMU. The concentrations used for this medium represent SWMU-wide values. Therefore, even if site-specific contamination is absent from surficial soil, exposure from inhalation of particulates and vapors from other sites was assumed to occur.

[b]Beef and milk chemical concentrations represent depot-wide values for TEAD-S. Therefore, the future resident at each site may be exposed to site-specific chemicals and also to those associated with other site locations within SWMU 13 and 17.

[c]Ingestion of arsenic detected in this site's soil is responsible for most of the hazard.

[d]Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons,and the Southwest Wastewater Lagoon is responsible for over 90 percent of the total air pathway hazard.

[e]Ingestion of arsenic, thallium, and fluoride detected in SWMU-wide monitoring wells is responsible for over 90 percent of the total groundwater pathway hazards.

allowable risk. Ingestion of arsenic in this site's soil is responsible for 100 percent of this risk.

The contribution to the total cancer risks to the off-site residents (adult and child) from this location are well below this threshold. Noncarcinogenic hazards to all receptors associated with this site under current land use conditions were found to be well below the State of Utah recommended value of 1.

The results of the human health risk assessment under future land use conditions indicate that the estimated total cancer risk to the potential future on-site adult and child resident of 6.13E-03 and 2.91E-03, respectively, exceed the State of Utah recommended threshold limit of allowable risk. Total cancer risk to a future construction worker was also found to exceed this allowable limit. Total noncarcinogenic hazards to the potential future on-site adult and child resident of 76 and 109, respectively, were found to be well above the State of Utah recommended value of 1. Total noncarcinogenic hazard to a future construction worker was found to be below this value.

Ingestion of arsenic detected in this site's soil is responsible for 100 percent of the potential cancer risks associated with the soil pathway for the future construction worker and the future on-site residents and with the consumption of homegrown produce for these residents. Ingestion of arsenic detected in this site's soil is also responsible for most of the potential noncancer hazards associated with soil contact and consumption of homegrown produce by the future on-site child resident.

Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, and the Pavement Perimeter Site is responsible for almost 90 percent of the total air pathway cancer risk to the future on-site adult resident. Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, the Southwest Wastewater Lagoon, and the Pavement Perimeter Site is responsible for approximately 90 percent of the cancer risk to the future on-site child resident. These latter sites, with the exception of the Pavement Perimeter Site, are also responsible for over 90 percent of the total noncancer air-pathway hazard to the future on-site child resident. Ingestion of arsenic detected in SWMU-wide monitoring wells is responsible for over 90 percent of the total groundwater pathway risks to future on-site residents (adults and children).

7.4.2.2 *Ecological Risk Assessment*

7.4.2.2.1 *Site Characterization.* The ecological assessment for the 3X Yard included a survey of the minimal vegetation and wildlife, and a qualitative habitat evaluation. This assessment did not include collection of either vegetation or wildlife samples for analysis. Human activity at this site is frequent. The site is fenced, and there is no indication that this area is a critical habitat for any endangered or threatened species. Species of vegetation and wildlife that have been observed at the 3X Yard include Russian thistle, shadscale, jackrabbits, and deer mice.

No evidence of surface water was observed during the field investigation. It is unlikely that significant surface water ever accumulates on this site as the result of storm episodes or snow melt.

7.4.2.2.2 *Conclusions.* Because this site exists entirely inside the fence at the CAMDS facility, is frequented by humans, and lacks suitable habitat, the potential of COPCs (arsenic and chromium) either directly or indirectly affecting receptor species is unlikely because of the amount of time wildlife would spend inside this area. The use of the site is not projected to change, so that no future adverse impacts to ecological receptors should occur.

7.4.3 Conclusions and Recommendations

COPCs associated with the 3X yard are the metals arsenic and chromium in surface and subsurface soils. The soil borings drilled during the 1991 and 1993 field efforts defined the horizontal and vertical extent of chromium as being contained in near surface soils in the immediate area of the potassium dichromate spill, as discussed in Section 7.4.2. Arsenic was detected above background (180 μg/g) in only one sample, and this does not appear to be due to facility operations.

The human health risk assessment evaluated both the current and future use exposure scenarios at the site. Results of the human health risk assessment under the current land use exposure scenario indicate that carcinogenic risk to the on-site worker exceeds the State of Utah recommended limit of allowable risk (due primarily to arsenic detected in site soil), but the contribution to the total carcinogenic risk to the off-site resident is well below the State of Utah limit. Noncarcinogenic hazards to all receptors under the current use conditions were found to be below State of Utah goal of 1.

Results of the human health risk assessment under future use conditions indicated that carcinogenic risk to the future on-site resident (adult and child) exceeded the State of Utah recommended limit for allowable risk (due to site-specific as well as SWMU-wide contamination). The risk to the future on-site construction worker exceeds the State of Utah recommended limit for allowable risk (due primarily to arsenic detected in site soil). Noncarcinogenic hazards exceed State of Utah criteria for future on-site residents but not for the future on-site construction worker.

It is important to emphasize that the exposure point concentrations for air and for beef and milk used in the human health risk assessment were estimated as SWMU-wide and area-wide (over TEAD-S) values, respectively. In so doing, it is possible to estimate an exposure to a receptor at a particular site despite the absence of site-related chemicals in surfical soil. This occurs because it has been assumed that exposure can take place to chemicals originating from other sites within SWMU 13 and/or SWMU 17 via the air pathway and through consumption of homegrown beef and milk products. Similarly, the groundwater exposure point concentrations were also derived as a SWMU-wide average for each chemical. Therefore, to avoid misrepresenting the results of the risk assessment, it is important to distinguish the portion of the risk and hazard estimates that are due to site-related contamination from that due to SWMU-wide and/or depot-wide contributions. Recommendations for each site within both SWMUs will be made pursuant to the provisions of Section R315-101-6 of the Utah Hazardous Waste Rules. Since the groundwater medium at SWMU 13 is already being recommended to the CMS (Site Management Plan), the site-specific recommendations will be based on the results of the risk assessment without the groundwater contribution.

In summary, all available data were used to determine whether past operations at the 3X Yard has created an environment that could result in any adverse effects to human health or to the local ecology. Results from the human health assessment indicate that adverse impacts to the future on-site resident at the site may occur primarily due to direct on-site soil contact and due to contact with contaminated groundwater although it is not expected that this site will become available for residency in the future. At this site, even if that portion of the risk and hazard contributed by SWMU-wide contaminants was removed as described above, the criteria in item (d) of R315-101-6 would be satisfied. This is because the risk under current land use would be less than 1E-04 but greater than 1E-06 under on-site residential land use. Therefore, this site should be carried through the CMS but not necessarily include provisions for corrective action. Instead, the CMS should, for this site, include management activities such as monitoring, deed notations, site security, etc.

7.5 BOILER BLOWDOWN DISCHARGE SITE

7.5.1 Previous Investigations and Phase II RFI Sampling Results

Previous investigations of the Boiler Blowdown Discharge Site were conducted by EA (1988) and Weston (1991). Rust E&I also investigated this site as part of this Phase II RFI.

EA, 1988. As part of the PA/SI field program conducted at TEAD, one sample (SR-CAM-1) of the boiler blowdown discharge fluid was collected and analyzed for explosives, agent breakdown products, VOCs, SVOCs, total phenols, total metals, inorganics, and gross alpha and gross beta radionuclides. Figure 7-28 shows the sample location, and Table 7-22 summarizes the analytical results.

No VOCs or agent breakdown products were detected in the sample. Only one SVOC, bis(2-ethylhexyl)phthalate at 2 μg/L, was detected. This detection is likely due to laboratory contamination as phthalate esters are listed on the USEPA list of common laboratory contaminants. The explosive compound tetryl was found at a concentration of 5.6 μg/L; however, the collected sample was reported to contain a great deal of sediment, so the tetryl may have come from the sediment rather than the boiler blowdown discharge. There is no federal or state drinking water standard for tetryl. For comparison, Oak Ridge National Laboratory (ORNL 1992) estimated from a reference dose value for tetryl that human consumption of drinking water having up to 350 μg/L of tetryl should result in no adverse

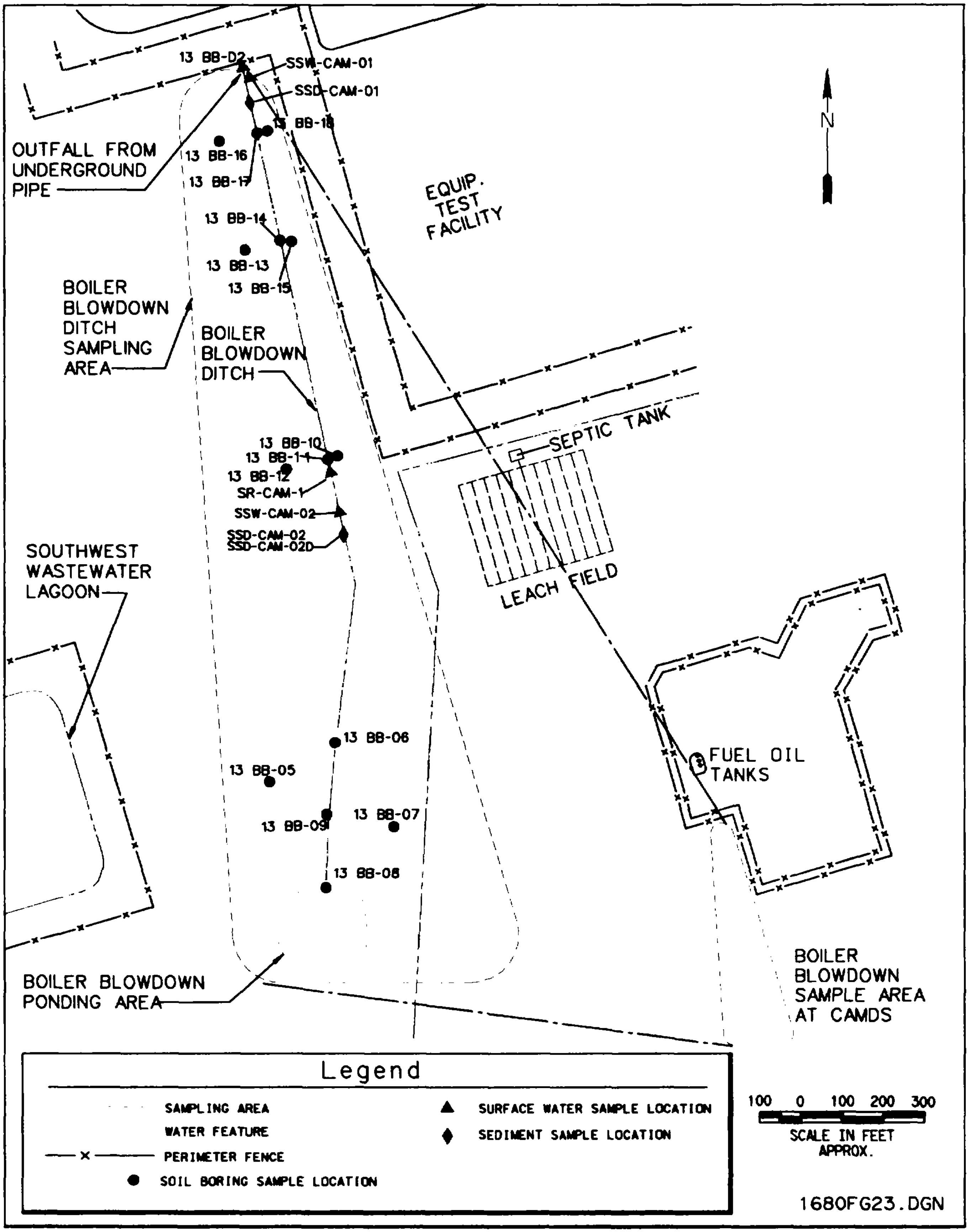

Figure 7-28. Surface Water, Sediment, and Soil Sample Locations at the Boiler Blowdown Discharge Site, SWMU 13

Table 7-22. SWMU 13 Wastewater Sample Results Collected at the Boiler Blowdown Discharge Site, PA/SI, 1988

Parameters[a]	SR-CAM-1 (μg/L)
Semi-Volatiles	
Bis(2-ethylhexyl)phthalate	2[b]
Explosives	
Tetryl	5.6
Metals	
Arsenic	12.7
Barium	49
Chromium	11.4
Copper	25
Lead	19
Silver	0.22
Sodium (mg/l)	122
Zinc	47
Inorganics	
Chloride (mg/l)	74
NO_2+NO_3 Nitrogen	840
Orthophosphate	3,300
Sulfate (mg/l)	60

Note.—The parameters listed were determined according to methods not certified by USATHAMA.
[a]Units are μg/l unless otherwise noted.
[b]Suspected laboratory contaminant.

Source: EA, 1988.

health effects following daily ingestion for a lifetime. Seven metals were detected, but none exceed Federal or State drinking water standards. Sodium was detected at 122,000 μg/L, which exceeds the USEPA recommended maximum concentration of 20,000 μg/L for a person on a sodium-restricted diet. Chloride, nitrate/nitrite, and sulfate were also detected at levels below drinking water standards. Orthophosphate was detected at 3,300 μg/L; there is no regulatory standard for this compound.

Weston, 1991. As a follow-up to the EA sampling, Weston (1991) collected a surface-water sample (SSW-CAM-01) and a sediment sample (SSD-CAM-01) at the point of boiler blowdown discharge (Figure 7-28). In addition, a surface-water sample (SSW-CAM-02) and a sediment sample (SSD-CAM-02) were collected from the boiler blowdown discharge area, which lies south of the discharge point. The samples were analyzed for VOCs, SVOCs, petroleum hydrocarbons, explosives, and anions only. The analytical results for these samples are presented in Tables 7-23 and 7-24.

No VOCs were detected in the surface-water and sediment samples. Unknown SVOCs were detected in both of the surface-water samples and in one of the sediment samples (SSD-CAM-02). The samples that were collected from the discharge area south of the discharge point contained the highest concentrations of these unknown SVOCs (210 μg/L in SSW-CAM-02 and 103 μg/g in SSD-CAM-02). Most of the SVOCs were tentatively identified as alkanes, which suggested the presence of fuel contamination. Petroleum hydrocarbons were detected in all of the surface-water and sediment samples, which also suggests fuel contamination. The highest concentrations of petroleum hydrocarbons occurred in the samples from the discharge point (7,020 μg/L in SSW-CAM-01 and 13,000 μg/g in SSD-CAM-01). There is no regulatory standard for petroleum hydrocarbons in drinking water; the State of Utah has an action level of 30 μg/g for TPHCs in soil.

The surface-water sample from the discharge point also showed a detection of the explosive compound 1,3,5-trinitrobenzene at a concentration of 4.34 μg/L. This result is similar to the study by EA (1988), which detected the explosive compound tetryl at 5.6 μg/L in a surface-water sample from this location. As with tetryl, there is no regulatory drinking water standard for 1,3,5-trinitrobenzene. For comparison, ORNL (1992) estimated from a reference dose value that human consumption of drinking water having up to 2 μg/L of 1,3,5-trinitrobenzene should result in no adverse health effects following daily ingestion for a lifetime.

The nitrate/nitrite results are the only anions that are discussed in Weston (1991). Nitrates and nitrites (as nitrogen) were not detected in the surface-water and sediment samples. However, the samples had very high detection limits (5,000 μg/L for surface water and greater than 15,000 μg/g for sediment), so the sampling results are inconclusive. The detection limit for surface water exceeded the nitrate/nitrite detection of 840 μg/L in the surface-water sample from the EA (1988) study.

Rust E&I, 1991. To confirm the results of the previous investigations and to further define the extent of contamination related to the Boiler Blowdown Discharge Site, Rust E&I collected a surface-water sample (13BB-D) from the boiler blowdown ditch and collected soil samples

Table 7-23. SWMU 13 Surface-Water Sample Results for the Boiler Blowdown Discharge Site RI, 1991

Parameter	Sample I.D. SSW-CAM-01 (all concentrations in μg/L)	SSW-CAM-02
Semi-Volatile Organic Compounds		
Unknowns	10 [1][a]	210 [4]
Explosives		
1,3,5-Trinitrobenzene	4.34	LT[b] (2.66)
Petroleum Hydrocarbons	7,020	3,860
Anions		
Nitrate/Nitrite	LT (5,000)	LT (5,000)

[a]The number in brackets indicates the number of unknown compounds detected.
[b]LT=analyte detection was less than the reporting limit; reporting limit is given in parentheses.

Table 7-24. SWMU 13 Sediment Sample Results for the Boiler Blowdown Discharge Site,RI, 1991

	Sample I.D.		
Parameter	**SSD-CAM-01**	**SSD-CAM-02**	**SSD-CAM-02D[(a)]**
	(all concentrations in μg/g)		
Semi-Volatile Organic Compounds			
Unknowns	none detected	103[(c)] [19][(b)]	[19][(b)] 8 [5]
Petroleum Hydrocarbons	13,000	12,000	2,100
Anions			
Nitrate/Nitrite	LT (15,500)[(d)]	LT (16,200)	LT (15,100)

[a]Duplicate sample of SSD-CAM-02.
[b]The number in brackets indicates the number of unknown compounds detected.
[c]Highest concentration among unknown compounds.
[d]LT = analyte detection was less than the reporting limit; reporting limit is given in parentheses.

Source: Weston, 1991.

from the ditch and ponding areas (see Figure 7-28). The surface-water sample was analyzed for metals, VOCs, and explosives. Table 7-25 presents a summary of the sampling results. No metals were detected. Two VOCs were detected: methylene chloride at 10.8 μg/L and chloromethane at 7.43 μg/L. Cyclotetramethylenetetranitramine (HMX) at 2.89 μg/L was the only explosive detected. This is consistent with the other detections of explosives at low concentrations in surface water by the previous investigations at this site.

The soil-sampling program included 14 soil borings, which were drilled in and immediately adjacent to the boiler blowdown ditch and ponding area to a nominal depth of 10 feet. Three soil samples were collected from each boring: one near-surface sample from depths of 0.5 to 3 feet; one mid-depth sample from depths of 4.5 to 7 feet; and 1 deeper sample from near the water table at depths of 8 to 11 feet. The soil samples were analyzed for TPHC, and detected concentrations ranged from 165 μg/g to 1,030 μg/g. One soil sample was also analyzed for total organic carbon, soil pH, moisture, grain size, and bulk density. Table 7-28 summarizes the analytical results for the soil samples, and Figure 7-28 shows the sample locations.

Detections of TPHC were limited to four soil samples near the discharge point of the boiler blowdown (Figure 7-24, Table 7-25): 216.0 μg/g TPHC in 13BB-14-1 from a depth of 0.5 feet; 805.0 μg/g TPHC in 13BB-15-1, from a depth of 3.0 feet; 1,030.0 μg/g TPHC in 13BB-16-3 from a depth of 10.5 feet; and 165.0 μg/g TPHC in 13BB-17-1 from a depth of 0.5 feet. All four detections exceed the State of Utah cleanup standards of 30 μg/g for gasoline-related TPHCs and 100 μg/g for diesel-related TPHCs in soil. Three of the samples containing petroleum hydrocarbons were located in the shallow subsurface (0.5 to 3 feet), indicating that the ditch is a likely source of the contaminants.

The presence of petroleum hydrocarbons in the fourth sample, 13BB-16-3, which also showed the highest concentration of TPHC, may be the result of shallow groundwater contamination. As explained in the section on groundwater contamination (Section 7.11), there is free hydrocarbon product floating on the groundwater table in monitoring wells that lie 150 to 300 feet north of the Boiler Blowdown Discharge Site (wells S-CAM-1, S-CAM-2, S-26-88, S-27-88, and S-28-88; see Figure 7-8). The depth to groundwater is approximately 10 feet, and high concentrations of TPHC are expected in soils near the groundwater table in the vicinity of the contaminated wells. TPHC contamination of soils associated with the floating product could extend as far south as the boiler blowdown discharge area. This possibility is further supported by the lack of TPHC detections in soil samples from depths of 4 to 7 feet, which indicates that hydrocarbon contamination associated with the discharge ditch is limited to near-surface soil.

<u>Rust E&I, 1993</u>. During the 1993 field investigation, Rust E&I collected one surface-water sample (13BB-D2) above the point where the water enters the ditch to determine if the discharge water is a potential source of contamination. This sample was analyzed for TPHCs and explosives. No TPHCs were detected. One explosive, 2,6-dinitrotoluene, was detected at 3.44 μg/L; however, a confirmatory analysis was performed and could not confirm the initial analysis. Table 7-25 presents the analytical results and Figure 7-28 shows the location of this sample.

Table 7-25. Surface Water and Soil Sample Results for the Boiler Blowdown Discharge Site, Phase II RFI

		VOC (μg/L)		Explosives (μg/L)		TPHCs[a] (μg/g)	pH	TOCs[b] (μg/g)
Sample ID	**Depth**	**Chloromethane**	**Methylene Chloride**	**2,6-Dinitrotoluene**	**HMX[c]**			
Surface Water Sample								
13BB-D	--[d]	7.43	10.8	ND[e]	2.89	--	--	--
13BB-D2	--	--	--	3.44	ND	--	--	--
Soil Sample								
13BB-07-2	5	--	--	--	--	ND	11.5	11,100
13BB-14-1	0.5	--	--	--	--	216	--	--
13BB-15-1	3	--	--	--	--	805	--	--
13BB-16-3	10.5	--	--	--	--	1,030	--	--
13BB-17-1	0.5	--	--	--	--	165	--	--
13BB-05-1[f]	0.5							
13BB-05-2	4.5							
13BB-05-3	8.0							
13BB-06-1	0.5							
13BB-06-2	4.5							
13BB-06-3	8.0							
13BB-07-1	0.5							
13BB-07-3	9.5							
13BB-08-1	0.5							
13BB-08-2	4.5							

Table 7-25. Surface Water and Soil Sample Results for the Boiler Blowdown Discharge Site, Phase II RFI (continued)

		VOC (µg/L)		Explosives (µg/L)		TPHCs[a] (µg/g)	pH	TOCs[b] (µg/g)
Sample ID	Depth	Chloromethane	Methylene Chloride	2,6-Dinitrotoluene	HMX[c]			
13BB-08-3	9.5							
13BB-09-1	0.5							
13BB-09-2	4.5							
13BB-09-3	9.5							
13BB-10-1	2.0							
13BB-10-2	6.0							
13BB-10-3	10							
13BB-11-1	0.5							
13BB-11-2	4.5							
13BB-11-3	9.5							
13BB-12-1	2.0							
13BB-12-2	6.0							
13BB-12-3	10							
13BB-13-1	2.5							
13BB-13-2	6.5							
13BB-13-3	10.5							
13BB-14-2	4.5							
13BB-14-3	9.5							
13BB-15-2	7.0							

Table 7-25. Surface Water and Soil Sample Results for the Boiler Blowdown Discharge Site, Phase II RFI (continued)

		VOC (μg/L)		Explosives (μg/L)		TPHCs[a] (μg/g)	pH	TOCs[b] (μg/g)
Sample ID	**Depth**	**Chloromethane**	**Methylene Chloride**	**2,6-Dinitrotoluene**	**HMX[c]**			
13BB-15-3	11							
13BB-16-1	2.5							
13BB-16-2	6.5							
13BB-17-2	4.5							
13BB-17-3	9.5							
13BB-18-1	2.5							
13BB-18-2	6.5							
13BB-18-3	10.5							

[a]TPHCs = Total Petroleum Hydrocarbons.
[b]TOCs = Total Organic Carbon.
[c]HMX = Cyclotetramethylenetetranitramine.
[d]-- = Analysis not performed
[e]ND = Analyte not detected at or above the CRL, SRL or MDL.
[f]The following sample IDs, where there were no detected contaminants, are included in the remainder of this table. A comprehensive listing of all the data is presented in Appendix D.

7.5.2 Nature and Extent of Contamination

Low concentrations of explosives have been detected in surface-water samples from the Boiler Blowdown Discharge Site. Although there are no Federal or State water quality criteria for explosives, the concentrations detected in surface water are low when compared with estimates of explosives concentrations in water that would present a health risk. Petroleum hydrocarbons and a number of unknown SVOCs have also been detected at the Boiler Blowdown Discharge Site. Most of the unknowns have been tentatively identified as alkanes, which is consistent with the petroleum hydrocarbon contamination. The only VOCs detected are low concentrations of methylene chloride and chloromethane in one surface-water sample. Methylene chloride and chloromethane are not suspected to be associated with the site and are commonly found as contaminants in laboratory analysis. An adequate comparison of both methylene chloride and chloromethane with a quality control sample was not possible; however, these two VOCs were evaluated through the risk assessment process discussed in the following section. No metals above background were detected at the site during this Phase II RFI.

Unknown SVOCs have also been detected in soil samples. As with the surface water, most of these unknowns have been tentatively identified as alkanes, which is consistent with the petroleum hydrocarbon contamination. No VOCs, explosives, or anions were detected in sediment samples from this site.

The horizontal and vertical extent of petroleum hydrocarbon contamination in soils appears to be limited to near surface soils in the upper confines of the discharge ditch near the discharge point. The presence of petroleum hydrocarbons in 13BB-16-3, which also showed the highest concentration of TPHC, may be the result of shallow groundwater contamination. As explained in the section on groundwater contamination (Section 7.11), there is free hydrocarbon product floating on the groundwater table in monitoring wells that lie 150 to 300 feet north of the Boiler Blowdown Discharge Site (wells S-CAM-1, S-CAM-2, S-26-88, S-27-88, and S-28-88; see Figure 7-8). The depth to groundwater is approximately 10 feet, and high concentrations of TPHC are commonly detected in soils near the groundwater table in the vicinity of the contaminated wells. TPHC contamination of soils associated with the floating product may extend as far south as the boiler blowdown discharge area. This possibility is further supported by the lack of TPHC detections in soil samples from depths of 4 to 7 feet, indicating that hydrocarbon contamination associated with the boiler blowdown discharge ditch is limited to near surface soil.

7.5.3 Risk Assessment Results

7.5.3.1 *Baseline Human Health Risk Assessment*

This section presents the results of the sample data screening approach previously described in Section 6.1.1 that led to (1) the selection of the COPCs, (2) the exposure pathways that are labeled in the conceptual site model as being complete, (3) the exposure point concentrations in each respective environmental medium for those COPCs that have published health criteria, and (4) the carcinogenic and noncarcinogenic risk estimates for each receptor population under current and future land use scenarios.

This section of the report evaluates exposure to COPCs detected in site soils as well as those contaminants measured or modeled in various media from SWMU-wide or depot-wide sources. The direct soil-contact pathway (e.g., ingestion and dermal exposure) is associated with site-specific chemicals. Similarly, ingestion of homegrown produce by future on-site residents is based on those contaminants (if any) measured in surface soil within this site. Site-specific contaminants in soil are also used as model inputs to the air pathway for current off-site residents and the future on-site construction worker.

Current on-site workers and future on-site residents, however, are assumed to be potentially exposed to SWMU-wide chemicals in air (i.e., those chemicals detected in surface media at all of the sites evaluated within SWMU 13). Exposure to SWMU-wide chemicals was also the approach selected for the groundwater pathway. Thus, future on-site residents are assumed to be potentially exposed to groundwater contaminants measured in monitoring wells located across SWMU 13. The results of the groundwater evaluation are also presented separately in Section 7.11.3.1. Finally, ingestion of beef and dairy products by future on-site residents is based on modeling contaminants detected in depot-wide surface soils; cattle are assumed to graze at contaminated sites within SWMU 13 and SWMU 17. Thus, the total cancer risk and noncarcinogenic hazards to the future on-site resident (adult and child) presented in the sections below include those contributions associated with exposures to SWMU-wide contamination in air and groundwater and to depot-wide chemicals in beef and milk.

7.5.3.1.1 ***Chemicals of Potential Concern.*** The surface and subsurface soils within this site were sampled and found to contain TPHC at levels ranging between 165 and 1,030 μg/g. Other than the existing State of Utah regulatory action level of 30 μg/g (gas) to 100 μg/g (diesel), there is no USEPA Health Criteria for TPHC and, thus, it was not evaluated further. The surface water within this site was sampled and found to contain VOCs and SVOCs. Methylene chloride and chloromethane were measured at levels of 10.8 and 7.43 μg/L, respectively. HMX and 2,6-dinitrotoluene were also measured at levels of 2.89 and 3.44 μg/L, respectively, although the analysis for 2,6-dinitrotoluene was unconfirmed.

7.5.3.1.2 ***Complete Exposure Pathways.*** The pathways assumed to be complete at this site are shown in the conceptual site model in Figure 7-29. Exposure pathways associated with site-specific soil contamination (dermal contact, ingestion, and plant uptake) for the current on-site worker, future construction worker, and potential future on-site resident are shown to be complete on the conceptual site model. However, since exposure to TPHC cannot be evaluated, these pathways were not included in the human health risk assessment. Likewise, inhalation of TPHC vapors by off-site residents and future construction workers could not be evaluated quantitively although this pathway is potentially complete (Figure 7-29). The

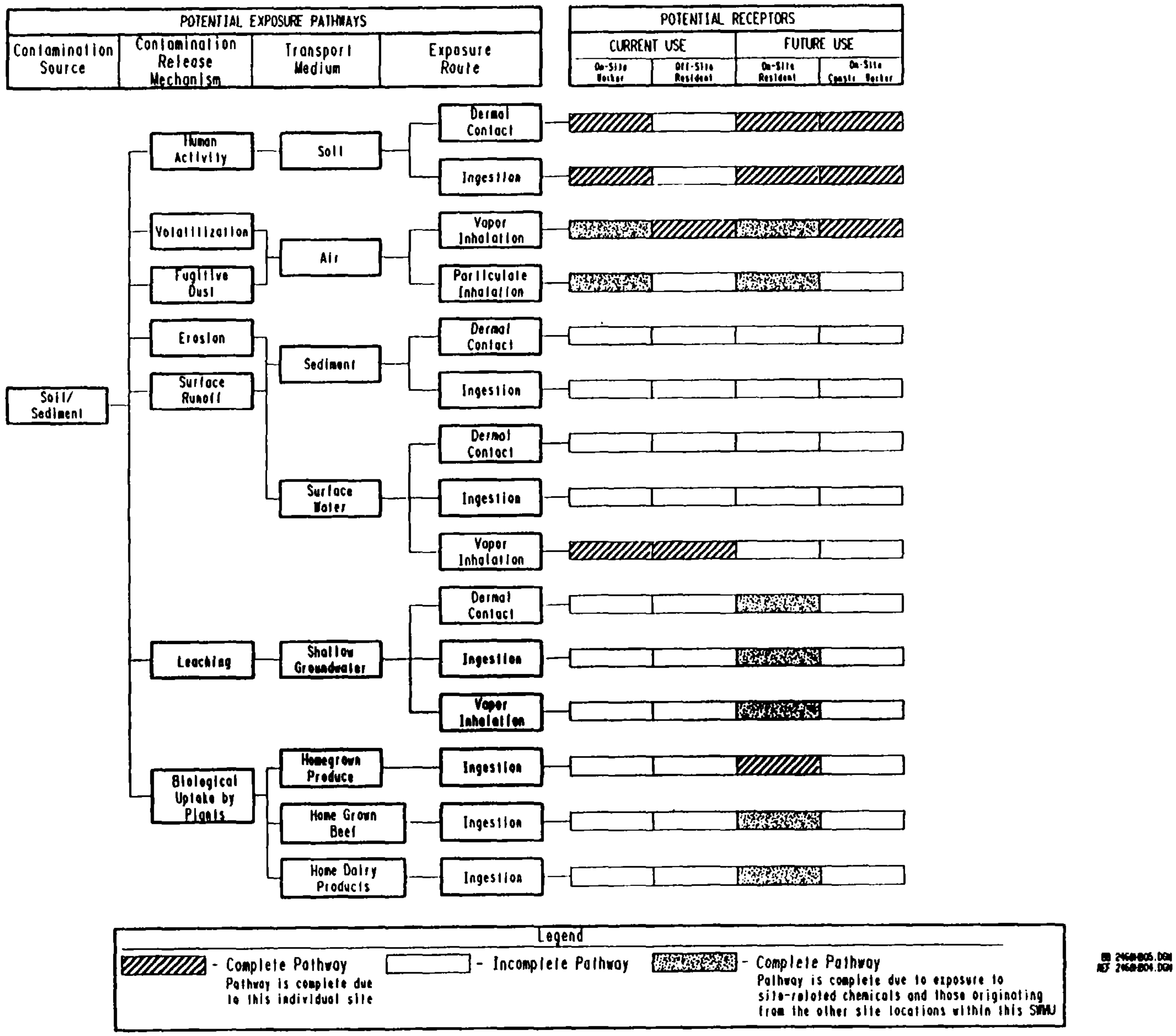

Figure 7-29. SWMU 13 Potential Human Exposure Pathway Conceptual Model for the Boiler Blowdown Discharge Site, Phase II RFI

surface water at this site was assumed to be inaccessible to on-site workers. However, exposure from inhalation of methylene chloride and chloromethane vapors from this site's surface water by current on-site workers and off-site residents was evaluated. The evaluation under future use conditions was based on the assumption that wastewater discharges to this site would discontinue and, thus, this medium would not contribute to any exposure by potential future on-site residents. Evaluation of exposure to SWMU-wide chemicals in groundwater by potential future on-site residents is described in Section 7.11.3.1.

Inhalation exposure by off-site residents of site-specific contaminants dispersed from surface water in ambient air represents the only complete exposure pathway for off-site residents.

The sites within SWMU 13 either overlap or are adjacent to each other so that it was practical to estimate air chemical levels as SWMU-wide concentrations instead of on a site-specific basis. Therefore, exposure from inhalation of SWMU-wide chemical concentrations by the on-site worker during daily visits to this site were included despite the fact that these chemicals were not all present in surficial media at this location. The modeling approach is presented in detail in Section 6.1.2.3.3. Exposure to air contaminants by future residents was also based on SWMU-wide modeling. Similarly, exposure by potential future on-site residents from ingestion of chemicals in beef and milk, derived as depot-wide averages using data collected at SWMUs 13 and 17, was also evaluated.

7.5.3.1.3 ***Exposure Point Concentrations.*** Exposure to airborne chemicals by the current on-site worker is based on SWMU-wide concentrations in air. Exposure to chemicals in beef and milk by potential future on-site residents is based on average values derived for all of TEAD-S using data collected from sites within both SWMUs. These exposure point concentrations were not summarized for this site since they are not unique and may actually be viewed from the same table at any other site within SWMU 13 (see Table 7-10). In addition to methylene chloride and chloromethane (detected in this site's surface water), this table includes airborne chemicals that originated from other sites within this SWMU that also contribute to overall worker exposure at this location, as well as the average values for chemicals in beef and milk use to estimate exposure by the future on-site resident. Exposure to chemicals in groundwater by potential future on-site residents is based on the SWMU-wide exposure point concentrations in Table 7-68.

Exposure associated with inhalation by off-site residents of ambient air potentially contaminated with methylene chloride and chloromethane (dispersed from the site's surface water) are based on a modeled (annual average) air concentration of 1.60E-09 for methylene chloride and 1.10E-09 mg/m^3 for chloromethane.

7.5.3.1.4 ***Risk Estimates.*** The receptor populations evaluated at this site include the current on-site worker, off-site residents, and potential future on-site residents. Cancer risks and noncarcinogenic hazards to these receptors were estimated based on exposure to SWMU-wide chemicals in air (worker and on-site residents) and groundwater (on-site residents); and to site-specific chemicals dispersed from surface water into ambient air (off-site residents). Evaluation of on-site residents also included risks/hazards potentially related to base-wide chemicals in beef/milk. The results under current and future land use are presented below. These results are summarized for each pathway in Tables 7-26 and 7-27. Risk calculations are included in Appendix H. Tables 7-26 and 7-27 show in bold font those risks and hazards which are site-specific (i.e., related to chemicals detected specifically in this site's soils).

Current Land Use

Cancer risk and noncarcinogenic hazards to the current on-site worker resulting from inhalation of SWMU-wide emissions of VOCs and fugitive dust were estimated to be 2.12E-07 and 1.15E-02, respectively. The contributions to the total cancer risks from this site's contaminants to the adult and child off-site residents were estimated to be 1.07E-12 and 7.49E-13, respectively. This site's contributions to their total noncarcinogenic hazards were estimated to be 3.85E-09 and 1.35E-08, respectively.

Future Land Use

Total cancer risks to the potential future on-site adult and child from exposure to chemicals in groundwater, air, beef, and milk were estimated to be 5.98E-03 and 2.79E-03, respectively. Total noncarcinogenic hazards to these receptors were estimated to be 7.54E+01 and 1.06E+02.

7.5.3.1.5 ***Conclusions.*** The results of the human health risk assessment under the current land use exposure scenario at this site indicate that the estimated cancer risk to the on-site worker of 2.12E-07 is below the 1E-06 State of Utah recommended threshold of allowable risk. The contribution to the total cancer risk to the off-site resident (adult and child) from this location is also well below this threshold. Noncarcinogenic hazards to all receptors associated with this site under current land use conditions were found to be well below the State of Utah recommended value of 1.

The results of the human health risk assessment under future land use conditions indicate that the estimated total cancer risk to the potential future on-site adult and child resident of 5.98E-03 and 2.79E-03, respectively, exceed the State of Utah recommended threshold of allowable risk. Total noncarcinogenic hazards to the potential future on-site adult and child resident of 75.4 and 106, respectively, were also found to be well above the State of Utah recommended value of 1. These risks/hazards are due to the air and groundwater pathways, as discussed further below.

Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, and the Pavement Perimeter Site is responsible for almost 90 percent of the total air pathway cancer risk to the future on-site adult resident. Inhalation

Table 7-26. SWMU 13 Summary of Carcinogenic Risks for the Boiler Blowdown Discharge Site, Phase II RFI

Potential Exposure Pathways		**Potential Receptors**			
		Current Use		**Future Use**	
Environmental Medium	**Potential Exposure Route**	**On-Site Worker[a]**	**Off-Site Resident Adult (Child)**	**Construction Worker**	**On-Site Resident Adult (Child)[b]**
Air	Vapor Inhalation	1.12E-10	**1.07E-12 (7.49E-13)**	NA	NE (NE)
	Particulate Inhalation	2.12E-07	NE	NE	3.09E-05[c] (3.98E-05)[d]
Groundwater	Dermal Contact	NA	NA	NA	1.55E-04 (4.79E-05)
	Ingestion	NA	NA	NA	5.79E-03[e] (2.70E-03)[e]
	Vapor Inhalation	NA	NA	NA	3.00E-07 (2.10E-07)
Homegrown Produce	Ingestion	NA	NA	NA	NE
Homegrown Beef	Ingestion	NA	NA	NA	1.35E-09 (5.55E-10)
Homegrown Dairy Products	Ingestion	NA	NA	NA	5.73E-10 (6.54E-10)
	Total Cancer Risk	2.12E-07	**1.07E-12 (7.49E-13)**	NA	5.98E-03 (2.79E-03)

Notes.—NA denotes not applicable. NE denotes not evaluated due to lack of USEPA Health Criteria for site-related chemicals within this pathway. **Bold** type designates site-specific risks (i.e., those potential risks that are attributed to chemicals detected at this site).

[a]Exposure to workers was evaluated based on the time spent at each site during assumed daily visits to each site within SWMU 13. Exposure to airborne chemicals was evaluated based on chemicals measured in surface soil and surface water within this SWMU. The concentrations used for this medium represent SWMU-wide values. Therefore, even if site-specific contamination is absent from surficial soil, exposure from inhalation of particulates and vapors from other sites was assumed to occur.

[b]Beef and milk chemical concentrations represent depot-wide values for TEAD-S. Therefore, the future resident at each site may be exposed to site-specific chemicals and also to those associated with other site locations within SWMU 13 and 17.

[c]Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, and the Pavement Perimeter Site is responsible for almost 90 percent of the total air pathway risk.

[d]Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, the Southwest Wastewater Lagoon, and the Pavement Perimeter Site is responsible for over 90 percent of the total air pathway risk.

[e]Ingestion of arsenic detected in SWMU-wide monitoring wells is responsible for at least 90 percent of the total groundwater pathway risks.

Table 7-27. SWMU 13 Summary of Noncarcinogenic Hazards for the Boiler Blowdown Discharge Site, Phase II RFI

Potential Exposure Pathways		Current Use		Future Use	
Environmental Medium	**Potential Exposure Route**	**On-Site Worker[a]**	**Off-Site Resident Adult (Child)**	**Construction Worker**	**On-Site Resident Adult (Child)[b]**
Air	Vapor Inhalation	4.96E-07	**3.85E-09 (1.35E-08)**	NA	8.57E-07 (2.67E-06)
	Particulate Inhalation	1.15E-02	NE	NE	1.41E+00 (9.21E+00)[c]
Groundwater	Dermal Contact	NA	NA	NA	5.02E-01 (2.81E-01)
	Ingestion	NA	NA	NA	7.35E+01[d] (9.61E+01)[d]
	Vapor Inhalation	NA	NA	NA	1.38E-02 (5.45E-03)
Homegrown Produce	Ingestion	NA	NA	NA	NE
Homegrown Beef	Ingestion	NA	NA	NA	8.30E-05 (1.07E-04)
Homegrown Dairy Products	Ingestion	NA	NA	NA	1.57E-04 (8.97E-04)
	Total Hazard	1.15E-02	**3.85E-09 (1.35E-08)**	NA	7.54E+01 (1.06E+02)

Notes.—NA *denotes not applicable.* NE denotes not evaluated due to lack of USEPA Health Criteria for site-related chemicals within this pathway. Bold type designates site-specific hazards (i.e., those potential hazards that are attributed to chemicals detected at this site).

[a]Exposure to workers was evaluated based on the time spent at each site during assumed daily visits to each site within SWMU 13. Exposure to airborne chemicals was evaluated based on chemicals measured in surface soil and surface water within this SWMU. The concentrations used for this medium represent SWMU-wide values. Therefore, even if site-specific contamination is absent from surficial soil, exposure from inhalation of particulates and vapors from other sites was assumed to occur.

[b]Beef and milk chemical concentrations represent depot-wide values for TEAD-S. Therefore, the future resident at each site may be exposed to site-specific chemicals and also to those associated with other site locations within SWMU 13 and 17.

[c]Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons,and the Southwest Wastewater Lagoon is responsible for over 90 percent of the total air pathway hazard.

[d]Ingestion of arsenic, thallium, and fluoride detected in SWMU-wide monitoring wells is responsible for over 90 percent of the total groundwater pathway hazards.

of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, the Southwest Wastewater Lagoon, and the Pavement Perimeter Site is responsible for approximately 90 percent of the cancer risk to the future on-site child resident. These latter sites, with the exception of the Pavement Perimeter Site, are also responsible for over 90 percent of the total noncancer air-pathway hazard to the future on-site child resident. Ingestion of arsenic detected in SWMU-wide monitoring wells is responsible for over 90 percent of the total groundwater pathway risks to future on-site residents (adults and children).

In summary, there are no significant risks/hazards that can be attributed to chemicals detected specifically in media at this site. The potentially significant risks/hazards associated with future on-site residents (via the air and groundwater pathways, as summarized above) are related to contaminants detected in soils at other sites or to chemicals that are likely to be naturally occurring within SWMU 13 (i.e., arsenic in groundwater).

7.5.3.2 *Ecological Risk Assessment*

7.5.3.2.1 ***Site Characterization.*** The ecological assessment for the Boiler Blowdown Discharge Site included a survey of vegetation and wildlife, and a qualitative habitat evaluation. This assessment did not include collection of either vegetation or wildlife samples for analysis. The potential wildlife inhabitants include small and large mammals, birds, and several of the raptor species. This area could be considered a critical habitat for endangered or threatened species as well as other key receptor species because it provides one of the only sources of permanent drinking water for wildlife at TEAD-S. Species of vegetation and wildlife that have been observed at this site are presented in Table 7-28.

Evidence of surface water was observed during the field investigation. It is possible that significant surface water accumulates on this site as the result of storm episodes, snow melt, and other natural and manmade occurrences.

7.5.3.2.2 ***Chemicals of Potential Concern.*** The ecological COPCs at the Boiler Blowdown Site include the explosives HMX and 2-6 DNT and organic compounds methylene chloride and chloromethane in surface water. TPHCs were detected in surface soil.

7.5.3.2.3 ***Results of Risk Characterization.*** Table 7-29 shows the results for calculations of hazard quotients and indices for the Boiler Blowdown Discharge Site. HQs of 1 and less were observed at this site.

7.5.3.2.4 ***Conclusions.*** Possible ecological risk at the Boiler Blowdown Discharge Site is minimal.

Table 7-28. SWMU 13 Vegetation and Wildlife Inventory for the Boiler Blowdown Discharge Site, Phase II RFI

Scientific Name	Common Name
VEGETATION SPECIES	
Salsola iberica	Russian thistle
Atriplex confertifolia	Shadescale
Chrysothamus nauseosus	Tall rabbitbrush
Artemesia tridentata	Big sagebrush
Eurotia lanata	Winterfat
Sitanion hystrix	Bottlebrush squirreltail grass
WILDLIFE SPECIES	
Antilocapra americana	Antelope
Odocoileus hemionus	Mule deer
Lepus californicus	Black-tailed jackrabbit
Buteo jamacensis	Redtailed hawk
Peromyscus maniculatus	Deer mouse
Pituophis melanoleucus deserticola	Great Basin gopher snake

Table 7-29. Hazard Quotients for Boiler Blowdown Discharge Site

Analyte Name	Soil EPC (mg/kg)	Water EPC (mg/L)	Air EPC (mg/m3)	ABS	American Robin: Soil Ingestion	American Robin: Dermal Contact with Soil	American Robin: Dietary Ingestion	American Robin: Water Ingestion	American Robin: Total
26DNT		0 003	NA	0.100	NA	NA	NA	ND	0
CH2CL2		0.011	NA	0 100	NA	NA	NA	ND	0
CH3CL		0 007	NA	0.100	NA	NA	NA	ND	0
HMX		0.003	NA	0 100	NA	NA	NA	ND	0
TPHC	216 000		ND	0 100	1.E+00	4.E-04	ND	NA	1.E+00
								HI total	1 E+00

Analyte Name	Golden Eagle: Soil Ingestion	Golden Eagle: Dermal Contact with Soil	Golden Eagle: Dietary Ingestion	Golden Eagle: Water Ingestion	Golden Eagle: Total
26DNT	NA	NA	NA	ND	0
CH2CL2	NA	NA	NA	ND	0
CH3CL	NA	NA	NA	ND	0
HMX	NA	NA	NA	ND	0
TPHC	1 E-05	3.E-08	ND	NA	1.E-05
				HI total	1 E-05

Analyte Name	Deer Mouse: Soil Ingestion	Deer Mouse: Dermal Contact with Soil	Deer Mouse: Dietary Ingestion	Deer Mouse: Water Ingestion	Deer Mouse: Inhalation	Deer Mouse: Total	Mule Deer: Soil Ingestion	Mule Deer: Dermal Contact with Soil	Mule Deer: Dietary Ingestion	Mule Deer: Water Ingestion	Mule Deer: Total
26DNT	NA	NA	NA	3.E-03	NA	3 E-03	NA	NA	NA	3 E-04	3 E-04
CH2CL2	NA	NA	NA	2 E-03	NA	2 E-03	NA	NA	NA	2 E-04	2.E-04
CH3CL	NA	NA	NA	3 E-04	NA	3 E-04	NA	NA	NA	4.E-05	4.E-05
HMX	NA	NA	NA	4.E-04	NA	4 E-04	NA	NA	NA	5.E-05	5.E-05
TPHC	2 E-02	1 E-04	ND	NA	0	2 E-02	1 E-06	5.E-09	ND	NA	1 E-06
					HI total	3.E-02				HI total	6 E-04

Note —NA indicates pathway incomplete ND indicates parameters unavailable.

7.5.4 Conclusions and Recommendations

COPCs associated with the Boiler Blowdown Discharge Site are TPHCs in soils and VOCs, and explosives in surface water. The soil borings drilled during the 1991 field effort defined the lateral and vertical extent of TPHCs in the soils. Only one sample detected TPHCs below 3 feet. The TPHCs detections within the soils at this site fall within the boundaries of soil contamination associated with the Fuel Spill Site as shown in Figures 7-21 and 7-22. These detections are believed to be related to past activities at the Fuel Spill Site and not the Boiler Blowdown Discharge Site. Additionally, an unconfirmed detection of 2,6-dinitrotoluene was the only analyte detected in the water sample collected in 1993 at the point where boiler blowdown fluids are discharged, indicating that these fluids are not the source of explosives or VOCs in surface water. Finally, the sediment samples collected did not contain any explosives, VOCs, or anions, indicating that the Boiler Blowdown Discharge Site has not received any of these contaminants during the time when sediment deposition occurred. Methylene chloride and chloromethane were the only VOCs detected at trace amounts in the surface water; however, these VOCs are considered common laboratory contaminants (see Section 6.1.1.2) and are not considered to be representative of a contamination problem (see Section 7.5.2).

The human health risk assessment evaluated the current and future use of the site. Results of the human health risk assessment under the current land use exposure scenario indicate that carcinogenic risk to the on-site worker is below the State of Utah recommended threshold of allowable risk, and the contribution to the total carcinogenic risk to the off-site resident is also well below the State of Utah criteria. Noncarcinogenic hazards to all receptors under the current use conditions were found to be below State of Utah criteria.

Results of the human health risk assessment under future land use conditions indicated that carcinogenic risk to the future on-site resident (adult and child) exceeded the State of Utah recommended threshold for allowable risk. Total noncarcinogenic hazards also exceed State of Utah criteria for the future on-site resident. These risks are primarily due to potential risks associated with dermal contact with and ingestion of contaminated groundwater.

It is important to emphasize that the exposure point concentrations for air and for beef and milk used in the human health risk assessment were estimated as SWMU-wide and area-wide (over TEAD-S) values, respectively. In so doing, it is possible to estimate an exposure to a receptor at a particular site despite the absence of site-related chemicals in surfical soil. This occurs because it has been assumed that exposure can take place to chemicals originating from other sites within SWMU 13 and/or SWMU 17 via the air pathway and through consumption of homegrown beef and milk products. Similarly, the groundwater exposure point concentrations were also derived as an area average for each chemical. Therefore, to avoid misrepresenting the results of the risk assessment, it is important to distinguish the portion of the risk and hazard estimates that are due to site-related contamination from that due to SWMU-wide and/or area-wide contributions. Recommendations for each site within both SWMUs will be made pursuant to the provisions of Section R315-101-6 of the Utah Hazardous Waste Rules. Since the groundwater medium at SWMU 13 is already being recommended to the CMS (Site Management Plan), the site-specific recommendations will be based on the results of the risk assessment without the groundwater contribution.

The ecological risk assessment indicated that current conditions would result in insignificant adverse impacts on ecological receptors.

In summary, all available data were used to determine whether past operations at the Boiler Blowdown Discharge Site have created an environment that could result in any adverse effects to human health or to the local ecology. Results from the human health risk assessment indicate that adverse impacts to the future on-site resident at the site may occur although it is not expected that this site will become available for residency in the future. For reasons explained above, the risk and hazard contributions due to groundwater and airborne chemicals originating from other site locations could be removed to demonstrate that the site specific risk and hazard are below 1E-06 and 1.0, respectively. In so doing, the criteria in item (C)(1) of R315-101-6 could be met and, therefore, a recommendation for no further action may be made.

7.6 DRAINAGE DITCH SITE

7.6.1 Previous Sampling and Phase II RFI Sampling Results

A previous investigation of the Drainage Ditch Site was conducted by Weston (1991), and additional investigation of this area was conducted by Rust E&I as part of this Phase II RFI.

Weston, 1991. As part of an RI at the CAMDS facility, Weston (1991) collected a sediment sample (SSD-CAM-03) from the drainage ditch leading from the CAMDS facility (Figure 7-30). The sample was analyzed for VOCs, SVOCs, petroleum hydrocarbons, explosives, and anions. Table 7-30 presents a summary of the analytical results.

No VOCs or explosives were detected in the sample. Unknown SVOCs were detected at concentrations ranging up to 69 $\mu g/g$. Most of the SVOCs were tentatively identified as alkanes, which is suggestive of fuel contamination. Petroleum hydrocarbons were detected in the sample at a concentration of 18 $\mu g/g$, which is also suggestive of fuel contamination. This hydrocarbon detection is below the State of Utah action level of 30 $\mu g/g$ for TPHC in soil. The nitrate/nitrite results are the only anions which are discussed in Weston (1991). Nitrates/nitrites were not detected in the sediment sample.

