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CNC CHARLESTON
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RESOURCE CONSERVATION AND RECOVERY ACT FACILITY INVESTIGATION REPORT ZONE G VOLUME II OF VI SECTIONS 10 TO 10.7 CNC CHARLESTON SC

2/20/1998

ENSAFE

ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVBASE CHARLESTON

VOLUME II of VI
SECTIONS 10 to 10.7

CONTRACT N62467-89-D-0318
CTO-029

Prepared for:

Comprehensive Long-Term Environmental Action Navy
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Revision: 0

10.0 SITE-SPECIFIC EVALUATIONS

The objectives of the approved final work plan were to: (1) identify COPCs (if present) at each site, (2) evaluate the nature and extent of any contamination, and (3) appraise sites requiring corrective measures. The site-specific evaluations are divided into investigation groups that were established in the approved final work plan. Each discussion includes detailed, site-specific summaries containing: (1) site history and previous investigations, (2) site-specific geology and hydrogeology, (3) field investigation approach and deviations from the approved final work plan, (4) nature and extent of contamination, (5) expected fate and transport of COPCs, (6) human health-based risk assessment, and (7) corrective measures considerations.

The site-specific discussions are designed to provide the information necessary to determine any required site-specific remedial alternatives, and to specify which sites are potential CMS candidates.

10.1 AOC 628, Sandblasting Area, Southeast of Building 68

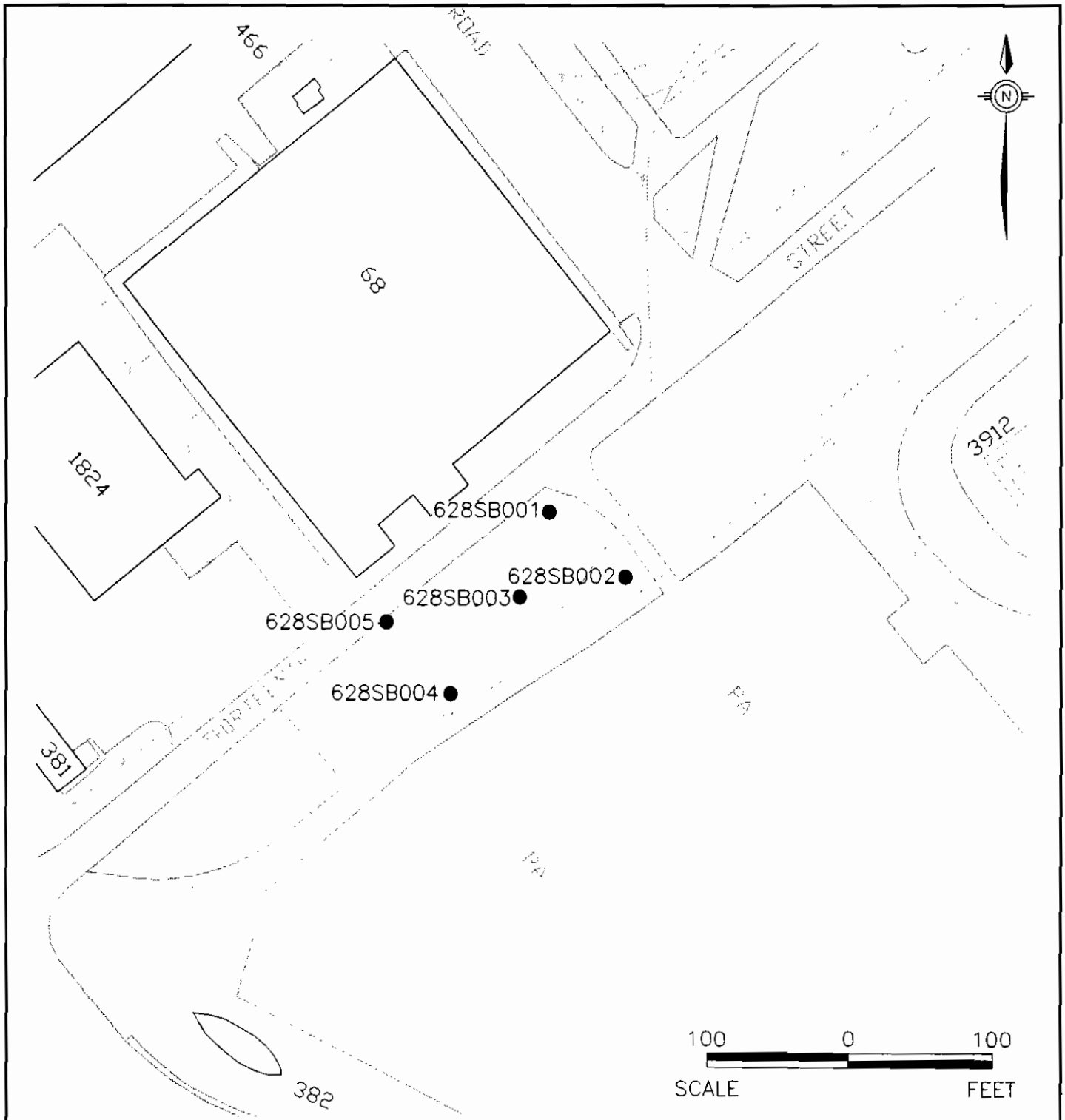
A CSI site, AOC 628 is a fenced area southeast of Building 68 that was used from 1962 to 1967 for abrasive blasting of large metal parts, including ship parts. Materials released, stored or disposed of included spent blasting media, paint and metallic residues, organic solvent wastes, and petroleum products.

10.1.1 Site Geology

The soil boring locations for AOC 628 are shown in Figure 10.1-1. The detailed stratigraphy at AOC 628 could not be determined as no monitoring well borings were installed at this site. Therefore, geologic and hydrogeologic data gathered from the immediately adjacent AOC 620 in Zone F, is presented. Based on three monitoring well borings, the stratigraphy consists of silt and clay overlying sandy clay. The silt and clay exhibits a grain size distribution of 8% sand, 32% silt, and 60% clay. The sandy clay extends to the maximum depth of the wells and exhibits an average grain size distribution of 55% sand, 10% silt, and 35% clay. Boring logs for these wells are contained in Appendix A of the *Draft Zone F RCRA Facility Investigation Report* (EnSafe, December 1997). Based on the Zone G shallow groundwater potentrometric maps contained in Section 2 the groundwater elevation at AOC 628 is approximately 4 ft msl. Shallow groundwater at AOC 628 flows generally to the southeast.

10.1.2 Field Investigation Approach

The objective of the field investigation at AOC 628 was to: (1) confirm the presence or absence of contamination in the site area; (2) delineate any contamination found; and (3) provide sufficient data to support a detailed evaluation of treatment alternatives, if required. Media sampled within the investigation area included site soil. Section 3 of this report details the methods used during the field investigation. Included in this section are descriptions of the hand-auger procedures used for soil sampling, and miscellaneous procedures used during the field investigation. Also



LEGEND

● – SOIL BORING

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CHARLESTON, S.C.

FIGURE 10.1–1
SAMPLING LOCATIONS
AOC #628
SANDBLASTING AREA,
SOUTHEAST OF BUILDING 68

DWG DATE: 01/15/98 | DWG NAME: 29CHZG09

discussed are the analytical protocols for sample analyses. Appendix D contains the analytical data report or samples collected in Zone G.

10.1.3 Soil Sampling and Analysis

The approved final RFI work plan proposed advancing five soil borings within the AOC 628 area to detect the presence of any soil contamination from this site. Upper and lower interval soil samples were proposed from each boring. Five soil borings were advanced during the field investigation, as depicted in Figure 10.1-1. Four borings included both soil sampling intervals, while one boring included the upper interval only. Where not collected, the lower interval sample was not collected due to obstructions in the borehole, or because of a shallow water table. In accordance with the approved final RFI work plan soil samples from AOC 628 were analyzed for metals, SVOCs, and VOCs at DQO Level III. Table 10.1.1 summarizes the AOC 628 soil samples and analyses.

Table 10.1.1
Zone G
AOC 628
Soil Samples and Analyses

Boring Location	Sample Identifier	Sample Interval	Date Collected	Analyses	Remarks
628SB001	628SB00101 628SB00202	Upper Lower	109/01/96	See Note	
628SB002	628SB00201 628SB00202	Upper Lower	10/01/96	See Note	
628SB003	628SB00301 628SB00302	Upper Lower	10/01/96	See Note	
628SB004	628SB00401	Upper	10/01/96	See Note	Lower interval not sampled
628SB005	628SB00501 628SB00502	Upper Lower	10/01/96	See Note	

Note:
SW-846 (metals, SVOCs, VOCs) at DQO Level III

10.1.3.1 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.1.2. Inorganic analytical results for soil are summarized in Table 10.1.3. Table 10.1.4 summarizes all analytes detected in soil at AOC 628. Appendix D contains a complete analytical data report for all Zone G samples collected.

Volatile Organic Compounds in Soil

Two VOCs were detected in surface soil. No VOCs in surface soil exceeded their respective RBC.

Three VOCs were detected in subsurface soil samples at this AOC. Methylene chloride was the only VOC which exceeded its respective SSL in subsurface soil. Figure 10.1-2 presents methylene chloride concentrations detected in subsurface soil.

Semivolatile Organic Compounds in Soil

Fourteen SVOCs were detected in surface soil samples at AOC 628. Benzo(a)pyrene and dibenz(a,h)anthracene exceeded exceeded their respective RBCs in surface soil samples at this AOC. Figure 10.1-3 presents total BEQ concentrations detected in surface soil at AOC 628.

Eighteen SVOCs were detected in subsurface soil samples at AOC 628. No SVOCs in subsurface soil exceeded their respective SSL.

Inorganic Elements in Soil

Eighteen metals were detected in surface soil samples collected at AOC 628. Arsenic, and chromium were detected at concentrations which exceeded the greater of their respective RBCs and background concentrations for Zone G surface soil. Concentrations of iron in all five samples exceeded the RBC. Because iron is considered an essential nutrient, no background for iron was established.

Table 10.1.2
Zone G
AOC 628
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (µg/kg)	Mean of Detections (µg/kg)	Reference Conc.* (µg/kg)	Number of Samples Exceeding Reference
Volatile Organic Compounds (Upper Interval - 5 Samples/Lower Interval - 4 Samples) (µg/kg)						
Benzene	Upper	1/5	2.00	2.00	22000	0
	Lower	0/4	ND	ND	30	0
2-Butanone (MEK)	Upper	0/5	ND	ND	4700000	0
	Lower	1/4	44.0	44.0	7900	0
Carbon disulfide	Upper	0/5	ND	ND	780000	0
	Lower	2/4	1.00 - 2.00	1.50	32000	0
Methylene chloride	Upper	0/5	ND	ND	85000	0
	Lower	1/4	32.0	32.0	20	1
Trichloroethene	Upper	1/5	2.00	2.00	58000	0
	Lower	0/4	ND	ND	60	0
Semivolatile Organic Compounds (Upper Interval - 5 Samples/Lower Interval - 4 Samples) (µg/kg)						
BEQs[1]	Upper	5/5	84.8 - 453.55	292	88	4
	Lower	0/4	NA	NA	NA	NA
Benzo(a)anthracene	Upper	5/5	54.0 - 260	149	880	0
	Lower	3/4	140 - 330	233	2000	0
Benzo(b)fluoranthene	Upper	5/5	76.0 - 320	213	880	0
	Lower	3/4	74.0 - 250	184	5000	0
Benzo(k)fluoranthene	Upper	5/5	79.0 - 250	182	8800	0
	Lower	3/4	64.0 - 350	225	49000	0

Table 10.1.2
Zone G
AOC 628
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (µg/kg)	Mean of Detections (µg/kg)	Reference Conc.* (µg/kg)	Number of Samples Exceeding Reference
Benzo(a)pyrene	Upper	5/5	66.0 - 270	179	88	4
	Lower	4/4	73.0 - 280	196	8000	0
Chrysene	Upper	5/5	53.0 - 650	287	88000	0
	Lower	4/4	89.0 - 540	272	160000	0
Dibenz(a,h)anthracene	Upper	4/5	46.0 - 120	77.0	88	1
	Lower	3/4	55.0 - 77.0	66.0	2000	0
Indeno(1,2,3-cd)pyrene	Upper	5/5	50.0 - 220	128	880	0
	Lower	3/4	100 - 180	150	14000	0
Acenaphthene	Upper	0/5	ND	ND	470000	0
	Lower	2/4	52.0 - 86.0	69.0	570000	0
Acenaphthylene	Upper	2/5	60.0 - 73.0	66.5	230000	0
	Lower	1/4	69.0	69.0	293000	0
Anthracene	Upper	4/5	60.0 - 170	101	2300000	0
	Lower	4/4	22.0 - 130	79.5	12000000	0
Benzo(g,h,i)perylene	Upper	5/5	54.0 - 300	153	230000	0
	Lower	3/4	130 - 190	157	4.66E08	0
Di-n-butylphthalate	Upper	0/5	ND	ND	780000	0
	Lower	1/4	24.0	24.0	2300000	0
Fluoranthene	Upper	4/5	180 - 2100	795	310000	0
	Lower	4/4	100 - 2100	775	4300000	0

Table 10.1.2
Zone G
AOC 628
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (µg/kg)	Mean of Detections (µg/kg)	Reference Conc.* (µg/kg)	Number of Samples Exceeding Reference
Fluorene	Upper	0/5	ND	ND	310000	0
	Lower	1/4	48.0	48.0	560000	0
2-Methylnaphthalene	Upper	1/5	42.0	42.0	310000	0
	Lower	0/4	ND	ND	126000	0
Naphthalene	Upper	0/5	ND	ND	310000	0
	Lower	1/4	44.0	44.0	84000	0
Phenanthrene	Upper	4/5	69.0 - 450	220	230000	0
	Lower	4/4	26.0 - 1100	359	1380000	0
Pyrene	Upper	4/5	160 - 1400	580	230000	0
	Lower	4/4	78.0 - 1400	557	4200000	0
1,2,4-Trichlorobenzene	Upper	0/5	ND	ND	78000	0
	Lower	1/4	76.0	76.0	5000	0

Notes:
1 = Calculated from methods deseribed in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995c)
* = Residential RBCs (THQ=0.1) were used as a referenee concentration for upper interval samples. Generic soil-to-groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as a reference concentration for lower interval samples
ND = Not detected
NL = Not listed
NA = Not applicable
mg/kg = Milligrams per kilogram
µg/kg = Micrograms per kilogram

Table 10.1.3
Zone G
AOC 628
Inorganic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Inorganics (Upper Interval - 5 Samples/Lower Interval - 4 Samples) (mg/kg)						
Aluminum (Al)	Upper	5/5	3130 - 10600	5780	7800	1
	Lower	4/4	5150 - 15800	9790	1000000	0
Antimony (Sb)	Upper	1/5	0.64	0.640	3.10	0
	Lower	2/4	0.50 - 0.57	0.535	5	0
Arsenic (As)	Upper	5/5	1.40 - 21.0	8.48	0.430	5
	Lower	4/4	7.50 - 19.4	11.9	29	0
Barium (Ba)	Upper	5/5	11.0 - 38.5	21.3	550	0
	Lower	4/4	16.5 - 44.4	29.6	1600	0
Beryllium (Be)	Upper	0/5	ND	ND	0.15	0
	Lower	1/4	1.30	1.30	63	0
Cadmium (Cd)	Upper	4/5	0.17 - 0.33	0.253	3.90	0
	Lower	3/4	0.32 - 0.42	0.360	8	0
Calcium (Ca)	Upper	5/5	5970 - 80600	34900	NL	NA
	Lower	4/4	5460 - 15500	10500	NL	NA
Chromium (Cr)	Upper	5/5	5.40 - 44.7	21.2	39.0	1
	Lower	4/4	22.4 - 32.6	26.0	1000000	0
Cobalt (Co)	Upper	5/5	0.86 - 2.20	1.83	470	0
	Lower	4/4	2.70 - 6.60	3.88	2000	0
Iron (Fe)	Upper	5/5	2780 - 23900	9690	2300	5
	Lower	4/4	11000 - 30600	16900	NL	NA

Table 10.1.3
Zone G
AOC 628
Inorganic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Lead (Pb)	Upper	5/5	11.2 - 97.0	54.9	400	0
	Lower	4/4	42.9 - 98.0	68.8	400	0
Magnesium (Mg)	Upper	5/5	798 - 2560	1550	NL	NA
	Lower	4/4	1450 - 4810	2570	NL	NA
Manganese (Mn)	Upper	5/5	55.4 - 146	96.8	180	0
	Lower	4/4	158 - 655	290	1100	0
Mercury (Hg)	Upper	5/5	0.04 - 0.19	0.136	2.30	0
	Lower	4/4	0.17 - 0.40	0.285	2.1	0
Nickel (Ni)	Upper	5/5	4.40 - 11.4	6.94	160	0
	Lower	4/4	6.70 - 10.9	8.98	130	0
Potassium (K)	Upper	4/5	396 - 2330	942	NL	NA
	Lower	4/4	649 - 2490	1250	NL	NA
Selenium (Se)	Upper	4/5	0.38 - 1.4	0.73	39.0	0
	Lower	4/4	0.38 - 1.8	0.87	5	0
Thallium (Tl)	Upper	0/5	ND	ND	0.63	0
	Lower	1/4	0.47	0.47	0.95	0
Vanadium (V)	Upper	5/5	4.30 - 37.9	16.5	55.0	0
	Lower	4/4	18.3 - 59.9	32.5	6000	0
Zinc (Zn)	Upper	5/5	24.5 - 91.6	73.1	2300	0
	Lower	4/4	101 - 161	138	12000	0

Notes:

*	=	Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil-to-groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as a reference concentration for lower interval samples
ND	=	Not detected
NL	=	Not listed
mg/kg	=	Milligrams per kilogram

Table 10.1.4
Zone G
AOC 628
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Volatile Organic Compounds (µg/kg)							
Benzene	628SB002	2.000	22000	NA	ND	30	NA
2-Butanone (MEK)	628SB002	ND	4700000	NA	44	7900	NA
Carbon disulfide	628SB002	ND	780000	NA	1.0	32000	NA
	628SB003	ND			2.0		
Methylene chloride	628SB001	ND	85000	NA	**32**	20	NA
Trichloroethene	628SB002	2.000	58000	NA	ND	60	NA
Semivolatile Organic Compounds (µg/kg)							
BEQs[1]	628SB001	**453.55**	88	NA	NA	NA	NA
	628SB002	84.843			NA		
	628SB003	**325.80**			NA		
	628SB004	**259.15**			NA		
	628SB005	**336.18**			NA		
Benzo(a)anthracene	628SB001	140	880	NA	140	2000	NA
	628SB002	54			330		
	628SB003	260			230		
	628SB004	170			NT		
	628SB005	120			ND		

Table 10.1.4
Zone G
AOC 628
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Benzo(b)fluoranthene	628SB001	250	880	NA	220.000	5000	NA
	628SB002	76			250.000		
	628SB003	210			190.000		
	628SB004	320			NT		
	628SB005	210			74.000		
Benzo(k)fluoranthene	628SB001	230	8800	NA	ND	49000	NA
	628SB002	79			350		
	628SB003	150			260		
	628SB004	250			NT		
	628SB005	200			64		
Benzo(a)pyrene	628SB001	**270**	88	NA	160	8000	NA
	628SB002	66			280		
	628SB003	**210**			270		
	628SB004	**150**			NT		
	628SB005	**200**			73		
Chrysene	628SB001	250	88000	NA	180	160000	NA
	628SB002	53			540		
	628SB003	300			280		
	628SB004	650			NT		
	628SB005	180			89		
Indeno(1,2,3-cd)pyrene	628SB001	220	880	NA	100	14000	NA
	628SB002	50			170		
	628SB003	110			180		
	628SB004	110			NT		
	628SB005	150			ND		

Table 10.1.4
Zone G
AOC 628
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Acenaphthene	628SB002	ND	470000	NA	52	570000	NA
	628SB003	ND			86		
Acenaphthylene	628SB003	ND	230000	NA	69	293000	NA
	628SB004	73			NT		
	628SB005	60			ND		
Anthracene	628SB001	60	2300000	NA	56	12000000	NA
	628SB002	ND			130		
	628SB003	75			110		
	628SB004	170			NT		
	628SB005	98			22		
Benzo(g,h,i)perylene	628SB001	300	230000	NA	130	4.66E08	NA
	628SB002	54			150		
	628SB003	110			190		
	628SB004	110			NT		
	628SB005	190			ND		
Dibenz(a,h)anthracene	628SB001	**120**	88	NA	55	2000	NA
	628SB003	56			77		
	628SB004	46			NT		
	628SB005	86			24		
Di-n-butylphthalate	628SB005	ND	780000	NA	24	2300000	NA
Fluoranthene	628SB001	190	310000	NA	340	4300000	NA
	628SB002	ND			2100		
	628SB003	710			560		
	628SB004	2100			NT		
	628SB005	180			100		

Table 10.1.4
Zone G
AOC 628
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Fluorene	628SB002	ND	310000	NA	48	560000	NA
2-Methylnaphthalene	628SB005	42	310000	NA	ND	126000	NA
Naphthalene	628SB003	ND	310000	NA	44	84000	NA
Phenanthrene	629SB001	100	230000	NA	180	1380000	NA
	628SB002	ND			1100		
	628SB003	260			130		
	628SB004	450			NT		
	628SB005	69			26		
Pyrene	628SB001	160	230000	NA	270	4200000	NA
	628SB002	ND			1400		
	628SB003	600			480		
	628SB004	1400			NT		
	628SB005	160			78		
1,2,4-Trichlorobenzene	628SB003	ND	78000	NA	76	5000	NA
Inorganics (mg/kg)							
Aluminum (Al)	628SB001	5590	7800	18700	5150	1000000	23600
	628SB002	3130			8010		
	628SB003	4450			10200		
	628SB004	10600			NT		
	628SB005	5150			15800		
Antimony (Sb)	628SB001	0.64	3.1	2.89	0.57	5	NL
	628SB002	ND			0.50		

Table 10.1.4
Zone G
AOC 628
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Arsenic (As)	628SB001	7.4	0.43	17.2[a]	10.8	29	15.5[a]
	628SB002	1.4			7.5		
	628SB003	6.2			10		
	628SB004	21			NT		
	628SB005	6.4			19.4		
Barium (Ba)	628SB001	17.1	550	109	16.5	1600	64.5
	628SB002	11			28.2		
	628SB003	23.1			44.4		
	628SB004	38.5			NT		
	628SB005	16.9			29.2		
Beryllium (Be)	628SB005	ND	0.15	1.20	1.3	63	1.63
Cadmium (Cd)	628SB001	0.31	3.9	1.07	0.42	8	0.48
	628SB002	0.20			0.34		
	628SB003	0.33			0.32		
	629SB005	0.17			ND		
Calcium (Ca)	628SB001	11300	NL	NL	5460	NL	NL
	628SB002	80600			9520		
	628SB003	69400			15500		
	628SB004	7080			NT		
	628SB005	5970			11700		
Chromium (Cr)	628SB001	22.2	7800 (III)	42.8	22.4	1000000	43.4[a]
	628SB002	5.4	39 (IV)		24.4		
	628SB003	14.9			24.4		
	628SB004	44.7			NT		
	628SB005	18.6			32.6		

Table 10.1.4
Zone G
AOC 628
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Cobalt (Co)	628SB001	2.2	470	6.60	3.1	2000	8.14
	628SB002	0.86			2.7		
	628SB003	2			3.1		
	628SB004	2.1			NT		
	628SB005	2			6.6		
Iron (Fe)	628SB001	**8090**	2300	NL	11000	NL	NL
	628SB002	**2780**			11500		
	628SB003	**7040**			14400		
	628SB004	**23900**			NT		
	628SB005	**6640**			30600		
Lead(Pb)	628SB001	97	400	181	57.6	400	66.3
	628SB002	11.2			76.5		
	628SB003	53.8			98		
	628SB004	63.7			NT		
	628SB005	48.9			42.9		
Magnesium (Mg)	628SB001	1250	NL	NL	1450	NL	NL
	628SB002	1260			1660		
	628SB003	1880			2360		
	628SB004	2560			NT		
	628SB005	798			4810		
Manganese (Mn)	628SB001	120	180	325	171	1100	291
	628SB002	67.3			158		
	628SB003	146			175		
	628SB004	55.4			NT		
	628SB005	95.1			655		

Table 10.1.4
Zone G
AOC 628
Analytes Detected in Surface and Subsurface Soil

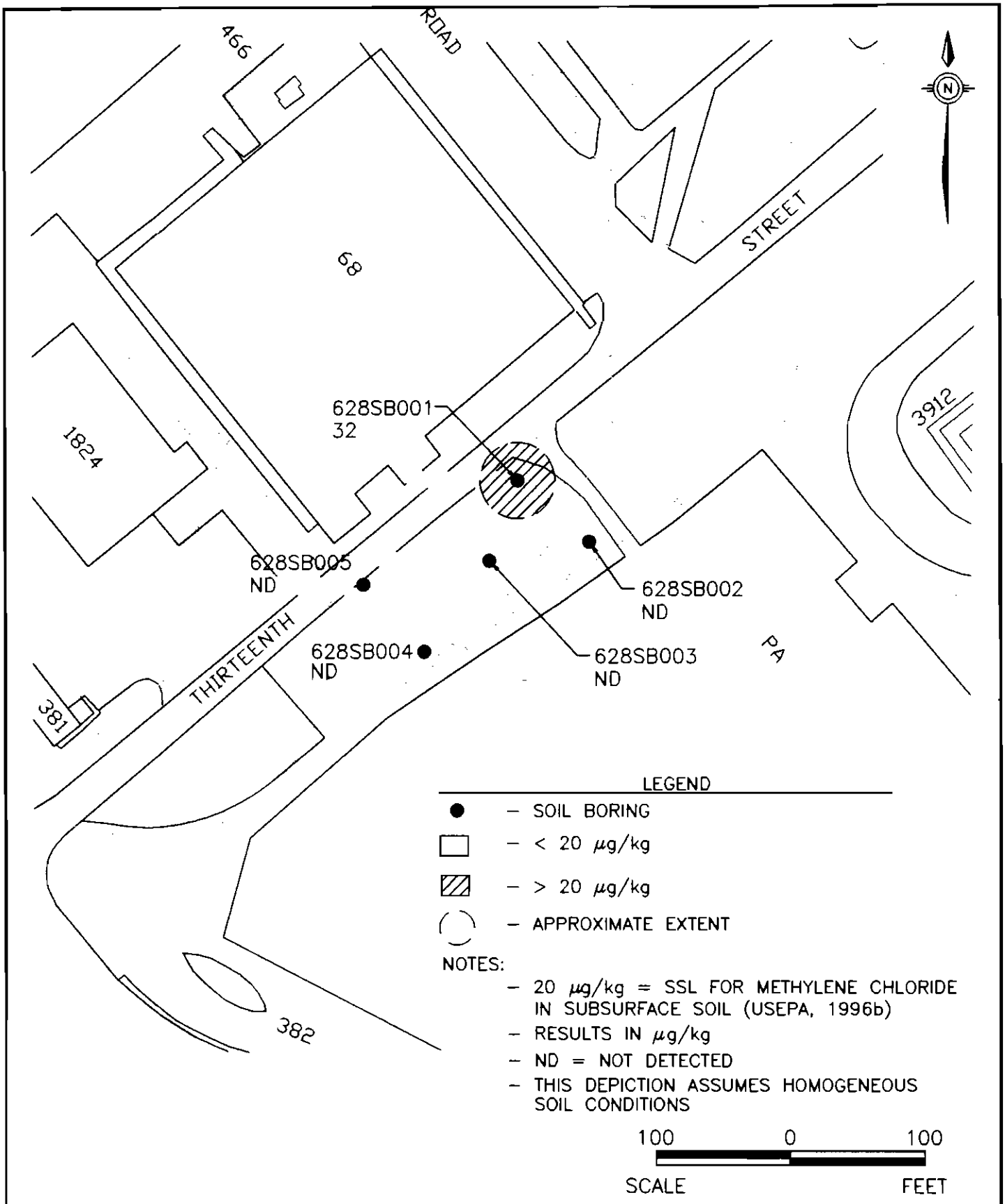
Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Mercury (Hg)	628SB001	0.19	2.3	1.03	0.26	2.1	0.31
	628SB002	0.04			0.40		
	628SB003	0.1			0.31		
	628SB004	0.16			NT		
	628SB005	0.19			0.17		
Nickel (Ni)	628SB001	6.8	160	20.6	10	130	18.3
	628SB002	4.4			6.7		
	628SB003	7.1			8.3		
	628SB004	5			NT		
	628SB005	11.4			10.9		
Potassium (K)	628SB001	530	NL	NL	649	NL	NL
	628SB002	ND			770		
	628SB003	511			1080		
	629SB004	2330			NT		
	628SB005	396			2490		
Selenium (Se)	628SB001	0.52	39	1.22	0.50	5	1.26
	628SB002	ND			0.38		
	628SB003	0.62			0.80		
	628SB004	1.40			NT		
	628SB005	0.38			1.80		
Thallium (Tl)	628SB002	ND	0.63	0.85	0.47	0.95	0.95

Table 10.1.4
Zone G
AOC 628
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Vanadium (V)	628SB001	15.8	55	60.9	18.3	6000	72.5
	628SB002	4.3			22.6		
	628SB003	12.3			29.1		
	628SB004	37.9			NT		
	628SB005	12.1			59.9		
Zinc (Zn)	628SB001	88.5	2300	519	145	12000	145
	628SB002	24.5			161		
	628SB003	79.5			144		
	628SB004	91.6			NT		
	628SB005	81.4			101		

Notes:

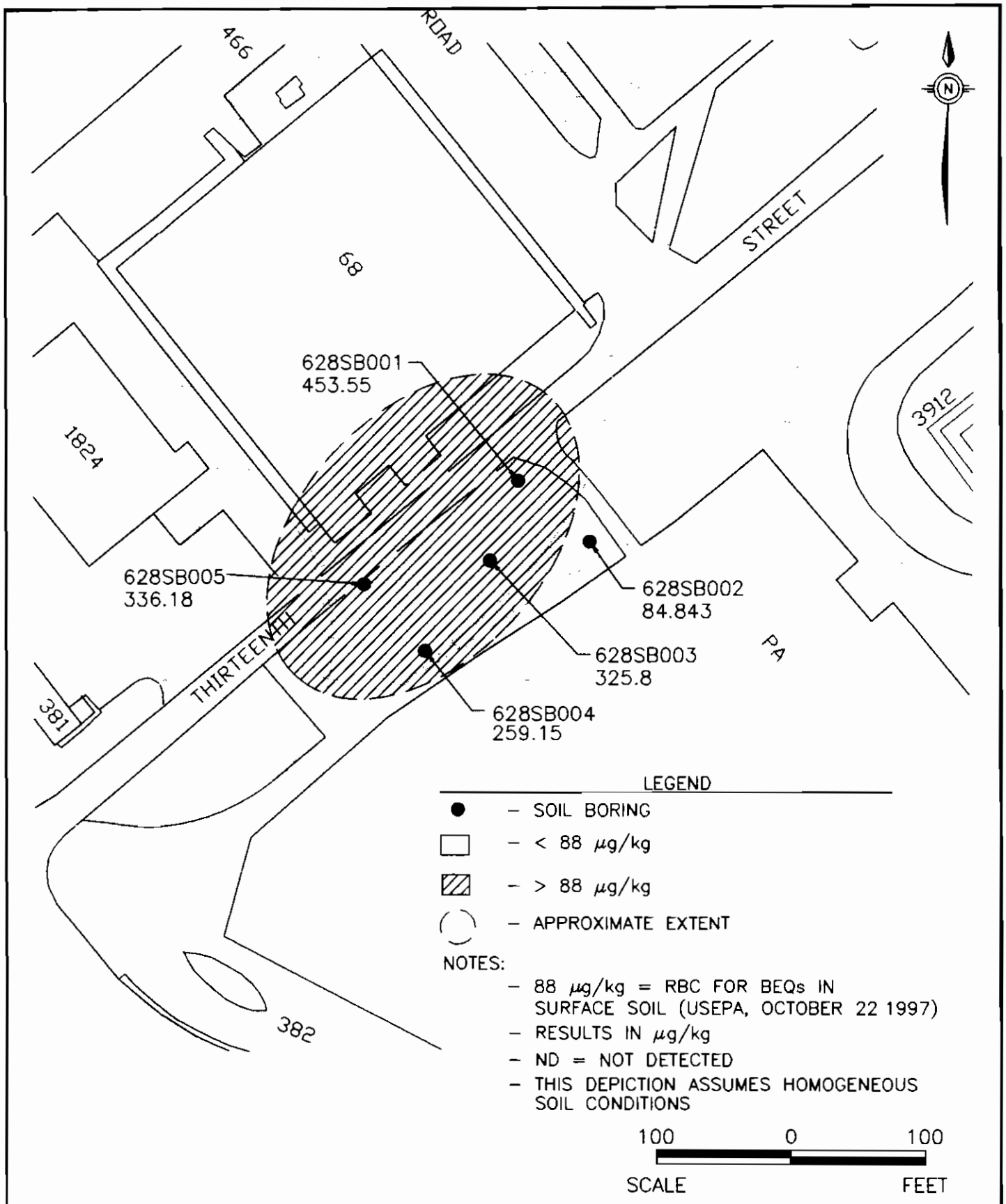
a = Background value for non-clay samples
* = Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil-to-groundwater SSLs (DAF=20) from the *Soil Screening Guidonce: Technical Background Document* (USEPA, 1996b) were used as a reference concentration for lower interval samples
l = Calculated from methods described in USEPA Interim *Supplemental Guidonce to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995c)
ND = Not detected
NT = Not taken
NL = Not listed
NA = Not applicable
Bolded concentrations exceed both the reference concentration (RBC or SSL) and the zone background
All background values for Zone G are based on twice the means of the grid sample concentrations



ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.1–2
METHYLENE CHLORIDE IN
SUBSURFACE SOIL
AOC #628
SANDBLASTING AREA, SOUTHEAST
OF BUILDING 68

DWG DATE: 01/28/98 | DWG NAME: 2907M002



ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.1–3
BEQs IN SURFACE SOIL
AOC #628
SANDBLASTING AREA, SOUTHEAST
OF BUILDING 68

DWG DATE: 02/03/98 | DWG NAME: 2907M003

Figure 10.1-4 presents arsenic concentrations detected in surface soil. Figure 10.1-5 presents chromium detected in surface soil.

Twenty metals were detected in subsurface soil samples at AOC 628. No subsurface metals concentrations exceeded the greater of their respective SSL or subsurface soil background concentrations.

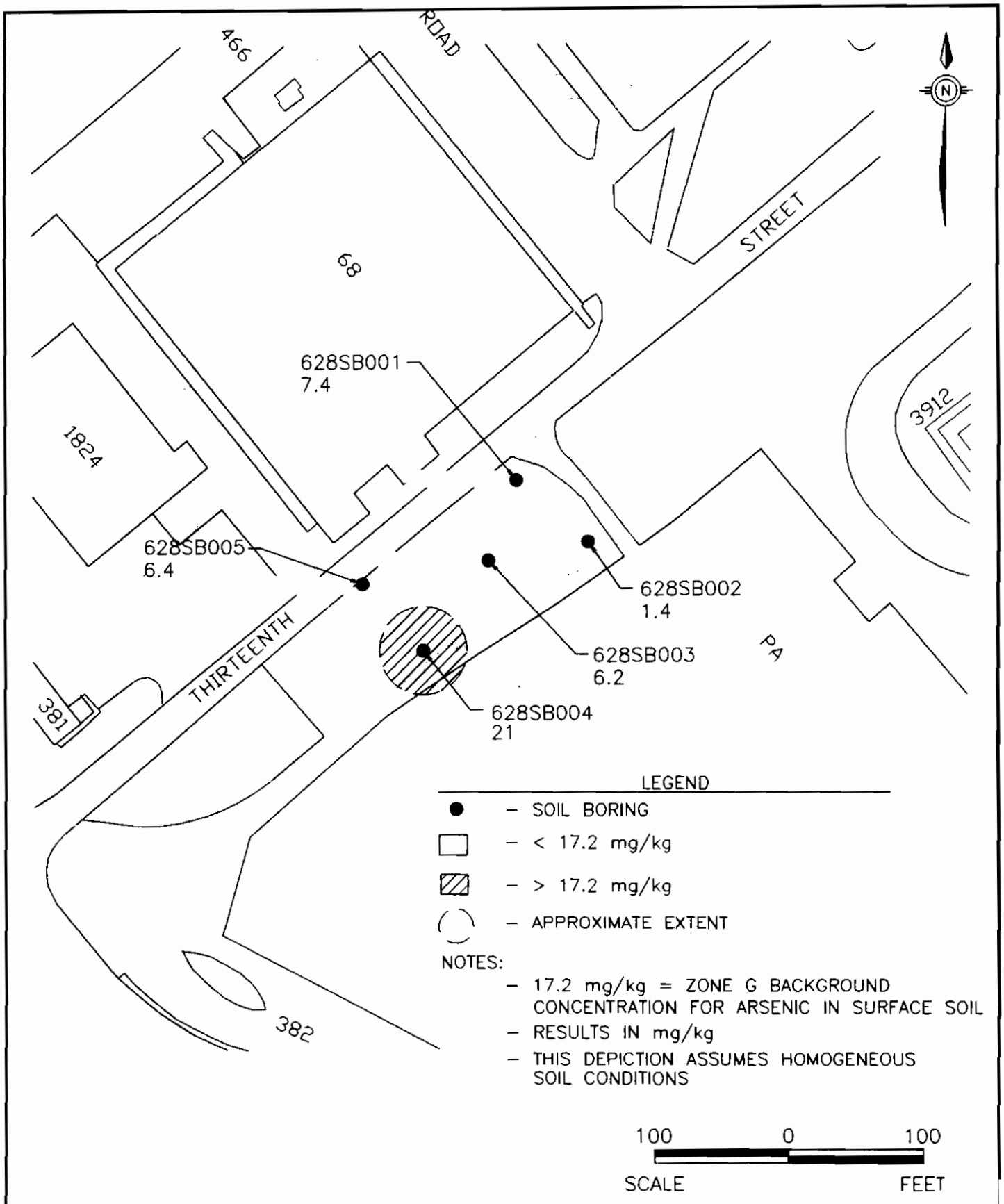
10.1.4 Fate and Transport Assessment

AOC 628 is a fenced area southeast of Building 68. Environmental media sampled as part of the investigation of AOC 628 include surface and subsurface soil. Potential constituent migration pathways investigated include soil-to-groundwater and emissions of volatile compounds from surface soil to air.

10.1.4.1 Soil-to-Groundwater Cross-Media Transport

Table 10.1.5 compares maximum detected organic and inorganic constituent concentrations in surface soil and subsurface soil samples to risk based soil screening levels considered protective of groundwater. For inorganic compounds, the maximum concentrations in soil are compared to the greater of either the risk based soil screening level or the corresponding background values. To provide a conservative screen, generic soil screening levels are used. Leachate entering the aquifer is assumed to be diluted by a ratio of 20:1, with no attenuation of constituents in soil (DAF = 20).

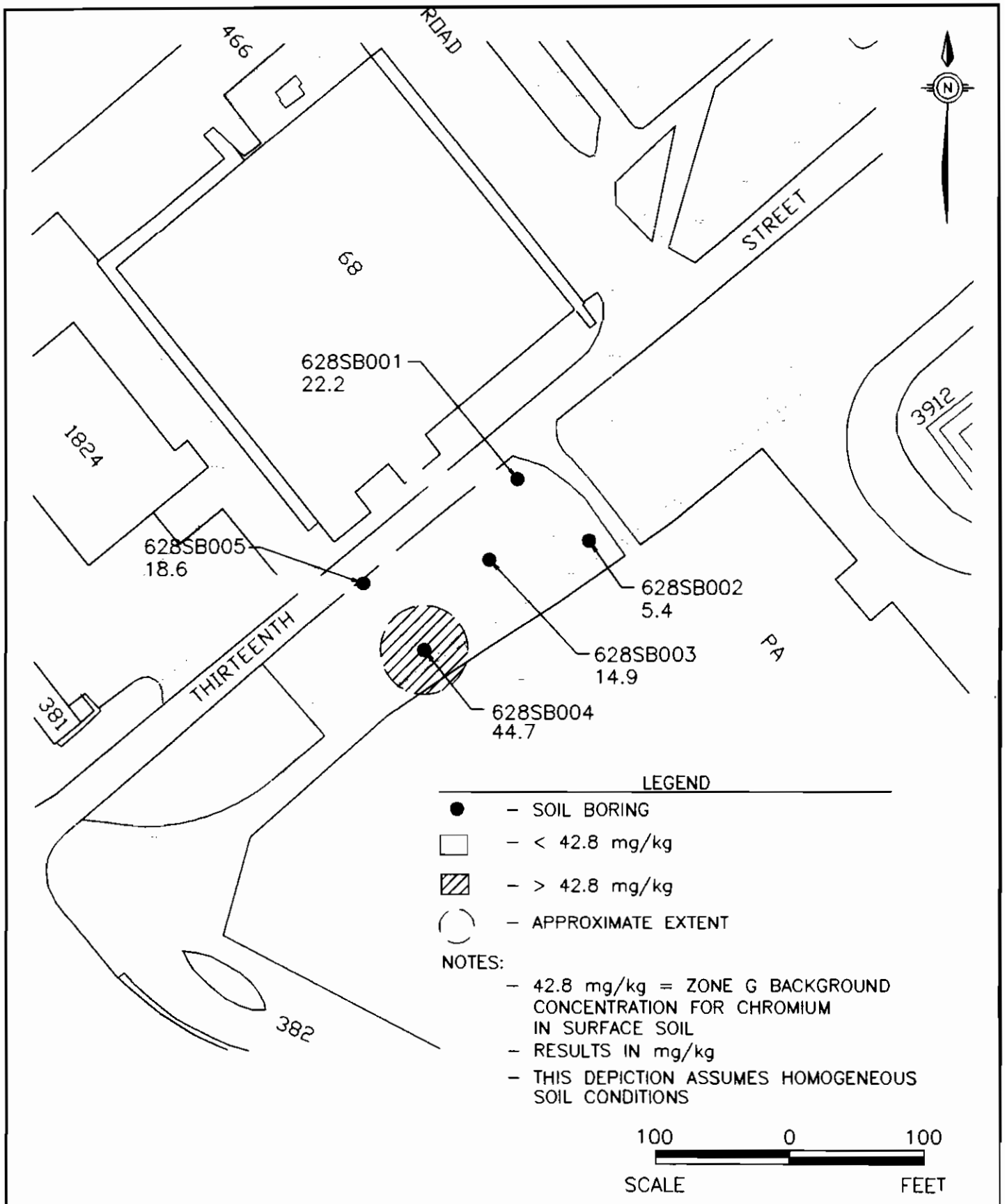
At AOC 628, one volatile organic compound - methylene chloride - was detected above its SSL in subsurface soil at sampling location 628SB001; the majority of other detected VOCs were present at location 628SB002. Notably, while it was detected in subsurface soil it is not present is surface soil. While historical practices at this AOC included use of organic solvents, the continued presence of methylene chloride (if associated with past activities) is enigmatic due to its



ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.1–4
ARSENIC IN SURFACE SOIL
AOC #628
SANDBLASTING AREA, SOUTHEAST
OF BUILDING 68

DWG DATE: 02/05/98 | DWG NAME: 2907M004



ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.1–5
CHROMIUM IN SURFACE SOIL
AOC #628
SANDBLASTING AREA, SOUTHEAST
OF BUILDING 68

DWG DATE: 01/28/98 | DWG NAME: 2907M005

Table 10.1.5
Chemicals Detected in Surface Soil and Subsurface Soil
Comparison to SSLs, Tap Water RBCs, Saltwater Surface Water Chronic Screening Levels, and Background Concentrations
NAVBASE Charleston, Zone G: AOC 628
Charleston, South Carolina

Parameter	Max. Concentration		Max. Concentration		Screening Concentration *					Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
	Surface Soil	Subsurface Soil	Shallow GW	Deep GW	Soil to GW SSL	Tap Water RBC	Saltwater Surf. Wtr. Chronic	Soil Units	Water Units			
Volatile Organic Compounds												
Benzene	2	ND	NA	NA	30	0.36	109	UG/KG	UG/L	NO	NO	NO
2-Butanone (MEK)	ND	44	NA	NA	7900	1900	NA	UG/KG	UG/L	NO	NO	NO
Carbon disulfide	ND	2	NA	NA	32000	1000	NA	UG/KG	UG/L	NO	NO	NO
Methylene chloride	ND	32	NA	NA	20	4.1	2560	UG/KG	UG/L	YES	NO	NO
Trichloroethene	2	ND	NA	NA	60	1.6	NA	UG/KG	UG/L	NO	NO	NO
Semivolatile Organic Compounds												
Acenaphthene	ND	86	NA	NA	570000	2200	9.7	UG/KG	UG/L	NO	NO	NO
Acenaphthylene	73	69	NA	NA	293000	1500	NA	UG/KG	UG/L	NO	NO	NO
Anthracene	170	130	NA	NA	12000000	11000	NA	UG/KG	UG/L	NO	NO	NO
Benzo(g,h,i)perylene	300	190	NA	NA	4.66E+08	1500	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene equivalents												
Benzo(a)anthracene	260	330	NA	NA	2000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene	270	280	NA	NA	8000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(b)fluoranthene	320	250	NA	NA	5000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(k)fluoranthene	250	350	NA	NA	49000	0.92	NA	UG/KG	UG/L	NO	NO	NO
Chrysene	650	540	NA	NA	160000	9.2	NA	UG/KG	UG/L	NO	NO	NO
Dibenzo(a,h)anthracene	120	77	NA	NA	2000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Indeno(1,2,3-cd)pyrene	220	180	NA	NA	14000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Di-n-butylphthalate	ND	24	NA	NA	2300000	3700	3.4	UG/KG	UG/L	NO	NO	NO
Fluoranthene	2100	2100	NA	NA	4300000	1500	1.6	UG/KG	UG/L	NO	NO	NO
Fluorene	ND	48	NA	NA	560000	1500	NA	UG/KG	UG/L	NO	NO	NO
2-Methylnaphthalene	42	ND	NA	NA	126000	1500	NA	UG/KG	UG/L	NO	NO	NO
Naphthalene	ND	44	NA	NA	84000	1500	23.5	UG/KG	UG/L	NO	NO	NO
Phenanthrene	450	1100	NA	NA	1380000	1500	NA	UG/KG	UG/L	NO	NO	NO
Pyrene	1400	1400	NA	NA	4200000	1100	NA	UG/KG	UG/L	NO	NO	NO
1,2,4-Trichlorobenzene	ND	76	NA	NA	5000	190	NA	UG/KG	UG/L	NO	NO	NO
Inorganic Compounds												
Aluminum	10600	15800	NA	NA	1000000	37000	NA	MG/KG	UG/L	NO	NO	NO
Antimony	0.64	0.57	NA	NA	5	15	NA	MG/KG	UG/L	NO	NO	NO
Arsenic	21	19.4	NA	NA	29	17.8	36	MG/KG	UG/L	NO	NO	NO
Barium	38.5	44.4	NA	NA	1600	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	ND	1.3	NA	NA	63	0.016	NA	MG/KG	UG/L	NO	NO	NO
Cadmium	0.33	0.42	NA	NA	8	18	9.3	MG/KG	UG/L	NO	NO	NO
Chromium (total)	44.7	32.6	NA	NA	1000000	180	50	MG/KG	UG/L	NO	NO	NO
Cobalt	2.2	6.6	NA	NA	2000	2200	NA	MG/KG	UG/L	NO	NO	NO
Lead	97	98	NA	NA	400	15	8.5	MG/KG	UG/L	NO	NO	NO
Manganese	146	655	NA	NA	1100	2906	NA	MG/KG	UG/L	NO	NO	NO
Mercury	0.19	0.4	NA	NA	2.1	11	0.025	MG/KG	UG/L	NO	NO	NO
Nickel	11.4	10.9	NA	NA	130	730	21.7	MG/KG	UG/L	NO	NO	NO
Selenium	1.4	1.8	NA	NA	5	180	71	MG/KG	UG/L	NO	NO	NO
Thallium	ND	0.47	NA	NA	0.95	2.9	21.3	MG/KG	UG/L	NO	NO	NO
Vanadium	37.9	59.9	NA	NA	6000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	91.6	161	NA	NA	12000	11000	86	MG/KG	UG/L	NO	NO	NO

Notes:
* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 20, from 1996 Soil Screening Guidance or calculated using values from Table 6.4
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, October 22, 1997
Salt Water Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region IV Bulletins, Ecological Risk Assessment, November, 1995; Table 2
For inorganics, the value shown is the greater of the relevant screening value or the corresponding background value.

NA - Not available/Not applicable
ND - Not detected
RBC - Risk based concentration
SSL - Soil screening level
MG/KG - Milligrams per kilogram
NG/KG - Nanograms per kilogram
PG/L - Picograms per liter
UG/KG - Micrograms per kilogram
UG/L - Micrograms per liter

extreme volatility. Its absence in surface soil may be due to degassing of soil, or it may also be the result of methylene chloride partitioning to gaseous phase from groundwater. Methylene chloride is a typical laboratory contaminant and could possibly be present as the result of cross contamination in the laboratory; however, data validation for AOC 628 did not eliminate its occurrence, and it should be regarded as actually present in the sample. Sampling location 628SB001 is located in the gravel at AOC 628. The relationship to location 628SB002 (where other VOCs were detected) is unclear, as is the relationship of soil-to-groundwater (e.g. groundwater impacts are unknown). Without further data, the pathway appears to have some merit at least with respect to methylene chloride; the presence of other VOCs and SVOCs detected in both surface and subsurface soil could also support the further investigation of this pathway.

No inorganics were found to exceed SSLs, therefore the pathway is considered invalid for this group of constituents.

10.1.4.2 Soil-to-Air Cross-Media Transport

Table 10.1.6 lists the VOCs detected in surface soil samples collected at AOC 628, along with corresponding soil-to-air screening levels. No volatile compounds were detected in site surface soil that exceeded applicable screening levels. Therefore, this migration pathway is considered invalid.

10.1.4.3 Fate and Transport Summary

Only one organic constituent - methylene chloride - was detected at one sampling location at a concentration exceeding its SSL. While historical activities at AOC 628 could have included the use of methylene chloride as a solvent, it is also a common laboratory contaminant. Assuming its actual presence in the subsurface soil, its absence in surface soil may represent degassing from surface soil, or volatilization from groundwater. The soil-to-groundwater migration pathway appears to have merit based on the presence of methylene chloride at concentrations above the

Table 10.1.6
Soil to Air Volatilization Screening Analysis
NAVBASE Charleston, Zone G: AOC 628
Charleston, South Carolina

VOCs	Maximum Concentration in Surface Soil	Soil to Air SSL*	Units	Exceeds SSL
Benzene	2	800	UG/KG	NO
Trichloroethene	2	5000	UG/KG	NO

* - Soil screening levels for transfers from soil to air were obtained from USEPA Soil Screening Guidance, Technical Background Document Appendix A, May 1996 (first preference) or from Soil Screening Levels - Transfers from Soil to Air, USEPA Region III Risk-Based Concentration Table, June 1996.

NA - Not available

SSL. Based on historical use of the site for blasting large metal parts for ships, metals would be expected to be present in the soil; however, inorganic constituents were not found to exceed their groundwater protection levels at AOC 628. The migration pathway for inorganic constituents to groundwater is therefore considered to be invalid. No volatile organic compounds were detected in site surface soil that exceeded applicable screening levels, thus the soil-to-air volatization pathway is invalid for this AOC.

10.1.5 Human Health Risk Assessment

10.1.5.1 Site Background and Investigative Approach

AOC 628 is a fenced area southeast of Building 68 that was formerly used for abrasive blasting of large metal parts. Materials released, stored, or disposed of included spent blasting media, paint and metallic residues, organic solvent wastes, and petroleum products.

During the CSI, five soil samples were collected from the upper interval and four soil samples were collected from the lower interval to identify potential impacts resulting from the activities listed above. Surface soil samples from all five boring locations were used to quantitatively assess soil exposure pathways. Subsurface soil is addressed in the previous section, Fate and Transport Assessment. Fate and transport screening did not identify any COPCs for the groundwater pathways. Groundwater is not currently used at Zone G for potable purposes, nor is it expected to be used for drinking water in the future. For these reasons, groundwater pathways were not included in the risk assessment for AOC 628. Section 10.1.3 provides a summary of the sampling effort for AOC 628 soil.

10.1.5.2 COPC Identification

Based on the screening comparisons described in Section 7 of this CSI and presented in Table 10.1.7, benzo(a)pyrene equivalents, arsenic, and chromium were identified as COPCs in surface soil.

Table 10.1.7
Chemicals Present in Site Samples
AOC 628 - Surface Soil
Naval Base Charleston, Zone G
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Screening Concentration Background	Units	Number Exceeding RBC	Number Exceeding Bkgd
Carcinogenic PAHs													
B(a)P Equiv.	*	5	5	84.843	453.55	291.9046	NA	NA	88	NA	UG/KG	4	
Benzo(a)anthracene		5	5	54	260	148.8	NA	NA	880	NA	UG/KG		
Benzo(a)pyrene	*	5	5	66	270	179.2	NA	NA	88	NA	UG/KG	4	
Benzo(b)fluoranthene		5	5	76	320	213.2	NA	NA	880	NA	UG/KG		
Benzo(k)fluoranthene		5	5	79	250	181.8	NA	NA	8800	NA	UG/KG		
Chrysene		5	5	53	650	286.6	NA	NA	88000	NA	UG/KG		
Dibenz(a,h)anthracene	*	4	5	46	120	77	370	370	88	NA	UG/KG	1	
Indeno(1,2,3-cd)pyrene		5	5	50	220	128	NA	NA	880	NA	UG/KG		
Inorganics													
Aluminum (Al)		5	5	3130	10600	5784	NA	NA	7800	18700	MG/KG	1	
Antimony (Sb)		1	5	0.64	0.64	0.64	0.33	0.39	3.1	2.89	MG/KG		
Arsenic (As)	*	5	5	1.4	21	8.48	NA	NA	0.43	17.2	MG/KG	5	1
Barium (Ba)		5	5	11	38.5	21.32	NA	NA	550	109	MG/KG		
Cadmium (Cd)		4	5	0.17	0.33	0.2525	0.05	0.05	3.9	1.07	MG/KG		
Calcium (Ca)		5	5	5970	80600	34870	NA	NA	NA	NA	MG/KG		
Chromium (Cr)	*	5	5	5.4	44.7	21.16	NA	NA	39	42.8	MG/KG	1	1
Cobalt (Co)		5	5	0.86	2.2	1.832	NA	NA	470	6.6	MG/KG		
Iron (Fe)		5	5	2780	23900	9690	NA	NA	NA	NA	MG/KG		
Lead (Pb)		5	5	11.2	97	54.92	NA	NA	400	181	MG/KG		
Magnesium (Mg)		5	5	798	2560	1549.6	NA	NA	NA	NA	MG/KG		
Manganese (Mn)		5	5	55.4	146	96.76	NA	NA	180	325	MG/KG		
Mercury (Hg)		5	5	0.04	0.19	0.136	NA	NA	2.3	1.03	MG/KG		
Nickel (Ni)		5	5	4.4	11.4	6.94	NA	NA	160	20.6	MG/KG		
Potassium (K)		4	5	396	2330	941.75	225	225	NA	NA	MG/KG		
Selenium (Se)		4	5	0.38	1.4	0.73	0.34	0.34	39	1.22	MG/KG		1
Vanadium (V)		5	5	4.3	37.9	16.48	NA	NA	55	60.9	MG/KG		
Zinc (Zn)		5	5	24.5	91.6	73.1	NA	NA	2300	519	MG/KG		
Semivoletile Organics													
2-Methylnaphthalene		1	5	42	42	42	370	430	310000	NA	UG/KG		
Acenaphthylene		2	5	60	73	66.5	370	390	230000	NA	UG/KG		
Anthracene		4	5	60	170	100.75	370	370	2300000	NA	UG/KG		
Benzo(g,h,i)perylene		5	5	54	300	152.8	NA	NA	230000	NA	UG/KG		
Fluoranthene		4	5	180	2100	795	370	370	310000	NA	UG/KG		
Phenanthrene		4	5	69	450	219.75	370	370	230000	NA	UG/KG		
Pyrene		4	5	160	1400	580	370	370	230000	NA	UG/KG		
Volatile Organics													
Benzene		1	5	2	2	2	6	6	22000	NA	UG/KG		
Trichloroethene		1	5	2	2	2	6	6	58000	NA	UG/KG		

Notes:
* - Indicates chemical was identified as a COPC
SQL - Sample quantitation limit
RBC - Risk-based concentration
UG/KG - micrograms per kilogram
MG/KG - milligrams per kilogram
NA - Not applicable or not available

10.1.5.3 Exposure Assessment

Exposure Setting

AOC 628 is located in an industrial setting approximately 465 feet northeast of the intersection of Hobson Avenue and Thirteenth Street.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers. Additional potentially exposed populations are hypothetical future site residents. Future site resident and worker exposure scenarios were addressed quantitatively in this risk assessment. Current exposure to workers is discussed qualitatively in relation to the future workers and future residents. The hypothetical future site worker scenario assumes continuous exposure to surface soil conditions. Current site workers' exposure would be less than that assumed for the hypothetical future site worker scenario because of their limited soil contact. Therefore, future worker assessment is considered to be conservatively representative of current site users. The future site resident scenario was built on the premise that existing features would be removed and replaced with dwellings.

Exposure Pathways

Exposure pathways for the hypothetical future site residents are dermal contact and incidental ingestion of surface soils. The exposure pathways for future site workers are the same as those for the future site residents with respect to soil. Uniform exposure was assumed for all sample locations. Table 10.1.8 presents the justification for exposure pathways assessed in this HHRA.

Table 10.1.8
Zone G
AOC 628
Exposure Pathways Summary

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Users (Site Workers)	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 628.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 628.
	Soil, Incidental ingestion	No (Qualified)	Future site use is considered conservatively representative of current site use.
	Soil, Dermal contact	No (Qualified)	Future site use is considered conservatively representative of current site use.
Future Land Uses			
Future Site Residents (Child and Adult), Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Fate and transport screening did not identify any COPCs for this exposure pathway.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	No	Volatile COPCs were not identified subsequent to risk-based screening comparisons.
	Soil, Incidental ingestion	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Soil, Dermal contact	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.

Table 10.1.8
Zone G
AOC 628
Exposure Pathways Summary

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Exposure Point Concentrations

The maximum detected concentrations were used exposure point concentrations since there were less than ten data points for each of the COPCs identified.

Quantification of Exposure

CDIs for ingestion and dermal contact with soils are shown in Tables 10.1.9 and 10.1.10, respectively.

10.1.5.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 7 of this report. Table 10.1.11 presents toxicological information specific to each COPC identified at AOC 628. This information was used in the quantification of risk/hazard associated with soil contaminants. Brief toxicological profiles for each COPC are provided in the following paragraphs:

Arsenic exposure via the ingestion route darkens and hardens the skin in chronically exposed humans. Inhalation exposure to arsenic causes neurological deficits, anemia, and cardiovascular effects (Klaassen et al., 1986). USEPA set 0.3 μg/kg-day as the oral RfD for arsenic based on a no observed adverse effects level (NOAEL) of 0.8 μg/kg-day in a human exposure study. Arsenic's effects on the nervous and cardiovascular systems are primarily associated with acute exposure to higher concentrations. Exposure to arsenic-containing materials has been shown to

Table 10.1.9
Chronic Daily Intakes
Incidental Ingestion of Surface Soil
AOC 628
Naval Base Charleston, Zone G
Charleston, South Carolina

Chemical	Fraction Ingested from Contaminated Source *	Exposure Point Concentration (mg/kg)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Inorganic							
Arsenic (As)	1	21	2.9E-05	2.7E-04	3.3E-05	1.0E-05	3.7E-06
Chromium (Cr)	1	45	6.1E-05	5.7E-04	7.0E-05	2.2E-05	7.8E-06
Carcinogenic PAHs							
Benzo(a)pyrene Equivalents	1	0.45	6.2E-07	5.8E-06	7.1E-07	2.2E-07	7.9E-08

NOTES:

lwa Lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
* Reflects the estimated fraction of the site impacted by the corresponding COPC.

Table 10.1.10
Chronic Daily Intakes
Dermal Contact with Surface Soil
AOC 628
Naval Base Charleston, Zone G
Charleston, South Carolina

Chemical	FI/FC *	Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (unitless)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident Iwa C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Inorganic								
Arsenic (As)	1	21	0.001	1.2E-06	3.9E-06	7.4E-07	8.4E-07	3.0E-07
Chromium (Cr)	1	45	0.001	2.5E-06	8.3E-06	1.6E-06	1.8E-06	6.4E-07
Carcinogenic PAHs								
Benzo(a)pyrene Equivalents	1	0.45	0.01	2.5E-07	8.4E-07	1.6E-07	1.8E-07	6.5E-08

NOTES:

CDI Chronic Daily Intake in mg/kg-day

H-CDI CDI for hazard quotient

C-CDI CDI for excess cancer risk

* Reflects the estimated fraction of the site impacted by the corresponding COPC.

\- The dermal absorption factor was applied to the exposure point concentration to reflect the ability for trans-dermal migration of inorganic and organic chemicals

Table 10.1.11
Toxicological Reference Information
for Chemicals of Potential Concern
AOC 628
Naval Base Charleston, Zone G
Charleston, South Carolina

	Non-Carcinogenic Toxicity Data									*Carcinogenic Toxicity Data*					
hemical	**Oral Reference Dose (mg/kg-day)**		**Confidence Level**	**Critical Effect**	**Uncertainty Factor Oral**	**Inhalation Reference Dose (mg/kg-day)**	**Confidence Level**	**Critical Effect**	**Uncertainty Factor Inhalation**	**Oral Slope Factor (kg-day/mg)**		**Inhalation Slope Factor (kg-day/mg)**		**Weight of Evidence**	**Tumor Type**
rsenic	0.0003	a	M	hyperpigmentation	3	NA	NA	NA	NA	1.5	a	15.1	a	A	various
nzo(a)pyrene Equivalents	NA		NA	NA	NA	NA	NA	NA	NA	7.3	a	6.1	b	B2	mutagen
romium III	1	a	L	NA	100/10	NA	NA	NA	NA	NA		ND	a	D	NA
romium VI	0.005	a	L	NA	500	NA	NA	NA	NA	NA		42	a	A	lung

tes:

= Integrated Risk Information System (IRIS)
= Withdrawn from IRIS/HEAST
A = Not applicable or not available
= Low confidence
= Medium confidence

cause cancer in humans. Inhaling these materials can lead to increased lung cancer risk, and ingestion is associated with increased skin cancer rates. Arsenic has been classified as a group A carcinogen by USEPA, which set the 1.5 $(mg/kg\text{-}day)^{-1}$ oral slope factor (SF) for arsenic. As listed in IRIS, the classification is based on sufficient evidence from human data. An increased lung cancer mortality was observed in multiple human populations exposed primarily through inhalation. Also, increased mortality from multiple internal organ cancers (liver, kidney, lung, and bladder) and an increased incidence of skin cancer were observed in populations consuming drinking water high in inorganic arsenic. Human milk contains about 3 μg/L arsenic. The RBC for arsenic in tap water is 0.045 μg/L. As listed in IRIS, the critical effect of this chemical is hyperpigmentation, keratosis, and possible vascular complications. The uncertainty factor was 3 and the modifying factor was 1.

Benzo(a)pyrene equivalents include the following list of polynuclear aromatic hydrocarbons (PAHs):

Benzo(a)anthracene	TEF	0.1
Benzo(b)fluoranthene	TEF	0.1
Dibenz(a,h)anthracene	TEF	1.0
Benzo(k)fluoranthene	TEF	0.01
Benzo(a)pyrene	TEF	1.0
Indeno(1,2,3-cd)pyrene	TEF	0.1
Chrysene	TEF	0.001

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of the PAHs above have not been well established. There are no reference doses (RfDs) for the PAHs above due to a lack of data. All PAHs listed above are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of benzo(a)pyrene, having an oral SF 7.3 $(mg/kg\ day)^{-1}$. Toxicity Equivalency Factors, also set by USEPA, are multipliers that are

applied to the detected concentrations, which are subsequently used to calculate excess cancer risk. These multipliers are discussed further in the exposure and toxicity assessment sections. Most carcinogenic PAHs have been classified as such due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soot, cigarette smoke, etc.). As listed in IRIS, the basis for the benzo(a)pyrene B2 classification is human data specifically linking benzo(a)pyrene to a carcinogenic effect are lacking. There are, however, multiple animal studies in many species demonstrating benzo(a)pyrene to be carcinogenic by numerous routes.

Benzo(a)pyrene has produced positive results in numerous genotoxicity assays. At the June 1992 Carcinogenic Risk Assessment Verification Endeavor (CRAVE) Work Group meeting, a revised risk estimate for benzo(a)pyrene was verified. This section provides information on three aspects of the carcinogenic risk assessment for the agent in question. The USEPA classification and quantitative estimates of exposure reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in application of a low-dose extrapolation procedure and presented as the risk per mg/kg-day. The unit risk is the quantitative estimate in terms of either risk per μg/L drinking water or risk per $\mu g/m^3$ air breathed. The third form in which risk is presented is drinking water or air concentration providing cancer risks of 1 in 10,000 or 1 in 1,000,000. The Carcinogenicity Background Document provides details on the carcinogenicity values found in IRIS. Users are referred to the Oral Reference Dose and Reference Concentration sections for information on long-term toxic effects other than carcinogenicity.

The basis for the dibenz(a,h)anthracene and benzo(b)fluoranthene B2 classification is listed in IRIS as no human data and sufficient data from animal bioassays. Benzo(b)fluoranthene produced tumors in mice after lung implantation, intraperitoneal or subcutaneous injection, and skin

painting. The basis for the benzo(a)anthracene B2 classification is listed in IRIS as no human data and sufficient data from animal bioassays. Benzo(a)anthracene produced tumors in mice exposed by gavage; intraperitoneal, subcutaneous or intramuscular injection; and topical application. Benzo(a)anthracene produced mutations in bacteria and in mammalian cells, and transformed mammalian cells in culture. The basis for the benzo(k)fluoranthene B2 classification is listed in IRIS as no human data and sufficient data from animal bioassays. Benzo(k)fluoranthene produced tumors after lung implantation in mice and when administered with a promoting agent in skin-painting studies. Equivocal results have been found in a lung adenoma assay in mice. Benzo(k)fluoranthene is mutagenic in bacteria. (Klaassen, et al., 1986).

Chromium exists in two stable, natural forms: trivalent (CrIII) and hexavalent (CrVI). Acute exposure to chromium can result in kidney damage following oral exposure or damage to the nasal mucosa and septum following inhalation exposure. Chronic inhalation exposure to CrVI has resulted in kidney and respiratory tract damage, as well as excess lung cancer in both animals and humans following occupational exposure. Only CrVI is believed to be carcinogenic by inhalation (IRIS). Oral RfD values for CrIII and CrVI forms of chromium are 1.0 and 5E-3 mg/kg-day, respectively. For CrIII, the RfD is based on liver toxicity in the rat. For the CrVI form, the RfD is based on unspecified pathological changes observed in rat studies. In addition, CrVI is considered a Group A carcinogen for inhalation exposures. An oral SF of 42 $(mg/kg\text{-}day)^{-1}$ has been established for the CrVI form. Vitamin supplements contain approximately 0.025 mg of chromium. As listed in IRIS, no critical effects were observed for CrIII. The uncertainty factor was 100 and the modifying factor was 10. As listed in IRIS, no critical effects were observed for CrVI. The uncertainty factor was 500 and the modifying factor was 1.

10.1.5.5 Risk Characterization

Exposure to surface soil onsite was evaluated under residential and industrial (site worker) scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. For noncarcinogenic contaminants evaluated for future site residents, hazard was computed separately to address child and adult exposure. Tables 10.1.12 and 10.1.13 present the computed carcinogenic risks and/or HQs associated with the incidental ingestion of and dermal contact with site surface soils, respectively.

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime weighted average) for AOC 628 surface soils is 5E-05. The dermal pathway ILCR is 8E-06. Arsenic and benzo(a)pyrene equivalents were contributors to ILCR projections for the ingestion and dermal pathways.

The ingestion HIs projected for the adult and child receptors are 0.1 and 1, respectively. The dermal pathway HIs were 0.02 for the adult resident receptor and 0.07 for the child resident receptor. The primary contributor to HI projections for the ingestion and dermal pathways was arsenic. Chromium was a secondary contributor.

Hypothetical Site Workers

Site worker ILCRs are 6E-06 for the ingestion pathway and 3E-06 for the dermal contact pathway. Arsenic and benzo(a)pyrene equivalents were contributors to ILCR projections for the ingestion and dermal pathways.

Site worker HIs were 0.04 for the ingestion pathway and 0.02 for the dermal pathway. The primary contributor to HI projections for the ingestion and dermal pathways was arsenic. Chromium was a secondary contributor.

Table 10.1.12
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC 628
Naval Base Charleston, Zone G
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident lwa ILCR	Future Worker Adult Hazard Quotient	Future Worker Adult ILCR
Inorganic							
Arsenic (As)	0.0003	1.5	0.096	0.89	4.9E-05	0.034	5.5E-06
Chromium (Cr)	0.005	NA	0.012	0.11	ND	0.004	ND
Carcinogenic PAHs							
Benzo(a)pyrene Equivalents	NA	7.3	ND	ND	5.2E-06	ND	5.8E-07
SUM Hazard Index/ILCR			0.1	1	5E-05	0.04	6E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime Cancer Risk

Table 10.1.13
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC 628
Naval Base Charleston, Zone G
Charleston, South Carolina

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident lwa ILCR	Future Worker Adult Hazard Quotient	Future Worker Adult ILCR
Inorganic								
Arsenic (As)	0.2	0.00006	7.5	0.020	0.065	5.5E-06	0.014	2.3E-06
Chromium (Cr)	0.2	0.001	NA	0.0025	0.008	ND	0.0018	ND
Carcinogenic PAHs								
Benzo(a)pyrene Equivalents	0.5	NA	14.6	ND	ND	2.3E-06	ND	9.5E-07
SUM Hazard Index/ILCR				0.02	0.07	8E-06	0.02	3E-06

NOTES:

NA Not available

ND Not Determined due to lack of available information

lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A

ILCR Incremental Lifetime Cancer Risk

\- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

COCs Identified

Chemicals of concern were identified based on cumulative (all pathway) risk and hazard projected for this site on a medium-specific basis. USEPA has established a generally acceptable risk range of 1E-04 to 1E-06, and a hazard index threshold of 1.0 (unity). As recommended by SCDHEC, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, and whose individual ILCR exceeds 1E-06 or whose hazard quotient exceeds 0.1. For carcinogens, this approach is relatively conservative, because a cumulative risk level of 1E-04 (and individual ILCR of 1E-06) is recommended by USEPA Region IV as the trigger for establishing COCs. The COC selection method presented was used in order to provide a more comprehensive evaluation of chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the remedial goal options development process. Table 10.1.14 presents the COCs identified for AOC 628 surface soil.

Future Site Residents

Arsenic and benzo(a)pyrene equivalents were identified as soil pathway COCs based on their contribution to cumulative residential ILCR projections.

Arsenic and chromium were identified as soil pathways COCs based on their contribution to cumulative residential HI projections.

Future Site Workers

Arsenic and benzo(a)pyrene equivalents were identified as soil pathway COCs based on their contribution to cumulative industrial ILCR projections.

No COCs were identified in AOC 628 surface soil based on contribution to cumulative industrial HI projections.

Table 10.1.14
Summary of Risk and Hazard-based COCs
AOC 628
Naval Base Charleston, Zone G
Charleston, South Carolina

Medium	Exposure Pathway		Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident Iwa ILCR	Future Site Worker Hazard Quotient	Future Site Worker ILCR	Identification of COCs
Surface Soil	Incidental Ingestion	**Inorganic**						
		Arsenic (As)	0.096	0.89	4.9E-05	0.034	5.5E-06	1 2 4
		Chromium (Cr)	0.012	0.11	ND	0.004	ND	1
		Carcinogenic PAHs						
		Benzo(a)pyrene Equivalents	ND	ND	5.2E-06	ND	5.8E-07	2 4
	Dermal	**Inorganic**						
		Arsenic (As)	0.020	0.065	5.5E-06	0.0140	2.3E-06	1 2 4
		Chromium (Cr)	0.003	0.008	ND	0.0018	ND	1
		Carcinogenic PAHs						
		Benzo(a)pyrene Equivalents	ND	ND	2.3E-06	ND	9.5E-07	2 4
Surface Soil Pathway Sum			0.1	1	6E-05	0.05	9E-06	

Notes:
ND indicates not determined due to the lack of available risk information.
ILCR indicates incremental excess lifetime cancer risk
HI indicates hazard index
1- Chemical is a COC by virtue of projected child residence noncarcinogenic hazard.
2- Chemical is a COC by virtue of projected future resident lifetime ILCR.
3- Chemical is a COC by virtue of projected site worker noncarcinogenic hazard.
4- Chemical is a COC by virtue of projected site worker ILCR.

The extent of the COCs identified in surface soil is briefly discussed below. To facilitate this discussion, residential soil RBCs and background concentrations were compared to each reported COC concentration. Arsenic was detected in all 5 surface soil samples at a concentration above its residential RBC (0.43 mg/kg), but only exceeded its background value (17.2 mg/kg) in 1 surface soil sample (628SB004) with a concentration of 21 mg/kg. Chromium was also detected in all 5 surface soil samples, but only exceeded its residential RBC (39 mg/kg) and its background value (42.8 mg/kg) in 1 surface soil sample (628SB004) with a concentration of 44.7 mg/kg. Benzo(a)pyrene equivalent compounds were detected in all 5 surface soil samples and exceeded their corresponding residential RBC (88 μg/kg) in 4 surface soil samples (628SB001, 628SB003, 628SB004, and 628SB005).

10.1.5.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure.

Residential use of the site would not be expected, based on current site uses and the nature of surrounding buildings. If this area were to be used as a residential site, the surface soil conditions would likely change — the soils could be covered with landscaping soil and/or a house. Consequently, exposure to surface soil conditions as represented by samples collected during the CSI would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current site workers and future site residents.

Determination of Exposure Point Concentrations

The maximum detected soil constituent concentrations were used as the exposure point concentrations for this site. Use of maximum detected concentrations represent conservative assumptions when applied as the EPC, such that it is unlikely that the maximum detected concentration would be exceeded by the true mean concentration. The EPCs used for arsenic and chromium were only marginally above their respective background concentrations.

Frequency of Detection and Spatial Distribution

Arsenic and chromium each exceeded their respective residential RBC and background value in the same surface soil sample (628SB004), indicating a potential "hot spot". However, arsenic exceeded its background value by only 3.8 mg/kg, and chromium exceeded its background value by only 1.9 mg/kg; indicating that concentrations are possibly representative of ambient conditions.

Quantification of Risk/Hazard

As indicated by the discussions above, the uncertainty inherent in the risk assessment process is great. In addition, many site-specific factors have affected the uncertainty of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below:

A conservative screening process was used to identify COPCs for AOC 628. The potential for eliminating CPSSs with the potential for cumulative HI greater than one was addressed for noncarcinogens through the use of RBCs that were reduced one order of magnitude. For carcinogens, the RBCs are based on a conservative target risk of 1E-06. Use of conservative RBCs in combination with the use of maximum detected concentrations minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment, only aluminum was reported at a concentrations near its

RBC (e.g. within 10% of its RBC). Aluminum was actually detected at a concentration exceeding its RBC, however, its maximum concentration did not exceed its corresponding background concentration. As a result, aluminum was eliminated from consideration in the risk assessment.

Background-related Risk

Aluminum was detected in AOC 628 surface soil at a concentration above its corresponding RBC. It was eliminated from consideration in the risk assessment based on comparison to its background value. It is not unusual for naturally occurring or background concentrations of some elements to exceed risk-based concentrations. It is the risk assessment's function to identify excess risk and/or hazard, or that which is above background levels. The following is a discussion of the residential scenario risk/hazard associated with the background concentration of aluminum.

The maximum surface soil concentration of aluminum (10,600 mg/kg) for AOC 628 equates with hazard quotients of 0.1 and 0.007 for the residential child and site worker, respectively. The background value for aluminum (18,700 mg/kg) results in hazard quotients of 0.3 and 0.01 for the residential child and site worker, respectively.

10.1.5.7 Risk Summary

The risk and hazard posed by contaminants at AOC 628 were assessed for future site workers and future site residents under reasonable maximum exposure assumptions. For surface soils, the incidental ingestion and dermal contact pathways were assessed in this HHRA. Table 10.1.15 presents the risk summary for each pathway/receptor group evaluated for AOC 628.

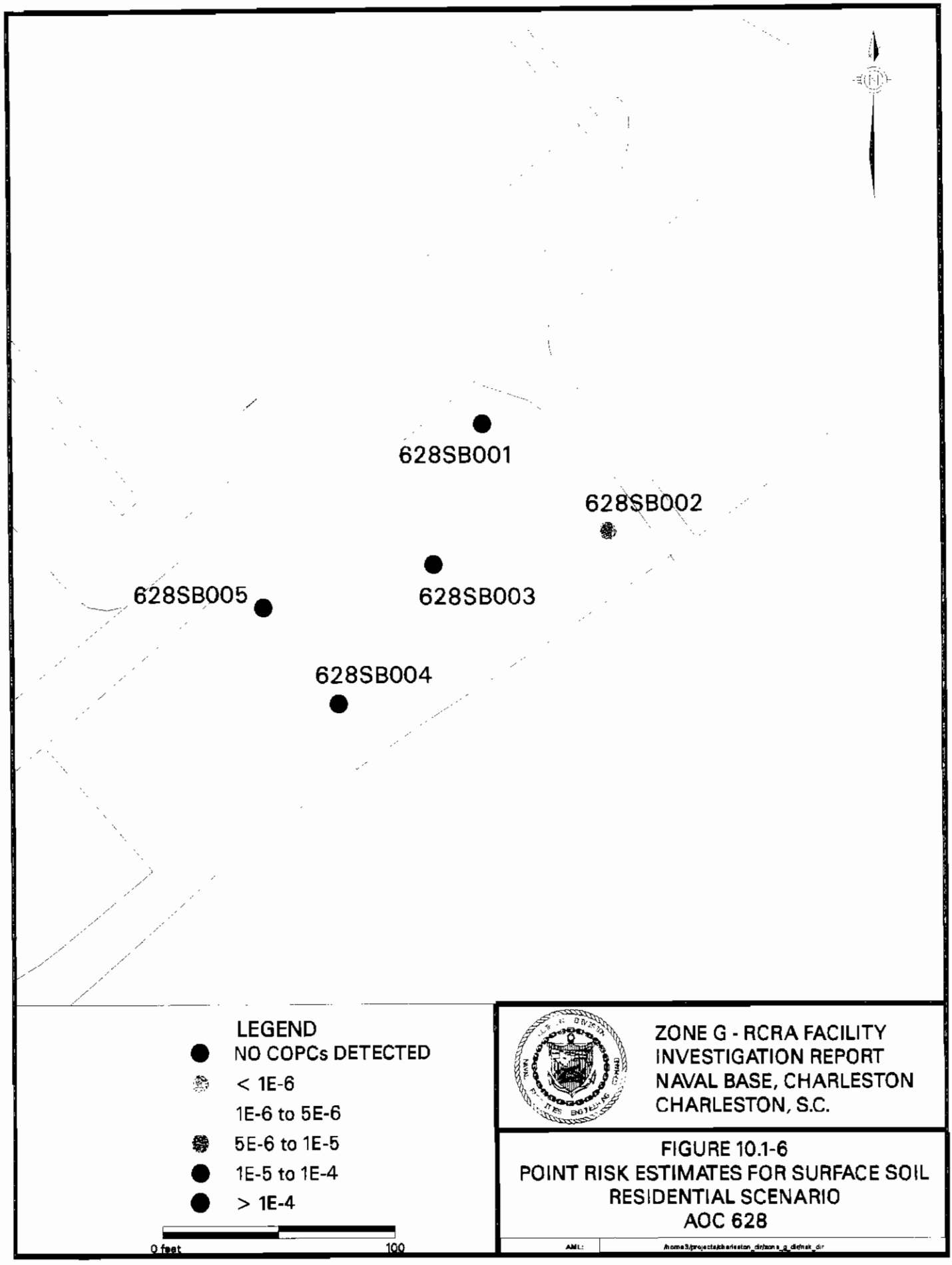
Residential Scenario

Residential soil pathway COCs identified for AOC 628 are arsenic, chromium, and benzo(a)pyrene equivalents. Figures 10.1-6 and 10.1-7 illustrate point risk and hazard estimates for AOC 628

Table 10.1.15
Summary of Risk and Hazard
AOC 628
Naval Base Charleston, Zone G
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	0.1	1	5E-05	0.04	6E-06
	Dermal Contact	0.02	0.07	8E-06	0.02	3E-06
Sum of Soil Pathways		0.1	1	6E-05	0.05	9E-06

Notes:
ILCR Indicates incremental lifetime cancer risk
HI Indicates hazard index



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INVESTIGATION REPORT
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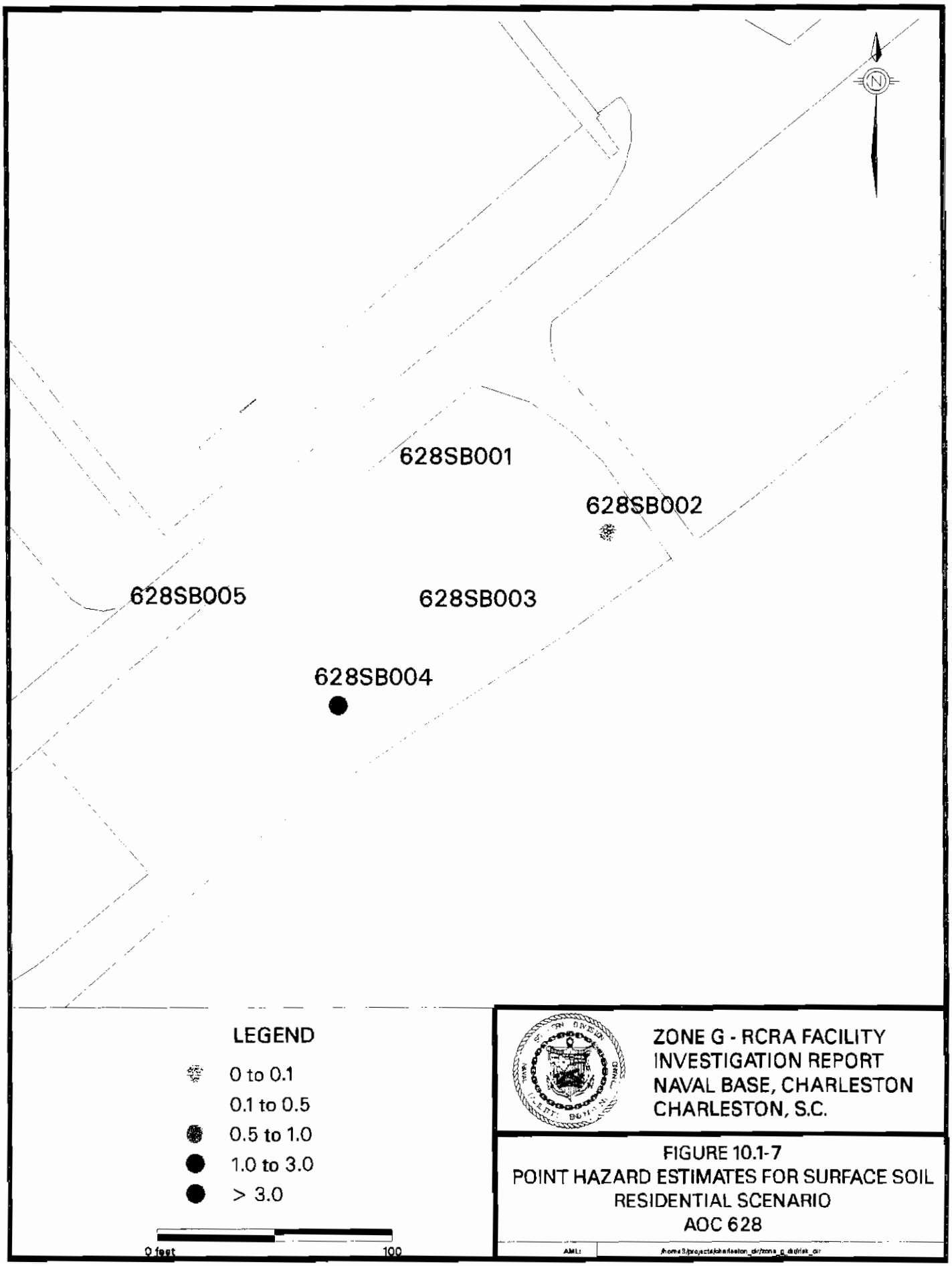
CHARLESTON, S.C.

FIGURE 10.1-6
POINT RISK ESTIMATES FOR SURFACE SOIL
RESIDENTIAL SCENARIO
AOC 628

AML: /home3/projects/charleston_dir/zone_g_dir/risk_dir



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CHARLESTON, S.C.

FIGURE 10.1-7
POINT HAZARD ESTIMATES FOR SURFACE SOIL
RESIDENTIAL SCENARIO
AOC 628

based on soil exposure pathways under a future residential scenario. Table 10.1.16 summarizes the point risk and hazard contribution of each COPC at each sample location. The point risk map is based on the unlikely assumption that a potential future site resident will be chronically exposed to specific points. Exposure to surface soil conditions is more likely the result of uniform exposure to the soil conditions of the entire site (or exposure unit area) rather than specific points. With this in mind, risk maps supplemented by the tables are useful in that they allow the reader to visualize how chemicals driving risk estimates are spatially distributed across the site.

All five sample locations yielded ILCRs that were greater than 1E-06. Arsenic was the primary contributor to risk at all sample locations, while benzo(a)pyrene equivalents were secondary contributors. However, arsenic only exceeded its background value at one location (628SB004). Risk estimates at AOC 628 ranged from 5E-06 (628SB002) to 6E-05 (628SB004), with a mean risk estimate of 3E-05.

Arsenic was the primary contributor to the hazard estimate at the only location at AOC 628 that yielded a hazard index above unity (628SB004). Chromium was a secondary contributor. Hazard index estimates ranged from 0.08 (628SB002) to 1.1 (628SB004), with a mean hazard estimate of 0.4.

Site Worker Scenario

Industrial soil pathway COCs identified for AOC 628 are arsenic and benzo(a)pyrene equivalents. Figure 10.1-8 illustrates point risk estimates for AOC 628 based on soil exposure pathways under a future industrial scenario. Table 10.1.17 summarizes the risk and hazard contribution of arsenic at each sample location. Although benzo(a)pyrene equivalents were identified as COCs for the site worker scenario, the maximum reported concentration of benzo(a)pyrene equivalents was below its corresponding industrial RBC. Therefore, benzo(a)pyrene equivalents were not included in point risk estimates for the industrial scenario.

Table 10.1.16
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOC 628
Naval Base Charleston, Zone G
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
628	001	Arsenic (As)	7.4	MG/KG	0.3382	84.75	19.3288	72.02
628	001	B(a)P Equiv.	453.55	UG/KG	NA		7.5109	27.98
628	001	Chromium (Cr)	22.2	MG/KG	0.0609	15.25	NA	
		Total			0.3991		26.8397	
628	002	Arsenic (As)	1.4	MG/KG	0.0640	81.21	3.6568	72.24
628	002	B(a)P Equiv.	84.843	UG/KG	NA		1.4050	27.76
628	002	Chromium (Cr)	5.4	MG/KG	0.0148	18.79	NA	
		Total			0.0788		5.0618	
628	003	Arsenic (As)	6.2	MG/KG	0.2834	87.40	16.1944	75.01
628	003	B(a)P Equiv.	325.8	UG/KG	NA		5.3953	24.99
628	003	Chromium (Cr)	14.9	MG/KG	0.0409	12.60	NA	
		Total			0.3243		21.5898	
628	004	Arsenic (As)	21	MG/KG	0.9599	88.67	54.8520	92.74
628	004	B(a)P Equiv.	259.15	UG/KG	NA		4.2916	7.26
628	004	Chromium (Cr)	44.7	MG/KG	0.1226	11.33	NA	
		Total			1.0825		59.1436	
628	005	Arsenic (As)	6.4	MG/KG	0.2925	85.15	16.7168	75.02
628	005	B(a)P Equiv.	336.18	UG/KG	NA		5.5672	24.98
628	005	Chromium (Cr)	18.6	MG/KG	0.0510	14.85	NA	
		Total			0.3435		22.2841	

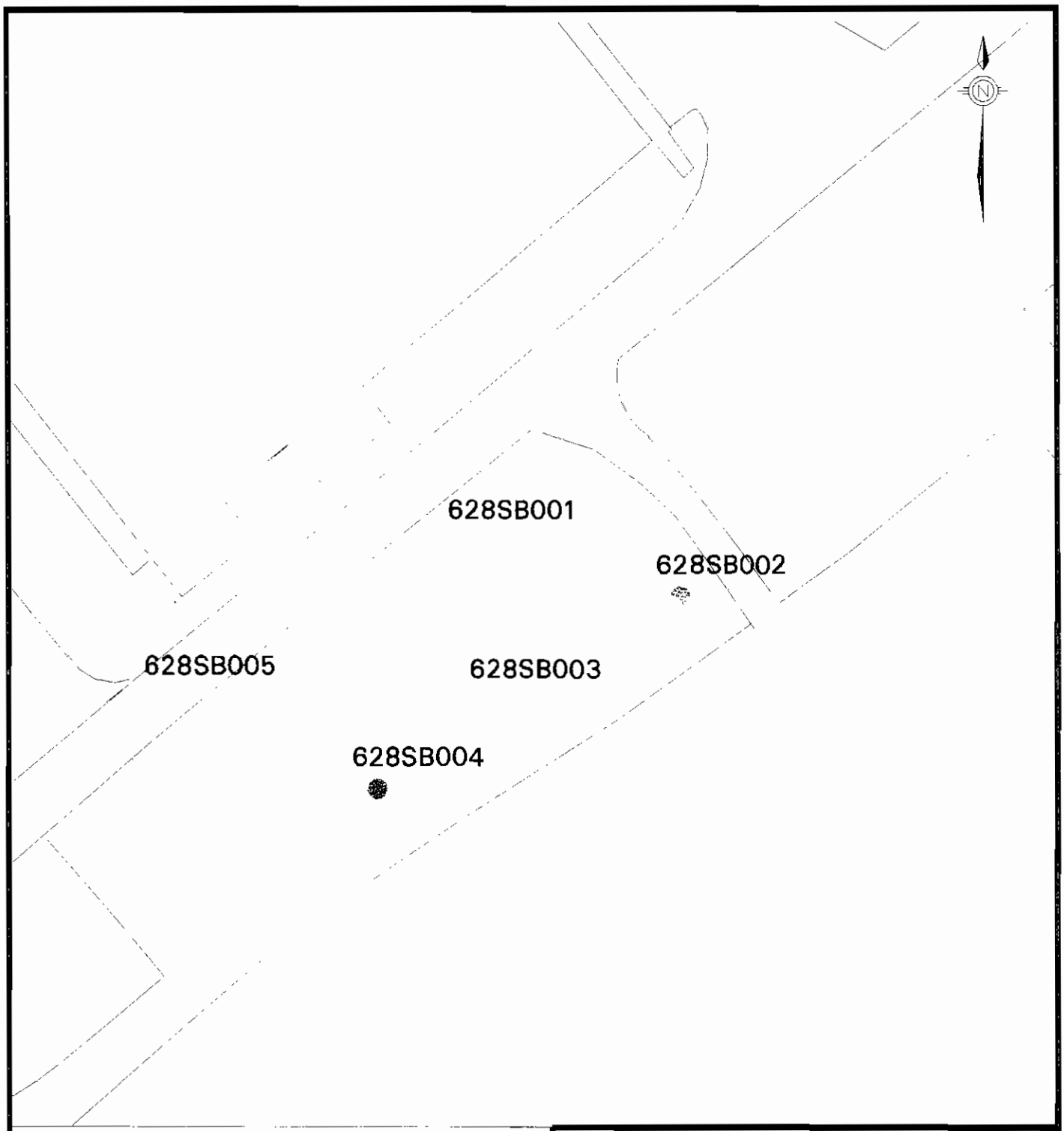

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FIGURE 10.1-8
POINT RISK ESTIMATES FOR SURFACE SOIL
INDUSTRIAL SCENARIO
AOC 628

AML: /home3/projects/charleston_dir/zone_g_dir/risk_dir

Table 10.1.17
Point Estimates of Risk and Hazard - Surface Soil Pathways
Industrial Scenario
AOC 628
Naval Base Charleston, Zone G
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
628	001	Arsenic (As)	7.4	MG/KG	0.0170	100	2.7344	100
		Total			0.0170		2.7344	
628	002	Arsenic (As)	1.4	MG/KG	0.0032	100	0.5173	100
		Total			0.0032		0.5173	
628	003	Arsenic (As)	6.2	MG/KG	0.0143	100	2.2909	100
		Total			0.0143		2.2909	
628	004	Arsenic (As)	21	MG/KG	0.0483	100	7.7596	100
		Total			0.0483		7.7596	
628	005	Arsenic (As)	6.4	MG/KG	0.0147	100	2.3648	100
		Total			0.0147		2.3648	

Four of five sample locations yielded an ILCR greater than 1E-06 (628SB001, 628SB003, 628SB004, 628SB005). Arsenic was the sole contributor to risk at AOC 628. Risk estimates ranged from 5E-07 (628SB002) to 8E-06 (628SB004), with a mean risk estimate of 3E-06.

Arsenic was also the sole contributor to hazard estimates at AOC 628; however, hazard indices did not exceed unity at any location for the industrial scenario. Hazard index estimates ranged from 0.003 (628SB002) to 0.05 (628SB004), with a mean hazard estimate of 0.02.

10.1.5.8 Remedial Goal Options

RGOs for carcinogens were based on the lifetime weighted average site resident as presented in Table 10.1.18 for surface soils. Hazard-based RGOs were calculated based on the hypothetical child resident, as noted in the table.

10.1.6 Corrective Measures Considerations

Based on the analytical results and the human health risk assessment for AOC 628, COCs requiring further evaluation through the CMS process have been identified for surface soil. The site is currently in an industrial setting, however risk to human health was evaluated under both the residential and industrial (site worker) scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. Hazard was evaluated for noncarcinogenic contaminants through incidental ingestion and dermal contact scenarios as well.

As recommended by SCDHEC, a COC is considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, and whose individual risk exceeds 1E-06 or whose hazard quotient exceeds 0.1.

Table 10.1.18
Remedial Goal Options for Soil
AOC 628
Naval Base Charleston, Zone G
Charleston, South Carolina

Residential-Based Remedial Goal Options

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	EPC mg/kg	Hazard-Based Remedial Goal Options 3 mg/kg	1 mg/kg	0.1 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Inorganics										
Arsenic (As)	1.5	0.0003	21.00	66	22	2.2	0.38	3.8	38	17.2
Chromium (Cr)	NA	0.005	44.70	1094	365	36.5	ND	ND	ND	42.8
Carcinogenic PAHs										
Benzo(a)pyrene Equivalents	7.3	NA	0.45	ND	ND	ND	0.06	0.6	6	NA

Worker-Based Remedial Goal Options

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	EPC mg/kg	Hazard-Based Remedial Goal Options 3 mg/kg	1 mg/kg	0.1 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Inorganics										
Arsenic (As)	1.5	0.0003	21.00	1304.68	434.89	43.489	2.706	27.06	270.6	17.2
Carcinogenic PAHs										
Benzo(a)pyrene Equivalents	7.3	NA	0.45	ND	ND	ND	0.297	2.97	29.7	NA

NOTES:
EPC Exposure point concentration
NA Not applicable
ND Not determined
- Remedial goal options were based on the residential or site worker lifetime weighted average for carcinogens and the child resident or site worker for noncarcinogens

Arsenic, chromium, and BEQs were identified as soil pathway COCs for AOC 628. Table 10.1.19 presents cumulative and COC-specific exposure risks and hazard quotients. Risk-based remedial goals for arsenic, chromium, and BEQs in surface soil are presented in Table 10.1.18.