Rust E&I, 1991. To assess the extent of contamination at the Drainage Ditch Site and to determine, if possible, a potential source for this contamination, Rust E&I collected soil samples from six soil borings downgradient from the point where the drainage pipe from the CAMDS facility discharges to the open ditch (Figure 7-30). A new fence has been installed in this area to enlarge the CAMDS facility, and much of the former drainage area is now covered with asphalt. A new drainage pipe was installed in the location where the open drainage ditch once existed. Drainage grates now feed runoff to this new drainage pipe and into the open

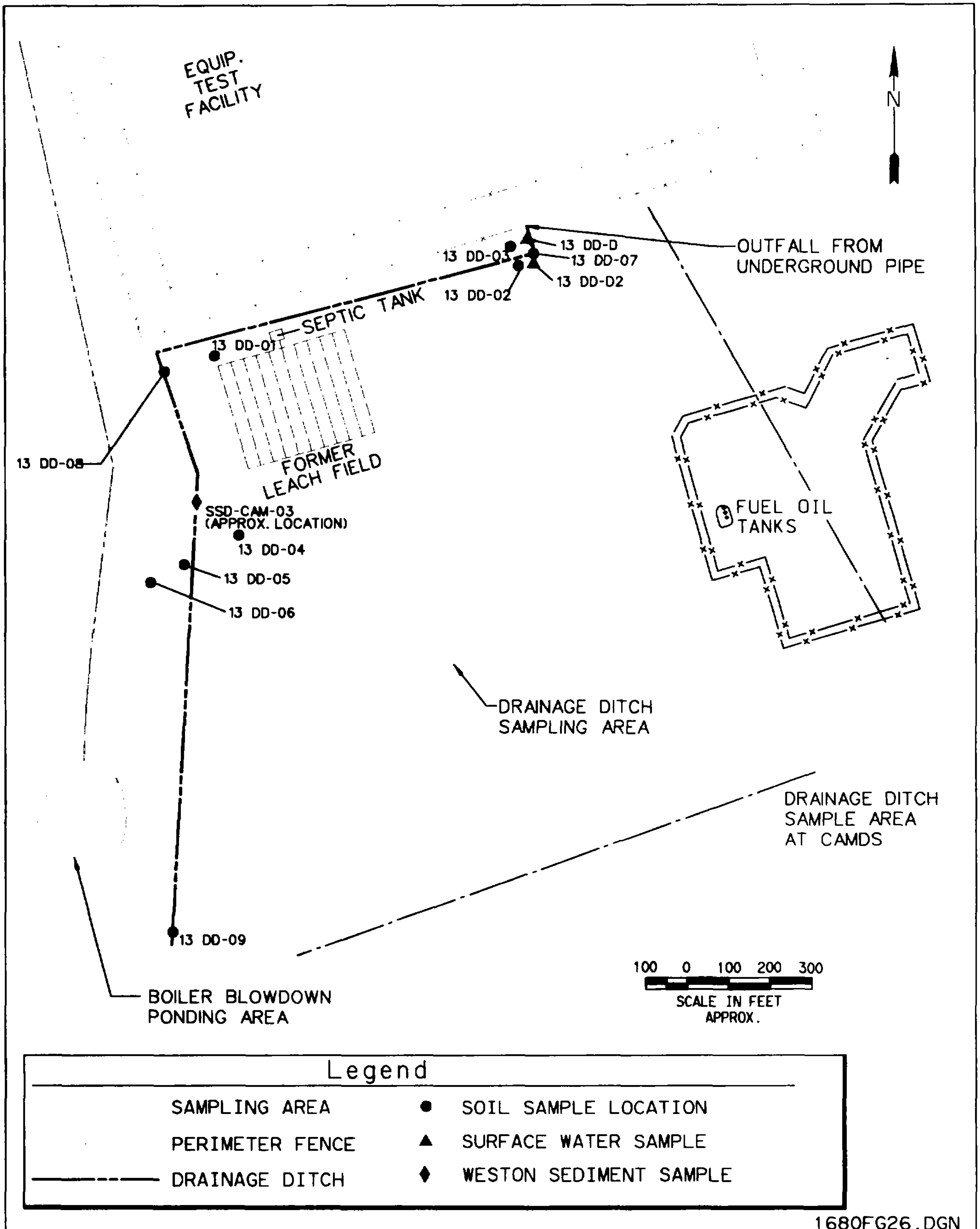

Figure 7-30. Soil Boring Sample Locations at the Drainage Ditch Site, SWMU 13

Table 7-30. SWMU 13 Sediment Sample Results for the Drainage Ditch Site, RI, 1991

Parameter	Sample I.D. SSD-CAM-03 (all concentrations in μg/g)
Semi-Volatile Organic Compounds	
Unknowns	69[a] [19][b]
Petroleum Hydrocarbons	18
Anions	
Nitrate/Nitrite	LT (9,560)[c]

[a]Highest concentration among the unknown compounds.
[b]The number in brackets indicates the number of unknown compounds detected.
[c]LT = analyte detection was less than the reporting limit; reporting limit is given in parentheses.

Source: Weston, 1991

drainage ditch. The six borings were drilled to depths of 10 to 13 feet, and three samples were collected from each boring: one near the surface, one near the middle, and one near the bottom of each boring. The samples were analyzed for VOCs, SVOCs, metals, explosives, agent breakdown products (ABPs), and anions. A soil pH of 9.84 was measured in sample 13DD-06-1.

Table 7-31 summarizes the soil sampling results for those analytes that were detected in at least one sample. No explosives or agent breakdown products were detected, and only 2 of the 18 soil boring samples had detections of VOC compounds. The compound 1,2-dichlorobenzene was detected at 0.038 μg/g in the middle sample of soil boring 13DD-01. This detection, however, was flagged with a "U," indicating that the detection was not verified in a confirmatory analysis. The compound 1,2-dimethylbenzene was detected at 0.0271 μg/g in the bottom sample of soil boring 13DD-04.

Analysis of the 18 soil boring samples revealed that the following metals were detected at concentrations exceeding background criteria: arsenic (4 samples), chromium (6 samples), copper (1 sample), lead (6 samples), and zinc (4 samples). The range of metals concentrations in these samples were arsenic, 37.3 μg/g to 55.1 μg/g; chromium, 36.3 μg/g to 290 μg/g; copper, 28.0 μg/g; lead, 86.0 μg/g to 250 μg/g; and zinc, 120 μg/g to 180 μg/g.

Anions detected above background in the soil boring samples were chloride (six samples); nitrate (one sample), and sulfate (six samples). Maximum anion concentrations were 1,900 μg/g for chloride; 5.79 μg/g for nitrate; and 26,000 μg/g for sulfate.

Table 7-31. SWMU 13 Soil Sample Results for the Drainage Ditch Site, Phase II RFI

Sample ID	Depth	VOC (µg/g)		Metals (µg/g)								Anions (µg/g)		pH
		1,2-Dichlorobenzene	1,2-Dimethylbenzene	Arsenic (BKGD[a] - 16.4)	Beryllium (BKGD - 1.11)	Chromium (BKGD - 23.5)	Copper (BKGD - 18.1)	Lead (BKGD - 69.8)	Nickel (BKGD - 30.0)	Zinc (BKGD - 62.9)	Chloride (BKGD 596)	Nitrate (BKGD - 4.67)	Sulfate (BKGD - 1697)	
13DD-01-1	1	0.038	ND[b]	ND	ND	ND	ND	ND	ND	ND	1,900	DS	2,100	--
13DD-01-2	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	1,700	ND	26,000	--
13DD-01-3	9	ND	--	ND	DS[c]	DS	DS	180	ND	ND	1,500	DS	5,600	--
13DD-02-2	8	ND	ND	ND	ND	ND	ND	130	ND	ND	ND	DS	DS	--
13DD-02-3	13	ND	ND	ND	ND	290	ND	130	ND	ND	610	DS	DS	--
13DD-03-1	5	--	--	ND	ND	47	ND	250	ND	ND	ND	DS	4,200	--
13DD-03-2	9	ND	ND	ND	ND	ND	ND	86	ND	ND	DS	DS	DS	--
13DD-03-3	13	ND	ND	ND	ND	ND	ND	ND	ND	ND	810	DS	DS	--
13DD-04-1	3	--	--	37.3	DS	37.4	DS	ND	ND	ND	ND	ND	23,000	--
13DD-04-2	7	ND	ND	51.5	DS	39.2	DS	ND	ND	130	DS	ND	DS	--
13DD-04-3	10.5	ND	0.0271	ND	DS	DS	DS	ND	ND	DS	DS	ND	DS	--
13DD-05-1	1	--	--	ND	ND	ND	28	DS	ND	180	ND	5.79	DS	--
13DD-05-2	5	ND	ND	ND	ND	ND	ND	180	ND	ND	ND	ND	DS	--
13DD-06-1	3	--	--	50	DS	36.3	DS	ND	ND	120	890	ND	5,000	9.84
13DD-06-2	7	ND	ND	55.1	DS	42.6	DS	ND	ND	130	DS	ND	DS	--
13DD-07-1	0.5	--	--	DS	DS	DS	DS	DS	DS	110	--	--	--	--
13DD-08-1	0.5	--	--	DS	DS	28.4	DS	DS	DS	81.4	--	--	--	--
13DD-08-2	3	--	--	17	DS	DS	DS	DS	DS	70.6	--	--	--	--
13DD-09-1	0.5	--	--	DS	1.17	31.2	24.6	DS	DS	129	--	--	--	--
13DD-09-2	3	--	--	21.9	1.67	48.7	22.6	DS	32.7	136	--	--	--	--
13DD-02-1[d]	3.5													
13DD-05-3	9.0													
13DD-06-3	10.5													
13DD-07-2	3.0													

[a]Bkgd=Background value for specified analyte.
[b]ND=Analyte not detected at or above the CRL, SRL, or MDL.
[c]DS=Data screened due to the 5 times or 10 times rules or did not exceed background values where applicable. (See Section 6 for data screening methodologies).
[d]The following sample IDs, where there were no detected contaminants, are included in the remainder of this table. A comprehensive listing of all the data is presented in Appendix D.

One surface-water sample (13 DD-D) was collected from the drainage ditch and analyzed for SVOCs, ABPs, explosives, and anions. Nitrate and sulfate were detected at concentrations of 84.3 μg/L and 150,000 μg/L, respectively. No SVOCs, ABPs, or explosives were detected.

Rust E&I, 1993. During the summer of 1993, Rust E&I conducted an investigation at the Drainage Ditch Site to better define the vertical extent of metals contamination in the ditch. Three additional soil borings (13DD-7, 13DD-8, and 13DD-9) were drilled to a depth of approximately 3 feet. Soil samples were collected at the 0-to-6-inch and 2-to-3-foot intervals and analyzed for metals.

Analysis of the six soil boring samples revealed that the following metals were detected at concentrations exceeding background criteria: arsenic (two samples), beryllium (two samples), chromium (three samples), copper (two samples), nickel (one sample), and zinc (five samples). The range of metals concentrations in these samples were arsenic, 17.0 μg/g to 21.9 μg/g; beryllium, 1.17 μg/g to 1.67 μg/g; chromium, 28.4 μg/g to 48.7 μg/g; copper, 22.6 μg/g to 24.6 μg/g; nickel, 32.7 μg/g; and zinc, 70.6 μg/g to 136 μg/g.

Three surface-water samples were to be collected from the drainage ditch at each of the boring locations and analyzed for metals if water was present when the soil borings were drilled. The ditch was dry during the drilling at two of the locations; therefore, only one water sample (13DD-D2) was collected and analyzed for metals. No metals were detected above their respective USEPA drinking water MCLs.

7.6.2 Nature and Extent of Contamination

Arsenic, beryllium, chromium, copper, nickel, lead, and zinc were detected above background in some of the boring soil samples collected at this site. The observed arsenic distribution would not be expected if the drainage ditch was a source of arsenic contamination. One would expect the arsenic concentrations to be highest in samples collected near the surface within the drainage ditch and decrease downward and laterally away from the ditch. Instead, no arsenic concentrations above background were detected in the shallow samples collected from within the drainage ditch. The only arsenic detections in samples collected from soil borings drilled within the drainage ditch were in the bottom samples of soil borings 13DD-08 and -09. The highest arsenic detections were in the shallow and middle samples of the two soil borings drilled farthest from the drainage ditch (soil borings 13DD-04 and 13DD-06). This distribution suggests that the drainage ditch is not the source of arsenic contamination.

Although copper, nickel, lead, and zinc were detected above background in some soil boring samples, the highest detections for each of these metals is less than the highest detection of that metal in the background soil samples. The highest chromium detection, 290 μg/g, is suspect because it occurred in a sample collected from the bottom of soil boring 13DD-02. Chromium was not detected above background in the two shallower samples in this soil boring, nor was it detected above background in the deeper samples of nearby soil borings 13DD-03 and 13DD-07.

The soil boring samples collected during the 1991 field effort contained the anions chloride, nitrate, and sulfate above background, but it is not likely that these detections represent soil contamination. Only 12 data points were available for background calculations for anions (see Section 5.0). Nevertheless, these three anions were carried through the risk assessment process, which is presented in the following section.

Nitrate and sulfate were detected in the one surface-water sample that was collected from the drainage ditch. No background values were determined for these anions in water.

7.6.3 Risk Assessment Results

7.6.3.1 *Baseline Human Health Risk Assessment*

This section presents the results of the sample data screening approach previously described in Section 6.1.1 that led to (1) the selection of the COPCs, (2) the exposure pathways that are labeled in the conceptual site model as being complete, (3) the exposure-point concentrations in each respective environmental medium for those COPCs that have published health criteria, and (4) the carcinogenic and noncarcinogenic risk estimates for each receptor population under current and future land use scenarios.

This section of the report evaluates exposure to COPCs detected in site soils as well as those contaminants measured or modeled in various media from SWMU-wide or depot-wide sources. The direct soil-contact pathway (e.g., ingestion and dermal exposure) is associated with site-specific chemicals. Similarly, ingestion of homegrown produce by future on-site residents is based on those contaminants (if any) measured in surface soil within this site. Site-specific contaminants in soil are also used as model inputs to the air pathway for current off-site residents and the future on-site construction worker.

Current on-site workers and future on-site residents, however, are assumed to be potentially exposed to SWMU-wide chemicals in air (i.e., those chemicals detected in surface media at all of the sites evaluated within SWMU 13). Exposure to SWMU-wide chemicals was also the approach selected for the groundwater pathway. Thus, future on-site residents are assumed to be potentially exposed to groundwater contaminants measured in monitoring wells located across SWMU 13. The results of the groundwater evaluation are also presented separately in Section 7.11.3.1. Finally, ingestion of beef and dairy products by future on-site residents is based on modeling contaminants detected in depot-wide surface soils; cattle are assumed to graze at contaminated sites within SWMU 13 and SWMU 17. Thus, the total cancer risk and noncarcinogenic hazards to the future on-site resident (adult and child) presented in the sections below include those contributions associated with exposures to SWMU-wide contamination in air and groundwater and to depot-wide chemicals in beef and milk.

7.6.3.1.1 ***Chemicals of Potential Concern*****.** The soil data for this site were grouped by depth and evaluated in the human health risk assessment accordingly. The COPCs measured in the surface (0 to 1.0 foot) and subsurface (1.0 to 9.0 foot) soil are summarized in Table 7-32.

Table 7-32. SWMU 13 Summary of Concentrations of Chemicals of Potential Concern in Surface and Subsurface Soil at the Drainage Ditch Site, Phase II RFI

Chemical	Background Concentration (mg/kg)	Frequency of Detection	Range of Detects (mg/kg)	Arithmetic Mean Concentration (mg/kg)	95% UCL (mg/kg)
Surface Soil					
Beryllium	1.11	3/5	0.651-1.17	0.72	**1.05**
Chromium	23.5	3/3	18.1-**31.2**	25.9	37.5
Copper	18.1	4/5	11.9-28.0	17.7	**25.4**
Nitrate	4.67	1/2	**5.79**	3.75	16.6
Zinc	62.9	4/5	81.4-180.0	108	**158**
Subsurface Soil					
Arsenic	16.4	7/9	4.43-55.1	29	**41.2**
Beryllium	1.11	9/15	0.242-1.67	0.55	**0.71**
Chromium	23.5	10/15	16.4-48.7	28.4	**33.8**
Copper	18.1	9/15	3.85-22.6	11.1	**13**
Lead	69.8	8/15	8.44-250.0	65.9	**102.5**
Zinc	62.6	7/15	26.7-136.0	65.3	**83.9**
1,2-Dichlorobenzene	NA	1/8	0.0378	0.013	**0.02**
Nickel	30	3/15	11.7-32.7	9.78	**13.8**

Note.—Chloride and sulfate were measured above background levels but were not evaluated further since they lack USEPA Health Criteria. **Bold** type designates the exposure point concentration selected for these media.

This table does not include chloride or sulfate, which were measured at elevated levels of 1,900 and 26,000 μg/g, respectively. These chemicals lack USEPA Health Criteria and, thus, were not evaluated further.

7.6.3.1.2 *Complete Exposure Pathways*. The pathways assumed complete at this site are shown on the conceptual site model in Figure 7-31. Exposure by current on-site workers and potential future on-site residents from ingestion of and dermal contact with COPCs measured in this site's surface soil was evaluated. Exposure by future construction workers from ingestion of and dermal contact with site-specific chemicals in subsurface soil was also evaluated. Exposure from inhalation of chemical emissions from surface soil by current on-site workers, off-site residents, and potential future on-site residents was evaluated. Inhalation of VOC and fugitive dust emissions from this site's subsurface soil by the future on-site construction worker was also evaluated.

Inhalation exposure by off-site residents of site-specific contaminants dispersed from surface soil in ambient air represents the only complete exposure pathway for these receptors.

Small seasonal discharges to this site do occur. This surface water was sampled and found to contain sulfate and nitrate. Health criteria for sulfate is currently unavailable and nitrate is already included in the soil exposure evaluation; therefore, exposure pathways associated with this surface water were not evaluated.

Chemicals measured in this site's surface soil (0 to 1.0 foot) were assumed to be available for plant uptake. Therefore, exposure by potential future on-site residents from consumption of vegetables grown at this site was evaluated. Evaluation of exposure to SWMU-wide chemicals in groundwater by future on-site residents is described in Section 7.11.3.1.

The sites within SWMU 13 either overlap or are adjacent to each other so that it was practical to estimate air chemical levels as SWMU-wide concentrations instead of on a site-specific basis. Therefore, exposure from inhalation of SWMU-wide chemical concentrations by the on-site worker during daily visits to this site was included despite the fact that these chemicals were not all present in surficial soil at this location. Exposures to airborne chemicals by future residents were also based on SWMU-wide concentrations. Similarly, exposures by potential future on-site residents from ingestion of chemicals in beef and milk, derived as depot-wide averages using data collected at SWMUs 13 and 17, were also evaluated.

7.6.3.1.3 *Exposure Point Concentrations*. Exposures from all complete pathways by all the identified receptors were estimated using the exposure-point concentrations in Table 7-33. These values include those that were based on soil chemical concentrations measured in surface and subsurface soil within this site.

Table 7-33 also includes values for airborne chemicals originating from several sites within this SWMU that contribute to overall worker and resident exposure at this location, as well as

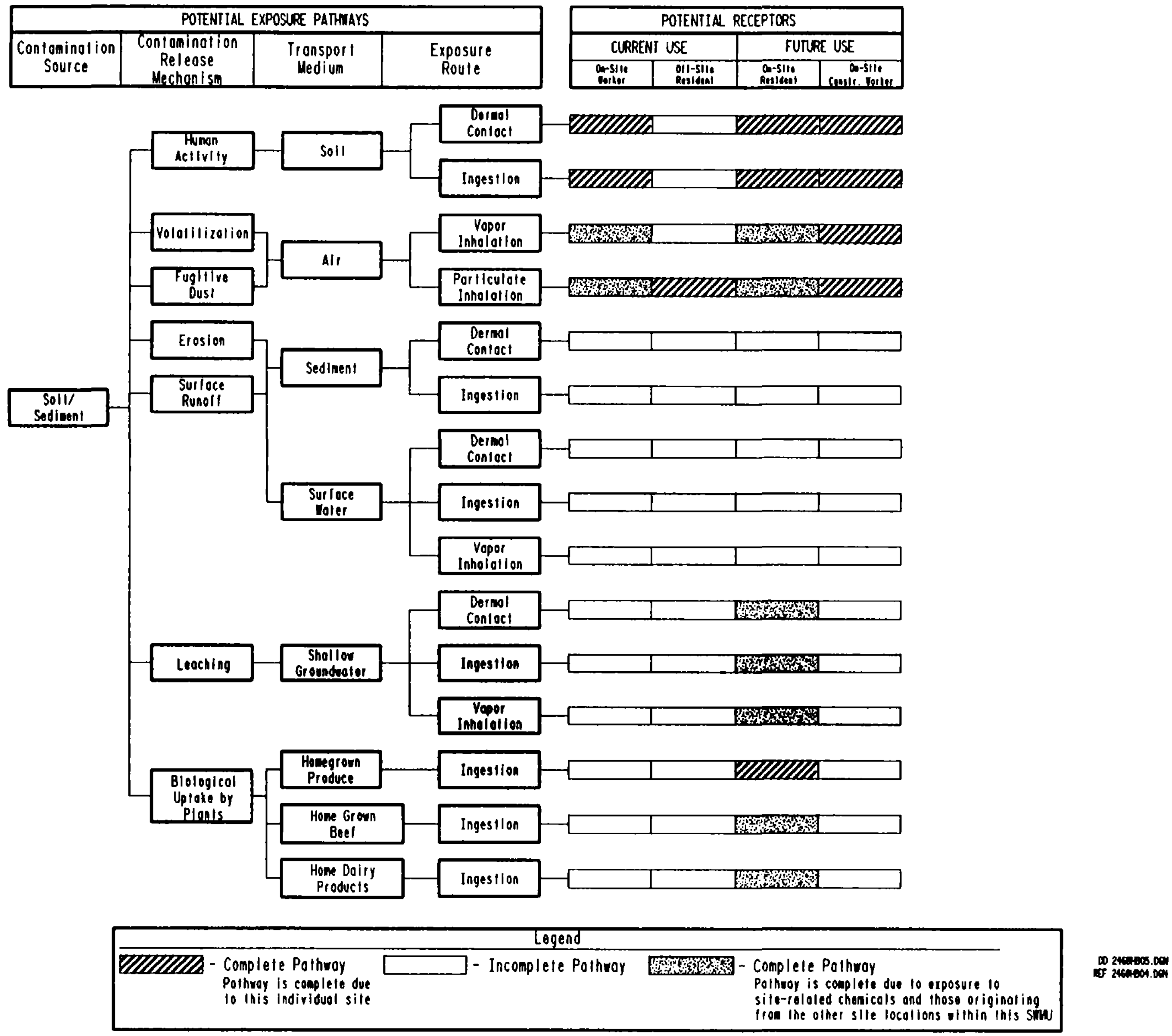

Figure 7-31. SWMU 13 Potential Human Exposure Pathway Conceptual Model for the Drainage Ditch Site, Phase II RFI

Table 7-33. SWMU 13 Exposure Point Concentrations for the Chemicals of Potential Concern at the Drainage Ditch Site, Phase II RFI

Receptor	Chemical	EXPOSURE POINT CONCENTRATIONS								
		Air[a] (mg/m^3)	Soil (mg/kg)	Milk[b] (mg/L)	Beef[b] (mg/g)	Potato[c] (mg/g)	Tomato (mg/g)	Carrot (mg/g)	Lettuce (mg/g)	Beans (mg/g)
On-Site Worker	Arsenic	2.15E-07	ND	---	---	---	---	---	---	---
	Beryllium	7.76E-09	1.05	---	---	---	---	---	---	---
	Chromium	5.6E-07	31.2	---	---	---	---	---	---	---
	Copper	2.01E-07	25.4	---	---	---	---	---	---	---
	Lead	8.33E-08	ND	---	---	---	---	---	---	---
	Mercury	1.27E-10	ND	---	---	---	---	---	---	---
	Nickel	1.24E-08	ND	---	---	---	---	---	---	---
	Nitrate	5.00E-07	5.79	---	---	---	---	---	---	---
	Uranium	2.64E-09	ND	---	---	---	---	---	---	---
	Zinc	1.31E-06	158.0	---	---	---	---	---	---	---
	Acetone	1.30E-05	ND	---	---	---	---	---	---	---
	Chloromethane	1.60E-06	ND	---	---	---	---	---	---	---
	Methylene chloride	2.35E-06	ND	---	---	---	---	---	---	---
	4-Methylphenol	3.16E-10	ND	---	---	---	---	---	---	---
	Methyl isobutyl ketone	1.50E-09	ND	---	---	---	---	---	---	---
	Methyl-n-butyl ketone	7.30E-10	NA	---	---	---	---	---	---	---
Off-Site Resident	Beryllium	2.10E-11	---	---	---	---	---	---	---	---
	Chromium	6.24E-10	---	---	---	---	---	---	---	---
	Copper	5.08E-10	---	---	---	---	---	---	---	---

Table 7-33. SWMU 13 Exposure Point Concentrations for the Chemicals of Potential Concern at the Drainage Ditch Site, Phase II RFI (continued)

Receptor	Chemical	EXPOSURE POINT CONCENTRATIONS								
		Air[a] (mg/m³)	Soil (mg/kg)	Milk[b] (mg/L)	Beef[b] (mg/g)	Potato[c] (mg/g)	Tomato (mg/g)	Carrot (mg/g)	Lettuce (mg/g)	Beans (mg/g)
Off-Site Resident (cont.)	Nitrate	1.16E-10	---	---	---	---	---	---	---	---
	Zinc	3.16E-09	---	---	---	---	---	---	---	---
Future On-Site Resident	Arsenic	2.1E-06 (3.49E-06)	<Bkgd	9.80E-08	1.63E-09	---	---	---	---	---
	Beryllium	4.81E-08 (7.4E-08)	1.05	9.32E-11	3.99E-11	3.9E-07	9.5E-08	1.9E-07	5.3E-07	4.4E-07
	Bis (2-ethylhexyl) phthlate	--- ---	ND	1.24E-09	1.51E-12	---	---	---	---	---
	Chromium	5.88E-06 (1.07E-05)	31.2	7.65E-08	4.0E-09	3.5E-05	8.4E-06	1.7E-05	1.2E-05	3.9E-05
	Copper	1.7E-06 (2.86E-06)	25.4	4.41E-05	1.13E-07	1.6E-03	3.8E-04	7.6E-04	5.1E-04	1.8E-03
	Lead	1.47E-06 (2.94E-06)	<Bkgd	1.55E-07	8.16E-11	---	---	---	---	---
	Mercury	6.19E-09 (1.24E-08)	ND	1.03E-09	1.26E-11	---	---	---	---	---
	Nickel	6.02E-07 (1.2E-06)	<Bkgd	8.52E-08	7.29E-09	---	---	---	---	---
	Nitrate[d]	4.89E-07 (6.64E-07)	5.79	NA	NA	NA	NA	NA	NA	NA
	Uranium	1.18E-07 (2.35E-07)	ND	2.0E-09	7.71E-12	---	---	---	---	---
	Zinc	1.03E-05 (1.73E-05)	158.0	4.63E-03	1.78E-05	2.3E-02	8.5E-03	1.1E-02	1.1E-02	4.0E-02
	4-Methylphenol	1.26E-08 (2.53E-08)	ND	4.07E-10	4.96E-13	---	---	---	---	---
	Methyl isobutyl ketone	8.00E-09 (9.50E-09)	ND	6.50E-12	7.92E-15	---	---	---	---	---
	Methyl-n-butyl ketone	4.00E-09 (4.800E-09)	NA	---	---	---	---	---	---	---
	Toluene	6.10E-09 (1.3E-08)	ND	2.48E-12	3.02E-15	---	---	---	---	---

Table 7-33. SWMU 13 Exposure Point Concentrations for the Chemicals of Potential Concern at the Drainage Ditch Site, Phase II RFI (continued)

Receptor	Chemical	EXPOSURE POINT CONCENTRATIONS								
		Air[a] (mg/m^3)	Soil (mg/kg)	Milk[b] (mg/L)	Beef[b] (mg/g)	Potato[c] (mg/g)	Tomato (mg/g)	Carrot (mg/g)	Lettuce (mg/g)	Beans (mg/g)
Future Construction Worker	Arsenic	1.81E-06	41.2	---	---	---	---	---	---	---
	Beryllium	3.12E-08	0.71	---	---	---	---	---	---	---
	Chromium	1.49E-06	33.8	---	---	---	---	---	---	---
	Copper	5.72E-07	13.0	---	---	---	---	---	---	---
	1,2-Dichlorobenzene	2.0E-08	0.02	---	---	---	---	---	---	---
	Lead	4.51E-06	102.5	---	---	---	---	---	---	---
	Nickel	6.07E-07	13.8	---	---	---	---	---	---	---
	Zinc	3.69E-06	83.9	---	---	---	---	---	---	---

Notes.—"---" denotes not applicable. ND denotes chemical was not detected in site soil.

[a]Air values represent average values for on-site worker and maximum values for future on-site resident for SWMU 13. Value in parenthesis is for child. Air chemical concentrations are based on corresponding subsurface soil values for construction worker.

[b]Milk and beef concentrations were derived to evaluate exposure to potential future on-site residents, and represent average values based on soil data collected from SWMU 13 and 17.

[c]Vegetable chemical concentrations are based on corresponding soil concentration.

[d]Transfer factors are not available for nitrate

average values for chemicals in beef and milk for all of TEAD-S that pertain to future on-site residents. Exposure to chemicals in groundwater by future on-site residents was based on the SWMU-wide exposure point concentrations in Table 7-68.

7.6.3.1.4 ***Risk Estimates***. The receptor populations evaluated at this site include the current on-site worker, off-site residents (adult and child), future construction worker, and future on-site residents (adult and child). Cancer risks and noncarcinogenic hazards to these receptor populations were estimated based on exposure to site-specific chemicals in detected surface soil and subsurface soil (construction worker); SWMU-wide chemicals in air and groundwater; and/or to depot-wide contaminants in beef and milk. The results of this evaluation under current and future land use are presented below. These results are also summarized for each exposure pathway in Tables 7-34 and 7-35. Actual risk calculations are presented in Appendix H. Tables 7-34 and 7-35 show in bold font those risks and hazards that are site-specific (i.e., related to chemicals detected specifically in this site's soils).

Current Land Use

Cancer risk to the current on-site worker from direct exposure to site-specific chemicals in surface soil and indirect exposure to SWMU-wide chemicals in air was estimated to be 3.06E-07, and the noncarcinogenic hazard to this receptor was estimated to be 1.19E-02. The contribution of this location to total cancer risk to the off-site adult was 2.90E-09, and the noncarcinogenic hazard, 1.49E-04. This site's contribution to the total cancer risk to the off-site child resident was 2.03E-09, and noncarcinogenic hazard, 5.22E-04.

Future Land Use

Total cancer risk to the construction worker was estimated to be 3.12E-06, and the total noncarcinogenic hazard, 2.56E-01. These estimates for the construction worker are based entirely on site-specific (subsurface soil) contamination.

Total cancer risks to the future on-site adult and child from exposure to chemicals in air, soil, groundwater, and homegrown products were estimated to be 5.95E-03 and 2.79E-03, respectively. Total noncarcinogenic hazards to these receptors were estimated to be 7.59E+01 and 1.07E+02, respectively. Site-specific contamination in surface soil and produce, as well as SWMU-wide chemicals in other media, contributed to these total risks/hazards.

7.6.3.1.5 ***Conclusions***. The results of the human health risk assessment under the current land use exposure scenario at this site indicates that the estimated cancer risk to the on-site worker of 3.06E-07 is below the 1E-06 State of Utah recommended threshold of allowable risk. This site's contribution to the total cancer risk to off-site residents (adult and child) are well below this limit. Noncarcinogenic hazards to all receptors associated with this site under current land use conditions were found to be well below the State of Utah recommended value of 1.

Table 7-34. SWMU 13 Summary of Carcinogenic Risks for the Drainage Ditch Site, Phase II RFI

Potential Exposure Pathways		**Current Use**		**Future Use**	
Environmental Medium	**Potential Exposure Route**	**On-Site Worker[a]**	**Off-Site Resident Adult (Child)**	**Construction Worker**	**On-Site Resident Adult (Child)[b]**
Soil	Dermal Contact	**6.69E-09**	NA	**2.50E-08**	**1.22E-07 (6.56E-08)**
	Ingestion	**8.75E-08**	NA	**2.91E-06[c]**	**2.65E-06[d] (4.95E-06)[d]**
Air	Particulate Inhalation	2.12E-07	**2.90E-09(2.03E-09)**	**1.86E-07**	3.09E-05[e] (3.98E-05)[f]
	Vapor Inhalation	1.12E-10	NA	NE	NE
Groundwater	Dermal Contact	NA	NA	NA	1.55E-04 (4.79E-05)
	Ingestion	NA	NA	NA	5.79E-03[g] (2.70E-03)[g]
	Vapor Inhalation	NA	NA	NA	3.00E-07 (2.10E-07)
Homegrown Produce	Ingestion	NA	NA	NA	**2.36E-06[d] (1.21E-06)[d]**
Homegrown Beef	Ingestion	NA	NA	NA	1.35E-09 (5.55E-10)
Homegrown Dairy Products	Ingestion	NA	NA	NA	5.73E-10 (6.54E-10)
	Total Cancer Risk	3.06E-07	**2.90E-09(2.03E-09)**	**3.12E-06**	5.95E-03 (2.79E-03)

Notes.—NA denotes not applicable. NE denotes not evaluated due to lack of USEPA Health Criteria for site-related chemicals within this pathway. Bold type designates site-specific risks (i.e., those potential risks that are attributed to chemicals detected at this site).

[a]Exposure to workers was evaluated based on the time spent at each site during assumed daily visits to each site within SWMU 13. Exposure to airborne chemicals was evaluated based on chemicals measured in surface soil and surface water within this SWMU. The concentrations used for this medium represent SWMU-wide values. Therefore, even if site-specific contamination is absent from surficial soil, exposure from inhalation of particulates and vapors from other sites was assumed to occur.

[b]Beef and milk chemical concentrations represent depot-wide values for TEAD-S. Therefore, the future resident at each site may be exposed to site-specific chemicals and also to those associated with other site locations within SWMU 13 and 17.

[c]Ingestion of arsenic detected in this site's soil is responsible for over 90 percent of the risk.

[d]Ingestion of beryllium detected in this site's soil is responsible for 100 percent of the risk.

[e]Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, and the Pavement Perimeter Site is responsible for almost 90 percent of the total air pathway risk.

[f]Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, the Southwest Wastewater Lagoon, and the Pavement Perimeter Site is responsible for over 90 percent of the total air pathway risk.

[g]Ingestion of arsenic detected in SWMU-wide monitoring wells is responsible for at least 90 percent of the total groundwater pathway risks.

Table 7-35. SWMU 13 Summary of Noncarcinogenic Hazards for the Drainage Ditch Site, Phase II RFI

Potential Exposure Pathways		Current Use		Future Use	
Environmental Medium	**Potential Exposure Route**	**On-Site Worker[a]**	**Off-Site Resident Adult (Child)**	**Construction Worker**	**On-Site Resident Adult (Child)[b]**
Soil	Dermal Contact	**2.90E-05**	NA	**2.04E-03**	**4.39E-04 (3.89E-04)**
	Ingestion	**4.16E-04**	NA	**2.14E-01**	**1.05E-02 (3.82E-02)**
Air	Particulate Inhalation	1.15E-02	**1.49E-04 (5.22E-04)**	**4.00E-02**	1.41E+00 (9.21E+00)[c]
	Vapor Inhalation	4.96E-07	NA	**1.47-09**	8.57E-07 (2.67E-06)
Groundwater	Dermal Contact	NA	NA	NA	5.02E-01 (2.81E-01)
	Ingestion	NA	NA	NA	7.35E+01[d] (9.61E+01)[d]
	Vapor Inhalation	NA	NA	NA	1.38E-02 (5.45E-03)
Homegrown Produce	Ingestion	NA	NA	NA	**4.26E-01 (1.08E+00)**
Homegrown Beef	Ingestion	NA	NA	NA	8.30E-05 (1.70E-04)
Homegrown Dairy Products	Ingestion	NA	NA	NA	1.57E-04 (8.97E-05)
	Total Hazard	1.19E-02	**1.49E-04 (5.22E-04)**	**2.56E-01**	7.59E+01 (1.07E+02)

Notes.—NA denotes not applicable. NE denotes not evaluated due to lack of USEPA Health Criteria for site-related chemicals within this pathway. Bold type designates site-specific hazards (i.e., those potential hazards that are attributed to chemicals detected at this site).

[a]Exposure to workers was evaluated based on the time spent at each site during assumed daily visits to each site within SWMU 13. Exposure to airborne chemicals was evaluated based on chemicals measured in surface soil and surface water within this SWMU. The concentrations used for this medium represent SWMU-wide values. Therefore, even if site-specific contamination is absent from surficial soil, exposure from inhalation of particulates and vapors from other sites was assumed to occur.

[b]Beef and milk chemical concentrations represent depot-wide values for TEAD-S. Therefore, the future resident at each site may be exposed to site-specific chemicals and also to those associated with other site locations within SWMU 13 and 17.

[c]Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, and the Southwest Wastewater Lagoon is responsible for at least 90 percent of the total air pathway hazard.

[d]Ingestion of arsenic, thallium, and fluoride detected in SWMU-wide monitoring wells is responsible for at least 90 percent of the total groundwater pathway hazards.

The results of the human health risk assessment under future land use conditions indicate that the estimated total cancers risk to the potential future on-site adult and child resident of 5.95E-03 and 2.79E-03, respectively, exceed the State of Utah recommended threshold of allowable risk. Total carcinogenic risk to the construction worker (3.12E-06) was found to exceed this limit. Total noncarcinogenic hazards to the potential future on-site adult and child resident of 75.9 and 107, respectively, were found to be well above the State of Utah recommended value of 1. Total noncarcinogenic hazard to the construction worker (0.26) was found to be below the State of Utah recommended value. Ingestion of arsenic detected in this site's subsurface soil is responsible for over 90 percent of the potential cancer risk associated with the soil pathway for the construction worker. Ingestion of beryllium in this site's surface soil is responsible all of the potential cancer risks associated with the soil pathway for the future on-site residents. Beryllium is also the risk-driver for the residential consumption of homegrown produce.

Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, and the Pavement Perimeter Site is responsible for almost 90 percent of the total air pathway cancer risk to the future on-site adult resident. Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, the Southwest Wastewater Lagoon, and the Pavement Perimeter Site is responsible for approximately 90 percent of the cancer risk to the future on-site child resident. These latter sites, with the exception of the Pavement Perimeter Site, are also responsible for over 90 percent of the total noncancer air-pathway hazard to future on-site residents (adults and children). Ingestion of arsenic detected in SWMU-wide monitoring wells is responsible for over 90 percent of the total groundwater pathway risks to future on-site residents (adults and children).

7.6.3.2 *Ecological Risk Assessment*

7.6.3.2.1 ***Site Characterization.*** The ecological assessment for the Drainage Ditch Site included a survey of vegetation and wildlife, and a qualitative habitat evaluation. This assessment did not include collection of either vegetation or wildlife samples for analysis. Human activity at this site is frequent. The potential wildlife inhabitants include small and large mammals, birds, and several of the raptor species. There is no indication that this area is a critical habitat for any endangered or threatened species. Species of vegetation and wildlife that have been observed at the Drainage Ditch Site are presented in Table 7-36.

Evidence of surface water was observed during the field investigation and it is likely that surface water accumulates on this site as the result of storm episodes or snow melt.

7.6.3.2.2 ***Chemicals of Potential Concern.*** Potential ecological COPCs at the Drainage Ditch Site include the metals beryllium, chromium, copper, and zinc, and the nitrate and sulfate anions in surface soil.

Table 7-36. SWMU 13 Vegetation and Wildlife Inventory at the Drainage Ditch Site, Phase II RFI

Scientific Name	Common Name
VEGETATION SPECIES	
Salsola iberica	Russian thistle
Atriplex confertifolia	Shadescale
Chrysothamus nauseosus	Tall rabbitbrush
Artemesia tridentata	Big sagebrush
Eurotia lanata	Winterfat
Sitanion hystrix	Bottlebrush squirreltail grass
WILDLIFE SPECIES	
Antilocapra americana	Antelope
Odocoileus hemionus	Mule deer
Lepus californicus	Black-tailed jackrabbit
Peromyscus maniculatus	Deer mouse
Pituophis cantenifer	Great Basin gopher snake

7.6.3.2.3. ***Results of Risk Characterization.*** HQs calculated for this site are shown in Table 7-37. Calculated potential hazards for the golden eagle and mule deer are negligible. The HI values for the American robin of approximately 40 and for the deer mouse of 2 are attributable to potential ingestion of soil containing chromium, copper, or zinc and potential ingestion of plants or invertebrates that may have bioaccumulated copper or zinc. In all cases, the HQ attributable to background values alone can account for most of the indicated hazard as shown in Appendix H. Indeed, the concentrations for chromium, copper, and zinc reported at the Drainage Ditch Site all fall within the detected range of background samples as reported in Table 5-2.

7.6.3.2.4 *Conclusions.* When compared with background values, calculated HQs are acceptable. For this reason, there appear to be no unacceptable risks to ecological receptors due solely to contaminants at this site.

7.6.4 Conclusions and Recommendations

COPCs associated with the Drainage Ditch Site are metals and anions in surface and subsurface soils, and anions in surface water. The soil borings drilled as part of this Phase II RFI indicate that metals detected above background in the subsurface soils are not a result of past activities at the Drainage Ditch Site, but rather due to natural variation of background concentrations. The anions chloride and sulfate were also detected above background and are most likely due to natural variation in background and do not represent a contamination problem at the site (see Section 7.6.2). Chloride and sulfate lack USEPA Health Criteria and could not be evaluated further in the human health risk assessment. These anions have low toxicity and are unlikely to be of concern.

The human health risk assessment evaluated both current and future use exposure scenarios at the site. Results of the human health risk assessment under the current land use exposure scenario indicate that carcinogenic risk to the on-site worker is below the State of Utah recommended threshold of allowable risk, and the contribution to the total carcinogenic risk to the off-site resident is well below the State of Utah criteria. Noncarcinogenic hazards to all receptors under the current use conditions were also found to be below State of Utah criteria.

Results of the human health risk assessment under future land use conditions indicated that carcinogenic risk to the future on-site resident (adult and child) exceeded the State of Utah recommended threshold range for allowable risk primarily due to dermal contact with and ingestion of contaminated groundwater. The risk to the future on-site construction worker exceeded the recommended limit due to arsenic in site soils. Noncarcinogenic hazards exceed State of Utah criteria for future on-site residents but not for the future on-site construction worker.

It is important to emphasize that the exposure point concentrations for air and for beef and milk used in the human health risk assessment were estimated as SWMU-wide and area-wide (over TEAD-S) values, respectively. In so doing, it is possible to estimate an exposure to a

Table 7-37. Hazard Quotients for Drainage Ditch Site

Analyte Name	Soil EPC (mg/kg)	Water EPC (mg/L)	Air EPC (mg/m3)	ABS	American Robin: Soil Ingestion	American Robin: Dermal Contact with Soil	American Robin: Dietary Ingestion	American Robin: Water Ingestion	American Robin: Total
BE	1.050		ND	0 010	0.04	1 E-06	ND	NA	4.E-02
CL	1900 000		ND	0 010	ND	ND	ND	NA	0
CR	31 200		ND	0 010	2 E+01	6 E-04	ND	NA	2 E+01
CU	25.400		ND	0.010	3 E-01	1 E-05	9 E-01	NA	1 E+00
NIT	5.790		ND	0 010	3 E-02	1.E-06	ND	NA	3 E-02
SO4	26000.000		ND	0 010	ND	ND	ND	NA	0
ZN	158.000		ND	0.010	4 E+00	1.E-04	2.E+01	NA	3 E+01
								Total HI	*4 E+01*

Analyte Name	Golden Eagle: Soil Ingestion	Golden Eagle: Dermal Contact with Soil	Golden Eagle: Dietary Ingestion	Golden Eagle: Water Ingestion	Golden Eagle: Total
BE	4 E-07	1.E-10	ND	NA	4 E-07
CL	ND	ND	ND	NA	0
CR	2 E-04	5 E-08	ND	NA	2 E-04
CU	3.E-06	1.E-09	2 E-05	NA	2 E-05
NIT	2.E-07	9 E-11	ND	NA	3 E-07
SO4	ND	ND	ND	NA	0
ZN	4 E-05	1 E-08	5 E-04	NA	5 E-04
				Total HI	7 E-04

Analyte Name	Deer Mouse: Soil Ingestion	Deer Mouse: Dermal Contact with Soil	Deer Mouse: Dietary Ingestion	Deer Mouse: Water Ingestion	Deer Mouse: Inhalation	Deer Mouse: Total
BE	2 E-03	1.E-06	ND	NA	ND	2 E-03
CL	ND	ND	ND	NA	ND	0
CR	2 E-01	1 E-04	ND	NA	ND	2.E-01
CU	5 E-02	4 E-05	6 E-01	NA	ND	6 E-01
NIT	3 E-03	2.E-06	ND	NA	ND	3.E-03
SO4	ND	ND	ND	NA	ND	0
ZN	7 E-02	5 E-05	2 E+00	NA	ND	2 E+00
					Total HI	2 E+00

Analyte Name	Mule Deer: Soil Ingestion	Mule Deer: Dermal Contact with Soil	Mule Deer: Dietary Ingestion	Mule Deer: Water Ingestion	Mule Deer: Total
BE	2 E-07	1.E-10	ND	NA	2 E-07
CL	ND	ND	ND	NA	0
CR	1 E-05	6 E-09	ND	NA	1 E-05
CU	5 E-06	3 E-09	5 E-05	NA	5.E-05
NIT	3 E-07	2 E-10	ND	NA	3 E-07
SO4	ND	ND	ND	NA	0
ZN	7 E-06	4 E-09	1 E-04	NA	1 E-04
				Total HI	2.E-04

Note.—NA indicates pathway incomplete. ND indicates parameters unavailable.

receptor at a particular site despite the absence of site-related chemicals in surface soil. This occurs because it has been assumed that exposure can take place to chemicals originating from other sites within SWMU 13 and/or SWMU 17 via the air pathway and through consumption of homegrown beef and milk products. Similarly, the groundwater exposure point concentrations were also derived as an area average for each chemical. Therefore, to avoid misrepresenting the results of the risk assessment, it is important to distinguish the portion of the risk and hazard estimates that are due to site-related contamination from that due to SWMU-wide and/or area-wide contributions. Recommendations for each site within both SWMUs will be made pursuant to the provisions of Section R315-101-6 of the Utah Hazardous Waste Rules. Since the groundwater medium at SWMU 13 is already being recommended to the CMS (Site Management Plan), the site specific recommendations will be based on the results of the risk assessment without the groundwater contribution.

The ecological assessment indicated that, although some calculated hazards for the American robin and the deer mouse exceed target endpoints, they are within the range of hazards that would be calculated from background levels of chromium, copper, and zinc in the TEAD-S area. The hazard quotients attributable to maximum background concentrations are in Appendix H. Hence, there are no adverse impacts to ecological receptors due solely to contaminants at this site.

In summary, all available data were used to determine whether past operations at the Drainage Ditch Site has created an environment that could result in any adverse effects to human health or to the local ecology. Results from the human health risk assessment indicate that adverse impacts to the future on-site resident at the site may occur although it is not expected that this site will become available for residency in the future. At this site, even if that portion of the risk and hazard contributed by SWMU-wide contaminants (air and groundwater) were removed as described above, the criteria in item (d) of R315-101-6 would be satisfied. This is because the risk under current land use would be less than 1E-04 but greater than 1E-06 under on-site residential land use. Therefore, this site should be carried through the CMS but not necessarily include provisions for corrective action. Instead, the CMS should include management activities such as monitoring, deed notations, site security, etc. for this site.

7.7 CHEMICAL UNLOAD SITE

7.7.1 Previous Sampling and Phase II RFI Sampling Results

No previous investigations have been conducted at this site prior to this Phase II RFI.

Rust E&I, 1991 To assess whether chemical releases occurred at the Chemical Unload Site, Rust E&I drilled soil boring 13CU-01 downgradient from the unloading area in 1991 (Figure 7-32). The soil boring was drilled to a depth of 10 feet, and samples were collected at depths of 1 to 2, 4 to 5, and 9 to 10 feet. The samples were analyzed for VOCs, SVOCs, metals, anions, and agent breakdown products. The sample results are presented in Table 7-38.

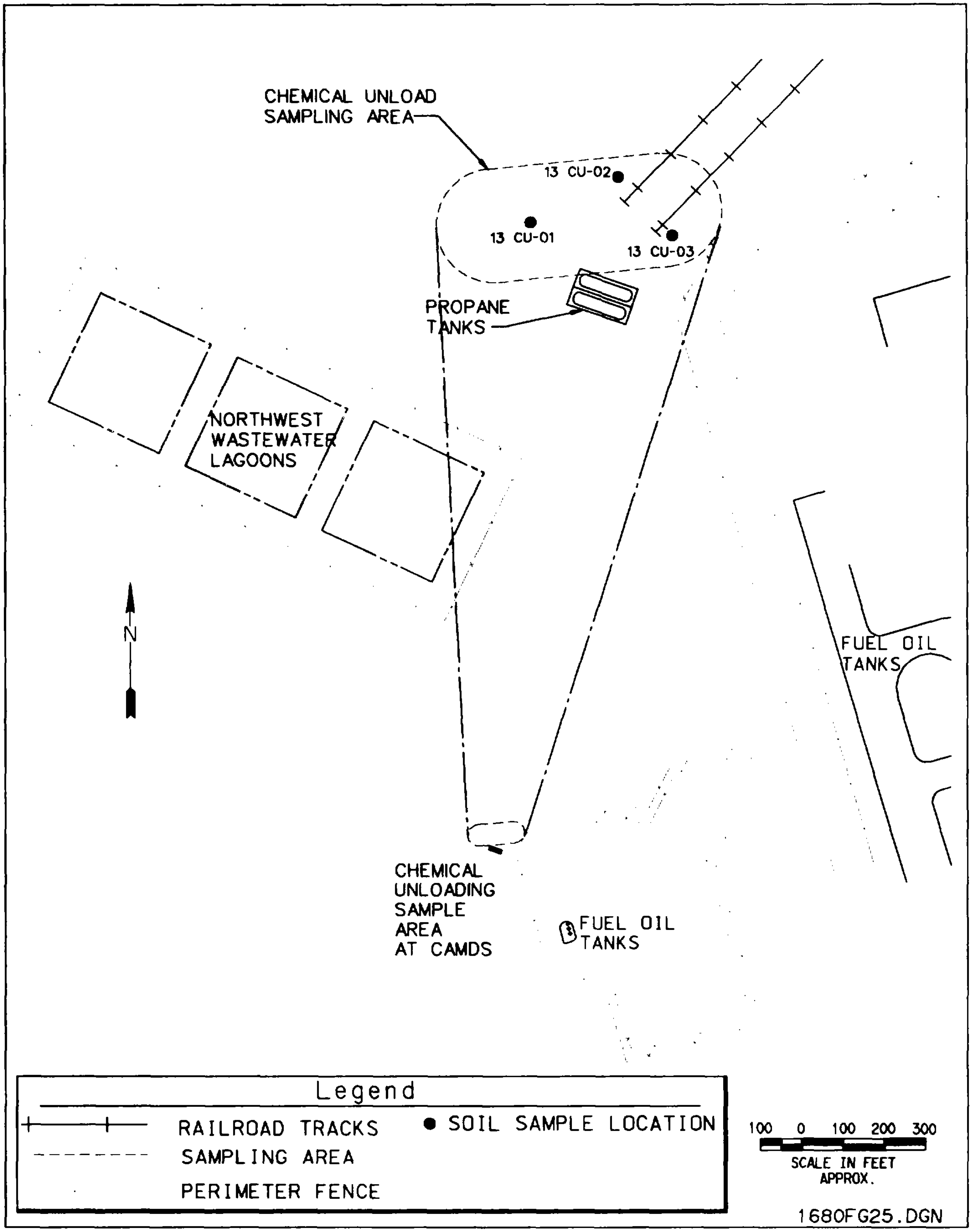

Figure 7-32. Soil Boring Sample Locations at the Chemical Unload Site, SWMU 13

Table 7-38. SWMU 13 Soil Sample Results for the Chemical Unload Site, Phase II RFI

Sample ID	Depth (ft)	VOC (µg/g)	SVOC (µg/g)	Metals (µg/g)					Anions (µg/L)			pH
		Chloroform	Bis (2-Ethylhexyl) Phthalate	Arsenic (BKGD[a] - 16.4)	Chromium (BKGD - 23.5)	Copper (BKGD - 18.1)	Lead (BKGD - 69.8)	Zinc (BKGD - 62.9)	Chloride (BKGD - 596)	Nitrate (BKGD - 4.67)	Sulfate (BKGD - 1697)	
13CU-01-1	1	ND[b]	ND	ND	ND	ND	98	120	5200	5.8	14,000	9.26
13CU-01-2	5	0.041	ND	40.5	35.7	DS	ND	110	ND	ND	3,400	9.92
13CU-01-3	9	ND	ND	ND	ND	ND	ND	ND	730	ND	DS[c]	10.7
13CU-02-2	5	ND	DS	DS	36.2	DS	DS	119	ND	8.56	DS	--[d]
13CU-02-3	10	ND	DS	DS	37.8	21.2	DS	129	ND	16.9	DS	--
13CU-03-2	5	ND	0.87	DS	DS	DS	DS	100	ND	12.1	DS	--
13CU-03-3	10	ND	2	DS	37.7	DS	DS	115	ND	7.06	1700	--
13CU-02-1[e]	0.5											
13CU-03-1	0.5											

[a]Bkgd=Background value for specified analyte.
[b]ND=Analyte not detected at or above the CRL, SRL, or MDL.
[c]DS=Data screened due to the 5 times or 10 times rules or did not exceed background values where applicable. (See Section 6.0 for data screening methodologies).
[d]-- = Analysis not performed.
[e]The following sample IDs, where there were no detected contaminants, are included in the remainder of this table. A comprehensive listing of all the data is presented in Appendix D.

The analytical results indicated one VOC, chloroform, was detected in a low concentration (0.041 μg/g) in the 4-to-5-foot sample. Chloride, nitrate, and sulfate were detected above their respective background limits. Metals detected above background were chromium, lead, arsenic, and zinc. Chromium was detected at 35.7 μg/g; arsenic was detected at 40.5 μg/g; and zinc was detected at 110 μg/g in the soil sample 13CU-01-2, collected at 4 to 5 feet. Soil sample 13CU-01-1, collected at the 1-to-2-foot interval, contained 120 μg/g of zinc and 98.0 μg/g of lead. Metals exceeding background were not detected in the sample 13CU-01-3 from the 9-to-10-foot interval. Soil samples 13CU-01-1, 13CU-01-2, and 13CU-01-3 were also analyzed for pH and yielded results of 9.26, 9.92, and 10.7, respectively (Table 7-38). (Section 5.0 discusses background concentrations at TEAD-S.)

Following evaluation of analytical data collected during the 1991 field effort, it was determined that additional sampling at the Chemical Unload Site was necessary in order to define the lateral and vertical extent of contamination.

Rust E&I 1993. As part of the 1993 field investigation, Rust E&I examined the Chemical Unload Site in order to confirm the presence of organic compounds and further define the inorganic contamination. Two additional soil borings (13CU-02 and 13CU-03) were drilled to a depth of 10 feet with samples collected at the 0-to-2-, 4-to-5-, and 9-to-10-foot intervals. The analyte suite for these samples included VOCs, SVOCs, agent breakdown products, metals, and anions. Table 7-38 includes the soil sampling results, and Figure 7-32 shows the locations of the soil borings.

The anion sulfate was detected above the background threshold at 1,700 μg/g in sample 13CU-03-3. Nitrate was detected at 16.9 μg/g (13CU-02-3) and 12.1 μg/g (13CU-03-2). Nitrate was also detected in the corresponding method blank quality control sample. Because these values were more than five times the value of the method blank, however, they were not screened out and were carried into the risk assessment.

Metals analysis indicated chromium and zinc exceeding background concentrations in five samples (13CU-02-2; 13CU-02-3; 13CU-02-3, duplicate; 13CU-03-2; and 13CU-03-3). Values ranged from 27.5 to 37.8 μg/g for chromium and 100 to 129 μg/g for zinc. All of these detections were at the 4-to-5-foot and 9-to-10-foot intervals. The method blank quality control sample also contained chromium and zinc. The values for chromium and zinc were, however, more than five times the value detected in the method blank and were evaluated through the risk assessment process. Copper was detected in 13CU-02-3 and its duplicate sample at 21.2 μg/g and 18.7 μg/g, respectively. Two samples contained the SVOC bis(2-ethylhexyl)phthalate at 0.87 μg/g in 13CU-03-2 and 2.0 μg/g in 13CU-03-3.

7.7.2 Nature and Extent of Contamination

Although arsenic, chromium, copper, lead, and zinc were detected in soil borings at the Chemical Unload Site, their concentrations are only slightly above their respective background concentrations (16.4 μg/g, arsenic; 23.5 μg/g, chromium; 18.1 μg/g, copper; 69.8 μg/g, lead;

and 62.9 μg/g, zinc; see Section 5.0). These data probably are not indicative of metals contamination but are most likely the result of natural variations of background concentrations within the soils at the site. However, the associated risk from these metals was evaluated through the risk assessment process. Anions detected above background include chloride (up to 5,200 μg/g), nitrate (up to 16.9 μg/g), and sulfate (up to 14,000 μg/g). As with the metals, it is possible that these anions do not represent a contamination problem at this site and that they are naturally occurring. Nevertheless, they will be carried through the risk assessment process.

Although the SVOC bis(2-ethylhexyl)phthalate was not detected within the method blank, it is considered a common laboratory contaminant and is not likely a result of site activities. In taking a conservative approach to the risk analysis, however, this SVOC was evaluated further in the risk assessment.

The VOC chloroform was detected at a low concentration and is likely the result of laboratory contamination. Although chloroform is not listed as a common laboratory contaminant within the *Risk Assessment Guidance for Superfund Sites*, it is commonly associated with laboratory analysis. Furthermore, a historical review of the data indicated that there were no known releases of VOCs at the Chemical Unload Site. However, any potential risk associated with chloroform was evaluated through the risk assessment process.

7.7.3 Risk Assessment Results

7.7.3.1 *Baseline Human Health Risk Assessment*

This section presents the results of the sample data screening approach previously described in Section 6.1.1 that led to (1) the selection of the COPCs, (2) the exposure pathways that are labeled in the conceptual site model as being complete, (3) the exposure-point concentrations in each respective environmental medium for those COPCs that have published health criteria, and (4) the carcinogenic and noncarcinogenic risk estimates for each receptor population under current and future land use scenarios.

This section of the report evaluates exposure to COPCs detected in site soils as well as those contaminants measured or modeled in various media from SWMU-wide or depot-wide sources. The direct soil-contact pathway (e.g., ingestion and dermal exposure) is associated with site-specific chemicals. Similarly, ingestion of homegrown produce by future on-site residents is based on those contaminants (if any) measured in surface soil within this site. Site-specific contaminants in soil are also used as model inputs to the air pathway for current off-site residents and the future on-site construction worker.

Current on-site workers and future on-site residents, however, are assumed to be potentially exposed to SWMU-wide chemicals in air (i.e., those chemicals detected in surface media at all of the sites evaluated within SWMU 13). Exposure to SWMU-wide chemicals was also the approach selected for the groundwater pathway. Thus, future on-site residents are assumed to be potentially exposed to groundwater contaminants measured in monitoring wells located across SWMU 13. The results of the groundwater evaluation are also presented separately in Section 7.11.3.1. Finally, ingestion of beef and dairy products by future on-site residents is based on modeling contaminants detected in depot-wide surface soils; cattle are assumed to graze at contaminated sites within SWMU 13 and SWMU 17. Thus, the total cancer risk and noncarcinogenic hazards to the future on-site resident (adult and child) presented in the sections below include those contributions associated with exposures to SWMU-wide contamination in air and groundwater and to depot-wide chemicals in beef and milk.

7.7.3.1.1 *Chemicals of Potential Concern.* The soil data for this site were grouped by depth and evaluated in the human health risk assessment accordingly. The COPCs measured in the surface (0 to 1.0 feet) and subsurface (1.0 to 10.0 feet) soil are summarized in Table 7-39.

This table does not include chloride or sulfate since these chemicals lack USEPA Health Criteria and, thus, were not evaluated further.

7.7.3.1.2 *Complete Exposure Pathways.* The pathways assumed complete at this site are shown on the conceptual site model in Figure 7-33. Exposure by current on-site workers and

Table 7-39. SWMU 13 Summary of Concentrations of Chemicals of Potential Concern in Surface and Subsurface Soil at the Chemical Unload Site, Phase II RFI

Chemical	Background Concentration (mg/kg)	Frequency of Detection	Range of Detects (mg/kg)	Arithmetic Mean Concentration (mg/kg)	95% UCL (mg/kg)
Surface Soil					
Lead	69.8	3/3	11.0-**98.0**	40.3	124.5
Nitrate	4.67	1/3	**5.8**	2.7	7.2
Zinc	62.9	3/3	40.0-**120.0**	67.1	144.4
Subsurface Soil					
Arsenic	16.4	5/5	9.33-40.5	17.1	**29.7**
Bis(2-ethylhexyl)phthalate	NA	2/6	0.87-2.0	0.62	**1.22**
Chloroform	NA	1/6	**0.0409**	0.088	0.13
Chromium	23.5	5/5	27.5-**37.7**	34.1	37.9
Copper	18.1	5/6	13.1-20.0	15.5	**18.4**
Nitrate	4.67	2/6	12.1-16.9	5.8	**11.5**
Zinc	62.9	5/6	100.0-**120.0**	100.7	125.8

Notes.—Chloride and sulfate were also detected in surface and subsurface but were not evaluated further due to lack of USEPA Health Criteria. NA denotes not applicable. **Bold** type designates the exposure point concentration selected for these media.

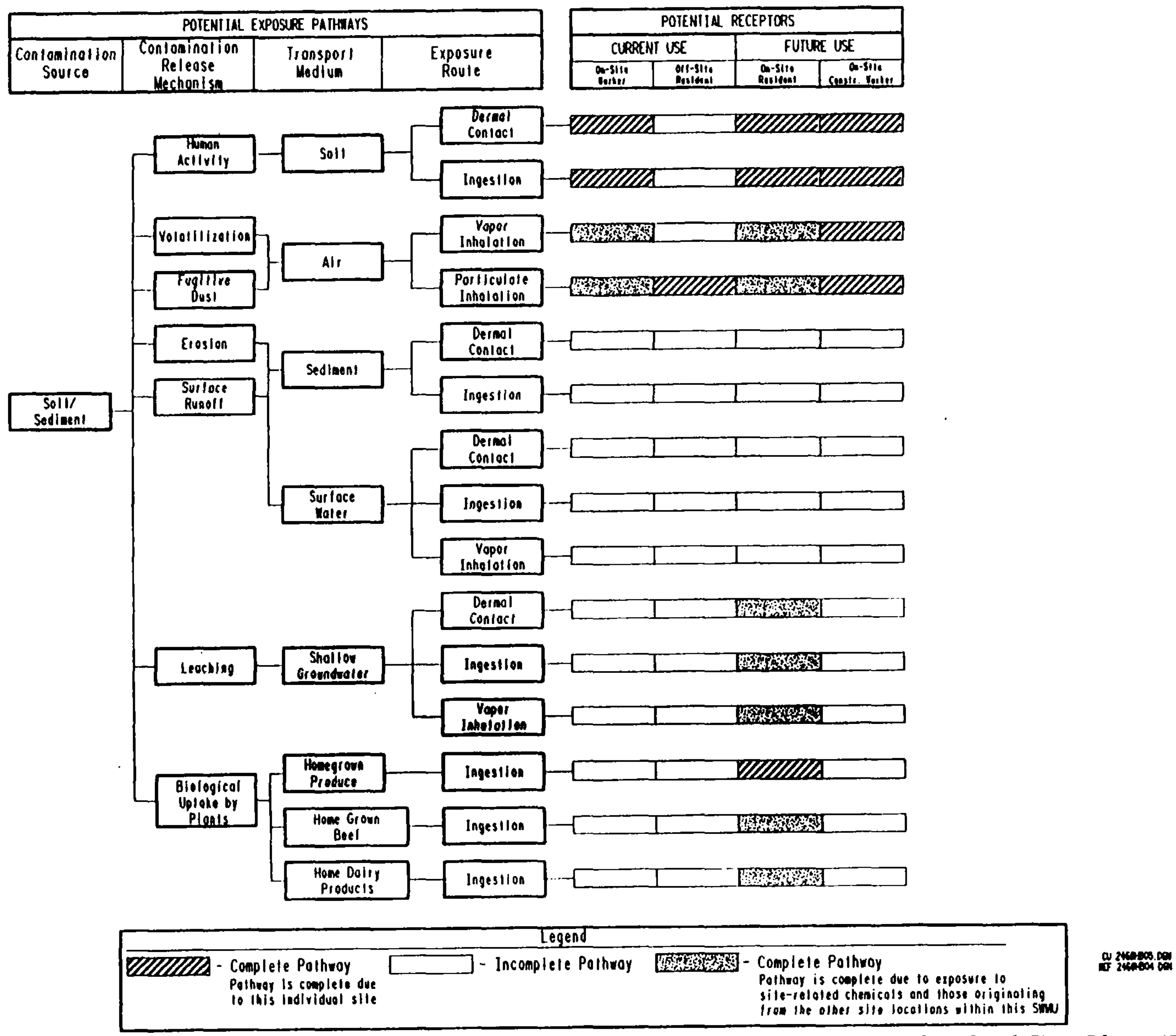

Figure 7-33. SWMU 13 Potential Human Exposure Pathway Conceptual Model for the Chemical Unload Site, Phase II RFI

potential future on-site residents from ingestion of and dermal contact with COPCs measured in this site's surface soil was evaluated. Exposure by future construction workers from ingestion of and dermal contact with site-specific chemicals in subsurface soil was also evaluated. Exposure from inhalation of chemical emissions from surface soil by current on-site workers, off-site residents, and potential future on-site residents was evaluated. Exposure to chloroform vapors and fugitive dust from this site's subsurface soil by the future on-site construction worker was also evaluated. Inhalation exposure by off-site residents of site-specific contaminants dispersed from surface soil in ambient air represents the only complete exposure pathway for these receptors.

This site does not include surface water or sediments and, thus, exposure pathways associated with these medium are incomplete.

Chemicals measured in this site's surface soil (0 to 1.0 foot) were assumed to be available for plant uptake. Therefore, exposure by potential future on-site residents from consumption of vegetables grown at this site was evaluated. Evaluation of exposure to SWMU-wide chemicals in groundwater by future on-site residents is described in Section 7.11.3.1.

The sites within SWMU 13 either overlap or are adjacent to each other so that it was practical to estimate air chemical levels as SWMU-wide concentrations instead of on a site-specific basis. Therefore, exposure from inhalation of SWMU-wide chemical concentrations by the on-site worker during daily visits to this site was included despite the fact that these chemicals were not all present in surficial soil at this location. Exposures to airborne chemicals by future residents were also based on SWMU-wide concentration. Similarly, exposures by potential future on-site residents from ingestion of chemicals in beef and milk, derived as depot-wide averages using data collected at SWMUs 13 and 17, were also evaluated.

7.7.3.1.3 ***Exposure Point Concentrations.*** Exposures from all complete pathways by the identified receptors were estimated using the exposure-point concentrations in Table 7-40. These values include those that were based on soil chemical concentrations measured in surface and subsurface soil within this site.

Table 7-40 also includes values for airborne chemicals originating from several sites within this SWMU that contribute to overall worker and resident exposure at this location, as well as average values for chemicals in beef and milk for all of TEAD-S that pertain to future on-site residents. The beef and milk values were estimated using data from SWMUs 13 and 17. Exposure to chemicals in groundwater by potential future on-site residents was based on the SWMU-wide exposure point concentrations in Table 7-68.

7.7.3.1.4 ***Risk Estimates.*** The receptor populations evaluated at this site include the current on-site worker, off-site residents (adult and child), future construction worker, and future on-site residents (adult and child). Cancer risks and noncarcinogenic hazards to these receptor populations were estimated based on exposure to site-specific chemicals detected in surface soil

Table 7-40. SWMU 13 Exposure Point Concentrations for the Chemicals of Potential Concern at the Chemical Unload Site, Phase II RFI

Receptor	Chemical	EXPOSURE POINT CONCENTRATIONS								
		Air[a] (mg/m^3)	Soil (mg/kg)	Milk[b] (mg/L)	Beef[b] (mg/g)	Potato[c] (mg/g)	Tomato (mg/g)	Carrot (mg/g)	Lettuce (mg/g)	Beans (mg/g)
On-Site Worker	Arsenic	2.15E-07	<Bkgd	---	---	---	---	---	---	---
	Beryllium	7.76E-09	<Bkgd	---	---	---	---	---	---	---
	Chromium	5.60E-07	<Bkgd	---	---	---	---	---	---	---
	Copper	2.01E-07	<Bkgd	---	---	---	---	---	---	---
	Lead	8.33E-08	98	---	---	---	---	---	---	---
	Mercury	1.27E-10	ND	---	---	---	---	---	---	---
	Nickel	1.24E-08	<Bkgd	---	---	---	---	---	---	---
	Nitrate	5.00E-07	5.8	---	---	---	---	---	---	---
	Uranium	2.64E-09	ND	---	---	---	---	---	---	---
	Zinc	1.31E-06	120	---	---	---	---	---	---	---
	Acetone	1.30E-05	ND	---	---	---	---	---	---	---
	Chloromethane	1.60E-06	ND	---	---	---	---	---	---	---
	Methyl chloride	2.35E-06	ND	---	---	---	---	---	---	---
	4-Methylphenol	3.16E-10	ND	---	---	---	---	---	---	---
	Methyl isobutyl ketone	1.50E-09	ND	---	---	---	---	---	---	---
	Methyl-n-butyl ketone	7.30E-10	NA	---	---	---	---	---	---	---
Off-Site Resident	Lead	6.37E-10	---	---	---	---	---	---	---	---
	Nitrate	3.77E-11	---	---	---	---	---	---	---	---
	Zinc	7.80E-10	---	---	---	---	---	---	---	---

Table 7-40. SWMU 13 Exposure Point Concentrations for the Chemicals of Potential Concern at the Chemical Unload Site, Phase II RFI (continued)

Receptor	Chemical	EXPOSURE POINT CONCENTRATIONS								
		Air[a] (mg/m³)	Soil (mg/kg)	Milk[b] (mg/L)	Beef[b] (mg/g)	Potato[c] (mg/g)	Tomato (mg/g)	Carrot (mg/g)	Lettuce (mg/g)	Beans (mg/g)
Future On-Site Resident	Arsenic	2.1E-06(3.49E-06)	<Bkgd	9.80E-08	1.63E-09	---	---	---	---	---
	Beryllium	4.81E-08(7.4E-08)	<Bkgd	9.32E-11	3.99E-11	---	---	---	---	---
	Chromium	5.9E-06(2.86E-06)	<Bkgd	7.65E-08	4.00E-09	---	---	---	---	---
	Copper	1.7E-06(1.0E-05)	<Bkgd	4.41E-05	1.13E-07	---	---	---	---	---
	Lead	1.47E-06(2.94E-06)	98	1.55E-07	8.16E-11	7.80E-05	5.30E-05	3.80E-05	2.80E-05	2.50E-04
	Mercury	6.19E-09(1.24E-08)	ND	1.03E-09	1.26E-11	---	---	---	---	---
	Nickel	6.02E-07(1.2E-06)	<Bkgd	8.52E-08	7.29E-09	---	---	---	---	---
	Nitrate[d]	4.89E-07(6.64E-07)	5.8	NA	NA	NA	NA	NA	NA	NA
	Uranium	1.18E-07(2.35E-07)	<Bkgd	2.00E-09	7.71E-12	---	---	---	---	---
	Zinc	1.03E-05(1.73E-05)	120	4.63E-03	1.78E-05	1.80E-02	6.50E-03	8.50E-03	8.40E-03	3.00E-02
	Bis(2-ethylhexyl) phthalate	---	ND	1.24E-09	1.51E-12	---	---	---	---	---
	1,2-Dimethylbenezene	---	ND	3.49E-12	4.25E-15	---	---	---	---	---
	4-Methylphenol	1.26E-08(2.53E-08)	ND	4.07E-10	4.96E-13	---	---	---	---	---
	Methyl isobutyl ketone	8.00E-09(9.50E-09)	ND	6.50E-12	7.92E-15	---	---	---	---	---
	Methyl-n-butyl ketone	4.00E-09 (4.80E-09)	NA	---	---	---	---	---	---	---
	Toluene	---	ND	2.48E-12	3.02E-15	---	---	---	---	---
Future Construction Worker	Arsenic	1.19E-06	29.7	---	---	---	---	---	---	---
	Bis(2-ethylhexyl) phthalate	4.88E-08	1.22	---	---	---	---	---	---	---
	Chloroform	5.40E-07	0.0409	---	---	---	---	---	---	---

Table 7-40. SWMU 13 Exposure Point Concentrations for the Chemicals of Potential Concern at the Chemical Unload Site, Phase II RFI (continued)

Receptor	Chemical	EXPOSURE POINT CONCENTRATIONS								
		Air[a] (mg/m^3)	Soil (mg/kg)	Milk[b] (mg/L)	Beef[b] (mg/g)	Potato[c] (mg/g)	Tomato (mg/g)	Carrot (mg/g)	Lettuce (mg/g)	Beans (mg/g)
Future Construction Worker (cont.)	Chromium	1.51e-06	37.7	---	---	---	---	---	---	---
	Copper	7.36e-07	18.4	---	---	---	---	---	---	---
	Nitrate	4.60e-07	11.5	---	---	---	---	---	---	---
	Zinc	4.80e-06	120	---	---	---	---	---	---	---

Notes.—"---" denotes not applicable. ND denotes chemical was not detected in site soil. <Bkgd denotes below background.

[a]Air values represent average levels for on-site worker and maximum levels for future resident over SWMU 13. Value in parenthesis is for child. Air chemical concentrations are based on corresponding subsurface soil values for construction worker.

[b]Milk and beef concentrations were derived to evaluate exposure to potential future on-site residents, and represent average values based on data collected from SWMUs 13 and 17.

[c]Vegetable chemical concentrations are based on corresponding soil concentration.

[d]Transfer factors for nitrate are not available.

and subsurface soil (construction worker); SWMU-wide chemicals in air and groundwater; and/or depot-wide contaminants in beef/milk. The results of this evaluation under current and future land use are presented below. These results are also summarized for each exposure pathway in Tables 7-41 and 7-42. Actual risk calculations are presented in Appendix H. Tables 7-41 and 7-42 show in bold font those risks and hazards that are site-specific (i.e., related to chemicals detected specifically in this site's soils).

Current Land Use

Cancer risk to the current on-site worker from indirect exposure to SWMU-wide chemicals in air was estimated to be 2.12E-07. The noncarcinogenic hazard to this receptor, which includes direct exposure to site-specific chemicals in soil, was estimated to be 2.48E-02. This site's contributions to the total cancer risk to the off-site adult and child were not evaluated since no carcinogens were detected in surface soils at this site. This site's contributions to total noncarcinogenic hazards to the off-site adult and child receptors were estimated to be 3.90E-07 and 1.36E-06, respectively.

Future Land Use

Total cancer risk to the construction worker was estimated to be 1.97E-06, and the total noncarcinogenic hazard, 9.81E-02. These estimates for the construction worker are based entirely on site-specific (subsurface soil) contamination.

Total cancer risks to the future on-site adult and child from exposure to chemicals in air, soil, groundwater, and homegrown products was estimated to be 5.98E-03 and 2.79E-03, respectively. Total noncarcinogenic hazards to these receptors were estimated to be 7.69E+01 and 1.12E+02, respectively. Site-specific contamination in surface soil and produce, as well as SWMU-wide chemicals in air and groundwater, contributed to the total noncancer hazards. Since carcinogens were not detected in this site's surface soil, future residential cancer risks are related only to the air and groundwater pathways and, thus, are not due to this site.

7.7.3.1.5 ***Conclusions.*** The results of the human health risk assessment under the current land use exposure scenario at this site indicates that the estimated cancer risk to the on-site worker of 2.12E-07 is well below the 1E-06 State of Utah recommended target range of allowable risk. The noncarcinogenic hazards to all receptors associated with this site under current land use conditions were found to be well below the State of Utah recommended value of 1.

The results of the human health risk assessment under future land use conditions indicate that the estimated total cancer risks to the potential future on-site adult and child resident of 5.98E-03 and 2.79E-03, respectively, exceed the State of Utah recommended threshold limit of allowable risk primarily due to ingestion of contaminated SWMU-wide groundwater (as discussed further below). Total carcinogenic risk to the construction worker (1.97E-06) was found to exceed this limit, and this risk was associated mainly with the ingestion of arsenic

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Table 7-41. SWMU 13 Summary of Carcinogenic Risks for the Chemical Unload Site, Phase II RFI

Potential Exposure Pathways		Current Use		Future Use	
Environmental Medium	**Potential Exposure Route**	**On-Site Worker[a]**	**Off-Site Resident Adult (Child)**	**Construction Worker**	**On-Site Resident Adult (Child)[b]**
Soil	Dermal Contact	NE	NA	**1.72E-08**	NE
	Ingestion	NE	NA	**1.79E-06[c]**	NE
Air	Particulate Inhalation	2.12E-07	NE	**1.67E-07**	3.09E-05[d](3.98E-05)[e]
	Vapor Inhalation	1.12E-10	NA	**9.17E-11**	NE
Groundwater	Dermal Contact	NA	NA	NA	1.55E-04(4.79E-05)
	Ingestion	NA	NA	NA	5.79E-03[f](2.70E-03)[f]
	Vapor Inhalation	NA	NA	NA	3.00E-07(2.10E-07)
Homegrown Produce	Ingestion	NA	NA	NA	NE
Homegrown Beef	Ingestion	NA	NA	NA	1.35E-09(5.55E-10)
Homegrown Dairy Products	Ingestion	NA	NA	NA	5.73E-10(6.54E-10)
	Total Cancer Risk	2.12E-07	NE	**1.97E-06**	5.98E-03(2.79E-03)

Notes.—NA denotes not applicable. NE denotes not evaluated due to lack of USEPA Health Criteria for site-related chemicals within this pathway. Bold type designates site-specific risks (i.e., those potential risks that are attributed to chemicals detected at this site).

[a]Exposure to workers was evaluated based on the time spent at each site during assumed daily visits to each site within SWMU 13. Exposure to airborne chemicals was evaluated based on chemicals measured in surface soil and surface water within this SWMU. The concentrations used for this medium represent SWMU-wide values. Therefore, even if site-specific contamination is absent from surficial soil, exposure from inhalation of particulates and vapors from other sites was assumed to occur.

[b]Beef and milk chemical concentrations represent depot-wide values for TEAD-S. Therefore, the future resident at each site may be exposed to site-specific chemicals and also to those associated with other site locations within SWMU 13 and 17.

[c]Ingestion of arsenic detected in this site's soil is responsible for most of the risk.

[d]Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, and the Pavement Perimeter Site is responsible for almost 90 percent of the total air pathway risk.

[e]Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, the Southwest Wastewater Lagoon, and the Pavement Perimeter Site is responsible for over 90 percent of the total air pathway risk.

[f]Ingestion of arsenic detected in SWMU-wide monitoring wells is responsible for at least 90 percent of the total groundwater pathway risks.

Table 7-42. SWMU 13 Summary of Noncarcinogenic Hazards for the Chemical Unload Site, Phase II RFI

Potential Exposure Pathways		Current Use		Future Use	
Environmental Medium	**Potential Exposure Route**	**On-Site Worker[a]**	**Off-Site Resident Adult (Child)**	**Construction Worker**	**On-Site Resident Adult (Child)[b]**
Soil	Dermal Contact	**9.47E-04**	NA	**5.49E-04**	**1.44E-02(3.87E-02)**
	Ingestion	**1.24E-02**	NA	**5.74E-02**	**3.13E-01(2.92E+00)[c]**
Air	Particulate Inhalation	1.15E-02	**3.90E-07(1.36E-06)**	**4.02E-02**	1.41E+00(9.21E+00)[d]
	Vapor Inhalation	4.96E-07	NA	NE	8.57E-07(2.67E-06)
Groundwater	Dermal Contact	NA	NA	NA	5.02E-01(2.81E-01)
	Ingestion	NA	NA	NA	7.35E+01[e](9.61E+01)[e]
	Vapor Inhalation	NA	NA	NA	1.38E-02(5.45E-03)
Homegrown Produce	Ingestion	NA	NA	NA	**1.17E+00[c](3.07E+00)[c]**
Homegrown Beef	Ingestion	NA	NA	NA	8.30E-05(1.70E-04)
Homegrown Dairy Products	Ingestion	NA	NA	NA	1.57E-04(8.97E-04)
	Total Hazard	2.48E-02	**3.90E-07(1.36E-06)**	**9.81E-02**	7.69E+01(1.12E+02)

Notes.—NA denotes not applicable. NE denotes not evaluated due to lack of USEPA Health Criteria for site-related chemicals within this pathway. Bold type designates site-specific hazards (i.e., those potential hazards that are attributed to chemicals detected at this site).

[a]Exposure to workers was evaluated based on the time spent at each site during assumed daily visits to each site within SWMU 13. Exposure to airborne chemicals was evaluated based on chemicals measured in surface soil and surface water within this SWMU. The concentrations used for this medium represent SWMU-wide values. Therefore, even if site-specific contamination is absent from surficial soil, exposure from inhalation of particulates and vapors from other sites was assumed to occur.

[b]Beef and milk chemical concentrations represent depot-wide values for TEAD-S. Therefore, the future resident at each site may be exposed to site-specific chemicals and also to those associated with other site locations within SWMU 13 and 17.

[c]Ingestion of lead detected in this site's soil is responsible for most of the hazard.

[d]Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, and the Southwest Wastewater Lagoon is responsible for at least 90 percent of the total air pathway hazard.

[e]Ingestion of arsenic, thallium, and fluoride detected in SWMU-wide monitoring wells is responsible for at least 90 percent of the total groundwater pathway hazards.

detected in this site's subsurface soil. Total noncarcinogenic hazards to the potential future on-site adult and child resident of 76.9 and 112, respectively, were found to be well above the State of Utah recommended value of 1 primarily due to the groundwater exposure pathway. Total noncarcinogenic hazard to the construction worker (0.10) was found to be well below the State of Utah recommended value.

Ingestion of lead detected in this site's surface soil is responsible for most of the potential hazards associated with the soil pathway and with the consumption of homegrown produce for the future residents (adults and children).

Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, and the Pavement Perimeter Site is responsible for almost 90 percent of the total air pathway cancer risk to the future on-site adult resident. Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, the Southwest Wastewater Lagoon, and the Pavement Perimeter Site is responsible for approximately 90 percent of the cancer risk to the future on-site child resident. These latter sites, with the exception of the Pavement Perimeter Site, are also responsible for over 90 percent of the total noncancer air-pathway hazard to future on-site residents (adults and children). Ingestion of arsenic detected in SWMU-wide monitoring wells is responsible for over 90 percent of the total groundwater pathway risks to future on-site residents (adults and children).

7.7.3.2 *Ecological Risk Assessment*

7.7.3.2.1 *Site Characterization.* The ecological assessment for the Chemical Unload Site included a survey of vegetation and wildlife, and a qualitative habitat evaluation. This assessment did not include collection of either vegetation or wildlife samples for analysis. Human activity at this site is frequent. The potential wildlife inhabitants include small and large mammals, birds, and several of the raptor species. There is no indication that this area is a critical habitat for any endangered or threatened species. Species of vegetation and wildlife that have been observed at the Chemical Unload Site are presented in Table 7-43. This site contains a stone-covered railroad track area and is small compared to other sites.

No evidence of surface water was observed during the field investigation. It is unlikely that significant surface water ever accumulates on this site as the result of storm episodes or snow melt.

7.7.3.2.2 *Chemicals of Potential Concern.* The potential ecological COPCs at the Chemical Unload Site include lead, zinc, chloride, nitrate, and sulfate in surface soil.

Table 7-43. SWMU 13 Vegetation and Wildlife Inventory for the Chemical Unload Site, Phase II RFI

Scientific Name	Common Name
VEGETATION SPECIES	
Salsola iberica	Russian thistle
Atriplex confertifolia	Shadescale
Chrysothamus nauseosus	Tall rabbitbrush
Sitanion hystrix	Bottlebrush squirreltail grass
WILDLIFE SPECIES	
Antilocapra americana	Antelope
Odocoileus hemionus	Mule deer
Lepus californicus	Black-tailed jackrabbit
Buteo jamacensis	Redtailed hawk
Peromyscus maniculatus	Deer mouse

7.7.3.2.3 ***Results of Risk Characterization***. Calculated HQs and HIs for the Chemical Unload Site are presented in Table 7-44. Calculated HQs for the golden eagle and the mule deer are negligible, and the calculated HQ and HI sum for the deer mouse are all less than the targeted endpoint of 1. The calculated potential HI for the American robin of approximately 10 is attributable to lead and zinc, which may be ingested in soil and/or plants and in invertebrates that have bioaccumulated these metals. However, the HQs attributable to background concentration account for much of the calculated site hazard. Indeed, the site values are within the range of background detects for TEAD-S (background range for lead is 7.3 to 254 μg/g and for zinc, 21.4 to 232 μg/g).

7.7.3.2.4. ***Conclusions***. When compared with background values, calculated HQs are acceptable. In addition, this site is small, frequented by humans, and mainly covered by crushed rock. As a result, there appear to be no excessive risks to ecological receptors due solely to contaminants at the Chemical Unload Site.

Table 7-44. Hazard Quotients for Chemical Unload Site

Analyte Name	Soil EPC (mg/kg)	Water EPC (mg/L)	Air EPC (mg/m3)	ABS
CL	5200.000		ND	0 010
NIT	5.800		ND	0 010
PB	98.000		ND	0 010
SO4	14000.000		ND	0 010
ZN	120.000		ND	0 010

Analyte Name	American Robin				
	Soil Ingestion	Dermal Contact with Soil	Dietary Ingestion	Water Ingestion	Total
CL	ND	ND	ND	NA	0
NIT	1.E-02	4.E-07	ND	NA	1 E-02
PB	2 E+00	6 E-05	4 E-01	NA	2 E+00
SO4	ND	ND	ND	NA	0
ZN	1 E+00	4 E-05	6 E+00	NA	7 E+00
				Total HI	1 E+01

Analyte Name	Golden Eagle				
	Soil Ingestion	Dermal Contact with Soil	Dietary Ingestion	Water Ingestion	Total
CL	ND	ND	ND	NA	0
NIT	4 E-08	1 E-11	ND	NA	4 E-08
PB	5.E-06	2 E-09	1.E-04	NA	1 E-04
SO4	ND	ND	ND	NA	0
ZN	4 E-06	1 E-09	6.E-05	NA	6 E-05
				Total HI	2 E-04

Analyte Name	Deer Mouse					
	Soil Ingestion	Dermal Contact with Soil	Dietary Ingestion	Water Ingestion	Inhalation	Total
CL	ND	ND	ND	NA	ND	0
NIT	1 0E-03	5 E-07	ND	NA	ND	7.E-04
PB	1 E-01	1 E-04	2 E-01	NA	ND	3 E-01
SO4	ND	ND	ND	NA	ND	0
ZN	1 E-02	9 E-06	2 E-01	NA	ND	3 E-01
					Total HI	6 E-01

Analyte Name	Mule Deer				
	Soil Ingestion	Dermal Contact with Soil	Dietary Ingestion	Water Ingestion	Total
CL	ND	ND	ND	NA	0
NIT	4 E-08	2 E-11	ND	NA	4 E-08
PB	9 E-06	5 E-09	2 E-05	NA	3 E-05
SO4	ND	ND	ND	NA	0
ZN	8.E-07	4 E-10	1 E-05	NA	1 E-05
				Total HI	4 E-05

Note.--NA indicates pathway incomplete ND indicates parameters unavailable

7.7.4 Conclusions and Recommendations

COPCs associated with the Chemical Unload Site are metals, anions, VOCs, and SVOCs in surface and subsurface soils. The soil borings drilled during the 1991 and 1993 field efforts determined that concentrations of metals only slightly exceeded background values and are not likely because of past activities at the site. Although the anions chloride, nitrate, and sulfate were detected in excess of background, it is believed that these detections are naturally occurring. VOCs and SVOCs detected are those commonly associated with laboratory methods and are not considered to represent contamination (see section 7.7.2). The anions chloride and sulfate lack USEPA Health Criteria and, thus, were not evaluated in the baseline human health risk assessment. These anions have low toxicity and are unlikely to be of concern.

The human health risk assessment evaluated both the current and future land use exposure scenarios at the site. Results of the human health risk assessment under the current land use exposure scenario indicate that total carcinogenic risk to the on-site worker is below the State of Utah recommended target of allowable risk. Noncarcinogenic hazards to all receptors under the current use conditions were found to be below State of Utah criteria.

Results of the human health risk assessment under future land use conditions indicated that carcinogenic risk to the future on-site resident (adult and child) exceeds the State of Utah recommended threshold range for allowable risk primarily from potential exposure to contaminated groundwater. The risk to the future on-site construction worker was also greater than the State of Utah limit for allowable risk due to arsenic detected in this site's soil. Total noncarcinogenic hazards exceed State of Utah criteria for the future on-site resident but not for the future on-site construction worker.

It is important to emphasize that the exposure point concentrations for air and for beef and milk used in the human health risk assessment were estimated as SWMU-wide and area-wide (over TEAD-S) values, respectively. In so doing, it is possible to estimate an exposure to a receptor at a particular site despite the absence of site-related chemicals in surface soil. This occurs because it has been assumed that exposure can take place to chemicals originating from other sites within SWMU 13 and/or SWMU 17 via the air pathway and through consumption of homegrown beef and milk products. Similarly, the groundwater exposure point concentrations were also derived as an area average for each chemical. Therefore, to avoid misrepresenting the results of the risk assessment, it is important to distinguish the portion of the risk and hazard estimates that are due to site-related contamination from that due to SWMU-wide and/or area-wide contributions. Recommendations for each site within both SWMUs will be made pursuant to the provisions of Section R315-101-6 of the Utah Hazardous Waste Rules. Since the groundwater medium at SWMU 13 is already being recommended to the CMS (Site Management Plan), the site specific recommendations will be based on the results of the risk assessment without the groundwater contribution.

The ecological assessment indicated that, although some calculated hazards for the American robin exceed target endpoints, they are within the range of TEAD-S background values. As a result, there are no adverse impacts to ecological receptors due solely to contaminants at this site.

All available data were used to determine whether past operations at the Chemical Unload Site has created an environment that could result in any adverse effects to human health or to the local ecology. Results from the human health risk assessment indicate that adverse carcinogenic impacts to the future on-site resident at the site may occur primarily as a result of exposure to contaminated groundwater. At this site, even if that portion of the risk and hazard contributed by SWMU-wide contaminants (air and groundwater) were removed, the criteria in item (d) of R315-101-6 would be satisfied. This is because the hazard under future land use to the child receptor would be greater than 1. Therefore, this site should be carried through the CMS but not necessarily include provisions for corrective action. Instead, the CMS should, for this site, include management activities such as monitoring, deed notations, site security, etc.

7.8 PAVEMENT PERIMETER SITE

7.8.1 Previous Sampling and Phase II RFI Sampling Results

No previous investigations have been conducted at the Pavement Perimeter Site prior to this Phase II RFI.

Rust E&I, 1991. During the 1991 field investigation, three soil borings were drilled along the perimeter fence of CAMDS in order to assess what types of potentially hazardous materials may be leaving the CAMDS facility via surface drainage from the paved areas. Two of the borings (13PP-01 and 13PP-02) were located on the east perimeter, and one boring (13PP-03) was located on the west perimeter (Figure 7-34). The borings were drilled to a depth of 10 feet, and soil samples were collected from each boring at the approximate depths of 1 foot, 5 feet, and 9 feet. The samples were analyzed for VOCs, SVOCs, metals, explosives, ABPs, anions, and pH.

Table 7-45 summarizes the soil sampling results for those analytes that were detected in at least one sample. No explosives or SVOCs were detected. Traces of two VOCs were detected: methyl isobutyl ketone at 0.019 μg/g, and methyl-N-butyl ketone at 0.011 μg/g in only one sample (13PP-01-1). The ABP fluoroacetic acid was detected at 12.7 μg/g in borings 13PP-02 and at 13.1 μg/g 13PP-01.

Metals detected above background concentrations include arsenic, chromium, and zinc. Arsenic and chromium were detected above background in all three of the 1991 soil borings (13PP-01 through 13PP-03) while zinc was only detected above background in one boring (13PP-03) at 130 μg/g. Arsenic and chromium concentrations ranged from 43.5 to 52.1 μg/g and 25.8 to 34.6 μg/g, respectively.

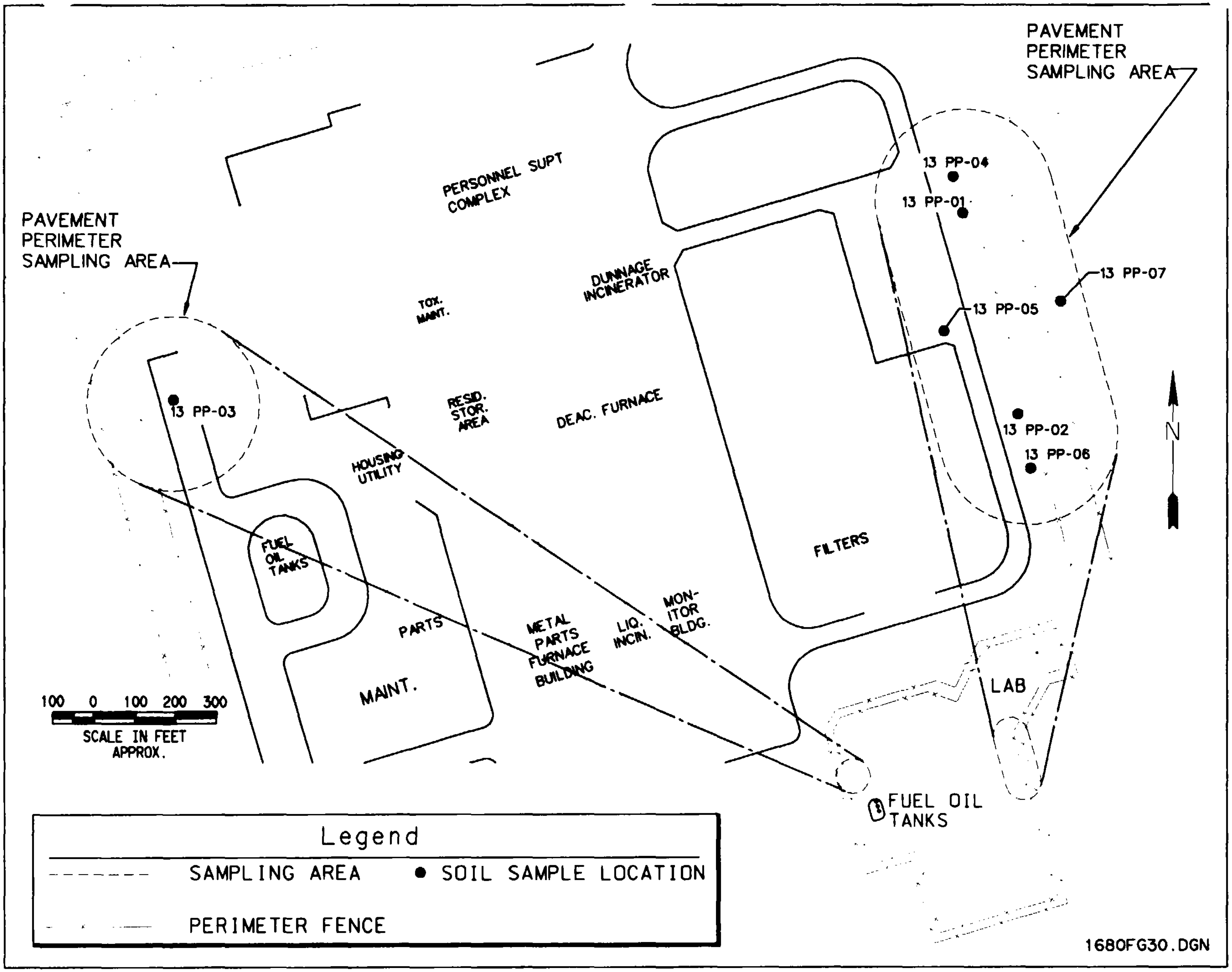

Figure 7-149. Soil Boring Sample Locations at the Pavement Perimeter Site, SWMU 13

Table 7-45. SWMU 13 Soil Sample Results for the Pavement Perimeter Site, Phase II RFI

Sample ID	Depth	VOC (µg/g) Methyl-N-Butyl Ketone	VOC (µg/g) Methylisobutyl Ketone	Metals (µg/g) Arsenic (BKGD[a] - 16.4)	Metals (µg/g) Chromium (BKGD - 23.5)	Metals (µg/g) Zinc (BKGD - 62.9)	Anions (µg/g) Chloride (BKGD - 596)	Anions (µg/g) Nitrate (BKGD - 4.67)	Anions (µg/g) Sulfate (BKGD - 1,697)	pH
13PP-01-1	1	0.011	0.019	ND[b]	27.5	ND	DS[c]	130	DS	9.33
13PP-01-2	5	ND	ND	52.1	DS	ND	6,500	55	22,000	10.60
13PP-01-3	9	ND	ND	ND	ND	ND	9,200	55	50,000	10.60
13PP-02-1	1	ND	ND	48.5	27.7	ND	DS	75	DS	9.94
13PP-02-2	5	ND	ND	51.2	25.8	ND	2,000	50	30,000	9.71
13PP-02-3	9	ND	ND	ND	ND	ND	8,300	66	57,000	9.90
13PP-03-1	1.5	ND	ND	ND	ND	130	DS	13.8	DS	10.60
13PP-03-2	5	ND	ND	43.5	34.6	ND	1,900	23.3	4,300	9.91
13PP-03-3	9	ND	ND	ND	DS	DS	2,600	12.5	2,400	10.4
13PP-04-1[d]	1.0									
13PP-04-2	4.0									
13PP-05-1	1.0									
13PP-05-2	4.0									
13PP-06-1	1.0									
13PP-06-2	4.0									
13PP-07-1	1.0									
13PP-07-2	4.0									

[a]Bkgd=Background value for specified analyte.
[b]ND=Analyte not detected at or above the CRL, SRL, or MDL.
[c]DS=Data screened due to the 5 times or 10 times rules or did not exceed background values where applicable. (See Section 6.0 for data screening methodologies).
[d]The following sample IDs, where there were no detected contaminants, are included in the remainder of this table. A comprehensive listing of all the data is presented in Appendix D.

In addition, the anions chloride (1,900 to 9,200 μg/g), nitrate (12.5 to 130 μg/g), and sulfate (2,400 to 57,000 μg/g) were also detected above background in all three of the soil borings.

Rust E&I 1993. During the summer of 1993, Rust E&I returned to the Pavement Perimeter Site to collect soil samples from four soil borings (13PP-04 through 13PP-07) in the vicinity of 13PP-01 and 13PP-02. The samples were collected from 0 to 0.5 foot and 4 to 5 feet and were analyzed for the ABP fluoroacetic acid. This analyte suite was chosen after noting a detection of this ABP in each of the previous two eastern soil borings. When the 1993 data were evaluated, Rust E&I also re-evaluated all of the 1991 data for this site. During this re-evaluation, it was discovered that the two above-mentioned fluoroacetic acid detections were not defendable data results as the method blank also contained fluoroacetic acid. Applying the "5X" rule as described in Section 6.0 eliminated these ABP detections. This was confirmed by the 1993 sampling as none of the samples contained any fluoroacetic acid.

7.8.2 Nature and Extent of Contamination

The metals that were detected at the Pavement Perimeter Site (arsenic, chromium, and zinc) do not appear to represent metals contamination even though they do exceed background.

Although the arsenic concentrations detected in the samples (up to 52.1 μg/g) exceed background by a fair amount (Table 7-45), they do not significantly exceed some of the individual values used to determine background (up to 39 μg/g). Indeed, the range of values used to calculate the background concentration of arsenic in soil varies by an order of magnitude (see Section 5.0). With chromium, none of the detected values (up to 34.6 μg/g) exceed some of the higher chromium values used to determine background (up to 56.2 μg/g). Zinc, being detected in only one sample at 130 μg/g, is well below the maximum value (232 μg/g) that was used in determining the background value for zinc in soils. Even though these detections of arsenic, chromium, and zinc do not likely represent a contamination problem, they were carried through the risk assessment process.

Although the soil samples collected from three 1991 soil borings (13PP-01 through 13PP-03) contained the anions chloride, nitrate, and sulfate in excess of background, it is not likely that these detections represent soil contamination. As with metals, some of the values used to determine background concentrations for chloride are higher than what was detected in the soil samples from these soil borings. Additionally, only 12 data points were available for background calculations for anions (see Section 5.0). Nevertheless, these three anions were carried through the risk assessment process.

It is not known why traces of the VOCs methyl-n-butyl ketone (0.011 μg/g) and methyl isobutyl ketone (0.019 μg/g) were detected in one sample at this site. Because these VOCs were only detected in trace amounts from only one sample, it is unlikely that there is a VOC contamination problem at this site. As with the metals and anions, these VOCs were still carried through the risk assessment process, which is presented in the following section.

7.8.3 Risk Assessment Results

7.8.3.1 *Baseline Human Health Risk Assessment*

This section presents the results of the sample data screening approach previously described in Section 6.1.1 that led to (1) the selection of the COPCs, (2) the exposure pathways that are labeled in the conceptual site model as being complete, (3) the exposure point concentrations in each respective environmental medium for those COPCs that have published health criteria, and (4) the carcinogenic and noncarcinogenic risk estimates for each receptor population under current and future land use scenarios.

This section of the report evaluates exposure to COPCs detected in site soils as well as those contaminants measured or modeled in various media from SWMU-wide or depot-wide sources. The direct soil-contact pathway (e.g., ingestion and dermal exposure) is associated with site-specific chemicals. Similarly, ingestion of homegrown produce by future on-site residents is based on those contaminants (if any) measured in surface soil within this site. Site-specific contaminants in soil are also used as model inputs to the air pathway for current off-site residents and the future on-site construction worker.

Current on-site workers and future on-site residents, however, are assumed to be potentially exposed to SWMU-wide chemicals in air (i.e., those chemicals detected in surface media at all of the sites evaluated within SWMU 13). Exposure to SWMU-wide chemicals was also the approach selected for the groundwater pathway. Thus, future on-site residents are assumed to be potentially exposed to groundwater contaminants measured in monitoring wells located across SWMU 13. The results of the groundwater evaluation are also presented separately in Section 7.11.3.1. Finally, ingestion of beef and dairy products by future on-site residents is based on modeling contaminants detected in depot-wide surface soils; cattle are assumed to graze at contaminated sites within SWMU 13 and SWMU 17. Thus, the total cancer risk and noncarcinogenic hazards to the future on-site resident (adult and child) presented in the sections below include those contributions associated with exposures to SWMU-wide contamination in air and groundwater and to depot-wide chemicals in beef and milk.

7.8.3.1.1 ***Chemicals of Potential Concern.*** The soil data for this site were grouped by depth and evaluated in the human health risk assessment accordingly. The COPCs measured in the surface (0 to 1.0 foot) and subsurface (1.0 to 9.0 feet) soil are summarized in Table 7-46. Chloride and sulfate were measured at elevated levels of 9,200 and 57,000 μg/g, respectively, but were not evaluated further since they lack USEPA Health Criteria.

7.8.3.1.2 ***Complete Exposure Pathways.*** The pathways assumed complete at this site, are shown on the conceptual site model in Figure 7-35. Exposure by current on-site workers and potential future on-site residents from ingestion of and dermal contact with COPCs measured

Table 7-46. SWMU 13 Summary of Concentrations for Chemicals of Potential Concern in Surface and Subsurface Soil at the Pavement Perimeter Site, Phase II RFI

Chemical	Background Concentration (mg/kg)	Frequency of Detection	Range of Detects (mg/kg)	Arithmetic Mean Concentration (mg/kg)	95% UCL (mg/kg)
Surface Soil					
Arsenic	16.4	½	**48.5**	30.3	145.5
Chromium	23.5	2/2	27.5-**27.7**	27.6	28.2
Nitrate	4.67	2/2	75.0-**130.0**	102.5	276
Methyl isobutyl ketone	NA	½	**0.019**	0.012	0.056
Subsurface Soil					
Arsenic	16.4	6/7	43.5-**52.1**	39.7	61.9
Chromium	23.5	4/4	15.0-34.6	23.4	**33.7**
Nitrate	4.67	6/7	12.5-66.0	39.4	**55.6**
Zinc	62.9	2/7	24.6-130.0	50.7	**76.7**

Note.—Methyl-n-butylketone, chloride, and sulfate were detected in surface and subsurface soil, but were not evaluated further since they lack USEPA Health Criteria. **Bold** type designates the exposure point concentration selected for these media.

in this site's surface soil was evaluated. Exposure by future construction workers from ingestion of and dermal contact with site-specific chemicals in this site's subsurface soil was also evaluated. Exposure from inhalation of fugitive dust and VOC emissions dispersed from SWMU-wide surface soils to current on-site workers and potential future on-site residents was also evaluated. Inhalation of chemical emissions dispersed from this site's surface soil to off-site residents was also evaluated. Exposure by future construction workers from inhalation of fugitive dust emissions from this site's subsurface soil was also evaluated. This site does not include surface water or lagoon sediments and, thus, exposure pathways associated with these medium are incomplete. Chemicals measured in this site's surface soil (0 to 1.0 foot) were assumed to be available for future plant uptake. Therefore, exposure by potential future on-site residents from consumption of vegetables grown at this site was evaluated. Evaluation of exposure to SWMU-wide chemicals in groundwater by potential future on-site residents is described in Section 7.11.3.1.