To determine the leaching potential of contaminants from the subsurface soil media to groundwater, contaminant concentrations in subsurface soil were compared against generic SSLs based on a DAF of 20. This comparison indicated one subsurface soil sample with contaminant concentrations exceeding the SSL. The contaminant, methylene chloride was detected at a concentration of 32 μg/kg exceeding the SSL (20 μg/kg). However, methylene chloride is a common laboratory contaminant. Due to the low concentration of methylene chloride detected its vertical distribution and the absence of other site-specific compounds with concentrations exceeding SSLs, its presence can most likely be attributed to lab contamination. Because of the isolated nature of this occurrence and its likely source, corrective measures for this compound are not recommended at this time. For more information regarding indirect exposure pathways associated with subsurface soil refer to Section 10.1.4, Fate and Transport Assessment for AOC 628.

Potential corrective measures for soil are presented in Table 10.1.20.

ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVBASE CHARLESTON

VOLUME II of VI
SECTIONS 10 to 10.7

CONTRACT N62467-89-D-0318
CTO-029

Prepared for:

Comprehensive Long-Term Environmental Action Navy
(CLEAN)
Charleston Naval Shipyard
Charleston, South Carolina

Prepared by:

EnSafe Inc.
5724 Summer Trees Drive
Memphis, Tennessee 38134
(901)372-7962

February 20, 1998
Revision: 0

Table 10.1.19
Zone G
AOC 628
Cumulative and Chemical-Specific Exposure Risks and Hazard

	Risk		Hazard	
Chemical	**Industrial**	**Residential**	**Industrial**	**Residential**
Soil				
Arsenic	7.8E-06	5.5E-05	0.05	0.96
Chromium	ND	ND	0.01	0.12
BEQs	1.5E-06	7.5E-06	ND	ND
Cumulative	9.3E-06	6.2E-05	0.06	1.07

Note:
ND = Not determined

Table 10.1.20
Zone G
AOC 628
Potential Corrective Measures

Medium	Compounds	Potential Corrective Measures
Soil	Arsenic, BEQs, Chromium	a) No action b) Excavate, offsite disposal, and monitoring c) Containment/capping

10.2 AOC 633, Substation, Building 451C

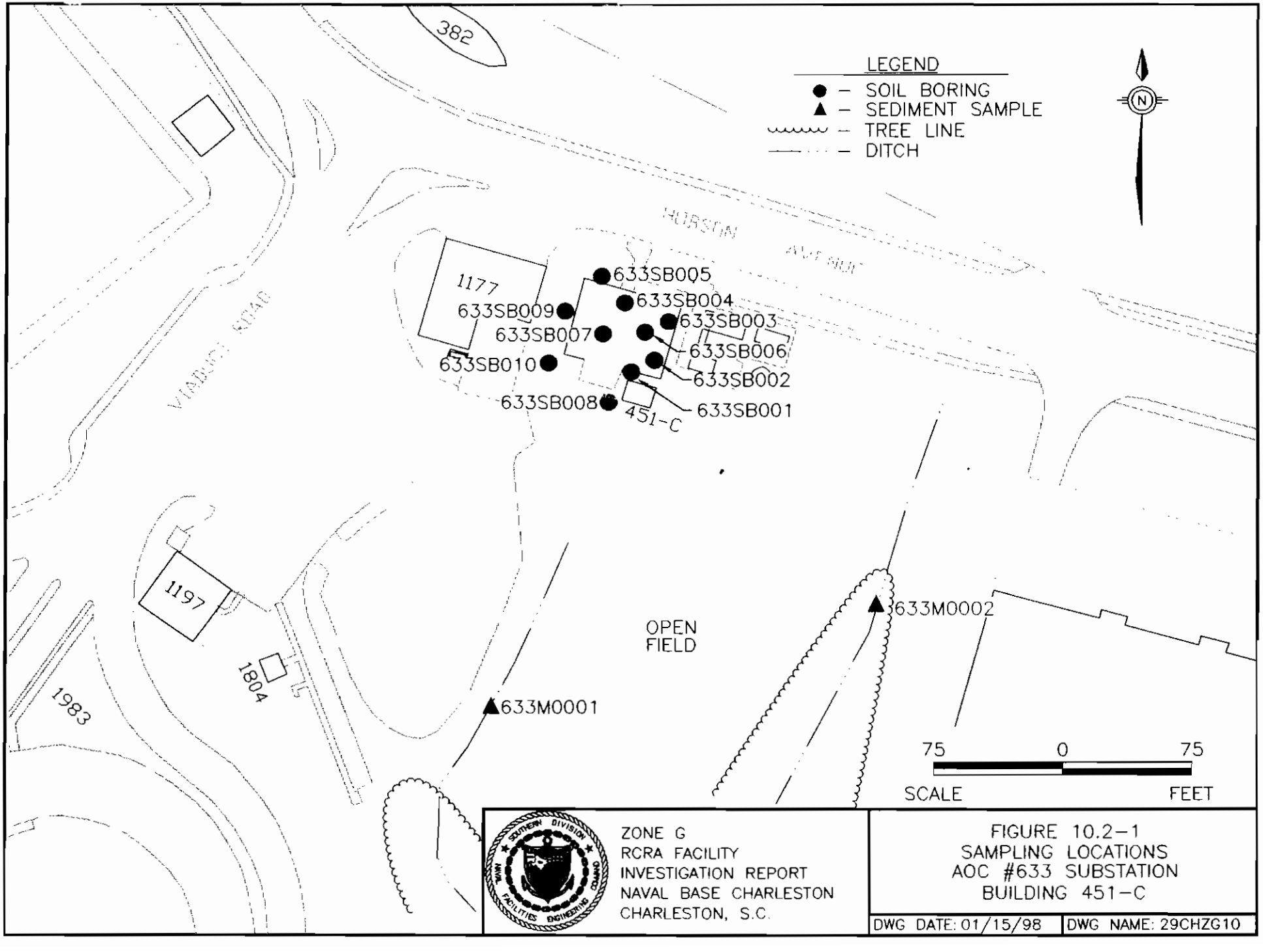
A CSI site, AOC 633 is located near Building 451C, an electrical substation built in 1943. The building is a block structure with a concrete roof and floor, several steel enclosures on concrete slabs and foundations from earlier buildings. Several high voltage switches, breakers and transformers are located in the two room block structure. Several large PCB releases have been documented from this site.

10.2.1 Site Geology

Figure 10.2-1 depicts the soil and sediment sampling locations at AOC 633. The detailed stratigraphy at AOC 633 could not be determined as no monitoring well borings were completed within this area. Geologic data for monitoring well boring FDS07B (installed during the investigation of the Fuel Distribution System), approximately 315 feet east of AOC 633, is therefore presented. The stratigraphy at this location consists of silty, gravelly, medium to coarse sand overlying organic silty clay. The silty clay unit was encountered near the total depth of the boring, occurring below 10 ft bgs. Based on the hydrogeologic data gathered from FDS07B, the groundwater elevation at AOC 633 is approximately 4.5 ft msl. Shallow groundwater at AOC 633 flows generally to the north in the direction of the Cooper River.

10.2.2 Field Investigation Approach

The objective of the field investigation at AOC 633 was to: (1) confirm the presence or absence of contamination in the site area; (2) delineate any contamination found; and (3) provide sufficient data to support a detailed evaluation of treatment alternatives, if required. Media sampled within the investigation area included soil and sediment. Section 3 of this report details the methods used during the field investigation. Included in this section are descriptions the hand-auger procedures used for soil sampling; sediment sampling procedures; and miscellaneous procedures used during the field investigation. Also discussed are the analytical protocols for sample analyses.


LEGEND
● – SOIL BORING
▲ – SEDIMENT SAMPLE
– TREE LINE
– DITCH
N
382
HORSTON AVENUE
VIADUCT ROAD
1177
633SB005
633SB004
633SB009
633SB003
633SB007
633SB006
633SB010
633SB002
633SB008
451-C
633SB001
1197
OPEN FIELD
633M0002
1804
1983
633M0001
75 0 75
SCALE FEET
ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 10.2-1
SAMPLING LOCATIONS
AOC #633 SUBSTATION
BUILDING 451-C
DWG DATE: 01/15/98
DWG NAME: 29CHZG10

10.2.3 Soil Sampling and Analysis

The approved final RFI work plan proposed advancing seven soil borings within the AOC 633 area to detect the presence of any soil contamination from this site. Upper and lower interval soil samples were proposed from each boring. Ten soil borings were advanced during the field investigation, as depicted in Figure 10.2-1. Five borings included both soil sampling intervals, while two included the upper interval only. Where not collected, the lower interval sample was deleted due to obstructions in the borehole, or because of a shallow water table. Three second-round soil borings were advanced to delineate PCB exceedances identified during the initial sampling round. Upper and lower interval samples were collected at all three second-round borings. In accordance with the approved final RFI work plan, all first-round soil samples from AOC 633 were analyzed for pesticide and PCB constituents at DQO Level III. Second-round samples were also sampled for pesticides and PCBs. Table 10.2.1 summarizes the AOC 633 soil samples and analyses.

10.2.3.1 Nature of Contamination in Soil

Pesticide and PCB analytical results for soil are summarized in Table 10.2.2. Table 10.2.3 summarizes all analytes detected in soil at AOC 633. Appendix D contains a complete analytical data report for all Zone G samples.

Pesticides and PCBs in Soil

Six pesticides were detected in AOC 633 surface soil samples. Five pesticides were detected in AOC 633 subsurface soil samples. No surface or subsurface soil pesticide concentrations exceeded a respective RBC or SSL.

Aroclor-1260 was detected in the surface and subsurface soil at concentrations above the RBC/SSL at AOC 633. Figure 10.2-2 presents Aroclor-1260 concentrations detected in surface soil. Figure 10.2-3 presents Aroclor-1260 concentrations detected in subsurface soil.

Table 10.2.1
Zone G
AOC 633
Soil Samples and Analyses

Boring Location	Sample Identifier	Sample Interval	Date Collected	Analyses	Remarks
633SB001	633SB00101	Upper	10/02/96	See note	
	633SB00202	Lower			
633SB002	633SB00201	Upper	10/02/96	See note	
	633SB00202	Lower			
633SB003	633SB00301	Upper	10/02/96	See note	
	633SB00302	Lower			
633SB004	633SB00401	Upper	10/02/96	See note	
	633SB00402	Lower			
633SB005	633SB00501	Upper	10/02/96	See note	Lower interval not sampled
633SB006	633SB00601	Upper	10/02/96	See note	Lower interval not sampled
633SB007	633SB00701	Upper	10/02/96	See note	
	633SB00702	Lower			
633SB008	633SB00801	Upper	1/07/97	See note	Second-round sample
	633SB00802	Lower			
633SB009	633SB00901	Upper	1/07/97	See note	Second-round sample
	633SB00902	Lower			
633SB010	634SB01001	Upper	1/07/97	See note	Second-round sample
	634SB01002	Lower			

Note:
SW-846 (Pesticides/PCBs) at DQO Level III.

Table 10.2.2
Zone G
AOC 633
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (µg/kg)	Mean of Detections (µg/kg)	Reference Conc.* (µg/kg)	Number of Samples Exceeding Reference
Pesticides and PCBs (Upper Interval - 10 Samples/Lower Interval - 8 Samples) (µg/kg)						
alpha-Chlordane	Upper	1/10	450	450	1800	0
	Lower	2/8	2.90 - 8.70	5.80	10000	0
gamma-Chlordane	Upper	1/10	420	420	1800	0
	Lower	2/8	3.10 - 9.30	6.20	10000	0
4,4'DDD	Upper	1/10	68.0	68.0	2700	0
	Lower	1/8	6.70	6.70	16000	0
4,4'-DDE	Upper	1/10	58.0	58.0	1900	0
	Lower	1/8	53.0	53.0	54000	0
4,4'-DDT	Upper	4/10	3.40 - 30.0	14.6	1900	0
	Lower	1/8	740	740	32000	0
Heptachlor epoxide	Upper	1/10	19.0	19.0	70.0	0
	Lower	0/8	ND	ND	700	0
Aroclor-1260	Upper	3/10	41.0 - 480	207	320	1
	Lower	2/8	310 - 25000	12700	1000	1

Notes:
* = Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil to groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as a reference concentration for lower interval samples.
ND = Not detected.
µg/kg = Micrograms per kilogram.

Table 10.2.3
Zone G
AOC 633
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Pesticides/PCBs (µg/kg)							
alpha-Chlordane	633SB009	ND	1800	NA	2.9	10000	NA
	633SB010	450			8.7		
gamma-Chlordane	633SB009	ND	1800	NA	3.1	10000	NA
	633SB010	420			9.3		
4,4'-DDD	633SB010	68	2700	NA	6.7	16000	NA
4,4'-DDE	633SB007	ND	1900.0	NA	53	54000	NA
	633SB010	58			ND		
4,4'-DDT	633SB001	30	1900	NA	ND	32000	NA
	633SB002	3.4			ND		
	633SB007	ND			740		
	633SB009	4			ND		
	633SB010	21			ND		
Heptachlor epoxide	633SB010	19	70	NA	ND	700	NA
Aroclor-1260	633SB001	480	320	NA	ND	1000	NA
	633SB002	41			ND		
	633SB004	ND			310		
	633SB007	ND			25000		
	633SB008	100			ND		

Notes:

* = Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil to groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as a reference concentration for lower interval samples.

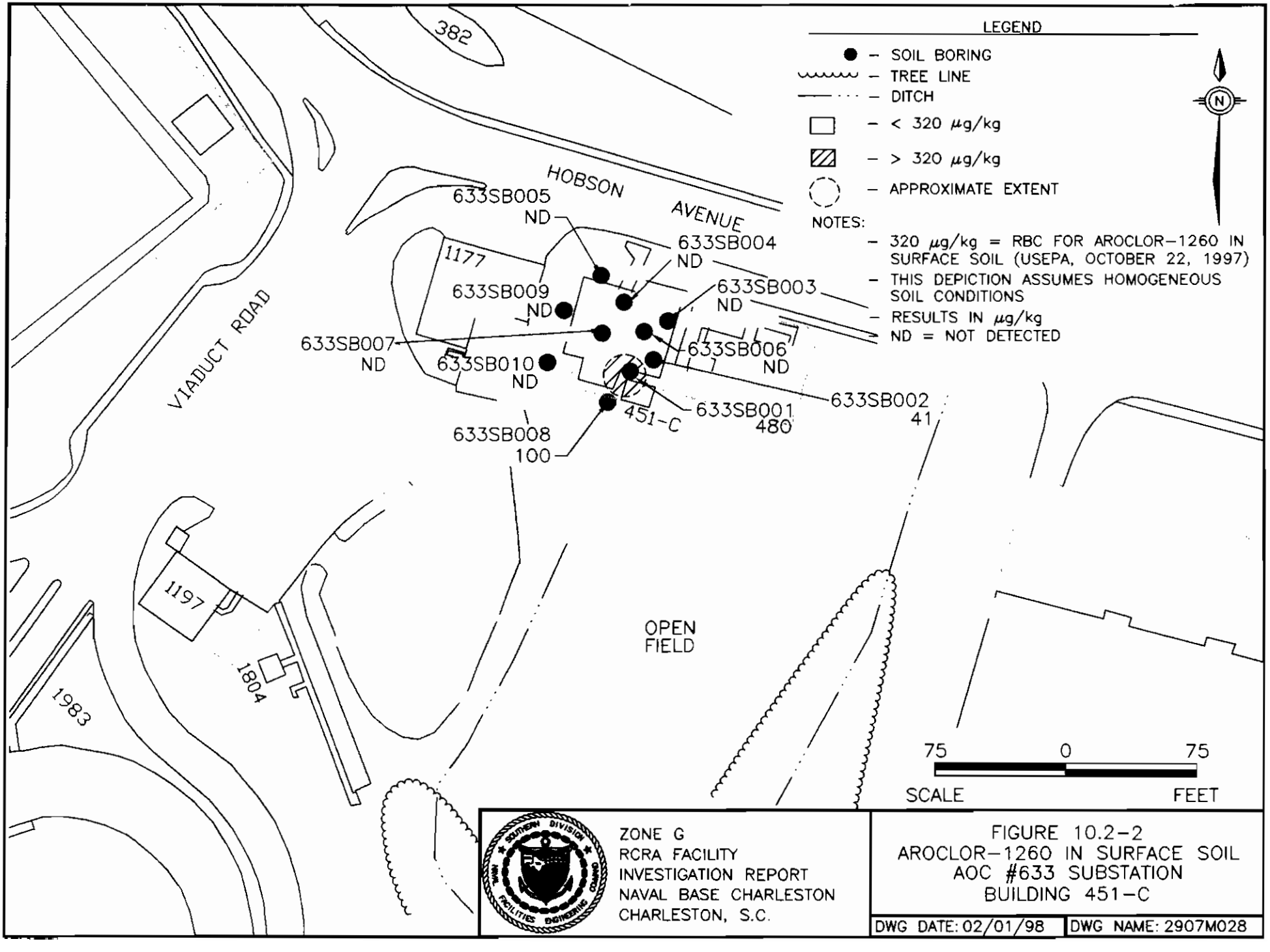
ND = Not detected.

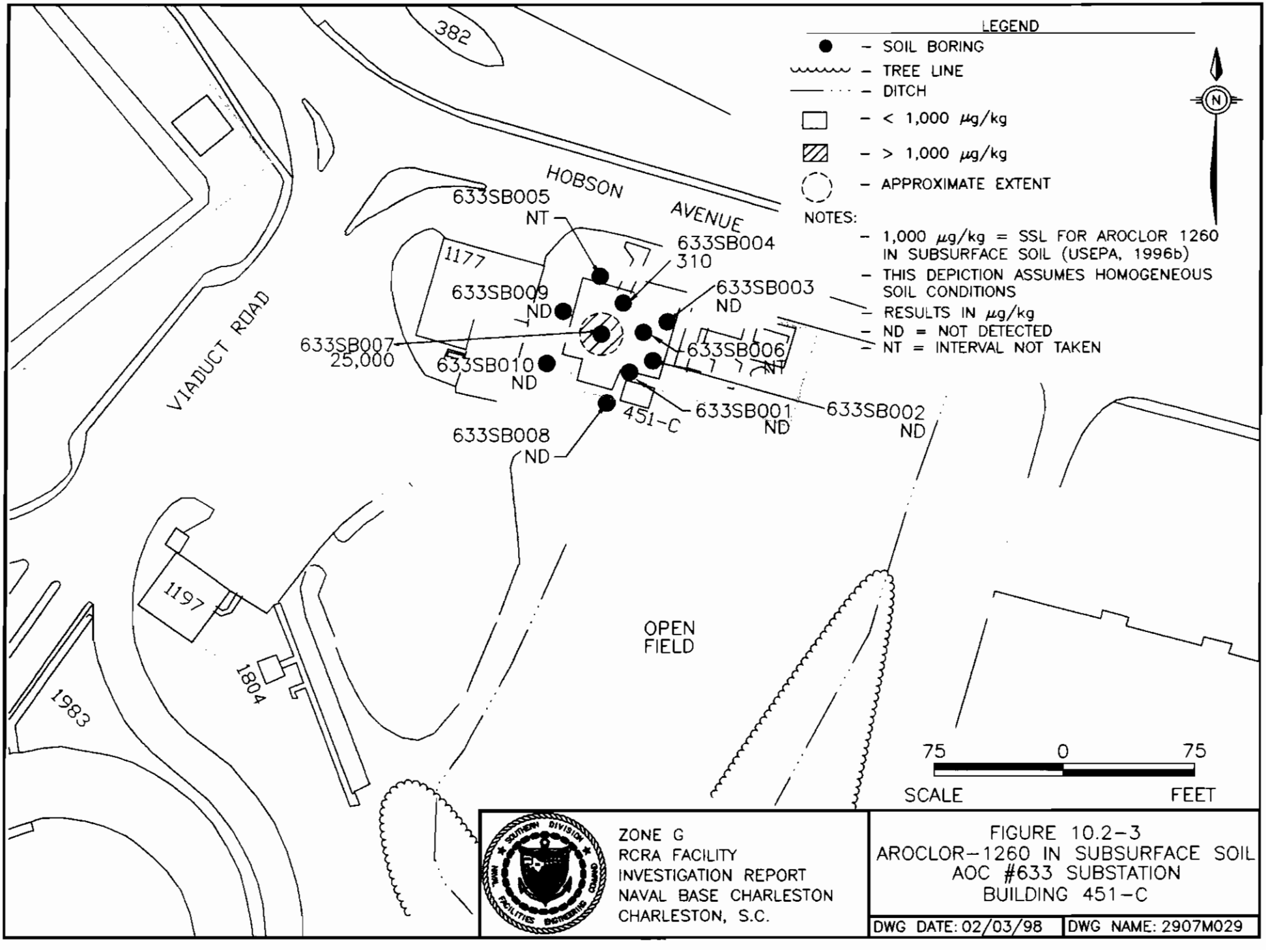
NT = Not taken.

NA = Not applicable.

Bolded concentrations exceed both the reference concentration (RBC or SSL) and the zone background.

All background values for Zone G are based on twice the means of the grid sample concentrations.


LEGEND
● – SOIL BORING
– TREE LINE
– DITCH
– < 320 µg/kg
– > 320 µg/kg
– APPROXIMATE EXTENT
NOTES:
– 320 µg/kg = RBC FOR AROCLOR–1260 IN SURFACE SOIL (USEPA, OCTOBER 22, 1997)
– THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
– RESULTS IN µg/kg
ND = NOT DETECTED
N
382
HOBSON AVENUE
633SB005
ND
633SB004
ND
1177
633SB009
ND
633SB003
ND
633SB007
ND
633SB010
ND
633SB006
ND
VIADUCT ROAD
633SB001
480
633SB002
41
451-C
633SB008
100
1197
1804
1983
OPEN FIELD
75 0 75
SCALE FEET
ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 10.2-2
AROCLOR–1260 IN SURFACE SOIL
AOC #633 SUBSTATION
BUILDING 451–C
DWG DATE: 02/01/98
DWG NAME: 2907M028


LEGEND
– SOIL BORING
– TREE LINE
– DITCH
– < 1,000 µg/kg
– > 1,000 µg/kg
– APPROXIMATE EXTENT
NOTES:
– 1,000 µg/kg = SSL FOR AROCLOR 1260 IN SUBSURFACE SOIL (USEPA, 1996b)
– THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
– RESULTS IN µg/kg
– ND = NOT DETECTED
– NT = INTERVAL NOT TAKEN
N
382
HOBSON AVENUE
VIADUCT ROAD
633SB005 NT
633SB004 310
633SB003 ND
633SB009 ND
633SB007 25,000
633SB010 ND
633SB006 NT
633SB001 ND
633SB002 ND
633SB008 ND
451-C
1177
1197
1804
1983
OPEN FIELD
75 0 75
SCALE FEET
ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 10.2-3
AROCLOR-1260 IN SUBSURFACE SOIL
AOC #633 SUBSTATION
BUILDING 451-C
DWG DATE: 02/03/98
DWG NAME: 2907M029

10.2.4 Sediment Sampling and Analysis

The approved final RFI work plan proposed collecting six sediment samples to identify contaminants introduced to AEC IV-1 from AOC 633 and also from two other nearby AOCs (AOCs 634 and 706). Six sediment samples were collected during the investigation. In accordance with the approved final RFI work plan, sediment samples were analyzed for pesticides/PCBs at DQO Level III. In addition, sediment samples were analyzed for metals, SVOCs, and VOCs at DQO Level III. Table 10.2.4 summarizes the AOC 633 sediment samples and analyses.

Table 10.2.4
Zone G
AOC 633
Sediment Samples and Analyses

Sample Location	Sample Identifier	Date Collected	Analyses	Remarks
633M0001	633M000101	9/26/96	See note	
633M0002	633M000201	9/26/96	See note	
633M0003	633M000301	9/26/96	See note	
633M0004	633M000401	9/26/96	See note	
633M0005	633M000501	9/26/96	See note	
633M0006	633M000601	9/26/96	See note	

Note:
SW-846 (metals, pesticides/PCBs, SVOCs, VOCs) at DQO Level III.

10.2.4.1 Nature of Contamination in Sediment

Organic compound analytical results for sediment are summarized in Table 10.2.5. Inorganic analytical results for sediment are summarized in Table 10.2.6. Table 10.2.7 summarizes all analytes detected in sediment at AOC 633. Appendix D contains a complete analytical data report for all Zone G samples. Section 8 discusses the ecological risk from these detections.

Table 10.2.5
Zone G
AOC 633
Organic Analytical Results for Sediment

Parameters	Frequency of Detection	Range of Detections (µg/kg)	Mean of Detections (µg/kg)	SSVs (µg/kg)	Number of Samples Exceeding SSVs
Volatile Organic Compounds (6 Samples) (µg/kg)					
2-Butanone (MEK)	1/6	20.0	20.0	NL	NA
Carbon disulfide	1/6	11.0	11.0	NL	NA
Semivolatile Organic Compounds (6 Samples) (µg/kg)					
BEQs[1]	3/6	14.7 - 178	79.4	NL	NA
Benzo(a)anthracene	3/6	60 - 180	137	330	0
Benzo(b)fluoranthene	3/6	78 - 310	213	NL	NA
Benzo(k)fluoranthene	2/6	77 - 200	139	NL	NA
Benzo(a)pyrene	1/6	130	130	330	0
Chrysene	3/6	91 - 260	200	330	0
Anthracene	1/6	60.0	60.0	330	0
Benzoic acid	1/6	79.0	79.0	NL	NA
Butylbenzylphthalate	1/6	63.0	63.0	NL	NA
bis(2-Ethylhexyl)phthalate	1/6	3400	3400	182	1
Fluoranthene	3/6	100 - 410	280	330	2
2-Methylnaphthalene	1/6	92.0	92.0	330	NA
Phenanthrene	2/6	100 - 270	185	330	0
Pyrene	3/6	120 - 650	390	330	2
Pesticides and PCBs (6 Samples) (µg/kg)					
alpha-Chlordane	2/6	5.10 - 86.0	45.6	1.7	2
gamma-Chlordane	2/6	9.10 - 130	69.6	1.7	2
4,4'-DDD	3/6	12.0 - 18.0	14.7	3.3	3
4,4'-DDE	4/6	8.10 - 34.0	21.0	3.3	4
4,4'-DDT	1/6	16.0	16.0	3.3	1
Aroclor-1260	1/6	270	270	33	1

Notes:

1 = Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995c).

µg/kg = Micrograms per kilogram.

NL = Not listed.

NA = Not available.

SSV = Sediment Screening Value.

SSVs from *Supplemental Guidance to RAGS: Region IV Bulletins, Ecological Risk Assessment, Bulletin 2* (USEPA, 1995a).

Table 10.2.6
Zone G
AOC 633
Inorganics Analytical Results for Sediment

Parameters	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	SSVs (mg/kg)	Number of Samples Exceeding SSVs
Inorganics (6 Samples)					
Aluminum (Al)	6/6	8850 - 34500	21400	NL	0
Antimony (Sb)	2/6	0.95 - 23.5	12.2	12	1
Arsenic (As)	6/6	4.90 - 25.3	15.8	7.24	5
Barium (Ba)	6/6	19.3 - 317	96.5	NL	NA
Beryllium (Be)	5/6	0.53 - 1.60	1.16	NL	NA
Cadmium (Cd)	4/6	0.39 - 4.90	1.92	1.0	3
Calcium (Ca)	6/6	2120 - 43700	22700	NL	NA
Chromium (Cr)	6/6	13.0 - 61.7	42.2	52.3	3
Cobalt (Co)	6/6	0.77 - 9.10	5.53	NL	NA
Copper (Cu)	5/6	34.4 - 1220	320	18.7	5
Iron (Fe)	6/6	8300 - 39100	25400	NL	NA
Lead (Pb)	6/6	6.90 - 393	153	30.2	5
Magnesium (Mg)	6/6	394 - 6440	3770	NL	NA
Manganese (Mn)	6/6	16.0 - 710	333	NL	NA
Mercury (Hg)	5/6	0.27 - 1.000	0.51	0.13	5
Nickel (Ni)	5/6	17.1 - 47.6	24.8	15.9	5
Potassium (K)	6/6	300 - 2810	1590	NL	NA
Selenium (Se)	6/6	0.47 - 1.50	1.09	NL	NA
Silver (Ag)	2/6	0.73 - 0.95	0.84	2.0	0
Sodium (Na)	3/6	1990 - 4030	2820	NL	NA
Tin (Sn)	1/6	52.8	52.8	NL	NA
Vanadium (V)	6/6	21.5 - 77.0	52.8	NL	NA
Zinc (Zn)	5/6	140 - 3260	832	124	5

Notes:
mg/kg = Milligrams per kilogram.
NL = Not listed.
NA = Not available.
SSV = Sediment Screening Value.
SSVs from *Supplemental Guidance to RAGs: Region IV Bulletins, Ecological Risk Assessment, Bulletin 2* (USEPA, 1995a).

Table 10.2.7
Zone G
AOC 633
Analytes Detected in Sediment Samples

Parameters	Location	Concentration	SSVs
Volatile Organic Compounds (µg/kg)			
Carbon disulfide	633M0003	11	NL
2-Butanone	633M0004	20	NL
Semivolatile Organic Compounds (µg/kg)			
BEQs[1]	633M0002	128.26	NL
	633M0003	45.25	
	633M0006	14.66	
Benzo(a)anthracene	633M0002	170	330
	633M0003	180	
	633M0006	60	
Benzo(b)fluoranthene	633M0002	310	NL
	633M0003	250	
	633M0006	78	
Benzo(k)fluoranthene	633M0003	200	NL
	633M0006	77	
Benzo(a)pyrene	633M0002	130	330
Chrysene	633M0002	260	330
	633M0003	250	
	633M0006	91	
Anthracene	633M0002	60	330
Benzoic acid	633M0002	79	NL
Butylbenzylphthalate	633M0002	63	NL
bis(2-ethylhexyl)phthalate	633M0003	3400	182
Fluoranthene	633M0002	410	330
	633M0003	330	
	633M0006	100	
2-Methylnaphthalene	633M0006	92	330
Phenanthrene	633M0002	270	330
	633M0006	100	
Pyrene	633M0002	400	330
	633M0003	650	
	633M0006	120	
Pesticides (µg/kg)			
alpha-Chlordane	633M0002	86	1.7
	633M0006	5.1	

Table 10.2.7
Zone G
AOC 633
Analytes Detected in Sediment Samples

Parameters	Location	Concentration	SSVs
gamma-Chlordane	633M0002	**130**	1.7
	633M0006	**9.1**	
4,4'-DDD	633M0002	**18**	3.3
	633M0005	**12**	
	633M0006	**14**	
4,4'-DDE	633M0002	**29**	3.3
	633M0003	**13**	
	633M0005	**8.1**	
	633M0006	**34**	
4,4'-DDT	633M0005	**16**	3.3
Aroclor-1260	633M0005	**270**	33
Inorganics (mg/kg)			
Aluminum (Al)	633M0001	9010	NL
	633M0002	24300	
	633M0003	26100	
	633M0004	34500	
	633M0005	25900	
	633M0006	8850	
Antimony (Sb)	633M0002	0.95	12
	633M0005	**23.5**	
Arsenic (As)	633M0001	4.9	7.24
	633M0002	**13.3**	
	633M0003	**22.7**	
	633M0004	**25.3**	
	633M0005	**19.2**	
	633M0006	**9.2**	
Barium (Ba)	633M0001	19.3	NL
	633M0002	59.8	
	633M0003	91.2	
	633M0004	54.3	
	633M0005	317	
	633M0006	37.1	
Beryllium (Be)	633M0002	0.89	NL
	633M0003	1.4	
	633M0004	1.6	
	633M0005	1.4	
	633M0006	0.53	
Cadmium (Cd)	633M0002	**1.1**	1.0
	633M0003	**1.3**	
	633M0005	**4.9**	
	633M0006	0.39	

Table 10.2.7
Zone G
AOC 633
Analytes Detected in Sediment Samples

Parameters	Location	Concentration	SSVs
Calcium (Ca)	633M0001	2120	NL
	633M0002	25900	
	633M0003	36900	
	633M0004	15000	
	633M0005	12700	
	633M0006	43700	
Chromium (Cr)	633M0001	13	52.3
	633M0002	47.6	
	633M0003	**57.2**	
	633M0004	**54.1**	
	633M0005	**61.7**	
	633M0006	19.8	
Cobalt (Co)	633M0001	0.77	NL
	633M0002	4.8	
	633M0003	8.0	
	633M0004	7.8	
	633M0005	9.1	
	633M0006	2.7	
Copper (Cu)	633M0002	**120**	18.7
	633M0003	**80.7**	
	633M0004	**34.4**	
	633M0005	**1220**	
	633M0006	**143**	
Iron (Fe)	633M0001	10100	NL
	633M0002	25100	
	633M0003	31500	
	633M0004	38400	
	633M0005	39100	
	633M0006	8300	
Lead (Pb)	633M0001	6.9	30.2
	633M0002	**182**	
	633M0003	**203**	
	633M0004	**57.7**	
	633M0005	**393**	
	633M0006	**75.6**	
Magnesium (Mg)	633M0001	394	NL
	633M0002	3320	
	633M0003	5990	
	633M0004	6440	
	633M0005	4930	
	633M0006	1530	

Table 10.2.7
Zone G
AOC 633
Analytes Detected in Sediment Samples

Parameters	Location	Concentration	SSVs
Manganese (Mn)	633M0001	16	NL
	633M0002	170	
	633M0003	432	
	633M0004	492	
	633M0005	710	
	633M0006	178	
Mercury (Hg)	633M0002	**0.57**	0.13
	633M0003	**0.37**	
	633M0004	**0.27**	
	633M0005	**1.0**	
	633M0006	**0.34**	
Nickel (Ni)	633M0002	**17.1**	15.9
	633M0003	**21.5**	
	633M0004	**20.4**	
	633M0005	**47.6**	
	633M0006	**17.2**	
Potassium (K)	633M0001	300	NL
	633M0002	1480	
	633M0003	2450	
	633M0004	2810	
	633M0005	1960	
	633M0006	547	
Selenium (Se)	633M0001	0.47	NL
	633M0002	1.4	
	633M0003	1.4	
	633M0004	1.5	
	633M0005	1.3	
	633M0006	0.48	
Silver (Ag)	633M0002	0.73	2.0
	633M0005	0.95	
Sodium (Na)	633M0002	1990	NL
	633M0003	4030	
	633M0004	2450	
Tin (Sn)	633M0005	52.8	NL
Vanadium (V)	633M0001	21.5	NL
	633M0002	64.5	
	633M0003	69.2	
	633M0004	77.0	
	633M0005	62.8	
	633M0006	21.8	

Table 10.2.7
Zone G
AOC 633
Analytes Detected in Sediment Samples

Parameters	Location	Concentration	SSVs
Zinc (Zn)	633M0002	**312**	124
	633M0003	**279**	
	633M0004	**140**	
	633M0005	**3260**	
	633M0006	**167**	

Notes:
1 = Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment, Bulletin 2* (USEPA, 1995c).
µg/kg = Micrograms per kilogram.
SSV = Sediment Screening Value.
Bolded concentrations exceed the SSV.
SSVs from *Supplemental Guidance to RAGS: Region IV Bulletins, Ecological Risk Assessment, Bulletin 2* (USEPA, 1995a).

Volatile Organic Compounds in Sediment

Two VOCs, 2-butanone, and carbon disulfide, were detected in AOC 633 sediment samples. No VOCs in sediment exceeded their respective sediment screening values (SSVs).

Semivolatile Organic Compounds in Sediment

Thirteen SVOCs were detected in AOC 633 sediment samples. Bis(2-ethylhexyl)phthalate, fluoranthene and pyrene exceeded their respective SSVs in sediment samples at this AOC. Figure 10.2-4 presents bis(2-ethylhexyl)phthalate concentrations detected in sediment at AOC 643. Figure 10.2-5 presents fluoranthene concentrations detected in sediment at this AOC. Figure 10.2-6 presents pyrene concentrations detected in sediment at this AOC.

Pesticides and PCBs in Sediment

Five pesticides were detected in AOC 633 sediment samples. All pesticides detected exceeded their respective SSV. Figures 10.2-7 through 10.2-11 present alpha-chlordane, gamma-chlordane, 4,4'-DDD, 4,4'-DDE, and 4,4'DDT concentrations in AOC 633 sediment samples, respectively.

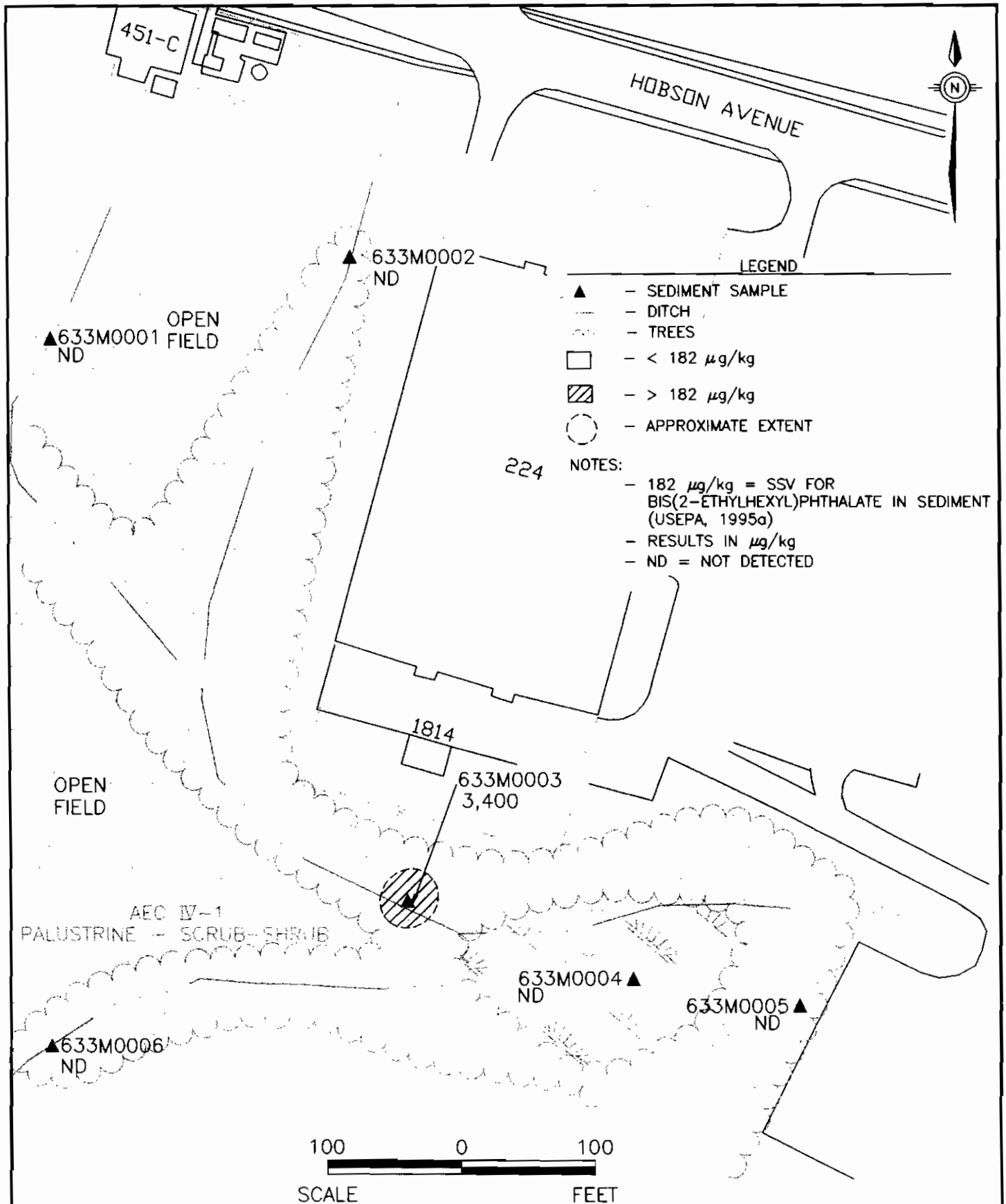


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FIGURE 10.2-4
BIS(2-ETHYLHEXYL)PHTHALATE IN SEDIMENT
SUBSTAION BUILDING 451C
AOC #633

DWG DATE: 02/02/98 | DWG NAME: 2907M030

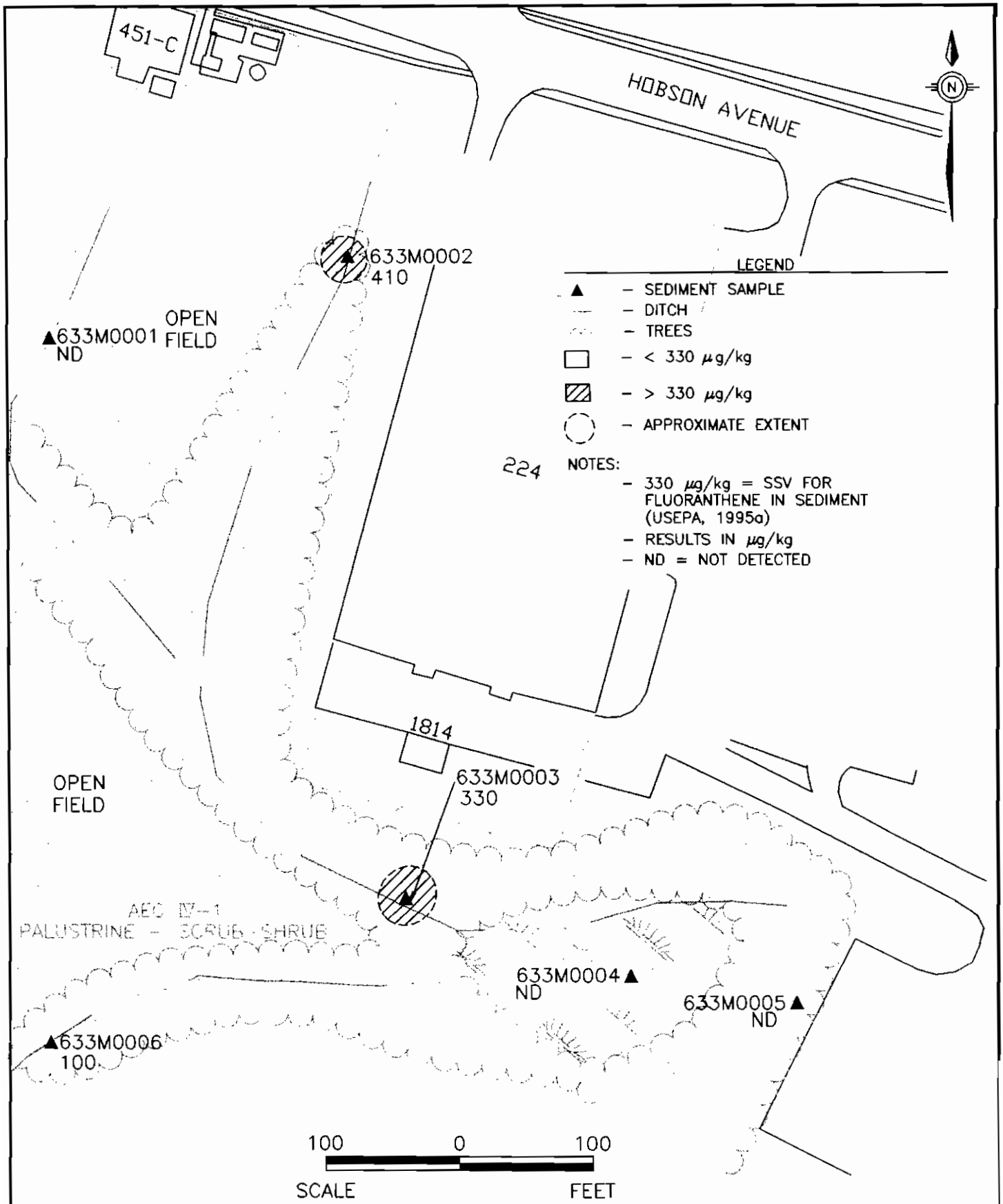

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FIGURE 10.2-5
FLUORANTHENE IN SEDIMENT
AOC #633
SUBSTATION BUILDING 451C

DWG DATE: 02/03/98 | DWG NAME: 2907M031

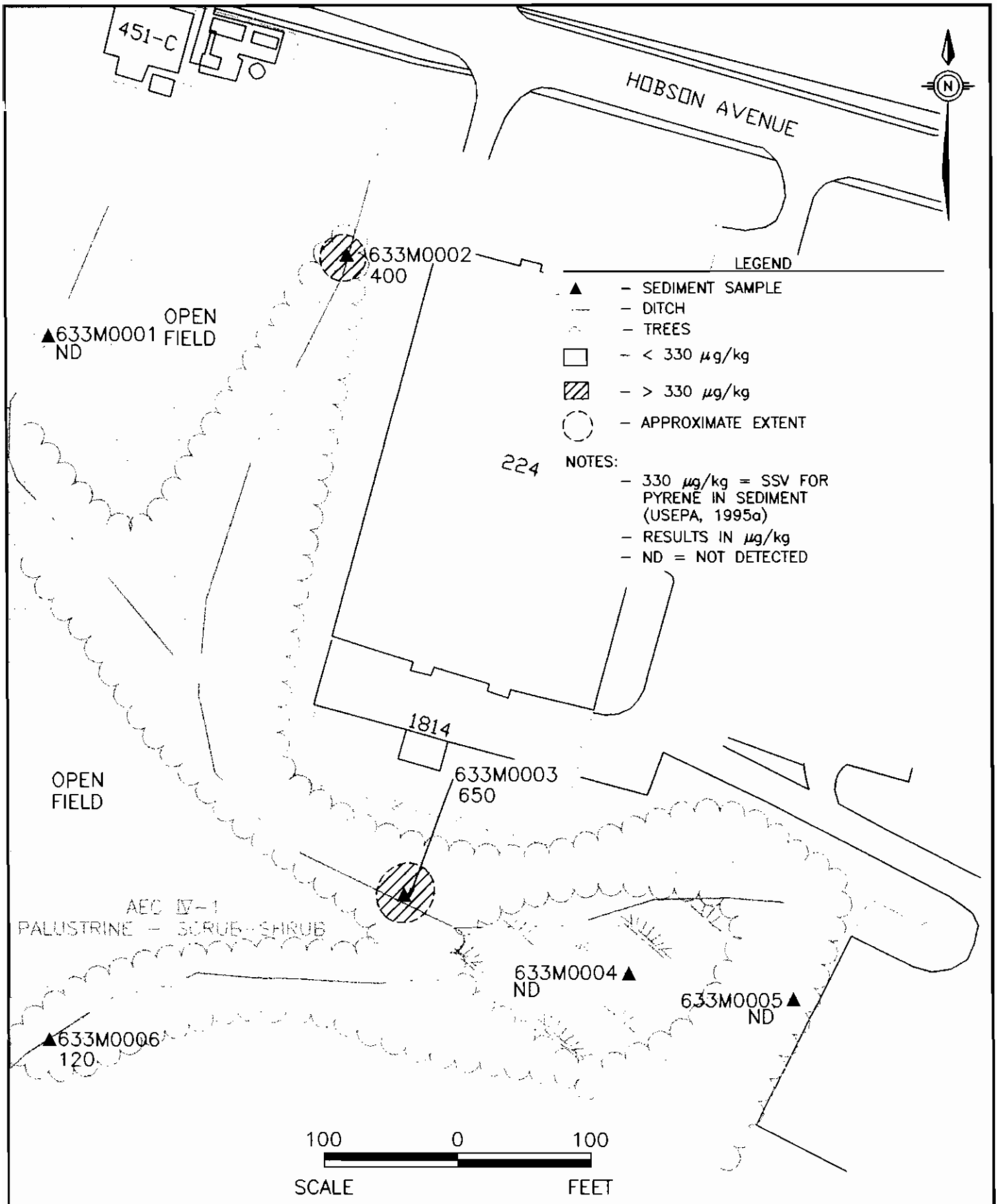

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FIGURE 10.2–6
PYRENE IN SEDIMENT
AOC #633
SUBSTATION BUILDING 451C

DWG DATE: 02/02/98 | DWG NAME: 2907M032

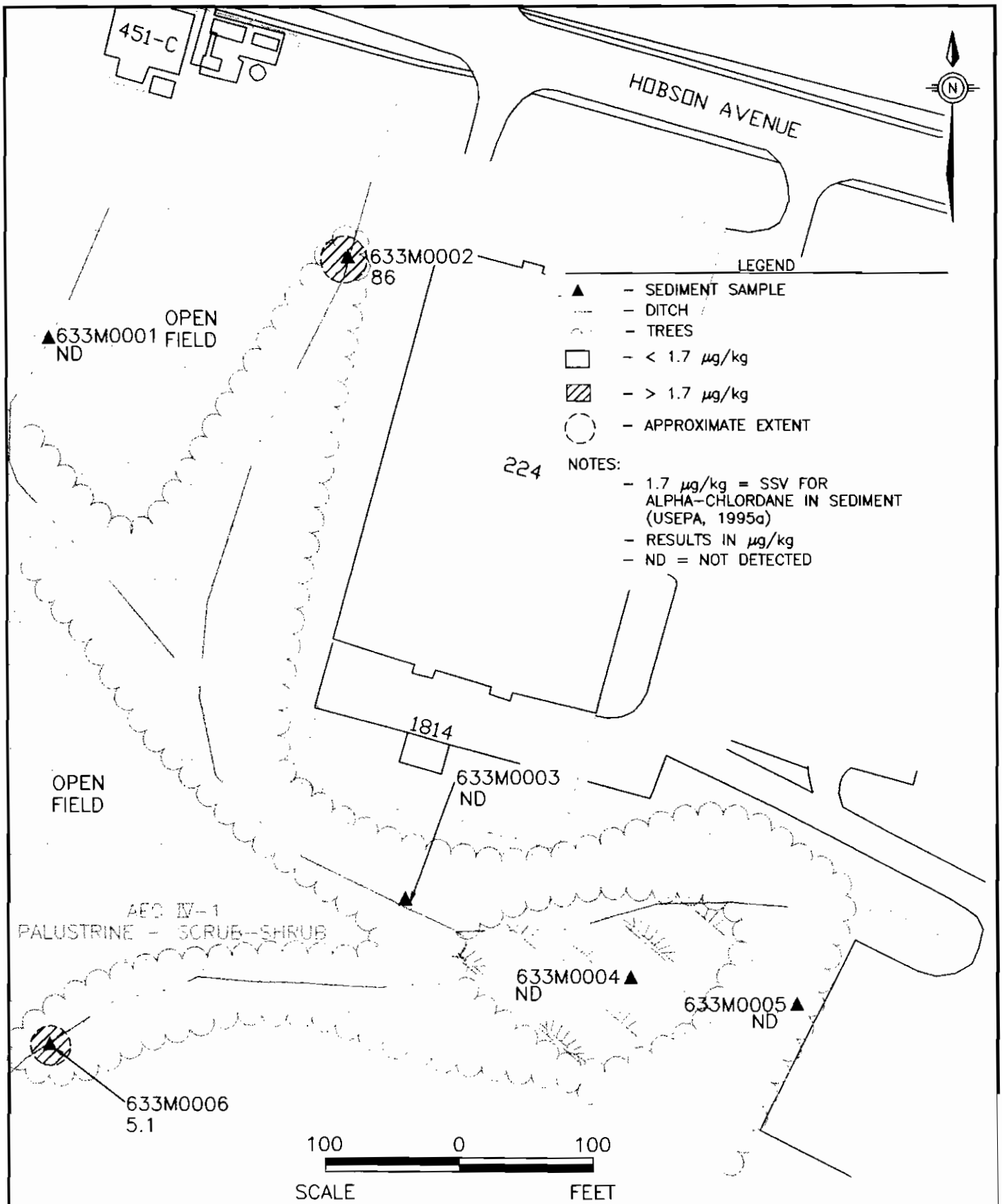

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FIGURE 10.2–7
ALPHA–CHLORDANE IN SEDIMENT
AOC #633
SUBSTATION BUILDING 451C

DWG DATE: 02/03/98 | DWG NAME: 2907M033

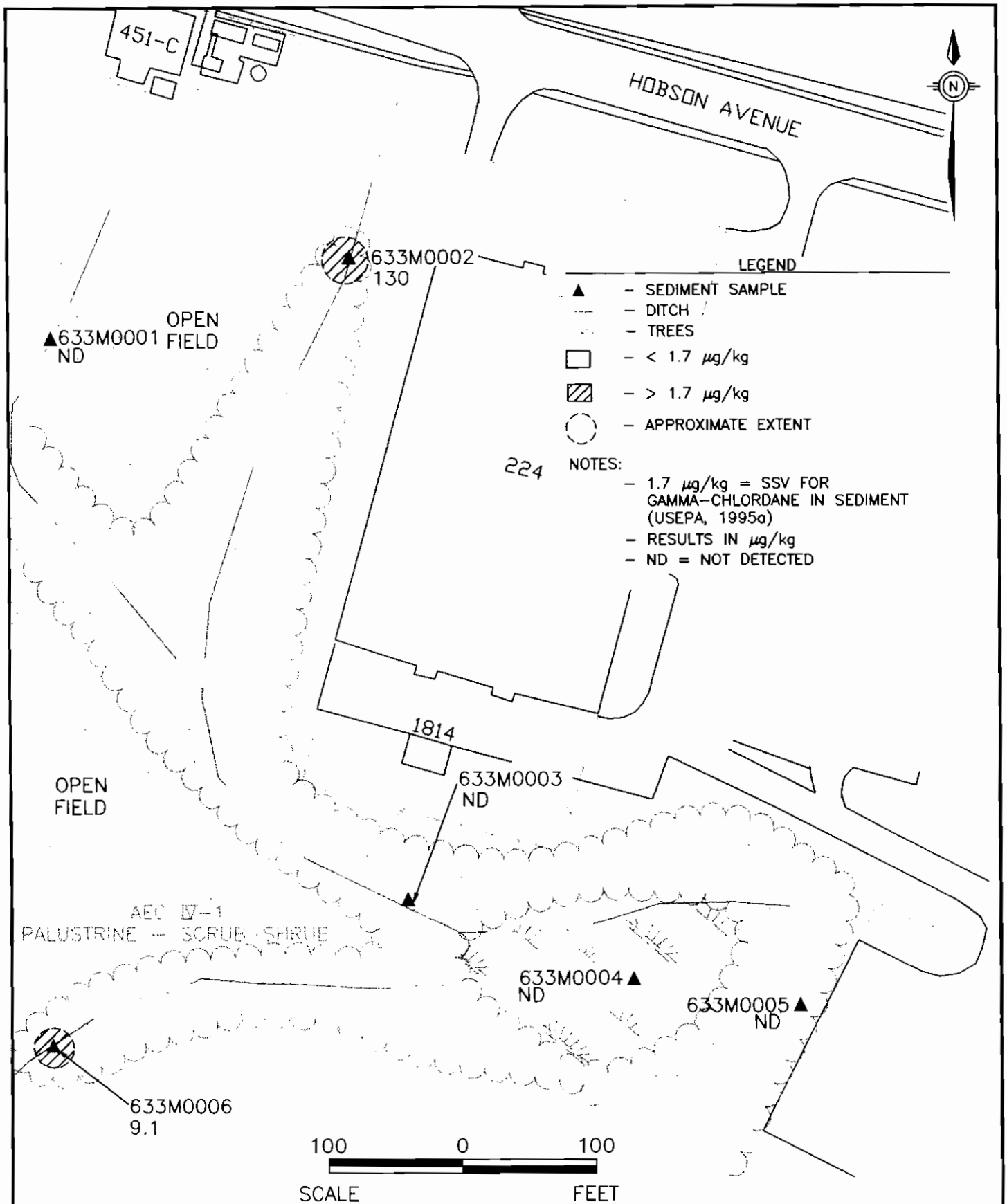

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FIGURE 10.2–8
GAMMA–CHLORDANE IN SEDIMENT
AOC #633
SUBSTATION BUILDING 451C

DWG DATE: 02/02/98 | DWG NAME: 2907M034

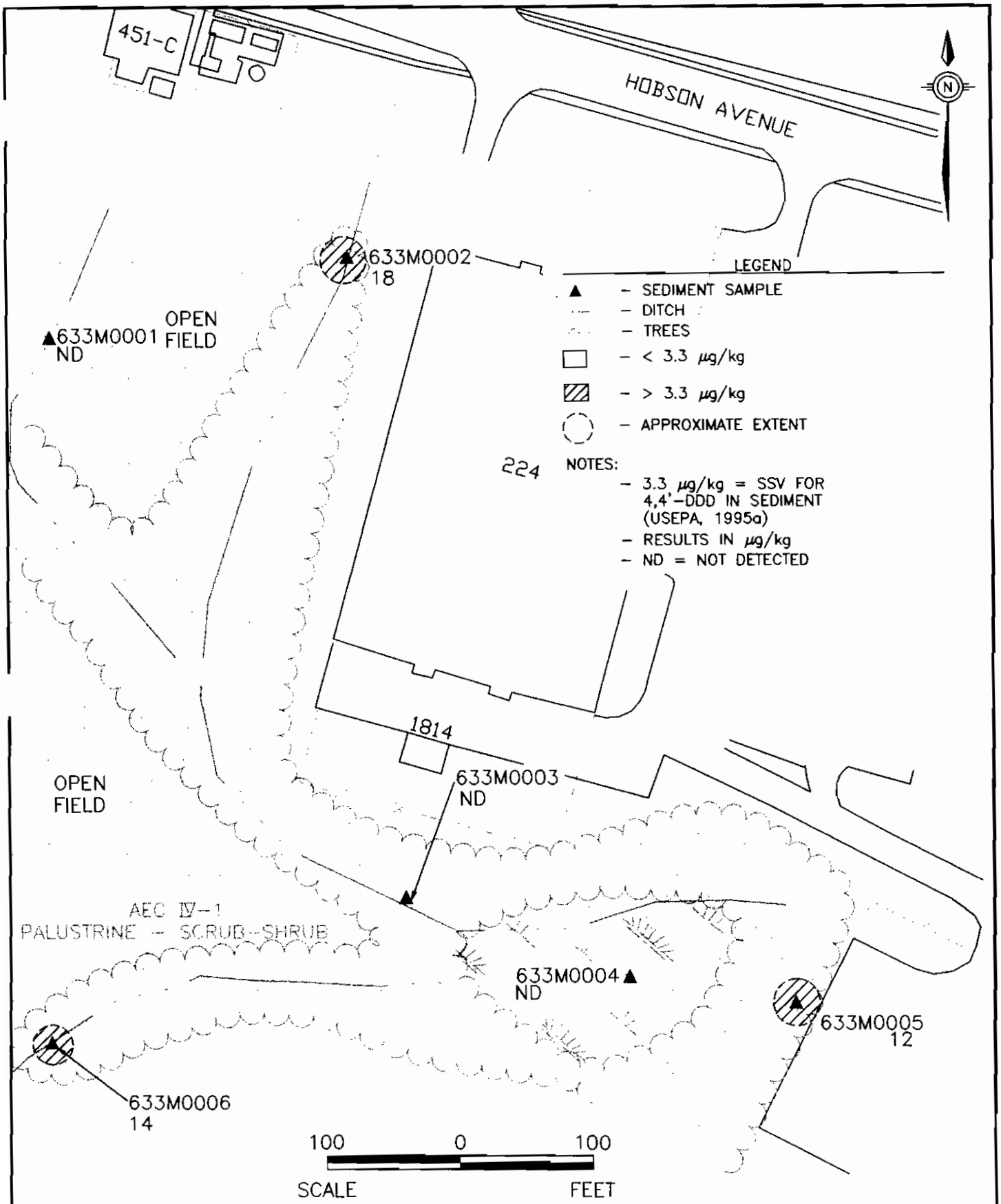

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FIGURE 10.2–9
4–4'–DDD IN SEDIMENT
AOC #633
SUBSTATION BUILDING 451C

DWG DATE: 02/02/98 | DWG NAME: 2907M035

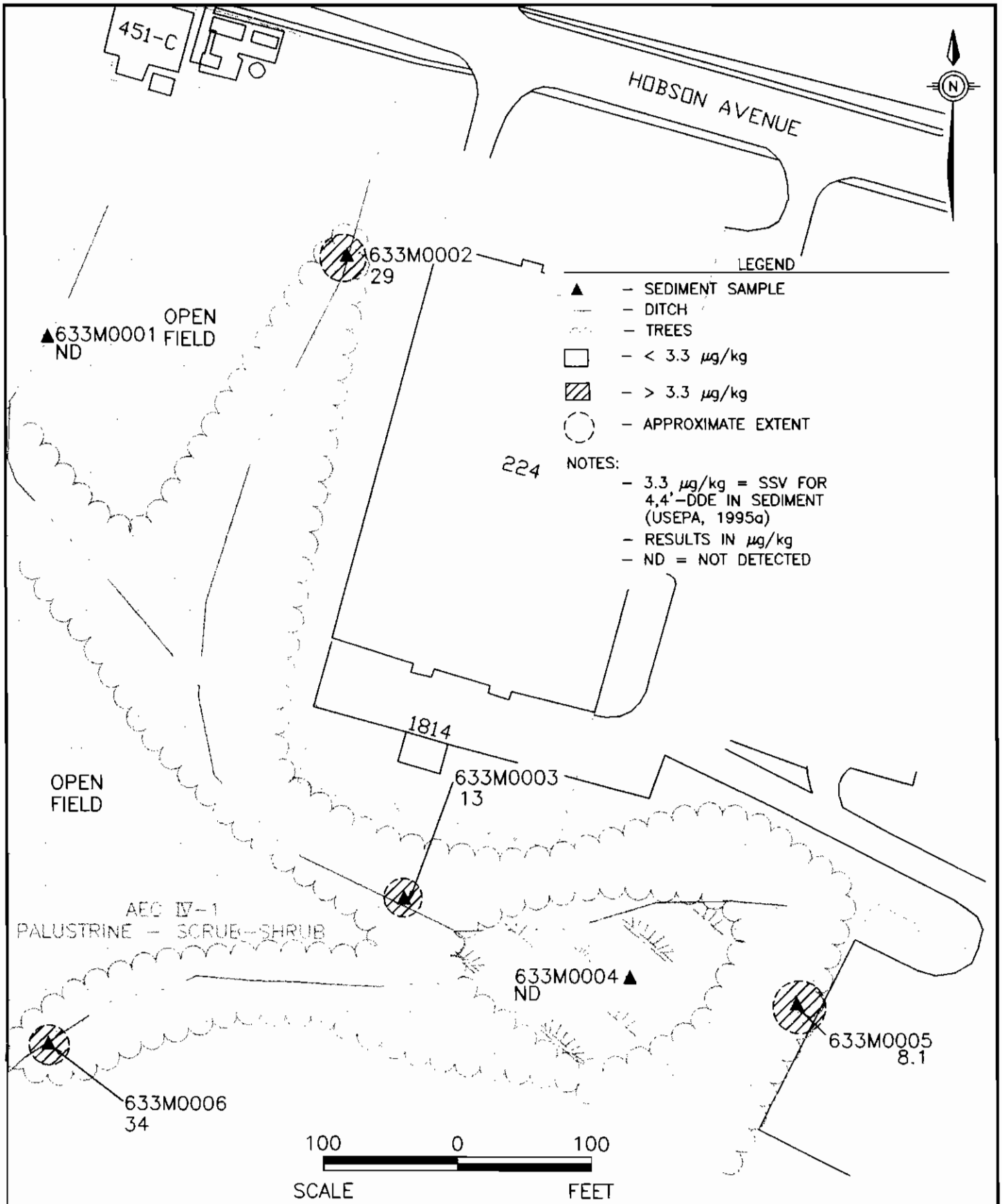

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FIGURE 10.2–10
4–4'–DDE IN SEDIMENT
AOC #633
SUBSTATION BUILDING 451C

DWG DATE: 02/02/98 | DWG NAME: 2907M036

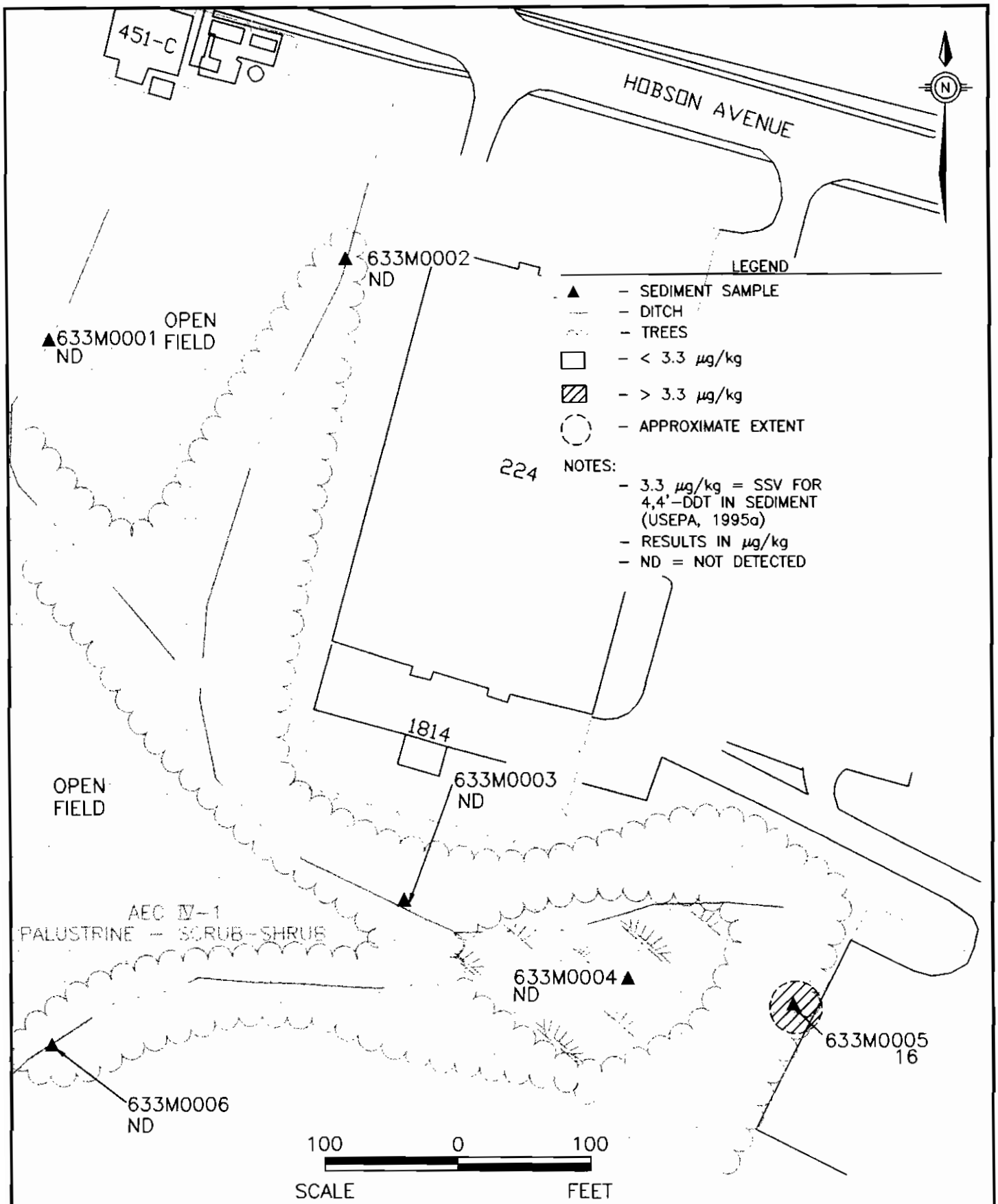

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FIGURE 10.2–11
4–4'–DDT IN SEDIMENT
AOC #633
SUBSTATION BUILDING 451C

DWG DATE: 02/02/98 | DWG NAME: 2907M037

Aroclor-1260 was also detected in AOC 633 sediments, at a concentration exceeding the SSV for this parameter. Figure 10.2-12 presents Aroclor-1260 concentrations in AOC 633 sediment samples.

Inorganic Elements in Sediment

Twenty-three metals were detected in AOC 633 sediment samples. Concentrations of nine metals detected exceeded their respective SSVs. Figures 10.2-13 through 10.2-21 present antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc concentrations in AOC 633 sediment samples, respectively.

10.2.5 Fate and Transport Assessment

AOC 633 is the electrical substation near Building 451C. Several large PCB releases have been documented from the site. Environmental media sampled as part of the AOC 633 investigation include surface soil, subsurface soil, and sediment. Potential constituent migration pathways investigated include soil-to-groundwater, surface soil-to-sediment, and emission of volatiles from surface soil to air.

10.2.5.1 Soil-to-Groundwater Cross-Media Transport

Table 10.2.8 compares maximum detected organic constituent concentrations in surface soil and subsurface soil samples to risk-based soil screening levels considered protective of groundwater. To provide a conservative screen, generic soil screening levels are used; leachate entering the aquifer is assumed to be diluted by a ratio of 20:1, with no attenuation of constituents in soil (DAF=20).

One organic — Aroclor-1260 — was detected above screening levels in subsurface soil from a single sampling location (633SB007). There were no exceedances in surface soil. This PCB was

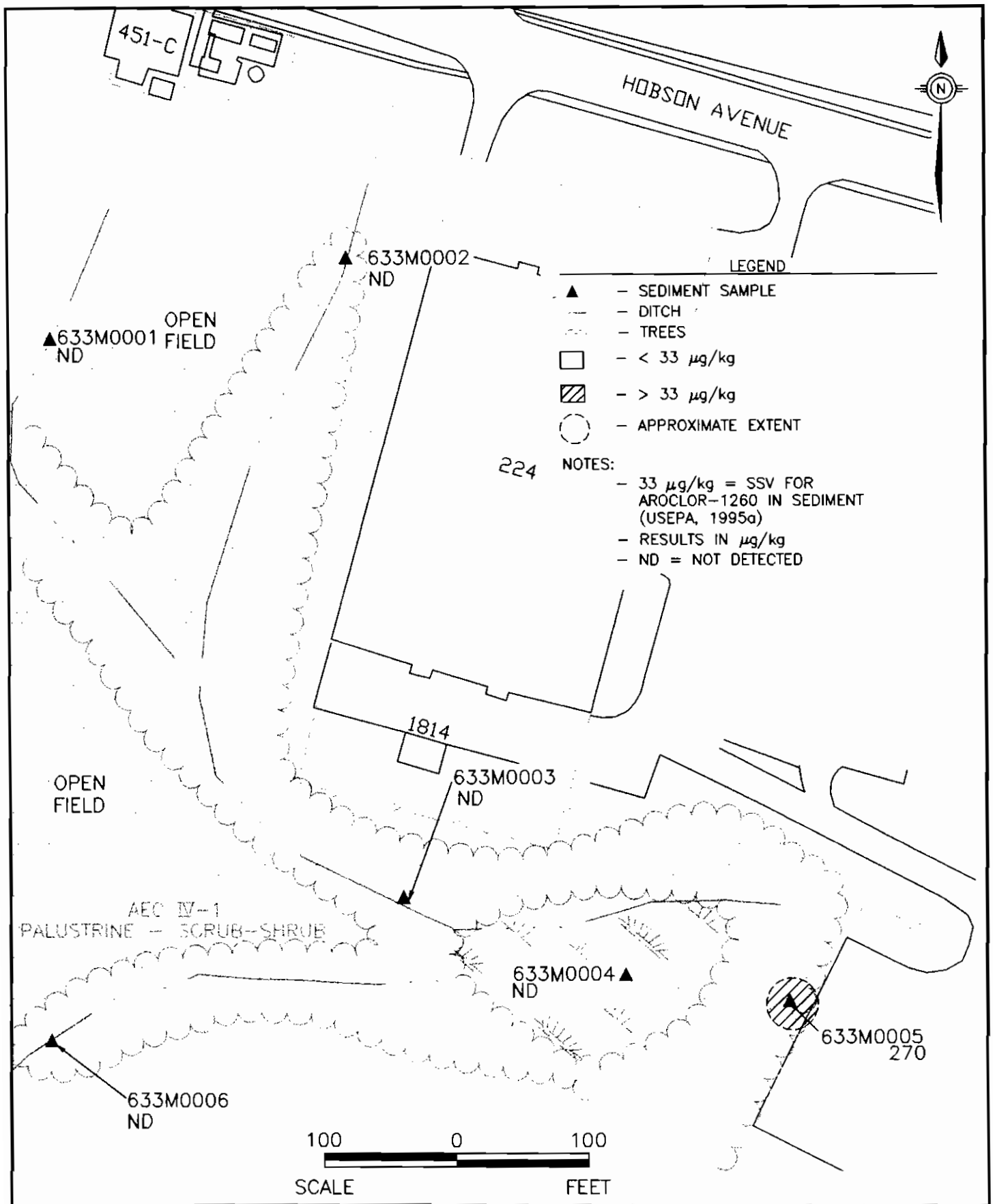

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FIGURE 10.2–12
AROCLOR–1260 IN SEDIMENT
AOC #633
SUBSTATION BUILDING 451C

DWG DATE: 02/02/98 | DWG NAME: 2907M038

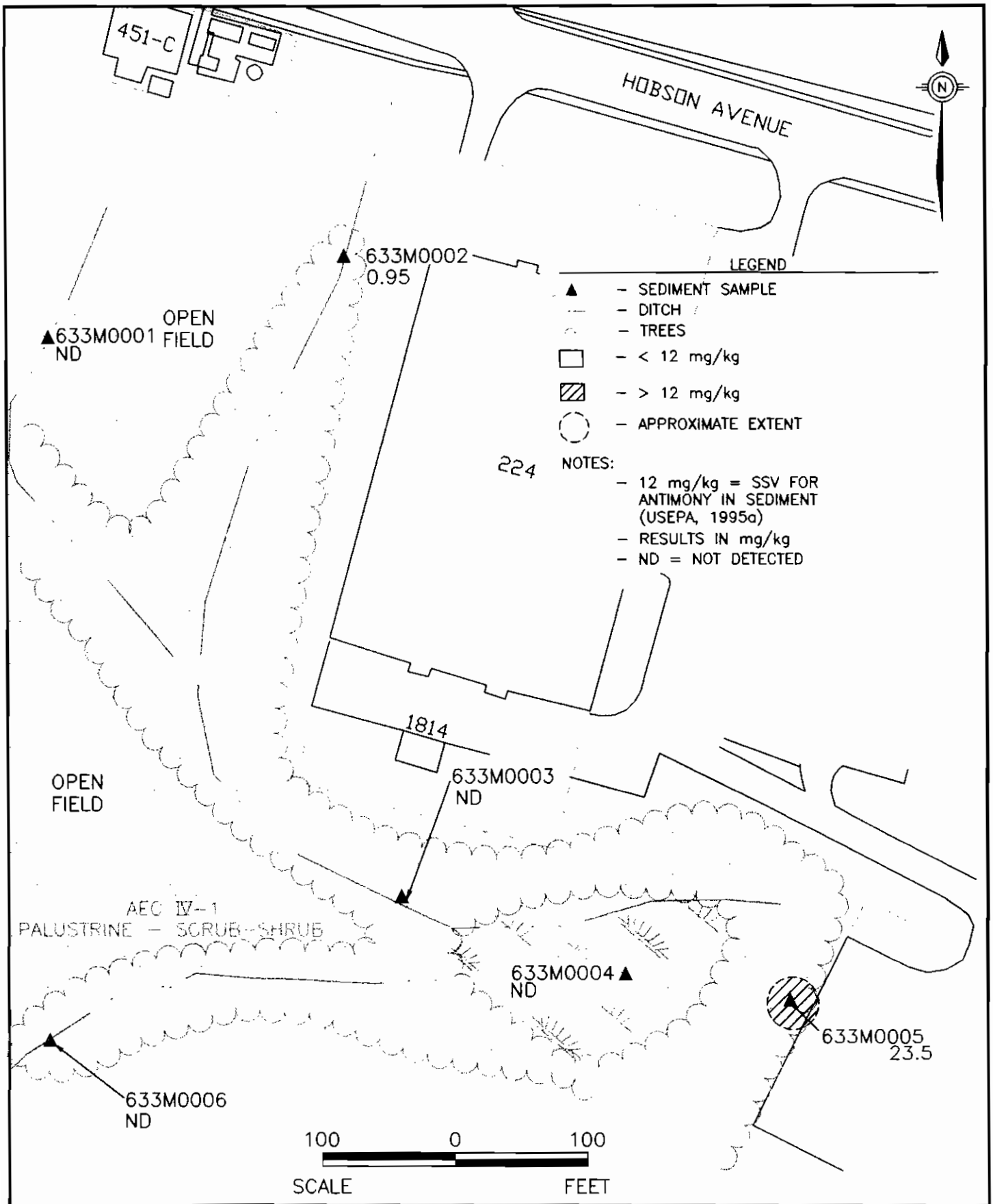

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FIGURE 10.2-13
ANTIMONY IN SEDIMENT
AOC #633
SUBSTATION BUILDING 451C

DWG DATE: 02/02/98 | DWG NAME: 2907M039

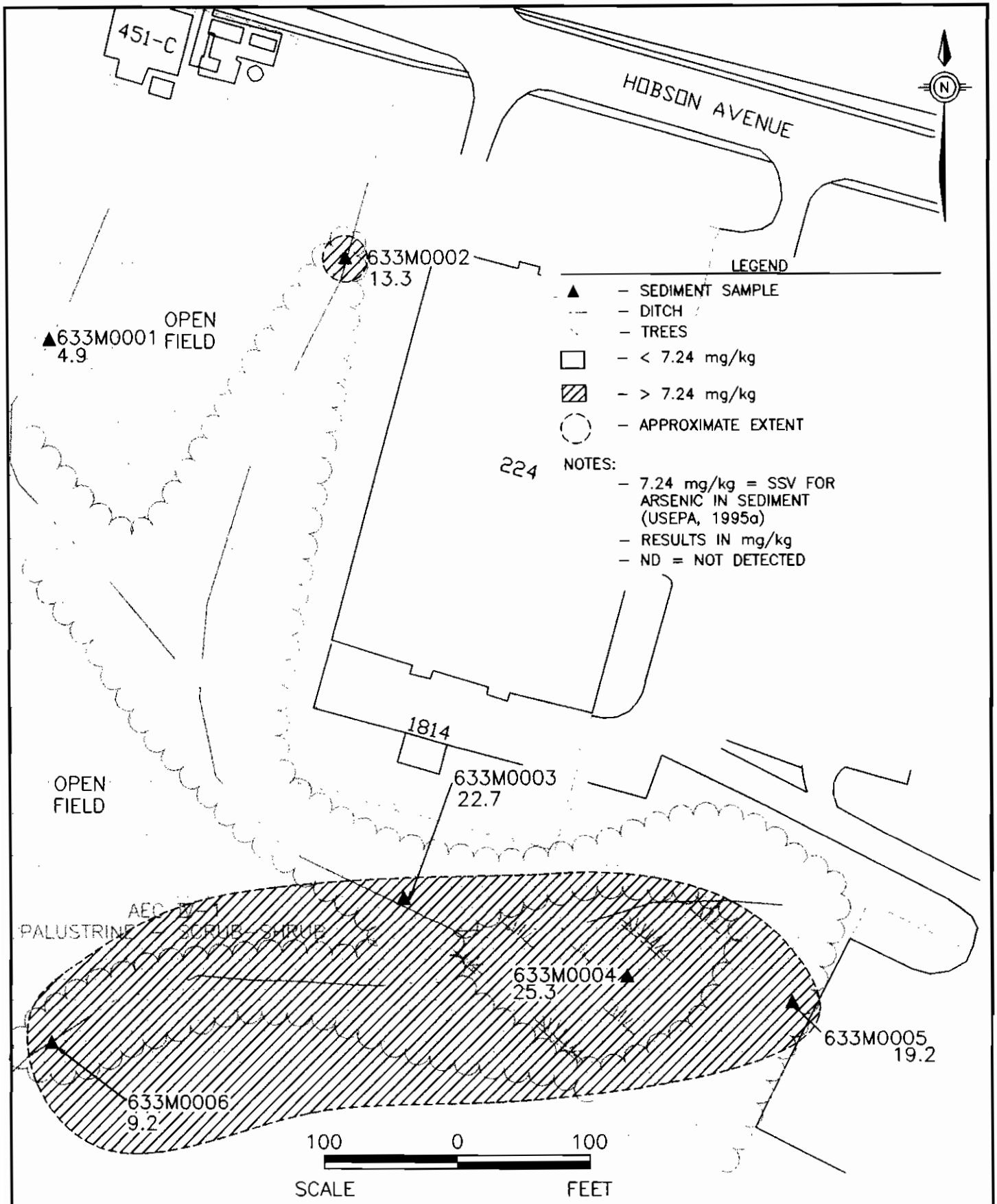

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FIGURE 10.2–14
ARSENIC IN SEDIMENT
AOC #633
SUBSTATION BUILDING 451C

DWG DATE: 02/02/98 | DWG NAME: 2907M040

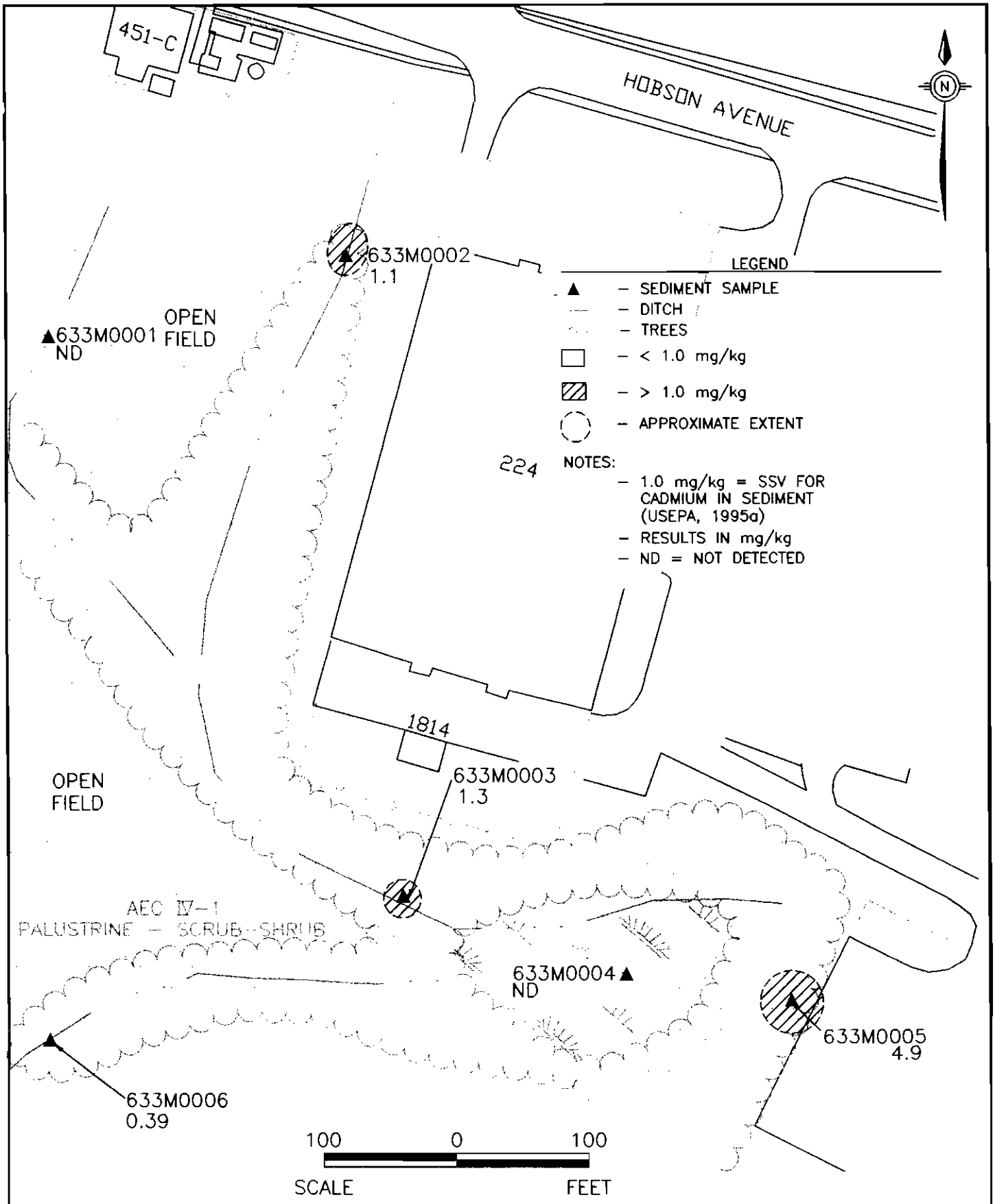

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FIGURE 10.2–15
CADMIUM IN SEDIMENT
AOC #633
SUBSTATION BUILDING 451C

DWG DATE: 02/02/98 | DWG NAME: 2907M041

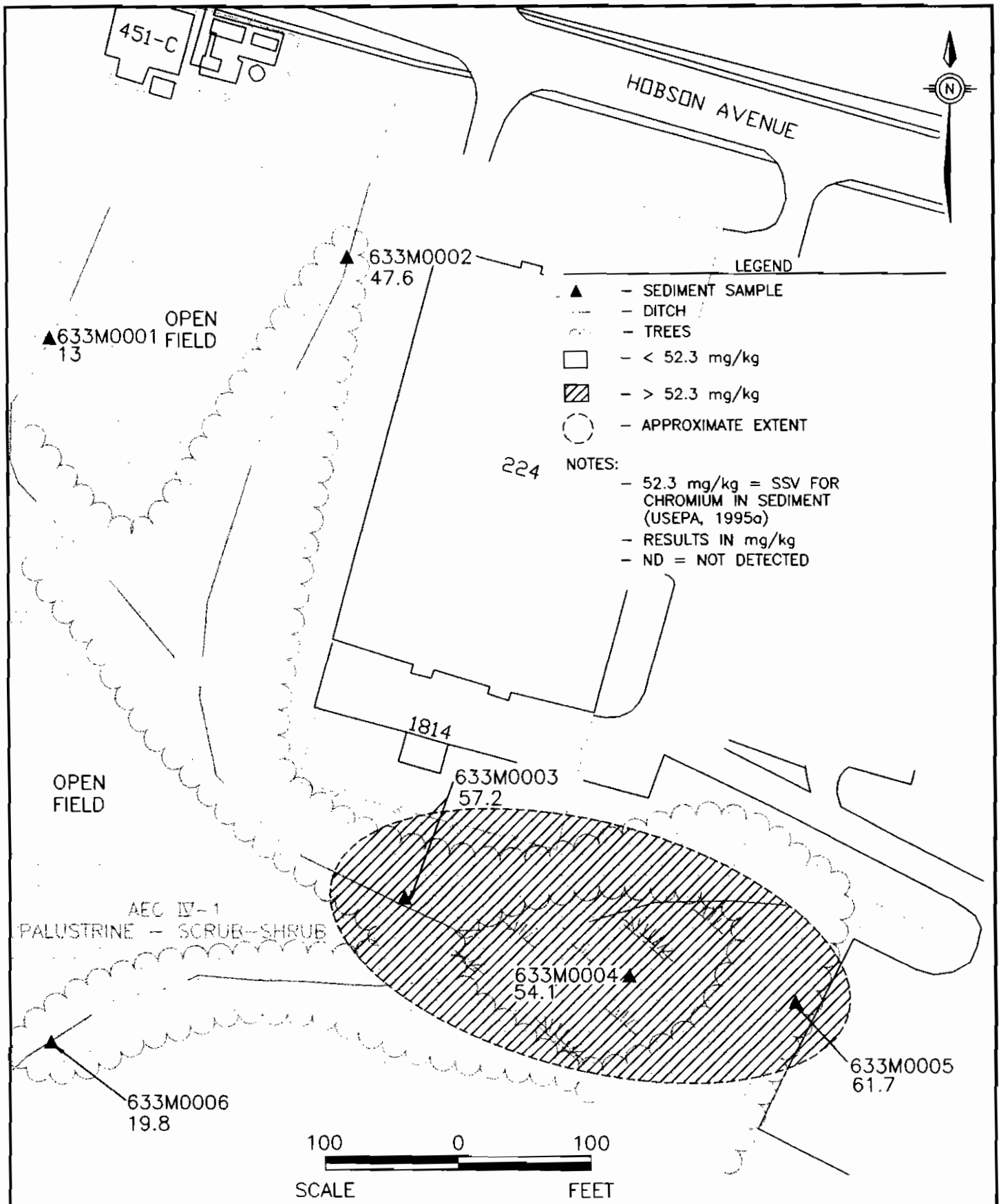

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FIGURE 10.2-16
CHROMIUM IN SEDIMENT
AOC #633
SUBSTATION BUILDING 451C

DWG DATE: 02/02/98 | DWG NAME: 2907M042

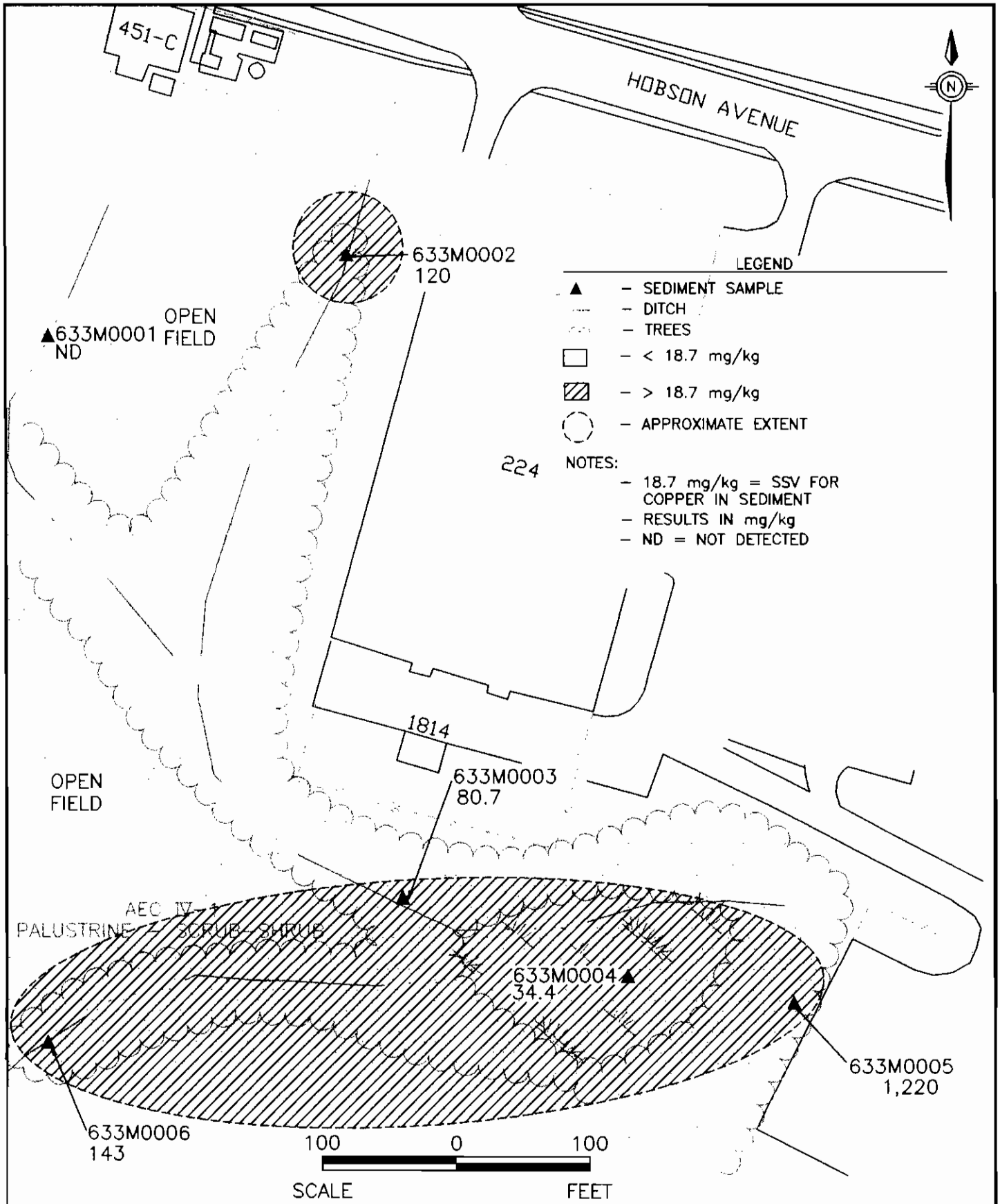

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FIGURE 10.2-17
COPPER IN SEDIMENT
AOC #633
SUBSTATION BUILDING 451C

DWG DATE: 02/02/98 | DWG NAME: 2907M043

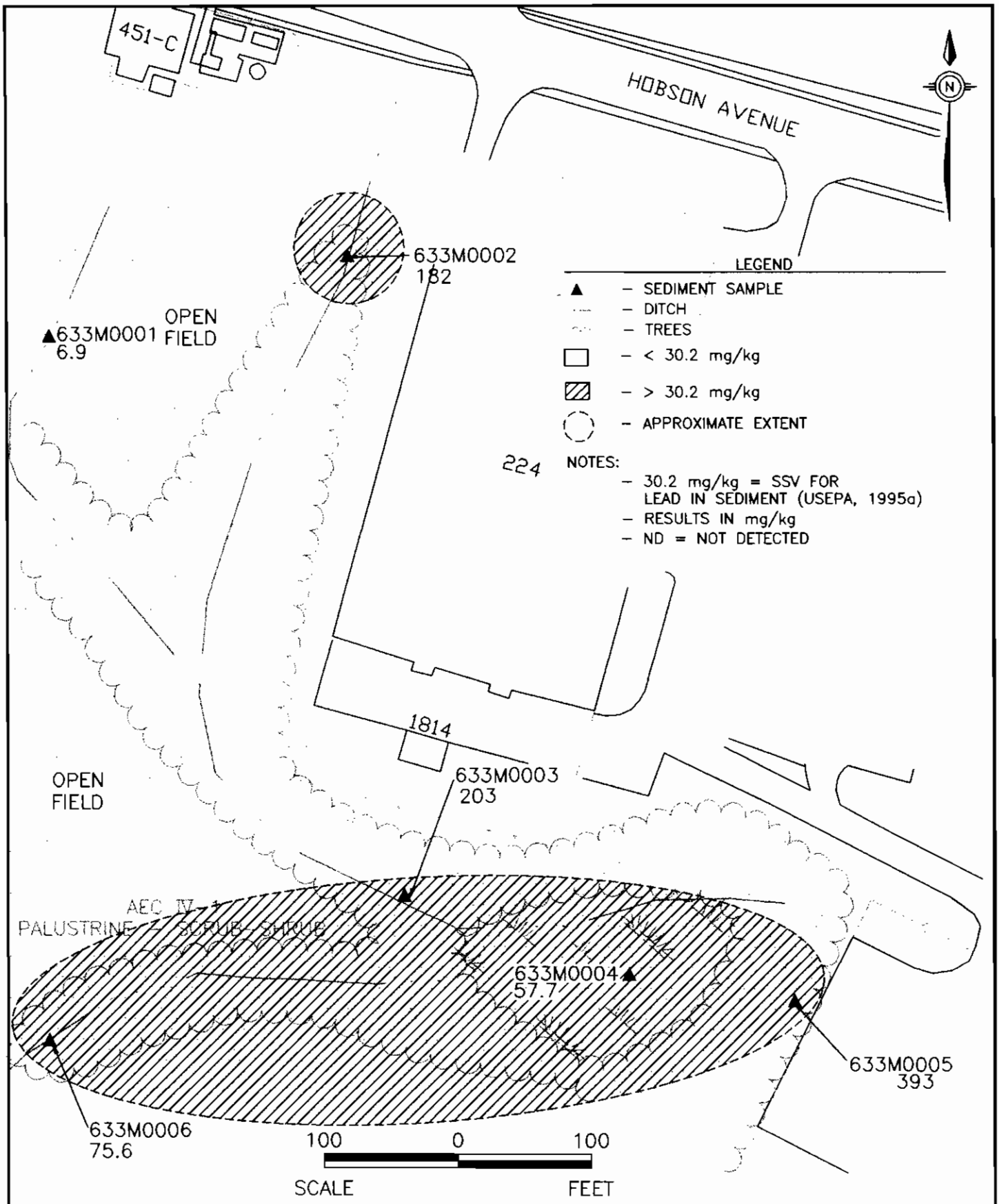

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FIGURE 10.2-18
LEAD IN SEDIMENT
AOC #633
SUBSTATION BUILDING 451C

DWG DATE: 02/02/98 | DWG NAME: 2907M044

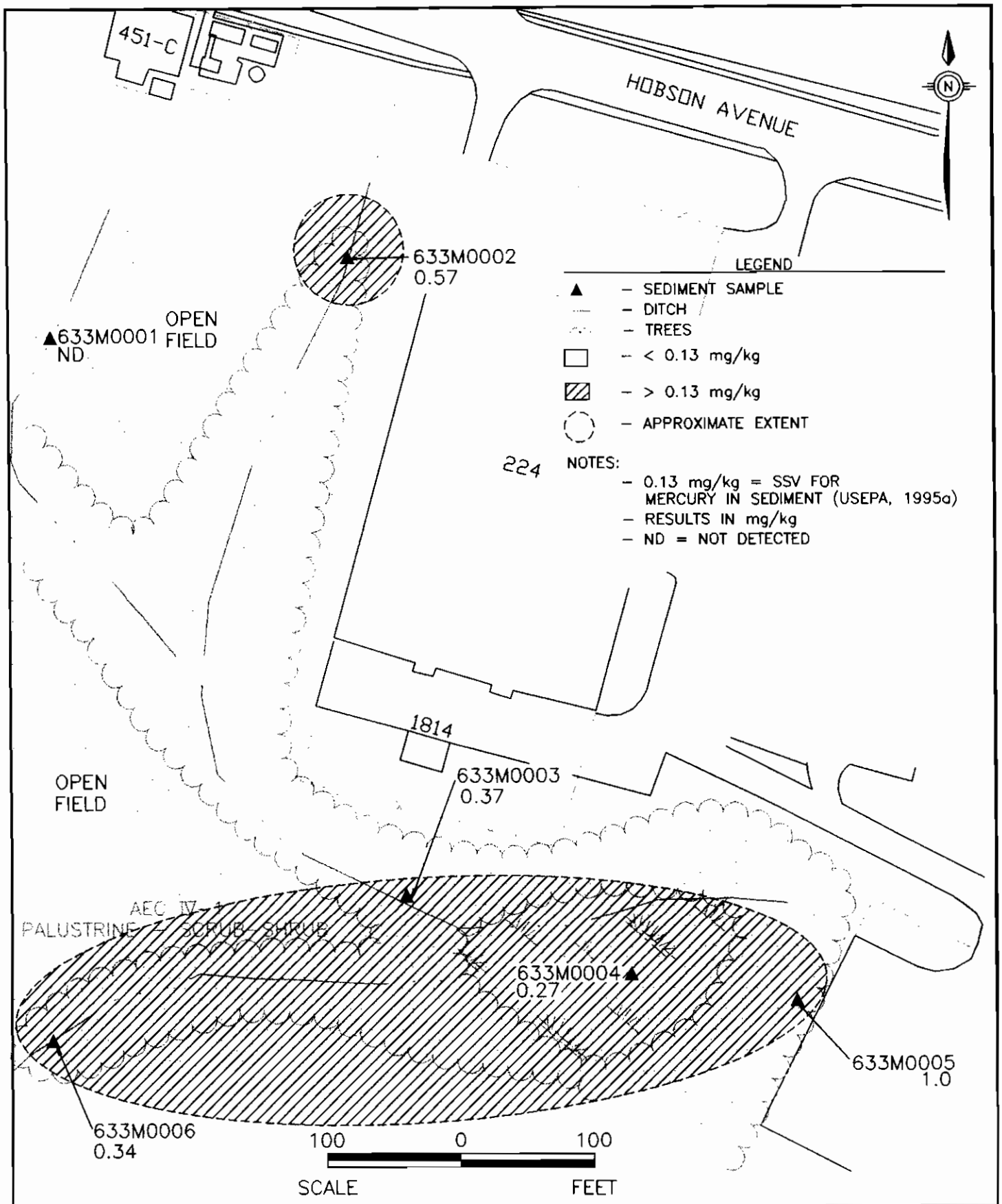

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FIGURE 10.2–19
MERCURY IN SEDIMENT
AOC #633
SUBSTATION BUILDING 451C