The sites within SWMU 13 either overlap or are adjacent to each other so that it was practical to estimate air chemical levels as SWMU-wide concentrations instead of on a site-specific basis. Therefore, exposure from inhalation of SWMU-wide chemical concentrations by the on-site worker during daily visits to this site was included despite the fact that these chemicals were not all present in surficial soil at this location. Exposures to airborne chemicals by future residents were also based on SWMU-wide concentrations. Similarly, exposures by potential

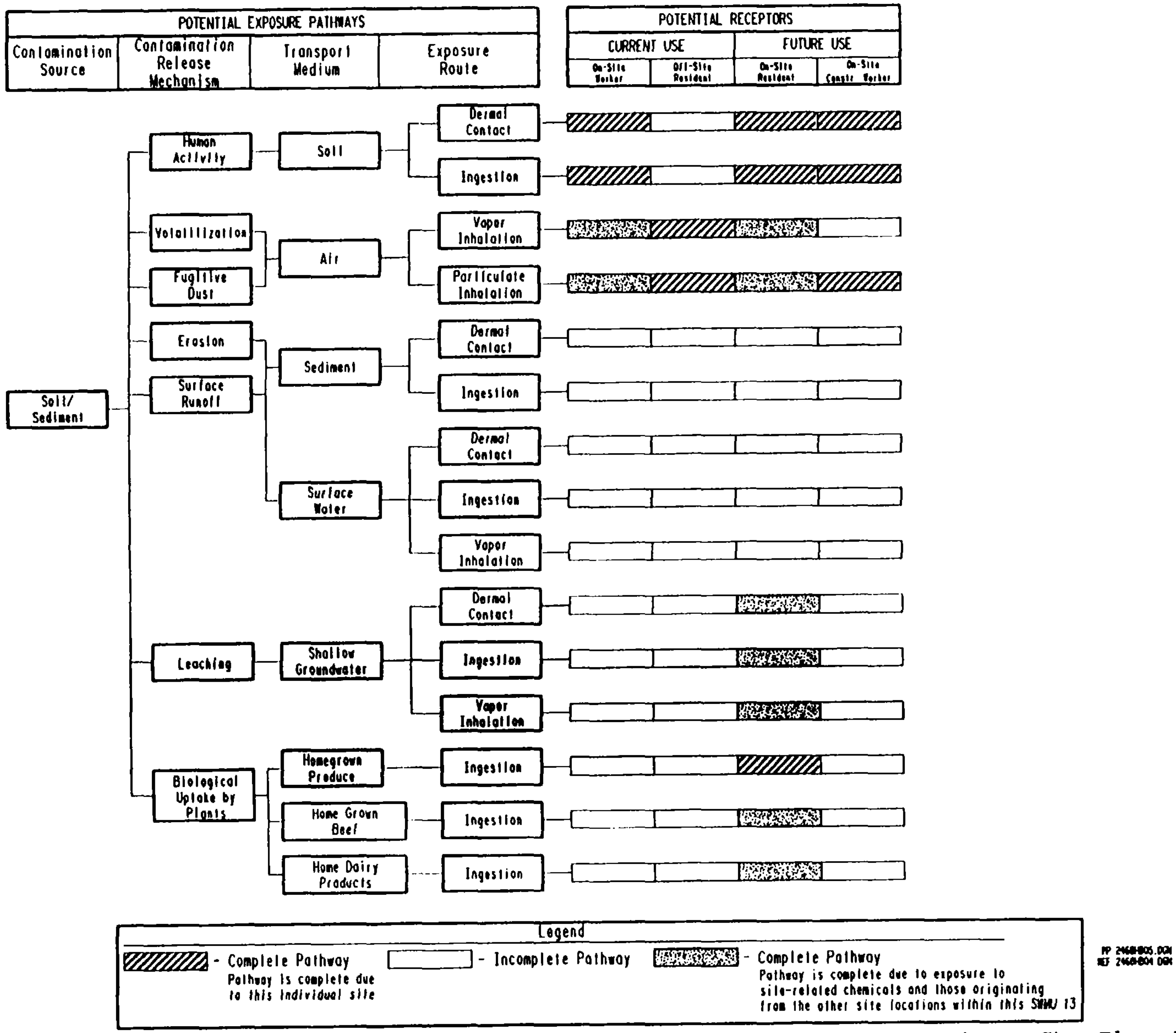

Figure 35. SWMU 13 Potential Human Exposure Pathway Conceptual Model for the Pavement Perimeter Site, Phase II RFI

future on-site residents from ingestion of chemicals in beef and milk, derived as depot-wide averages using data collected at SWMUs 13 and 17, were also evaluated.

7.8.3.1.3 *Exposure Point Concentrations*. Exposures from all complete pathways by the identified receptors were estimated using the exposure point concentrations in Table 7-47. These values include those that were based on soil chemical concentrations measured in surface and subsurface soil within this site. This table also includes airborne chemicals that originated either from this site (for the off-site resident and on-site construction worker) or from other sites within SWMU 13 that also contribute to overall current worker exposure and on-site resident exposures at this location, as well as average values for chemicals in beef and milk averaged for all of TEAD-S vis-à-vis the future on-site resident. Exposure to chemicals in groundwater by potential future on-site residents was based on the SWMU-wide exposure point concentrations in Table 7-68.

7.8.3.1.4 *Risk Estimates*. The receptor populations evaluated at this site include the current on-site worker, off-site residents (adult and child), future construction worker, and future on-site residents (adult and child). Cancer risks and noncarcinogenic hazards to these receptor populations were estimated based on exposure to site-specific chemicals detected in surface soil and subsurface soil (construction worker); SWMU-wide chemicals in air and groundwater; and/or depot-wide contaminants in beef/milk. The results of this evaluation under current and future land use are presented below. These results are also summarized for each exposure pathway in Tables 7-48 and 7-49. Actual risk calculations are presented in Appendix H. Tables 7-48 and 7-49 show in bold font those risks and hazards that are site-specific (i.e., related to chemicals detected specifically in this site's soils).

__Current Land Use__

Cancer risk to the current on-site worker from indirect exposure to SWMU-wide chemicals in air and direct exposure to this site's surface soil was estimated to be 1.73E-06, and the noncarcinogenic hazard to this receptor was estimated to be 2.13E-02. Ingestion of arsenic in this site's soil is responsible for all of the total cancer risk to the worker. This site's contribution to the total cancer risk to the off-site adult was 1.16E-09, and its contribution to the noncarcinogenic hazard was 3.64E-05. Cancer risk contribution from this site to the child resident was 8.09E-10; and to the total noncarcinogenic hazard, 1.27E-04.

__Future Land Use__

Total cancer risk to the construction worker was estimated to be 3.33E-06, and the total noncarcinogenic hazard, 1.31E-01. These estimates for the construction worker are based entirely on site-specific (subsurface soil) contamination.

Total cancer risks to the future on-site adult and child from exposure to chemicals in air, soil, produce, beef, dairy products, and groundwater were estimated to be 6.17E-03 and 2.95E-03,

Table 7-47 SWMU 13 Exposure Point Concentrations for the Chemicals of Potential Concern at the Pavement Perimeter Site, Phase II RFI

Receptor	Chemical	EXPOSURE POINT CONCENTRATIONS								
		Air[a] (mg/m^3)	Soil (mg/kg)	Milk[b] (mg/L)	Beef[b] (mg/g)	Potato* (mg/g)	Tomato (mg/g)	Carrot (mg/g)	Lettuce (mg/g)	Beans (mg/g)
On-Site Worker	Arsenic	2.15E-07	48.5	---	---	---	---	---	---	---
	Beryllium	7.76E-09	<bkgd	---	---	---	---	---	---	---
	Chromium	5.60E-07	27.7	---	---	---	---	---	---	---
	Copper	2.01E-07	<bkgd	---	---	---	---	---	---	---
	Lead	8.33E-08	ND	---	---	---	---	---	---	---
	Mercury	1.27E-10	ND	---	---	---	---	---	---	---
	Nickel	1.21E-08	ND	---	---	---	---	---	---	---
	Nitrate	5.00E-07	130	---	---	---	---	---	---	---
	Uranium	2.64E-09	ND	---	---	---	---	---	---	---
	Zinc	1.31E-06	<bkgd	---	---	---	---	---	---	---
	Acetone	1.30E-05	ND	---	---	---	---	---	---	---
	Chloromethane	1.60e-06	ND	---	---	---	---	---	---	---
	Methylene Chloride	2.35E-06	ND	---	---	---	---	---	---	---
	Methyl isobutyl ketone	1.50E-09	0.019	---	---	---	---	---	---	---
	Methyl-n-butyl ketone	7.30E-10	0.011	---	---	---	---	---	---	---
	4-Methylphenol	3.16E-10	ND	---	---	---	---	---	---	---

Table 7-47 SWMU 13 Exposure Point Concentrations for the Chemicals of Potential Concern at the Pavement Perimeter Site, Phase II RFI (continued)

Receptor	Chemical	EXPOSURE POINT CONCENTRATIONS								
		Air[a] (mg/m^3)	Soil (mg/kg)	Milk[b] (mg/L)	Beef[b] (mg/g)	Potato* (mg/g)	Tomato (mg/g)	Carrot (mg/g)	Lettuce (mg/g)	Beans (mg/g)
Off-Site Resident	Arsenic	2.67E-10	---	---	---	---	---	---	---	---
	Chromium	1.52E-10	---	---	---	---	---	---	---	---
	Nitrate	7.15E-10	---	---	---	---	---	---	---	---
	Methyl isobutyl ketone	2.40E-12	---	---	---	---	---	---	---	---
	Methyl-n-butyl ketone	1.20E-12	---	---	---	---	---	---	---	---
Future On-Site Resident	Arsenic	2.10E-06(3.49E-06)	48.5	9.80E-08	1.63E-09	7.30E-05	1.70E-05	3.50E-05	9.70E-05	8.10E-05
	Beryllium	4.81E-08(7.4E-08)	ND	9.32E-11	3.99E-11	---	---	---	---	---
	Chromium	5.90E-06(1.10E-05)	27.7	7.65E-08	4.00E-09	3.10E-05	7.50E-06	1.50E-05	1.00E-05	3.50E-05
	Copper	1.70E-06(1.00E-05)	ND	4.41E-05	1.13E-07	---	---	---	---	---
	Lead	1.47E-06(2.99E-06)	ND	1.55E-07	8.16E-11	---	---	---	---	---
	Mercury	6.17E-09(1.24E-8)	ND	1.03E-09	1.26E-11	---	---	---	---	---
	Nickel	6.02E-07(1.20E-06)	ND	8.52E-08	7.29E-09	---	---	---	---	---
	Nitrate[d]	4.89E-07(6.64E-07)	130	NA	NA	NA	NA	NA	NA	NA
	Uranium	1.18E-07(2.35E-07)	ND	2.00E-09	7.71E-12	---	---	---	---	---
	Zinc	1.03E-05(1.73E-05)	ND	4.63E-03	1.78E-05	---	---	---	---	---
	Bis(2-ethylhexyl) phthalate	---	ND	1.24E-09	1.51E-12	---	---	---	---	---
	1,2-Dimethylbenzene	---	ND	3.49E-12	4.25E-15	---	---	---	---	---
	Methylisobutylketone	8.00E-09(9.50E-09)	0.019	6.50E-12	7.92E-15	6.2E-07	9.1E-06	6.2E-07	7.5E-06	4.2E-05

Table 7-47 SWMU 13 Exposure Point Concentrations for the Chemicals of Potential Concern at the Pavement Perimeter Site, Phase II RFI (continued)

Receptor	Chemical	EXPOSURE POINT CONCENTRATIONS								
		Air[a] (mg/m^3)	Soil (mg/kg)	Milk[b] (mg/L)	Beef[b] (mg/g)	Potato[c] (mg/g)	Tomato (mg/g)	Carrot (mg/g)	Lettuce (mg/g)	Beans (mg/g)
Future On-Site Resident (cont.)	4-Methylphenol	1.26E-08(2.53E-08)	ND	4.07E-10	4.96E-13	---	---	---	---	---
	Methyl-n-butyl ketone	4.00E-09(4.80E-09)	0.011	---	---	---	---	---	---	---
	Toluene	---	ND	2.48E-12	3.02E-15	---	---	---	---	---
Future Construction Worker	Arsenic	0.000002	52.1	---	---	---	---	---	---	---
	Chromium	0.000001	33.7	---	---	---	---	---	---	---
	Nitrate	0.000002	55.6	---	---	---	---	---	---	---
	Zinc	0.000003	76.7	---	---	---	---	---	---	---

Notes.—"---" denotes not applicable. ND denotes chemical was not detected in site soil.

[a]Air values represent average values for on-site worker and maximum levels for future on-site resident of SWMU 13. Value in parenthesis is for child. Air chemical concentrations are based on corresponding subsurface soil values for construction worker.

[b]Milk and beef concentrations were derived to evaluate exposure to potential future on-site residents and represent average values based on data collected from SWMUs 13 and 17.

[c]Vegetable chemical concentrations are based on corresponding soil concentration.

[d]Transfer factors are not available for nitrate.

Table 7-48. SWMU 13 Summary of Carcinogenic Risks for the Pavement Perimeter Site, Phase II RFI

Potential Exposure Pathways		Potential Receptors			
		Current Use		Future Use	
Environmental Medium	Potential Exposure Route	On-Site Worker[a]	Off-Site Resident Adult (Child)	Construction Worker	On-Site Resident Adult (Child)[b]
Soil	Dermal Contact	**1.08E-07**	NA	**3.01E-08**	**1.96E-06(1.06E-06)**
	Ingestion	**1.41E-06**[c]	NA	**3.15E-06**[c]	**4.27E-05[c](7.97E-05)[c]**
Air	Particulate Inhalation	2.12E-07	**1.16E-09(8.09E-10)**	**1.54E-07**	3.09E-05[d](3.98E-05)[e]
	Vapor Inhalation	1.12E-10	NE	NA	NE
Groundwater	Dermal Contact	NA	NA	NA	1.55E-04(4.79E-05)
	Ingestion	NA	NA	NA	5.79E-03[f](2.70E-03)[f]
	Vapor Inhalation	NA	NA	NA	3.00E-07(2.10E-07)
Homegrown Produce	Ingestion	NA	NA	NA	**1.52E-04[c](7.81E-05)[c]**
Homegrown Beef	Ingestion	NA	NA	NA	1.35E-09(5.55E-10)
Homegrown Dairy Products	Ingestion	NA	NA	NA	5.37E-10(6.54E-10)
	Total Cancer Risk	1.73E-06[c]	**1.16E-09(8.09E-10)**	**3.33E-06**	6.17E-03(2.95E-03)

Notes.—NA denotes not applicable. NE denotes not evaluated due to lack of USEPA Health Criteria for site-related chemicals within this pathway. Bold type designates site-specific risks (i.e., those potential risks that are attributed to chemicals detected at this site).

[a]Exposure to workers was evaluated based on the time spent at each site during assumed daily visits to each site within SWMU 13. Exposure to airborne chemicals was evaluated based on chemicals measured in surface soil and surface water within this SWMU. The concentrations used for this medium represent SWMU-wide values. Therefore, even if site-specific contamination is absent from surficial soil, exposure from inhalation of particulates and vapors from other sites was assumed to occur.

[b]Beef and milk chemical concentrations represent depot-wide values for TEAD-S. Therefore, the future resident at each site may be exposed to site-specific chemicals and also to those associated with other site locations within SWMU 13 and 17.

[c]Ingestion of arsenic detected in this site's soil is responsible for all of the risk.

[d]Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, and the Pavement Perimeter Site is responsible for almost 90 percent of the total air pathway risk.

[e]Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, the Southwest Wastewater Lagoon, and the Pavement Perimeter Site is responsible for over 90 percent of the total air pathway risk.

[f]Ingestion of arsenic detected in SWMU-wide monitoring wells is responsible for at least 90 percent of the total groundwater pathway risks.

Table 7-49. SWMU 13 Summary of Noncarcinogenic Hazards for the Pavement Perimeter Site, Phase II RFI

Potential Exposure Pathways		Potential Receptors			
		Current Use		Future Use	
Environmental Medium	Potential Exposure Route	On-Site Worker[a]	Off-Site Resident Adult (Child)	Construction Worker	On-Site Resident Adult (Child)[b]
Soil	Dermal Contact	**6.94E-04**	NA	**9.46E-04**	**1.05E-02(2.76E-02)**
	Ingestion	**9.07E-03**	NA	**9.90E-02**	**2.29E-01(2.08E+00)[c]**
Air	Particulate Inhalation	1.15E-02	**3.64E-5(1.27E-05)**	**3.06E-02**	1.41E+00(9.21+00)[d]
	Vapor Inhalation	4.96E-07	**3.16E-11(1.10E-11)**	NA	8.57E-07(2.67E-06)
Groundwater	Dermal Contact	NA	NA	NA	5.02E-01(1.81E-01)
	Ingestion	NA	NA	NA	7.35E+01[e](9.61E+01)[e]
	Vapor Inhalation	NA	NA	NA	1.38E-02(5.45E-03)
Homegrown Produce	Ingestion	NA	NA	NA	**8.08E-01(2.04E+00)[c]**
Homegrown Beef	Ingestion	NA	NA	NA	8.30E-05(1.70E-04)
Homegrown Dairy Products	Ingestion	NA	NA	NA	1.57E-04(8.97E-04)
	Total Hazard	2.13E-02	**3.64E-5(1.27E-04)**	**1.31E-01**	7.65E+01(1.10E+02)

Notes.—NA denotes not applicable. NE denotes not evaluated due to lack of USEPA Health Criteria for site-related chemicals within this pathway. Bold type designates site-specific hazards (i.e., those potential hazards that are attributed to chemicals detected at this site).

[a]Exposure to workers was evaluated based on the time spent at each site during assumed daily visits to each site within SWMU 13. Exposure to airborne chemicals was evaluated based on chemicals measured in surface soil and surface water within this SWMU. The concentrations used for this medium represent SWMU-wide values. Therefore, even if site-specific contamination is absent from surficial soil, exposure from inhalation of particulates and vapors from other sites was assumed to occur.

[b]Beef and milk chemical concentrations represent depot-wide values for TEAD-S. Therefore, the future resident at each site may be exposed to site-specific chemicals and also to those associated with other site locations within SWMU 13 and 17.

[c]Ingestion of arsenic detected in this site's soil is responsible for over 90 percent of the hazard.

[d]Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons,and the Southwest Wastewater Lagoon is responsible for over 90 percent of the total air pathway hazard.

[e]Ingestion of arsenic, thallium, and fluoride detected in SWMU-wide monitoring wells is responsible for over 90 percent of the total groundwater pathway hazards.

respectively. Total noncarcinogenic hazards to these receptors were estimated to be 7.65E+01 and 1.10E+02, respectively.

7.8.3.1.5 *Conclusions.* The results of the human health risk assessment under the current land use exposure scenario at this site indicates that the estimated cancer risk to the on-site worker of 1.73E-06 is greater than the 1E-06 State of Utah recommended target limit of allowable risk. The contribution to the total cancer risks to the off-site resident (adult and child) from this location is well below this limit. Noncarcinogenic hazards to all receptors associated with this site under current land use conditions were found to be well below the State of Utah recommended value of 1.

The results of the human health risk assessment under future land use conditions indicate that the estimated total cancer risks to the potential future on-site adult and child resident of 6.17E-03 and 2.95E-03, respectively, exceed the State of Utah recommended threshold limit of allowable risk, primarily due to the ingestion of arsenic in groundwater. Total carcinogenic risk to the construction worker (3.33E-06) was also found to exceed this limit. Total noncarcinogenic hazards to the potential future on-site adult and child resident of 76.5 and 110, respectively, were found to be well above the State of Utah recommended value of 1 primarily from potential ingestion of arsenic, thallium, and fluoride in contaminated groundwater. Total noncarcinogenic hazard to the construction worker (0.13) was found to be well below the State of Utah recommended value.

Ingestion of arsenic detected in this site's soil is responsible for all of the potential cancer risks associated with the soil pathway, for the future construction worker and the future on-site residents, and with the consumption of homegrown produce for these residents. Ingestion of arsenic detected in this site's soil is also responsible for all of the potential noncancer hazards associated with soil contact and consumption of homegrown produce by future on-site residents (adults and children).

Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, and the Pavement Perimeter Site is responsible for almost 90 percent of the total air pathway cancer risk to the future on-site adult resident. Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, the Southwest Wastewater Lagoon, and the Pavement Perimeter Site is responsible for approximately 90 percent of the cancer risk to the future on-site child resident. These latter sites, with the exception of the Pavement Perimeter Site, are also responsible for over 90 percent of the total noncancer air-pathway hazard to the future on-site child resident. Ingestion of arsenic detected in SWMU-wide monitoring wells is responsible for over 90 percent of the total groundwater pathway risks to future on-site residents (adults and children).

7.8.3.2 *Ecological Risk Assessment*

7.8.3.2.1 ***Site Characterization.*** The ecological assessment for the Pavement Perimeter Site included a survey of vegetation and wildlife, and a qualitative habitat evaluation. This assessment did not include collection of either vegetation or wildlife samples for analysis. Human activity at this site is frequent. The potential wildlife inhabitants include small mammals, birds, and several of the raptor species. There is no indication that this area is a critical habitat for any endangered or threatened species.

No evidence of surface water was observed during the field investigation. It is unlikely that significant surface water ever accumulates on this site as the result of storm episodes or snow melt.

7.8.3.2.2 ***Conclusions.*** Continued frequent human activity is projected at this site, which consists of pavement-covered ground and is located within the CAMDS fence. As a result, there is no ecological habitat and no adverse impacts to ecological receptors should occur.

7.8.4 Conclusions and Recommendations

COPCs associated with the Pavement Perimeter Site are metals, anions, and VOCs in surface and subsurface soils. The soil borings drilled during the 1991 and 1993 field efforts determined that concentrations of metals only slightly exceeded background values and are not likely because of past activities at the site. Although the anions chloride, nitrate, and sulfate were detected in excess of background, it is believed that these detections also do not represent a contamination problem. Methyl-n-butyl ketone has no oral health criteria and, therefore, was not evaluated for the food ingestion pathways. It was detected at a low concentration in only one surface sample and, as a VOC, would not be expected to bioaccumulate in the food chain. Therefore, this chemical is unlikely to be of concern. The anions chloride and sulfate also lack USEPA Health Criteria and, thus, were not evaluated in the baseline human health risk assessment.

The human health risk assessment evaluated both the current and future land use exposure scenarios at the site. Results of the human health risk assessment under the current land use exposure scenario indicate that carcinogenic risk to the on-site worker exceeds the State of Utah recommended threshold of allowable risk (due primarily to arsenic detected in this site's soil), but the contribution to the total carcinogenic risk to the off-site resident is well below this criteria. Noncarcinogenic hazards to all receptors under the current use conditions were found to be below State of Utah criteria.

Results of the human health risk assessment under future land use conditions indicated that carcinogenic risk to the future on-site resident (adult and child) exceeds the State of Utah recommended threshold for allowable risk primarily from potential exposure to contaminated groundwater. The total carcinogenic risk to the future on-site construction worker also exceeds the State of Utah recommended limit for allowable risk due primarily to arsenic detected in this site's soils. Total noncarcinogenic hazards exceed USEPA criteria for the future on-site resident but not for the future on-site construction worker.

It is important to emphasize that the exposure point concentrations for air and for beef and milk used in the human health risk assessment were estimated as SWMU-wide and area-wide (over TEAD-S) values, respectively. In so doing, it is possible to estimate an exposure to a receptor at a particular site despite the absence of site-related chemicals in surficial soil. This occurs because it has been assumed that exposure can take place to chemicals originating from other sites within SWMU 13 and/or SWMU 17 via the air pathway and through consumption of homegrown beef and milk products. Similarly, the groundwater exposure point concentrations were also derived as an area average for each chemical. Therefore, to avoid misrepresenting the results of the risk assessment, it is important to distinguish the portion of the risk and hazard estimates that are due to site-related contamination from that due to SWMU-wide and/or area-wide contributions. Recommendations for each site within both SWMUs will be made pursuant to the provisions of Section R315-101-6 of the Utah Hazardous Waste Rules. Since the groundwater medium at SWMU 13 is already being recommended to the CMS (Site Management Plan), the site-specific recommendations will be based on the results of the risk assessment without the groundwater contribution.

All available data were used to determine whether past operations at the Pavement Perimeter Site has created an environment that could result in any adverse effects to human health or to the local ecology. Results from the human health risk assessment indicate that adverse impacts to the future on-site resident at the site may occur although it is not expected that this site will become available for residency in the future. At this site, even if that portion of the risk and hazard contributed by SWMU-wide contaminants (air and groundwater) were removed as described above, the criteria in item (d) of R315-101-6 would be satisfied. This is because the risk under current land use would be less than 1E-04 but greater than 1E-06 under on-site residential land use. Therefore, this site should be carried through the CMS but not necessarily include provisions for corrective action. Instead, the CMS should, for this site, include management activities such as monitoring, deed notations, site security, etc.

7.9 SODIUM HYDROXIDE SPILL SITE

7.9.1 Previous Sampling and Phase II RFI Sampling Results

Although TEAD did conduct some work at the Sodium Hydroxide Spill Site (see Section 4.0), no formal environmental investigations have been conducted at the site prior to this Phase II RFI.

Rust E&I 1993. During the summer of 1993, Rust E&I conducted an investigation at the Sodium Hydroxide Spill Site (Figure 7-36) to determine the extent of sodium hydroxide (NaOH) contamination that may remain in the soils in the vicinity of the spill. In order to achieve this, four soil borings (13SH-01 through 13SH-04, Figure 7-36) were drilled to a

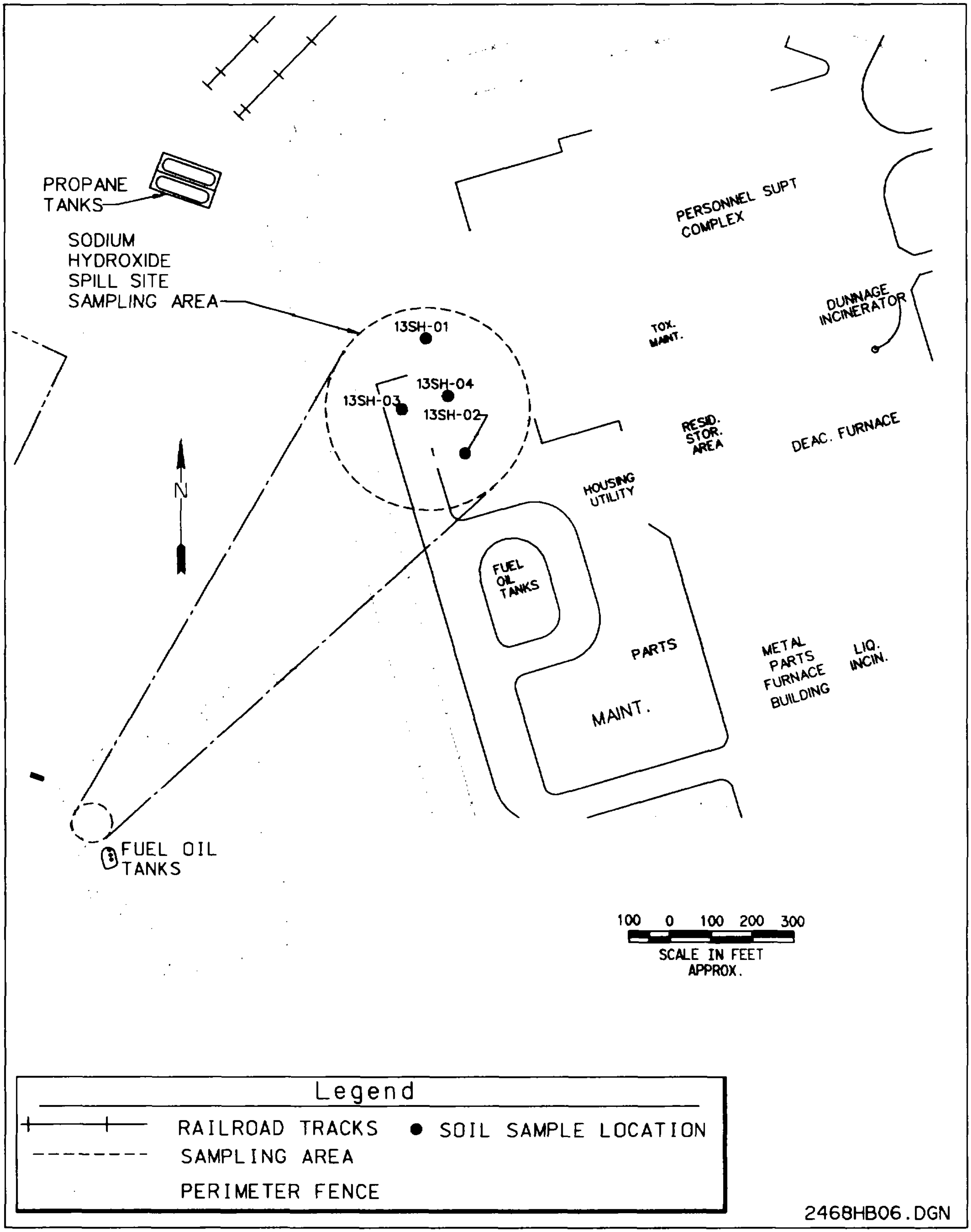

Figure 7-36. Soil Boring Sample Locations at the Sodium Hydroxide Spill Site, SWMU 13

depth of approximately 10 feet. Soil samples were collected from the 0-to-2, 4-to-5, and 9-to-10 foot intervals and were analyzed for alkalinity and pH. The alkalinity analysis consisted of four parameters: total alkalinity, alkalinity/bicarbonate, alkalinity/carbonate, and alkalinity/hydroxide. Table 7-50 presents a summary of the data while a complete listing of all of the data is presented in Appendix D.

Alkalinity in three of the four soil borings (13SH-01, 13SH-02, and 13SH-03) exceeded the background of 48,428 μg/g. Values ranged from 50,000 μg/g in 13SH-01 to 400,000 μg/g in 13SH-04. Alkalinity/bicarbonate was also detected above background in 13SH-01 through 13SH-03 (20,000 to 48,000 μg/g), while alkalinity/carbonate was detected above background in only one boring, 13SH-02 at 140,000 μg/g. Soil boring 13SH-04 was drilled within the spill site and was the only boring to contain alkalinity/hydroxide above background. All three samples from this boring contained alkalinity/hydroxide, with values ranging from 140,000 to 400,000 μg/g. Also unique to this boring were the elevated pH levels (11 to 12). The pH values from the remaining Sodium Hydroxide Spill Site samples ranged from 7.9 to 8.5 and are very near the mean pH value for the CAMDS facility which is 8.07 (see Section 5.0).

7.9.2 Nature and Extent of Contamination

Alkalinity is a measure of the capacity of a water to neutralize strong acid. In natural waters this capacity is usually attributable to bases such as carbonate, bicarbonate, and hydroxide (Snoeyink and Jenkins 1980). With this in mind, any soils that still contain NaOH as a result of the spill should yield sample results with elevated alkalinity due to the base hydroxide (alkalinity/hydroxide). This is exactly what the soil samples from 13SH-04 show. No other borings contained alkalinity/hydroxide above background. Similarly, the pH in all three of the soil samples from 13SH-04 were significantly more basic than all of the other samples collected at this site. Therefore, it is likely that the approximate lateral extent of the NaOH-contaminated soil can be defined by the retaining wall around the site, which is represented by the rectangular area around the soil boring location 13SH-04 presented in Figure 7-36. Because the alkalinity/hydroxide levels and the pH values increase with depth at the 13SH-04 soil boring location, it is likely that NaOH is entering the groundwater. It does appear that any NaOH that may be reaching the water table (approximately 10 feet) is being buffered by the groundwater because the pH of the water in the nearby wells ranges from approximately 7 to 8, which is consistent with the pH in other CAMDS wells (Appendix A).

7.9.3 Risk Assessment Results

7.9.3.1 *Baseline Human Health Risk Assessment*

This section presents the results of the sample data screening approach previously described in Section 6.1.1 that led to (1) the selection of the COPCs, (2) the exposure pathways that are labeled in the conceptual site model as being complete, (3) the exposure-point concentrations in each respective environmental medium for those COPCs that have published health criteria,

Table 7-50. SWMU 13 Soil Sample Results for the Sodium Hydroxide Spill Site, Phase II RFI

		Anions (μg/g)				pH
Sample ID	Depth	Alkalinity (BKGD[a] 48,428)	Alkalinity - Bicarbonate (BKGD 18,000)	Alkalinity - Carbonate (BKGD 53,000)	Alkalinity - Hydroxide (BKGD 17,000)	
13SH-01-1	2	50000	ND[b]	DS[c]	DS	8
13SH-01-2	5	DS	20000	DS	ND	7.9
13SH-01-3	9	DS	DS	DS	ND	7.9
13SH-02-1	2	190000	48000	140000	ND	8.5
13SH-02-2	5	DS	DS	DS	ND	8
13SH-02-3	10	DS	ND	DS	ND	8.2
13SH-03-1	2	DS	ND	DS	ND	8.2
13SH-03-2	5	DS	21000	ND	ND	8
13SH-03-3	10	DS	ND	DS	ND	8.2
13SH-04-1	2	140000	ND	ND	140000	11
13SH-04-2	5	330000	ND	ND	330000	12
13SH-04-3	10	400000	ND	ND	400000	12

[a]BKGD = Background value for specified analyte.
[b]ND = Analyte not detected at or above the CRL, SRL, or MDL.
CDs = Data were screened out due to the 5 times and 10 times rules or did not exceed background values where applicable (see Section 6.0 for data screening methodologies).

and (4) the carcinogenic and noncarcinogenic risk estimates for each receptor population under current and future land use scenarios.

This section of the report evaluates exposure to COPCs detected in site soils as well as those contaminants measured or modeled in various media from SWMU-wide or depot-wide sources. The direct soil-contact pathway (e.g., ingestion and dermal exposure) is associated with site-specific chemicals. Similarly, ingestion of homegrown produce by future on-site residents is based on those contaminants (if any) measured in surface soil within this site. Site-specific contaminants in soil are also used as model inputs to the air pathway for current off-site residents and the future on-site construction worker.

Current on-site workers and future on-site residents, however, are assumed to be potentially exposed to SWMU-wide chemicals in air (i.e., those chemicals detected in surface media at all of the sites evaluated within SWMU 13). Exposure to SWMU-wide chemicals was also the approach selected for the groundwater pathway. Thus, future on-site residents are assumed to be potentially exposed to groundwater contaminants measured in monitoring wells located across SWMU 13. The results of the groundwater evaluation are also presented separately in Section 7.11.3.1. Finally, ingestion of beef and dairy products by future on-site residents is based on modeling contaminants detected in depot-wide surface soils; cattle are assumed to graze at contaminated sites within SWMU 13 and SWMU 17. Thus, the total cancer risk and noncarcinogenic hazards to the future on-site resident (adult and child) presented in the sections below include those contributions associated with exposures to SWMU-wide contamination in air and groundwater and to depot-wide chemicals in beef and milk.

7.9.3.1.1 ***Chemicals of Potential Concern.*** Hydroxide, carbonate, and bicarbonate anions were measured within this site at depths ranging between 2 and 10 feet bgs. Elevated soil pH levels ranging between 7.9 and 12.0 were measured at this location. USEPA Health Criteria for these anions are not currently available and, thus, it was not feasible to evaluate human health impacts associated with exposure to these chemicals.

7.9.3.1.2 ***Complete Exposure Pathways.*** The conceptual site model for this area is shown in Figure 7-37. Although shown to be complete pathways in Figure 7-37, exposure due to ingestion of and dermal contact with corrosive soil at this site by on-site workers, future construction workers, and future on-site residents was not evaluated because of lack of USEPA Health Criteria. Likewise, site-specific exposure pathways associated with plant uptake (future resident) and with dust inhalation (construction worker and off-site resident) could not be evaluated quantitively although these pathways are potentially complete. It should be noted that exposures from inhalation of SWMU-wide chemical concentrations by the on-site worker during daily visits to this site was evaluated by including chemicals that were not found in the surface soil at this location, but instead originated from other sites with this SWMU. Similarly, exposure by potential future on-site residents from inhalation of SWMU-wide chemicals in air and from ingestion of depot-wide chemicals in beef and milk were also

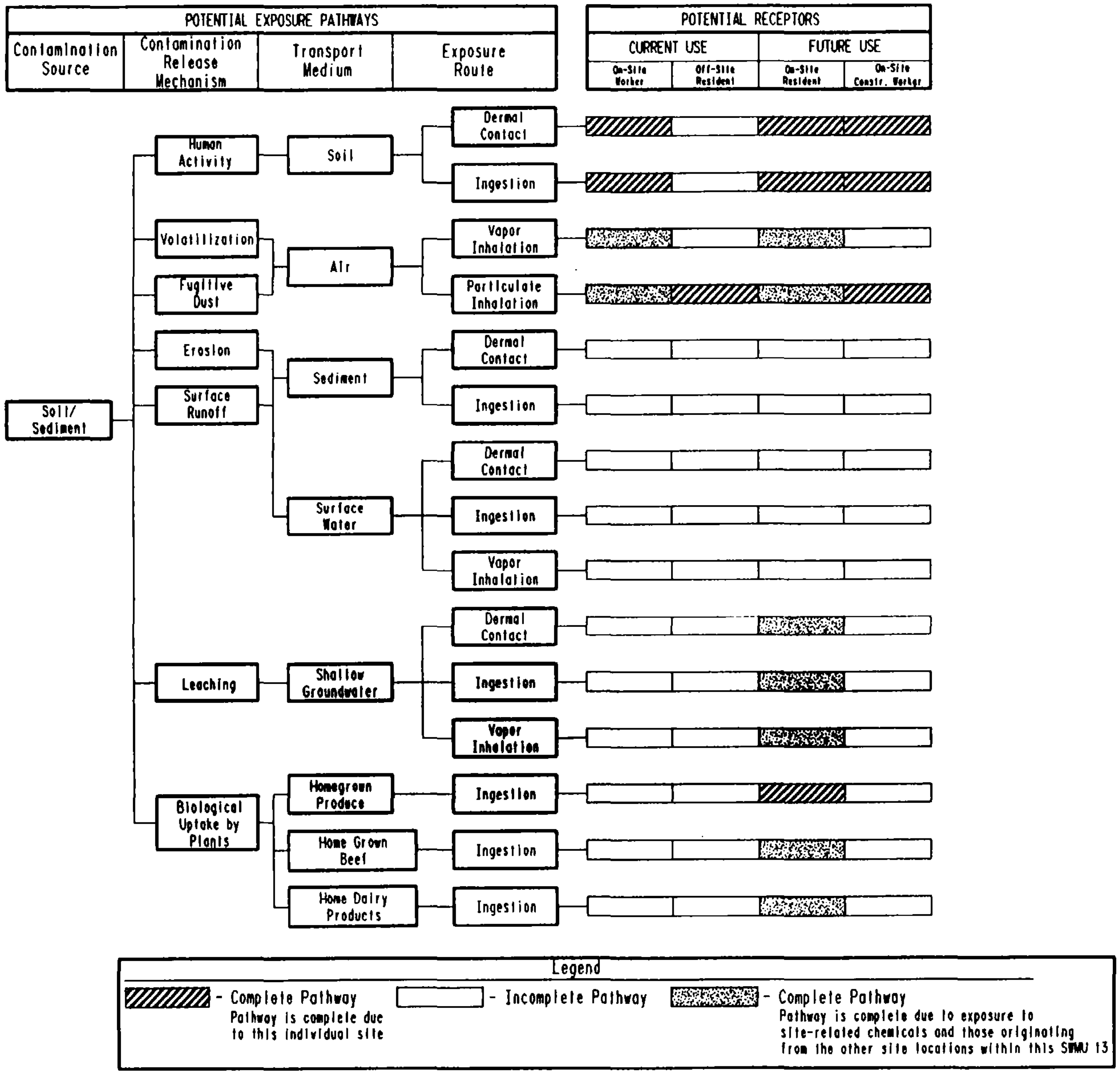

Figure 7-37. SWMU 13 Potential Human Exposure Pathway Conceptual Model for the Sodium Hydroxide Spill Site, Phase II RFI

evaluated. Exposure to SWMU-wide chemicals measured in groundwater monitoring wells also represents a complete exposure pathway for future residents.

7.9.3.1.3 *Exposure Point Concentrations.* Exposures to chemicals in air by the current on-site worker and future residents were based on the SWMU-wide value for each chemical over all of SWMU 13. Exposure to chemicals in beef and milk by potential future on-site residents was based on average values derived for all of TEAD-S using data from SWMUs 13 and 17. These exposure point concentrations are not summarized in table format for this site since they are not unique and may actually be viewed from the same table at any other site within SWMU 13 (see Table 7-10). Exposure to chemicals in groundwater by the potential future on-site resident are based on the SWMU-wide exposure point concentrations in Table 7-68.

7.9.3.1.4 *Risk Estimates.* The receptor populations evaluated at this site are the current on-site worker and the potential future on-site resident. Cancer risk and noncarcinogenic hazard to the current on-site worker were estimated to be 2.12E-07 and 1.15E-02, respectively. Total cancer risks to the potential future on-site adult and child from exposure to chemicals in air, homegrown products, and groundwater were estimated to be 5.98E-03 and 2.82E-03. Total noncarcinogenic hazard to these receptors was estimated to be 7.54E+01 and 1.06E+02. These results are summarized for each pathway in Tables 7-51 and 7-52. As indicated on the footnotes to these tables, none of these risks/hazards are attributable to chemicals detected at this site.

7.9.3.1.5 *Conclusions.* The results of the human health risk assessment under the current land use scenario at this site indicate that the estimated cancer risk to the on-site worker of 2.12E-07 is below the 1E-06 State of Utah-recommended target limit of allowable risk. Noncarcinogenic hazard to this receptor of 1.15E-02 was found to be well below the State of Utah recommended value of 1.

The results of the human health risk assessment under future land use conditions indicate that the estimated total cancer risks to the potential future on-site adult and child resident of 5.98E-03 and 2.82E-03, respectively, exceed the State of Utah-recommended threshold limit of allowable risk primarily from potential ingestion of arsenic in groundwater. As with the carcinogenic risks, total noncarcinogenic hazards to the potential future on-site adult and child resident of 75.4 and 106, respectively, were found to be well above the State of Utah recommended value of 1, primarily due to the ingestion of arsenic, thallium, and fluoride in groundwater.

Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, and the Pavement Perimeter Site is responsible for almost 90 percent of the total air pathway cancer risk to the future on-site adult resident. Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, the Southwest Wastewater Lagoon, and the Pavement

Table 7-51. SWMU 13 Summary of Carcinogenic Risks for the Sodium Hydroxide Spill Site, Phase II RFI

Potential Exposure Pathways		Current Use		Future Use	
Environmental Medium	**Potential Exposure Route**	**On-Site Worker[a]**	**Off-Site Resident Adult (Child)**	**Construction Worker**	**On-Site Resident Adult (Child)[b]**
Soil	Dermal Contact	NE	NA	NE	NE
	Ingestion	NE	NA	NE	NE
Air	Particulate Inhalation	2.12E-07	NE	NE	3.09E-05[c](3.98E-05)[d]
	Vapor Inhalation	1.12E-10	NA	NA	NE
Groundwater	Dermal Contact	NA	NA	NA	1.55E-04(4.79E-05)
	Ingestion	NA	NA	NA	5.79E-03[e](2.73E-03)[e]
	Vapor Inhalation	NA	NA	NA	3.00E-07(2.10E-07)
Homegrown Produce	Ingestion	NA	NA	NA	NE
Homegrown Beef	Ingestion	NA	NA	NA	1.35E-09(5.55E-10)
Homegrown Dairy Products	Ingestion	NA	NA	NA	5.73E-10(6.54E-10)
	Total Cancer Risk	2.12E-07	NE	NE	5.98E-03(2.82E-03)

Notes.—NA denotes not applicable. NE denotes not evaluated due to lack of USEPA Health Criteria for site-related chemicals within this pathway.

[a]**Exposure to workers was evaluated based on the time spent at each site during assumed daily visits to each site within SWMU 13. Exposure to airborne chemicals was evaluated based on chemicals measured in surface soil and surface water within this SWMU. The concentrations used for this medium represent SWMU-wide values. Therefore, even if site-specific contamination is absent from surficial soil, exposure from inhalation of particulates and vapors from other sites was assumed to occur.**

[b]Beef and milk chemical concentrations represent depot-wide values for TEAD-S. Therefore, the future resident at each site may be exposed to site-specific chemicals and also to those associated with other site locations within SWMU 13 and 17.

[c]Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, and the Pavement Perimeter Site is responsible for almost 90 percent of the total air pathway risk.

[d]Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, the Southwest Wastewater Lagoon, and the Pavement Perimeter Site is responsible for over 90 percent of the total air pathway risk.

[e]Ingestion of arsenic detected in SWMU-wide monitoring wells is responsible for at least 90 percent of the total groundwater pathway risks.

Table 7-52. SWMU 13 Summary of Noncarcinogenic Hazards for the Sodium Hydroxide Spill, Phase II RFI

Potential Exposure Pathways					
		Current Use		**Future Use**	
Environmental Medium	**Potential Exposure Route**	**On-Site Worker[a]**	**Off-Site Resident Adult (Child)**	**Construction Worker**	**On-Site Resident Adult (Child)[b]**
Soil	Dermal Contact	NE	NA	NE	NE
	Ingestion	NE	NA	NE	NE
Air	Particulate Inhalation	1.15E-02	NE	NE	1.41E+00(9.21E+00)[c]
	Vapor Inhalation	4.96E-06	NA	NE	8.57E-07(2.67E-06)
Groundwater	Dermal Contact	NA	NA	NA	5.02E-01(2.81E-01)
	Ingestion	NA	NA	NA	7.35E+01[d](9.61E+01)[d]
	Vapor Inhalation	NA	NA	NA	1.38E-02(5.45E-03)
Homegrown Beef	Ingestion	NA	NA	NA	8.30E-05(1.70E-04)
Homegrown Dairy Products	Ingestion	NA	NA	NA	1.57E-04(8.97E-04)
	Total Hazard	1.15E-02	NE	NE	7.54E+01(1.06E+02)

Notes.—NA denotes not applicable. NE denotes not evaluated due to lack of USEPA Health Criteria for site-related chemicals within this pathway.

[a]Exposure to workers was evaluated based on the time spent at each site during assumed daily visits to each site within SWMU 13. Exposure to airborne chemicals was evaluated based on chemicals measured in surface soil and surface water within this SWMU. The concentrations used for this medium represent SWMU-wide values. Therefore, even if site-specific contamination is absent from surficial soil, exposure from inhalation of particulates and vapors from other sites was assumed to occur.

[b]Beef and milk chemical concentrations represent depot-wide values for TEAD-S. Therefore, the future resident at each site may be exposed to site-specific chemicals and also to those associated with other site locations within SWMU 13 and 17.

[c]Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, and the Southwest Wastewater Lagoon is responsible for at least 90 percent of the total air pathway hazard.

[d]Ingestion of arsenic, thallium, and fluoride detected in SWMU-wide monitoring wells is responsible for at least 90 percent of the total groundwater pathway hazards.

Perimeter Site is responsible for approximately 90 percent of the cancer risk to the future on-site child resident. These latter sites, with the exception of the Pavement Perimeter Site, are also responsible for over 90 percent of the total noncancer air-pathway hazard to future on-site residents (adjults and children). Ingestion of arsenic detected in SWMU-wide monitoring wells is responsible for over 90 percent of the total groundwater pathway risks to future on-site residents (adults and children).

In summary, there are no significant risks/hazards that can be attributed to chemicals detected specifically in media at this site. The potentially significant risks/hazards associated with future on-site residents (via the air and groundwater pathways, as summarized above) are related to contaminants detected in soils at other sites or to chemicals that are likely to be naturally occurring within SWMU 13 (i.e., arsenic in groundwater).

7.9.3.2 *Ecological Risk Assessment*

7.9.3.2.1 ***Site Characterization.*** The ecological assessment for the Sodium Hydroxide Spill Site did not include a survey of vegetation and wildlife, and a qualitative habitat evaluation. This assessment did not include collection of either vegetation or wildlife samples for analysis. Human activity at this site is frequent. The potential wildlife inhabitants include small mammals, birds, and several of the raptor species. There is no indication that this area is a critical habitat for any endangered or threatened species.

Some evidence of surface water was observed during the field investigation. However, it is unlikely that significant surface water ever accumulates on this site as the result of storm episodes or snow melt.

7.9.3.2.2 ***Conclusions.*** All contaminants that might be of concern to ecological receptors at this site were detected at a minimum of 2 feet below the surface. In addition, continued frequent human activity is projected at this site, which is within the CAMDS fence. Hence, there is no ecological habitat and no adverse impacts to ecological receptors should occur.

7.9.4 Conclusions and Recommendations

COPCs associated with the Sodium Hydroxide Spill Site are alkalinity, alkalinity/hydroxide, alkalinity/carbonate, and alkalinity/bicarbonate in surface and subsurface soils. The soil borings drilled during the 1993 field effort defined the lateral extent of sodium hydroxide contamination. Sample analyses also showed significant levels of pH toward the basic end of the pH scale that increased with depth from surface to subsurface soils. It is likely that sodium hydroxide components related to the spill are entering the groundwater below the spill area.

The human health risk assessment evaluated both the current and future land use exposure scenarios for the current on-site worker and the future on-site resident at the site. Results of the human health risk assessment under the current land use exposure scenario indicate that carcinogenic risk to the on-site worker is below the State of Utah recommended target limit of allowable risk. Noncarcinogenic hazards to the current on-site worker under the current use conditions were also found to be below State of Utah criteria.

Results of the human health risk assessment under future land use conditions indicated that total carcinogenic risk to the future on-site resident (adult and child) exceeds the State of Utah recommended limit for allowable risk. Total noncarcinogenic hazards also exceed State of Utah criteria for the future on-site resident. These risks and hazards exceed criteria largely from potential dermal contact with and ingestion of SWMU-wide chemicals in groundwater.

In summary, all available data were used to determine whether past operations at the Sodium Hydroxide Spill Site have created an environment that could result in any adverse effects to human health or to the local ecology. Results from the human health risk assessment indicate that adverse impacts could occur to the future on-site resident although it is not expected that this site will become available for residency in the future. There are no significant risks/hazards that can be attributed to chemicals detected specifically at this site.

Because alkalinity/hydroxide, alkalinity/carbonate, and alkalinity/bicarbonate were not quantitatively evaluated in the human health risk assessment and because very basic pH results were detected at the surface and increased with depth (possibly impacting groundwater), it is recommended that the Sodium Hydroxide Spill Site be carried through the CMS process. Additionally, up to 6,800 pounds of sodium hydroxide may still be in the soil (see Section 4.1.1.8). Because a reportable quantity (CFR, Part 117) minimum amount is 1,000 pounds, as mentioned above, this site should be carried through the CMS process.

7.10 WASTEWATER LAGOONS SITE

7.10.1 Previous Sampling and Phase II RFI Sampling Results

No previous investigations have been conducted at any of the four wastewater lagoons prior to this Phase II RFI.

Rust E&I 1993. During the summer of 1993, Rust E&I conducted an investigation at the three Northwest Wastewater Lagoons and the one Southwest Wastewater Lagoon (Figure 7-38) to determine whether the water or the sludge at any of the lagoons was contaminated. In order to achieve this, one sludge sample and one water sample was collected from each of the four lagoons (sludge samples 13WL-01 through 13WL-04 and water samples 13WL-S1 through 13WL-S4; duplicate samples were collected at Lagoon 1). Samples were collected where the effluent enters the lagoon. (Note: The three northwest lagoons operate as a cascading system: the effluent enters Lagoon 3 and cascades into Lagoon 2 and then into Lagoon 1; see Section 4.0.) These samples were analyzed for VOCs, SVOCs, TPHCs, explosives, ABPs, metals, anions, gross alpha, gross beta, and total uranium. Total organic carbon and pH were also determined for all eight of these samples. Tables 7-53a and 53b

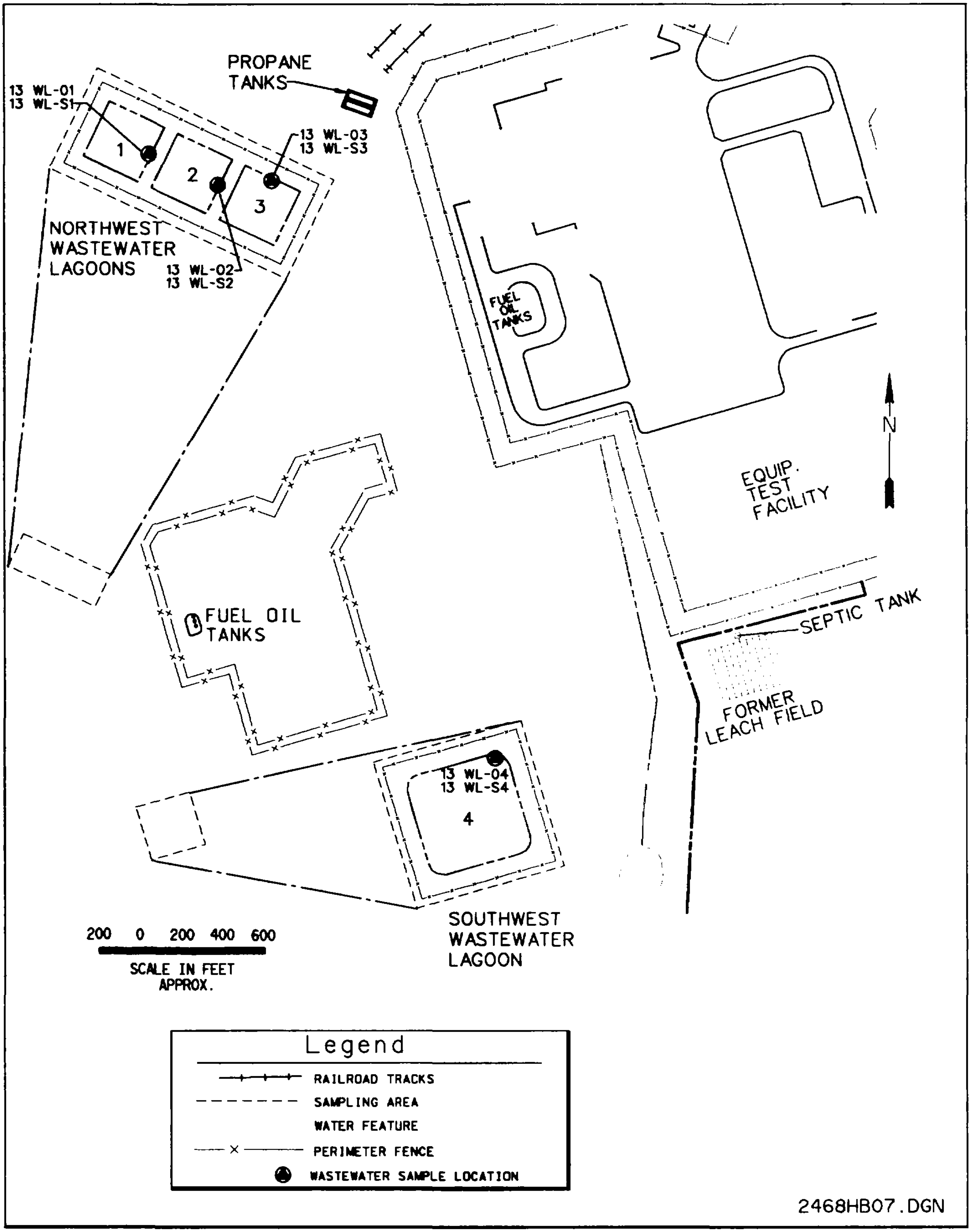

Figure 7-38. SWMU 13 Wastewater and Sludge Sample Locations at the Wastewater Lagoons Site, Phase II RFI

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Table 7-53a. SWMU 13 Surface Water Sampl[illegible]sults for the Wastewater Lagoons Site, Phase II RFI

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Sample ID	VOC (µg/L) Acetone	TPHC (µg/L) Total Petroleum Hydrocarbons	Explosives (µg/L) 1,3-Dinitrobenzene	Explosives (µg/L) 2,4,6-Trinitrotoluene	Explosives (µg/L) 2,4-Dinitrotoluene	Explosives (µg/L) Cyclotetramethylene-tetranitramine	Metals (µg/L) Arsenic	Anions (µg/L) Nitrate	Anions (µg/L) Sulfate[b]	Radionuclides (pc/L) Gross Alpha	Radionuclides (pc/L) Gross Beta	Total Uranium (µg/L)	pH	TOC (µg/L) Total Organic Carbon
Water														
13WL-S1	ND[a]	ND	ND	ND	ND	ND	130	10.9	63,000	2.2	16	2.3	9.5	41,000
13WL-S2	140	200	ND	ND	ND	ND	59.1	13.8	55,000	4.6	6.4	1.8	9.6	49,000
13WL-S3	81	570	ND	ND	ND	ND	DS[b]	ND	48,000	2.3	12	1.5	9.7	33,000
13WL-S4	94	820	4.71	1.83	5.02	22	106	26	33,000	6.1	16	7.8	8.8	180,000

[a]ND=Analyte not detected at or above the CRL, SRL, or MDL.
[b]DS=Data screened due to the 5 times and 10 times rule or did not exceed background values where applicable. (See Section 6.0 for data screening methodologies).

Table 7-53b. SWMU 13 Sludge Sample Results for the Wastewater Lagoons Site, Phase II RFI

Sludge

Sample ID	SVOC (µg/g) 4-Methylphenol	Metals (µg/g) Arsenic (BKGD)[c] 16.4	Metals (µg/g) Beryllium (BKGD) - 1.11	Metals (µg/g) Chromium (BKGD - 23.5	Metals (µg/g) Copper (BKGD) 18.1	Metals (µg/g) Mercury (BKGD) - 0.319	Metals (µg/g) Nickel (BKGD) - 30.0	Metals (µg/g) Zinc (BKGD) - 62.9	Anions (µg/g) Chloride (BKGD) 596	Anions (µg/g) Fluoride (BKGD) 11.5	Radionuclides (pc/g) Alpha Gross	Radionuclides (pc/g) Beta Gross	Total Uranium (µg/g)	pH	TOC (µg/g) Total Organic Carbon
Sludge															
13WL-01	ND[c]	45.3	ND	47.8	42.6	0.464	43.7	156	630	ND	25	28	3.4	8.1	17,000
13WL-02	ND	DS[d]	1.16	32.8	19.2	DS	DS	114	DS	ND	28	31	4	8.2	10,000
13WL-03	ND	DS	DS	DS	22.4	DS	DS	106	DS	ND	17	24	3.1	7.5	6,300
13WL-04	0.79	DS	DS	29.8	27.7	ND	DS	127	DS	18.6	25	24	3.1	8.5	33,000

[a]ND=Analyte not detected at or above the CRL, SRL, or MDL.
[b]DS=Data screened due to the 5 times and 10 times rule or did not exceed background values where applicable. (See Section 6.0 for data screening methodologies).
[c]Bkgd=Background value for specified analyte.

present a summary of the analytical results, and a complete listing of all of the data is presented in Appendix A.

Even though the three northwest lagoons operate as a cascading system, analytical results from these three lagoons are discussed separately, along with the results from the southwest lagoon.

Lagoon 1. The sludge samples from Lagoon 1 (sample 13WL-01 and a duplicate) contained six metals above background. Arsenic was detected above background in the sample as well as the duplicate at 45.3 and 27.6 μg/g, respectively. Chromium exceeded background in both samples at 47.8 and 27.3 μg/g. Copper (42.6 and 24.2 μg/g) and zinc (156 and 106 μg/g) also exceeded background in both samples, while mercury (0.46 μg/g) and nickel (43.7 μg/g) exceeded background in the sample but not in the duplicate.

As with the metals discussed above, total uranium (3.4 and 3.3 μg/g), gross alpha (25 and 20 picocuries per liter (pci/L)), and gross beta (28 and 25 pci/L) were detected in the sample as well as the duplicate. The only other detections in the Lagoon 1 sludge sample were the anions chloride at 630 μg/g and fluoride at 18.6 μg/g.

The water samples from Lagoon 1 (sample 13WL-S1 and a duplicate) contained arsenic in the sample and the duplicate at 128 and 130 μg/L, respectively. As with the sludge sample from this lagoon, total uranium (2.3 and 2.0 μg/L), gross alpha (1.9 and 2.2 pc/L), and gross beta (16.0 and 15.0 pc/L) were detected in the water sample as well as the duplicate. Additionally, nitrate/nitrite and sulfate were the anions that were detected in the water sample. Nitrate/nitrite was detected in the sample at 10.9 μg/L and sulfate was detected in the sample at 63,000 μg/L and in the duplicate at 62,000 μg/L.

Lagoon 2. The sludge samples from Lagoon 2 (sample 13WL-02) contained four metals above background: beryllium (1.16 μg/g), chromium (32.8 μg/g), copper (19.2 μg/g), and zinc (114 μg/g). Total uranium, gross alpha, and gross beta were also detected in this sample at 4.0 μg/g, 28.0 pci/L, and 31.0 pci/L, respectively.

The water sample (13WL-S2) contained arsenic at 59.1 μg/L, total uranium at 1.8 μg/L, gross alpha at 4.6 pci/L, and gross beta at 6.4 pci/L along with the anions nitrate/nitrite at 13.8 μg/L and sulfate at 55,000 μg/L. One VOC, acetone at 140 μg/L, and TPHCs at 200 μg/L were also detected in the water at this lagoon.

Lagoon 3. Lagoon 3 (sample 13WL-03) also contained metals above background (copper at 22.4 μg/g and zinc at 106 μg/g) in the sludge sample, along with the radionuclides total uranium (3.10μg/g), gross alpha (17.0 pci/L), and gross beta (24.0 pci/L).

The water sample (13WL-S3) contained total uranium at 1.5 μg/L, gross alpha at 2.3 pci/L, and gross beta at 12.0 pci/L, along with the anion sulfate at 48,000 μg/L. One VOC, acetone at 81 μg/L, and TPHCs at 570 μg/L were also detected in the water at this lagoon.

Lagoon 4. As with the three northwest lagoons, the sludge samples from Lagoon 4, the Southwest Wastewater Lagoon (sample 13 WL-04), also contained metals and radionuclides. Chromium, copper, and zinc were detected above background at 29.8, 27.7, and 127 μg/g, respectively. Total uranium was detected at 3.10 μg/g while gross alpha and gross beta were detected at 25.0 and 24.0 pci/L, respectively. One SVOC, 4-methylphenol, was also detected in this sample at 0.79 μg/g.

The water sample (13WL-S4) contained arsenic at 106 μg/L, total uranium at 7.8 μg/L, gross alpha at 6.1 pci/L, and gross beta at 16.0 pci/L along with the anions nitrate/nitrite (26.0 μg/L) and sulfate (33,000 μg/L). One VOC, acetone at 94 μg/L, and TPHCs at 820 μg/L were also detected in the water at this lagoon. Unlike any of the other water samples, 13WL-S4 contained explosives. The compounds 1,3-dinitrobenzene (4.71 μg/L), 2,4,6-trinitrotoluene (1.83 μg/L), 2,4-dinitrotoluene (5.02 μg/L), and HMX (22.0 μg/L) were all detected in 13WL-S4. However, a confirmatory analysis was performed, but did not confirm the initial analytical results.

7.10.2 Nature and Extent of Contamination

The radionuclides, total uranium, gross alpha, and gross beta were detected in the sludge and water samples from all of the Northwest Wastewater Lagoons as well as the Southwest Wastewater Lagoon. Arsenic was also quite prevalent as it was detected in the water samples from all four lagoons and was also detected in the sludge sample from Lagoon 1. Metals detected above soil background values occurred in the sludge samples from the four lagoons and consisted of beryllium, chromium, copper, mercury, nickel, and zinc.

Only two anions, chloride and fluoride, were detected above background in the sludge samples and were found in Lagoon 1 and Lagoon 4, respectively. Anions detected in the water samples (no background values were determined for these anions in water) consisted of nitrate/nitrite and sulfate, and were detected in all four lagoons.

Only one VOC, acetone, was detected in the water samples. TPHCs were also detected in the water samples. These VOC and TPHC detections occurred in Lagoon 2, Lagoon 3, and Lagoon 4. Similarly, only one SVOC was detected in the sludge samples from the lagoons (4-methylphenol detected in Lagoon 4).

Unique to the Southwest Wastewater Lagoon was the occurrence of explosives in the water sample, where four explosives were detected. However, the analytical results are suspect because of interferences encountered during analysis. Although it was concluded that explosive contamination is not likely to be present at Lagoon 4, these explosives were carried forward through the risk assessment process.

Given the limited historical information regarding operations at these lagoons, the potential source(s) of the above-mentioned analytes detected in the sludge and water samples collected at this site are unknown. Because background data were not available for radionuclides in sludge or water, it was not determined whether the radionuclide occurrences are naturally occurring or whether they represent contamination. However, no known operations related to SWMU 13 should be contributing radionuclides to these lagoons and radionuclides are commonly associated with volcanic minerals such as those found in the bluffs surrounding Rush Valley.

Therefore, it is quite possible that these radionuclide detections are naturally occurring. Nevertheless, all of the radionuclide detections were carried through the risk assessment process, along with the other analytes discussed in this section.

Because the Northwest Wastewater Lagoons were constructed according to Utah regulations and because it is probable that TEAD also followed appropriate regulations when constructing the Southwest Wastewater Lagoon (see Section 4), it is unlikely that lagoon contents are "leaking" into the surrounding and underlying soils. Additionally, the groundwater maps presented in Section 7.0 do not indicate that any groundwater mounding is occurring in the vicinity of these lagoons. Therefore, it is likely that any contamination at this site will remain in the lagoons. However, if some lagoon leakage were to occur, downgradient monitoring wells can be used to monitor any changes in water quality.

7.10.3 Risk Assessment Results

7.10.3.1 *Baseline Human Health Risk Assessment*

This section presents the results of the sample data screening approach previously described in Section 6.1.1 that led to (1) the selection of the COPCs, (2) the exposure pathways that are labeled in the conceptual site model as being complete, (3) the exposure point concentrations in each respective environmental medium for those COPCs that have published health criteria, and (4) the carcinogenic and noncarcinogenic risk estimates for each receptor population under current and future land use scenarios.

This section of the report evaluates exposure to COPCs detected in site soils as well as those contaminants measured or modeled in various media from SWMU-wide or depot-wide sources. The direct soil-contact pathway (e.g., ingestion and dermal exposure) is associated with site-specific chemicals. Similarly, ingestion of homegrown produce by future on-site residents is based on those contaminants in soils are also used as model inputs to the air pathway for current off-site residents.

Current on-site worker and future on-site residents, however, are assumed to be potentially exposed to SWMU-wide chemicals in air (i.e., those chemicals detected in surface media at all of the sites evaluated within SWUM 13). Exposure to SWMU-wide chemicals was also the approach selected for the groundwater pathway. Thus, future on-site residents are assumed to be potentially exposed to groundwater contaminants measured in monitoring wells located across SWMU 13. The results of the groundwater evaluation are also presented separately in Section 7.11.3.1. Ingestion of beef and dairy products by future on-site residents is based on modeling contaminants detected in depot-wide surface soils; cattle are assumed to graze at contaminated sites within SWMU 13 and SWMU 17. Thus, the total cancer risk and noncarcinogenic hazards to the future on-site resident (adult and child) presented in the sections below include those contributions associated with exposures to SWMU-wide contamination in air and groundwater and to depot-wide chemicals in beef and milk.

Finally, future construction workers may be exposed to site contaminants when and if the lagoons are repaired or enlarged.

7.10.3.1.1 *Chemicals of Potential Concern.* The sediment (sludge) and wastewater data for this site were grouped into two separate areas and evaluated in the human health risk assessment accordingly. The data were grouped between that portion belonging to the Northwest Wastewater Lagoons 1, 2, and 3, and those belonging to the Southwest Wastewater Lagoon, Lagoon 4. The COPCs in sediment and surface water for both groups are summarized in Tables 7-54 and 7-55. Chloride was measured in the sediment of Lagoon 1 at a level of 630 μg/g but was not evaluated further since it lacks USEPA Health Criteria. Measurable levels of gross alpha and gross beta radiation were detected in the wastewater and bottom sediments at this site. However, these radionuclides do not currently have verified USEPA Health Criteria. Therefore, exposure to gross alpha and gross beta radiation was not evaluated further.

It should be noted that the wastewater at both locations contained measurable levels of TPHC, nitrate, and sulfate. At Lagoon 4, the wastewater also contained arsenic and the sediment contained fluoride. These chemicals were not included in the human health risk assessment because, under current land use conditions, it was assumed that the only exposure to receptors from these locations would be from inhalation of VOC emissions from the wastewater. Under future land use conditions, it was assumed that use of the lagoons would discontinue and, thus, any future exposure would result only from site-related chemicals in the residual sediment (referred to as soil under future conditions).

7.10.3.1.2 *Complete Exposure Pathways.* The pathways assumed complete for both lagoon groups are shown in the conceptual site model in Figure 7-39. Exposure by potential future on-site residents from ingestion of and dermal contact with site-specific COPCs measured in the lagoon soil (sediments) was evaluated. Exposure from inhalation of fugitive dust by and off-site residents was not evaluated since it was assumed that the lagoon bottom sediments are covered with wastewater under current conditions and are not available during the time the lagoons are in service. However, exposure from fugitive dust emissions by potential future on-site residents was evaluated (as part of the SWMU-wide air modeling discussed previously) since it is assumed that future service of the lagoons will discontinue and, thus, sediments will be subject to wind erosion. Likewise, future on-site construction workers may be exposed to sediments (soil) via direct contact and through inhalation of particulates. The surface water in the lagoons was assumed to be inaccessible to on-site workers and, therefore, exposure due to dermal contact and ingestion of this medium were not evaluated. However, acetone was detected in surface water at both groups of lagoons, and exposure to acetone vapors by current on-site workers and off-site residents was evaluated. Chemicals measured in the lagoon

Table 7-54. SWMU 13 Summary of Concentrations of Chemicals of Potential Concern in Sediment and Surface Water at the Wastewater Lagoons 1, 2, and 3, Phase II RFI

Chemical	Background Concentration (mg/kg)	Frequency of Detection	Range of Detects (mg/kg)	Arithmetic Mean Concentration (mg/kg)	95% UCL (mg/kg)
Sediment					
Arsenic	16.4	3/3	13.3-**36.5**	21.8	43.3
Beryllium	1.11	2/3	0.935-**1.16**	0.77	1.6
Chromium	23.5	3/3	20.7-**37.6**	30.4	45
Copper	18.1	3/3	19.2-**33.4**	25	37.6
Mercury	0.319	3/3	0.087-**0.364**	0.19	0.45
Nickel	30	3/3	22.8-**35.4**	28.2	39.1
Uranium	NA	3/3	3.1-**4.0**	3.5	4.3
Zinc	62.9	3/3	106.0-**131.0**	117	138.5
Surface Water					
Acetone[a]	NA	2/3	81.0-140.0 μg/L	75.0 μg/L	**140.0** μg/L

Notes.—NA denotes not applicable. Chloride and gross alpha and gross beta were detected in the sediment of Lagoons 1, 2, and 3, but was not evaluated further due to lack of USEPA Health Criteria. TPHC, nitrate, sulfate, and radionuclides were measured in the wastewater but are not evaluated since the pathway is incomplete. **Bold** type designates the exposure point concentration selected for these media.

[a]Acetone levels in air are based on the concentration in surface water.

Table 7-55. SWMU 13 Summary of Concentrations of Chemicals of Potential Concern in Sediment and Surface Water at the Wastewater Lagoon 4, Phase II RFI

Chemical	Background Concentration (mg/kg)	Frequency of Detection	Range of Detects (mg/kg)	Arithmetic Mean Concentration (mg/kg)	95% UCL (mg/kg)
Sediment					
Chromium	23.5	1/1	**29.8**	NA	NA
Copper	18.1	1/1	**27.7**	NA	NA
Uranium	NA	1/1	**3.1**	NA	NA
Zinc	62.9	1/1	**127**	NA	NA
4-Methylphenol	NA	1/1	**0.79**	NA	NA
Surface Water					
Acetone[a]	NA	1/1	**94.0** μg/L	NA	NA

Note.—NA denotes not applicable. TPHC, fluoride, nitrate, sulfate, and radionuclides were measured in the wastewater at this location but were not evaluated further because the pathway for these chemicals is not complete. **Bold** type designates the exposure point concentration selected for these media.

aAcetone levels in air are based on the concentration in surface water.

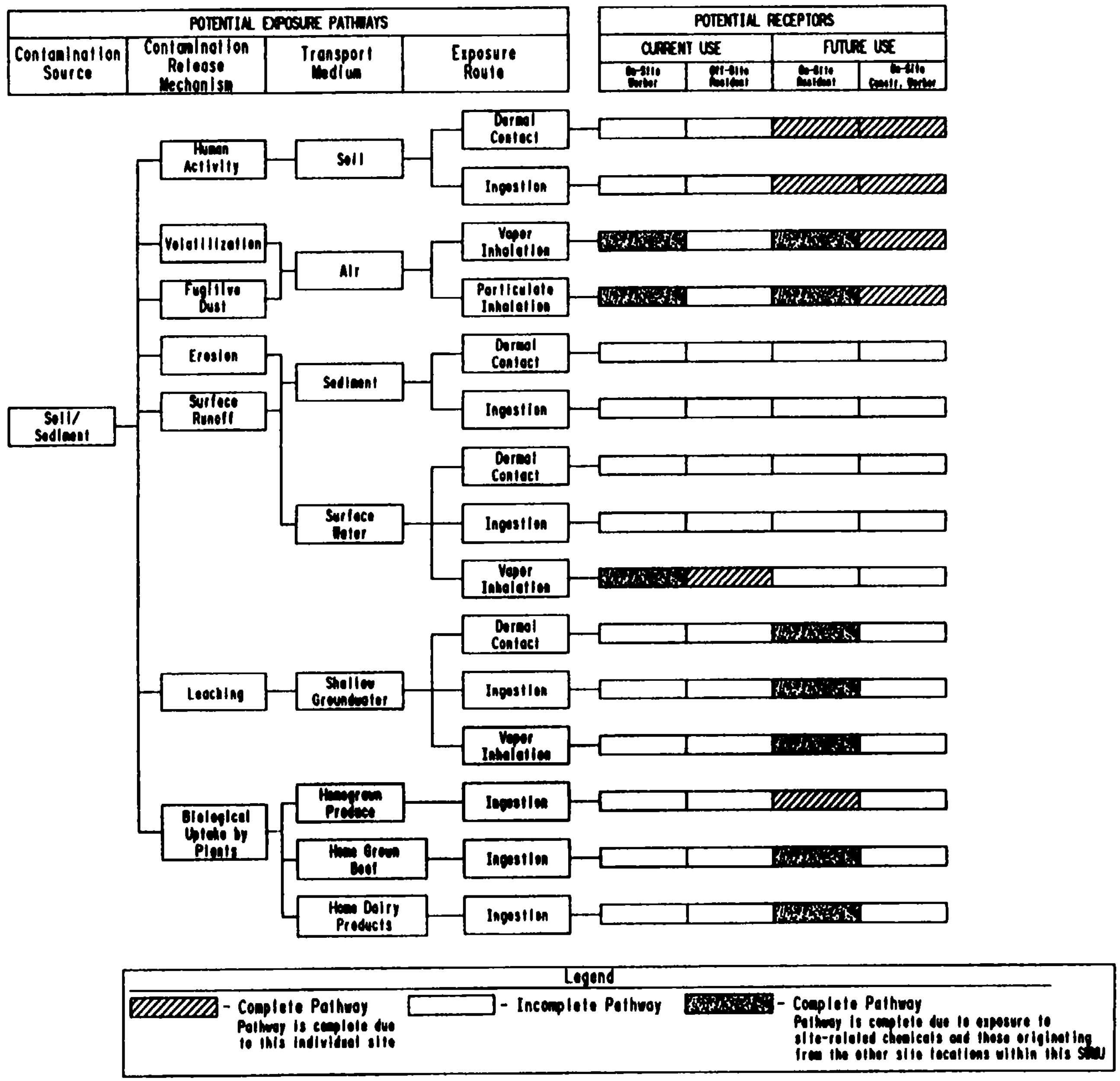

Figure 7-39. SWMU 13 Potential Human Exposure Pathway Conceptual Model for the Wastewater Lagoon Site, Phase II RFI

sediments were assumed to be available for plant uptake. Therefore, exposure by potential future on-site residents from consumption of vegetables grown at this site was evaluated. Evaluation of exposure to SWMU-wide chemicals in groundwater by potential future on-site residents is described in Section 7.11.3.1.

Inhalation exposure by off-site residents of acetone dispersed from lagoon surface in ambient air represents the only complete exposure pathway for these receptors.

The sites within SWMU 13 either overlap or are adjacent to each other so that it was practical to estimate air chemical levels as SWMU-wide concentrations instead of on a site-specific basis. Therefore, exposure from inhalation of SWMU-wide chemical concentrations by the on-site worker during daily visits to this site was included despite the fact that these chemicals were not all present in surficial soil at this location. Exposures to airborne chemicals by future residents were also based on SWMU-wide concentrations. Similarly, exposures by potential future on-site residents from ingestion of chemicals in beef and milk, derived as depot-wide averages using data collected at SWMUs 13 and 17, were also evaluated.

7.10.3.1.3 ***Exposure Point Concentrations.*** Exposures from all complete pathways by all the identified receptors were estimated using the exposure-point concentrations in Tables 7-56 and 7-57. These tables include site-specific values based on soil (sediment) and surface water chemical concentrations measured within both lagoon groups. Tables 7-56 and 7-57 show the off-site air concentrations modeled from this site's surface water (lagoons) to the off-site residents. These tables also show values for airborne chemicals originating from several sites within this values for chemicals in beef and milk for all of TEAD-S that pertain to future on-site residents. The beef and milk values were estimated using data from SWMUs 13 and 17. Exposure to chemicals in groundwater by potential future on-site residents was based on the SWMU-wide exposure point concentrations in Table 7-68.

7.10.3.1.4 ***Risk Estimates.*** The receptor populations evaluated at this site include the current on-site worker, off-site residents (adult and child), and the potential future construction worker and on-site residents (adult and child). Cancer risk and noncarcinogenic hazards to these receptor populations were estimated based on exposure to site-specific chemicals detected in soil (sediment) and surface water; SWMU-wide chemicals in air and groundwater; and/or depot-wide chemicals in beef/milk. The results of this evaluation under current and future land use for each lagoon data group are presented below. These results are also summarized for each exposure pathway in Tables 7-58, 7-59, 7-60, and 7-61, respectively. Actual risk calculations are presented in Appendix H. Tables 7-58 through 7-61 show in bold font those risks and hazards which are site-specific (i.e., related to chemicals detected specifically in this site's soils).

Current Land Use

Cancer risk to the current on-site worker at the Northwest Wastewater Lagoons from exposure

Table 7-56. SWMU 13 Exposure Point Concentrations for the Chemicals of Potential Concern at Wastewater Lagoons 1, 2, and 3, Phase II RFI

Receptor	Chemical	EXPOSURE POINT CONCENTRATIONS								
		Air[a] (mg/m³)	Sediment (mg/kg)	Milk[b] (mg/L)	Beef[b] (mg/g)	Potato* (mg/g)	Tomato (mg/g)	Carrot (mg/g)	Lettuce (mg/g)	Beans (mg/g)
Current On-Site Worker	Arsenic	2.15E-07	NA	---	---	---	---	---	---	---
	Beryllium	7.76E-09	NA	---	---	---	---	---	---	---
	Chromium	5.60E-07	NA	---	---	---	---	---	---	---
	Copper	2.01E-07	NA	---	---	---	---	---	---	---
	Lead	8.33E-08	NA	---	---	---	---	---	---	---
	Mercury	1.27E-10	NA	---	---	---	---	---	---	---
	Nickel	1.24E-08	NA	---	---	---	--	---	---	---
	Nitrate[d]	5.00E-07	NA	---	---	---	---	---	---	---
	Uranium	2.64E-09	NA	---	---	---	---	---	---	---
	Zinc	1.31E-06	NA	---	---	---	---	---	---	---
	Acetone	1.30E-05	NA	---	---	---	---	---	---	---
	Chloromethane	1.60E-06	NA	---	---	---	---	---	---	---
	Methylene Chloride	2.35E-06	NA	---	---	---	---	---	---	---
	4-Methylphenol	3.16E-10	NA	---	---	---	---	---	---	---
	Methyl isobutyl ketone	1.50E-09	NA	---	---	---	---	---	---	---
	Methyl-n-butyl ketone	7.30E-10	NA	---	---	---	---	---	---	---
Future On-Site Resident	Arsenic	2.1E-06 (3.49E-06)	36.5	9.8E-08	1.63E-09	5.5E-05	1.3E-05	2.6E-05	7.3E-05	6.1E-05
	Beryllium	4.81E-08 (7.4E-08)	1.16	9.32E-11	3.99E-11	4.4E-07	1.1E-07	2.1E-07	5.8E-07	4.9E-07
	Chromium	5.90E-06 (1.10E-05)	37.6	7.65E-08	4.0E-09	4.2E-05	1.0E-05	2.0E-05	1.4E-05	4.7E-05
	Copper	1.7E-06 (1.00E-05)	33.4	4.41E-05	1.13E-07	2.1E-03	5.0E-04	1.0E-03	6.7E-04	2.3E-03

Table 7-56. SWMU 13 Exposure Point Concentrations for the Chemicals of Potential Concern at Wastewater Lagoons 1, 2, and 3, Phase II RFI (continued)

Receptor	Chemical	EXPOSURE POINT CONCENTRATIONS								
		Air[a] (mg/m³)	Sediment (mg/kg)	Milk[b] (mg/L)	Beef[b] (mg/g)	Potato* (mg/g)	Tomato (mg/g)	Carrot (mg/g)	Lettuce (mg/g)	Beans (mg/g)
Future On-Site Resident (cont.)	Lead	1.47E-06 (2.94E-06)	<Bkgd	1.55E-07	8.16E-11	---	---	---	---	---
	Mercury	6.17E-09 (1.24E-08)	0.364	1.03E-09	1.26E-11	1.8E-05	4.4E-06	8.7E-06	1.6E-05	2.0E-05
	Nickel	6.02E-07 (1.2E-06)	35.4	8.52E-08	7.29E-09	5.3E-04	1.3E-04	2.5E-04	5.0E-04	5.9E-04
	Nitrate[d]	4.89E-07 (6.64E-07)	ND	NA	NA	---	---	---	---	---
	Uranium	1.18E-07 (2.35E-07)	4.0	2.0E-09	7.71E-12	1.4E-05	9.6E-07	6.7E-06	3.4E-06	4.5E-06
	Zinc	1.03E-05 (1.73E-05)	131.0	4.63E-03	1.78E-05	1.9E-02	7.1E-03	9.3E-03	9.2E-03	3.3E-02
	Bis(2-ethylhexyl) phthalate	---	ND	1.24E-09	1.51E-12	---	---	---	---	---
	1,2-Dimethylbenzene	---	ND	3.49E-12	4.25E-15	---	---	---	---	---
	4-Methylphenol	1.26E-08 (2.53E-08)	ND	4.07E-10	4.96E-13	---	---	---	---	---
	Methyl isobutyl ketone	8.00E-09 (9.50E-09)	ND	6.50E-12	7.92E-15	---	---	---	---	---
	Methyl-n-butyl ketone	4.00E-09(4.80E-09)	ND	---	---	---	---	---	---	---
Off-Site Resident	Acetone	1.70E-07	---	---	---	---	---	---	---	---
	Toluene	---	ND	2.48E-12	3.02E-15	---	---	---	---	---
Future Construction worker	Arsenic	1.24E-06	36.5	---	---	---	---	---	---	---
	Beryllium	3.94E-08	1.16	---	---	---	---	---	---	---
	Chromium	1.28E-06	37.6	---	---	---	---	---	---	---
	Copper	1.14E-06	33.4	---	---	---	---	---	---	---
	Mercury	1.24E-08	0.364	---	---	---	---	---	---	---

Table 7-56. SWMU 13 Exposure Point Concentrations for the Chemicals of Potential Concern at Wastewater Lagoons 1, 2, and 3, Phase II RFI (continued)

Receptor	Chemical	EXPOSURE POINT CONCENTRATIONS								
		Air[a] (mg/m^3)	Sediment (mg/kg)	Milk[b] (mg/L)	Beef[b] (mg/g)	Potato[c] (mg/g)	Tomato (mg/g)	Carrot (mg/g)	Lettuce (mg/g)	Beans (mg/g)
	Nickel	1.20E-06	36.5	---	---	---	---	---	---	---
	Uranium	1.36E-07	4.0	---	---	---	---	---	---	---
	Zinc	4.45E-06	131	---	---	---	---	---	---	---

Notes.—NA denotes sediment is not available to receptor. ND denotes not detected. "---" denotes not applicable.

[a]Air chemical concentrations represent average levels for on-site worker and maximum for future resident. Value in parenthesis represents that for child.

[b]Beef and milk concentrations were derived as area averages.

[c]Vegetable chemical concentrations based on corresponding soil concentrations.

[d]Transfer factors are not available for nitrate.

Table 7-57. SWMU 13 Exposure Point Concentrations for the Chemicals of Potential Concern at Wastewater Lagoon 4, Phase II RFI

Receptor	Chemical	EXPOSURE POINT CONCENTRATIONS								
		Air[a] (mg/m^3)	Soil (mg/kg)	Milk[b] (mg/L)	Beef[b] (mg/g)	Potato[c] (mg/g)	Tomato (mg/g)	Carrot (mg/g)	Lettuce (mg/g)	Beans (mg/g)
Current On-Site Worker	Arsenic	2.15E-07	NA	---	---	---	---	---	---	---
	Beryllium	7.76E-09	NA	---	---	---	---	---	---	---
	Chromium	5.60E-07	NA	---	---	---	---	---	---	---
	Copper	2.01E-07	NA	---	---	---	---	---	---	---
	Lead	8.33E-08	NA	---	---	---	---	---	---	---
	Mercury	1.27E-10	NA	---	---	---	---	---	---	---
	Nickel	1.21E-08	NA	---	---	---	---	---	---	---
	Nitrate	5.00E-07	NA	---	---	---	---	---	---	---
	Uranium	2.64E-09	NA	---	---	---	---	---	---	---
	Zinc	1.31E-06	NA	---	---	---	---	---	---	---
	Acetone	1.30E-05	NA	---	---	---	---	---	---	---
	Chloromethane	1.60E-06	NA	---	---	---	---	---	---	---
	Methylene Chloride	2.35E-06	NA	---	---	---	---	---	---	---
	4-Methylphenol	3.16E-10	NA	---	---	---	---	---	---	---
	Methyl isobutyl ketone	1.50E-09	NA	---	---	---	---	---	---	---
	Methyl-n-butyl ketone	7.30E-10	NA	---	---	---	---	---	---	---
Off-Site Resident	Acetone	9.90E-08	NA	---	---	---	---	---	---	---
Future On-Site Resident	Arsenic	2.1E-06 (3.49E-06)	ND	9.8E-08	1.63E-09	---	---	---	---	---
	Beryllium	4.81E-08 (7.4E-08)	ND	9.32E-11	3.99E-11	---	---	---	---	---

Table 7-57. SWMU 13 Exposure Point Concentrations for the Chemicals of Potential Concern at Wastewater Lagoon 4, Phase II RFI (continued)

Receptor	Chemical	EXPOSURE POINT CONCENTRATIONS								
		Air[a] (mg/m³)	Soil (mg/kg)	Milk[b] (mg/L)	Beef[b] (mg/g)	Potato[c] (mg/g)	Tomato (mg/g)	Carrot (mg/g)	Lettuce (mg/g)	Beans (mg/g)
Future On-Site Resident (cont.)	Chromium	5.90E-06 (1.10E-05)	29.8	7.65E-08	4.0E-09	3.4E-05	8.0E-06	1.6E-05	1.1E-05	3.8E-0
	Copper	1.7E-06 (1.00E-05)	27.7	4.41E-05	1.13E-07	1.7E-03	4.2E-04	8.3E-04	5.5E-04	1.9E-0
	Lead	1.47E-06 (2.99E-06)	ND	1.55E-07	8.16E-11	---	---	---	---	---
	Mercury	6.17E-09 (1.24E-08)	ND	1.03E-09	1.26E-11	---	---	---	---	---
	Nickel	6.02E-07 (1.2E-06)	ND	8.52E-08	7.29E-09	---	---	---	---	---
	Nitrate[d]	4.89E-07 (6.64E-07)	ND	NA	NA	---	---	---	---	---
	Uranium	1.18E-07 (2.35E-07)	3.1	2.0E-09	7.71E-12	1.1E-05	7.4E-07	5.2E-06	2.6E-06	3.5E-0
	Zinc	1.03E-05 (1.73E-05)	127.0	4.63E-03	1.78E-05	1.9E-02	6.9E-03	9.0E-03	8.9E-03	3.2E-0
	BEHP	---	ND	1.24E-09	1.51E-12	---	---	---	---	---
	1,2-Dimethylbenzene	---	ND	3.49E-12	4.25E-15	---	---	---	---	---
	4-Methylphenol	1.26E-08 (2.53E-08)	0.79	4.07E-10	4.96E-13	2.9E-04	1.4E-04	2.9E-04	1.2E-04	6.5E-0
	MIBK	8.00E-09(9.50E-09)	ND	6.50E-12	7.92E-15	---	---	---	---	---
	Methyl-n-butyl ketone	4.00E-09(4.80E-09)	NA	---	---	---	---	---	---	---
	Toluene	---	ND	2.48E-12	3.02E-15	---	---	---	---	---
Future Construction Worker	Chromium	5.96E-07	29.8	---	---	---	---	---	---	---
	Copper	5.54E-07	27.7	---	---	---	---	---	---	---
	Uraniium	6.20E-08	3.1	---	---	---	---	---	---	---
	Zinc	2.54E-06	127	---	---	---	---	---	---	---
	4-Methylphenol	1.58E-08	0.79	---	---	---	---	---	---	---

Notes.—NA denotes sediment is not available to receptor. ND denotes not detected. "---" denotes not applicable.

[a]Air chemical concentrations represent average levels for on-site worker and maximum for future resident.

[b]Beef and milk concentrations were derived as area averages.

[c]Vegetable chemical concentrations based on corresponding soil concentrations.

[d]Transfer factors are not available for nitrate.

Table 7-58. SWMU 13 Summary of Carcinogenic Risks for Northwest Wastewater Lagoons 1, 2, and 3, Phase II RFI

Potential Exposure Pathways		Current Use		Future Use	
Environmental Medium	**Potential Exposure Route**	**On-Site Worker[a]**	**Off-Site Resident Adult (Child)**	**Construction Worker**	**On-Site Resident Adult (Child)[b]**
Soil	Dermal Contact	NA	NA	2.30E-08	**1.61E-06 (8.67E-07)**
	Ingestion	NA	NA	2.40E-06	**3.31E-05[c] (6.55E-05)[c]**
Air	Particulate Inhalation	2.12E-07	NA (NA)	1.52E-07	3.09E-05[d] (3.98E-05)[e]
	Vapor Inhalation	1.12E-10	NE (NE)	NA	NE (NE)
Surface water	Vapor Inhalation	EA	EA	NA	NA
Groundwater	Dermal Contact	NA	NA	NA	1.55E-04 (4.79E-05)
	Ingestion	NA	NA	NA	5.79E-03[f] (2.70E-03)[f]
	Vapor Inhalation	NA	NA	NA	3.00E-07 (2.10E-07)
Homegrown Produce	Ingestion	NA	NA	NA	**1.17E-04[c] (6.01E-05)[c]**
Homegrown Beef	Ingestion	NA	NA	NA	1.35E-09 (5.55E-10)
Homegrown Dairy Products	Ingestion	NA	NA	NA	**5.73E-10 (6.54E-10)**
	Total Cancer Risk	2.12E-07	NA/NE (NA/NE)	2.58E-06	6.13E-03 (2.86E-03)

Notes.—NA denotes not applicable. NE denotes not evaluated due to lack of USEPA Health Criteria for site-related chemicals within this pathway. EA denotes evaluated above (i.e., emissions of VOCs detected in surface water were included in the air pathway). Bold type designates site-specific risks (i.e., those potential risks that are attributed to chemicals detected at this site).

[a]Exposure to workers was evaluated based on the time spent at each site during assumed daily visits to each site within SWMU 13. Exposure to airborne chemicals was evaluated based on chemicals measured in surface soil and surface water within this SWMU. The concentrations used for this medium represent SWMU-wide values. Therefore, even if site-specific contamination is absent from surficial soil, exposure from inhalation of particulates and vapors from other sites was assumed to occur.

[b]Beef and milk chemical concentrations represent base-wide values for TEAD-S. Therefore, the future resident at each site may be exposed to site-specific chemicals and also to those associated with other site locations within SWMU 13 and 17.

[c]Ingestion of arsenic detected in this site's soil is responsible for most of the risk.

[d]Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, and the Pavement Perimeter Site is responsible for almost 90 percent of the total air pathway risk.

[e]Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, the Southwest Wastewater Lagoon, and the Pavement Perimeter Site is responsible for over 90 percent of the total air pathway risk.

[f]Ingestion of arsenic detected in SWMU-wide monitoring wells is responsible for at least 90 percent of the total groundwater pathway risks.

Table 7-59. SWMU 13 Summary of Noncarcinogenic Hazards for the Northwest Wastewater Lagoons 1, 2, and 3, Phase II RFI

Potential Exposure Pathways		Current Use		Future Use	
Environmental Medium	Potential Exposure Route	On-Site Worker[a]	Off-Site Resident Adult (Child)	Construction Worker	On-Site Resident Adult (Child)[b]
Soil	Dermal Contact	NA	NA	6.87E-04	**8.44E-03 (2.16E-02)**
	Ingestion	NA	NA	7.23E-02	**1.85E-01 (1.64E+00)[c]**
Air	Particulate Inhalation	1.15E-02	NA (NA)	3.41E-02	1.41E+00 (9.21E+00)[d]
	Vapor Inhalation	4.96E-07	**NE (NE)**	NA	8.57E-07 (2.67E-06)
Surface water	Vapor Inhalation	EA	EA	NA	NA
Groundwater	Dermal Contact	NA	NA	NA	5.02E-01 (2.81E-01)
	Ingestion	NA	NA	NA	7.35E+01[e] (9.61E+01)[e]
	Vapor Inhalation	NA	NA	NA	1.38E-02 (5.43E-03)
Homegrown Produce	Ingestion	NA	NA	NA	**1.29E+00[f](2.87E+00)[g]**
Homegrown Beef	Ingestion	NA	NA	NA	8.30E-05 (1.70E-04)
Homegrown Dairy Products	Ingestion	NA	NA	NA	**1.57E-04 (8.97E-04)**
	Total Hazard	1.15E-02	NA/NE (NA/NE)	1.07E-01	7.69E+01 (1.16E+02)

Notes.—NA denotes not applicable. EA denotes evaluated above (i.e., emissions of VOCs detected in surface water were included in the air pathway). **Bold type designates site-specific hazards (i.e., those potential hazards that are attributed to chemicals detected at this site).**

[a]Exposure to workers was evaluated based on the time spent at each site during assumed daily visits to each site within SWMU 13. Exposure to airborne chemicals was evaluated based on chemicals measured in surface soil and surface water within this SWMU. The concentrations used for this medium represent SWMU-wide values. Therefore, even if site-specific contamination is absent from surficial soil, exposure from inhalation of particulates and vapors from other sites was assumed to occur.

[b]Beef and milk chemical concentrations represent depot-wide values for TEAD-S. Therefore, the future resident at each site may be exposed to site-specific chemicals and also to those associated with other site locations within SWMU 13 and 17.

[c]Ingestion of arsenic detected in this site's soil is responsible for at least 90 percent of the hazard.

[d]Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons,and the Southwest Wastewater Lagoon is responsible for at least 90 percent of the total air pathway hazard.

[e]Ingestion of arsenic, thallium, and fluoride detected in SWMU-wide monitoring wells is responsible for at least 90 percent of the total groundwater pathway hazards.

[f]Ingestion of arsenic, zinc, mercury, and copper detected in this site's soil is responsible for at least 90 percent of the hazard.

[g]Ingestion of arsenic, mercury, and copper detected in this site's soil is responsible for at least 90 percent of the hazard.

Table 7-60. SWMU 13 Summary of Carcinogenic Risks for the Southwest Wastewater Lagoon 4, Phase II RFI

Potential Exposure Pathways		**Current Use**		**Future Use**	
Environmental Medium	**Potential Exposure Route**	**On-Site Worker[a]**	**Off-Site Resident Adult (Child)**	**Construction Worker**	**On-Site Resident Adult (Child)[b]**
Soil	Dermal Contact	NA	NA	NE	NE (NE)
	Ingestion	NA	NA	NE	NE (NE)
Air	Particulate Inhalation	2.12E-07	NA (NA)	5.12E-08	3.09E-05[c] (3.98E-05)[d]
	Vapor Inhalation	1.12E-10	NE (NE)	NA	NE (NE)
Surface water	Vapor Inhalation	EA	EA	NA	NA
Groundwater	Dermal Contact	NA	NA	NA	1.55E-04 (4.79E-05)
	Ingestion	NA	NA	NA	5.79E-03[e] (2.70E-03)[e]
	Vapor Inhalation	NA	NA	NA	3.00E-07 (2.10E-07)
Homegrown Produce	Ingestion	NA	NA	NA	NE (NE)
Homegrown Beef	Ingestion	NA	NA	NA	1.35E-09 (5.55E-10)
Homegrown Dairy Products	Ingestion	NA	NA	NA	5.73E-10 (6.54E-10)
	Total Cancer Risk	**2.12E-07**	**NA/NE (NA/NE)**	**5.12E-08**	**5.98E-03 (2.89E-03)**

Notes.—NA denotes not applicable. NE denotes not evaluated due to lack of USEPA Health Criteria for site-related chemicals within this pathway. EA denotes evaluated above (i.e., emissions of VOCs detected in surface water were included in the air pathway).

[a]Exposure to workers was evaluated based on the time spent at each site during assumed daily visits to each site within SWMU 13. Exposure to airborne chemicals was evaluated based on chemicals measured in surface soil and surface water within this SWMU. The concentrations used for this medium represent SWMU-wide values. Therefore, even if site-specific contamination is absent from surficial soil, exposure from inhalation of particulates and vapors from other sites was assumed to occur.

[b]Beef and milk chemical concentrations represent depot-wide values for TEAD-S. Therefore, the future resident at each site may be exposed to site-specific chemicals and also to those associated with other site locations within SWMU 13 and 17.

[c]Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, and the Pavement Perimeter Site is responsible for almost 90 percent of the total air pathway risk.

[d]Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, the Southwest Wastewater Lagoon, and the Pavement Perimeter Site is responsible for over 90 percent of the total air pathway risk.

[e]Ingestion of arsenic detected in SWMU-wide monitoring wells is responsible for at least 90 percent of the total groundwater pathway risks.

Table 7-61. SWMU 13 Summary of Noncarcinogenic Hazards for the Southwest Wastewater Lagoon 4, Phase II RFI

Potential Exposure Pathways		Current Use		Future Use	
Environmental Medium	**Potential Exposure Route**	**On-Site Worker[a]**	**Off-Site Resident Adult (Child)**	**Construction Worker**	**On-Site Resident Adult (Child)[b]**
Soil	Dermal Contact	NA	NA	2.44E-05	**5.66E-04 (7.67E-04)**
	Ingestion	NA	NA	2.17E-03	**1.14E-02 (4.93E-02)**
Air	Particulate Inhalation	1.15E-02	NA (NA)	1.59E-02	1.41E+00 (9.21E+00)[c]
	Vapor Inhalation	4.96E-07	NE (NE)	NA	8.57E-07 (2.67E-06)
Surface water	Vapor Inhalation	EA	EA	NA	NA
Groundwater	Dermal Contact	NA	NA	NA	5.02E-01 (2.81E-01)
	Ingestion	NA	NA	NA	7.35E+01[d](9.61E+01)[d]
	Vapor Inhalation	NA	NA	NA	1.38E-02 (5.43E-03)
Homegrown Produce	Ingestion	NA	NA	NA	**6.52E-01 (1.67E+00)**
Homegrown Beef	Ingestion	NA	NA	NA	8.30E-05 (1.70E-04)
Homegrown Dairy Products	Ingestion	NA	NA	NA	1.57E-04 (8.97E-04)
	Total Hazard	1.51E-02	NA(NE)/NA(NE)	1.81E-02	7.61E+01 (1.07E+02)

Notes.—NA denotes not applicable. EA denotes evaluated above (i.e., emissions of VOCs detected in surface water were included in the air pathway. **Bold type designates site-specific hazards** (i.e., those potential hazards that are attributed to chemicals detected at this site).

[a]Exposure to workers was evaluated based on the time spent at each site during assumed daily visits to each site within SWMU 13. Exposure to airborne chemicals was evaluated based on chemicals measured in surface soil and surface water within this SWMU. The concentrations used for this medium represent SWMU-wide values. Therefore, even if site-specific contamination is absent from surficial soil, exposure from inhalation of particulates and vapors from other sites was assumed to occur.

[b]Beef and milk chemical concentrations represent depot-wide values for TEAD-S. Therefore, the future resident at each site may be exposed to site-specific chemicals and also to those associated with other site locations within SWMU 13 and 17.

[c]Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons,and the Southwest Wastewater Lagoon is responsible for at least 90 percent of the total air pathway hazard.

[d]Ingestion of arsenic, thallium, and fluoride detected in SWMU-wide monitoring wells is responsible for at least 90 percent of the total groundwater pathway hazards.

to SWMU-wide airborne chemicals at the Northwest Wastewater Lagoons was estimated to be 2.12E-07, and the noncarcinogenic hazard to this receptor was estimated to be 1.15E-02.

Cancer risk at the Southwest Wastewater Lagoon to the current on-site worker from exposure to SWMU-wide airborne chemicals was estimated to be 2.12E-07, and the noncarcinogenic hazard to this receptor was estimated to be 1.51E-02.

Future Land Use

Total cancer risks at the Northwest Wastewater Lagoons to the future on-site adult and child from exposure to SWMU-wide air, site-specific soil (sediment) homegrown produce, and SWMU-wide groundwater were estimated to be 6.13E-03 and 2.86E-03, respectively. Total noncarcinogenic hazards to these receptors were estimated to be 7.69E+01 and 1.16E+02, respectively. Total cancer risk to the future construction worker was estimated to be 2.58E-06. The total noncancer hazard to this receptor was estimated to be 1.07E-01.

Total cancer risks at the Southwest Wastewater Lagoon to the potential future on-site adult and child from exposure to SWMU-wide air, site-specific soil (sediment) homegrown products, and SWMU-wide groundwater were estimated to be 5.98E-03 and 2.89E-03, respectively. Total noncarcinogenic hazards to these receptors were estimated to be 7.61E+01 and 1.07E+02, respectively. The total cancer risk to the future construction worker was estimated to be 5.12E-08, and the total noncancer hazard was 1.81E-02.

7.10.3.1.5 ***Conclusions.*** The results of the human health risk assessment under the current land use exposure scenario at this site indicates that the estimated cancer risk to the on-site worker of 2.12E-07 at each of the lagoon sites is below the 1E-06 State of Utah recommended threshold of allowable risk. Noncarcinogenic hazards to all receptors associated with this site under current land use conditions were found to be well below the State of Utah recommended value of 1.

The results of the human health risk assessment under future land use conditions indicate that the estimated total cancer risks to the potential future on-site adult at both lagoon locations of 6.13E-03 and 5.98E-03 exceed the State of Utah recommended threshold of allowable risk, as does the cancer risk to the future construction worker of 2.58E-06. For the potential future on-site child, the estimated total cancer risks at both lagoon locations of 2.86E-03 and 2.89E-03 also exceed this limit. Total noncarcinogenic hazards to the potential future on-site adult at both lagoon sites of 76.9 and 76.1 were found to be well above the State of Utah recommended value of 1. Similarly, for the potential future on-site child resident, the total estimated noncarcinogenic hazards at both lagoon sites of 116 and 107 were found to be well above this value. These risks are primarily related to ingestion of arsenic detected in SWMU-wide monitoring wells, as discussed further below.

Ingestion of arsenic detected in soil (sediment) at the Northwest Wastewater Lagoons is responsible for over 90 percent of the potential cancer risks associated with the soil pathway, and with the consumption of homegrown produce for future residents. Ingestion of arsenic detected in this site's soil is also responsible for over 90 percent of the potential noncancer hazards associated with soil contact for the future on-site child resident. Arsenic, copper, and zinc are the noncancer hazard drivers for the consumption of homegrown produce by future residents at the Northwest Wastewater Lagoons; these metals were detected in surface soil (sediment) at this site.

Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, and the Pavement Perimeter Site is responsible for almost 90 percent of the total air pathway cancer risk to the future on-site adult resident. Inhalation of chromium dispersed from surface soils at the 3X Yard, the Drainage Ditch Site, the Northwest Wastewater Lagoons, the Southwest Wastewater Lagoon, and the Pavement Perimeter Site is responsible for approximately 90 percent of the cancer risk to the future on-site child resident. With the exception of ingestion of homegrown produce, no significant hazards are attributable to site-specific contaminants at the Southwest Wastewater Lagoon. There are no significant cancer risks attributable to this site. These latter sites, with the exception of the Pavement Perimeter Site, are also responsible for over 90 percent of the total noncancer air-pathway hazard to future on-site residents (adults and children). Ingestion of arsenic detected in SWMU-wide monitoring wells is responsible for over 90 percent of the total groundwater pathway risks to future on-site residents (adults and children).

7.10.3.2 *Ecological Risk Assessment*

7.10.3.2.1 ***Site Characterization.*** The ecological assessment for the Wastewater Lagoons included a survey of vegetation and wildlife, and a qualitative habitat evaluation. This assessment did not include collection of either vegetation or wildlife samples for analysis. Human activity at this site is frequent. The potential wildlife inhabitants include small mammals, birds, and several of the raptor species. It is unlikely that large mammals could have access to the wastewater lagoons because the area is enclosed with chain-link fencing. There is no indication that this area is a critical habitat for any endangered or threatened species. Species of vegetation include Russian thistle, shadscale, winterfat, big sagebrush, and bottlebrush squirreltail grass. Also, black-tailed jackrabbits, deer mice, and red-tailed hawks were observed at the Wastewater Lagoons.

The four lagoons at this site all contain water, and it is likely that more water accumulates in and possibly around the lagoons as the result of storm episodes and snow melt.

7.10.3.2.2 ***Chemicals of Potential Concern.*** The COPCs at the Wastewater Lagoons are presented in Table 7-62. While TPHC, nitrate, and uranium were not included in the human health risk assessment, they were all included as ecological COPCs because values do exist for ecological effects. Sulfate and chloride were not evaluated because of lack of TBVs.

Table 7-62. SWMU 13 Ecological Chemicals of Potential Concern at the Wastewater Lagoons, Phase II RFI

Contaminants	Where Detected
Metals	
Arsenic	Surface Water and Sediments
Beryllium	Sediments
Chromium	Sediments
Copper	Sediments
Mercury	Sediments
Nickel	Sediments
Uranium	Sediments and Surface Water
Zinc	Sediments
TPHCs	
TPHC	Surface Water
Anions	
Chloride	Sediments
Fluoride	Sediments
Nitrate	Surface Water
Sulfate	Surface Water
VOCs	
Acetone	Surface Water
SVOCs	
4-Methylphenol	Sediments

7.10.3.2.3 *Results of Risk Assessment*. Calculated potential HQs for Wastewater Lagoons 1, 2, and 3 are shown in Table 7-63 and those calculated for Lagoon 4 in Table 7-64. In both sets of data, total HIs for the American robin and the deer mouse exceed the target endpoint of 1. The indicated hazards are due to potential ingestion of arsenic, chromium, copper, nickel, and zinc in the sediments, plants, or invertebrates. All of the detects for these metals, except nickel, are within the range of background values detected at TEAD-S and, as such, are not likely to produce unacceptable risks to ecological receptors. See Table 5-2 for TEAD-S soil background values and Appendix H for HQs calculated on maximum background detects. Nickel concentrations and HQs are just above background values and unlikely to present a site-specific problem. All HQs calculated for the golden eagle and mule deer are negligible.