DWG DATE: 02/03/98 | DWG NAME: 2907M045

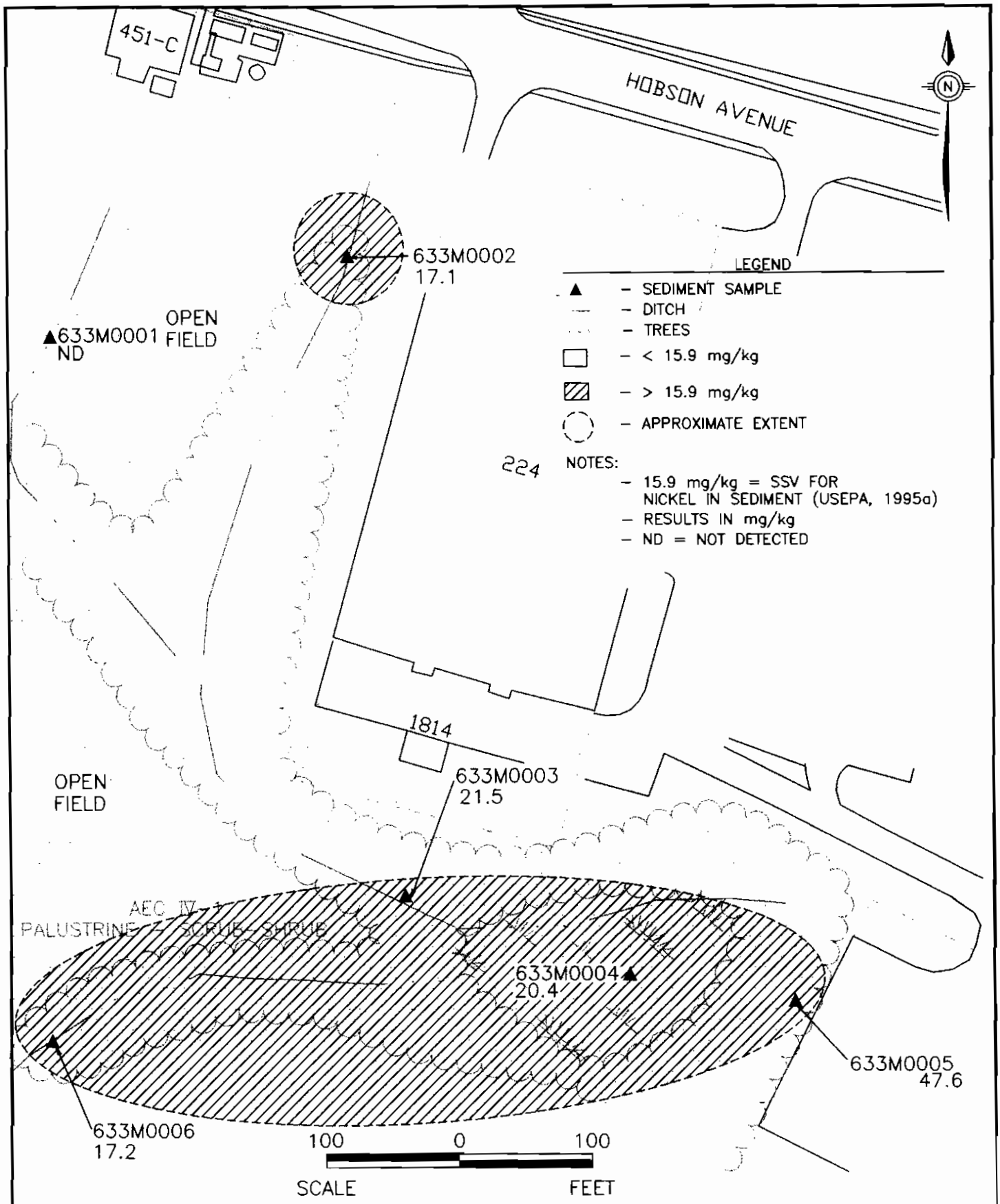

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FIGURE 10.2-20
NICKEL IN SEDIMENT
AOC #633
SUBSTATION BUILDING 451C

DWG DATE: 02/02/98 | DWG NAME: 2907M046

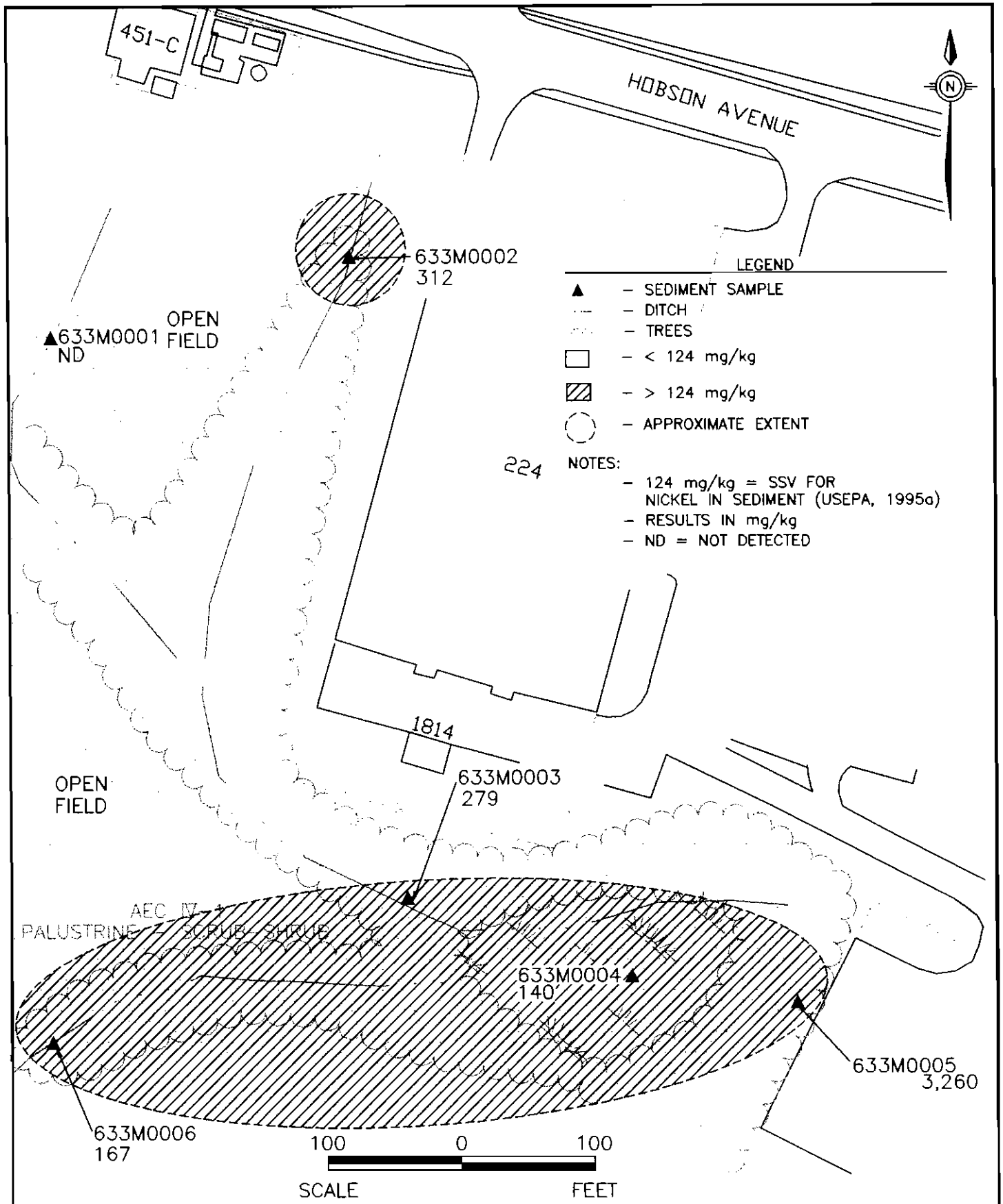

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FIGURE 10.2–21
ZINC IN SEDIMENT
AOC #633
SUBSTATION BUILDING 451C

DWG DATE: 02/02/98 | DWG NAME: 2907M047

Table 10.2.8
Chemicals Detected in Surface Soil, Subsurface Soil, and Shallow Groundwater
Comparison to SSLs, Tap Water RBCs, Saltwater Surface Water Chronic Screening Levels, and Background Concentrations
NAVBASE Charleston, Zone G: AOC 633
Charleston, South Carolina

Parameter	Max. Concentration		Max. Concentration		Screening Concentration *			Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
	Surface Soil	Subsurface Soil	Shallow GW	Deep GW	Soil to GW SSL	Tap Water RBC	Saltwater Surf. Wtr. Chronic					
Pesticides/PCB Compounds												
Aroclor-1260	480	25000	NA	NA	1000	0.034	0.03	UG/KG	UG/L	YES	NO	NO
alpha-Chlordane	450	8.7	NA	NA	10000	0.19	0.004	UG/KG	UG/L	NO	NO	NO
gamma-Chlordane	420	9.3	NA	NA	10000	0.19	0.004	UG/KG	UG/L	NO	NO	NO
4,4'-DDD	68	6.7	NA	NA	16000	0.28	0.025	UG/KG	UG/L	NO	NO	NO
4,4'-DDE	58	53	NA	NA	54000	0.2	0.14	UG/KG	UG/L	NO	NO	NO
4,4'-DDT	30	740	NA	NA	32000	0.2	0.001	UG/KG	UG/L	NO	NO	NO
Heptachlor epoxide	19	ND	NA	NA	700	0.0012	0.0036	UG/KG	UG/L	NO	NO	NO

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 20, from 1996 Soil Screening Guidance or calculated using values from Table 6.4
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, October 22, 1997
Salt Water Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region IV Bulletins, Ecological Risk Assessment, November, 1995; Table 2
For inorganics, the value shown is the greater of the relevant screening value or the corresponding background value.

NA - Not available/Not applicable
ND - Not detected
RBC - Risk based concentration
SSL - Soil screening level
MG/KG - Milligrams per kilogram
NG/KG - Nanograms per kilogram
PG/L - Picograms per liter
UG/KG - Micrograms per kilogram
UG/L - Micrograms per liter

detected in 3 of 10 surface soil samples, and in 2 of 8 subsurface soil samples. Notably, within the context of individual locations, the surface soil detections were not repeated in the subsurface, nor were the subsurface detections accompanied by surface detections. The presence of Aroclor-1260 is consistent with site history (accidental release from electrical transformers), as PCBs were commonly used as a primary ingredient of transformer coolant oil. The vertical distribution of this PCB is somewhat enigmatic in that residuals from surface releases typically occur in the upper soil column as released fluids are adsorbed by soil media. The presence of PCBs in the subsurface at two locations, without accompanying surface residual, is likely indicative of the lateral dispersion of a release away from the release point in the subsurface. This is a reasonable scenario in that accidental releases were probably of low volume and encompassed very small surface areas. The spatial occurrence of PCB detections, in conjunction with the limited occurrence of only one exceedance, indicates that significant residual mass of this contaminant is present at the site. However, what mass is there is at concentrations that may provide a threat to groundwater through leaching, and therefore the soil-to-groundwater pathway does have validity as a contributor to overall risk. The groundwater use pathway is invalid due to non-use of the resource. However, migration of groundwater-to-surface water may have validity, given the proximal occurrence of a wetland downslope of AOC 633.

10.2.5.2 Soil-to-Sediment Cross-Media Transport

Table 10.2.7 lists the analytes detected in sediment samples collected as part of the AOC 633 investigation. Sediments are associated with stormwater drainage paths which feed into a wetland complex immediately south of AOC 634. Given the nature of these pathways and their spatial occurrence, they are subject to potential contamination from a broad area in Zone G which encompasses several AOCs. With limited sampling and potential provenance from several sources, it is difficult and in most cases conjectural to define trends in contaminants and attribute causality to those trends. Additionally, the most important factor to a discussion of these sediments is the risk posed to potential receptors. Consequently, this discussion will be limited to only the

most obvious chemical features of the data, and the consequent risk is evaluated in the ERA, Section 8.

Sediment locations 633M0001 and 633M0002 are in closest proximity to AOC 633, with locations 633M0003 and 633M0004 downslope several hundred feet. Locations 633M0005 and 633M0006 are clearly associated with other sites in Zone G. Location 633M0001 had no detections of organic compounds, while 633M0002 had detections of PAHs and pesticides. The pesticides detected were similar to, and at lower concentrations than those that were present in AOC 633 surface soil. Based on empirical data and non-detects for locations 633M0003 and 633M0004, the overall concentrations of these pesticides decrease downslope. Locations 633M0003 and 633M0004 exhibited detections of VOCs, while PAHs were limited to 633M0002 and 633M0003. Inorganic detections were common in sediments as in soil; location 633M0001 typically had lower overall concentrations, while concentrations at location 633M0002 were primarily consistent with 633M0003 and 633M0004, revealing no consistent discernable trends. The presence of organics and inorganic constituents is inextricably linked to stormwater drainage. AOC 633 surface soil could have conceivably sourced the pesticides in sediments, but it is most likely that there detections represent residuals from routine pesticide application around and near the drainage paths themselves. The presence of VOCs in 633M0003 and 633M0004 at low concentrations is somewhat suspect, but the sediment in the drainage system would naturally be expected to immobilize PAHs, pesticides and PCBs (large high molecular weight compounds with a high affinity for adsorption to organic material) and metals (strong electropositive affinity for oxidation, hydroxide precipitation, and adsorption to both organic and inorganic material). Stormwater runoff not directly associated with an AOC could reasonably be expected to contain pesticides (residual from routine application), PAHs (associated with asphalt pavement) and metals (present in pesticides and roadway runoff, and naturally occurring in native soil that becomes entrained in stormwater). As a result, attribution of sediment constituents to a particular AOC is problematic and in this case not wholly correct without additional data.

10.2.5.3 Soil-to-Air Cross-Media Transport

AOC 633 soil samples were not analyzed for volatiles, therefore this pathway cannot be validated.

10.2.5.4 Fate and Transport Summary

One organic (Aroclor-1260) was present in subsurface soil above SSLs, while none were present in surface soil above SSLs. PCB detections in surface soil were not repeated in the subsurface at individual locations, nor were subsurface detections accompanied by surface detections. The presence of PCBs is consistent with the site history, while the vertical distribution is consistent with small accidental releases and subsequent soil removal activities. The limited occurrence of exceedances indicates that a significant mass of residual is not present at the site, but concentrations are such that the soil-to-groundwater pathway has some merit.

Correlation of sediment results with AOC 633 surface soil results is problematic in that a large portion of the sediment load is probably derived from stormwater runoff, and sampling locations are widely separated and are downgradient of other Zone G sites. Pesticides were common detections between AOC 633 surface soil and a proximal sediment sample, and concentrations of pesticides trend downward downslope from AOC 633. Whether sediment pesticides detections are clearly attributable to AOC 633 or to residual from application around and near the drainage ditches themselves is not discernable. Inorganics were also commonly detected in sediments, with no definable consistent trends. Given the chemical nature of pesticides, PAHs, and metals, it can reasonably be expected that they will be immobilized by and within sediment, outside of physical sediment transport downslope. Because of this and the clear problem of source attribution, the evaluation of sediment results should be focused on the consequent risk to ecological receptors they present. This is presented in the ERA for Zone G contained in Section 8. The soil-to-air volatilization pathway at this AOC is unsubstantiated by the data and is considered invalid.

10.2.6 Human Health Risk Assessment

10.2.6.1 Site Background and Investigative Approach

AOC 633 is the electrical substation near Building 451C. Several large PCB releases have been documented at this site.

Ten soil borings were advanced to identify potential impacts resulting from the activities listed above. Surface soil samples from all ten boring locations were used to quantitatively assess the direct contact soil exposure pathways. Contaminants associated with subsurface soil were addressed in the previous section, Fate and Transport Assessment. Six sediment samples were collected from the drainage paths located south of Building 451C. Section 10.2.3 summarizes the sampling effort for AOC 633 soil.

10.2.6.2 COPC Identification

Soil

Based on the screening comparisons described in Section 7 of this RFI and presented in Table 10.2.9, Aroclor-1260 was identified as a COPC in surface soil.

Aroclor-1260 was also detected in one of six sediment samples, however, its maximum sediment concentration (270 μg/kg) did not exceed its residential RBC (320 μg/kg).

10.2.6.3 Exposure Assessment

Exposure Setting

AOC 633 is in an urban setting on the former naval base, located near the corner of Viaduct Road and Hobson Avenue. An area of open field is located to the south of the site with two drainage paths which direct runoff south of the site.

Table 10.2.9
Chemicals Present in Site Samples
AOC 633 - Surface Soil
Naval Base Charleston, Zone G
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Screening Concentration Background	Units	Number Exceeding RBC	Number Exceeding Bkgd
Pesticides/PCBs													
Aroclor-1260	*	3	10	41	480	207	73	89	320	NA	UG/KG	1	
4,4'-DDD		1	10	68	68	68	2.7	3.3	2700	NA	UG/KG		
4,4'-DDE		1	10	58	58	58	2.7	3.3	1900	NA	UG/KG		
4,4'-DDT		4	10	3.4	30	14.6	2.8	20	1900	NA	UG/KG		
alpha-Chlordane		1	10	450	450	450	1.4	1.7	1800	NA	UG/KG		
gamma-Chlordane		1	10	420	420	420	1.4	1.7	1800	NA	UG/KG		
Heptachlor epoxide		1	10	19	19	19	1.4	1.7	70	NA	UG/KG		

Notes:
* - Indicates chemical was identified as a COPC
SQL - Sample quantitation limit
RBC - Risk-based concentration
UG/KG - micrograms per kilogram
NA - Not applicable or not available

Potentially Exposed Populations

Potentially exposed populations are current and future site workers, hypothetical future site residents, and/or adolescent site trespassers. Future site resident and worker exposure scenarios were addressed quantitatively in this risk assessment. The future site resident scenario was built on the premise that existing features would be removed and replaced with dwellings. Current exposure to workers is discussed qualitatively in relation to the future workers; and current adolescent trespassers are addressed qualitatively in relation to future site child residents. The hypothetical future site worker scenario assumes continuous exposure to surface soil conditions. Current site workers' exposure would be less than that assumed for the hypothetical future site worker scenario because of their limited soil contact. Therefore, future worker assessment is considered to be conservatively representative of current site users. Similarly, the future site residential scenario is considered conservatively representative of the current trespasser.

Exposure Pathways

Exposure pathways for the hypothetical future site residents are dermal contact and incidental ingestion of surface soils. The exposure pathways for future site workers are the same as those for the future site residents. For the soil pathways, uniform exposure was assumed for all sample locations. Table 10.2.10 presents the justification for exposure pathways assessed in this HHRA.

Exposure Point Concentrations

The exposure point concentration was set equal to the 95% UCL as described in Section 7 of this RFI and summarized on Table 10.2.11.

Quantification of Exposure

Soil

CDIs for ingestion and dermal contact with soils are shown in Tables 10.2.12 and 10.2.13, respectively.

Table 10.2.10
Zone G
AOC 633
Exposure Pathways Summary

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Users (Site Worker/Trespasser)	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 633.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 633.
	Soil, Incidental ingestion	No (Qualified)	Future site use is considered conservatively representative of current site use.
	Soil, Dermal contact	No (Qualified)	Future site use is considered conservatively representative of current site use.
Future Land Uses			
Future Site Residents, Site Worker, Trespasser	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Soil, Incidental ingestion	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Soil, Dermal contact	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Table 10.2.11
Summary of Statistical Analysis
Surface Soil COPCs; AOC 633
Naval Base Charleston, Zone G
Charleston, South Carolina

COPC	Natural Log Transformed n	mean	SD	H-stat	UCL (mg/kg)	MAX (mg/kg)	EPC (mg/kg)	
Pesticides/PCBs								
Aroclor-1260	10	-2.899	0.818	2.745	0.16	0.48	0.16	UCL

NOTES:

mean Arithmetic mean of the logtransformed data
n Number of samples analyzed
SD Standard deviation for a sample of data
H-stat "H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with USEPA Supplemental Guidance to RAGS, Calculating the Concentration Term
NA Not applicable
EPC Exposure point concentration
UCL 95 percentile upper confidence level mean
MAX Maximum reported concentration

Table 10.2.12
Chronic Daily Intakes
Incidental Ingestion of Surface Soil
AOC 633
Naval Base Charleston, Zone G
Charleston, South Carolina

Chemical	Fraction Ingested from Contaminated Source *	Exposure Point Concentration (mg/kg)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Pesticides/PCBs							
Aroclor-1260	1	0.16	2.2E-07	2.1E-06	2.5E-07	8.0E-08	2.8E-08

NOTES:

lwa Lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
* Reflects the estimated fraction of the site impacted by the corresponding COPC.

Table 10.2.13
Chronic Daily Intakes
Dermal Contact with Surface Soil
AOC 633
Naval Base Charleston, Zone G
Charleston, South Carolina

Chemical	FI/FC *	Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (unitless)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Pesticides/PCBs								
Aroclor-1260	1	0.16	0.01	9.1E-08	3.0E-07	5.7E-08	6.5E-08	2.3E-08

NOTES:

CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
* Reflects the estimated fraction of the site impacted by the corresponding COPC.
\- The dermal absorption factor was applied to the exposure point concentration to reflect the ability for trans-dermal migration of inorganic and organic chemicals

10.2.6.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 7 of this report. Table 10.2.14 presents toxicological information specific to the COPC identified at AOC 633. This information was used in the quantification of risk/hazard associated with the soil contaminants. A brief toxicological profile for Aroclor-1260, the only COPC, is provided in the following paragraph.

PCB Aroclors are a group of chlorinated hydrocarbons (such as Aroclors-1248, 1254, and 1260) that accumulate in fat tissue. Occupational exposure (both inhalation and dermal) to PCBs causes eye and lung irritation, loss of appetite, liver enlargement, increased serum liver enzyme levels, rashes and chloracne, and decreased birth weight of infants in heavily exposed worker/mothers. Of the effects listed above, the liver is the primary target organ (Klaassen, et al, 1986) (Dreisbach, et al, 1987). USEPA classified PCB aroclors as group B2 probable human carcinogens, primarily based on animal data. Oral ingestion of PCBs causes liver and stomach tumors in rat studies. The cancer potency of PCB mixtures is determined using a tiered approach. The high risk and persistence tier uses an upper-bound slope factor of 2.0 $(mg/kg\text{-}day)^{-1}$ and is appropriate for food chain exposures, sediment and soil ingestion, dust or aerosol inhalation, and dermal exposure. The low risk and persistence tier uses an upper-bound slope factor of 0.4 $(mg/kg\text{-}day)^{-1}$ and is appropriate for ingestion of water soluble congeners and inhalation of evaporated congeners. The lowest risk and persistence tier uses an upper-bound slope factor of 0.07 $(mg/kg\text{-}day)^{-1}$ and is appropriate for PCB congener mixtures with congeners having more than four chlorines comprising less than 1/2% of the mixture.

10.2.6.5 Risk Characterization

Surface Soil Pathways

Exposure to surface soil onsite was evaluated under residential and site worker scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated.

Table 10.2.14
Toxicological Reference Information
for Chemicals of Potential Concern
AOC 633
Naval Base Charleston, Zone G
Charleston, South Carolina

	Non-Carcinogenic Toxicity Data								*Carcinogenic Toxicity Data*				
hemical	Oral Reference Dose (mg/kg-day)	Confidence Level	Critical Effect	Uncertainty Factor Oral	Inhalation Reference Dose (mg/kg-day)	Confidence Level	Critical Effect	Uncertainty Factor Inhalation	Oral Slope Factor (kg-day/mg)		Inhalation Slope Factor (kg-day/mg)	Weight of Evidence	Tumor Type
CB Aroclor-1260 (soil)	NA	NA	NA	NA	NA	NA	NA	NA	2	a	NA	B2	hepatocellular carcinoma

tes:

= Integrated Risk Information System (IRIS)

A = Not applicable or not available

For noncarcinogenic contaminants evaluated for future site residents, hazard was computed separately to address child and adult exposure. Tables 10.2.15 and 10.2.16 present the computed carcinogenic risks and/or HQs associated with the incidental ingestion of and dermal contact with site surface soils, respectively.

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime weighted average) for AOC 633 surface soils is 5E-07. The dermal pathway ILCR is 2E-07. Risk under a residential scenario are considered a highly conservative estimate of the risk under a trespasser scenario.

Hypothetical Site Workers

Site worker ILCRs are 6E-08 for the ingestion pathway and 9E-08 for the dermal contact pathway.

COCs Identified

COCs were identified based on cumulative (all pathway) risk and hazard projected for this site on a medium-specific basis. USEPA has established a generally acceptable risk range of 1E-04 to 1E-06, and a hazard index threshold of 1.0 (unity). As recommended by SCDHEC, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, and whose individual ILCR exceeds 1E-06 or whose hazard quotient exceeds 0.1. For carcinogens, this approach is relatively conservative, because a cumulative risk level of 1E-04 (and individual ILCR of 1E-06) is recommended by USEPA Region IV as the trigger for establishing COCs. The COC selection method presented was used in order to provide a more comprehensive evaluation of chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the RGOs development process. Table 10.2.17 presents the COCs identified for AOC 633 surface soil.

Table 10.2.15
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC 633
Naval Base Charleston, Zone G
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident lwa ILCR	Future Worker Adult Hazard Quotient	Future Worker Adult ILCR
Pesticides/PCBs							
Aroclor-1260	NA	2	ND	ND	5.1E-07	ND	5.7E-08
SUM Hazard Index/ILCR			ND	ND	5E-07	ND	6E-08

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime Cancer Risk

Table 10.2.16
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC 633
Naval Base Charleston, Zone G
Charleston, South Carolina

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident lwa ILCR	Future Worker Adult Hazard Quotient	Future Worker Adult ILCR
Pesticides/PCBs								
Aroclor-1260	0.5	NA	4	ND	ND	2.3E-07	ND	9.3E-08
SUM Hazard Index/ILCR				ND	ND	2E-07	ND	9E-08

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime Cancer Risk
- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Table 10.2.17
Summary of Risk and Hazard-based COCs
AOC 633
Naval Base Charleston, Zone G
Charleston, South Carolina

Medium	Exposure Pathway		Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident Iwa ILCR	Future Site Worker Hazard Quotient	Future Site Worker ILCR	Identification of COCs
Surface Soil	Incidental Ingestion	**Pesticides/PCBs** Aroclor-1260	ND	ND	5.1E-07	ND	5.7E-08	
	Dermal	**Pesticides/PCBs** Aroclor-1260	ND	ND	2.3E-07	ND	9.3E-08	
Surface Soil Pathway Sum			ND	ND	7E-07	ND	2E-07	

Notes:
ND indicates not determined due to the lack of available risk information.
ILCR indicates incremental excess lifetime cancer risk
HI indicates hazard index
1- Chemical is a COC by virtue of projected child residence noncarcinogenic hazard.
2- Chemical is a COC by virtue of projected future resident lifetime ILCR.
3- Chemical is a COC by virtue of projected site worker noncarcinogenic hazard.
4- Chemical is a COC by virtue of projected site worker ILCR.

Surface Soils

Future Site Residents

No COCs were identified based on the residential scenario.

Future Site Workers

No COCs were identified based on the site worker scenario.

10.2.6.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure.

Residential use of the site would not be expected, based on current site uses and the nature of surrounding buildings. If this area were to be used as a residential site, the surface soil conditions would likely change — the soils could be covered with landscaping soil and/or a house. Consequently, exposure to surface soil conditions as represented by samples collected during the CSI would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current site workers and future site residents.

Determination of Exposure Point Concentrations

The exposure point concentration was set equal to the 95% UCL. Using the 95% UCL as the EPC represents a conservative assumption since it is unlikely that the 95% UCL is exceeded by the true mean concentration.

Frequency of Detection and Spatial Distribution

Aroclor-1260 was detected in three of ten surface soil samples and in only one surface soil sample at a concentration above its RBC.

Quantification of Risk/Hazard

As indicated by the discussions above, the uncertainty inherent in the risk assessment process is great. In addition, many site-specific factors have affected the uncertainty of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

Soil

A conservative screening process was used to identify COPCs for AOC 633. The potential for eliminating CPSSs with the potential for cumulative HI greater than one was addressed for noncarcinogens through the use of RBCs that were reduced one order of magnitude. For carcinogens, the RBCs are based on a conservative target risk of 1E-06. Use of conservative RBCs in combination with the use of maximum detected concentrations minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment, none was reported at a concentration close to its RBC (e.g. within 10% of its RBC).

SW-846 Pesticides and PCBs were the only parameters for which soil was analyzed. No risk assessment conclusions can be inferred regarding parameters that were not included as part of the CSI.

10.2.6.7 Risk Summary

The risk and hazard posed by contaminants at AOC 633 were assessed for future site workers and future site residents under RME assumptions. For surface soils, the incidental ingestion and

dermal contact pathways were assessed in this HHRA. Table 10.2.18 presents the risk summary for each pathway/receptor group evaluated for AOC 633.

Soil — Residential Scenario

There were no residential soil pathway COCs identified for AOC 633. Table 10.2.19 summarizes the risk and hazard contribution of each COPC at each sample location. These point risk estimates are based on the unlikely assumption that a potential future site resident will be chronically exposed to specific points. Exposure to surface soil conditions is more likely the result of uniform exposure to the soil conditions of the entire site (or exposure unit area) rather than specific points. With this in mind, point risk estimates are useful in that they allow the reader to visualize how chemicals driving risk estimates are distributed across the site. Figure 10.2-22 presents the point risk estimates for surface soil in a residential scenario at AOC 633.

Aroclor-1260 was the only COPC identified for AOC 633 surface soil and was detected at a concentration equating with a risk estimate above 1E-06 in only one surface soil sample (633SB001). Most of the surface soil samples collected for AOC 633 were nondetect with regard to Aroclor-1260. Risk estimates ranged from 2E-07 (633SB002) to 2E-06 (633SB001). The mean risk estimate is 4E-07, assuming a deminimus risk of 1E-07 for surface soil samples with nondetects.

Soil — Site Worker Scenario

There were no site worker soil pathway COCs identified for AOC 633.

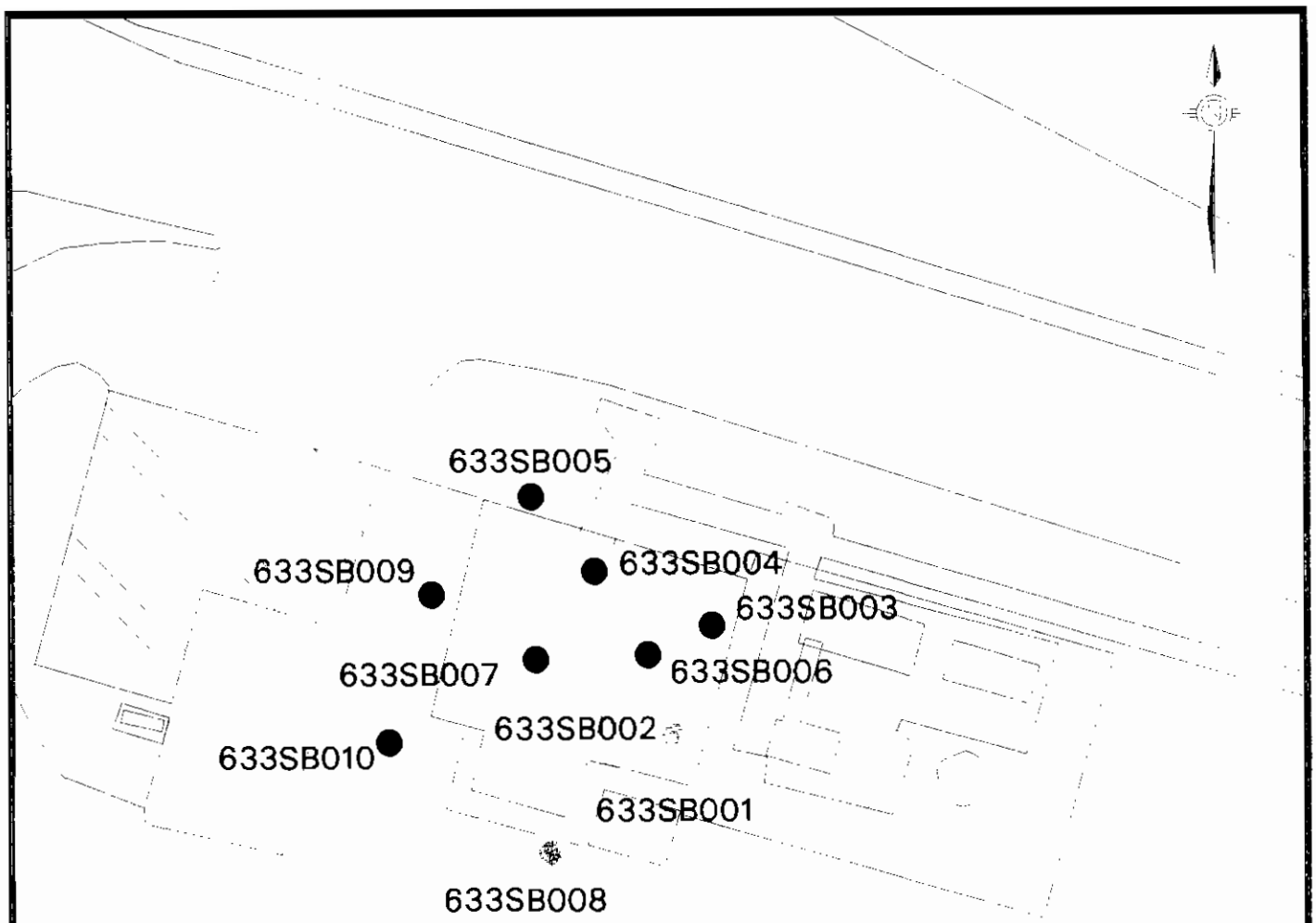
Table 10.2.18
Summary of Risk and Hazard
AOC 633
Naval Base Charleston, Zone G
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	ND	ND	5E-07	ND	6E-08
	Dermal Contact	ND	ND	2E-07	ND	9E-08
Sum of Soil Pathways		ND	ND	7E-07	ND	1E-07

Notes:
ILCR Indicates incremental lifetime cancer risk
HI Indicates hazard index

Table 10.2.19
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOC 633
Naval Base Charleston, Zone G
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
633	001	Aroclor-1260	480	UG/KG	NA		2.1778	100
		Total			NA		2.1778	
633	002	Aroclor-1260	41	UG/KG	NA		0.1860	100
		Total			NA		0.1860	
633	003	Aroclor-1260	ND	UG/KG	NA		NA	
		Total			NA		NA	
633	004	Aroclor-1260	ND	UG/KG	NA		NA	
		Total			NA		NA	
633	005	Aroclor-1260	ND	UG/KG	NA		NA	
		Total			NA		NA	
633	006	Aroclor-1260	ND	UG/KG	NA		NA	
		Total			NA		NA	
633	007	Aroclor-1260	ND	UG/KG	NA		NA	
		Total			NA		NA	
633	008	Aroclor-1260	100	UG/KG	NA		0.4537	100
		Total			NA		0.4537	
633	009	Aroclor-1260	ND	UG/KG	NA		NA	
		Total			NA		NA	
633	010	Aroclor-1260	ND	UG/KG	NA		NA	
		Total			NA		NA	



LEGEND

- NO COPCs DETECTED
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

0 feet 70

ZONE G - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 10.2-22
POINT RISK ESTIMATES FOR SURFACE SOIL
RESIDENTIAL SCENARIO
AOC 633

AML: /roms3/projects/charleston_dir/zone_g_dir/risk_cir

10.2.7 Corrective Measures Considerations

Based on the analytical results and the human health risk assessment for AOC 633, no COCs have been identified. Risk to human health from COPCs was evaluated under both the residential and industrial (site worker) scenarios for incidental ingestion and dermal contact. Hazard was evaluated for noncarcinogenic contaminants through incidental ingestion and dermal contact scenarios as well.

As recommended by SCDHEC, a COC is considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, and whose individual risk exceeds 1E-06 or whose hazard quotient exceeds 0.1. Based on these criteria no chemicals were identified as soil pathway COCs for AOC 633.

To determine the leaching potential of contaminants from the subsurface soil media to groundwater, contaminant concentrations in subsurface soil were compared against generic SSLs based on a DAF of 20. This comparison indicated one subsurface soil sample with contaminant concentrations exceeding the SSL. The contaminant, Aroclor-1260 was detected at a concentration of 25,000 μg/kg exceeding the SSL (1,000 μg/kg). Because of the isolated nature of this occurrence, corrective measures are not recommended at this time. For more information regarding indirect exposure pathways associated with subsurface soil refer to Section 10.2.5, Fate and Transport Assessment.

10.3 AOC 634, Flammable Material Storage, Building 1814

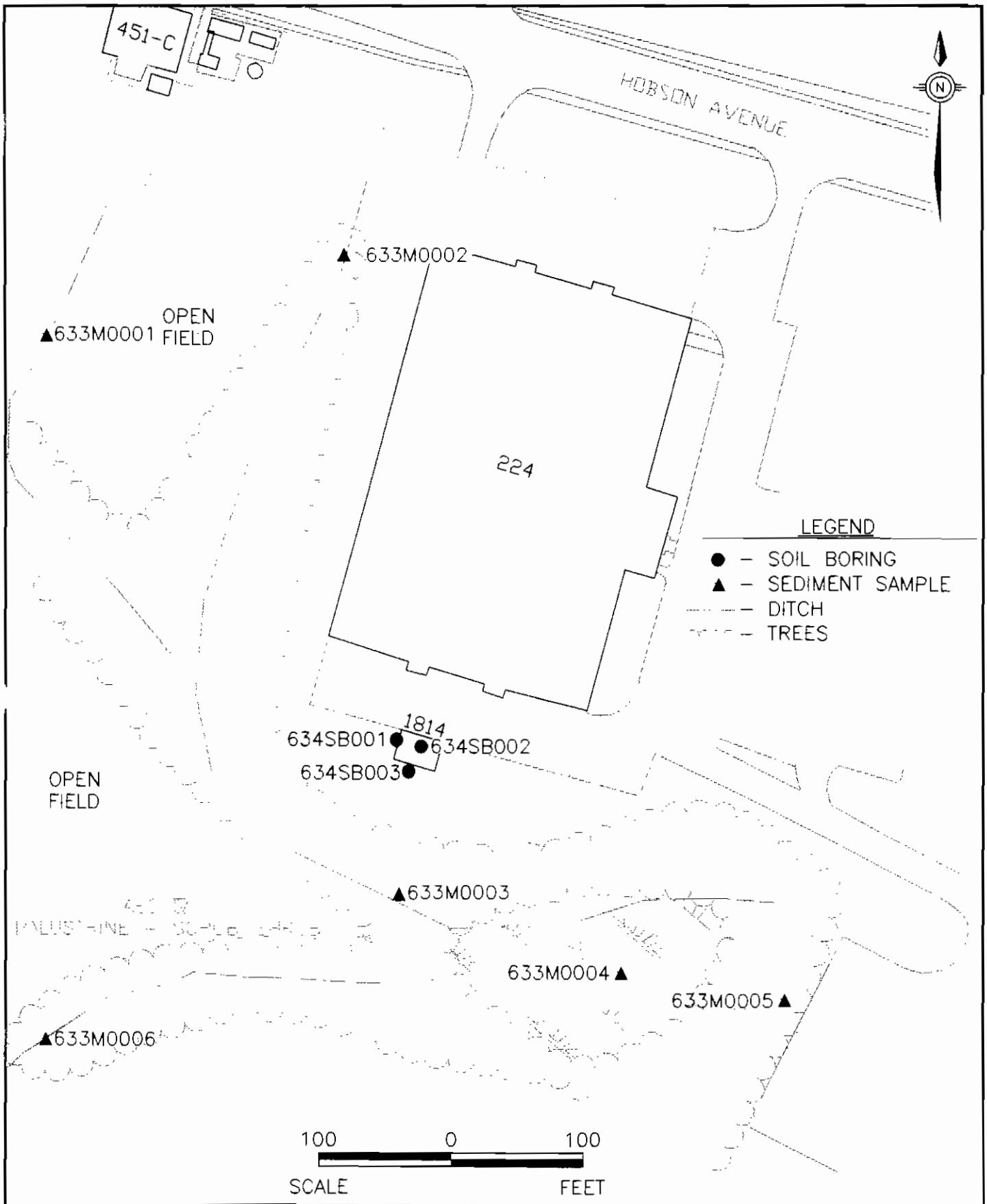
A CSI site, AOC 634 is located at Building 1814, a former flammable materials storage facility. Built in 1977, Building 1814 was used until 1992 to store small (less than one gallon) containers of flammable material. The building is no longer used, and the 1995 RFA cited that the roof of the building and its surrounding chain link fence have been removed. Paint and flammable materials were stored at this facility.

10.3.1 Site Geology

Figure 10.3-1 depicts the soil sampling locations within this area. The detailed stratigraphy at AOC 634 could not be determined as no monitoring well borings were installed within this area. Geologic data for monitoring well boring 706001, approximately 340 feet southeast of AOC 634 is therefore presented. The stratigraphy at AOC 706 consists of clayey fill with asphalt and crushed rock to approximately 5 ft bgs, overlying intervals of silty and clayey sand with shell hash and phosphate nodules. The sand at 706001 extends to a depth of approximately 14 ft bgs. The clay was encountered near the total depth of the boring at 14 ft bgs. No samples for grain size analysis were collected from any interval in the monitoring well boring for 706001. The total depth of monitoring well 706001 is 14 ft bgs. Based on zone wide hydrogeologic data the groundwater elevation at AOC 634 should be approximately 5 ft msl. Shallow groundwater at AOC 634 flows generally to the north or northeast. The boring log for monitoring well 706001 is contained in Appendix A.

10.3.2 Field Investigation Approach

The objective of the field investigation at AOC 634 was to: (1) confirm the presence or absence of contamination in the site area; (2) delineate any contamination found; and (3) provide sufficient data to support a detailed evaluation of treatment alternatives, if required. Media sampled within the investigation area included site soil. Section 3 of this report details the methods used during the field investigation. Included in this section are descriptions of the hand-auger procedures used



ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.3-1
SAMPLING LOCATIONS
AOC #634
FLAMMABLE MATERIAL STORAGE
BUILDING 1814

DWG DATE: 01/15/98 | DWG NAME: 29CHZG08

for soil sampling, and miscellaneous procedures used during the field investigation. Also discussed are the analytical protocols for sample analyses. Appendix D contains the analytical data report for samples collected in Zone G.

10.3.3 Soil Sampling and Analysis

The approved final RFI work plan proposed advancing three soil borings within the AOC 634 area to detect the presence of any soil contamination from this site. Upper and lower interval soil samples were proposed from each boring. Three soil borings were advanced during the field investigation, as depicted in Figure 10.3-1. Upper and lower interval soil samples were collected from each boring. In accordance with the approved final RFI work plan, soil samples were analyzed for metals and VOCs at DQO Level III. Table 10.3.1 summarizes the AOC 634 soil samples and analyses.

Table 10.3.1
Zone G
AOC 634
Soil Samples and Analyses

Boring Location	Sample Identifier	Sample Interval	Date Collected	Analyses	Remarks
634SB001	634SB00101	Upper	10/03/96	See note	No deviations from work plan.
	634SB00102	Lower			
634SB002	634SB00201	Upper	10/03/96	See note	
	634SB00201	Lower			
634SB003	634SB00301	Upper	10/03/96	See note	
	634SB00302	Lower			

Note:
SW-846 (metals, VOCs) at DQO Level III.

10.3.3.1 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.3.2. Inorganic analytical results for soil are summarized in Table 10.3.3. Table 10.3.4 summarizes all analytes detected in soil at AOC 634. Appendix D contains a complete analytical data report for all Zone G samples collected.

Volatile Organic Compounds in Soil

No VOCs were detected in surface soil at AOC 634. One VOC, carbon disulfide, was detected at one location in subsurface soil at a concentration far below its SSL.

Inorganic Elements in Soil

Twenty-one metals were detected in surface soil and with the exception of iron, all were detected at concentrations below their respective RBC and background. Iron was detected above its surface soil RBC, however no background was established because iron is considered an essential nutrient. In subsurface soil, 22 metals were detected at AOC 634. None of the subsurface metal concentrations exceeded their respective SSLs and/or background concentrations for Zone G subsurface soil.

10.3.4 Fate and Transport Assessment

Environmental media sampled as part of the AOC 634 investigation include surface and subsurface soil. The potential constituent migration pathways investigated for AOC 634 include the soil-to-groundwater and the soil-to-air pathways.

10.3.4.1 Soil-to-Groundwater Cross-Media Transport

Table 10.3.5 compares maximum detected organic constituent concentrations in surface soil and subsurface soil samples to risk-based SSLs considered protective of groundwater. For inorganics,

Table 10.3.2
Zone G
AOC 634
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (µg/kg)	Mean of Detections (µg/kg)	Reference Conc.* (µg/kg)	Number of Samples Exceeding Reference
Volatile Organic Compounds (Upper Interval - 3 Samples/Lower Interval - 3 Samples) (µg/kg)						
Carbon disulfide	Upper	0/3	ND	ND	780000	0
	Lower	1/3	6.00	6.00	32000	0

Notes:

1 = Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995c)

* = Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil-to-groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as a reference concentration for lower interval samples

ND = Not detected

NL = Not listed

NA = Not applicable

µg/kg = Micrograms per kilogram

Table 10.3.3
Zone G
AOC 634
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Inorganics (Upper Interval - 3 Samples/Lower Interval - 3 Samples) (mg/kg)						
Aluminum (Al)	Upper	3/3	4930 - 5250	5060	7800	0
	Lower	3/3	4950 - 15700	8800	1000000	0
Antimony (Sb)	Upper	0/3	ND	ND	3.10	0
	Lower	1/3	0.420	0.420	5	0
Arsenic (As)	Upper	3/3	1.70 - 4.50	2.77	0.430	3
	Lower	3/3	5.90 - 28.0	14.8	29	0
Barium (Ba)	Upper	3/3	13.5 - 18.5	16.0	550	0
	Lower	3/3	17.6 - 28.3	22.2	1600	0
Beryllium (Be)	Upper	3/3	0.15 - 0.32	0.210	0.15	3
	Lower	3/3	0.52 - 1.2	0.780	63	0
Cadmium (Cd)	Upper	2/3	0.060 - 0.27	0.165	3.90	0
	Lower	2/3	0.25 - 0.31	0.280	8	0
Calcium (Ca)	Upper	3/3	22800 - 95400	48600	NL	NA
	Lower	3/3	12900 - 104000	63700	NL	NA
Chromium (Cr)	Upper	3/3	7.40 - 12.5	9.13	39.0	0
	Lower	3/3	27.2 - 34.3	31.4	1000000	0
Cobalt (Co)	Upper	3/3	1.50 - 3.50	2.33	470	0
	Lower	3/3	1.20 - 6.70	3.13	2000	0
Copper (Cu)	Upper	3/3	4.60 - 15.2	10.0	27000	0
	Lower	3/3	8.30 - 25.3	15.0	920	0

Table 10.3.3
Zone G
AOC 634
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Iron (Fe)	Upper	3/3	4380 - 5390	4780	2300	3
	Lower	3/3	5450 - 25700	12400	NL	NA
Lead (Pb)	Upper	3/3	7.00 - 19.0	11.8	400	0
	Lower	3/3	18.0 - 40.8	26.2	400	0
Magnesium (Mg)	Upper	3/3	653 - 1960	1140	NL	NA
	Lower	3/3	2670 - 5410	3750	NL	NA
Manganese (Mn)	Upper	3/3	35.6 - 114	65.3	180	0
	Lower	3/3	56.0 - 212	113	1100	0
Mercury (Hg)	Upper	3/3	0.05 - 0.13	0.0767	2.30	0
	Lower	3/3	0.09 - 0.22	0.167	2.1	0
Nickel (Ni)	Upper	2/3	3.60 - 6.60	5.10	160	0
	Lower	3/3	8.80 - 11.9	10.4	130	0
Potassium (K)	Upper	1/3	375	375	NL	NA
	Lower	3/3	713 - 2510	1320	NL	NA
Selenium (Se)	Upper	1/3	0.35	0.350	39.0	0
	Lower	3/3	1.20 - 1.90	1.47	5	0
Silver (Ag)	Upper	1/3	2.50	2.50	39.0	0
	Lower	0/3	ND	ND	34.0	0
Sodium (Na)	Upper	2/3	603 - 670	637	NL	NA
	Lower	3/3	2620 - 7040	4200	NL	NA
Thallium (Tl)	Upper	0/3	ND	ND	0.63	0
	Lower	1/3	0.66	0.660	0.95	0

Table 10.3.3
Zone G
AOC 634
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Vanadium (V)	Upper	3/3	9.70 - 12.9	11.7	55.0	0
	Lower	3/3	16.7 - 65.6	33.8	6000	0
Zinc (Zn)	Upper	2/3	33.8 - 55.4	44.6	2300	0
	Lower	3/3	41.9 - 98.1	63.9	12000	0

Notes:
* = Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil-to-groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as a reference concentration for lower interval samples
ND = Not detected
NL = Not listed
NA = Not applicable
mg/kg = Milligrams per kilogram

Table 10.3.4
Zone G
AOC 634
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL[a] (DAF=20)	Subsurface Background
Volatile Organic Compounds (µg/kg)							
Carbon disulfide	634SB003	ND	780000	NA	6	32000	NA
Inorganics (mg/kg)							
Aluminum (Al)	634SB001	5010	7800.0	18700	4950	1000000	23600
	634SB002	4930			5740		
	634SB003	5250			15700		
Antimony (Sb)	634SB002	ND	3.1	2.89	0.42	5	NL
Arsenic (As)	634SB001	2.1	0.43	17.2[a]	5.9	29	15.5[a]
	634SB002	4.5			10.4		
	634SB003	1.7			28		
Barium (Ba)	634SB001	13.5	550.0	109	17.6	1600	64.5
	634SB002	15.9			20.8		
	634SB003	18.5			28.3		
Beryllium (Be)	634SB001	0.16	0.15	1.20	0.52	63	1.63
	634SB002	0.32			0.62		
	634SB003	0.15			1.2		
Cadmium (Cd)	634SB001	0.06	3.9	1.07	0.25	8	0.48
	634SB002	0.27			0.31		
Calcium (Ca)	634SB001	27700	NL	NL	104000	NL	NL
	634SB002	95400			74200		
	634SB003	22800			12900		

Table 10.3.4
Zone G
AOC 634
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Chromium (Cr)	634SB001	7.5	39 VI	42.8	27.2	1000000	43.4[a]
	634SB002	12.5	7800 III		32.6		
	634SB003	7.4			34.3		
Cobalt (Co)	634SB001	2	470.0	6.60	1.2	2000	8.14
	634SB002	1.5			1.5		
	634SB003	3.5			6.7		
Copper (Cu)	634SB001	10.2	27000	260	8.3	920	32.6
	634SB002	15.2			11.5		
	634SB003	4.6			25.3		
Iron (Fe)	634SB001	**4380**	2300	NL	6120	NL	NL
	634SB002	**5390**			5450		
	634SB003	**4570**			25700		
Lead(Pb)	634SB001	9.5	400.0	181	18	400	66.3
	634SB002	19			19.9		
	634SB003	7			40.8		
Magnesium (Mg)	634SB001	653	NL	NL	3160	NL	NL
	634SB002	1960			2670		
	634SB003	817			5410		
Manganese (Mn)	634SB001	35.6	180.0	325	69.8	1100	291
	634SB002	114			56		
	634SB003	46.2			212		

Table 10.3.4
Zone G
AOC 634
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Mercury (Hg)	634SB001	0.05	2.3	1.03	0.22	2.1	0.31
	634SB002	0.13			0.09		
	634SB003	0.05			0.19		
Nickel (Ni)	634SB001	ND	160.0	20.6	8.8	130	18.3
	634SB002	6.6			10.6		
	634SB003	3.6			11.9		
Potassium (K)	634SB001	ND	NL	NL	713	NL	NL
	634SB002	375			735		
	634SB003	ND			2510		
Selenium (Se)	634SB001	ND	39.0	1.22	1.3	5	1.26
	634SB002	ND			1.9		
	634SB003	0.35			1.2		
Silver (Ag)	634SB001	2.5	39.0	NL	ND	34	NL
Sodium (Na)	634SB001	ND	NL	NL	2940	NL	NL
	634SB002	670			2620		
	634SB003	603			7040		
Thallium (Tl)	634SB003	ND	0.63	0.85	0.66	0.95	0.95
Vanadium (V)	634SB001	9.7	55.0	60.9	16.7	6000	72.5
	634SB002	12.6			19.1		
	634SB003	12.9			65.6		

Table 10.3.4
Zone G
AOC 634
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Zinc (Zn)	634SB001	33.8	2300.0	519	41.9	12000	145
	634SB002	55.4			51.7		
	634SB003	ND			98.1		

Notes:

a = Background value for non-clay samples
* = Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil-to-groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as a reference concentration for lower interval samples
l = Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995c)
ND = Not detected
NT = Not taken
NL = Not listed
NA = Not applicable
Bolded concentrations exceed both the reference concentration (RBC or SSL) and the zone background
All background values for Zone G are based on twice the means of the grid sample concentrations

Table 10.3.5
Chemicals Detected in Surface Soil, Subsurface Soil, and Shallow Groundwater
Comparison to SSLs, Tap Water RBCs, Saltwater Surface Water Chronic Screening Levels, and Background Concentrations
NAVBASE Charleston, Zone G: AOC 634
Charleston, South Carolina

Parameter	Max. Concentration Surface Soil	Max. Concentration Subsurface Soil	Max. Concentration Shallow GW	Max. Concentration Deep GW	Screening Concentration * Soil to GW SSL	Screening Concentration * Tap Water RBC	Screening Concentration * Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds												
Carbon disulfide	ND	6	NA	NA	32000	1000	NA	UG/KG	UG/L	NO	NO	NO
Inorganic Compounds												
Aluminum	5250	15700	NA	NA	1000000	37000	NA	MG/KG	UG/L	NO	NO	NO
Antimony	ND	0.42	NA	NA	5	15	NA	MG/KG	UG/L	NO	NO	NO
Arsenic	4.5	28	NA	NA	29	17.8	36	MG/KG	UG/L	NO	NO	NO
Barium	18.5	28.3	NA	NA	1600	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	0.32	1.2	NA	NA	63	0.016	NA	MG/KG	UG/L	NO	NO	NO
Cadmium	0.27	0.31	NA	NA	8	18	9.3	MG/KG	UG/L	NO	NO	NO
Chromium (total)	12.5	34.3	NA	NA	1000000	180	50	MG/KG	UG/L	NO	NO	NO
Cobalt	3.5	6.7	NA	NA	2000	2200	NA	MG/KG	UG/L	NO	NO	NO
Copper	15.2	25.3	NA	NA	920	130000	8.33	MG/KG	UG/L	NO	NO	NO
Lead	19	40.8	NA	NA	400	15	8.5	MG/KG	UG/L	NO	NO	NO
Manganese	114	212	NA	NA	1100	2906	NA	MG/KG	UG/L	NO	NO	NO
Mercury	0.13	0.22	NA	NA	2.1	11	0.025	MG/KG	UG/L	NO	NO	NO
Nickel	6.6	11.9	NA	NA	130	730	21.7	MG/KG	UG/L	NO	NO	NO
Selenium	0.35	1.9	NA	NA	5	180	71	MG/KG	UG/L	NO	NO	NO
Silver	2.5	ND	NA	NA	34	180	2.9	MG/KG	UG/L	NO	NO	NO
Thallium	ND	0.66	NA	NA	0.95	2.9	21.3	MG/KG	UG/L	NO	NO	NO
Vanadium	12.9	65.6	NA	NA	6000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	55.4	98.1	NA	NA	12000	11000	86	MG/KG	UG/L	NO	NO	NO

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 20, from 1996 Soil Screening Guidance or calculated using values from Table 6.4
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, October 22, 1997
Salt Water Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region IV Bulletins, Ecological Risk Assessment, November, 1995; Table 2
For inorganics, the value shown is the greater of the relevant screening value or the corresponding background value.

NA - Not available/Not applicable
ND - Not detected
RBC - Risk based concentration
SSL - Soil screening level
MG/KG - Milligrams per kilogram
NG/KG - Nanograms per kilogram
PG/L - Picograms per liter
UG/KG - Micrograms per kilogram
UG/L - Micrograms per liter

maximum concentrations in soil are compared to the greater of (a) risk-based soil screening levels, or (b) background concentrations for subsurface soil. To provide a conservative screen, generic soil screening levels are used; leachate entering the aquifer is assumed to be diluted by a ratio of 20:1, with no attenuation of constituents in soil (DAF=20).

No inorganic parameters or organic compounds were detected in site soil above applicable SSLs. Consequently, no significant residual mass remains onsite which poses a threat to groundwater quality. Due to the absence of any analytes present above SSLs, this pathway is invalid for this site.

10.3.4.2 Soil-to-Air Cross-Media Transport

No VOCs were detected in the surficial soil samples. As a result, the soil-to-air migration pathway is not valid at AOC 634.

10.3.4.3 Fate and Transport Summary

Environmental media samples at AOC 634 included surface and subsurface soil. While a number of parameters were detected in these samples, none were present at concentrations above their applicable SSLs. As a result, the soil-to-groundwater pathway is considered invalid at this site. No VOCs were detcted above their applicable soil-to-air volatilization concentrations, and therefore this pathway is considered invalid.

10.3.5 Human Health Risk Assessment

10.3.5.1 Site Background and Investigative Approach

AOC 634 is a former flammable materials storage facility, located at Building 1814. Materials stored at this site include paint and flammable materials.

During the CSI, a total of three soil borings were advanced to identify potential impacts resulting from the activities listed above. Surface soil samples from all three boring locations were used to quantitatively assess the direct contact soil exposure pathways. Subsurface soil detections were addressed in the previous section, Fate and Transport Assessment. Section 10.3.3 provides a summary of the sampling effort for AOC 634 soil.

10.3.5.2 COPC Identification

Based on the screening comparisons described in Section 7 of this RFI and presented in Table 10.3.6. No COPCs were identified in surface soil. Arsenic and beryllium were detected in surface soil samples at concentrations exceeding their RBCs but lower than their background concentrations. As a result, arsenic and beryllium were eliminated as COPCs based on comparison to their background concentrations. Wilcoxon rank sum test analysis confirmed that site concentrations of arsenic and beryllium were consistent with their background concentrations.

10.3.5.3 Risk Uncertainty

COPC Selection

A conservative screening process was used to identify COPCs for AOC 634. The potential for eliminating CPSSs with the potential for cumulative HI greater than one was addressed for noncarcinogens through the use of RBCs that were reduced one order of magnitude. For carcinogens the RBCs are based on a conservative target risk of 1E-06. Use of conservative RBCs in combination with the use of maximum detected concentrations minimizes the likelihood of a

Table 10.3.6
Chemicals Present in Site Samples
AOC 634 - Surface Soil
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentrations RBC	Screening Concentrations Reference	Units	Number Exceeding RBC	Number Exceeding Bkgd
Inorganics													
Aluminum (Al)		3	3	4930	5250	5063	NA	NA	7800	18700	MG/KG		
Arsenic (As)		3	3	1.7	4.5	2.8	NA	NA	0.43	17.2	MG/KG	3	
Barium (Ba)		3	3	13.5	18.5	16.0	NA	NA	550	109	MG/KG		
Beryllium (Be)		3	3	0.15	0.32	0.21	NA	NA	0.15	1.2	MG/KG	3	
Cadmium (Cd)		2	3	0.06	0.27	0.17	0.04	0.04	3.9	1.07	MG/KG		
Calcium (Ca)	N	3	3	22800	95400	48633	NA	NA	NA	NA	MG/KG		
Chromium (Cr)		3	3	7.4	12.5	9.1	NA	NA	39	42.8	MG/KG		
Cobalt (Co)		3	3	1.5	3.5	2.3	NA	NA	470	6.6	MG/KG		
Copper (Cu)		3	3	4.6	15.2	10.0	NA	NA	27000	260	MG/KG		
Iron (Fe)	N	3	3	4380	5390	4780	NA	NA	NA	NA	MG/KG		
Lead (Pb)		3	3	7	19	11.8	NA	NA	400	181	MG/KG		
Magnesium (Mg)	N	3	3	653	1960	1143	NA	NA	NA	NA	MG/KG		
Manganese (Mn)		3	3	35.6	114	65.3	NA	NA	180	325	MG/KG		
Mercury (Hg)		3	3	0.05	0.13	0.077	NA	NA	2.3	1.03	MG/KG		
Nickel (Ni)		2	3	3.6	6.6	5.1	3.3	3.3	160	20.6	MG/KG		
Potassium (K)	N	1	3	375	375	375	223	225	NA	NA	MG/KG		
Selenium (Se)		1	3	0.35	0.35	0.35	0.34	0.35	39	1.22	MG/KG		
Silver (Ag)		1	3	2.5	2.5	2.5	0.21	0.22	39	NA	MG/KG		
Sodium (Na)	N	2	3	603	670	637	386	386	NA	NA	MG/KG		
Vanadium (V)		3	3	9.7	12.9	11.7	NA	NA	55	60.9	MG/KG		
Zinc (Zn)		2	3	33.8	55.4	44.6	11.8	11.8	2300	519	MG/KG		

N - Essential nutrient
SQL - Sample quantitation limit
MG/KG - milligram per kilogram
NA - Not applicable

significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment, none was reported at a concentration close to its RBC (e.g. within 10% of its RBC). Arsenic and beryllium were detected at concentrations exceeding their RBCs and were not considered COPCs based on a direct comparison of their maximum concentrations to their background concentrations. Wilcoxon rank sum test analysis confirmed that site concentrations of arsenic and beryllium were consistent with their background concentrations.

10.3.5.4 Risk Summary

Surface soil data were screened according to the risk-based screening evaluation presented in Section 7 of this RFI. As a result of conservative risk-based screening, no surface soil COPCs were identified for AOC 634.

10.3.6 Corrective Measures Considerations

Based on the analytical results and the human health risk assessment for AOC 634, no COPCs or COCs have been identified. Arsenic and beryllium were detected in surface soil samples at concentrations exceeding their RBCs but lower than their background concentrations. As a result, arsenic and beryllium were eliminated as COPCs based on comparison to their background concentrations.

To determine the leaching potential of contaminants from the subsurface soil media to groundwater, contaminant concentrations in subsurface soil were compared against generic SSLs based on a DAF of 20. This comparison did not indicate contaminant concentrations above the SSLs, therefore there exists no leaching potential at AOC 634. For further information regarding the subsurface soil detections refer to Section 10.3.4, Fate and Transport Assessment.

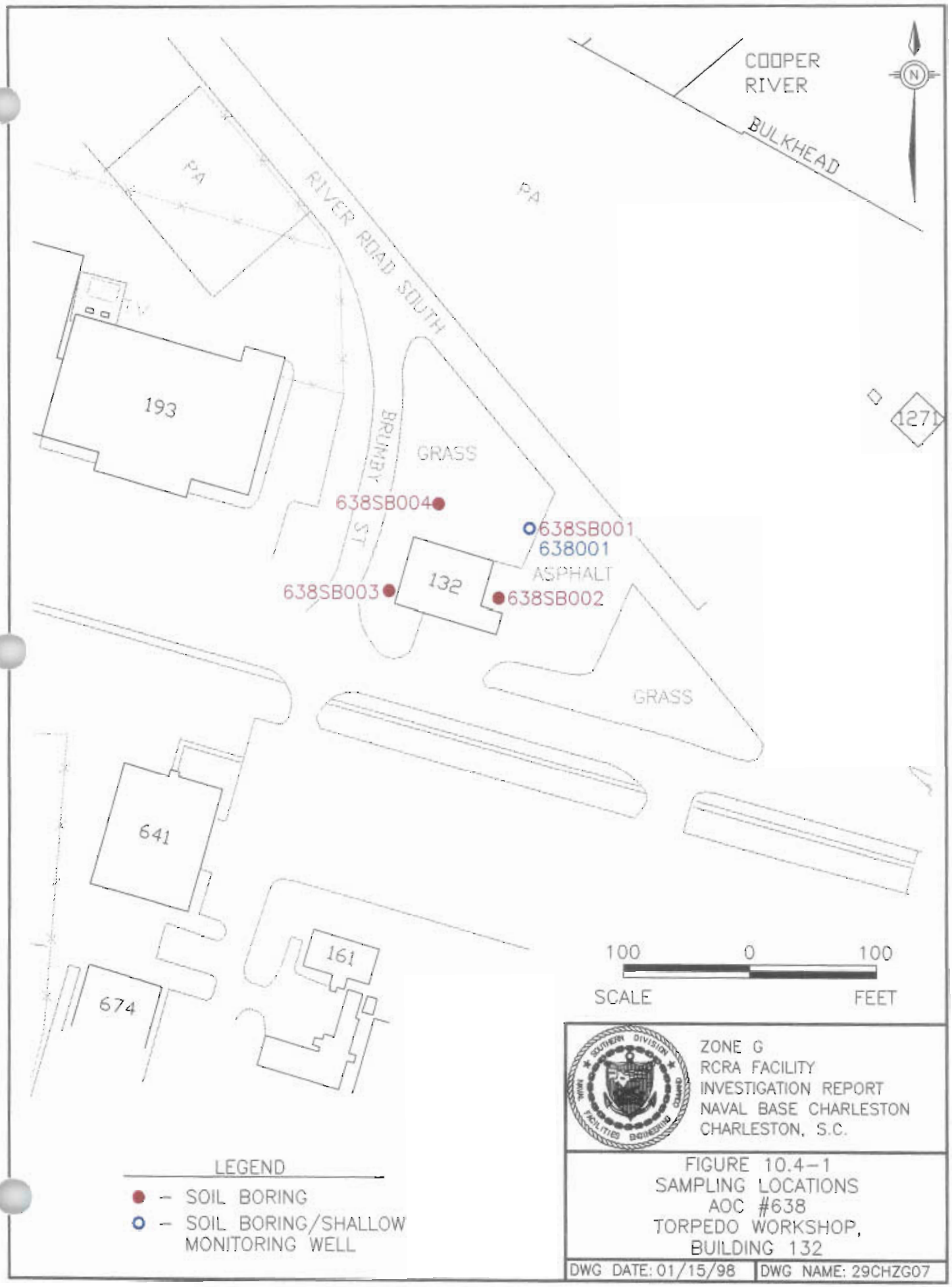
10.4 AOC 638, Former Torpedo Workshop, Building 132

A CSI site, AOC 638 is the former torpedo workshop at Building 132, which was used from 1944 until 1991. Building 132 is on the northeast corner of the intersection of Brumby Street and Hobson Avenue. From 1991 to 1995, the building was used by the Public Works Department for equipment and parts storage. The building is currently vacant.

10.4.1 Site Geology and Hydrogeology

The soil boring and groundwater monitoring well locations associated with the AOC 638 CSI are shown in Figure 10.4-1. Appendix A contains the boring logs and the monitoring well construction diagrams for the wells installed at AOC 638. Based on one monitoring well boring advanced at the site, the general stratigraphy at AOC 638 consists of organic silty clay overlying silty sand and sandy silt to a depth of 12 ft bgs. The silty sand represents the Qs unit. A sample was collected for grain size analysis from the Qm interval. This sample exhibited a grain size distribution of 4% sand, 37% silt, and 59% clay. The silty clay extends to a depth of approximately 8 ft bgs. The silty sand and sandy silt extends to the total depth of 12.4 ft bgs.

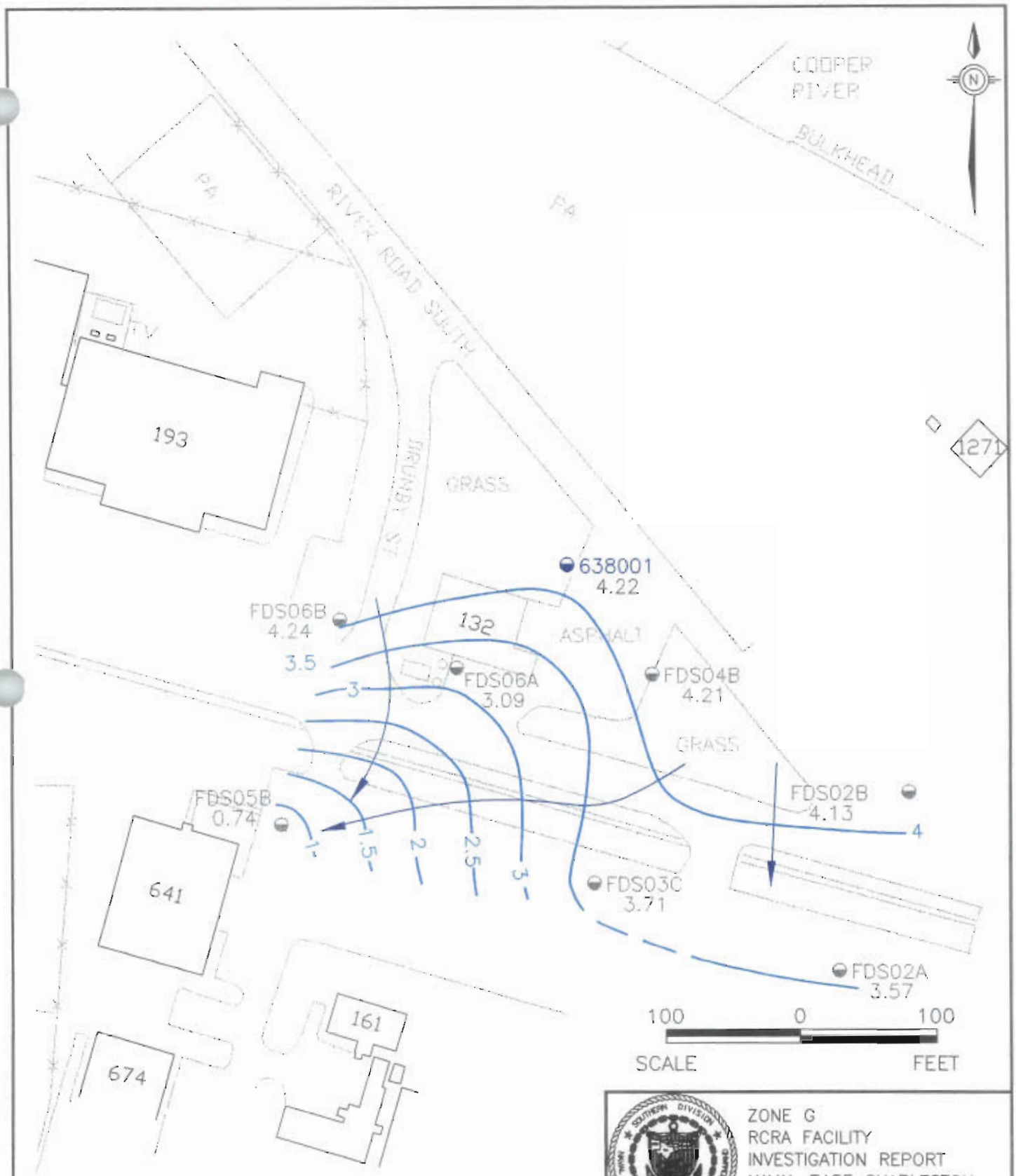
The groundwater elevation at AOC 638 is approximately 4.0 ft msl. Figures 10.4-2 and 10.4-3 depict the shallow groundwater potentiometric surface and inferred flow direction at low- and high-tide respectively. Minor differences in the static water levels and the overall flow pattern at the AOC 638 area were observed between high and low-tide. No slug tests were run within the AOC 638 area, therefore, no horizontal hydraulic conductivity was calculated. The low-tide horizontal hydraulic gradient, based on Figure 10.4-2 is 9.5E-03 to the southwest. The flow velocity at low-tide is approximately 8.8E-02 ft/day. The high-tide horizontal hydraulic gradient based on Figure 10.4-3 is 4.0E-02. Shallow groundwater flow velocity at high-tide is approximately 3.7E-01 ft/day to the south-southwest.



ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.4-1
SAMPLING LOCATIONS
AOC #638
TORPEDO WORKSHOP,
BUILDING 132

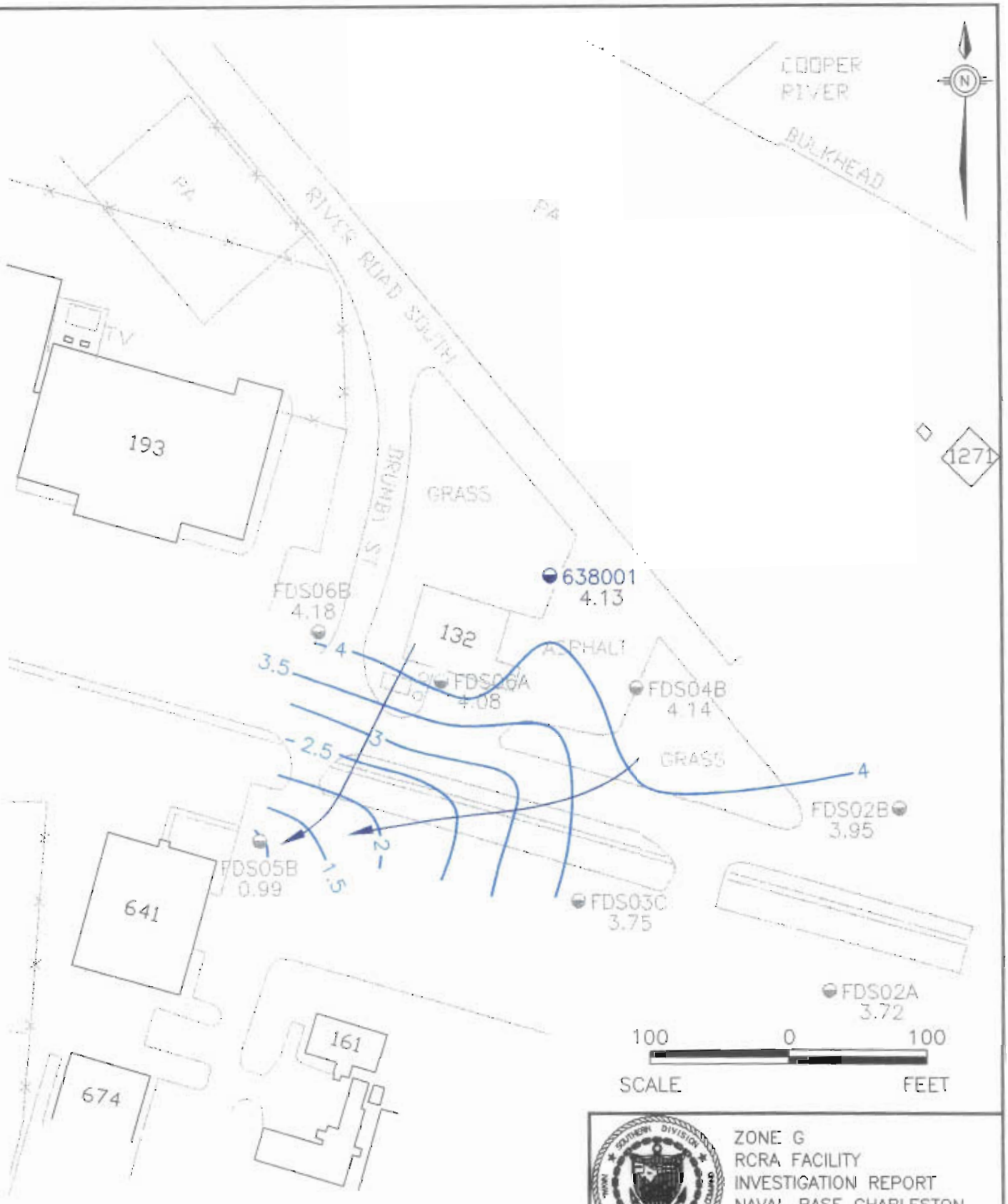
DWG DATE: 01/15/98 | DWG NAME: 29CHZG07



ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.4-2
SHALLOW GROUNDWATER
LOW-TIDE POTENTIOMETRIC MAP
AOC #638
TORPEDO WORKSHOP, BLDG 132

DWG DATE: 12/31/97 | DWG NAME: 29ZGLTTW



ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.4–3
SHALLOW GROUNDWATER
HIGH–TIDE POTENTIOMETRIC MAP
AOC #638
TORPEDO WORKSHOP, BLDG 132

DWG DATE: 01/15/98 | DWG NAME: 29ZGHTTW

10.4.2 Field Investigation Approach

The objective of the field investigation at AOC 638 was to: (1) confirm the presence or absence of contamination in the site area; (2) delineate any contamination found; and (3) provide sufficient data to support a detailed evaluation of treatment alternatives, if required. Media sampled within the investigation area included soil and groundwater. Section 3 of this report details the methods used during the field investigation. Included in this section are descriptions of the hand-auger procedures used for soil sampling; groundwater sampling procedures; and miscellaneous procedures used during the field investigation. Also discussed are the analytical protocols for sample analyzes. Appendix D contains the analytical data report for samples collected in Zone G.

10.4.3 Soil Sampling and Analyzes

The approved final RFI work plan proposed advancing four soil borings within the AOC 638 area to detect the presence of any soil contamination from this site. Upper and lower interval soil samples were proposed from each boring. During the field investigation, four soil borings were advanced, as depicted in Figure 10.4-1. Three borings included both upper and lower sampling intervals, while one boring included the upper interval only. One lower interval sample was not collected due to obstructions in the borehole. In accordance with the approved final RFI work plan, soil samples were analyzed for metals, pesticides/PCBs, SVOCs, and VOCs at DQO Level III. One sample was also analyzed for cyanide. In addition, one upper interval duplicate soil sample was collected for Appendix IX analyzes at DQO Level IV. Table 10.4.1 summarizes the AOC 638 soil samples and analyses.

10.4.3.1 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.4.2. Inorganic analytical results for soil are summarized in Table 10.4.3. Table 10.4.4 summarizes all analytes detected in soil at AOC 638. Appendix D contains a complete analytical data report for all Zone G samples collected.

Table 10.4.1
Zone G
AOC 638
Soil Samples and Analyzes

Boring Location	Sample Identifier	Sample Interval	Date Collected	Analyzes	Remarks
638SB001	638SB00101	Upper	9/19/96	Note 1 /cyanide	
	638CB00101*			Note 2	*Duplicate sample
	638SB00102	Lower			
638SB002	638SB00201	Upper	9/19/96	Note 1	Lower interval not sampled due to obstruction
638SB003	638SB00301	Upper	9/19/96	Note 1	
	638SB00302	Lower			
638SB004	638SB00401	Upper	9/19/96	Note 1	
	638SB00402	Lower			

Notes:
1 = SW-846 (metals, pesticides/PCBs, SVOCs, VOCs) at DQO Level III
2 = Appendix IX suite: Appendix IX (pesticides/PCBs, herbicides, SVOCs, VOCs); SW-846 (metals, dioxins, OP-pesticides); cyanide; hex-chrome at DQO Level IV
* = Duplicate sample

Table 10.4.2
Zone G
AOC 638
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (µg/kg)	Mean of Detections (µg/kg)	Reference Conc.* (µg/kg)	Number of Samples Exceeding Reference
Volatile Organic Compounds (Upper Interval - 4 Samples plus 1 Duplicate Sample/Lower Interval - 3 Samples) (µg/kg)						
Acetone	Upper	0/4	ND	ND	780000	0
	Lower	1/3	120	120	16000	0
Carbon disulfide	Upper	0/4	ND	ND	780000	0
	Lower	1/3	2.00	2.00	32000	0
Methylene chloride	Upper	0/4	ND	ND	85000	0
	Lower	1/3	10.0	10.0	20	0
Trichloroethene	Upper	0/4	ND	ND	58000	0
	Lower	1/3	3.00	3.00	60	0
Semivolatile Organic Compounds (Upper Interval - 4 Samples plus 1 Duplicate Sample/Lower Interval - 3 Samples) (µg/kg)						
BEQs[1]	Upper	3/4	0.460 - 220.09	90.1	88	1
	Lower	0/0	NA	NA	NA	NA
Benzo(a)anthracene	Upper	1/4	99.0	99.0	880	0
	Lower	3/3	93.0 - 210	134	2000	0
Benzo(b)fluoranthene	Upper	1/4	185	185	880	0
	Lower	2/3	92.0 - 180	136	5000	0
Benzo(k)fluoranthene	Upper	3/4	46.0 - 150	91.7	8800	0
	Lower	3/3	120 - 140	133	49000	0
Benzo(a)pyrene	Upper	2/4	49.0 - 130	89.5	88	1
	Lower	2/3	130	130	8000	0

Table 10.4.2
Zone G
AOC 638
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (µg/kg)	Mean of Detections (µg/kg)	Reference Conc.* (µg/kg)	Number of Samples Exceeding Reference
Chrysene	Upper	2/4	56.0 - 190	123	88000	0
	Lower	3/3	110 - 220	180	160000	0
Dibenz(a,h)anthracene	Upper	1/4	48.0	48.0	88	0
	Lower	0/3	ND	ND	2000	0
Indeno(1,2,3-cd)pyrene	Upper	1/4	120	120	880	0
	Lower	2/3	60.0 - 74.0	67.0	14000	0
Anthracene	Upper	0/4	ND	ND	2300000	0
	Lower	1/3	100	100	12000000	0
Benzo(g,h,i)perylene	Upper	2/4	39.0 - 114	76.5	230000	0
	Lower	1/3	140	140	4.66E08	0
Di-n-octylphthalate	Upper	0/4	ND	ND	160000	0
	Lower	1/3	130	130	10000000	0
bis(2-Ethylhexyl)phthalate	Upper	0/4	ND	ND	46000	0
	Lower	1/3	700	700	3600000	0
Fluoranthene	Upper	2/4	50.0 - 205	128	310000	0
	Lower	3/3	140 - 850	397	4300000	0
2-Methylnaphthalene	Upper	1/4	42.0	42.0	310000	0
	Lower	0/3	ND	ND	126000	0
Phenanthrene	Upper	1/4	114	114	230000	0
	Lower	1/3	280	280	1380000	0

Table 10.4.2
Zone G
AOC 638
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (µg/kg)	Mean of Detections (µg/kg)	Reference Conc.* (µg/kg)	Number of Samples Exceeding Reference
Pyrene	Upper	2/4	52.0 - 215	134	230000	0
	Lower	3/3	150 - 780	403	4200000	0
Pesticides and PCBs (Upper Interval - 4 Samples plus 1 Duplicate Sample/Lower Interval - 3 Samples) (µg/kg)						
alpha-Chlordane	Upper	2/4	1.90 - 9.45	5.68	1800	0
	Lower	0/3	ND	ND	10000	0
gamma-Chlordane	Upper	2/4	3.60 - 40.5	22.1	1800	0
	Lower	0/3	ND	ND	10000	0
4,4'DDD	Upper	2/4	6.60 - 35.5	21.1	2700	0
	Lower	1/3	19.0	19.0	16000	0
4,4'-DDE	Upper	2/4	11.0 - 76.0	43.5	1900	0
	Lower	1/3	38.0	38.0	54000	0
4,4'-DDT	Upper	2/4	6.00 - 15.0	10.5	1900	0
	Lower	0/3	ND	ND	32000	0
Heptachlor epoxide	Upper	1/4	2.8	2.8	70	0
	Lower	0/3	ND	ND	700	0
Methoxychlor	Upper	1/4	110	110	39000	0
	Lower	0/3	ND	ND	160000	0
Dioxins (Upper Interval - 1 Duplicate Sample) (ng/kg)						
Dioxin(2,3,7,8-TCDD TEQ)[1]	Upper	1/1	0.3205	0.3205	1000	0
	Lower	0/0	NA	NA	1900	0

Notes:

1	=	Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995c)
*	=	Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil-to-groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as a reference concentration for lower interval samples
ND	=	Not detected
NL	=	Not listed
NA	=	Not applicable
µg/kg	=	Micrograms per kilogram
ng/kg	=	Nanograms per kilogram

Table 10.4.3
Zone G
AOC 638
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Inorganics (Upper Interval - 4 Samples plus 1 Duplicate Samples/Lower Interval - 3 Samples) (mg/kg)						
Aluminum (Al)	Upper	4/4	5660 - 9400	6995	7800	1
	Lower	3/3	12900 - 30900	19700	1000000	0
Arsenic (As)	Upper	4/4	6.00 - 13.0	9.20	0.430	4
	Lower	3/3	8.70 - 15.0	12.8	29	0
Barium (Ba)	Upper	4/4	18.9 - 41.0	25.8	550	4
	Lower	3/3	24.0 - 44.3	34.1	1600	0
Beryllium (Be)	Upper	4/4	0.30 - 0.565	0.431	0.150	0
	Lower	3/3	0.81 - 1.60	1.08	63	0
Cadmium (Cd)	Upper	3/4	0.16 - 2.6	0.977	3.90	0
	Lower	2/3	0.20 - 0.21	0.205	8	0
Calcium (Ca)	Upper	4/4	2340 - 30500	15800	NL	NA
	Lower	3/3	6020 - 26100	15600	NL	NA
Chromium (Cr)	Upper	4/4	10.4 - 23.9	16.8	39.0	0
	Lower	3/3	27.9 - 47.8	35.3	1000000	0
Cobalt (Co)	Upper	4/4	1.20 - 4.25	2.16	470	0
	Lower	3/3	4.10 - 8.30	5.50	2000	0
Copper (Cu)	Upper	4/4	8.30 - 417	113	27000	0
	Lower	3/3	18.0 - 141	62.5	920	0

Table 10.4.3
Zone G
AOC 638
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc. (mg/kg)	Number of Samples Exceeding Reference
Iron (Fe)	Upper	4/4	4980 - 14900	9380	2300	4
	Lower	3/3	17100 - 34100	23800	NL	NA
Lead (Pb)	Upper	4/4	17.7 - 148.5	68.8	400	0
	Lower	3/3	20.7 - 76.1	49.2	400	0
Magnesium (Mg)	Upper	4/4	624 - 1370	1130	NL	NA
	Lower	3/3	3300 - 5400	4100	NL	NA
Manganese (Mn)	Upper	4/4	54.7 - 126	95.1	180	0
	Lower	3/3	141 - 459	285	1100	0
Mercury (Hg)	Upper	4/4	0.06 - 0.755	0.239	2.30	0
	Lower	3/3	0.20 - 0.53	0.360	2.1	0
Nickel (Ni)	Upper	4/4	2.70 - 19.95	8.56	160	0
	Lower	3/3	9.80 - 13.7	11.2	130	0
Potassium (K)	Upper	4/4	345 - 647	483	NL	NA
	Lower	3/3	1730 - 2630	2160	NL	NA
Selenium (Se)	Upper	4/4	0.46 - 0.76	0.624	39.0	0
	Lower	3/3	1.30 - 2.00	1.57	5	0
Sodium (Na)	Upper	2/4	305 - 536.5	421	NL	NA
	Lower	2/3	1110 - 1620	1370	NL	NA
Thallium (Tl)	Upper	0/4	ND	ND	0.63	0
	Lower	1/3	0.700	0.700	0.95	1

Table 10.4.3
Zone G
AOC 638
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Tin (Sn)	Upper	2/4	6.00 - 6.10	6.05	4700	0
	Lower	2/3	10.6 - 11.1	10.9	11000	0
Vanadium (V)	Upper	4/4	13.9 - 26.6	20.1	55.0	0
	Lower	3/3	40.7 - 76.8	52.9	6000	0
Zinc (Zn)	Upper	4/4	33.9 - 308	113	2300	0
	Lower	3/3	59.5 - 144	108	12000	0

Notes:

* = Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil-to-groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as a reference concentration for lower interval samples

ND = Not detected

NL = Not listed

NA = Not applicable

mg/kg = Milligrams per kilogram

Table 10.4.4
Zone G
AOC 638
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Volatile Organic Compounds (µg/kg)							
Acetone	638SB004	ND	780000	NA	120	16000	NA
Carbon disulfide	638SB004	ND	780000	NA	2	32000	NA
Methylene chloride	638SB004	ND	85000	NA	10	20	NA
Trichloroethene	638SB001	ND	58000	NA	3	60	NA
Semivolatile Organic Compounds (µg/kg)							
BEQs[1]	638SB001	220.09	88.0	NA	NA	NL	NA
	638SB002	0.46			NA		
	638SB003	49.85			NA		
	638SB004	ND			NA		
Benzo(a)anthracene	638SB001	99	880	NA	210	2000	NA
	638SB003	ND			100		
	638SB004	ND			93		
Benzo(b)fluoranthene	638SB001	185	880	NA	180	5000	NA
	638SB004	ND			92		
Benzo(k)fluoranthene	638SB001	150	8800	NA	140	49000	NA
	638SB002	46			NT		
	638SB003	79			140		
	638SB004	ND			120		

Table 10.4.4
Zone G
AOC 638
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Benzo(a)pyrene	638SB001	130	88	NA	ND	8000	NA
	638SB003	49			130		
	638SB004	ND			130		
Chrysene	638SB001	190	88000	NA	220	160000	NA
	638SB003	56			210		
	638SB004	ND			110		
Dibenz(a,h)anthracene	638SB001	48	88	NA	ND	2000	NA
Indeno(1,2,3-cd)pyrene	638SB001	120	880	NA	ND	14000	NA
	638SB003	ND			74		
	638SB004	ND			60		
Anthracene	638SB001	ND	2300000	NA	100	12000000	NA
Benzo(g,h,i)perylene	638SB001	114	230000	NA	ND	4.66E08	NA
	638SB003	39			140		
Di-n-octylphthalate	638SB001	ND	160000	NA	130	10000000	NA
bis(2-Ethylhexyl)phthalate	638SB001	ND	46000	NA	700	3600000	NA
Fluoranthene	638SB001	205	310000	NA	850	4300000	NA
	638SB003	50			200		
	638SB004	ND			140		
2-Methylnapthalene	638SB001	42	310000	NA	ND	126000	NA
Phenanthrene	638SB001	114	230000	NA	280	1380000	NA

Table 10.4.4
Zone G
AOC 638
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Pyrene	638SB001	215	230000	NA	780	4200000	NA
	638SB003	52			280		
	638SB004	ND			150		
Pesticides/PCBs (µg/kg)							
alpha-Chlordane	638SB001	9.45	1800	NA	ND	10000	NA
	638SB003	1.9			ND		
gamma-Chlordane	638SB001	40.5	1800	NA	ND	10000	NA
	638SB003	3.6			ND		
4,4'-DDD	638SB001	35.5	2700	NA	ND	16000	NA
	638SB003	6.6			19		
4,4'-DDE	638SB001	76	1900.0	NA	ND	54000	NA
	638SB003	11			38		
4,4'-DDT	638SB001	15	1900	NA	ND	32000	NA
	638SB003	6			ND		
Heptachlor epoxide	638SB001	2.8	70	NA	ND	700	NA
Methyoxychlor	638SB001	110	39000	NA	ND	160000	NA
Dioxins (ng/kg)							
Dioxin (2,3,7,8-TCDD TEQs)[1]	638SB001	0.3205	1000	NA	NT	1900	NA

Table 10.4.4
Zone G
AOC 638
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Inorganics (mg/kg)							
Aluminum (Al)	638SB001	6320	7800.0	18700	12900	1000000	23600
	638SB002	9400			NT		
	638SB003	6600			15200		
	638SB004	5660			30900		
Arsenic (As)	638SB001	10.9	0.43	17.2[a]	8.7	29	15.5[a]
	638SB002	13.0			NT		
	638SB003	6.9			14.6		
	638SB004	6.0			15		
Barium (Ba)	638SB001	41	550.0	109	24	1600	64.5
	638SB002	23.2			NT		
	638SB003	18.9			34.1		
	638SB004	20.2			44.3		
Beryllium (Be)	638SB001	0.565	0.15	1.20	0.81	63	1.63
	638SB002	0.50			NT		
	638SB003	0.36			0.84		
	638SB004	0.30			1.6		
Cadmium (Cd)	638SB001	2.6	3.9	1.07	0.20	8	0.48
	638SB003	0.16			0.21		
	638SB004	0.17			ND		
Calcium (Ca)	638SB001	27200	NL	NL	26100	NL	NL
	638SB002	2340			NT		
	638SB003	30500			14600		
	638SB004	3180			6020		

Table 10.4.4
Zone G
AOC 638
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Chromium (Cr)	638SB001	23.9	39 VI	42.8	27.9	1000000	43.4[a]
	638SB002	17.1	7800 III		NT		
	638SB003	15.7			30.1		
	638SB004	10.4			47.8		
Cobalt (Co)	638SB001	4.25	470.0	6.60	4.1	2000	8.14
	638SB002	1.9			NT		
	638SB003	1.3			4.1		
	638SB004	1.2			8.3		
Copper (Cu)	638SB001	417	27000	260	18	920	32.6
	638SB002	8.3			NT		
	638SB003	15.6			141		
	638SB004	9.9			28.6		
Iron (Fe)	638SB001	10025	2300	NL	20100	NL	NL
	638SB002	14900			NT		
	638SB003	4980			17100		
	638SB004	7600			34100		
Lead(Pb)	638SB001	148.5	400.0	181	20.7	400	66.3
	638SB002	17.7			NT		
	638SB003	25.1			76.1		
	638SB004	83.9			50.7		
Magnesium (Mg)	638SB001	1370	NL	NL	3590	NL	NL
	638SB002	1170			NT		
	638SB003	1370			3300		
	638SB004	624			5400		

Table 10.4.4
Zone G
AOC 638
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Manganese (Mn)	638SB001	122.5	180.0	325	256	1100	291
	638SB002	126			NT		
	638SB003	54.7			141		
	638SB004	77.1			459		
Mercury (Hg)	638SB001	0.755	2.3	1.03	0.35	2.1	0.31
	638SB002	0.08			NT		
	638SB003	0.06			0.53		
	638SB004	0.06			0.20		
Nickel (Ni)	638SB001	19.95	160.0	20.6	9.8	130	18.3
	638SB002	3.6			NT		
	638SB003	8.0			10.2		
	638SB004	2.7			13.7		
Potassium (K)	638SB001	566	NL	NL	2130	NL	NL
	638SB002	647			NT		
	638SB003	375			1730		
	638SB004	345			2630		
Selenium (Se)	638SB001	0.525	39.0	1.22	1.3	5	1.26
	638SB002	0.46			NT		
	638SB003	0.75			1.4		
	638SB004	0.76			2.0		
Sodium (Na)	638SB001	536.5	NL	NL	1620	NL	NL
	638SB002	305			NT		
	638SB003	ND			1110		
Thallium (Tl)	638SB001	ND	0.63	0.85	0.7	0.95	0.95

Table 10.4.4
Zone G
AOC 638
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Tin (Sn)	638SB003	6.0	4700	9.67	10.6	11000	2.96
	638SB004	6.1			11.1		
Vanadium (V)	638SB001	23.2	55.0	60.9	41.3	6000	72.5
	638SB002	26.6			NT		
	638SB003	13.9			40.7		
	638SB004	16.6			76.8		
Zinc (Zn)	638SB001	308	2300.0	519	59.5	12000	145
	638SB002	60.2			NT		
	638SB003	48.2			144		
	638SB004	33.9			121		

Notes:
a = Background value for non-clay samples
* = Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil-to-groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as a reference concentration for lower interval samples
I = Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995c)
ND = Not detected
NT = Not taken
NL = Not listed
NA = Not applicable
Bolded concentrations exceed both the reference concentration (RBC or SSL) and the zone background
All background values for Zone G are based on twice the means of the grid sample concentrations

Volatile Organic Compounds in Soil

No VOCs were detected in AOC 638 surface soil samples. Four VOCs were detected in AOC 638 subsurface soil samples. Three of the subsurface detections were from the same sample (638SB004). No subsurface soil VOC concentrations exceeded their respective SSL.