7.10.3.2.4 *Conclusions*. When compared to the TEAD-S background levels, calculated HQs are within the levels of uncertainty inherent in the risk assessment process. No adverse impacts to ecological receptors due to contaminants at the Wastewater Lagoon site are likely.

7.10.4 Conclusions and Recommendations

The COPCs at this site are radionuclides, metals, anions, traces of VOCs and SVOCs, and TPHCs. All available information indicates that the sludge and wastewater in all four of the lagoons is being contained within the lagoons, defining the lateral and vertical extent at these lagoons.

The human health risk assessment evaluated both the current and future use scenarios at this site. Results under the current use scenario indicate that the carcinogenic risk to the on-site worker and off-site resident is well below the State of Utah limit and the noncarcinogenic hazard to these receptors is also well below State of Utah criteria.

Under the future use scenarios, the cancer risk and the noncarcinogenic hazard to the on-site resident were both above State of Utah levels. However, the future on-site resident scenario is hypothetical and unlikely to occur; it was only included for completeness. The cancer risk to the future construction worker also exceeded 1E-06 at the Northwest Lagoons.

It is important to emphasize that the exposure point concentrations for air (vis-à-vis current worker and future residents) and for beef/milk used in the human health risk assessment were estimated as SWMU-wide and depot-wide (over TEAD-S) values, respectively. In so doing, it is possible to estimate an exposure to a receptor at a particular site despite the absence of site-specific chemicals in surficial soil. This occurs because it has been assumed that exposure can take place to chemicals originating from other sites within SWMU 13 and/or SWMU 17 via the air pathway and through consumption of homegrown beef and milk products. Similarly, the groundwater exposure point concentrations were also derived as a SWMU-wide average for each chemical. Therefore, to avoid misrepresenting the results of the risk assessment, it is

Table 7-63. *Hazard Quotients for Wastewater Lagoons 1, 2, and 3*

Analyte Name	Soil EPC (mg/kg)	Water EPC (mg/L)	Air EPC (mg/m3)	ABS	American Robin: Soil Ingestion	American Robin: Dermal Contact with Soil	American Robin: Dietary Ingestion	American Robin: Water Ingestion	American Robin: Total	Golden Eagle: Soil Ingestion	Golden Eagle: Dermal Contact with Soil	Golden Eagle: Dietary Ingestion	Golden Eagle: Water Ingestion	Golden Eagle: Total
ACET		0.140	NA	0 100	NA	NA	NA	ND	0	NA	NA	NA	ND	0
AS	36.500	0 130	ND	0.010	2.E+00	6.E-05	8.E-01	6 E-03	3.E+00	8 E-06	3 E-09	4 E-06	1 E-03	1 E-03
BE	1.160		ND	0.010	4.E-02	1 E-06	ND	NA	4 E-02	2 E-07	6 E-11	ND	NA	2 E-07
CL	630 000		ND	0.010	ND	ND	ND	NA	0	ND	ND	ND	NA	0
CR	37.600		ND	0 010	2.E+01	7 E-04	ND	NA	2.E+01	9 E-05	3.E-08	ND	NA	9 E-05
CU	33.400		ND	0.010	4.E-01	1 E-05	1 E+00	NA	2 E+00	2 E-06	6 E-10	1 E-05	NA	1 E-05
HG	0 364		ND	0.010	1 E-01	4.E-06	2 E-01	NA	3.E-01	5.E-07	2.E-10	4.E-06	NA	4.E-06
NI	35.400		ND	0.010	9 E-01	3 E-05	5 E-01	NA	1.E+00	4.E-06	1.E-09	2.E-06	NA	6 E-06
NIT		0.014	NA	0 010	NA	NA	NA	1 E-04	1.E-04	NA	NA	NA	1 E-05	1.E-05
SO4		63 000	NA	0 010	NA	NA	NA	ND	0	NA	NA	NA	ND	0
TPHC		0.570	NA	0 100	NA	NA	NA	3 E-03	3 E-03	NA	NA	NA	5.E-04	5 E-04
U	4 000	0.002	ND	0.010	2 E-01	8 E-06	ND	1.E-04	2 E-01	1 E-06	3.E-10	ND	2 E-05	2 E-05
ZN	131 000		ND	0 010	3.E+00	1 E-04	2 E+01	NA	2.E+01	2 E-05	5 E-09	2 E-04	NA	2 E-04
								HI Total	5.E+01				HI Total	2.E-03

Analyte Name	Deer Mouse: Soil Ingestion	Deer Mouse: Dermal Contact with Soil	Deer Mouse: Dietary Ingestion	Deer Mouse: Water Ingestion	Deer Mouse: Inhalation	Deer Mouse: Total	Mule Deer: Soil Ingestion	Mule Deer: Dermal Contact with Soil	Mule Deer: Dietary Ingestion	Mule Deer: Water Ingestion	Mule Deer: Total
ACET	NA	NA	NA	4.E-03	NA	4 E-03	NA	NA	NA	5.E-04	5.E-04
AS	9 E-01	6.E-04	2.E+00	1 E-01	ND	3 E+00	6 E-05	3.E-08	1 E-04	2 E-02	2 E-02
BE	1.E-03	1.E-06	ND	NA	ND	0	1.E-07	5.E-11	ND	NA	1.E-07
CL	ND	ND	ND	NA	ND	0	ND	ND	ND	NA	0
CR	2 E-01	1.E-04	ND	NA	ND	2.E-01	7 E-06	4 E-09	ND	NA	7 E-06
CU	5.E-02	3.E-05	5.E-01	NA	ND	5.E-01	3 E-06	2 E-09	3.E-05	NA	3 E-05
HG	1 E-02	6 E-06	8 E-02	NA	ND	9 E-02	5 E-07	3 E-10	5 E-06	NA	6 E-06
NI	1 E-02	9 E-06	3 E-02	NA	ND	4.E-02	8.E-07	4 E-10	3 E-06	NA	4 E-06
NIT	NA	NA	NA	2 E-04	NA	2 E-04	NA	NA	NA	3.E-05	3 E-05
SO4	NA	NA	NA	ND	NA	0	NA	NA	NA	ND	0
TPHC	NA	NA	NA	1 E-03	NA	1 E-03	NA	NA	NA	1.E-04	1 E-04
U	1.E-02	5.E-06	ND	2 E-04	ND	1 E-02	5.E-07	3 E-10	ND	2 E-05	3 E-05
ZN	4 E-02	3 E-05	8 E-01	NA	ND	9 E-01	3 E-06	1.E-09	4 E-05	NA	5 E-05
					HI Total	4 E+00				HI Total	2 E-02

Note —NA indicates pathway incomplete ND indicates parameters unavailable

Table 7-64. Hazard Quotients for Wastewater Lagoon 4

Analyte Name	Soil EPC (mg/kg)	Water EPC (mg/L)	Air EPC (mg/m3)	ABS	American Robin: Soil Ingestion	American Robin: Dermal Contact with Soil	American Robin: Dietary Ingestion	American Robin: Water Ingestion	American Robin: Total
4MP	0 79		3.26E-02	0.100	ND	ND	ND	NA	0
ACET		0 094	NA	0 100	NA	NA	NA	ND	0
AS		0 106	NA	0.010	NA	NA	NA	5 E-03	5.E-03
CR	29 8		ND	0 010	2 E+01	6 E-04	ND	NA	2 E+01
CU	27.7		ND	0 010	4 E-01	1 E-05	9 E-01	NA	1.E+00
F	18.6		ND	0.010	ND	ND	ND	NA	0
NIT		0.026	NA	0.010	NA	NA	NA	1.E-04	1 E-04
SO4		33.000	NA	0.010	NA	NA	NA	ND	0
TPHC		0.820	NA	0 100	NA	NA	NA	4 E-03	4 E-03
U	3 1	0 078	ND	0.010	2.E-01	1.E-05	ND	4 E-03	2.E-01
ZN	127 0		ND	0.010	3.E+00	1 E-04	2 E+01	NA	2 E+01
								HI Total	4.E+01

Analyte Name	Golden Eagle: Soil Ingestion	Golden Eagle: Dermal Contact with Soil	Golden Eagle: Dietary Ingestion	Golden Eagle: Water Ingestion	Golden Eagle: Total
4MP	ND	ND	ND	NA	0
ACET	NA	NA	NA	ND	0
AS	NA	NA	NA	8 E-04	8 E-04
CR	7.E-05	2 E-08	ND	NA	7 E-05
CU	2 E-06	5.E-10	1.E-05	NA	1 E-05
F	ND	ND	ND	NA	0
NIT	NA	NA	NA	2 E-05	2E-05
SO4	NA	NA	NA	ND	0
TPHC	NA	NA	NA	7E-04	7 E-04
U	8 E-07	3 E-10	ND	7E-04	7 E-04
ZN	1.E-05	5 E-09	2 E-04	NA	2 E-04
				HI Total	2 49E-03

Analyte Name	Deer Mouse: Soil Ingestion	Deer Mouse: Dermal Contact with Soil	Deer Mouse: Dietary Ingestion	Deer Mouse: Water Ingestion	Deer Mouse: Inhalation	Deer Mouse: Total
4MP	2.E-04	2 E-06	ND	NA	1 E-03	2.E-03
ACET	NA	NA	NA	2 E-03	NA	2 E-03
AS	NA	NA	NA	1 E-01	NA	1.E-01
CR	1 E-01	1 E-04	ND	NA	ND	1 E-01
CU	4 E-02	3.E-05	4 E-01	NA	ND	4 E-01
F	1 E-01	7.E-05	ND	NA	ND	1.E-01
NIT	NA	NA	NA	4 E-04	NA	4 0-04
SO4	NA	NA	NA	ND	NA	0
TPHC	NA	NA	NA	2 E-03	NA	2 E-03
U	1.E-02	4.E-06	ND	6 E-03	ND	1 E-02
ZN	4 E-02	3.E-05	8 E-01	NA	ND	8.E-01
					HI Total	2 E+00

Analyte Name	Mule Deer: Soil Ingestion	Mule Deer: Dermal Contact with Soil	Mule Deer: Dietary Ingestion	Mule Deer: Water Ingestion	Mule Deer: Total
4MP	2 E-08	8 E-11	ND	3E-04	2.E-08
ACET	NA	NA	NA	3E-04	3 E-04
AS	NA	NA	NA	2E-02	2 E-02
CR	5 E-06	3.E-09	ND	NA	5.E-06
CU	3 E-06	1 E-09	2 E-05	NA	3 E-05
F	7.E-06	4.E-09	ND	NA	7.E-06
NIT	NA	NA	NA	1 E-04	6 E-05
SO4	NA	NA	NA	ND	0
TPHC	NA	NA	NA	2 E-04	2 E-04
U	4.E-07	2 E-10	ND	1 E-03	8 E-04
ZN	3.E-06	1 E-09	4 E-05	NA	4 E-05
				HI Total	2 E-02

Note —NA indicates pathway incomplete. ND indicates parameters unavailable important to distinguish the portion of the risk and hazard estimates that are due to site-specific contamination from that due to SWMU-wide and/or depot-wide contributions.

Recommendations for each site within both lagoon sites will be made pursuant to the provisions of Section R315-101-6 of the Utah Hazardous Waste Rules. Since the groundwater medium at SWMU 13 is already being recommended to the CMS (Site Management Plan), the site-specific recommendations will be based on the results of the risk assessment without the groundwater contribution.

The ecological assessment indicated that, although some calculated HQs for the American robin and the deer mouse exceed target endpoints, they compare favorably to background levels. Hence, there are no adverse impacts to ecological receptors due solely to contaminants at this site.

All available data were used to determine whether past operations at the Wastewater Lagoons Site has created an environment that could result in any adverse effects to human health or to the local ecology. Results from the human health and ecological risk assessments indicate that no adverse effects will occur under any of the scenarios evaluated except the future on-site resident from the human health risk assessment. The chloride and the radionuclides (gross alpha and gross beta) that were detected at this site could not be quantitatively evaluated under the human health risk assessment due to the lack of USEPA Health Criteria. However, it is likely that these detections are natural occurrences and do not represent a contamination problem at this site. A number of tentatively identified compounds were detected in sediment in the Northwest Wastewater Lagoons. The vast majority of these are hydrocarbons that would have been included in the TPHC analyses.

At the Northwest Wastewater Lagoons, even if that portion of the risk and hazard contributed by SWMU-wide chemicals (air and groundwater) was removed as described above, the criterion in item (d) of R315-101-6 would be satisfied. This is because the risk under current land use would be less than 1E-04 but greater than 1E-06 under on-site residential land use due to site-specific chemicals in soil. Therefore, this site should be carried through the CMS but not necessarily include provisions for corrective action. Instead, the CMS should include management activities such as monitoring, deed notations, site security, etc. At the Southwest Wastewater Lagoon, the hazard exceeded 1.0 for the future child resident.

7.11 GROUNDWATER

The results of the soil sampling, described in Sections 7.2 through 7.10, and the groundwater chemistry data, described in previous sections of this report, are the basis for the following discussion of specific analytes. Section 7.1 of this report gives a detailed description of the geology and hydrology of the surficial aquifer characteristics underlying SWMU 13, including groundwater elevation data, flow directions, and hydraulic conductivities. A regional overview of the geology and surficial aquifer characteristics is summarized in section 3.0 of this report. Previous investigators have provided additional information regarding the TEAD-S geology, hydrology, and geochemistry.

EA Engineering, Science and Technology installed three wells during the summer of 1986, and collected groundwater samples from only one of the wells. Explosives, ABPs, VOCs, SVOCs, metals, inorganics, and gross alpha/beta were analyzed and the results are discussed in detail in Section 7.2.1.

Additional work by Weston (1991) described the results of groundwater sampling and analysis from their wells and wells installed by ERTEC and EA. In May and June of 1991, Rust E&I installed 14 additional wells at the CAMDS facility during the initial field effort. Subsequently, groundwater samples were collected from all 30 wells associated with the CAMDS facility and analyzed for organic compounds (agent breakdown products, explosives, total petroleum hydrocarbons, SVOCs, and VOCs) and inorganic compounds (anions, radionuclides, and metals). The 1993 field effort included the installation of five more wells near the CAMDS facility in August 1993. Groundwater samples were collected from all 35 wells in August and September 1993, and were analyzed for the same chemicals as the 1991 samples listed above.

Section 7.11.1 describes the Phase II groundwater sampling results and also summarizes the data reported in the 1991 Weston Report, which represents the most recent data collected prior to the Rust E&I sampling events. The nature and extent of the detected contaminants are discussed in Section 7.11.2.

7.11.1 Previous Groundwater Sampling and Phase II RFI Sampling Results

Six borings drilled by Weston were converted into monitoring wells S-25-88, S-26-88, S-27-88, S-28-88, S-29-88, and S-30-88. After well development, groundwater samples were collected and analyzed. Monitoring wells previously installed by ERTEC (S-1 and S-3) and EA (S-CAM-1 and S-CAM-2) were also sampled by Weston (1991). Well S-3 is located approximately 3,600 feet north (cross-gradient) from the CAMDS facility, and any compounds detected in groundwater were not considered to be the result of operations of CAMDS. All of these groundwater samples were analyzed for VOCs, SVOCs, explosives, agent breakdown products, petroleum hydrocarbons, metals, anions, and radionuclides. Analytical results are presented in Table 7-6, which was taken directly from the Weston 1991 Report.

The primary VOCs detected in 5 of the 10 wells sampled (S-CAM-1, S-CAM-2, S-25-88, S-26-88, S-27-88, S-28-88) were benzene, carbon tetrachloride, and trichloroethene. Wells S-CAM-1, S-25-88, and S-28-88 contained benzene concentrations, which ranged from 4.51 μg/L (S-25-88) to 41.9 μg/L (S-CAM-1). Carbon tetrachloride was detected in only two wells, S-25-88 (69 μg/L) and S-27-88 (17 μg/L). Trichloroethene was detected in samples collected from wells S-25-88, S-26-88, and S-28-88 in concentrations ranging from 0.801 μg/L (S-26-88) to 9.01 μg/L (S-25-88).

Wells S-CAM-1, S-CAM-2, S-25-88, S-26-88, S-27-88, S-28-88, and S-30-88 contained SVOCs. Total SVOC concentrations ranged from 12 μg/L (S-30-88) to 634.7 μg/L (S-CAM-2). Of these SVOCs, naphthalene (or alkylated naphthalene, no analytical distinction was made as shown in Table 7-6) was the most prevalent, detected in each of the wells containing SVOCs with the exception of Well S-30-88. Naphthalene was detected in these wells in concentrations ranging from 17 μg/L (S-28-88) to 334 μg/L (S-CAM-2). Benzene (along with benzene derivatives) was detected in Wells S-CAM-2, S-25-88, S-26-88, S-27-88, and S-28-88 in concentrations ranging from 49 μg/L (S-26-88) to 151 μg/L (S-27-88). (Because of its molecular structure, benzene is sometimes detected using SVOC and VOC analytical methods.) Other SVOCs associated with samples collected from these wells include alkane, benzene acetic acid, bromacil, decane, dihydro-methyl-IH-indene, dimethyl benzoic acid, naphthalene acetic acid, and propanoic acid.

Explosives were detected in samples collected from S-CAM-1, S-CAM-2, S-25-88, S-26-88, S-28-88, S-29-88, S-30-88, and S-3. The most common explosive contained in these samples was 2,4,6-trinitrotoluene, which was detected in concentrations ranging from 1.65 μg/L (S-25-88) to 30 μg/L (S-CAM-1). Two other explosives were detected from S-26-88 and S-28-88: 0.88 μg/L 2,4-dinitrotoluene and 9.8 μg/L 1,3,5-trinitrobenzene, respectively.

The chemical agent breakdown product IMPA was detected in Wells S-CAM-1, S-CAM-2, S-27-88, S-28-88, S-29-88, S-30-88, S-1, and S-3. Concentrations ranged from 11 μg\L (S-30-88) to 30 μg/L (S-CAM-2).

Petroleum hydrocarbons were detected in samples collected from all 10 wells in concentrations ranging from 560 μg/L (S-3) to 190,000 μg/L (S-CAM-1). Well S-CAM-1 was not sampled prior to this time because of the presence of free-phase hydrocarbons during the sampling round completed by EA in 1988.

Total and/or dissolved arsenic, copper, lead, and zinc were present in all 10 wells sampled. Arsenic concentrations were generally an order of magnitude higher compared to the other metals. Silver and antimony (total and/or dissolved) were detected in all 10 wells with the exception of S-1; total nickel was present in samples collected from all wells with the exception of S-3 (dissolved nickel was detected in S-CAM-1, S-CAM-2, S-25-88, S-26-88, and S-27-88 only). Total beryllium was detected only in S-28-88, S-30-88, and S-1; total cadmium and dissolved selenium were found exclusively in S-30-88 and S-27-88. Total chromium and dissolved chromium were detected in only one well, S-28-88, in the highest concentration of any metal analyzed (1,600 and 1,900 μg/L, respectively).

Chloride concentrations ranged from 7,830 mg/L (S-30-88) to 237 mg/L (S-26-88) in all 10 wells, while sulfate was detected in the same wells in concentrations from 140 mg/L (S-1) to 4,800 mg/L (S-27-88 and S-28-88). The highest anion concentration was associated with S-30-88, which contained 27,000 mg/L nitrate/nitrite. Well S-1 also contained smaller concentrations of bromide and fluoride (0.128 and 0.964 mg/L, respectively).

Samples collected from Well S-30-88 contained the highest levels of gross alpha and gross beta. Gross alpha was also detected in CAM-2, S-25-88, S-26-88, S-27-88, and S-1. Wells S-CAM-1, S-CAM-2, S-26-88, S-27-88, S-28-88, S-29-88, and S-1 also contained gross beta. Uranium was detected in all 10 wells, with the highest concentration in Well S-27-88.

Rust E&I, 1991 and 1993. Groundwater samples were collected for chemical analysis from the 30 existing monitoring wells associated with SWMU 13 in May/June 1991. Five additional groundwater monitoring wells were installed and subsequently sampled with the 30 monitoring wells during August/September 1993. The analyte suite for both sampling events consisted of agent breakdown products, anions, explosives, metals, radionuclides, SVOCs, TPHCs, and VOCs.

The data from both of the sampling events were screened as described in Section 6.0. Comparing the two data sets provided inconsistent results as shown in Table 7-65. This table provides information pertaining to the wells that contained detectable concentrations of the contaminants, the maximum and minimum concentrations, and the CRL (where available) for both the 1991 and 1993 data.

The data sets were analyzed by two different USAEC-approved laboratories (see Section 6.0). In some instances, there were two different analytical methods used for the detection of the same analytes. In some cases, the two methods provided drastically different results. Some contaminants (i.e., chromium and silver) were not detected in any of the wells in 1993 after appearing to be widespread according to the 1991 data. Fluoroacetic acid was detected in 18 wells in 1991 but not in any of the wells in 1993. The laboratory analyzing the 1991 groundwater samples used a method for detecting fluoroacetic acid that was not capable of distinguishing it from formic acid, which is a naturally occurring organic acid that is a breakdown product of various plants. As a result, all samples that indicated the presence of fluoroacetic acid in 1991 are considered suspect. It is also important to note that during the 1991 sampling event, an insufficient number of duplicate samples and field blanks were collected to allow thorough comparisons of groundwater data to QC samples and proper data validation.

Four contaminants detected in 1991 (1,2-dimethylbenzene, dimethylnaphthalene, trimethylnaphthalene, and methylnaphthalenes) were not analyzed for in 1993. These secondary fuel-related compounds were detected in 1991 during the analysis for SVOCs. An additional 16 contaminants that were detected in at least one well in 1991 were not detected in any of the same wells in 1993 (Table 7-65).

Because of the discrepancies among the results of the two sampling events, it was necessary to use the most defensible data set. The 1993 data provides the most defensible data according to the USAEC and USEPA QA/QC guidelines. As a result, only the 1993 data were used for the quantitative risk assessment calculations as outlined in the USEPA publication on risk assessment guidance (USEPA, 1980).

The remainder of this section and Section 7.11.2 present data related exclusively to the contaminants detected during the 1993 sampling event. All of the 1993 data are presented in Appendix D and summarized in Table 7-66 and in Figures 7-40 through 7-60. Contaminants detected in at least five wells are represented by individual concentration contour maps, while the remaining groundwater contaminants are included in summary figures for each analyte group (i.e., SVOCs, VOCs, etc.). Groundwater analytical sampling data from the 1991 sampling event are also included in Appendix D.

Table 7-65. SWMU 13 Comparison of 1991 and 1993 Groundwater Results, Phase II RFI

	1993 DATA				1991 DATA			
Contaminant	**Number of Wells with Detects**	**Maximum Concentration Detected (μg/L)**	**Minimum Concentration Detected (μg/L)**	**Detection Limit[a] (μg/L)**	**Number of Wells with Detects**	**Maximum Concentration Detected (μg/L)**	**Minimum Concentration Detected (μg/L)**	**Detection Limit[a] (μg/L)**
Agent Breakdown Products								
Fluoroacetic acid (FC2A)	0	—	—	80	18	1,040	104	259
Isopropylmethyl Phosphonic Acid (IMPA)	4	4,000	510	100	12	3,000	26.1	19.6
Anions								
Bromide	11	8,800	4,500	407	10	6,500	1,700	50
Chloride	15	13,000,000	4,300,000	278	13	23,000,000	4,200,000	273
Fluoride	14	38,000	1,400	153	2	100,000	77,000	71
Nitrate	NA[b]	NA	NA	NA	20	40,000	30.8	24.3
Nitrite	NA	NA	NA	NA	0	—	—	28.3
Nitrate/Nitrite (Non Specific)	24	16,000	13.0	10.0	NA	NA	NA	NA
Sulfate	35	6,800,000	220,000	175	30	8,100,000	290,000	137
Explosives								
1,3-Dinitrobenzene	2	0.958	0.914	0.458	2	2.9	0.993	0.1
1,3,5-Trinitrobenzene	2	4.9	1.10	0.21	4	8.62	0.46	0.388
2,4-Dinitrotoluene	2	9.22	2.85	0.397	1	20.0	—	1.16
2,6-Dinitrotoluene	3	24.4	2.49	0.6	0	—	—	1.11

Table 7-65. *SWMU 13 Comparison of 1991 and 1993 Groundwater Results, Phase II RFI (continued)*

Contaminant	1993 DATA				1991 DATA			
	Number of Wells with Detects	Maximum Concentration Detected (µg/L)	Minimum Concentration Detected (µg/L)	Detection Limit[a] (µg/L)	Number of Wells with Detects	Maximum Concentration Detected (µg/L)	Minimum Concentration Detected (µg/L)	Detection Limit[a] (µg/L)
2,4,6-Trinitrotoluene	3	7.3	1.47	0.426	4	16.0	2.74	0.767
3-Nitrotoluene	1	19.0	—	2.9	NA	NA	NA	NA
HMX	1	17.0	—	0.533	0	—	—	0.869
Nitrobenzene	2	4.41	3.08	0.682	0	—	—	1.54
RDX	2	33.0	12.7	0.416	2	12.0	8.6	0.617
Tetryl	0	—	—	0.631	4	19.0	1.25	0.191
Metals								
Arsenic	23	1,100	56.5	2.35	9	800	73.1	43.8
Beryllium	1	12.0	—	1.12	0	—	—	0.341
Cadmium	5	18.6	7.64	6.78	0	—	—	2.67
Chromium	0	—	—	16.8	9	140	27.4	4.47
Selenium	4	420	44.6	2.53	0	—	—	104
Silver	0	—	—	10.0	14	1,000	35.2	32.0
Thallium	6	421	164	125	NA	NA	NA	NA
Radionuclides								
Alpha Gross	30	92.0	4.1	17	27	480	7.0	1.6
Beta Gross	34	200	17.0	NDL[c]	27	2,700	30	10
Total Uranium	35	130	2.2	NDL	NA	NA	NA	NA
Uranium	NA	NA	NA	NA	30	90.0	7.0	NDL

Table 7-65. SWMU 13 Comparison of 1991 and 1993 Groundwater Results, Phase II RFI (continued)

Contaminant	1993 DATA Number of Wells with Detects	1993 DATA Maximum Concentration Detected (μg/L)	1993 DATA Minimum Concentration Detected (μg/L)	1993 DATA Detection Limit[a] (μg/L)	1991 DATA Number of Wells with Detects	1991 DATA Maximum Concentration Detected (μg/L)	1991 DATA Minimum Concentration Detected (μg/L)	1991 DATA Detection Limit[a] (μg/L)
Semi-Volatile Organic Compounds								
2-Chloronaphthalene	1	5.8	—	2.6	0	—	—	9.6
2-Methylnaphthalene	4	1,000	300	1.3	6	8,000	65.0	10
Acenaphthene	3	110	19.0	5.8	4	66.0	37.0	14.0
Acenaphylene	0	—	—	5.1	1	300	—	19.0
Anthracene	3	230	11.0	5.2	1	500	—	20.0
Bis(2-Ethylhexyl) Phthalate	2	26.0	12.0	7.7	0	—	—	32.0
Bromodichloromethane	0	—	—	1.0	1	3.2	—	1.34
Bromacil	4	50.0	7.70	2.9	NA	NA	NA	NA
Dimethylnaphthalene	NA	NA	NA	NA	7	10,000	20	NDL
Fluorene	4	200	90.0	9.2	1	400	—	10
Methylnaphthalene	NA	NA	NA	NA	7	600	30	NDL
Naphthalene	7	400	10	0.5	5	3,000	96	17.0
Phenanthrene	5	1,000	55.0	9.9	5	4,000	170	22.0
Trimethynapyhthalene	NA	NA	NA	NA	3	700	200	NDL

Table 7-65. SWMU 13 Comparison of 1991 and 1993 Groundwater Results, Phase II RFI (continued)

	1993 DATA				1991 DATA			
Contaminant	Number of Wells with Detects	Maximum Concentration Detected (µg/L)	Minimum Concentration Detected (µg/L)	Detection Limit[a] (µg/L)	Number of Wells with Detects	Maximum Concentration Detected (µg/L)	Minimum Concentration Detected (µg/L)	Detection Limit[a] (µg/L)
Total Petroleum Hydrocarbons								
Total Petroleum Hydrocarbons	NA	NA	NA	NA	5	875,000	6,160	1070
Total Petroleum Hydrocarbons/Diesel	4	260,000	560	100	NA	NA	NA	NA
Total Petroleum Hydrocarbons/Gas	4	48,000	950	100	NA	NA	NA	NA
Volatile Organic Compounds								
1,1,1-Trichloroethane	0	—	—	1.0	6	1.56	0.256	0.179
1,1,2-Trichloroethane	0	—	—	1.0	1	0.084	—	0.066
1,1-Dichloroethane	0	—	—	1.0	3	0.324	0.168	0.269
1,1-Dichloroethylene	0	—	—	1.0	2	0.292	0.179	0.256
1,2-Dichlorobenzene	0	—	—	1.2	9	78.0	0.678	0.548
1,2-Dimethylbenzene	NA	NA	NA	NA	6	71.0	2.23	0.374
1,3-Dimethylbenzene	2	19.0	2.5	1.0	8	120	0.266	0.167
1,4-Dichlorobenzene	0	—	—	1.5	2	0.863	0.81	0.215
Benzene	8	33.0	1.0	1.0	9	98.0	0.295	0.128
Chloromethane	0	—	—	1.2	2	1.82	0.99	0.733
Chloroform	0	—	—	1.0	11	25.0	0.842	0.727

Table 7-65. SWMU 13 Comparison of 1991 and 1993 Groundwater Results, Phase II RFI (continued)

Contaminant	1993 DATA				1991 DATA			
	Number of Wells with Detects	Maximum Concentration Detected (µg/L)	Minimum Concentration Detected (µg/L)	Detection Limit[a] (µg/L)	Number of Wells with Detects	Maximum Concentration Detected (µg/L)	Minimum Concentration Detected (µg/L)	Detection Limit[a] (µg/L)
Dibromochloromethane	0	—	—	1.0	1	2.44	—	0.383
Ethylbenzene	4	30.0	2.0	1.0	4	6.0	1.36	0.317
Methylene Chloride	0	—	—	1.0	1	10.6	—	2.38
Toluene	4	29.0	1.4	1.0	9	1.24	0.36	0.0362
Trichloroethylene	4	6.0	1.2	1.0	5	10.0	0.758	0.366
Xylene	5	270	2.7	2.0	NA	NA	NA	NA

[a]Detection limit equals the CRL, SRL, or MDL where applicable.
[b]NA = Not analyzed.
[c]NDL = No detection limit listed.

Table 7-66. SWMU 13 Groun... ...ter Sample Results, Phase II RFI[a]

Well Number	Agent Breakdown Products (µg/L)	Anions (µg/L)					Explosives (µg/L)								
	Isopropyl Methylphosphonic Acid (IMPA)	Bromide (BKGD)[b]-1,500	Chloride (BKGD) - 4,100,000	Fluoride (BKGD) - 14,000	Nitrite, Nitrate - Nonspecific	Sulfate	1,3,5-Trinitrobenzene	1,3-Dinitrobenzene	2,4,6-Trinitrotoluene	2,4-Dinitrotoluene	2,6-Dinitrotoluene	3-Ninitrotoluene	HMX	RDX	Nitrobenzene
S-1	ND[c]	ND	DS	DS	ND	300,000	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-103-93	ND	6,600	5,600,000	21,000	4,400	4,300,000	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-104-93	ND	ND	6,600,000	DS	ND	3,500,000	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-105-93	1,000	ND	5,500,000	DS	DS	1,700,000	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-106-93	4,000	4,600	DS	DS	410	1,200,000	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-107-93	ND	ND	DS	DS	DS	730,000	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-25-88	510	4,500	DS	DS	DS	2,400,000	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-26-88	ND	DS[d]	DS	DS	2,900	1,700,000	ND	ND	ND	ND	2.49	19	ND	ND	4.41
S-27-88	ND	5,100	5,800,000	18,000	5,800	4,900,000	ND	0.914	ND	ND	ND	ND	ND	12.7	ND
S-28-88	ND	4,500	DS	DS	DS	2,500,000	ND	ND	1.47	ND	ND	ND	ND	33	ND
S-29-88	ND	ND	DS	DS	1,500	4,200,000	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-30-88	ND	ND	4,600,000	16,000	550	4,900,000	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-54-90	ND	ND	8,900,000	25,000	250	6,000,000	1.1	ND	2.5	2.85	ND	ND	ND	ND	3.08
S-55-90	ND	ND	11,000,000	27,000	13,000	4,100,000	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-56-90	ND	ND	13,000,000	38,000	DS	6,300,000	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-57-90	ND	ND	11,000,000	28,000	78.9	5,300,000	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-58-90	ND	7,400	4,400,000	14,000	157	1,700,000	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-59-90	ND	8,800	DS	DS	ND	870,000	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-60-90	ND	7,100	DS	DS	ND	930,000	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-76-91	ND	ND	5,100,000	17,000	1,100	3,700,000	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-77-91	ND	5,600	4,300,000	DS	29.9	1,300,000	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-78-91	ND	ND	9,200,000	23,000	750	5,100,000	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-79-91	ND	5,100	DS	DS	24.3	1,300,000	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-80-91	ND	ND	DS	DS	3,500	220,000	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-81-91	2,400	ND	DS	DS	2,700	730,000	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-82-91	ND	ND	DS	16,000	ND	3,500,000	ND	ND	7.3	9.22	ND	ND	ND	ND	ND
S-83-91	ND	ND	4,600,000	18,000	1,100	6,000,000	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-84-91	ND	ND	6,100,000	14,000	DS	2,000,000	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-85-91	ND	4,900	DS	DS	13	960,000	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-86-91	ND	ND	DS	14,000	16,000	6,800,000	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-87-91	ND	ND	DS	DS	12,000	1,200,000	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-91-91	ND	ND	DS	DS	153	850,000	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-92-91	ND	ND	DS	DS	670	880,000	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-CAM-1	ND	ND	DS	DS	1,200	2,900,000	ND	0.958	ND	ND	24.4	ND	ND	ND	ND
S-CAM-2	ND	ND	DS	DS	510	150,000	4.9	ND	ND	ND	6.81	ND	17	ND	ND
S-103-93 Dup	ND	ND	5,900,000	22,000	4,500	4,500,000	--[e]	ND	ND	ND	ND	ND	ND	ND	ND

See footnotes on last page.

Table 7-66. SWMU 13 Ground[illegible]er Sample Results, Phase II RFI[a] (continued)

Well Number	TPHC (µg/L) Total Petroleum Hydrocarbons, Diesel Fraction	TPHC (µg/L) Total Petroleum Hydrocarbons, Gas Fraction	VOCs (µg/L) 1,3-Dimethylbenzene	VOCs (µg/L) Benzene	VOCs (µg/L) Ethylbenzene	VOCs (µg/L) Toluene	VOCs (µg/L) Trichloroethylene	VOCs (µg/L) Xyelene
S-1	--	ND	ND	ND	ND	ND	ND	ND
S-103-93	ND	ND	ND	ND	ND	ND	ND	ND
S-104-93	ND	ND	ND	ND	ND	ND	ND	ND
S-105-93	--	ND	ND	ND	ND	ND	ND	ND
S-106-93	ND	ND	ND	ND	ND	ND	ND	ND
S-107-93	ND	ND	ND	ND	ND	ND	ND	ND
S-25-88	560	ND	2.5	4.1	ND	ND	4.2	4.2
S-26-88	25,000	3,100	ND	ND	ND	6.1	ND	25
S-27-88	260,000	ND	ND	5.9	2.0	1.4	ND	66
S-28-88	--	48,000	19	5.9	30	29	ND	270
S-29-88	--	ND	ND	1.0	ND	ND	ND	ND
S-30-88	--	ND	ND	ND	ND	ND	ND	ND
S-54-90	ND	ND	ND	ND	ND	ND	ND	ND
S-55-90	--	ND	ND	1.0	ND	ND	1.2	2.7
S-56-90	ND	ND	ND	ND	ND	ND	ND	ND
S-57-90	--	ND	ND	ND	ND	ND	ND	ND
S-58-90	--	ND	ND	ND	ND	ND	ND	ND
S-59-90	--	ND	ND	ND	ND	ND	ND	ND
S-60-90	--	ND	ND	ND	ND	ND	ND	ND
S-76-91	--	ND	ND	ND	ND	ND	6	ND
S-77-91	--	ND	ND	ND	ND	ND	ND	ND
S-78-91	--	ND	ND	ND	ND	ND	2.6	ND
S-79-91	--	ND	ND	ND	ND	ND	ND	ND
S-80-91	--	ND	ND	ND	ND	ND	ND	ND
S-81-91	--	ND	ND	ND	ND	ND	ND	ND
S-82-91	--	950	ND	ND	ND	ND	ND	ND
S-83-91	--	ND	ND	4.0	ND	ND	ND	ND
S-84-91	--	ND	ND	ND	ND	ND	ND	ND
S-85-91	--	ND	ND	ND	ND	ND	ND	ND
S-86-91	--	ND	ND	ND	ND	ND	ND	ND
S-87-91	ND	ND	ND	ND	ND	ND	ND	ND
S-91-91	--	ND	ND	ND	ND	ND	ND	ND
S-92-91	--	ND	ND	ND	ND	ND	ND	ND
S-CAM-1	--	11,000	ND	33	24	5.5	ND	ND
S-CAM-2	45,000	ND	ND	28	3.0	ND	ND	ND
S-103-93-Dup	ND	ND	ND	ND	ND	ND	ND	ND

See footnotes on last page.

Table 7-66. SWMU 13 Groundwater Sample Results, Phase II RFI[a] (continued)

	Metals (µg/L)					Radionuclides (µg/L)			Semi-VOCs (µg/L)								
Well Number	Arsenic (BKGD) - 50.0	Beryllium (BKGD) - 5.0	Cadmium (BKGD) - 4.01	Selenium (BKGD) - 36.0	Thallium (BKGD) - 6.99	Gross Alpha	Gross Beta	Total Uranium	2-Chloronaphthalene	2-Methylnaphthalene	Acenephthene	Anthracene	Bis (2-Ethylhexyl) Phthalate	Bromacil	Fluorene	Naphthalene	Phenanthrene
S-1	170	ND	ND	ND	ND	22	29	14	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-103-93	DS	DS	ND	70.6	ND	40	73	37	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-104-93	111	DS	ND	DS	ND	9.4	97	23	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-105-93	88.6	ND	ND	ND	186	92	140	29	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-106-93	58.1	ND	ND	ND	ND	ND	27	16	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-107-93	DS	ND	ND	ND	ND	4.1	28	2.2	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-25-88	1,100	ND	ND	ND	ND	22	100	49	ND	ND	ND	ND	ND	50	ND	ND	ND
S-26-88	240	ND	ND	ND	ND	31	45	45	ND	ND	ND	11	ND	ND	120	30	ND
S-27-88	1,100	ND	ND	58.3	ND	45	150	130	5.8	310	19	ND	ND	15	ND	200	110
S-28-88	720	ND	ND	ND	ND	28	21	58	ND	300	ND	40	ND	ND	200	230	55
S-29-88	500	ND	ND	ND	ND	35	100	44	ND	ND	ND	ND	ND	34	ND	400	1,000
S-30-88	81	DS	9.16	ND	164	ND	ND	53	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-54-90	DS	DS	ND	DS	ND	33	170	40	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-55-90	DS	DS	11.4	420	287	23	82	32	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-56-90	220	DS	18.6	ND	421	77	120	12	ND	ND	ND	ND	12	ND	ND	ND	ND
S-57-90	300	ND	11.1	DS	ND	15	200	70	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-58-90	DS	12	ND	ND	194	ND	130	15	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-59-90	DS	ND	ND	ND	ND	33	70	14	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-60-90	DS	ND	ND	ND	ND	9.2	57	13	ND	ND	ND	ND	26	ND	ND	ND	ND
S-76-91	190	ND	ND	ND	ND	17	110	55	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-77-91	56.5	ND	ND	ND	ND	16	42	17	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-78-91	73.7	ND	7.64	DS	ND	16	130	47	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-79-91	DS	ND	ND	ND	ND	30	57	17	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-80-91	DS	ND	ND	DS	ND	17	17	7.7	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-81-91	720	ND	ND	ND	ND	16	28	24	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-82-91	320	ND	ND	ND	ND	74	130	75	ND	ND	ND	ND	ND	ND	ND	10	ND
S-83-91	DS	DS	ND	ND	ND	61	130	70	ND	ND	ND	ND	ND	7.7	ND	ND	ND
S-84-91	DS	DS	ND	ND	174	ND	19	22	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-85-91	67.8	ND	ND	ND	ND	26	84	15	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-86-91	100	ND	ND	44.6	ND	92	96	94	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-87-91	70.3	ND	ND	DS	ND	10	30	28	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-91-91	118	ND	ND	ND	ND	ND	48	16	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-92-91	DS	ND	ND	DS	ND	12	55	14	ND	ND	ND	ND	ND	ND	ND	ND	ND
S-CAM-1	870	ND	ND	ND	ND	24	96	47	ND	1,000	110	230	ND	ND	140	200	600
S-CAM-2	500	ND	ND	DS	ND	66	59	24	ND	900	75	ND	ND	ND	90	200	400
S-103-93-Dup	--	--	--	--	--	31	78	39	ND	ND	ND	ND	ND	ND	ND	ND	ND

See footnotes on last page.

[a]Only detected contaminants are included in this table. A comprehensive listing of all of the data is present in Appendix D.
[b]Bkgd=Background value for specified analyte.
[c]ND=Analyte not detected at or above the CRL, SRL, or MDL.
[d]DS=Data screened out as described in Section 6.
[e]-- = Analysis not performed.

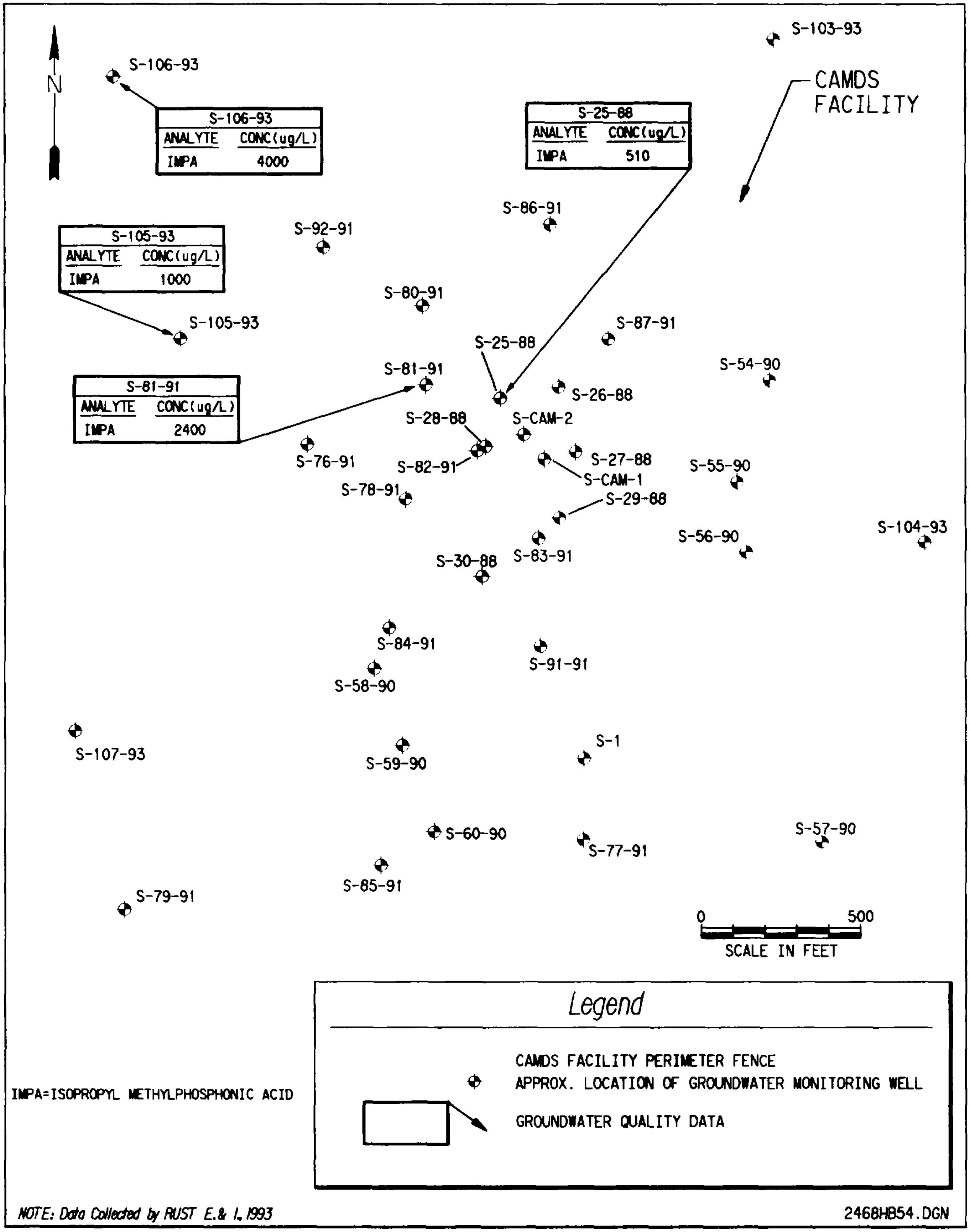

Figure 7-40. SWMU 13 Contaminant Distribution Map for IMPA in Groundwater, Phase II RFI

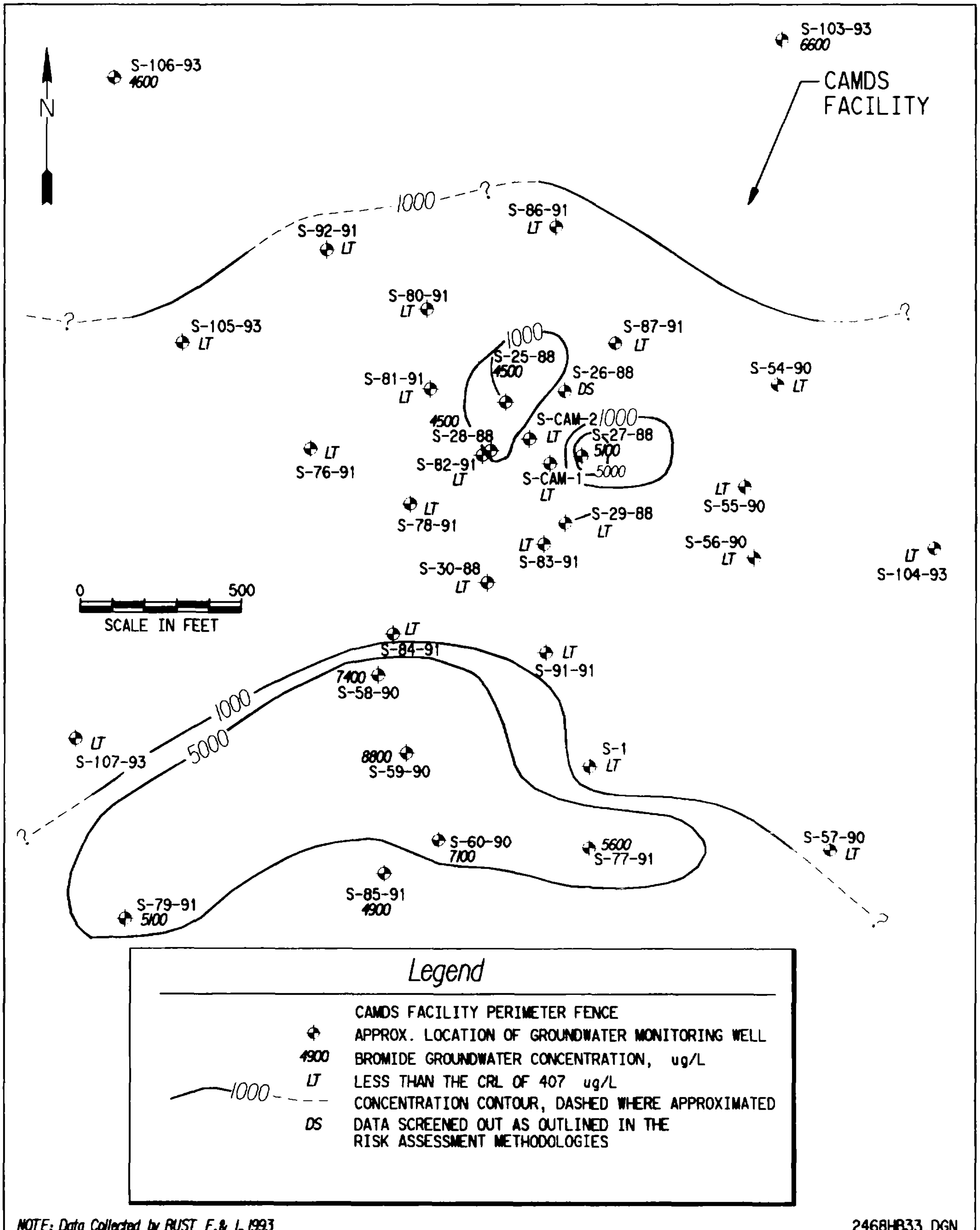

Figure 7-41. SWMU 13 Contaminant Distribution Map for Bromide in Groundwater, Phase II RFI

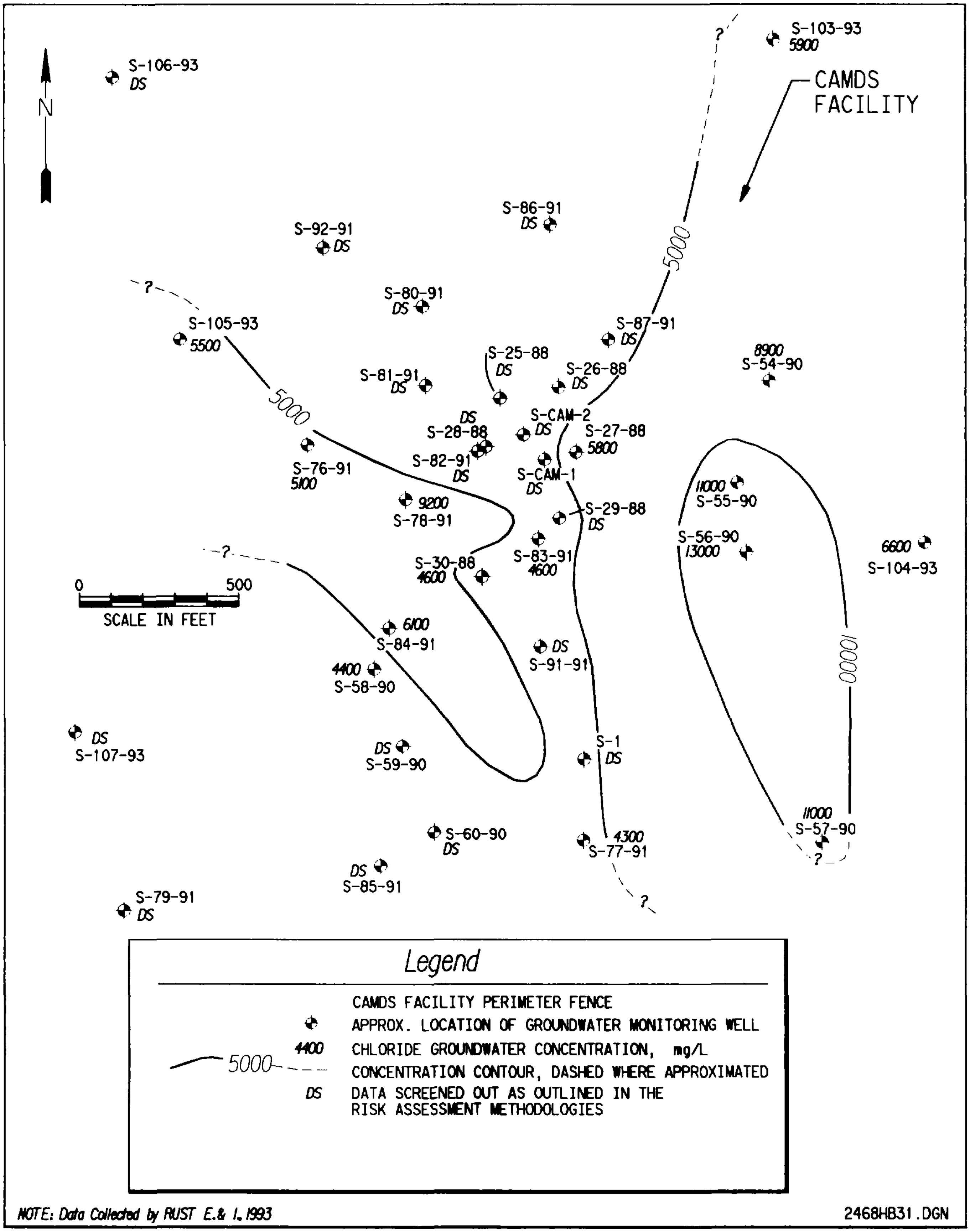

Figure 7-42. SWMU 13 Contaminant Distribution Map for Chloride in Groundwater, Phase II RFI

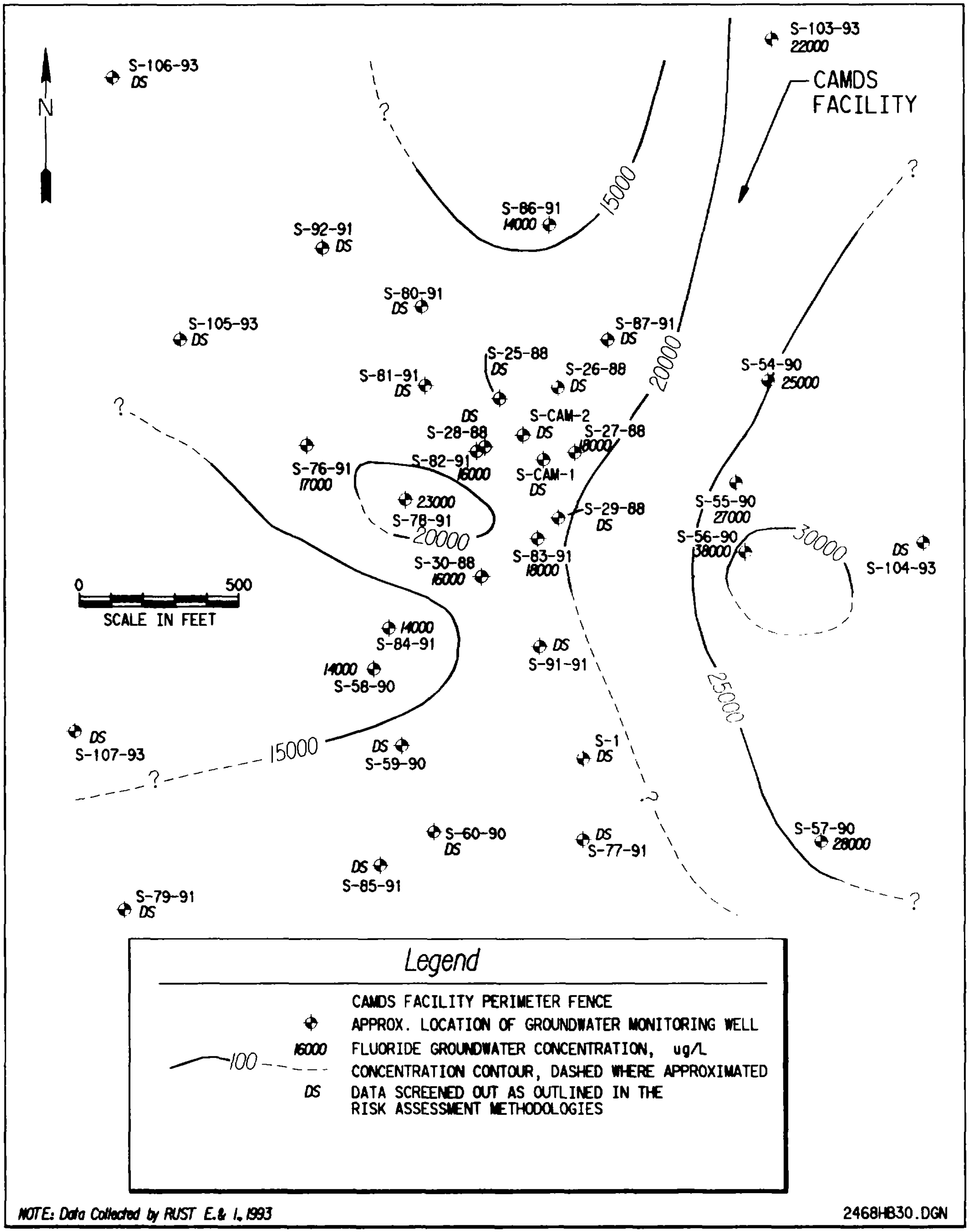

Figure 7-43. SWMU 13 Contaminant Distribution Map for Fluoride in Groundwater, Phase II RFI

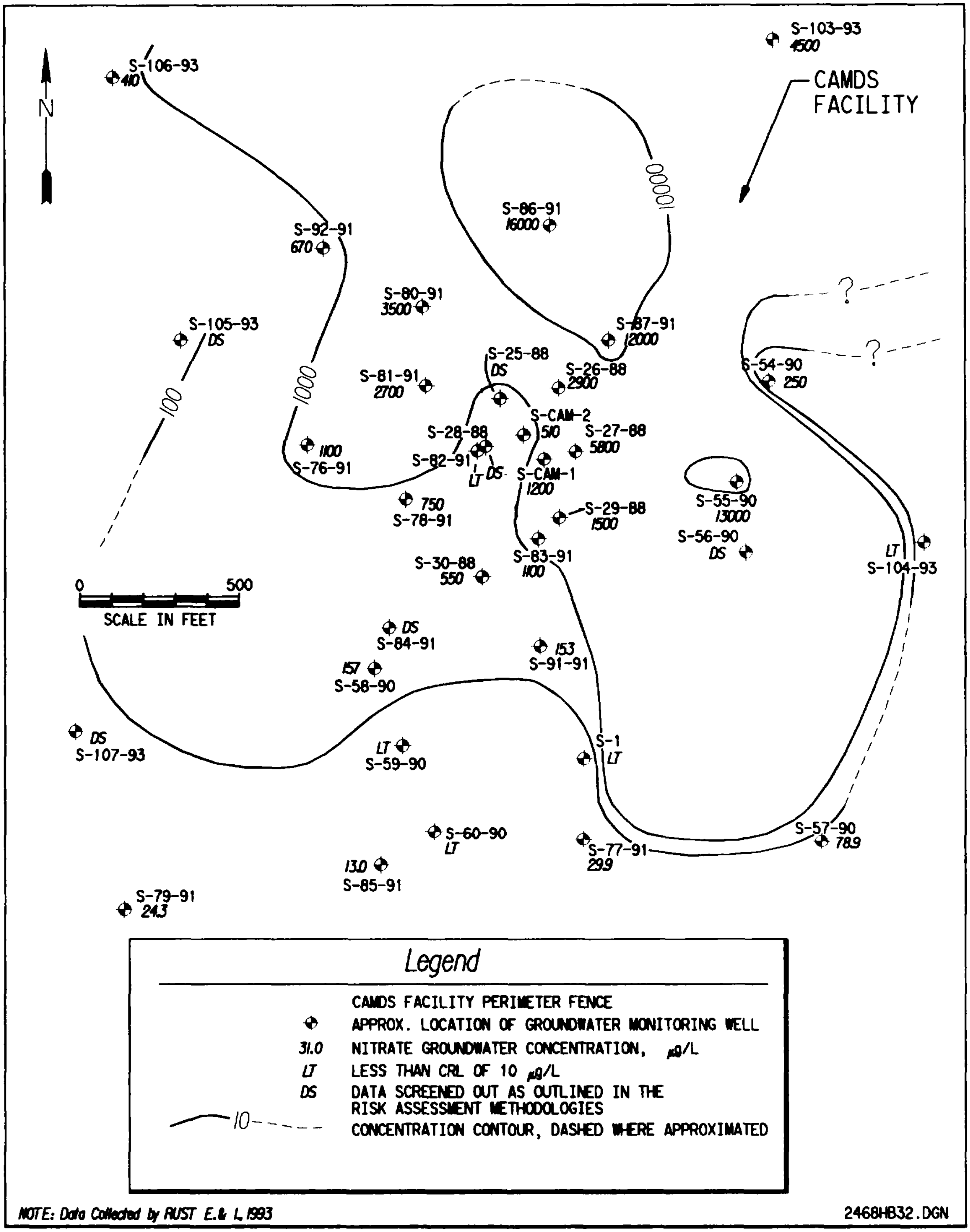

Figure 7-44. SWMU 13 Contaminant Distribution Map for Nitrate/Nitrite in Groundwater, Phase II RFI

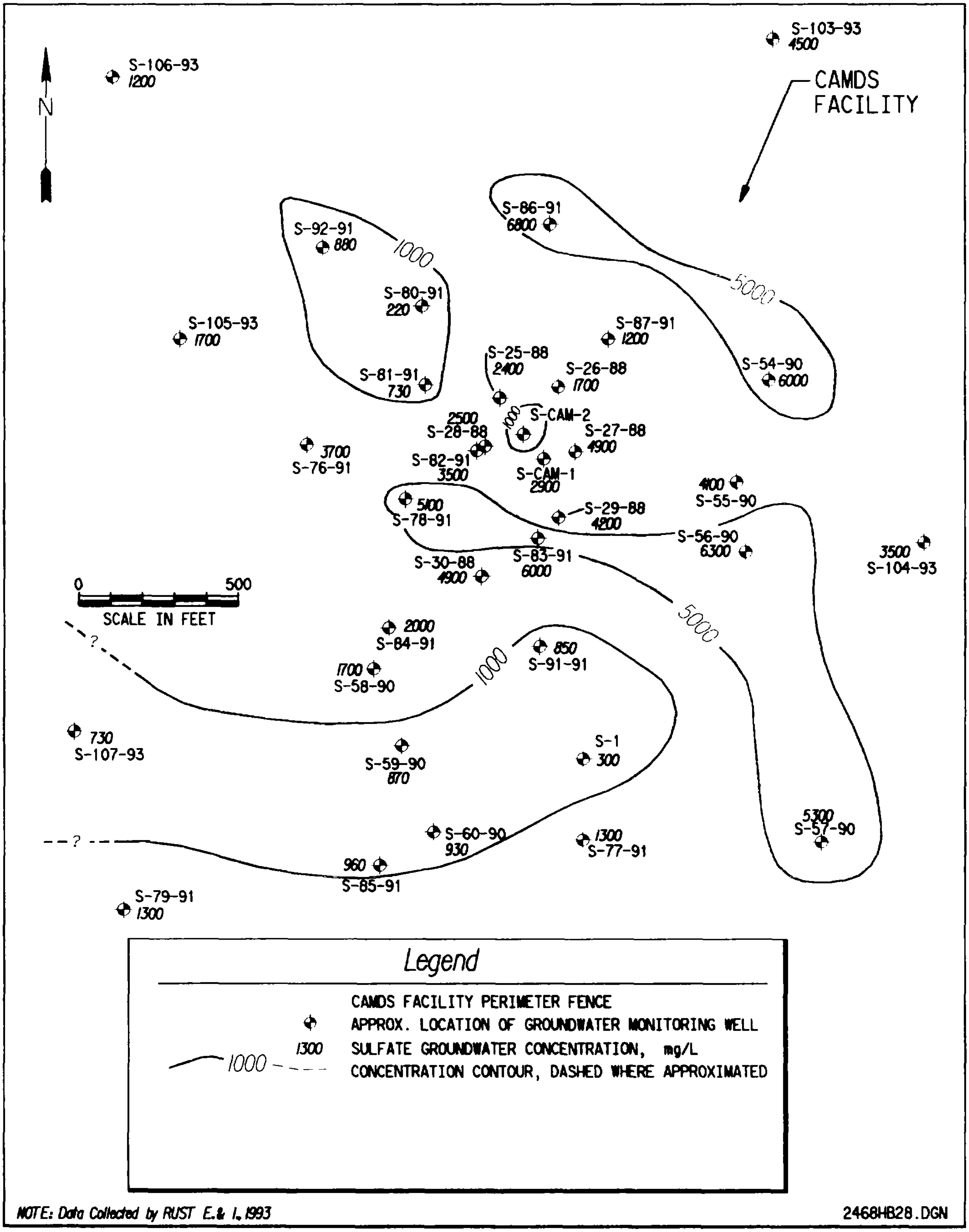

Figure 7-45. SWMU 13 Contaminant Distribution Map for Sulfate in Groundwater, Phase II RFI

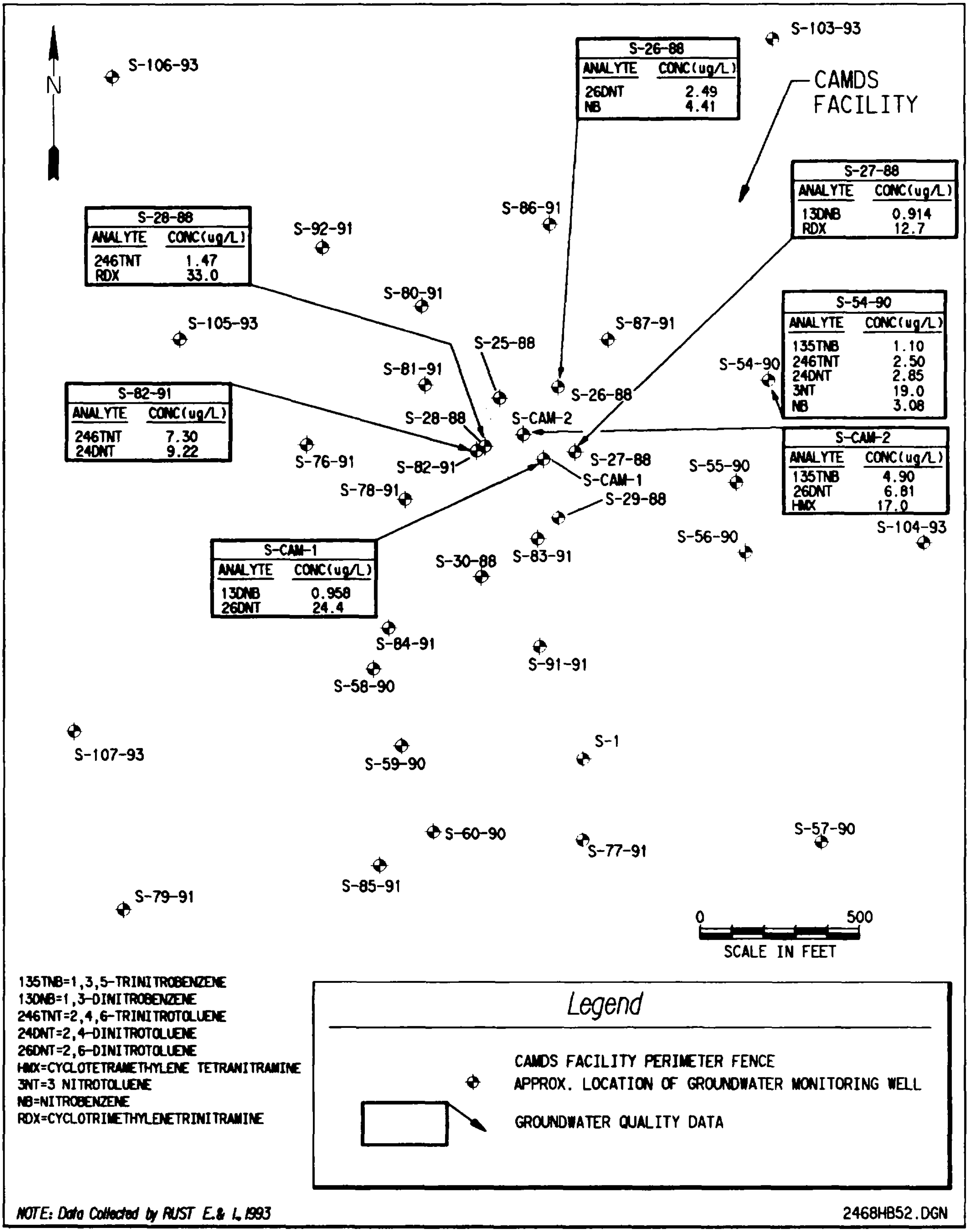

Figure 7-46. SWMU 13 Contaminant Distribution Map for Explosives in Groundwater, Phase II RFI

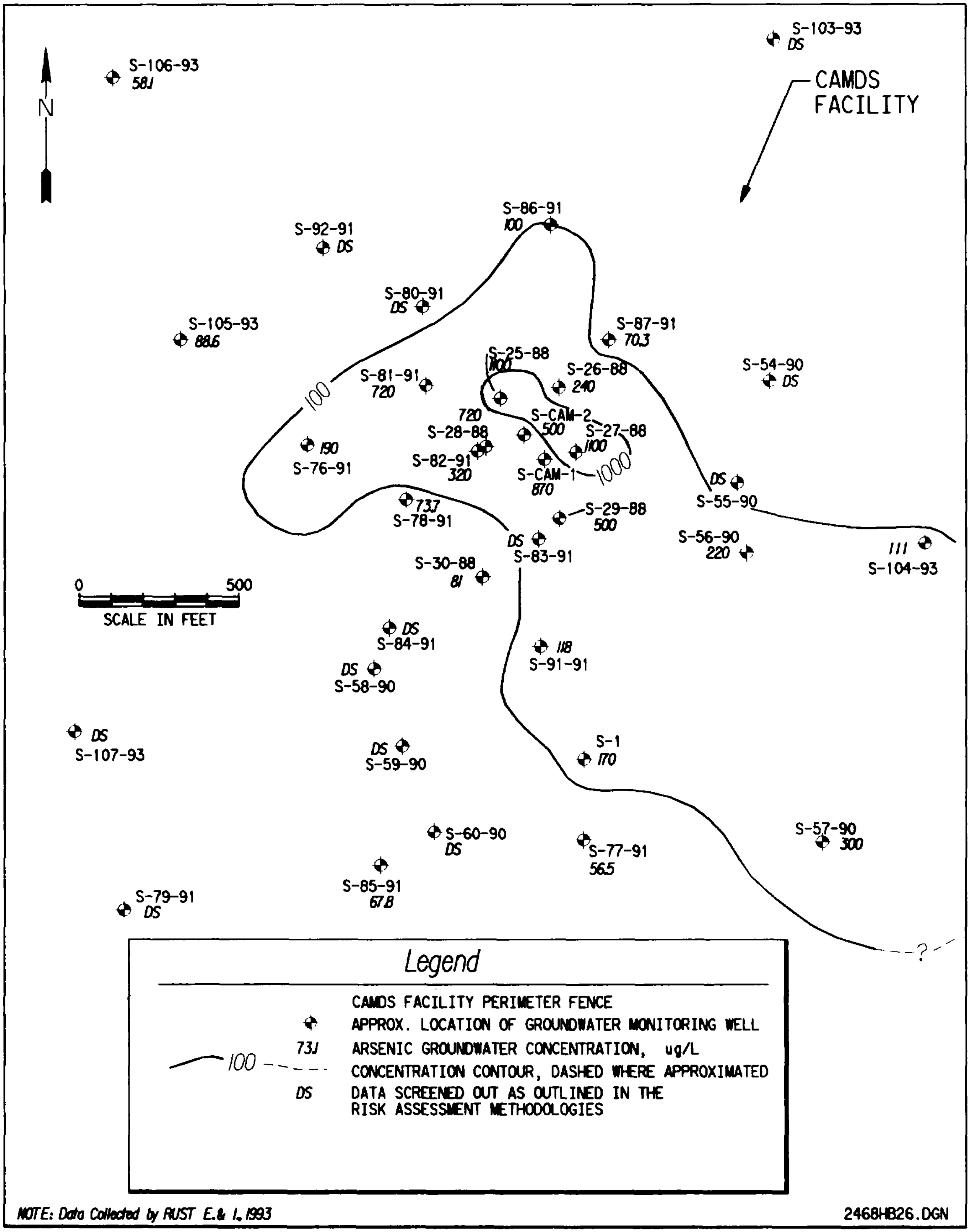

Figure 7-47. SWMU 13 Contaminant Distribution Map for Arsenic in Groundwater, Phase II RFI

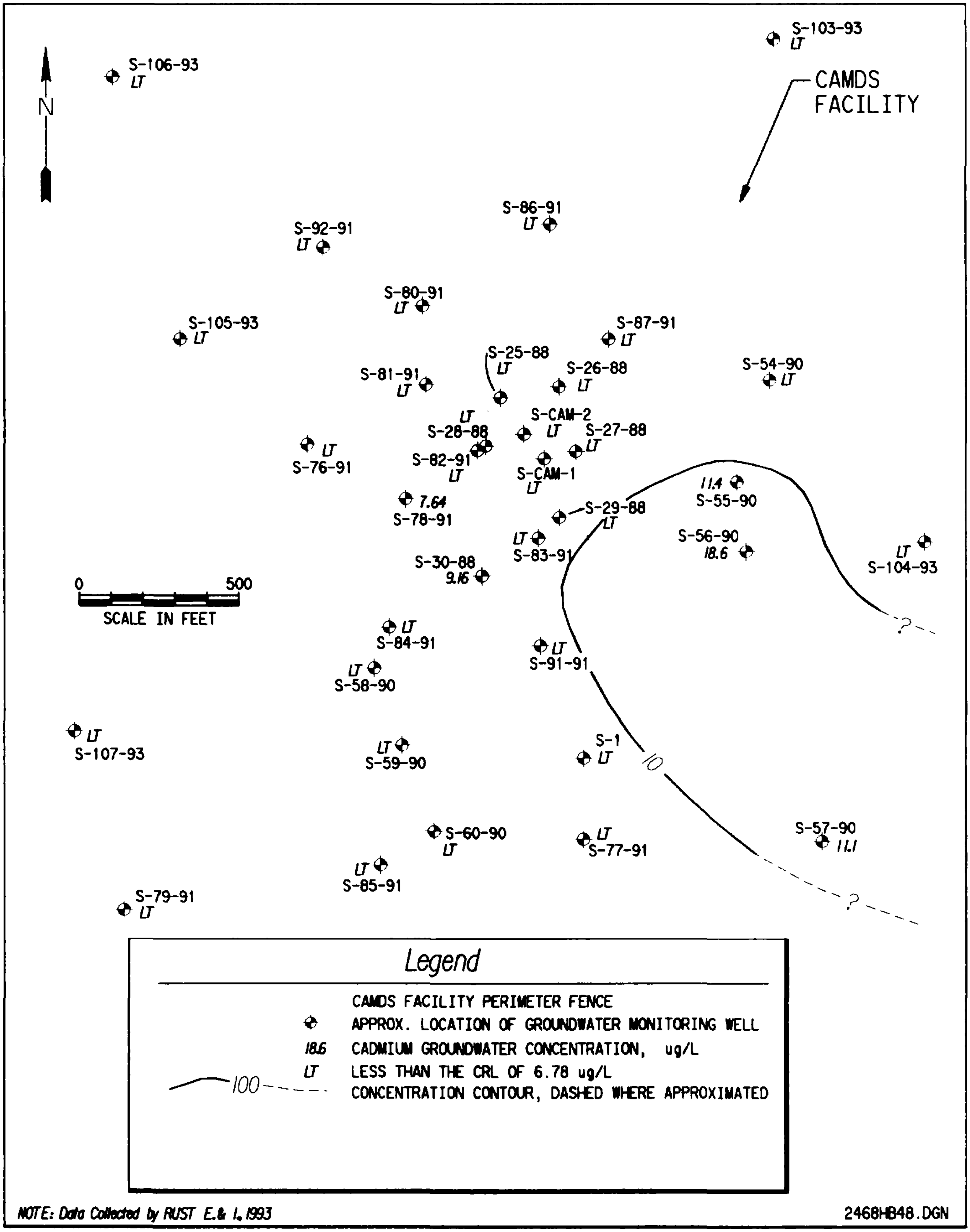

Figure 7-48. SWMU 13 Contaminant Distribution Map for Cadmium in Groundwater, Phase II RFI

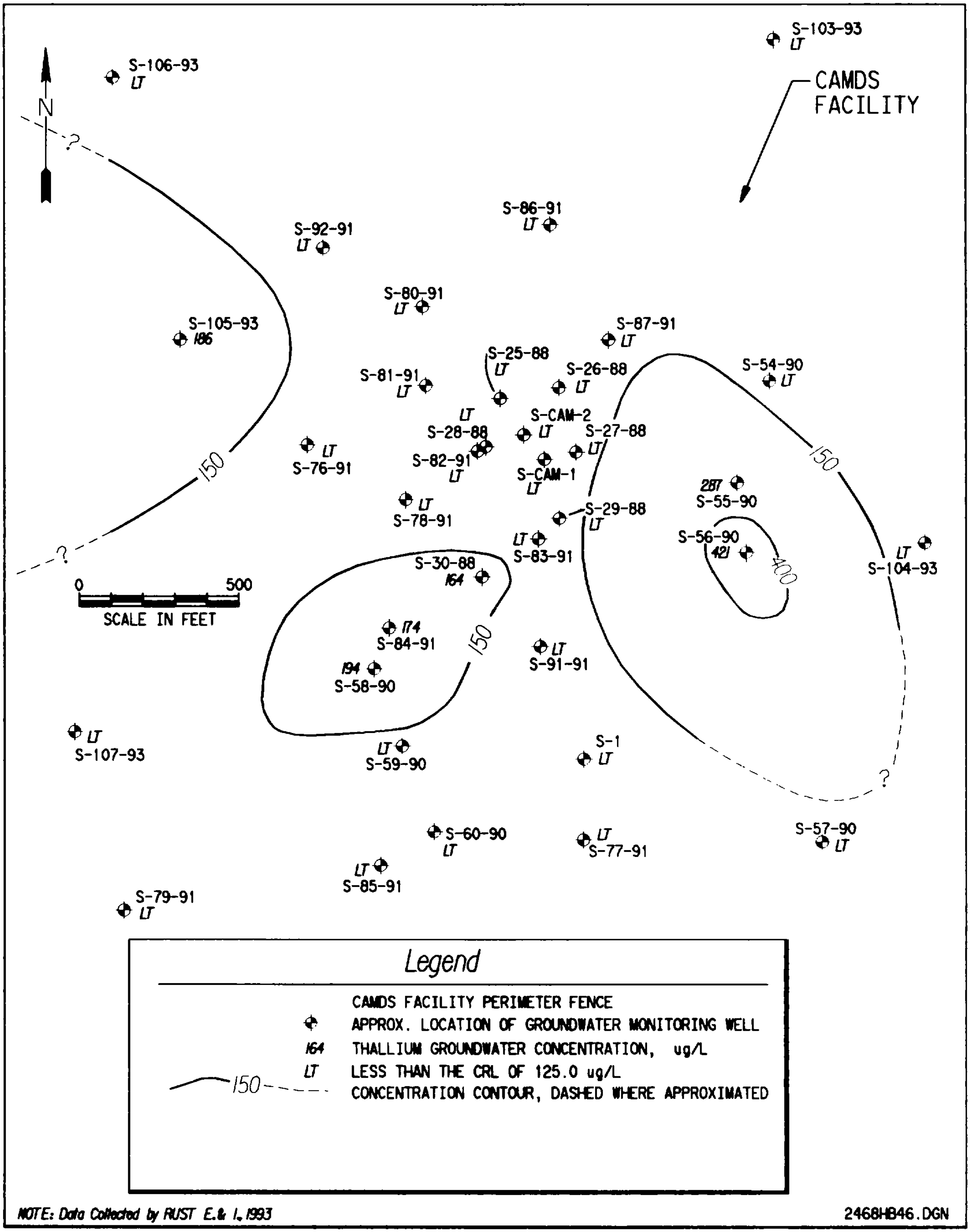

Figure 7-49. SWMU 13 Contaminant Distribution Map for Thallium Groundwater, Phase II RFI

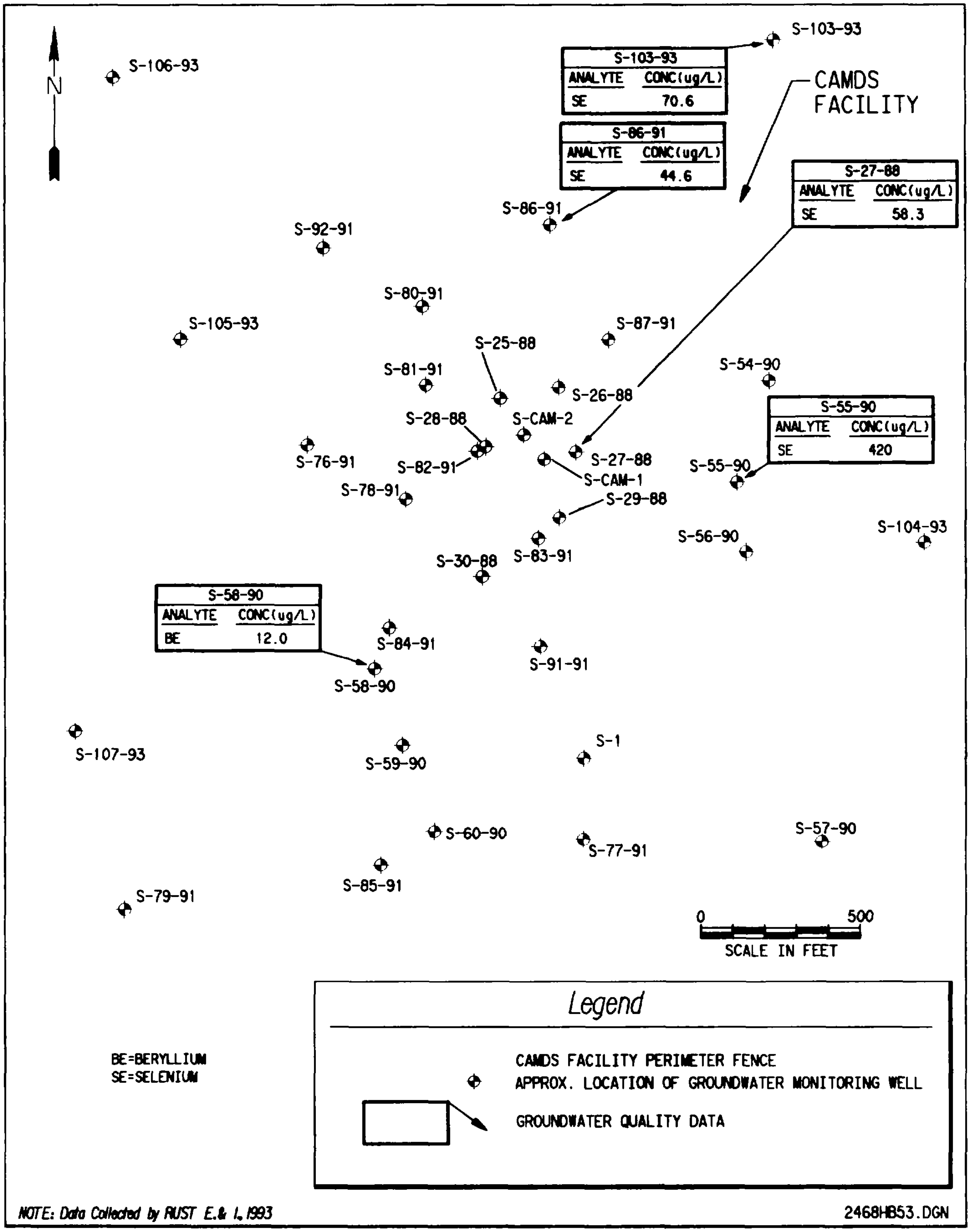

Figure 7-50. SWMU 13 Contaminant Distribution Map for Selenium and Beryllium in Groundwater, Phase II RFI

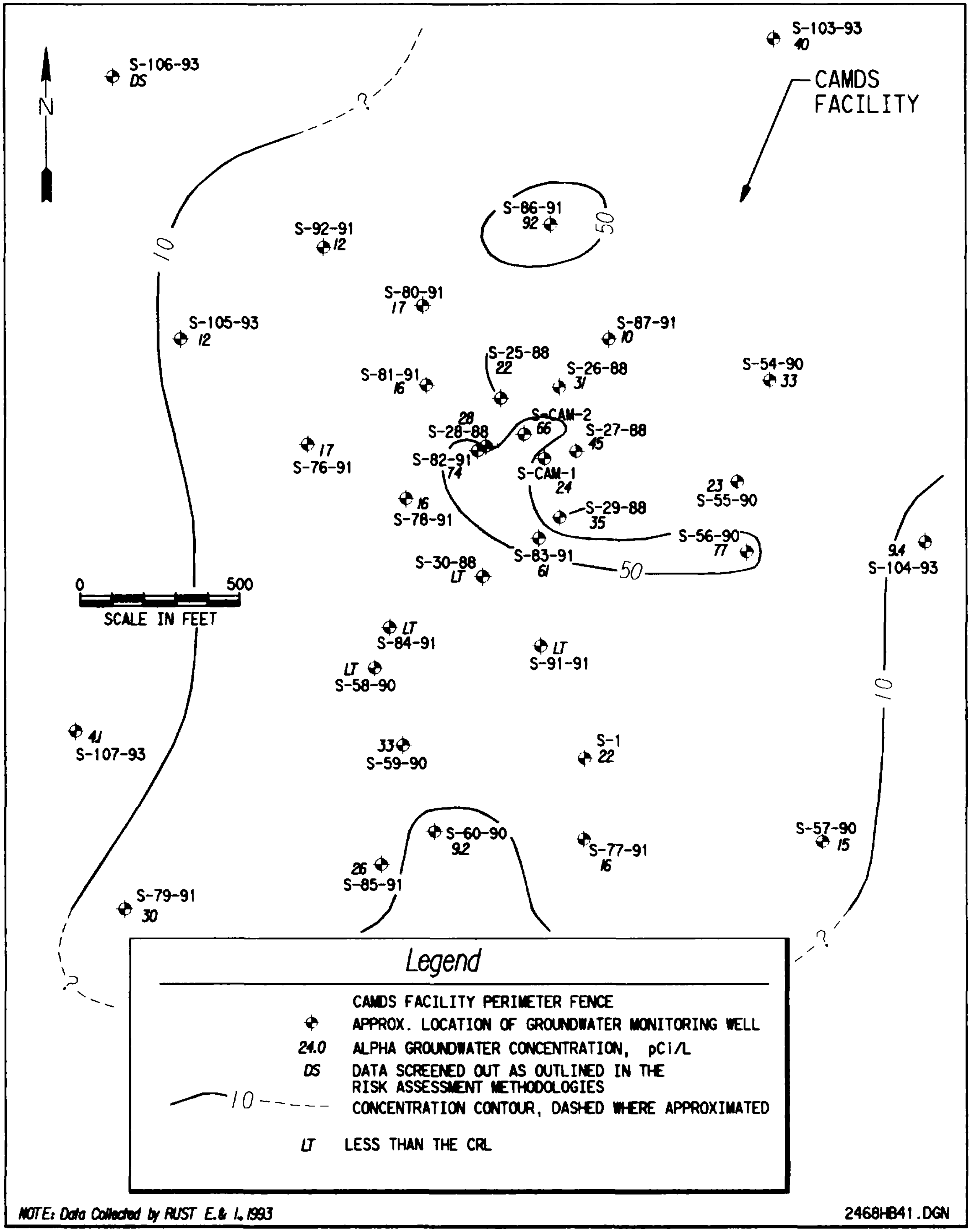

Figure 7-51. SWMU 13 Contaminant Distribution Map for Gross Alpha in Groundwater, Phase II RFI

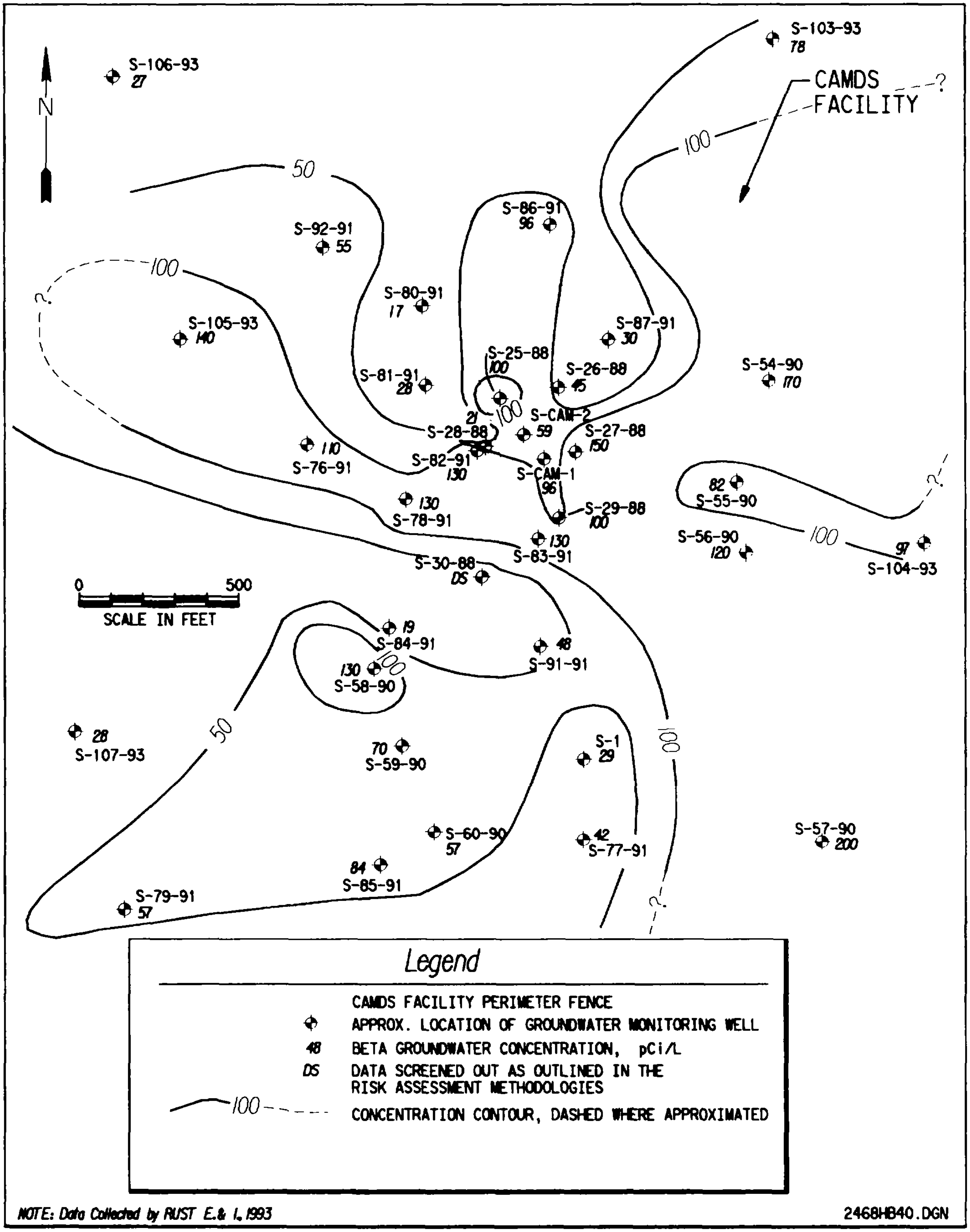

Figure 7-52. SWMU 13 Contaminant Distribution Map for Gross Beta in Groundwater, Phase II RFI

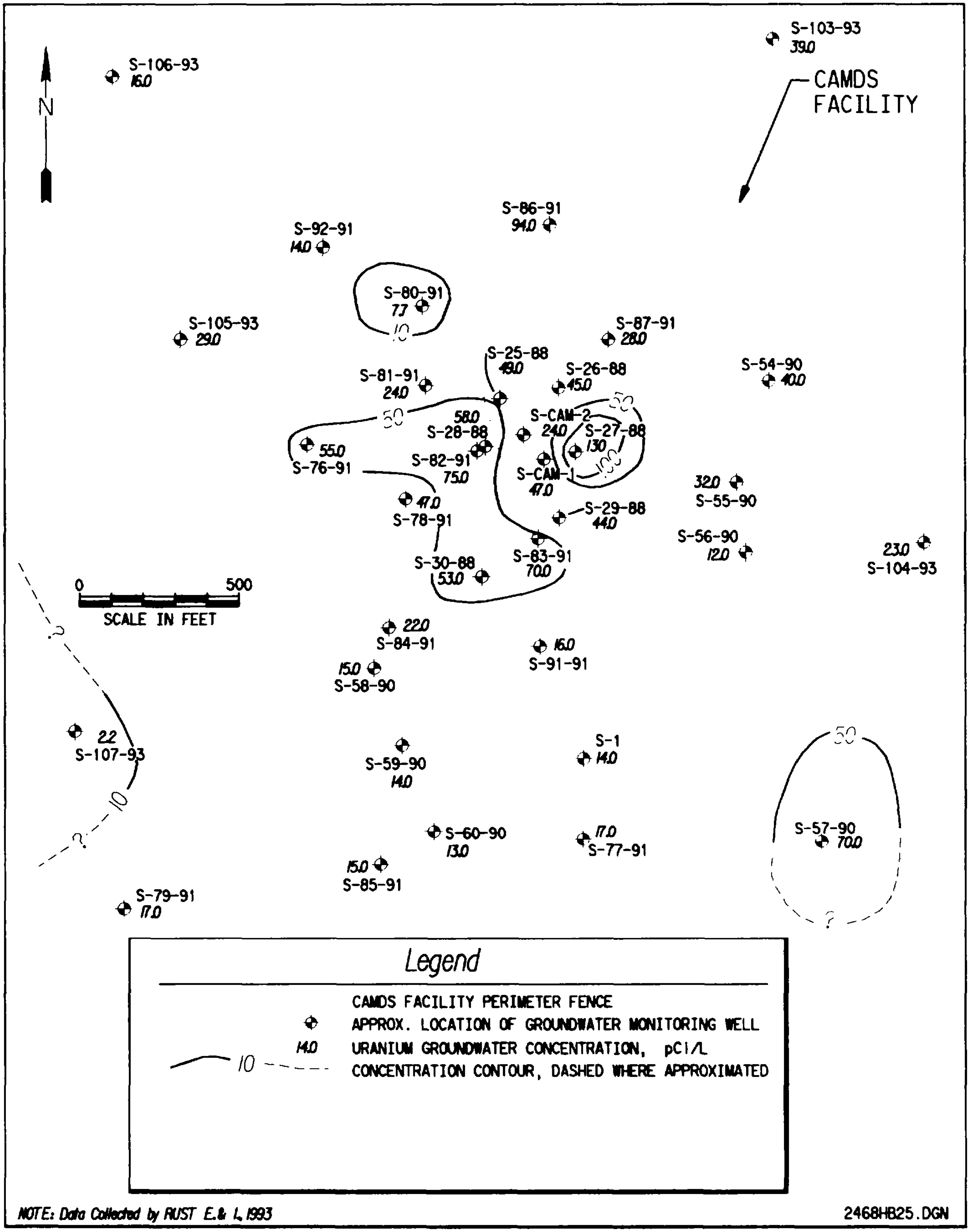

Figure 7-53. SWMU 13 Contaminant Distribution Map for Uranium in Groundwater, Phase II RFI

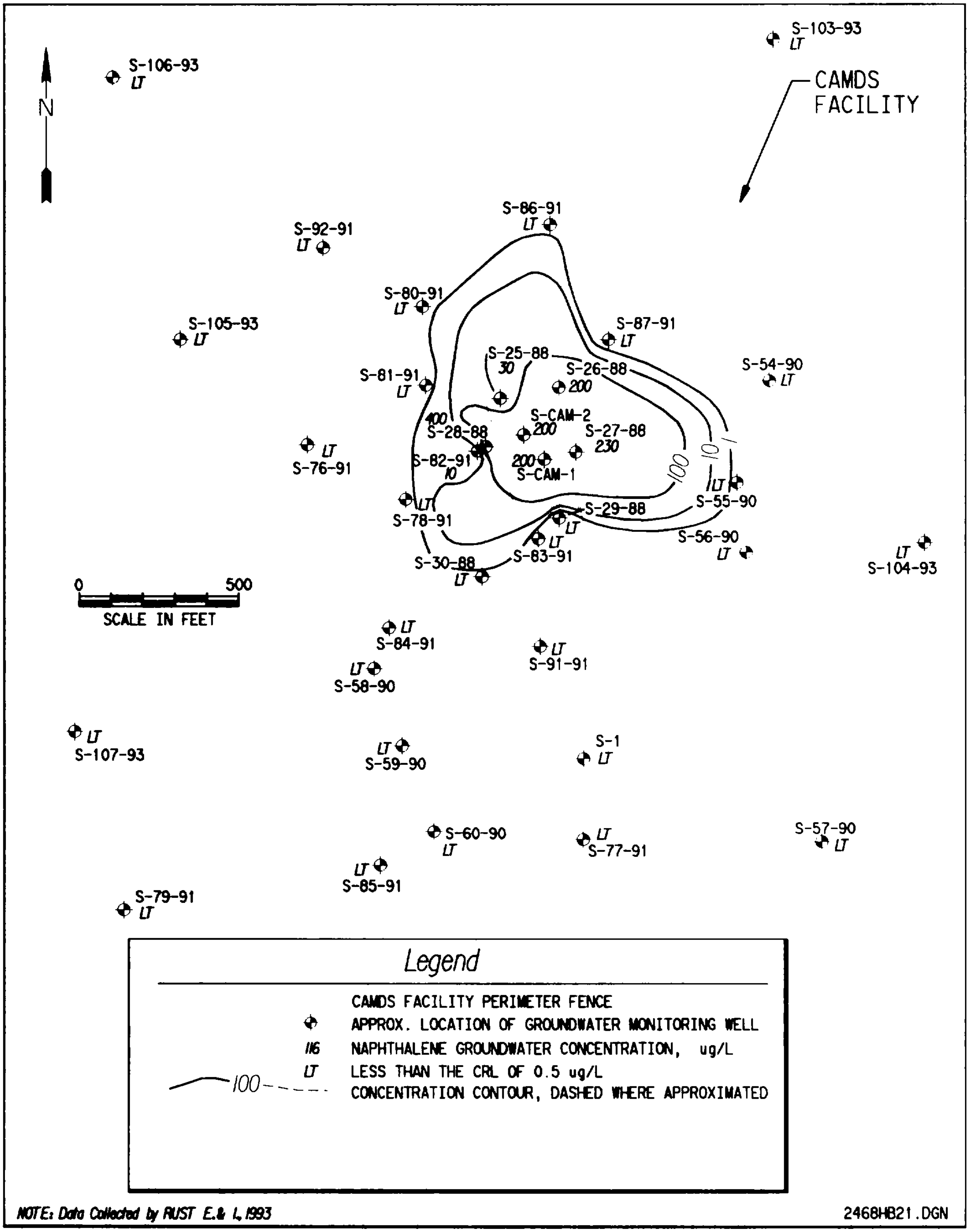

Figure 7-54. SWMU 13 Contaminant Distribution Map for Naphthalene in Groundwater, Phase II RFI

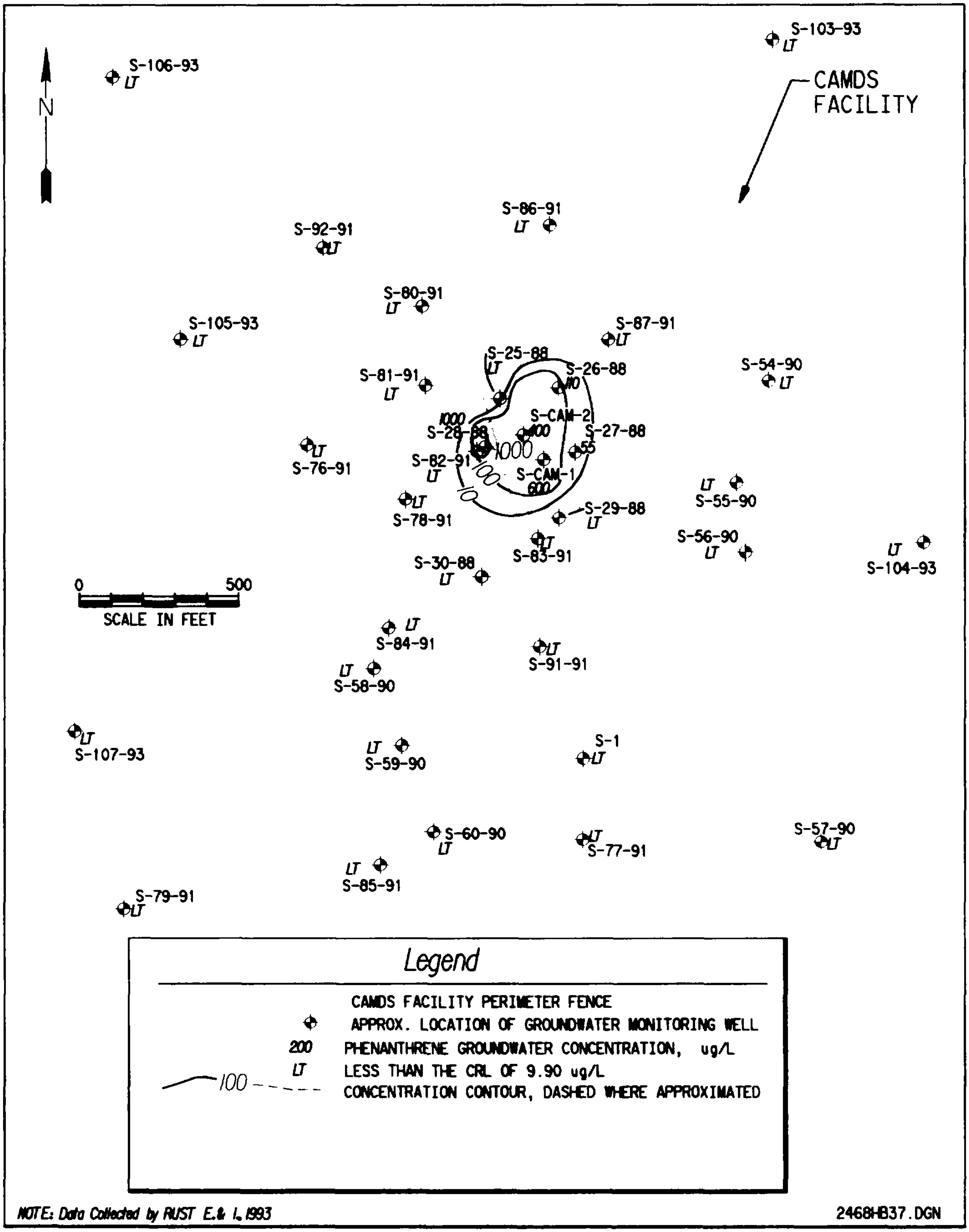

Figure 7-55. SWMU 13 Contaminant Distribution Map for Phenanthrene in Groundwater, Phase II RFI

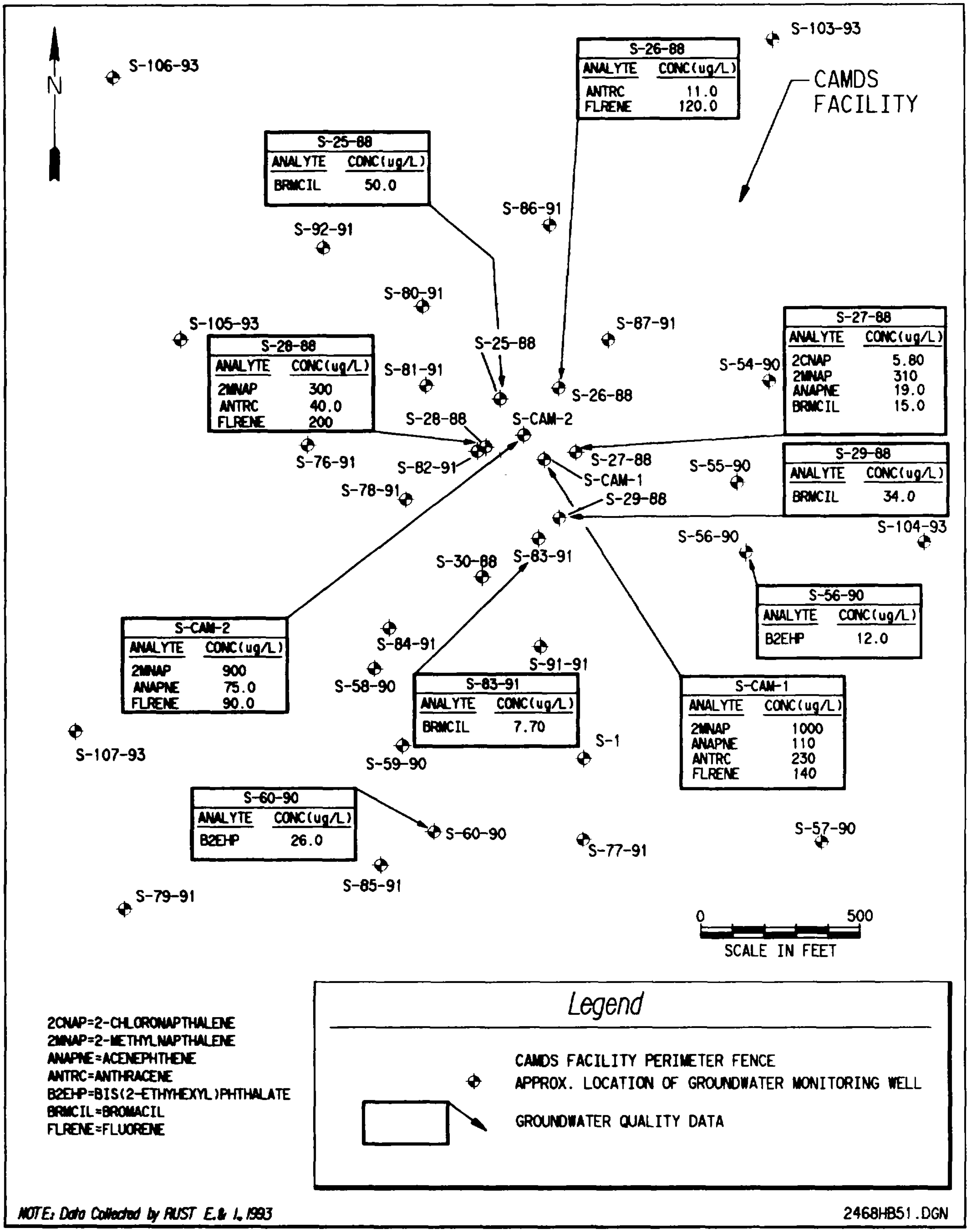

Figure 7-56. SWMU 13 Contaminant Distribution Map for Semi-Volatile Organic Compounds in Groundwater, Phase II RFI