Semivolatile Organic Compounds in Soil

Twelve SVOCs were detected in surface soil samples at AOC 638. Benzo(a)pyrene exceeded its respective RBC in one surface soil sample at this AOC. Figure 10.4-4 presents the total BEQ concentrations detected in surface soil at AOC 638.

Thirteen SVOCs were detected in subsurface soil samples at AOC 638. No SVOCs in subsurface soil exceeded their respective SSL.

Pesticides and PCBs in Soil

Seven pesticides were detected in surface soil samples at AOC 638. No pesticides in surface soil exceeded their respective RBC. Two pesticides were detected in subsurface soil samples at concentrations below their respective SSLs. No PCBs were detected in either surface or subsurface soil samples.

Other organic compounds

Dioxin (2,3,7,8-TCDD TEQ) was detected in one surface soil duplicate sample below the RBC for this parameter.

Inorganic Elements in Soil

Twenty-one metals were detected in surface soil samples collected at AOC 638. Twenty-two metals were detected in subsurface soil samples collected at AOC 638. No metals were detected

in either surface or subsurface soils at concentrations exceeding the greater of their respective RBCs/SSLs and background concentrations for Zone G surface or subsurface soils. Iron was detected above its RBC but because it is considered an essential nutrient no background concentration has been established.

10.4.4 Groundwater Sampling and Analysis

The approved final RFI work plan proposed the installation and sampling of one shallow monitoring well within the AOC 638 area to: (1) assess groundwater quality, and (2) identify contaminants which may be migrating from the site in the shallow aquifer. During the field investigation, the proposed well was installed at approximately 12.4-ft bgs in the upper sand layer of the Wando Formation. In accordance with the approved final RFI work plan, the sample collected from this well was analyzed for metals, pesticides/PCBs, SVOCs, and VOCs at DQO Level III. This sample was also analyzed for cyanide. Table 10.4.5 summarizes the AOC 638 groundwater samples and analyses.

Table 10.4.5
Zone G
AOC 638
Groundwater Samples and Analyzes

Well Number	Well Depth	Sample Identifier	Date Sampled	Analyzes	Remarks
638001	Shallow	63800101	11/22/96	See note	

Note:
SW-846 (metals, pesticides/PCBs, SVOCs, VOCs), cyanide at DQO Level III.

10.4.4.1 Nature of Contamination in Groundwater

Inorganic analytical results for groundwater are summarized in Table 10.4.6. Table 10.4.7 summarizes all analytes detected in groundwater at AOC 638. Appendix D contains a complete analytical data report for all Zone G samples collected.

Table 10.4.6
Zone G
AOC 638
Inorganic Analytical Results for Groundwater

Parameters	Interval	Frequency of Detection	Range of Detections (μg/L)	Mean of Detections (μg/L)	Tap Water RBC* (μg/L)	MCL/SMCL* (μg/L)	Number of Samples Exceeding RBC
Inorganics (1 Shallow Sample) (μg/L)							
Aluminum (Al)	Shallow	1/1	26.7	26.7	3700	50	0
Arsenic (As)	Shallow	1/1	5.10	5.10	0.045	50	1
Barium (Ba)	Shallow	1/1	23.8	23.8	260	2000	0
Calcium (Ca)	Shallow	1/1	89500	89500	NL	NL	NA
Iron (Fe)	Shallow	1/1	6680	6680	1100	300	1
Magnesium (Mg)	Shallow	1/1	259000	259000	NL	NL	NA
Manganese (Mn)	Shallow	1/1	196	196	84	50	1
Potassium (K)	Shallow	1/1	109000	109000	NL	NL	NA
Sodium (Na)	Shallow	1/1	2520000	2520000	NL	NL	NA

Notes:
* = Tap Water RBCs (THQ=0.1) from *Risk-Based Concentration Table* (USEPA, October 22, 1997), and MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996e)
μg/L = Micrograms per liter
NL = Not listed
NA = Not applicable

Table 10.4.7
Zone G
AOC 638
Analytes Detected in Shallow Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Shallow Background
Volatile Organic Compounds (µg/L)							
Acetone	638001	ND	ND	3	370	NL	NA
Inorganics (µg/L)							
Aluminum (Al)	638001	26.7	ND	ND	3700	50	692
Arsenic (As)	638001	5.1	5.0	4.7	0.045	50	17.8
Barium (Ba)	638001	23.8	16.4	ND	260	2000	31
Calcium (Ca)	638001	89500	69000	70200	NL	NL	NL
Iron (Fe)	638001	6680	5870	4680	1100	300	NL
Magnesium (Mg)	638001	259000	224000	162000	NL	NL	NL
Manganese (Mn)	638001	196	116	162	84	50	2906
Nickel (Ni)	638001	ND	0.83	ND	73	100	4.08
Potassium (K)	638001	109000	146000	79000	NL	NL	NL
Sodium (Na)	638001	2520000	2620000	1530000	NL	NL	NL
Thallium (Tl)	638001	ND	6.4	ND	0.29	2	NL

Notes:

NA = Not applicable.
NL = Not listed
ND = Not detected
* = Tap Water RBCs (THQ=0.1) from *Risk-Based Concentration Table* (USEPA, October 22, 1997), and MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996e)
µg/L = Micrograms per liter
Bolded concentrations exceed both the RBC and the zone background
All background values for Zone G are based on twice the means of the grid sample concentrations. Background values for groundwater are based on two sampling rounds in two wells at each depth

Volatile Organic Compounds in Groundwater

No VOCs were detected during the first-round of groundwater sampling at AOC 638.

Semivolatile Organic Compounds in Groundwater

No SVOCs were detected in shallow groundwater at AOC 638.

Pesticides and PCBs in Groundwater

No pesticides or PCBs were detected in shallow groundwater at AOC 638.

Inorganic Elements in Groundwater

Nine metals were detected in shallow groundwater at AOC 638. No metals detected in the first-quarter groundwater sampling results exceeded their respective tap water RBCs or Zone G shallow groundwater background concentration. Iron was detected at concentrations exceeding its tap water RBC. No background concentration was calculated because iron is considered an essential nutrient.

10.4.5 Fate and Transport Assessment

AOC 638 was used as a torpedo workshop from 1944 until 1991. From 1991 to 1995, the Public Works Department used the site for equipment and parts storage. Environmental media sampled as part of AOC 638 include surface soil, subsurface soil, and shallow groundwater. Potential constituent migration pathways investigated for AOC 638 include soil-to-groundwater, groundwater-to-surface water, and emission of volatiles from surface soil to air.

10.4.5.1 Soil-to-Groundwater Cross-Media Transport

Table 10.4.8 compares maximum detected organic constituent concentrations in surface soil and subsurface soil samples to risk-based soil screening levels considered protective of groundwater. For inorganics, maximum concentrations in soil are compared to the greater of (a) risk-based soil

Table 10.4.8
Chemicals Detected in Surface Soil, Subsurface Soil, and Shallow Groundwater
Comparison to SSLs, Tap Water RBCs, Saltwater Surface Water Chronic Screening Levels, and Background Concentrations
NAVBASE Charleston, Zone G: AOC 638
Charleston, South Carolina

Parameter	Max. Concentration		Max. Concentration		Screening Concentration *							
	Surface Soil	Subsurface Soil	Shallow GW	Deep GW	Soil to GW SSL	Tap Water RBC	Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds												
Acetone	ND	120	ND	NA	16000	3700	NA	UG/KG	UG/L	NO	NO	NO
Carbon disulfide	ND	2	ND	NA	32000	1000	NA	UG/KG	UG/L	NO	NO	NO
Methylene chloride	ND	10	ND	NA	20	4.1	2560	UG/KG	UG/L	NO	NO	NO
Trichloroethene	ND	3	ND	NA	60	1.6	NA	UG/KG	UG/L	NO	NO	NO
Semivolatile Organic Compounds												
Anthracene	ND	100	ND	NA	12000000	11000	NA	UG/KG	UG/L	NO	NO	NO
Benzo(g,h,i)perylene	114	140	ND	NA	4.66E+08	1500	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene equivalents												
Benzo(a)anthracene	99	210	ND	NA	2000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene	130	130	ND	NA	8000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(b)fluoranthene	185	180	ND	NA	5000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(k)fluoranthene	150	140	ND	NA	49000	0.92	NA	UG/KG	UG/L	NO	NO	NO
Chrysene	190	220	ND	NA	160000	9.2	NA	UG/KG	UG/L	NO	NO	NO
Dibenzo(a,h)anthracene	48	ND	ND	NA	2000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Indeno(1,2,3-cd)pyrene	120	74	ND	NA	14000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Di-n-octylphthalate	ND	130	ND	NA	10000000	730	NA	UG/KG	UG/L	NO	NO	NO
bis(2-Ethylhexyl)phthalate (BEHP)	ND	700	ND	NA	3600000	4.8	NA	UG/KG	UG/L	NO	NO	NO
Fluoranthene	205	850	ND	NA	4300000	1500	1.6	UG/KG	UG/L	NO	NO	NO
2-Methylnaphthalene	42	ND	ND	NA	126000	1500	NA	UG/KG	UG/L	NO	NO	NO
Phenanthrene	114	280	ND	NA	1380000	1500	NA	UG/KG	UG/L	NO	NO	NO
Pyrene	215	780	ND	NA	4200000	1100	NA	UG/KG	UG/L	NO	NO	NO
Pesticides/PCB Compounds												
alpha-Chlordane	9.5	ND	ND	NA	10000	0.19	0.004	UG/KG	UG/L	NO	NO	NO
gamma-Chlordane	40.5	ND	ND	NA	10000	0.19	0.004	UG/KG	UG/L	NO	NO	NO
4,4'-DDD	35.5	19	ND	NA	16000	0.28	0.025	UG/KG	UG/L	NO	NO	NO
4,4'-DDE	76	38	ND	NA	54000	0.2	0.14	UG/KG	UG/L	NO	NO	NO
4,4'-DDT	15	ND	ND	NA	32000	0.2	0.001	UG/KG	UG/L	NO	NO	NO
Heptachlor epoxide	2.8	ND	ND	NA	700	0.0012	0.0036	UG/KG	UG/L	NO	NO	NO
Methoxychlor	110	ND	ND	NA	160000	180	0.03	UG/KG	UG/L	NO	NO	NO
Dioxin Compounds												
Dioxin (TCDD TEQ)	0.3205	NA	NA	NA	1900	0.45	10	NG/KG	PG/L	NO	NO	NO
Inorganic Compounds												
Aluminum	9400	30900	26.7	NA	1000000	37000	NA	MG/KG	UG/L	NO	NO	NO
Arsenic	13	15	5.1	NA	29	17.8	36	MG/KG	UG/L	NO	NO	NO
Barium	41	44.3	23.8	NA	1600	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	0.57	1.6	ND	NA	63	0.016	NA	MG/KG	UG/L	NO	NO	NO
Cadmium	2.6	0.21	ND	NA	8	18	9.3	MG/KG	UG/L	NO	NO	NO
Chromium (total)	23.9	47.8	ND	NA	1000000	180	50	MG/KG	UG/L	NO	NO	NO
Cobalt	4.3	8.3	ND	NA	2000	2200	NA	MG/KG	UG/L	NO	NO	NO
Copper	417	141	ND	NA	920	130000	8.33	MG/KG	UG/L	NO	NO	NO
Lead	149	76.1	ND	NA	400	15	8.5	MG/KG	UG/L	NO	NO	NO
Manganese	126	459	196	NA	1100	2906	NA	MG/KG	UG/L	NO	NO	NO
Mercury	0.76	0.53	ND	NA	2.1	11	0.025	MG/KG	UG/L	NO	NO	NO
Nickel	20	13.7	ND	NA	130	730	21.7	MG/KG	UG/L	NO	NO	NO
Selenium	0.76	2	ND	NA	5	180	71	MG/KG	UG/L	NO	NO	NO
Thallium	ND	0.7	ND	NA	0.95	2.9	21.3	MG/KG	UG/L	NO	NO	NO
Tin	6.1	11.1	ND	NA	11000	22000	NA	MG/KG	UG/L	NO	NO	NO
Vanadium	26.6	76.8	ND	NA	6000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	308	144	ND	NA	12000	11000	86	MG/KG	UG/L	NO	NO	NO

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 20, from 1996 Soil Screening Guidance or calculated using values from Table 6.4
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, October 22, 1997
Salt Water Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region IV Bulletins, Ecological Risk Assessment, November, 1995; Table 2
For inorganics, the value shown is the greater of the relevant screening value or the corresponding background value.

NA - Not available/Not applicable
ND - Not detected
RBC - Risk based concentration
SSL - Soil screening level
MG/KG - Milligrams per kilogram
NG/KG - Nanograms per kilogram
PG/L - Picograms per liter
UG/KG - Micrograms per kilogram
UG/L - Micrograms per liter

screening levels, or (b) background concentrations for subsurface soil. To provide a conservative screen, generic soil screening levels are used; leachate entering the aquifer is assumed to be diluted by a ratio of 20:1, with no attenuation of constituents in soil (DAF=20).

No inorganic parameters nor organic compounds were detected in site soil above applicable SSLs. Consequently, no significant residual mass remains onsite which poses a threat to groundwater quality. Due to the absence of any analytes present above SSLs, this pathway is invalid for this site.

10.4.5.2 Groundwater-to-Surface Water Cross-Media Transport

Table 10.4.8 also compares maximum detected organic constituent concentrations in shallow groundwater samples to risk-based concentrations for drinking water, and to chronic ambient saltwater quality criteria values for the protection of aquatic life (saltwater surface water chronic screening values). For inorganics, maximum concentrations in groundwater are compared to the greater of (a) risk-based drinking water concentrations, or (b) background concentrations for groundwater, as well as to the saltwater/surface water chronic values. To provide a conservative screen, no attenuation or dilution of constituents in groundwater is assumed before comparison to the relevant standards.

No inorganic constituents nor organic compounds were detected above applicable RBCs or surface water screening values. Consequently, this pathway is considered invalid for this site.

10.4.5.3 Soil-to-Air Cross-Media Transport

None of the VOCs were reported at a maximum concentration exceeding their corresponding soil-to-air volatilization screening level. As a result, the soil-to-air migration pathway is not valid at AOC 638.

10.4.5.4 Fate and Transport Summary

Environmental media sampled at AOC 638 included surface and subsurface soil and shallow groundwater. While a number of parameters were detected in these samples, none were present at concentrations above their applicable SSLs. As a result, the soil-to-groundwater pathway is considered invalid at this site. Additionally, no analytes were detected above RBCs and surface water screening criteria in shallow groundwater, and as a result the groundwater-to-surface water pathway is also considered invalid. No VOCs were detected above their applicable soil-to-air volatilization concentrations, and this pathway is considered invalid as well.

10.4.6 Human Health Risk Assessment

10.4.6.1 Site Background and Investigative Approach

AOC 638 is a former torpedo workshop that was located at Building 132, which was in operation from 1944 to 1991.

During the CSI, a total of four soil borings were advanced to identify potential impacts resulting from the activities listed above. Surface soil data was used to quantitatively assess the direct contact soil exposure pathways. Contaminants reported in subsurface soil via cross media transfer were assessed in the previous section, Fate and Transport Assessment. One monitoring well was installed in the shallow aquifer. Data from the initial sampling event were used to quantitatively assess groundwater exposure pathways. Sections 10.4.3 and 10.4.4 provide summaries of the sampling effort for AOC 638 soil and groundwater.

10.4.6.2 COPC Identification

Soil

Based on the screening comparisons described in Section 7 of this RFI and presented in Table 10.4.9, BEQs were identified as COPCs for surface soil. Aluminum, arsenic, and beryllium were detected at maximum concentrations exceeding their RBCs but below their

Table 10.4.9
Chemicals Present in Site Samples
AOC 638 - Surface Soil
Naval Base Charleston, Zone G
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Screening Concentration Background	Units	Number Exceeding RBC	Number Exceeding Bkgd
Carcinogenic PAHs													
B(a)P Equiv.	*	3	4	0.46	220.09	90.132	831.96	831.96	88	NA	UG/KG	1	
Benzo(a)anthracene		1	4	99	99	99	360	450	880	NA	UG/KG		
Benzo(a)pyrene	*	2	4	49	130	89.5	360	450	88	NA	UG/KG	1	
Benzo(b)fluoranthene		1	4	185	185	185	360	450	880	NA	UG/KG		
Benzo(k)fluoranthene		3	4	46	150	91.6667	360	360	8800	NA	UG/KG		
Chrysene		2	4	56	190	123	360	450	88000	NA	UG/KG		
Dibenz(a,h)anthracene		1	4	48	48	48	360	450	88	NA	UG/KG		
Indeno(1,2,3-cd)pyrene		1	4	120	120	120	360	450	880	NA	UG/KG		
TCDD Equivalents													
1234678-HpCDD		1	1	10.6	10.6	10.6	NA	NA	NA	NA	NG/KG		
1234678-HpCDF		1	1	7.54	7.54	7.54	NA	NA	NA	NA	NG/KG		
123478-HxCDF		1	1	0.751	0.751	0.751	NA	NA	NA	NA	NG/KG		
Dioxin Equiv.		1	1	0.3205	0.3205	0.3205	NA	NA	1000	NA	NG/KG		
OCDD		1	1	58	58	58	NA	NA	NA	NA	NG/KG		
OCDF		1	1	5.97	5.97	5.97	NA	NA	NA	NA	NG/KG		
Inorganics													
Aluminum (Al)		4	4	5660	9400	6995	NA	NA	7800	18700	MG/KG	1	
Arsenic (As)		4	4	6	13	9.2	NA	NA	0.43	17.2	MG/KG	4	
Barium (Ba)		4	4	18.9	41	25.825	NA	NA	550	109	MG/KG		
Beryllium (Be)		4	4	0.3	0.565	0.4313	NA	NA	0.15	1.2	MG/KG	4	
Cadmium (Cd)		3	4	0.16	2.6	0.9767	0.05	0.05	3.9	1.07	MG/KG		1
Calcium (Ca)		4	4	2340	30500	15805	NA	NA	NA	NA	MG/KG		
Chromium (Cr)		4	4	10.4	23.9	16.775	NA	NA	39	42.8	MG/KG		
Cobalt (Co)		4	4	1.2	4.25	2.1625	NA	NA	470	6.6	MG/KG		
Copper (Cu)		4	4	8.3	417	112.7	NA	NA	27000	260	MG/KG		1
Iron (Fe)		4	4	4980	14900	9376.25	NA	NA	NA	NA	MG/KG		
Lead (Pb)		4	4	17.7	148.5	68.8	NA	NA	400	181	MG/KG		
Magnesium (Mg)		4	4	624	1370	1133.5	NA	NA	NA	NA	MG/KG		
Manganese (Mn)		4	4	54.7	126	95.075	NA	NA	180	325	MG/KG		
Mercury (Hg)		4	4	0.06	0.755	0.2388	NA	NA	2.3	1.03	MG/KG		
Nickel (Ni)		4	4	2.7	19.95	8.5625	NA	NA	160	20.6	MG/KG		
Potassium (K)		4	4	345	647	483.25	NA	NA	NA	NA	MG/KG		
Selenium (Se)		4	4	0.46	0.76	0.6238	NA	NA	39	1.22	MG/KG		
Sodium (Na)		2	4	305	536.5	420.75	155	271	NA	NA	MG/KG		
Tin (Sn)		2	4	6	6.1	6.05	1.7	5.3	4700	9.67	MG/KG		
Vanadium (V)		4	4	13.9	26.6	20.075	NA	NA	55	60.9	MG/KG		
Zinc (Zn)		4	4	33.9	308	112.575	NA	NA	2300	519	MG/KG		
Pesticides													
4,4'-DDD		2	4	6.6	35.5	21.05	2.7	3.4	2700	NA	UG/KG		
4,4'-DDE		2	4	11	76	43.5	2.7	3.4	1900	NA	UG/KG		
4,4'-DDT		2	4	6	15	10.5	2.7	3.4	1900	NA	UG/KG		
alpha-Chlordane		2	4	1.9	9.45	5.675	1.4	1.8	1800	NA	UG/KG		
gamma-Chlordane		2	4	3.6	40.5	22.05	1.4	1.8	1800	NA	UG/KG		
Heptachlor epoxide		1	4	2.8	2.8	2.8	1.4	1.8	70	NA	UG/KG		
Methoxychlor		1	4	110	110	110	14	18	39000	NA	UG/KG		
Semivolatile Organics													
2-Methylnaphthalene		1	4	42	42	42	360	450	310000	NA	UG/KG		
Benzo(g,h,i)perylene		2	4	39	114	76.5	360	450	230000	NA	UG/KG		
Fluoranthene		2	4	50	205	127.5	360	450	310000	NA	UG/KG		
Phenanthrene		1	4	114	114	114	360	450	230000	NA	UG/KG		
Pyrene		2	4	52	215	133.5	360	450	230000	NA	UG/KG		

Notes:
* - Indicates chemical was identified as a COPC
SQL - Sample quantitation limit
RBC - Risk-based concentration
UG/KG - micrograms per kilogram
NG/KG - nanograms per kilogram
MG/KG - milligrams per kilogram
NA - Not applicable or not available

background concentrations. These inorganics were therefore eliminated from further consideration in the AOC 638 HHRA. Wilcoxon rank sum test analyzes did not result in the inclusion of any parameter that had been screened out on the basis of background concentration.

Groundwater

As shown in Table 10.4.10, no COPCs were identified for AOC 638 shallow groundwater. Arsenic and manganese were detected at maximum concentrations exceeding their RBCs but not exceeding their background concentration. These inorganic parameters were therefore eliminated from further consideration in the AOC 638 HHRA. An insufficient number of groundwater samples were collected to perform Wilcoxon rank sum test analyses; therefore these analyses were not performed for AOC 638 groundwater.

10.4.6.3 Exposure Assessment

Exposure Setting

AOC 638 is in a moderately developed urban setting, approximately 450 feet south of the waterfront along the Cooper River. This site comprises Building 132 and the surrounding parcels of grass. All potable water is provided through the city's water supply. Shallow groundwater at the site is not currently nor anticipated to be used in the future as potable or process water.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers, hypothetical future site residents, and adolescent trespassers. Future site resident and site worker exposure scenarios were addressed quantitatively in this risk assessment. Current exposure to workers is discussed qualitatively in relation to the future workers and future residents. The hypothetical future site worker scenario assumes continuous exposure to surface soil conditions. Current site workers' exposure would be less than that assumed for the hypothetical future site worker scenario because

Table 10.4.10
Chemicals Present in Site Samples
AOC 638 - Groundwater
Naval Base Charleston, Zone G
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentration Residential RBC	Screening Concentration Background	Units	Number Exceeding RBC	Number Exceeding Bkgd
Inorganics												
Aluminum (Al)	1	1	26.7	26.7	26.7	NA	NA	3700	692	UG/L		
Arsenic (As)	1	1	5.1	5.1	5.1	NA	NA	0.045	17.8	UG/L	1	
Barium (Ba)	1	1	23.8	23.8	23.8	NA	NA	260	31	UG/L		
Calcium (Ca)	1	1	89500	89500	89500	NA	NA	NA	NA	UG/L		
Iron (Fe)	1	1	6680	6680	6680	NA	NA	NA	NA	UG/L		
Magnesium (Mg)	1	1	259000	259000	259000	NA	NA	NA	NA	UG/L		
Manganese (Mn)	1	1	196	196	196	NA	NA	84	2906	UG/L	1	
Potassium (K)	1	1	109000	109000	109000	NA	NA	NA	NA	UG/L		
Sodium (Na)	1	1	2520000	2520000	2520000	NA	NA	NA	NA	UG/L		

Notes:
SQL - Sample quantitation limit
RBC - Risk-based concentration
UG/L - micrograms per liter
NA - Not applicable or not available

of their limited soil contact. Therefore, future worker assessment is considered to be conservatively representative of current site workers. The location of the site does not allow convenient access to potential trespassers. Since future use of the site is uncertain, the adolescent trespasser was qualitatively addressed relative to the child resident. The future site resident scenario was built on the premise that existing buildings would be removed and replaced with dwellings.

Exposure Pathways

Exposure pathways for the hypothetical future site residents and site workers are dermal contact and incidental ingestion of surface soils. Uniform exposure was assumed for all sample locations. The groundwater pathways were excluded because there were no COPCs identified. Table 10.4.11 presents the justification for exposure pathways assessed in this HHRA.

Exposure Point Concentrations

Since less than ten samples were collected, the maximum detected concentration was used as EPCs, as discussed in Section 7 of this RFI.

Quantification of Exposure

Soil

CDIs for ingestion and dermal contact with soils are shown in Tables 10.4.12 and 10.4.13, respectively.

10.4.6.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 7 of this report. Table 10.4.14 presents toxicological information specific to each COPC identified at AOC 638. This information was used in the quantification of risk/hazard associated with soil contaminants. Brief toxicological profiles for each COPC are provided in the following paragraphs.

Table 10.4.11
Zone G
AOC 638
Exposure Pathways Summary

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Site Users/Maintenance	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or process water at AOC 638.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or process water at AOC 638.
	Soil, Incidental ingestion	No (Qualified)	Future land use assessment is considered to be conservatively representative of current receptors.
	Soil, Dermal contact	No (Qualified)	Future land use assessment is considered to be conservatively representative of current receptors.
Future Land Uses			
Future Site Residents, Site Worker, Trespassers	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	No COPCs were identified for shallow groundwater based on conservative screening.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	No	No COPCs were identified for shallow groundwater based on conservative screening.
	Soil, Incidental ingestion	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Soil, Dermal contact	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Table 10.4.12
Chronic Daily Intakes
Incidental Ingestion of Surface Soil
AOC 638
Naval Base Charleston, Zone G
Charleston, South Carolina

Chemical	Fraction Ingested from Contaminated Source *	Exposure Point Concentration (mg/kg)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Carcinogenic PAHs							
Benzo(a)p	1	0.22	3.0E-07	2.8E-06	3.4E-07	1.1E-07	3.8E-08

NOTES:

lwa Lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
* Reflects the estimated fraction of the site impacted by the corresponding COPC.

Table 10.4.13
Chronic Daily Intakes
Dermal Contact with Surface Soil
AOC 638
Naval Base Charleston, Zone G
Charleston, South Carolina

Chemical	FI/FC *	Exposure Point Concentration (mg/kg)	Dermal Absorption Factor (unitless)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Inorganic								
Benzo(a)pyrene Equivalents	1	0.22	0.01	1.2E-07	4.1E-07	7.7E-08	8.8E-08	3.2E-08

NOTES:

CDI Chronic Daily Intake in mg/kg-day

H-CDI CDI for hazard quotient

C-CDI CDI for excess cancer risk

* Reflects the estimated fraction of the site impacted by the corresponding COPC.

\- The dermal absorption factor was applied to the exposure point concentration to reflect the ability for trans-dermal migration of inorganic and organic chemicals

Table 10.4.14
Toxicological Reference Information
for Chemicals of Potential Concern
AOC 638
Naval Base Charleston, Zone G
Charleston, South Carolina

	Non-Carcinogenic Toxicity Data								*Carcinogenic Toxicity Data*					
Chemical	Oral Reference Dose (mg/kg-day)	Confidence Level	Critical Effect	Uncertainty Factor Oral	Inhalation Reference Dose (mg/kg-day)	Confidence Level	Critical Effect	Uncertainty Factor Inhalation	Oral Slope Factor (kg-day/mg)		Inhalation Slope Factor (kg-day/mg)		Weight of Evidence	Tumor Type
Benzo(a)pyrene Equivalents	NA	NA	NA	NA	NA	NA	NA	NA	7.3	a	6.1	b	B2	mutagen

Notes:

a = Integrated Risk Information System (IRIS)

b = Withdrawn from IRIS/HEAST

NA = Not applicable or not available

BEQs include the following list of PAHs:

Benzo(a)anthracene	TEF	0.1
Benzo(b)fluoranthene	TEF	0.1
Dibenz(a,h)anthracene	TEF	1.0
Benzo(k)fluoranthene	TEF	0.01
Benzo(a)pyrene	TEF	1.0
Indeno(1,2,3-cd)pyrene	TEF	0.1
Chrysene	TEF	0.001

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of the PAHs above have not been well established. There are no RfDs for the PAHs above due to a lack of data. All PAHs listed above are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of benzo(a)pyrene, having an oral SF 7.3 $(mg/kg\text{-}day)^{-1}$. TEFs, also set by USEPA, are multipliers that are applied to the detected concentrations, which are subsequently used to calculate excess cancer risk. These multipliers are discussed further in the exposure and toxicity assessment sections. Most carcinogenic PAHs have been classified as such due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soot, cigarette smoke, etc.). As listed in IRIS, the basis for the benzo(a)pyrene B2 classification is human data specifically linking benzo(a)pyrene to a carcinogenic effect are lacking. There are, however, multiple animal studies in many species demonstrating benzo(a)pyrene to be carcinogenic by numerous routes.

Benzo(a)pyrene has produced positive results in numerous genotoxicity assays. At the June 1992 CRAVE Work Group meeting, a revised risk estimate for benzo(a)pyrene was verified. This section provides information on three aspects of the carcinogenic risk assessment for the agent in

question: The USEPA classification and quantitative estimates of exposure. The classification reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in application of a low-dose extrapolation procedure and presented as the risk per (mg/kg-day). The unit risk is the quantitative estimate in terms of either risk per μg/L drinking water or risk per $\mu g/m^3$ air breathed. The third form in which risk is presented is drinking water or air concentration providing cancer risks of 1 in 10,000 or 1 in 1,000,000. The Carcinogenicity Background Document provides details on the carcinogenicity values found in IRIS. Users are referred to the Oral Reference Dose and Reference Concentration sections for information on long-term toxic effects other than carcinogenicity.

The basis for the dibenz(a,h)anthracene and benzo(b)fluoranthene B2 classification is listed in IRIS as no human data and sufficient data from animal bioassays. Benzo(b)fluoranthene produced tumors in mice after lung implantation, intraperitoneal or subcutaneous injection, and skin painting. The basis for the benzo(a)anthracene B2 classification is listed in IRIS as no human data and sufficient data from animal bioassays. Benzo(a)anthracene produced tumors in mice exposed by gavage; intraperitoneal, subcutaneous or intramuscular injection; and topical application. Benzo(a)anthracene produced mutations in bacteria and in mammalian cells, and transformed mammalian cells in culture. The basis for the benzo(k)fluoranthene B2 classification is listed in IRIS as no human data and sufficient data from animal bioassays. Benzo(k)fluoranthene produced tumors after lung implantation in mice and when administered with a promoting agent in skin-painting studies. Equivocal results have been found in a lung adenoma assay in mice. Benzo(k)fluoranthene is mutagenic in bacteria. (Klaassen, et al., 1986).

10.4.6.5 Risk Characterization

Surface Soil Pathways

Exposure to surface soil onsite was evaluated under both residential and site worker scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were

evaluated. For noncarcinogenic contaminants evaluated for future site residents, hazard was computed separately to address child and adult exposure. Tables 10.4.15 and 10.4.16 present the computed carcinogenic risks and/or HQs associated with the incidental ingestion of and dermal contact with site surface soils, respectively.

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime weighted average) for AOC 638 surface soils is 3E-06. The dermal pathway ILCR is 1E-06. BEQs were the sole contributors to the ingestion and dermal pathways. Though the adolescent trespasser was not quantitatively addressed for this site, the following semiquantitative analysis was performed using the results of the residential risk analysis. Exposure frequency and duration under the residential scenario are 350 days/year and 30 years, respectively, compared to 52 day/year and 7 years for the adolescent trespasser. Substituting the trespasser exposure frequency and duration into the CDI equation would result in a risk estimate approximately 98% below the residential risk estimate. Assuming that adolescent trespassers gain access to the site, the cumulative soil pathway (both ingestion and dermal) risk for the adolescent trespasser was estimated to be approximately 1E-07.

Hypothetical Site Workers

Site worker ILCRs are 3E-07 and 5E-07 for the ingestion and dermal contact pathways, respectively. BEQs were the sole contributors for each pathway.

COCs Identified

COCs were identified based on cumulative (all pathway) risk and hazard projected for this site on a medium-specific basis. USEPA has established a generally acceptable risk range of 1E-04 to 1E-06, and a hazard index threshold of 1.0 (unity). As recommended by SCDHEC, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, and whose individual ILCR exceeds 1E-06 or whose hazard

Table 10.4.15
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC 638
Naval Base Charleston, Zone G
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident lwa ILCR	Future Worker Adult Hazard Quotient	Future Worker Adult ILCR
Carcinogenic PAHs							
Benzo(a)pyrene Equivalents	NA	7.3	ND	ND	2.5E-06	ND	2.8E-07
SUM Hazard Index/ILCR			ND	ND	3E-06	ND	3E-07

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime Cancer Risk

Table 10.4.16
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC 638
Naval Base Charleston, Zone G
Charleston, South Carolina

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident lwa ILCR	Future Worker Adult Hazard Quotient	Future Worker Adult ILCR
Carcinogenic PAHs								
Benzo(a)pyrene Equivalents	0.5	NA	14.6	ND	ND	1.1E-06	ND	4.6E-07
SUM Hazard Index/ILCR				ND	ND	1E-06	ND	5E-07

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime Cancer Risk
- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

quotient exceeds 0.1. For carcinogens, this approach is relatively conservative, because a cumulative risk level of 1E-04 (and individual ILCR of 1E-06) is recommended by USEPA Region IV as the trigger for establishing COCs. The COC selection method presented was used to provide a more comprehensive evaluation of chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the RGO development process. Table 10.4.17 presents the COCs identified for AOC 638 surface soil and shallow groundwater.

Surface Soils

Future Site Residents

BEQs were identified as soil pathway COCs based on their contribution to cumulative ILCR projections.

Future Site Workers

No soil pathway COCs were identified for the site worker scenario.

The extent of the COCs identified in surface soil is briefly discussed below. To facilitate this discussion of the extent of COC concentrations, residential soil RBCs were compared to each reported concentration for each COC. BEQs were detected in three of four surface soil samples and at a concentration above its residential RBC in only one surface soil sample.

10.4.6.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure. Residential use of the site would not be expected, based on current site uses and the nature of

Table 10.4.17
Summary of Risk and Hazard-based COCs
AOC 638
Naval Base Charleston, Zone G
Charleston, South Carolina

Medium	Exposure Pathway		Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident Iwa ILCR	Future Site Worker Hazard Quotient	Future Site Worker ILCR	Identification of COCs
Surface Soil	Incidental Ingestion	**Carcinogenic PAHs** Benzo(a)pyrene Equivalents	ND	ND	2.5E-06	ND	2.8E-07	2
	Dermal	**Carcinogenic PAHs** Benzo(a)pyrene Equivalents	ND	ND	1.1E-06	ND	4.6E-07	2
Surface Soil Pathway Sum			ND	ND	4E-06	ND	7E-07	

Notes:
ND indicates not determined due to the lack of available risk information.
ILCR indicates incremental excess lifetime cancer risk
HI indicates hazard index
1- Chemical is a COC by virtue of projected child residence noncarcinogenic hazard.
2- Chemical is a COC by virtue of projected future resident lifetime ILCR.
3- Chemical is a COC by virtue of projected site worker noncarcinogenic hazard.
4- Chemical is a COC by virtue of projected site worker ILCR.

surrounding buildings and features. Current reuse plans call for continued commercial/industrial or recreational use of Zone G. If this area were to be used as a residential site, existing features would be demolished, and the surface soil conditions would likely change — the soils could be covered with landscaping soil and/or a house. Consequently, exposure to surface soil conditions as represented by samples collected during the RFI would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current site workers and future site residents.

Groundwater is not currently used at AOC 638 for potable or industrial purposes. A base-wide system provides drinking and process water to buildings throughout Zone G. This system is planned to remain in operation under the current base reuse plan. As a result, use of shallow groundwater would not be expected under future site use scenarios. Therefore, the scenario established to project risk/hazard associated with shallow groundwater exposure is highly conservative, and associated pathways are not expected to be completed in the future.

Determination of Exposure Point Concentrations

The maximum detected soil constituent concentration was used as the exposure point concentration for this site. Use of maximum detected concentrations represent conservative assumptions when applied as the EPC, such that it is unlikely that the maximum detected concentration underestimates the true mean concentration. Although characterizing the site with only four surface soil samples adds some uncertainty as to how well the extent of BEQ contamination has been defined, no area of gross contamination is indicated based on current data.

Quantification of Risk/Hazard

As indicated by the discussions above, the uncertainty and variability inherent in the risk assessment process is great. In addition, many site-specific factors have affected the uncertainty

of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

Soil

A conservative screening process was used to identify COPCs for AOC 638. The potential for eliminating CPSSs with the potential for cumulative HI greater than one was addressed for noncarcinogens through the use of RBCs that were reduced one order of magnitude. For carcinogens, the RBCs are based on a conservative target risk of 1E-06. Use of conservative RBCs in combination with the use of maximum detected concentrations minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment, none was reported at a concentration close to its RBC (e.g., within 10% of its RBC).

Groundwater

The same conservative screening process used for soil is also used for groundwater. Of the CPSSs screened and eliminated from formal assessment, none was reported at a concentration close to its RBC (e.g., within 10% of its RBC).

Background-related Risk

Soil

Aluminum, arsenic, and beryllium were detected in AOC 638 surface soil above their respective RBCs and arsenic and manganese were detected in AOC 638 groundwater above their respective tap water RBCs. These elements were not considered in the risk assessment based on comparison to background concentrations. It is not unusual for naturally occurring or background concentrations of some elements to exceed RBCs. It is the risk assessment's function to identify excess risk and/or hazard, or that which is above background levels. The following is a discussion

of the residential scenario risk/hazard associated with background concentrations of these elements.

The arsenic (17.2 mg/kg) and beryllium (1.2 mg/kg) background surface soil concentrations equate with an cumulative ILCR of 5E-05 (based on the adult and child lifetime weighted average). The cumulative soil residential risk for AOC 638 is 4E-06. The background surface soil concentrations of aluminum (18,700 mg/kg), arsenic (17.2 mg/kg), and beryllium (1.2 mg/kg) equate with an cumulative HI of 1 (based on the resident child). The cumulative soil resident child HI for AOC 638 was not determined in the absence of any noncarcinogenic COPCs. The background shallow groundwater concentration for arsenic (17.8 μg/L) equates with an ILCR of 4E-04 (based on the adult and child lifetime weighted average). The background shallow groundwater concentration of manganese (2,906 μg/L) equates with a an HI of 3. There were no COPCs identified for AOC 638 shallow groundwater.

10.4.6.7 Risk Summary

The risk and hazard posed by contaminants at AOC 638 were assessed for the future site worker and the future site resident under RME assumptions. In surface soils, the incidental ingestion and dermal contact pathways were assessed in this HHRA. The groundwater pathway was not assessed since there were no COPCs identified. Table 10.4.18 presents the risk summary for each soil pathway/receptor group evaluated for AOC 638.

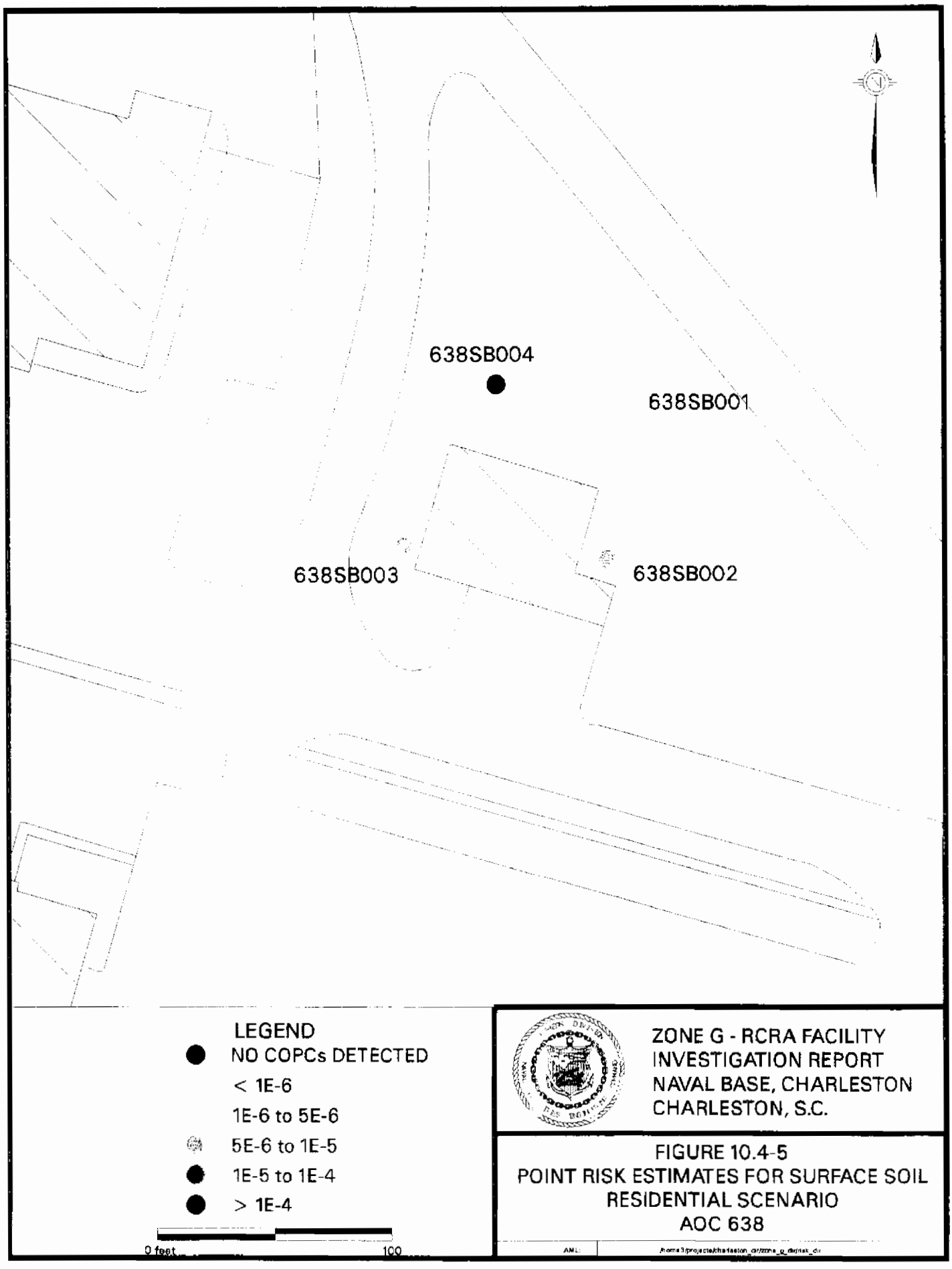
Soil — Residential Scenario

Residential soil pathway COCs identified for AOC 638 include BEQs. Figure 10.4-5 illustrates point risk estimates for AOC 638 surface soil pathways under a residential scenario. Table 10.4.19 summarizes the risk contribution of each COPC at each sample location. This point risk map is based on the unlikely assumption that a potential future site resident will be chronically exposed to specific points. Exposure to surface soil conditions is more likely the result of uniform

Table 10.4.18
Summary of Risk and Hazard
AOC 638
Naval Base Charleston, Zone G
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	ND	ND	3E-06	ND	3E-07
	Dermal Contact	ND	ND	1E-06	ND	5E-07
Sum of Soil Pathways		ND	ND	4E-06	ND	7E-07

Notes:
ILCR Indicates incremental lifetime cancer risk
HI Indicates hazard index



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CHARLESTON, S.C.