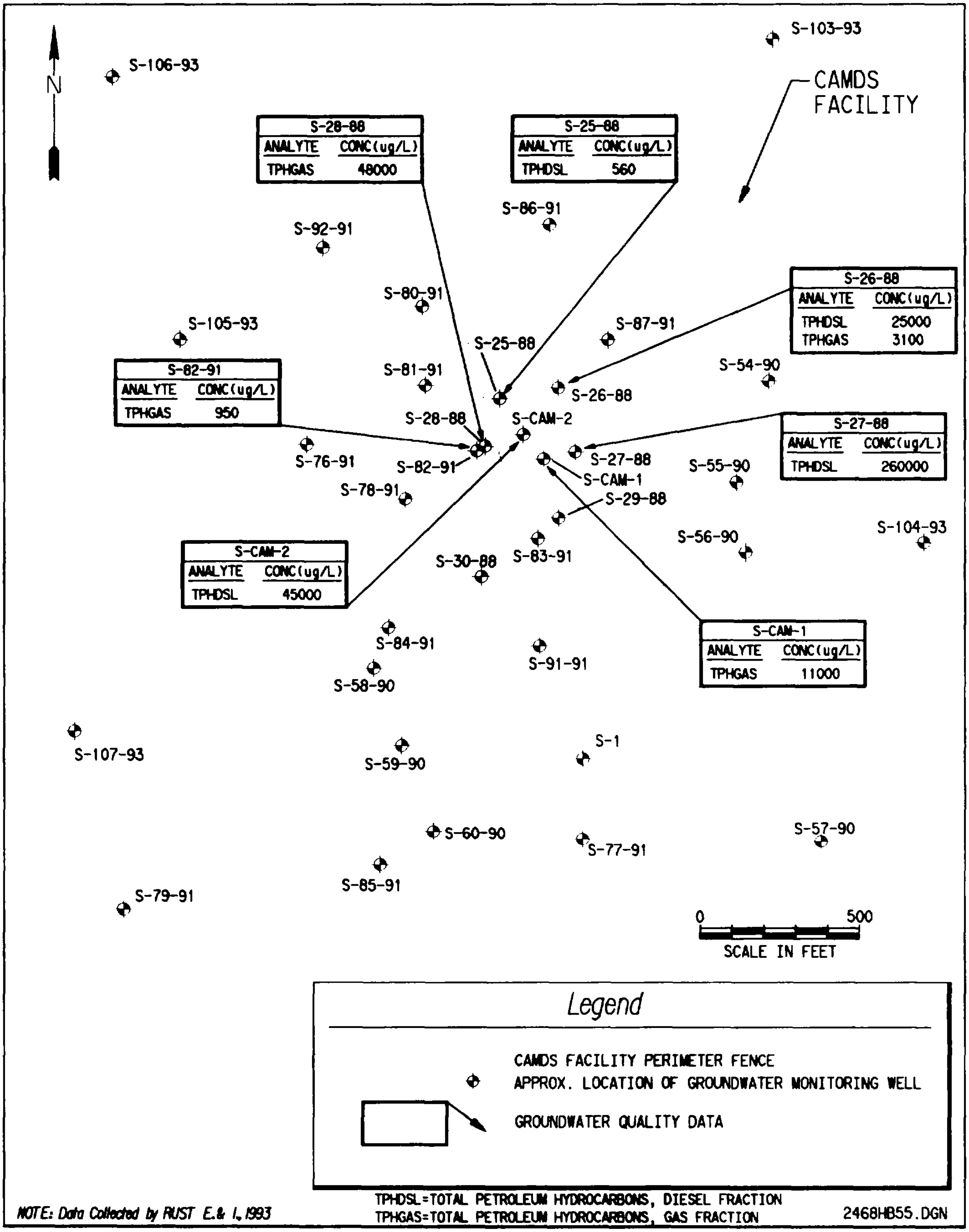

Figure 7-57. SWMU 13 Contaminant Distribution Map for Total Petroleum Hydrocarbons in Groundwater, Phase II RFI

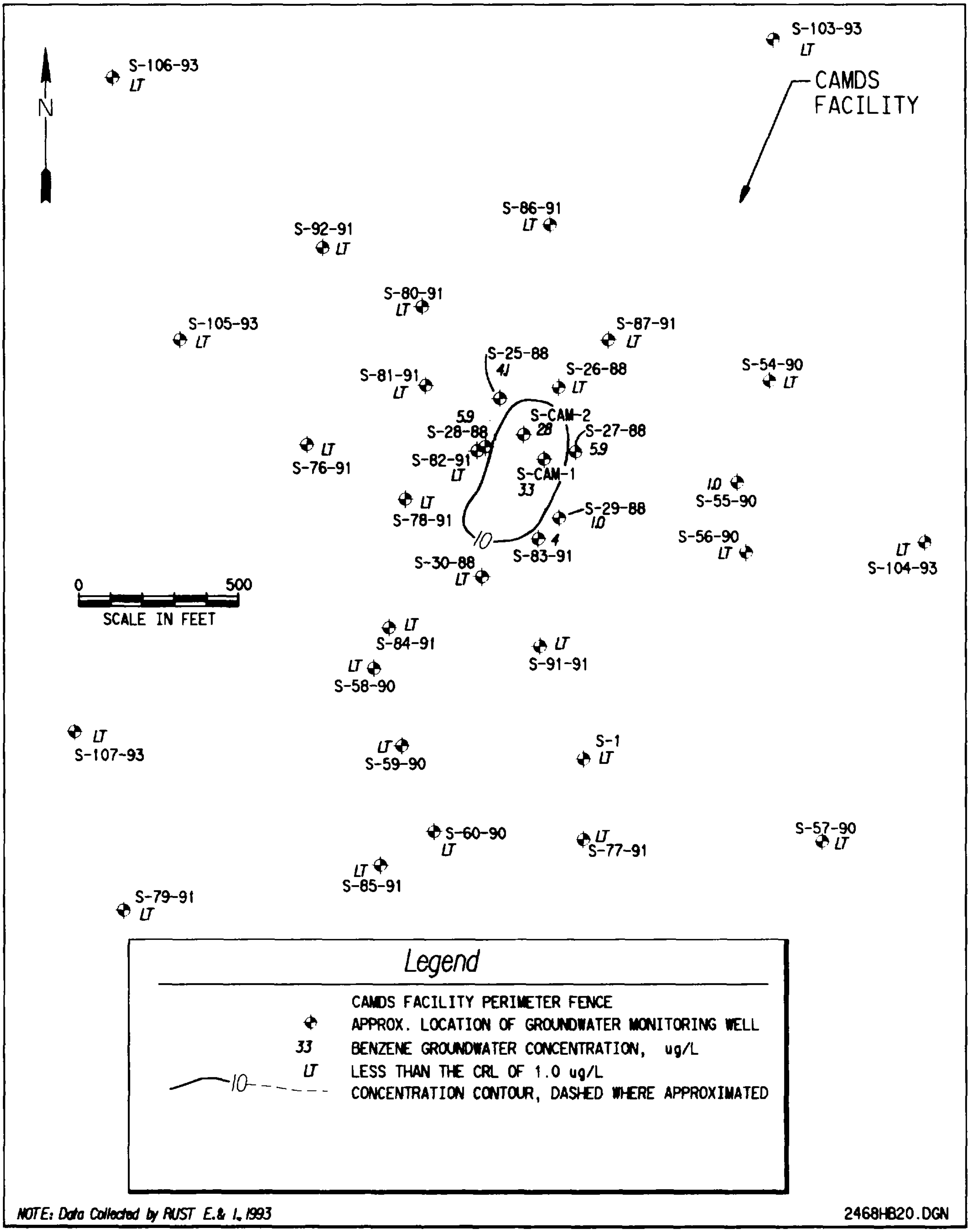

Figure 7-58. SWMU 13 Contaminant Distribution Map for Benzene in Groundwater, Phase II RFI

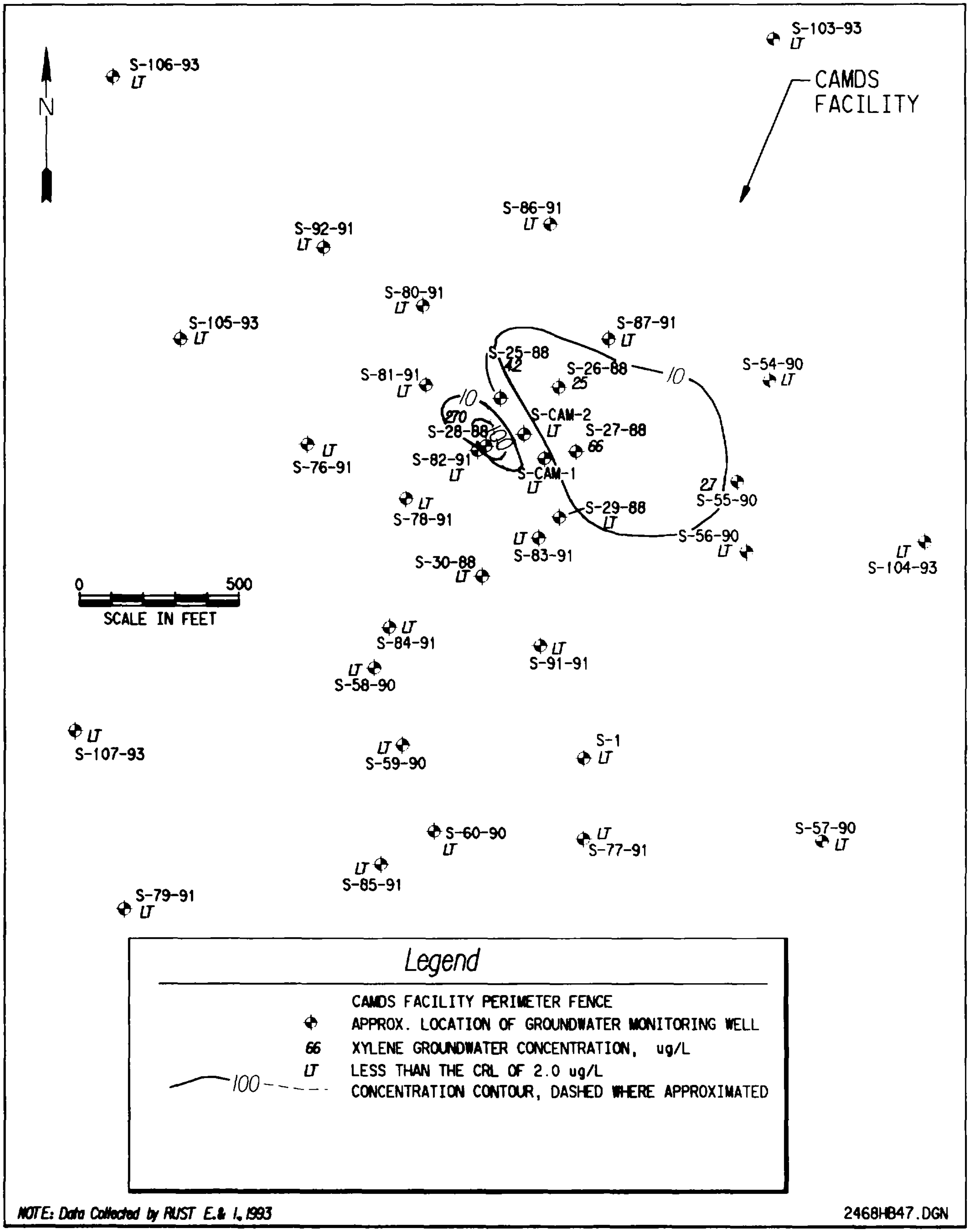

Figure 7-59. SWMU 13 Contaminant Distribution Map for Xylenes in Groundwater, Phase II RFI

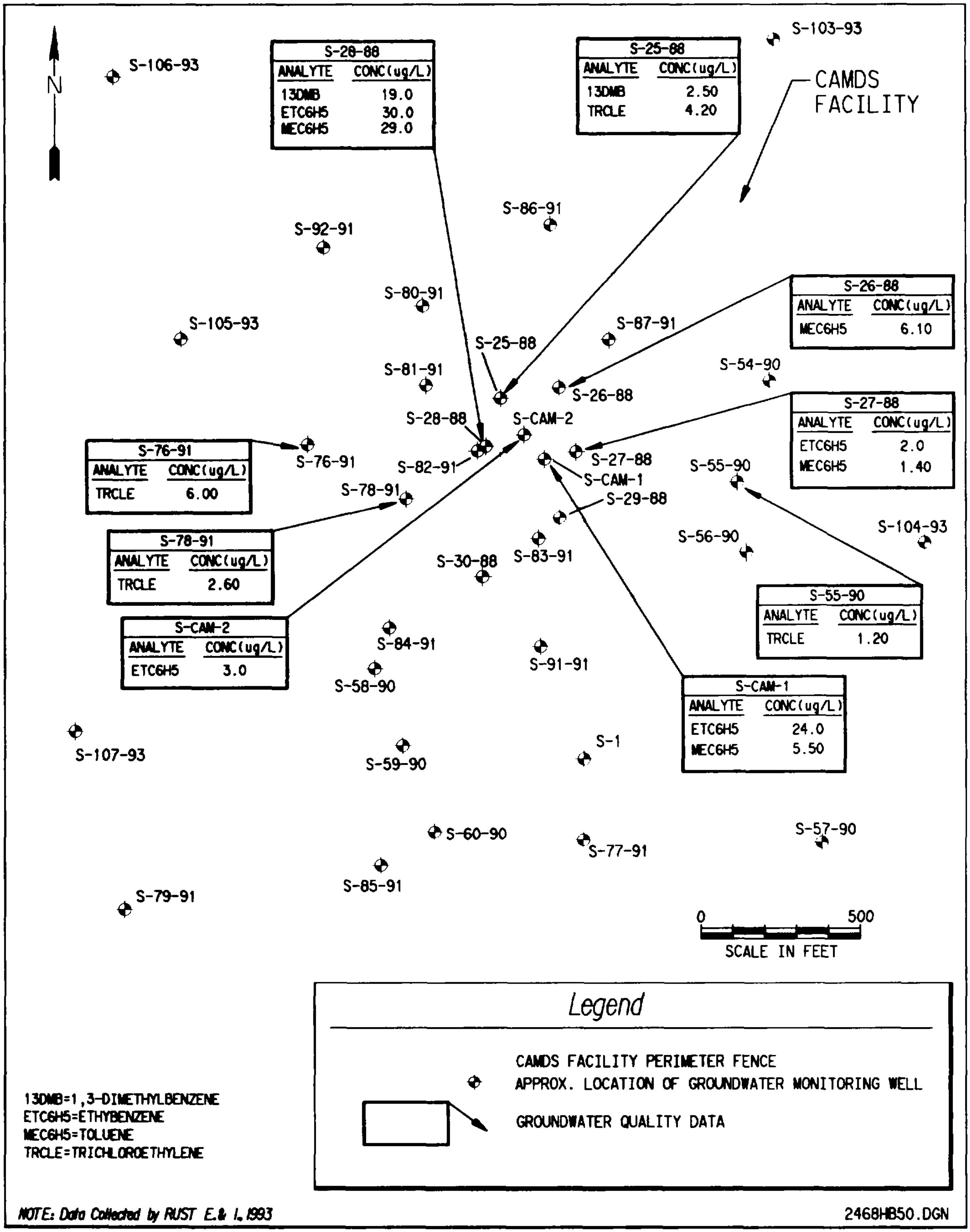

Figure 7-60. SWMU 13 Contaminant Distribution Map for Volatile Organic Compounds in Groundwater, Phase II RFI

7.11.1.1 *Agent Breakdown Products*

The only agent breakdown product detected in the groundwater monitoring wells associated with SWMU 13 during the 1993 sampling event was IMPA. Samples collected from 4 of the 35 wells contained IMPA in concentrations ranging from 510 μg/L to 4,000 μg/L (Figure 7-40).

7.11.1.2 *Anions*

Five anions were detected in various wells across the site in above background concentrations. Bromide concentrations ranged from 4,500 μg/L to 8,800 μg/L in 11 wells (Figure 7-41), chloride concentrations ranged from 4,300,000 μg/L to 13,000,000 μg/L in 15 wells (Figure 7-42), and fluoride (Figure 7-43) concentrations ranged from 1,400 μg/L to 38,000 μg/L in 14 wells. The remaining two anions, nitrate/nitrite (nonspecific, detected in 24 wells) and sulfate (detected in all 35 wells) were present in concentrations ranging from 13 to 16,000 μg/L and 220,000 to 6,800,000 μg/L, respectively (Figures 7-44 and 7-45).

7.11.1.3 *Explosives*

A total of nine explosive compounds were detected, all in relatively low concentrations and present in no more than three wells (Figure 7-46). The compounds 2,4,6-trinitrotoluene and 2,6-dinitrotoluene were both detected in three wells in concentrations ranging from 1.47 to 7.3 μg/L and 2.49 to 24.4 μg/L, respectively. The compounds 1,3,5-trinitrobenzene, 1,3-dinitrobenzene, 2,4-dinitrotoluene, nitrobenzene, and RDX were detected in samples from only two wells. The compound 1,3,5-trinitrobenzene was detected at a maximum concentration of 4.9 μg/L; 1,3-dinitrobenzene had a maximum concentration of 19 μg/L; and 2,4-dinitrotoluene was present with a maximum concentration of 9.22 μg/L. Nitrobenzene and RDX were detected at maximum concentrations of 4.41 and 33 μg/L, respectively. The remaining two detected explosives, HMX and 3-nitrotoluene, were present in only one well each at concentrations of 17 μg/L and 19 μg/L, respectively.

7.11.1.4 *Metals and Radionuclides*

Arsenic, cadmium, thallium, beryllium, and selenium were all detected in concentrations above background at SWMU 13. Arsenic was the most prevalent metal species in groundwater, detected above background in 23 different wells (Figure 7-47). Concentrations for arsenic ranged from 56.5 to 1,100 μg/L. Cadmium was detected above background in 5 wells in concentrations ranging from 7.64 to 18.6 μg/L (Figure 7-48). Thallium, as shown in Figure 7-49, was present in concentrations ranging from 164 μg/L to 421 μg/L in 6 wells.

Figure 7-50 presents the data for selenium and beryllium in groundwater. Selenium was detected in 4 wells in concentrations ranging from 44.6 to 420 μg/L, while beryllium was present in only one well at 12 μg/L. Gross alpha, gross beta, and uranium were detected in 30, 34, and 35 wells, respectively. Gross alpha was detected in concentrations ranging from 4.1 to 92 pci/L (Figure 7-51), while gross beta was present in concentrations ranging from 17 to 200 pci/L (Figure 7-52). Uranium (Figure 7-53) was present in above background concentrations ranging from 2.2 to 130 μg/L.

7.11.1.5 *Semi-Volatile Organic Compounds*

Nine different SVOCs were detected in groundwater samples collected from the wells at SWMU 13. Naphthalene was the most prevalent, present in 7 of the 35 wells at a concentration range of 10 to 400 μg/L (Figure 7-54). Figure 7-55 represents the concentration contour map for phenanthrene, which was detected in 5 wells with maximum and minimum concentrations of 55 and 1,000 μg/L.

The remaining seven SVOCs are presented in Figure 7-56. The compounds 2-methylnaphthalene, bromacil, and fluorene were each detected in four wells, with concentration ranges of 300 to 1,000 μg/L, 7.7 to 50 μg/L, and 90 to 200 μg/L, respectively. Acenaphthene was detected in three wells at concentrations ranging from 19 to 110 μg/L, while anthracene, also detected in three wells, was present in concentrations ranging from 11 to 230 μg/L. Bis(2-ethylhexyl) phthalate, present in 2 wells, had minimum and maximum concentrations of 12 and 26 μg/L. The remaining SVOCs, 2-chloronaphthalene, was detected in only a single well at a concentration of 5.8 μg/L.

7.11.1.6 *Total Petroleum Hydrocarbons*

The 1993 samples were analyzed for TPHCs in both the diesel (TPHC-DSL) and gas (TPHC-GAS) fraction. As shown in Figure 7-57, both TPHC-DSL and TPHC-GAS compounds were detected in four wells. TPHC-DSL contaminants were detected within the concentration range of 560 to 260,000 μg/L. Gas fraction petroleum hydrocarbons were detected in concentrations ranging from 950 to 48,000 μg/L.

7.11.1.7 *Volatile Organic Compounds*

A total of six VOCs were detected in the 1993 groundwater samples. The most prevalent VOC was benzene, detected in groundwater samples collected from 8 of the 35 wells (Figure 7-58).

Benzene concentrations ranged from 1 to 33 μg/L. Xylene was detected in concentrations ranging from 2.7 μg/L to 270 μg/L in five of the wells (Figure 7-59).

The remaining four VOC contaminants are presented in Figure 7-60. Ethylbenzene, toluene, and traces of trichloroethene were each detected in 4 of the 35 wells. Concentration ranges for ethylbenzene, toluene, and trichloroethene were from 2 to 30 μg/L, 1.4 to 29 μg/L, and 1.2 to

6 μg/L, respectively. The compound 1,3-dimethylbenzene (m-xylene) was detected in only two wells, at minimum and maximum concentrations of 2.5 and 19 μg/L.

7.11.2 Nature and Extent of Contamination

This section discusses the nature and the extent of the contaminants detected in groundwater. In addition, the maximum concentrations will be compared to MCLs or TBC guidance levels where applicable. MCLs and TBC values are presented in Table 7-67.

The horizontal extent of explosives, SVOC, VOC, and TPHC contamination was defined by Phase II RFI sampling and analysis, whereas the extent of an agent breakdown product (IMPA), anions, metals, and radionuclides was not defined. Because of the nature of the subsurface alluvial deposits, the vertical extent could not be accurately defined. As previously described, the subsurface consists of interbedded gravel, sand, silt, and clay deposits, indicating that no continuous aquifer underlies the site. Monitoring wells and soil borings were typically drilled to the first confining clay layer and completed. Therefore, no analytical data were collected below the upper water-bearing zone.

Without analytical groundwater data from underlying water-bearing units across the site, vertical extent of contamination cannot be determined. However, clay deposits (some up to 50 feet thick) were encountered during the drilling of every boring and are believed to be underlying the entire facility (see Figure 3-3). Clays typically have a hydraulic conductivity value ranging from 10^{-7} to 10^{-9} cm/sec (Freeze and Cherry, 1979), which should effectively retard vertical flow through these subsurface lacustrine clays.

7.11.2.1 *Agent Breakdown Products*

IMPA was the only agent breakdown product detected in the samples collected from the groundwater monitoring wells at SWMU 13. IMPA is the initial breakdown product created by the hydrolysis of sarin, a nerve agent. There have been no reported spills or releases of this nerve agent into the soil or groundwater near the CAMDS facility. It is important to note that IMPA is a by-product of the chemical demilitarization process that was used at CAMDS.

Figure 7-40 is a summary figure showing the wells and associated concentrations of this contaminant. As the map shows, the horizontal extent is not defined to the northwest, where the highest concentration (4 mg/L) was detected in Well S-106-93. IMPA has a TBC value of 0.7 mg/L.

In order to determine the current extent of IMPA in groundwater at SWMU 13, the same modeling procedures followed for the risk assessment groundwater modeling (Section 6.1.2.3) were applied. Using this very conservative approach, the results indicate that currently the IMPA is retained within the TEAD-S facility. It will take more than 90 years for IMPA to reach the TEAD-S boundary at a maximum concentration on the order of 10^{-6} μg/L.

Table 7-67. SWMU 13 Chemical-Specific Applicable or Relevant and Appropriate Requirements for Cleanup of Groundwater

Chemical	SDWA[a] MCL/MCLG[b]	Proposed SDWA MCL/MGCL	Utah MCL[c]	TBC Value[d]
Agent Breakdown Products				
Isopropylmethyl phosphonic acid (IMPA)	–	–	–	700[e]
Anions				
Bromide	–	–	–	–
Chloride	250,000[f]	–	–	–
Fluoride	4,000/ 4,000[g]	–	4,000	–
Total Nitrate and Nitrite (as Nitrogen)	10,000/ 10,000[h]	–	10,000	–
Sulfate	250,000[f]	400,000/ 500,000[i]	500,000– 1,000,000	–
Explosives				
1,3-Dinitrobenzene	–	–	–	1.0[e]
1,3,5-Trinitrobenzene	–	–	–	2[j]
2,4-Dinitrotoluene	–	–	–	0.05[k]
2,4,6-Trinitrotoluene	–	–	–	2[e]
2,6-Dinitrotoluene	–	–	–	–
3-Nitrotoluene	–	–	–	–
HMX	–	–	–	400[e]
Nitrobenzene	–	–	–	–
RDX	–	–	–	2[e]
Metals				
Arsenic	50[l]	–	50	–
Beryllium	4/4[m]	–	4	–
Cadmium	5/5[h]	–	10	–

Table 7-67. SWMU 13 Chemical-Specific Applicable or Relevant and Appropriate Requirements for Cleanup of Groundwater (continued)

Chemical	SDWA[a] MCL/MCLG[b]	Proposed SDWA MCL/MGCL	Utah MCL[c]	TBC Value[d]
Selenium	50/50	–	50	–
Thallium	2/0.5	–	2	–
Radionuclides				
Gross Alpha	15 pCi/L[n]	15 pCi/L[n]	15 pCi/L	–
Gross Beta	4 mrem/yr[n]	4 mrem/yr[n]	4 mrem/yr	–
Uranium	–	20[r]	–	–
Semi-Volatile Organic Compounds				
2-Chloronaphthalene	–	–	–	–
2-Methylnaphthalene	–	–	–	–
Acenaphthene	–	–	–	–
Anthracene	–	–	–	–
Bis(2-ethylhexyl)-phthalate	6/0[m]	–	–	–
Bromacil	–	–	–	–
Fluorene	20	–	–	–
Naphthalene	–	–	–	20[e]
Phenanthrene	–	–	–	–
Total Petroleum Hydrocarbons	–	–	–	–
Diesel Phase	–	–	–	500[o]
Gas Phase	–	–	–	500[o]
Volatile Organic Compounds				
Benzene	5/0[p]	–	5	–
Ethylbenzene	700/700	–	700	–
1,3-Dimethylbenzene	–	–	–	–

Table 7-67. SWMU 13 Chemical-Specific Applicable or Relevant and Appropriate Requirements for Cleanup of Groundwater (continued)

Chemical	SDWA[a] MCL/MCLG[b]	Proposed SDWA MCL/MGCL	Utah MCL[c]	TBC Value[d]
Toluene	1,000	–	1,000	–
Trichloroethylene	5/0[k]	–	5	–
Total Xylene	10,000	–	10,000	–

Note.—Values in μg/L except where noted.

[a]SDWA=Safe Drinking Water Act.

[b]MCL=Maximum Contaminant Level;MCLG=Maximum Contaminant Level Goal.

[c]Utah Administrative Code R309-103, effective July 1, 1991.

[d]TBC=to be considered guidance.

[e]USEPA Office of Drinking Water lifetime health advisory.

[f]National secondary drinking water standard; designed to protect the aesthetic qualty of water (44 FR 42198, July 19, 1979), also Utah Secondary Maximum Contaminant Levels.

[g]MCL - 51 FR 11396 (April 2, 1986); applies to community water systems; MCLG - 50 FR 47141 (November 14, 1985).

[h]56 FR 3526 (January 30, 1991), effective July 30, 1992.

[i]55 FR 30370 (July 25, 1990).

[j]Estimated from a reference dose. The concentration in drinking water that is assumed to result in no adverse health effects following daily ingestion for a lifetime.

[k]Estimated from a carcinogen slope factor for a risk of 10^{-6}. The concentration in drinking water that will result in one excess cancer death in 1 x 10^{-6} people following a lifetime exposure to contaminated drinking water.

[l]40 FR 59570 (December 24, 1975).

[m]57 FR 31776 (July 17, 1992), effective July 17, 1992.

[n]41 FR 28404 (July 9, 1976). These interim values were changed to proposed status in July 1991 (56 FR 33050, July 18, 1991); final rule expected April 1993.

[o]These values are action levels from the State of Utah, not TBC's.

[p]52 FR 25690 (July 8, 1987).

Sources: EA, 1988; Halliburton NUS, 1992; and ORNL, 1992.

7.11.2.2 *Anions*

The depositional environment associated with Rush Valley (discussed in Section 7.1.2.4) influences the presence of anions detected in groundwater at SWMU 13. Distribution maps for bromide, chloride, fluoride, nitrate, and sulfate are presented as Figures 7-41 through 7-45. Each of the five anions are widely distributed, detected in at least 11 of the 35 wells. Of all the different compounds detected in groundwater, the anions were present in the highest concentrations. Although concentrations of these anions are elevated, they are within expected concentration ranges for the semi-brackish hydrogeochemical environment typically associated with basin and range deposits (Hem 1970).

The Phase II RFI groundwater sampling results for anions further support the water quality zones proposed by Hood (1969) and others, who noted an abrupt change in groundwater total dissolved solids (TDS) concentrations between the northeastern two-thirds and the southwestern one-third of TEAD-S. Groundwater encountered to the northeast (Zone I) predominantly flows through alluvium, is hard and fresh, and contains relatively low magnesium and TDS concentrations. To the southwest (Zone II), groundwater flows through lacustrine deposits, resulting in brackish conditions, characterized by high concentrations of sulfate, chloride, and TDS. The groundwater quality change correlates with the highest recognized Lake Bonneville shoreline in the vicinity of TEAD-S. SWMU 13 is located in this transition zone (Zone II) at the base of a large alluvial fan overlying lacustrine sediments, including fine-grained sands, silts, and clays (Ebasco 1991). As result, relatively high anion concentrations are expected.

Bromide, which does not have a MCL or TBC value, was detected at a maximum concentration of 8,800 μg/L in a down-gradient well (S-59-90). However, the upgradient well S-103-93 contained 6,600 μg/L of bromide (Figure 7-41). These concentrations are typical of the evaporitic hydrogeochemical environment present at CAMDS. The background concentration was estimated to be 1,500 μg/L. As a result, bromide appears to be naturally occurring and, therefore, does not appear to be from any known past operations associated with SWMU 13.

The MCL for chloride is 250,000 μg/L, while background for the TEAD-S area was calculated to be 4,100,000 μg/L. The distribution map (Figure 7-42) shows the highest chloride concentrations to the southeast. However, like bromide, chloride is believed to be naturally occurring, since elevated chloride concentrations are expected in this depositional environment.

As with chloride, the fluoride background concentration of 14,000 μg/L exceeds the State of Utah MCL of 4,000 μg/L. Fluoride concentrations in most groundwaters are commonly below 1,000 μg/L. However, other parts of Rush Valley contain groundwater with fluoride concentrations greater than 1,000 μg/L (Hood 1969), and natural groundwater containing up to 50,000 μg/L fluoride has been encountered in other aquifers in the western United States (Hem 1970). The high background concentration, in conjunction with the distribution of fluoride (Figure 7-43), suggests the fluoride is naturally occurring and is not present as a result of SWMU 13 operations.

The analysis for nitrate/nitrite was nonspecific during the 1993 data analysis. Both nitrate and nitrite are commonly associated with the presence of fertilizers and explosives. In the vicinity of TEAD-S, there is little agricultural activity, suggesting the source of nitrate/nitrite is not associated with fertilizer use. There have been explosives detected in groundwater; however, the highest nitrate concentrations are located upgradient of the explosive detections (see Figure 7-46). However, previous investigations (ERTEC 1982) have collected groundwater samples containing over 20,000 μg/L nitrate from a well located at TEAD-S in zone I (see Section 5). In addition, Hem (1970) encountered a groundwater sample containing 68,000 μg/L naturally occurring nitrate in a desert environment. As a result, the source of the elevated nitrate/nitrite concentrations is undetermined and does not appear to be associated with activity at SWMU 13. No background data were available for determining background concentrations of nitrate. Based on the State of Utah MCL of 10,000 μg/L for nitrate and nitrite (as nitrogen), only three wells contained concentrations above the MCL.

There was insufficient data to calculate a background concentration for sulfate. The State of Utah MCL for sulfate ranges from 500,000 to 1,000,000 μg/L. As described in the overview, high sulfate concentrations are common in this semi-arid depositional environment and are generally associated with the precipitation and dissolution of gypsum and anhydrite. As shown in the distribution map, Well S-86-91, upgradient of the CAMDS facility, contained the highest concentration, further suggesting sulfate is naturally occurring.

7.11.2.3 *Explosives*

Only 7 of the 35 wells (S-26-88, S-27-88, S-28-88, S-54-90, S-82-91, S-CAM-1 and S-CAM-2) contained explosives, all of which are located within the fuel spill area near the CAMDS facility. According to TEAD-S personnel, activity at the CAMDS facility is not likely to result in the release of explosives into the groundwater. However, as shown in Figure 7-46, the explosive data suggest CAMDS is the most likely source.

The compounds 2,6-dinitrotoluene, 3-nitrotoluene, and nitrobenzene do not have MCL or TBC values assigned to them. The remaining detected explosives have only TBC values. The compound 2,4,6-trinitrotoluene has a TBC of 2 μg/L and was detected above the TBC in only one well (S-82-91 at 7.3 μg/L). The compound 1,3,5-trinitrobenzene also has a TBC of 2 μg/L and was above this value in only one well (S-CAM-2 at 4.9 μg/L). RDX was detected in two wells above its TBC of 2 μg/L (S-27-88 and S-28-88 had 12.7 and 33 μg/L, respectively), while 1,3-dinitrobenzene and HMX were not present above their respective TBC values of 1 μg/L and 400 μg/L. The compound 2,4-dinitrotoluene was detected in two wells above its very low TBC value of 0.05 μg/L (S-54-90 contained 2.85 μg/L, and S-82-91 contained 9.22 μg/L). As shown on Figure 7-46, the horizontal extent of explosive contamination has been defined by the Phase II RFI sampling.

7.11.2.4 *Metals and Radionuclides*

Figures 7-47 through 7-50 are the distribution maps for the metals detected in groundwater, while Figures 7-51 through 7-53 are the distribution maps for the radionuclides. As with the anions, the metals and radionuclides are generally widespread. Background concentrations have been determined for the detected metals, based on the groundwater sampling of upgradient monitoring wells in TEAD-S in 1991 by Ebasco (as detailed in Section 5.2).

The presence of heavy metals in groundwater may be associated with the mining of vein-and-replacement-type base-and-precious-metal deposits associated with faulting in the Oquirrh Mountains northeast of TEAD-S. These deposits are primarily silver, lead, and zinc and a number of trace metals, including arsenic as a by-product. These deposits also likely contain antimony, bismuth, cadmium, selenium, and uranium.

Arsenic is the most widespread of the metals, detected in samples collected from 23 of the 35 wells. Elevated concentrations were also detected in soil (up to 180 μg/g) within the CAMDS facility. High concentrations of arsenic are typical in aquifers that are relatively high in clay content and of relatively low groundwater yield. In addition, most aquifers with elevated concentrations are located in the western United States and result from weathered mineral deposits (Korte 1991). Ebasco (1991) detected arsenic in the background wells at elevated concentrations, also suggesting arsenic is naturally occurring in this environment. The MCL and background concentrations are both 50 μg/L.

Based on the distribution map (Figure 7-47), there are elevated concentrations of arsenic that may also be related to the fuel spill. Studies have shown that certain metal concentrations may increase in the presence of petroleum hydrocarbons. With increased soil bacteria activity (caused by the presence of petroleum hydrocarbon compounds), there is a depletion of dissolved oxygen in the groundwater and the production of an anaerobic environment. The ultimate effect of the increased biological activity is a decreased pH and an increased reducing environment. Under these conditions, metal species are reduced to their more soluble form, resulting in an increase in groundwater concentrations (Baedecker et al. 1989). The groundwater data suggest arsenic concentrations are potentially affected by this type of altered geochemical environment.

The distribution maps of cadmium (Figure 7-48) and thallium (Figure 7-49) suggest these metals are not present due to operations at SWMU 13. Cadmium (detected above background in 5 wells) has a MCL of 5 μg/L and an estimated background concentration of 4.01 μg/L. The MCL of thallium (detected above background in 6 wells) is 2 μg/L, and the estimated background concentration is 6.99 μg/L.

Selenium was detected in four wells above background (36 μg/L), three of which are above the MCL of 50 μg/L (Figure 7-50). Beryllium was detected in only one sample (S-58-90) at a concentration above the MCL of 4 μg/L (12 μg/L).

The distribution maps showing gross alpha, gross beta, and uranium distribution (Figures 7-51, 7-52 and 7-53, respectively) do not indicate a potential source. Gross alpha and gross beta are a measure of activities/decays of dissolved uranium or other isotopes in groundwater. Since there is no evidence of use or historical data of releases to the soils or groundwater at CAMDS, it is likely that uranium, gross alpha, and gross beta are naturally occurring, potentially being associated with the mining activity of vein deposits east/northeast of TEAD-S.

7.11.2.5 *Semi-Volatile Organic Compounds*

SVOCs are commonly associated with fuel and are likely present in groundwater as result of the documented tank farm fuel spill. Each of the SVOCs, with the exception of bis(2-ethylhexyl) phthalate, was detected in wells associated with the fuel spill, as shown in Figures 7-54 through 7-56.

Figure 7-54 presents the horizontally defined naphthalene plume. The TBC value for naphthalene is 2 μg/L and was exceeded in samples collected from six wells. Phenanthrene, which has no MCL or TBC values, is limited to a plume that is centered in the same area (indicating a similar source) but is not as widespread (Figure 7-55).

The distribution of the remaining SVOCs is shown in Figure 7-56. As earlier mentioned, each of the other compounds were detected in wells near the CAMDS facility, except for bis(2-ethylhexyl) phthalate. This contaminant was present in S-60-90 and S-56-90 at concentrations above the MCL of 6 μg/L (26 and 12 μg/L, respectively). None of the other SVOCs (2-methylnaphthalene, bromacil, fluorene, 2-chloronaphthalene, anthracene, or acenaphthene) have either MCL or TBC values.

7.11.2.6 *Total Petroleum Hydrocarbons*

Figure 7-57 shows the distribution of fuel-related TPHCs. As expected, these compounds were detected in the seven wells that are closest to the tank farm fuel spill site. According to Utah Cleanup Standards for hydrocarbon contaminated groundwater, the action levels for both TPHC gasoline and diesel are 500 μg/L. All wells containing gasoline and diesel phase hydrocarbons were present above these action levels.

7.11.2.7 *Volatile Organic Compounds*

Five of the detected VOCs are commonly associated with fuels and are likely present as result of the tank farm fuel spill. The remaining VOC, trichloroethene is a widely used degreasing agent. However, there are no reported spills or past operations using trichloroethene at the CAMDS facility, and its source is unknown. As with the SVOCs and explosives, these contaminants were detected generally in wells closest to the CAMDS facility.

Figure 7-58 shows the well defined benzene plume. Four wells contained concentrations above the MCL of 5 μg/L. The xylene plume is more widespread than the benzene plume and centered in approximately the same area (Figure 7-59). None of the wells within the plume produced samples containing concentrations higher than the MCL of 10,000 μg/L for xylene.

The distribution of the four remaining VOCs is shown on Figure 7-60. Ethylbenzene, 1,3-dimethylbenzene (m-xylene), and toluene were not detected above their MCLs, while trichloroethene was detected above the MCL (5 μg/L) in only one well (S-76-91 contained 6 μg/L).

7.11.3 Risk Assessment Results

7.11.3.1 *Baseline Human Health Risk Assessment*

Exposure to site-related chemicals in groundwater by potential future on-site residents was evaluated for all of SWMU 13. This section of the report will describe the evaluation of exposure to those chemicals measured in the groundwater within SWMU 13. The results of this evaluation were added to the total risk to the potential future on-site resident (adult and child) at each release site.

7.11.3.1.1 ***Chemicals of Potential Concern.*** The groundwater COPCs were determined from those chemicals detected in 1 or more of the 35 CAMDS monitoring wells during the 1993 sampling effort. Table 7-68 includes the off-site groundwater concentrations of these chemicals. The off-site concentrations were derived with the use of a saturated zone flow and transport computer model using the approach described in Section 6.1.2.3.2. The model input concentrations were the maximum value for each chemical using the most recent set of monitoring results from the CAMDS wells. These chemicals are summarized on Table 7-68.

7.11.3.1.2 ***Complete Exposure Pathways.*** Exposure from dermal contact with and ingestion of site-related chemicals in groundwater by potential future on-site residents was evaluated. Exposure from inhalation of VOCs in groundwater during showering and bathing activities was also evaluated.

7.11.3.1.3 ***Exposure Point Concentrations.*** Exposure to site-related chemicals in groundwater by potential future on-site residents was evaluated based on the exposure point concentrations in Table 7-68. These values are 95 percent UCL of the mean or the maximum detected value, whichever was lower, for the data groupings of all 35 CAMDS monitoring wells for the August and September 1993 sampling event.

Based on the results of the saturated zone modeling summarized in Table 7-68, the estimated time for these chemicals to reach a peak groundwater concentration at the off-site location

Table 7-68. SWMU 13 Summary of Concentrations of Chemicals of Potential Concern in Groundwater, Phase II RFI

Chemical	Frequency of Detection	Range of Detects (mg/L)	Arithmetic Mean Concentration (mg/L)	95% UCL (mg/L)	Exposure Point Concentration (mg/L)	Estimated Peak Off-Site Concentration (mg/L)	Peak Concentration Time (years)
Isopropyl methyl-phosphoric acid (IMPA)	4/35	0.51-4.0	0.27	0.49	0.49	1.0E-03	90
1,3-Dinitrobenzene	2/29	0.00091-0.00096	0.00028	0.00034	0.00034	6.87E-07	80
2,4-Dinitrotoluene	2/35	0.0028-0.0092	0.0007	0.00117	0.00117	6.27E-06	90
2,6-Dinitrotoluene	3/35	0.0025-0.024	0.0014	0.0026	0.0026	1.68E-05	90
Fluoride	35/35	3.35-38.0	12.91	15.23	15.23	5.66E-02	80
HMX	1/34	0.017	0.0016	0.0025	0.0025	2.1E-05	80
Nitrate	24/35	0.013-16.0	1.97	3.09	3.09	5.5E-02	81
Nitrobenzene	2/33	0.003-0.006	0.00092	0.00129	0.00129	1.1E-17	26
3-Nitrotoluene	1/35	0.019	0.0019	0.0028	0.0028	8.4E-06	209
RDX	2/35	0.0127-0.033	0.0012	0.0037	0.0037	4.9E-05	83
1,3,5-Trinitrobenzene	2/35	0.0011-0.005	0.00044	0.0007	0.0007	3.15E-06	90
2,4,6-Trinitrotoluene	3/32	0.0015-0.0073	0.0036	0.001	0.001	1.99E-06	210
Acenaphthene	3/35	0.019-0.11	0.0085	0.0147	0.0147	1.0E-99	DC
Anthracene	3/35	0.011-0.230	0.01	0.021	0.021	1.0E-99	DC
Bis(2-ethylhexyl)phthalate	2/35	0.012-0.026	0.0047	0.0058	0.0058	1.0E-99	DC
2-Chloronaphthalene	1/35	0.0058	0.0014	0.0016	0.0016	2.4E-07	1075
Fluorene	4/35	0.09-0.20	0.002	0.0327	0.0327	1.0E-99	DC
2-Methylnaphthalene	4/35	0.030-1.00	0.0723	0.138	0.138	5.87E-05	950
Naphthalene	7/35	0.010-0.40	0.036	0.062	0.062	1.0E-99	DC

Table 7-68. SWMU 13 Summary of Concentrations of Chemicals of Potential Concern in Groundwater, Phase II RFI (continued)

Chemical	Frequency of Detection	Range of Detects (mg/L)	Arithmetic Mean Concentration (mg/L)	95% UCL (mg/L)	Exposure Point Concentration (mg/L)	Estimated Peak Off-Site Concentration (mg/L)	Peak Concentration Time (years)
Phenanthrene	5/35	0.055-1.00	0.066	0.1238	0.1238	1.0E-99	DC
Benzene	8/35	0.001-0.028	0.0025	0.004	0.004	1.4E-11	29
1,3-Dimethylbenzene	2/35	0.0025-0.019	0.0011	0.002	0.002	6.9E-17	22
Ethylbenzene	4/35	0.002-0.030	0.00213	0.0039	0.0039	1.0E-99	DC
Toluene	4/35	0.0014-0.029	0.0016	0.003	0.003	1.0E-99	DC
Trichloroethylene	4/35	0.0012-0.006	0.0008	0.001	0.001	6.5E-10	41
Xylene	2/10	0.061-0.10	0.020	0.039	0.039	1.5E-15	22
Arsenic	35/35	0.011-1.10	0.234	0.322	0.322	4.25E-04	320
Beryllium	9/35	0.0013-0.012	0.0012	0.0018	0.0018	3.16E-08	165,000
Cadmium	5/35	0.0076-0.0186	0.0045	0.0055	0.0055	6.59E-05	360
Selenium	12/35	0.0029-0.420	0.021	0.041	0.041	6.59E-05	360
Thallium	6/35	0.164-0.421	0.092	0.114	0.114	1.76E-06	380,000

Notes.--DC=Contaminant degrades completely prior to reaching off-site receptor. Exposure from inhalation of VOCs during showering was evaluated based on the following average air concentrations: benzene (0.0132 mg/m^3), ethylbenzene (0.0102 mg/m^3), trichloroethene (0.00276 mg/m^3), toluene (0.00844 mg/m^3) and xylenes (0.0102 mg/m^3).

varies between 22 and 380,000 years. Therefore, exposure to these COPCs by current off-site residents (adult and child) was assumed negligible and was not evaluated further.

7.11.3.1.4 ***Risk Estimates.*** The cancer risk and noncarcinogenic hazard associated with exposure to this environmental medium was only evaluated for the potential future on-site resident (adult and child). The results of this evaluation indicate that the cancer risk to the adult receptor was estimated to be 5.95E-03, and the noncarcinogenic, 7.40E+01. The cancer risk to the child receptor was estimated to be 2.78E-03, and the noncarcinogenic hazard, 9.64E+01. These results have been included as a contribution to the total carcinogenic risk and noncarcinogenic hazard to the potential future on-site resident at each of the sites within SWMU 13. Table 7-69 includes a summary of these results for each exposure route associated with this medium.

Table 7-69. Summary of Carcinogenic Risk and Noncarcinogenic Hazard for Groundwater, SWMU 13

Potential Exposure Route	Carcinogenic Risk Future On-Site Resident (child)		Noncarcinogenic Hazard Future On-Site Resident (child)
Dermal Contact	1.55E-04 (4.79E-05)		5.02E-01 (2.81E-01)
Ingestion	5.79E-03 (2.73E-03)[a]		7.35E+01 (9.61E+01)[b]
Vapor Inhalation	3.00E-07 (2.10E-07)		1.38E-02 (5.45E-03)
Total Risk	5.95E-03 (2.78E-03)	Total Hazard	7.40E+01 (9.64E+01)

Notes.—Value in parenthesis represents that for child receptor.

[a]Ingestion of arsenic detected in SWMU-wide monitoring wells is responsible for at least 90 percent of the total groundwater pathway risks.

[b]Ingestion of arsenic, thallium, and fluoride detected in SWMU-wide monitoring wells is responsible for at least 90 percent of the total groundwater pathway hazards.

7.11.3.2 *Ecological Risk Assessment*

Groundwater was not evaluated for adverse ecological effects on biota at individual sites at SWMU 13 because the depth to groundwater (minimum of 6 feet) represents an unlikely exposure pathway of COPCs to ecological receptors.

7.11.3.2.1 ***Conclusions.*** The groundwater exposure pathway to biota (vegetation and wildlife) is incomplete and, therefore, no adverse impacts to receptor species should occur due to exposure to any groundwater COPCs.

7.11.4 Conclusions and Recommendations

Groundwater samples were collected from the monitoring wells associated with SWMU 13 in May/June 1991 and August/September 1993. Only the 1993 data set was used to determine the nature and extent of the COPCs and for risk assessment purposes, since it represented the most recent and accurate groundwater data associated with the site.

IMPA was the only chemical agent breakdown product detected in groundwater samples collected from SWMU 13. IMPA was not horizontally defined, having the highest concentration (which exceeds the TBC value) present in S-106-93. The only possible source of IMPA is the chemical demilitarization process (see Section 7.11.2.1).

A total of five anions were detected in elevated concentrations. Both chloride and fluoride background concentrations were higher than associated MCL or TBC values. Bromide was detected over five times above the background concentration. Sufficient data were not available to calculate background concentrations for sulfate and nitrate/nitrite. Bromide, chloride, fluoride, and sulfate were all present in concentrations commonly associated with the semi-arid hydrogeochemical environment encountered at TEAD-S. As a result, all are considered to be present in groundwater as naturally occurring, and their respective elevated concentrations are not the result of activity at SWMU 13. It is not known why nitrate/nitrite was detected in the groundwater, and studies have shown nitrate concentrations in natural groundwaters up to 20,000 μg/L, which is higher than any detected concentrations during the Phase II investigation. However, it does not appear to be associated with the presence of explosives in groundwater. Its source is unknown.

Nine different explosives were detected in only 7 of the 35 monitoring wells. Of these explosives, only 2,4,6-trinitrotoluene, 1,3,5-trinitrobenzene, RDX, and 2,4-dinitrotoluene were detected above their respective TBC concentrations. There are no MCL values assigned to any of the detected explosives. According to TEAD-S personnel, there are no documented releases of explosives into the groundwater; however, the distribution of the explosives suggests its source is associated with operations at the CAMDS facility.

Metals detected in groundwater include arsenic, beryllium, cadmium, thallium, and selenium, all of which are present above their respective background and MCL concentrations. Three radionuclides (gross alpha, gross beta, and uranium) were also detected above MCL concentrations. Each of these contaminants are believed to be naturally occurring and are present in groundwater because of mining activity in the Oquirrh Mountains to the northeast.

A total of nine SVOCs were detected in the groundwater samples, all present in the wells associated with the fuel spill area. Of the nine, only two (naphthalene and bis(2-ethylhexyl) phthalate) are present above respective TBC and MCL concentrations.

Six VOCs along with TPHCs were detected, all of which were a result of the fuel spill. Of the VOCs detected, only benzene and trichloroethene were present in concentrations above their MCLs. TPHCs were present above State of Utah action levels.

The COPCs were evaluated during the human health risk assessment. Nine potential contaminants identified by the screened groundwater data were not evaluated in the risk assessment because there was no health criteria available for these COPCs. These nine COPCs consist of bromide, chloride, sulfate, fluoride, bromacil, TPHCs, gross alpha, and gross beta. The anions have low toxicity and are not likely to be of concern. A large number of tentatively identified compounds (TICs) were detected in groundwater samples. The vast majority of these are hydrocarbons that would be included in the TPHC analyses. TPHCs have State of Utah action levels in groundwater.

Based on computer simulations (Appendix H), the estimated times for the remaining COPCs to reach peak concentrations at the off-site receptor ranges from 22 (for m-xylene) to 380,000 (for thallium) years, using a very conservative approach (see Section 6.1). This wide range is the result of a given analyte's chemical properties and migration potential. In addition, concentrations would be significantly reduced (compared to the latest sampling results) according to these modeling results. Indeed, all non-naturally occurring COPCs (i.e., VOCs, SVOCs, explosives) would reach the TEAD-S boundary below their respective MCL or TBC concentrations. As a result, the exposure to these COPCs by current off-site residents (both adult and child) was assumed to be negligible and was not evaluated further.

Based on the evaluation for the potential future on-site receptor, the results indicate the adult and child cancer risks are estimated to be 7.07E-3 and 3.28E-3, respectively. The noncarcinogenic hazards for the adult is estimated to be 7.95E+1 and for the child, 9.75E+01. Arsenic alone contributes over 95 percent of the total groundwater cancer risk. Similarly, arsenic and thallium combined account for approximately 98 percent of the total groundwater non-cancer hazard potential to future on-site residents.

Groundwater was not evaluated in the ecological risk assessment since it is not available for ingestion by vegetation or wildlife.

Exposure to SWMU-related chemicals in groundwater by current on-site workers and future construction workers was not evaluated because the current source of drinking water is located significantly off-site. The exposure to current off-site residents was not evaluated because the results of the groundwater pathway were only included in the future land use (Residential Scenario) evaluation. Since the groundwater pathway was evaluated comprehensively, the cancer risk and hazard associated with this medium was included at each release site within SWMU 13. The results of the risk assessment indicate that cancer risk and hazard resulting from exposure SWMU-related chemicals in groundwater are unacceptably high. As a result, the criterion in item (c)(1) of R315-101-6 cannot be met and, therefore, the no further action option cannot be pursued. Based on the provisions of item (d) of R315-101-6, if the cancer risk and hazard under a future land use exposure scenario exceed 1E-06 and 1.0, respectively, then this environmental medium should be further evaluated in the CMS. However, the CMS is not required to contain corrective actions but should include appropriate management activities such as monitoring, deed notations, site security, or post closure care.