FIGURE 10.4-5
POINT RISK ESTIMATES FOR SURFACE SOIL
RESIDENTIAL SCENARIO
AOC 638

Table 10.4.19
Point Estimates of Risk and Hazard - Surface Soil Pathway
Residential Scenario
AOC 638
Naval Base Charleston, Zone G
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
638	001	B(a)P Equiv.	220.1	UG/KG	NA		3.6448	100
		Total			NA		3.6448	
638	002	B(a)P Equiv.	0.46	UG/KG	NA		0.0076	100
		Total			NA		0.0076	
638	003	B(a)P Equiv.	49.8	UG/KG	NA		0.8255	100
		Total			NA		0.8255	
638	004	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			NA		NA	

exposure to the soil conditions of the entire site (or exposure unit area) rather than specific points. With this in mind, risk maps supplemented by the tables are useful in that they allow the reader to visualize how chemicals driving risk estimates are spatially distributed across the site.

BEQs contributed to risk estimates above 1E-06 at only one soil sample locations (638SB001). Risks estimates ranged from 8E-09 (638SB002) to 4E-06 (638SB001).

Soil — Site Worker Scenario

There were no industrial soil pathway COCs identified for AOC 638.

Groundwater — Residential Scenario

There were no COPCs identified for AOC 638 groundwater.

10.4.6.8 Remedial Goal Options

Soil

RGOs for carcinogens were based on the lifetime weighted average site resident as presented in Table 10.4.20 for surface soil.

10.4.7 Corrective Measures Considerations

Based on the analytical results and the human health risk assessment for AOC 638, COCs requiring further evaluation through the CMS process have been identified for surface soil. The site is currently in a moderately developed urban setting and risk to human health was evaluated under both the residential and industrial (site worker) scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. Hazard was evaluated for noncarcinogenic contaminants through incidental ingestion and dermal contact scenarios as well.

Table 10.4.20
Remedial Goal Options for Soil
AOC 638
Naval Base Charleston, Zone G
Charleston, South Carolina

Residential-Based Remedial Goal Options

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	EPC mg/kg	Hazard-Based Remedial Goal Options 3 mg/kg	1 mg/kg	0.1 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Carcinogenic PAHs										
Benzo(a)pyrene Equivalents	7.3	NA	0.2	ND	ND	ND	0.06	0.6	6	NA

NOTES:

EPC Exposure point concentration
NA Not applicable
ND Not determined
- Remedial goal options were based on the residential or site worker lifetime weighted average for carcinogens and the child resident or site worker for noncarcinogens

As recommended by SCDHEC, a COC is considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, and whose individual risk exceeds 1E-06 or whose hazard quotient exceeds 0.1.

BEQs were identified as soil pathway COCs for AOC 638. Table 10.4.21 presents cumulative and COC-specific exposure risks and hazard quotients. Risk-based remedial goals for surface soil are presented in Table 10.4.20.

To determine the leaching potential of contaminants from the subsurface soil media to groundwater, contaminant concentrations in subsurface soil were compared against generic SSLs based on a DAF of 20. This comparison did not indicate contaminant concentrations above the SSLs, therefore there exists no leaching potential at AOC 638. For further information regarding subsurface soil refer to Section 10.4.5, Fate and Transport Assessment.

Potential corrective measures for soil are presented in Table 10.4.22.

Table 10.4.21
Zone G
AOC 638
Cumulative and Chemical-Specific Exposure Risks and Hazard

	Risk		Hazard	
Chemical	**Industrial**	**Residential**	**Industrial**	**Residential**
Soil				
BEQs	7.0E-07	4.0E-06	ND	ND
Cumulative	7.0E-07	4.0E-06	ND	ND

Note:
ND = Not determined

Table 10.4.22
Zone G
AOC 638
Potential Corrective Measures

Medium	Compounds	Potential Corrective Measures
Soil	BEQs	a) No action b) Excavate, offsite disposal, and monitoring c) Containment/capping

10.5 AOC 642, Former Pistol Range, Present Parking Lot

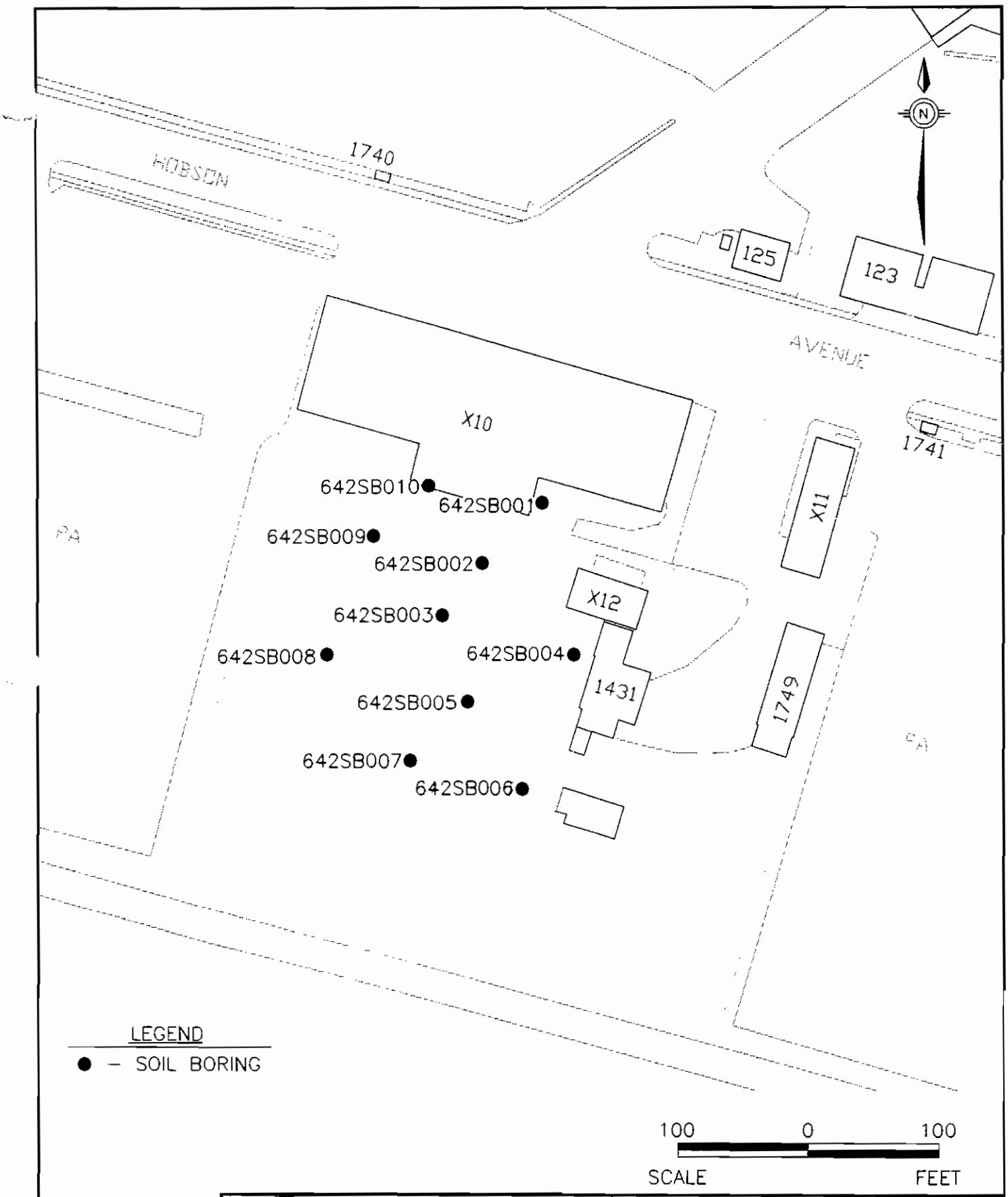
A CSI site, AOC 642 is the former pistol range located south of Building X-10, and west of Buildings X-12 and 1431. Hobson Avenue is to the north, while Dyess Avenue is south of the site. The site is currently a fenced, asphalt paved, parking area. The area was used as a pistol range during the 1940s. It is unknown if any spent lead bullets were removed from the site.

10.5.1 Site Geology

Figure 10.5-1 depicts the soil sampling locations within this area. The detailed stratigraphy at AOC 642 could not be determined as no monitoring well borings were installed at the site. Geologic and hydrogeologic data gathered from adjacent SWMU 8 was used for this AOC. Stratigraphy encountered consists of silty sand overlying clayey silt and silty clay. The sand extends to a maximum depth of 14 ft bgs in well 008001. The clayey silt and silty clay extends to the maximum depth of the well at approximately 20 feet. No samples were collected for grain size analysis from the SWMU 8 wells because the wells were pre-existing. The Qc unit in Zone G generally exhibits an average grain size distribution of 56% sand, 15% silt, and 29% clay. Based on the hydrogeologic data gathered from adjacent SWMU 8, the groundwater elevation at AOC 642 should be between five and six ft msl. Shallow groundwater at AOC 642 flows generally to the northwest.

10.5.2 Field Investigation Approach

The objective of the field investigation at AOC 642 was to: (1) confirm the presence or absence of contamination in the site area; (2) delineate any contamination found; and (3) provide sufficient data to support a detailed evaluation of treatment alternatives, if required. Media sampled within the investigation area included site soil. Section 3 of this report details the methods used during the field investigation. Included in this section are descriptions of the hand-auger procedures used



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CHARLESTON, S.C.

FIGURE 10.5–1
SAMPLING LOCATIONS
AOC #642
FORMER PISTOL RANGE,
PRESENT PARKING LOT

DWG DATE: 01/15/98 | DWG NAME: 29CHZG13

for soil sampling, as well as the miscellaneous procedures used during the field investigation. Also discussed are the analytical protocols for sample analyses. Appendix D contains the analytical data report for samples collected in Zone G.

10.5.3 Soil Sampling and Analyses

The approved final RFI work plan proposed advancing ten soil borings within the AOC 642 area to detect the presence of any metals contamination from this site. Upper and lower interval soil samples were proposed from each boring. During the field investigation, ten soil borings were advanced, as depicted in Figure 10.5-1. One boring included both upper and lower sampling intervals, while nine other borings were limited to the upper interval only. At these locations the lower interval sample was not collected due to a shallow water table. In accordance with the approved final RFI work plan, soil samples were analyzed for metals at DQO Level III . In addition, one upper interval duplicate soil sample was collected for Appendix IX analyses at DQO Level IV. Table 10.5.1 summarizes the AOC 642 soil samples and analyses.

10.5.3.1 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.5.2. Inorganic analytical results for soil are summarized in Table 10.5.3. Table 10.5.4 summarizes all analytes detected in soil at AOC 642. Appendix D contains a complete analytical data report for all Zone G samples collected.

Organic Compounds in Soil

Dioxin (2,3,7,8-TCDD TEQ) was detected in one surface soil duplicate sample at a concentration far below the RBC for this parameter.

Table 10.5.1
Zone G
AOC 642 Soil Samples

Boring Location	Sample Identifier	Sample Interval	Date Collected	Analyses	Remarks
642SB001	642SB00101 642CB00101*	Upper	9/18/96	Note 1 Note 2	Lower interval not sampled due to water table *Duplicate sample
642SB002	642SB00201	Upper	9/18/96	Note 1	Lower interval not sampled due to water table
642SB003	642SB00301	Upper	9/18/96	Note 1	Lower interval not sampled due to water table
642SB004	642SB00401	Upper	9/18/96	Note 1	Lower interval not sampled due to water table
642SB005	642SB00501	Upper	9/18/96	Note 1	Lower interval not sampled due to water table
642SB006	642SB00601	Upper	9/18/96	Note 1	Lower interval not sampled due to water table
642SB007	642SB00701	Upper	9/18/96	Note 1	Lower interval not sampled due to water table
642SB008	642SB00801 642SB00802	Upper Lower	9/18/96	Note 1	
642SB009	642SB00901	Upper	9/18/96	Note 1	Lower interval not sampled due to water table
642SB010	642SB01001	Upper	9/18/96	Note 1	Lower interval not sampled due to water table

Notes:
1 = SW-846 (metals) at DQO Level III
2 = Appendix IX suite: Appendix IX (pesticides/PCBs, herbicides, SVOCs, VOCs); SW-846 (metals, dioxins, OP-pesticides) cyanide; hex-chrome at DQO Level IV
* = Duplicate sample

Table 10.5.2
Zone G
AOC 642
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (µg/kg)	Mean of Detections (µg/kg)	Reference Conc.* (µg/kg)	Number of Samples Exceeding Reference
Dioxins (1 Duplicate Sample) (µg/kg)						
Dioxin(2,3,7,8-TCDD TEQ)[1]	Upper	1/1	0.1749	0.1749	1000	0
	Lower	0/0	NA	NA	1900	0

Notes:
1 = Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995c)
* = Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil-to-groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as a reference concentration for lower interval samples
NA = Not applicable
µg/kg = Micrograms per kilogram

Table 10.5.3
Zone G
AOC 642
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Inorganic (Upper Interval - 10 Samples plus 1 Duplicate Sample/Lower Interval - 1 Sample) (mg/kg)						
Aluminum (Al)	Upper	10/10	1110 - 6530	2420	7800	0
	Lower	1/1	3290	3290	1000000	0
Arsenic (As)	Upper	10/10	4.5 - 82	20.9	0.43	10
	Lower	1/1	1.70	1.70	29	0
Barium (Ba)	Upper	10/10	5.80 - 92.7	43.3	550	0
	Lower	1/1	4.9	4.9	1600	0
Beryllium (Be)	Upper	10/10	0.24 - 1.20	0.506	0.150	10
	Lower	1/1	0.10	0.1000	63	0
Cadmium (Cd)	Upper	9/10	0.21 - 2.7	1.08	3.9	0
	Lower	0/1	ND	ND	8	0
Calcium (Ca)	Upper	10/10	4980 - 312000	76700	NL	NA
	Lower	1/1	2080	2,080	NL	NA
Chromium (Cr)	Upper	10/10	5.3 - 23.5	11.2	39	0
	Lower	1/1	4.8	4.8	1000000	0
Cobalt (Co)	Upper	10/10	1.10 - 17.4	5.74	470	0
	Lower	1/1	0.38	0.38	2000	0
Copper (Cu)	Upper	9/10	5.9 - 58.3	29.6	27000	0
	Lower	1/1	2.1	2.1	920	0

Table 10.5.3
Zone G
AOC 642
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Iron (Fe)	Upper	10/10	3080 - 13400	8280	2300	10
	Lower	1/1	2570	2570	NL	NA
Lead (Pb)	Upper	10/10	2.80 - 70.3	35.3	400	0
	Lower	1/1	3.9	3.9	400	0
Magnesium (Mg)	Upper	10/10	638 - 33900	5100	NL	NA
	Lower	1/1	296	2960	NL	NA
Manganese (Mn)	Upper	10/10	42.1 - 350	125	180	2
	Lower	1/1	18.7	18.7	1100	0
Mercury (Hg)	Upper	5/10	0.04 - 0.06	0.0480	2.30	0
	Lower	0/1	ND	ND	2.10	0
Nickel (Ni)	Upper	9/10	1.90 - 253	44.8	160	1
	Lower	1/1	1.90	1.90	130	0
Potassium (K)	Upper	5/10	266 - 596	421	NL	NA
	Lower	0/1	ND	ND	NL	NA
Selenium (Se)	Upper	6/10	0.46 - 0.80	0.695	39.0	0
	Lower	0/1	ND	ND	5	0
Sodium (Na)	Upper	2/10	357 - 1550	954	NL	NA
	Lower	0/1	ND	ND	NL	NA
Thallium (Tl)	Upper	5/10	0.40 - 1.00	0.664	0.63	2
	Lower	0/1	ND	ND	0.95	0

Table 10.5.3
Zone G
AOC 642
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Vanadium (V)	Upper	10/10	5.4 - 45.5	20.4	55	0
	Lower	1/1	4.00	4.00	6000	0
Zinc (Zn)	Upper	10/10	10.3 - 822	186	2300	0
	Lower	1/1	7.5	7.5	12000	0

Notes:
* = Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil-to-groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996c) were used as a reference concentration for lower interval samples
ND = Not detected
NL = Not listed
NA = Not applicable
mg/kg = Milligrams per kilogram

Table 10.5.4
Zone G
AOC 642
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Dioxins (ng/kg)							
Dioxin (2,3,7,8-TCDD TEQs)[1]	642SB001	0.1749	1000	NA	NT	1900	NA
Inorganics (mg/kg)							
Aluminum (Al)	642SB001	6530	7800.0	18700	NT	1000000	23600
	642SB002	2130			NT		
	642SB003	1590			NT		
	642SB004	2420			NT		
	642SB005	1110			NT		
	642SB006	2050			NT		
	642SB007	1150			NT		
	642SB008	2530			3290		
	642SB009	2100			NT		
	642SB010	2610			NT		
Arsenic (As)	642SB001	6.5	0.43	17.2[a]	NT	29	15.5[a]
	642SB002	4.5			NT		
	642SB003	19.4			NT		
	642SB004	31.7			NT		
	642SB005	8.9			NT		
	642SB006	82			NT		
	642SB007	30.7			NT		
	642SB008	5			1.7		
	642SB009	6.4			NT		
	642SB010	13.5			NT		

Table 10.5.4
Zone G
AOC 642
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Barium (Ba)	642SB001	18.0	550.0	109	NT	1600	64.5
	642SB002	8.8			NT		
	642SB003	52.3			NT		
	642SB004	44.2			NT		
	642SB005	66.9			NT		
	642SB006	92.7			NT		
	642SB007	37.2			NT		
	642SB008	5.8			4.9		
	642SB009	67.3			NT		
	642SB010	39.8			NT		
Beryllium (Be)	642SB001	0.27	0.15	1.20	NT	63	1.63
	642SB002	0.24			NT		
	642SB003	0.75			NT		
	642SB004	0.46			NT		
	642SB005	0.40			NT		
	642SB006	1.20			NT		
	642SB007	0.58			NT		
	642SB008	0.32			0.10		
	642SB009	0.41			NT		
	642SB010	0.43			NT		

Table 10.5.4
Zone G
AOC 642
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Cadmium (Cd)	642SB001	0.24	3.9	1.07	NT	8	0.48
	642SB002	0.29			NT		
	642SB003	1.7			NT		
	642SB004	1.1			NT		
	642SB005	1.0			NT		
	642SB006	0.21			NT		
	642SB007	2.7			NT		
	642SB009	2.1			NT		
	642SB010	0.36			NT		
Calcium (Ca)	642SB001	18100	NL	NL	NT	NL	NL
	642SB002	59700			NT		
	642SB003	61600			NT		
	642SB004	39300			NT		
	642SB005	155000			NT		
	642SB006	4980			NT		
	642SB007	77500			NT		
	642SB008	5110			2080		
	642SB009	312000			NT		
	642SB010	33500			NT		

Table 10.5.4
Zone G
AOC 642
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC[a] (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL[a] (DAF=20)	Subsurface Background
Chromium (Cr)	642SB001	11.4	39 VI	42.8	NT	1000000	43.4[a]
	642SB002	5.3	7800 III		NT		
	642SB003	14			NT		
	642SB004	11			NT		
	642SB005	8.1			NT		
	642SB006	10.3			NT		
	642SB007	10.1			NT		
	642SB008	6.5			4.8		
	642SB009	23.5			NT		
	642SB010	11.8			NT		
Cobalt (Co)	642SB001	3.4	470.0	6.60	NT	2000	8.14
	642SB002	1.1			NT		
	642SB003	4.9			NT		
	642SB004	4			NT		
	642SB005	3			NT		
	642SB006	12.1			NT		
	642SB007	17.4			NT		
	642SB008	1.2			0.38		
	642SB009	7.7			NT		
	642SB010	2.6			NT		

Table 10.5.4
Zone G
AOC 642
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Copper (Cu)	642SB001	6.4	27000	260	NT	920	32.6
	642SB002	5.9			NT		
	642SB003	46.2			NT		
	642SB004	27.4			NT		
	642SB005	23.3			NT		
	642SB006	38.7			NT		
	642SB007	58.3			NT		
	642SB008	ND			2.1		
	642SB009	39.9			NT		
	642SB010	19.9			NT		
Iron (Fe)	642SB001	7600	2300	NL	NT	NL	NL
	642SB002	3080			NT		
	642SB003	13400			NT		
	642SB004	12400			NT		
	642SB005	4900			NT		
	642SB006	11800			NT		
	642SB007	12800			NT		
	642SB008	5360			2570		
	642SB009	5500			NT		
	642SB010	5970			NT		

Table 10.5.4
Zone G
AOC 642
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Lead(Pb)	642SB001	12.4	400.0	181	NT	400	66.3
	642SB002	6.5			NT		
	642SB003	47.2			NT		
	642SB004	70.3			NT		
	642SB005	43.1			NT		
	642SB006	17.6			NT		
	642SB007	48.4			NT		
	642SB008	2.8			3.9		
	642SB009	69.2			NT		
	642SB010	35			NT		
Magnesium (Mg)	642SB001	1054	NL	NL	NT	NL	NL
	642SB002	996			NT		
	642SB003	1270			NT		
	642SB004	638			NT		
	642SB005	2480			NT		
	642SB006	4090			NT		
	642SB007	33900			NT		
	642SB008	1070			296		
	642SB009	3920			NT		
	642SB010	1620			NT		

Table 10.5.4
Zone G
AOC 642
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Manganese (Mn)	642SB001	42.1	180.0	325	NT	1100	291
	642SB002	80.2			NT		
	642SB003	135			NT		
	642SB004	80			NT		
	642SB005	162			NT		
	642SB006	72.7			NT		
	642SB007	205			NT		
	642SB008	68.5			18.7		
	642SB009	350			NT		
	642SB010	56.5			NT		
Mercury (Hg)	642SB001	0.04	2.3	1.03	NT	2.1	0.31
	642SB003	0.04			NT		
	642SB005	0.06			NT		
	642SB009	0.06			NT		
	642SB010	0.04			NT		
Nickel (Ni)	642SB001	6.6	160.0	20.6	NT	130	18.3
	642SB002	4.7			NT		
	642SB003	27.6			NT		
	642SB004	17.2			NT		
	642SB006	53.2			NT		
	642SB007	253			NT		
	642SB008	1.9			1.9		
	642SB009	28.6			NT		
	642SB010	10.8			NT		

Table 10.5.4
Zone G
AOC 642
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Potassium (K)	642SB001	426	NL	NL	NT	NL	NL
	642SB003	279			NT		
	642SB008	539			ND		
	642SB009	596			NT		
	642SB010	266			NT		
Selenium (Se)	642SB001	0.46	39.0	1.22	NT	5	1.26
	642SB003	0.70			NT		
	642SB004	0.79			NT		
	642SB006	0.80			NT		
	642SB007	0.78			NT		
	642SB010	0.64			NT		
Sodium (Na)	642SB001	357	NL	NL	NT	NL	NL
	642SB008	1550			ND		
Thallium (Tl)	642SB001	0.40	0.63	0.85	NT	0.95	0.95
	642SB003	0.47			NT		
	642SB004	1.0			NT		
	642SB006	0.87			NT		
	642SB007	0.58			NT		

Table 10.5.4
Zone G
AOC 642
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Vanadium (V)	642SB001	19.8	55.0	60.9	NT	6000	72.5
	642SB002	5.4			NT		
	642SB003	26			NT		
	642SB004	38.2			NT		
	642SB005	15.2			NT		
	642SB006	14			NT		
	642SB007	18.6			NT		
	642SB008	8.1			4.0		
	642SB009	45.5			NT		
	642SB010	12.8			NT		
Zinc (Zn)	642SB001	22.5	2300.0	519	NT	12000	145
	642SB002	20.2			NT		
	642SB003	196			NT		
	642SB004	190			NT		
	642SB005	81			NT		
	642SB006	822			NT		
	642SB007	241			NT		
	642SB008	10.3			7.5		
	642SB009	218			NT		
	642SB010	58.1			NT		

Notes:

a = Background value for non-clay samples.

* = Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil-to-groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as a reference concentration for lower interval samples.

1 = Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995c).

ND = Not detected.

NT = Not taken.

NL = Not listed.

NA = Not applicable.

Bolded concentrations exceed both the reference concentration (RBC or SSL) and the zone background.

All background values for Zone G are based on twice the means of the grid sample concentrations.

Inorganic Elements in Soil

Twenty-one metals were detected in AOC 642 surface soil samples. Arsenic, manganese, nickel, and thallium were detected at concentrations exceeding the greater of their respective RBCs and background concentrations for Zone G surface soil. Iron was detected above its RBC in surface soil. No background was established for iron because it is considered to be an essential nutrient. Figures 10.5-2 through 10.5-5 present arsenic, manganese, nickel, and thallium concentrations detected in surface soil, respectively.

Fifteen metals were detected in subsurface soil samples at AOC 642. No metal concentrations detected in subsurface soil exceeded the greater of their respective SSL or subsurface soil background concentrations.

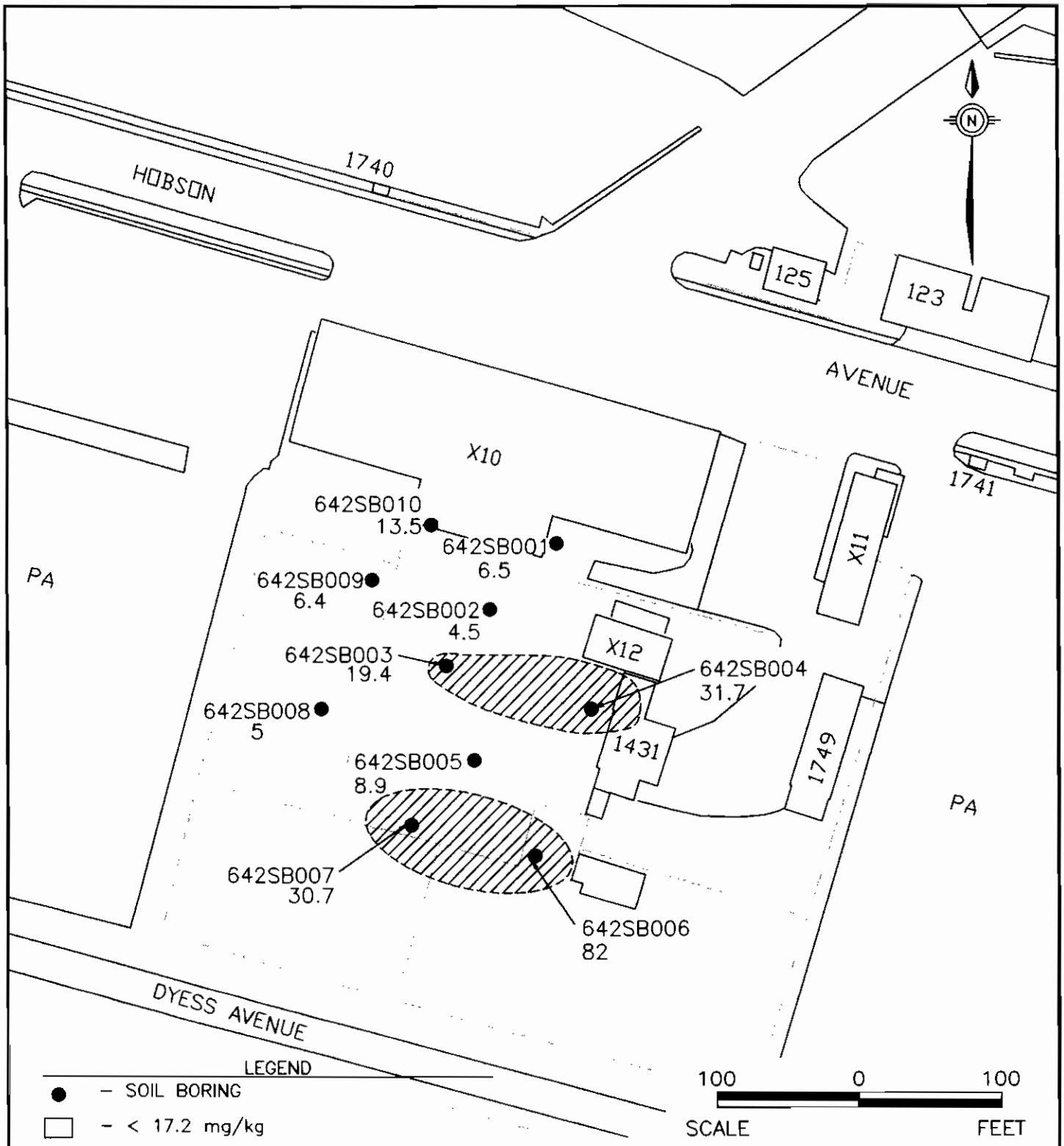
10.5.4 Fate and Transport Assessment

Environmental media sampled as part of the AOC 642 investigation include surface soil and subsurface soil. Potential constituent migration pathways investigated for AOC 642 include soil-to-groundwater and emission of volatiles from surface soil to air.

10.5.4.1 Soil-to-Groundwater Cross-Media Transport

Table 10.5.5 compares maximum detected organic constituent concentrations in surface soil and subsurface soil samples to risk-based SSLs considered protective of groundwater. For inorganics, maximum concentrations in soil are compared to the greater of (a) risk-based SSLs, or (b) background concentrations. To provide a conservative screen, generic SSLs are used; leachate entering the aquifer is assumed to be diluted by a ratio of 20:1, with no attenuation of constituents in soil (DAF=20).

For this AOC, nine of 10 soil sampling locations were characterized by a high water table, and, as a result, only surface soil samples were collected at these locations. No organics were detected



NOTES:

- 17.2 mg/kg = ZONE G BACKGROUND CONCENTRATION FOR ARSENIC IN SURFACE SOIL
- RESULTS IN mg/kg
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS

ZONE G
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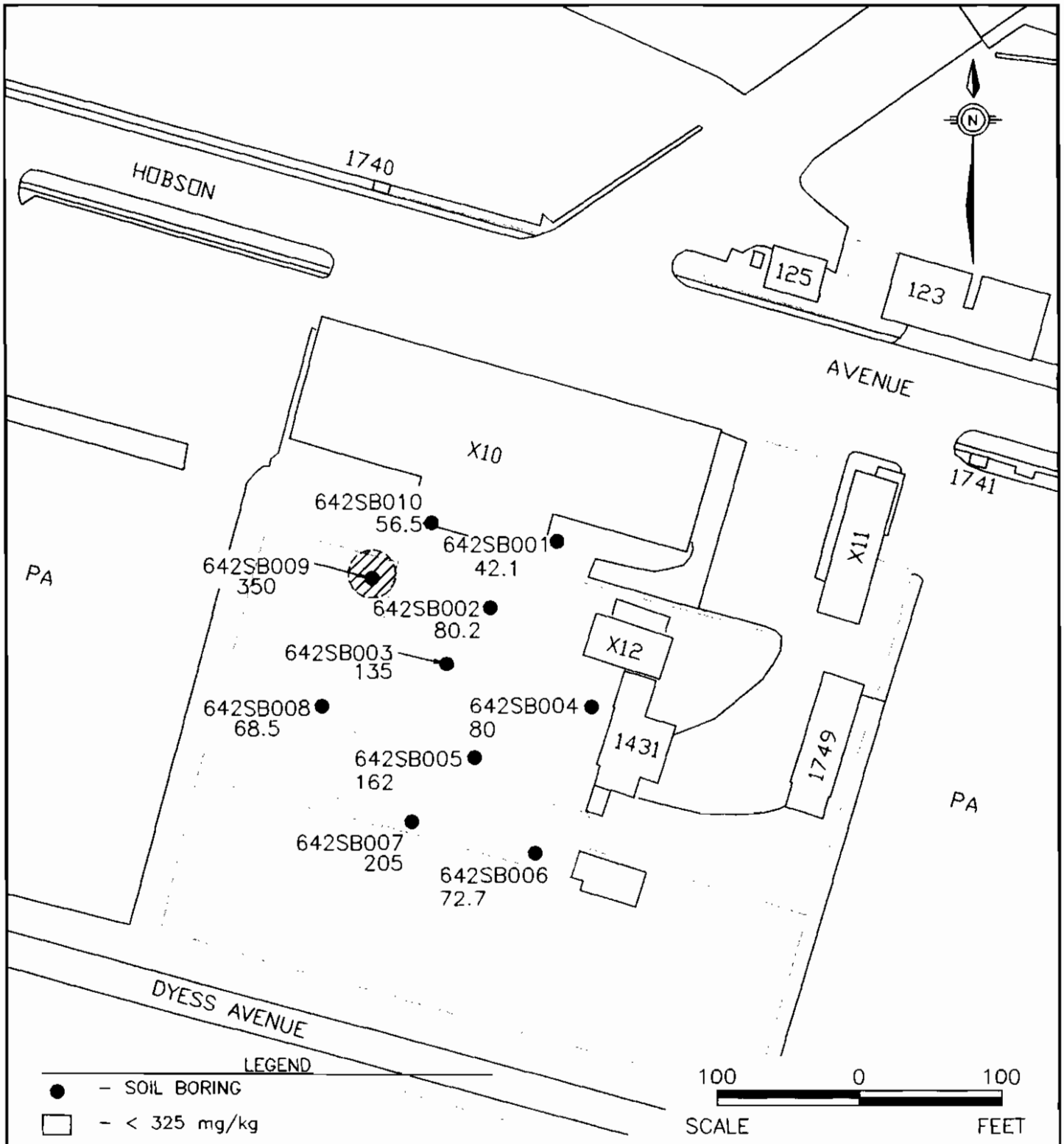
CHARLESTON, S.C.

FIGURE 10.5–2
ARSENIC IN SURFACE SOIL
AOC #642
FORMER PISTOL RANGE,
PRESENT PARKING LOT

DWG DATE: 02/03/98 | DWG NAME: 2907M009



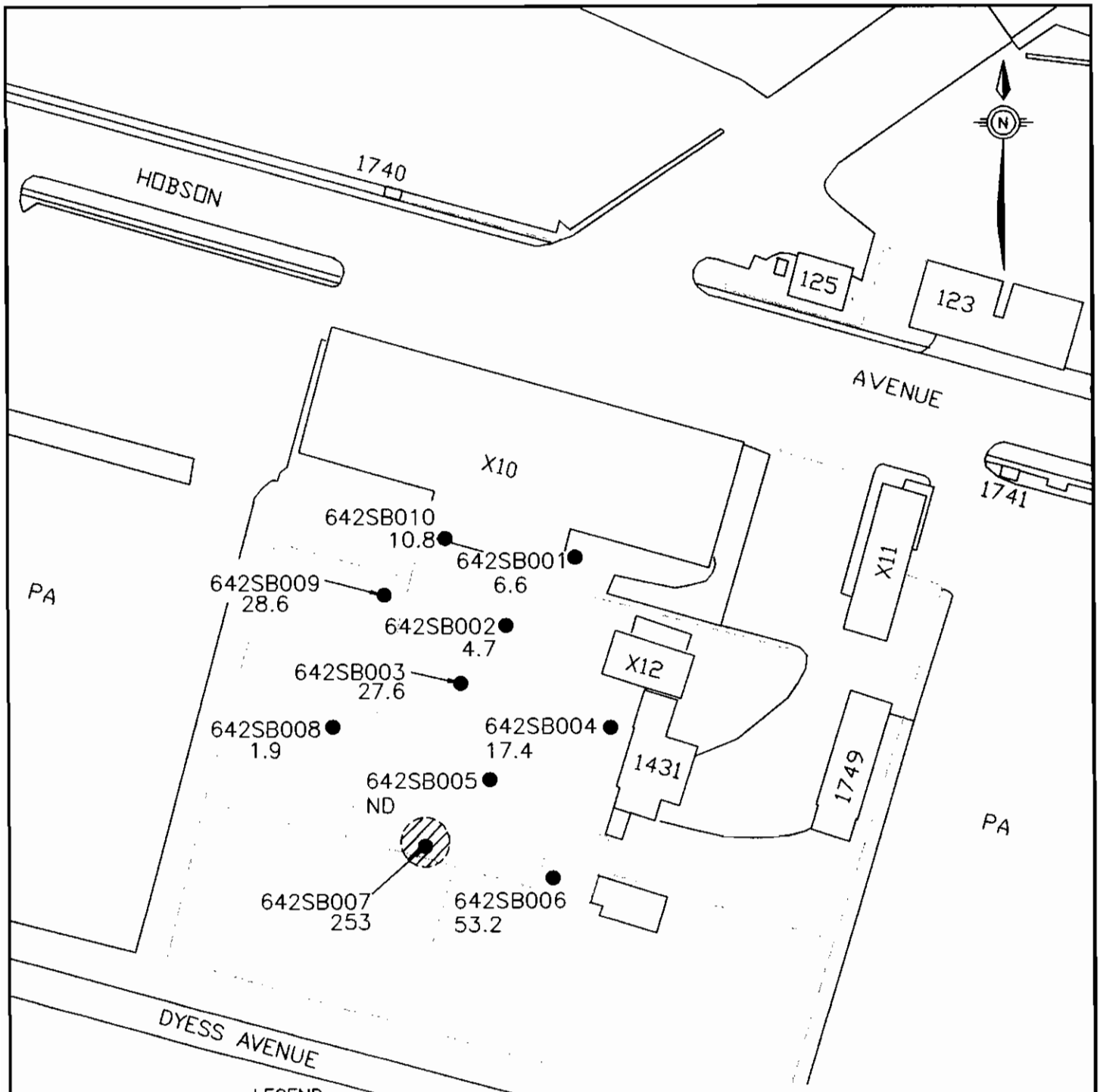
NOTES:

- 325 mg/kg = ZONE G BACKGROUND CONCENTRATION FOR MANGANESE IN SURFACE SOIL
- RESULTS IN mg/kg
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS

ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.5–3
MANGANESE IN SURFACE SOIL
AOC #642
FORMER PISTOL RANGE,
PRESENT PARKING LOT

DWG DATE: 02/01/98 | DWG NAME: 2907M010



ZONE G
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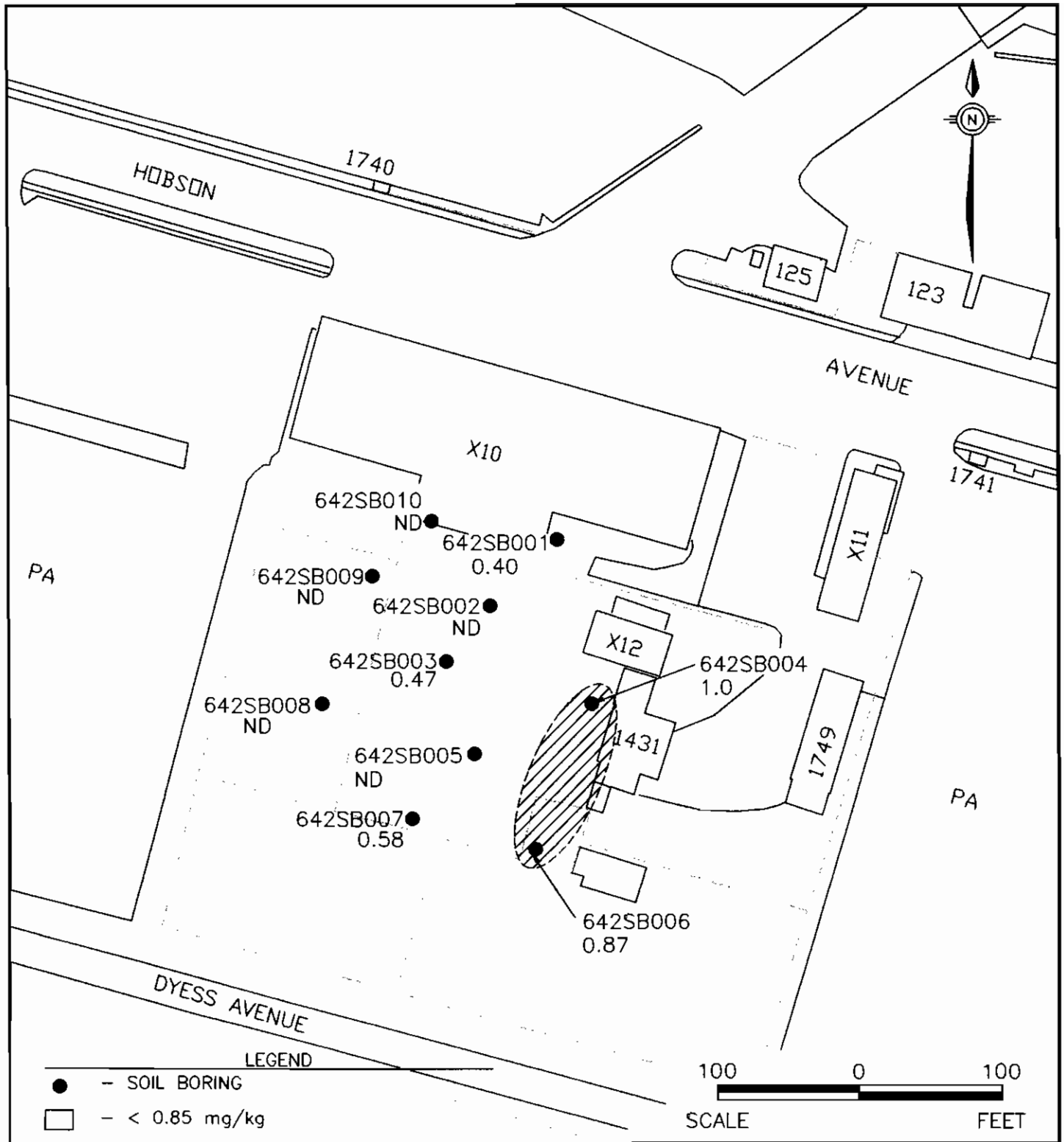
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.5–4
NICKEL IN SURFACE SOIL
AOC #642
FORMER PISTOL RANGE,
PRESENT PARKING LOT

DWG DATE: 02/03/98 | DWG NAME: 2907M011



NOTES:

- 0.85 mg/kg = ZONE G BACKGROUND CONCENTRATION FOR THALLIUM IN SURFACE SOIL
- RESULTS IN mg/kg
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- ND = NOT DETECTED

ZONE G
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NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.5–5
THALLIUM IN SURFACE SOIL
AOC #642
FORMER PISTOL RANGE,
PRESENT PARKING LOT

DWG DATE: 02/01/98 | DWG NAME: 2907M008

Table 10.5.5
Chemicals Detected in Surface Soil, Subsurface Soil, and Shallow Groundwater
Comparison to SSLs, Tap Water RBCs, Saltwater Surface Water Chronic Screening Levels, and Background Concentrations
NAVBASE Charleston, Zone G: AOC 642
Charleston, South Carolina

Parameter	Max. Concentration Surface Soil	Max. Concentration Subsurface Soil	Max. Concentration Shallow GW	Max. Concentration Deep GW	Screening Concentration * Soil to GW SSL	Screening Concentration * Tap Water RBC	Screening Concentration * Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Dioxin Compounds												
Dioxin (TCDD TEQ)	0.1749	NA	NA	NA	1900	0.45	10	NG/KG	PG/L	NO	NO	NO
Inorganic Compounds												
Aluminum	6530	3290	NA	NA	1000000	37000	NA	MG/KG	UG/L	NO	NO	NO
Arsenic	82	1.7	NA	NA	29	17.8	36	MG/KG	UG/L	YES	NO	NO
Barium	92.7	4.9	NA	NA	1600	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	1.2	0.1	NA	NA	63	0.016	NA	MG/KG	UG/L	NO	NO	NO
Cadmium	2.7	ND	NA	NA	8	18	9.3	MG/KG	UG/L	NO	NO	NO
Chromium (total)	23.5	4.8	NA	NA	1000000	180	50	MG/KG	UG/L	NO	NO	NO
Cobalt	17.4	0.38	NA	NA	2000	2200	NA	MG/KG	UG/L	NO	NO	NO
Copper	58.3	2.1	NA	NA	920	130000	8.33	MG/KG	UG/L	NO	NO	NO
Lead	70.3	3.9	NA	NA	400	15	8.5	MG/KG	UG/L	NO	NO	NO
Manganese	350	18.7	NA	NA	1100	2906	NA	MG/KG	UG/L	NO	NO	NO
Mercury	0.06	ND	NA	NA	2.1	11	0.025	MG/KG	UG/L	NO	NO	NO
Nickel	253	1.9	NA	NA	130	730	21.7	MG/KG	UG/L	YES	NO	NO
Selenium	0.8	ND	NA	NA	5	180	71	MG/KG	UG/L	NO	NO	NO
Thallium	1	ND	NA	NA	0.95	2.9	21.3	MG/KG	UG/L	YES	NO	NO
Vanadium	45.5	4	NA	NA	6000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	822	7.5	NA	NA	12000	11000	86	MG/KG	UG/L	NO	NO	NO

* Screening Concentrations:
Soil to GW - Generic SSLs based on DAF = 20, from 1996 Soil Screening Guidance or calculated using values from Table 6.4
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, October 22, 1997
Salt Water Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region IV Bulletins, Ecological Risk Assessment, November, 1995; Table 2
For inorganics, the value shown is the greater of the relevant screening value or the corresponding background value.

NA - Not available/Not applicable
ND - Not detected
RBC - Risk based concentration
SSL - Soil screening level
MG/KG - Milligrams per kilogram
NG/KG - Nanograms per kilogram
PG/L - Picograms per liter
UG/KG - Micrograms per kilogram
UG/L - Micrograms per liter

in the surface soil duplicate sample at concentrations above their SSLs. Three inorganics - arsenic, nickel, and thallium, were detected in surface soil above screening levels. While arsenic was present in all samples collected, screening exceedances were noted only at locations 642SB004, 642SB006, and 642SB007. Notably, the concentrations at 642SB004 and 642SB007 were only slightly above the SSL, while at 642SB006 it was significantly higher. Nickel was detected in all but one sample, but exceeded screening only at location 642SB007. Thallium was detected in five of the surface soil samples, but only slightly exceeded screening at location 642SB004. The presence of these exceedances in site soil is not consistent with a causality from past site activities, namely the process of discharging firearms. The most common metal to be expected from such activities is lead, which was present in all samples but did not exceed appropriate screening. The consistent presence of arsenic, nickel, and thallium in soil samples, and the inconsistent nature of exceedances of these same metals, argues that they are more likely indicative of ambient conditions and do not represent significant residual mass that poses a threat to groundwater. The fact that these metals do occur at this AOC above screening levels for soil-to-groundwater implies that the pathway does have some merit, but the rationale for additional fate and transport should be tempered by the lack of source attribution and inconsistent exceedances. Additionally, the pathway in essence becomes invalid when the physical condition of the site (100% paved, which prevents infiltration and thus leaching potential) is considered. Additionally, even if these parameters were present above effects levels in groundwater, the ingestion pathway is invalid due to non-use of the resource. Groundwater-to-surface water migration is of no significant concern at this AOC, as the distance to the nearest potential receptor (Cooper River) is approximately 500 feet away.

10.5.4.2 Soil-to-Air Cross-Media Transport

No VOCs were detected in AOC 642 surface soil. Consequently, the soil-to-air migration pathway is invalid at this site.

10.5.4.3 Fate and Transport Summary

Parameters exceeding applicable SSLs in soil at this AOC were limited to three inorganics — arsenic, nickel, and thallium. While defections of these inorganics were common in site soil, exceedances for arsenic were present in only three samples and nickel and thallium were present in only one each. The nature of the parameter exceedances is inconsistent with past site activities, thus shedding some doubt on provenance. The widespread occurrence of these metals in soil, and the inconsistent occurrence of exceedances, suggests that their occurrence is reflective of ambient conditions. When based entirely on SSL exceedances the soil-to-groundwater pathway appears to have some merit; however, the pavement covering the site essentially invalidates the pathway by limiting infiltration. The soil-to-air pathway is not considered valid at this AOC given that no VOCs were detected in site soil.

10.5.5 Human Health Risk Assessment

10.5.5.1 Site Background and Investigative Approach

AOC 642 is the former pistol range located south of Building X-10 and west of Buildings X-12 and 1431. The site is currently an asphalt paved parking area and is surrounded by a perimeter fence. Materials released at the site include spent lead bullets.

During the CSI, a total of ten soil borings were advanced to identify potential impacts resulting from the activities listed above. Surface soil samples from all ten boring locations were used to quantitatively assess the direct contact soil exposure pathways. Subsurface soil detections were addressed in the previous section, Fate and Transport Assessment. Section 10.5.3 provides a summary of the sampling effort for AOC 642 soil.

10.5.5.2 COPC Identification

Based on the screening comparisons described in Section 7 of this RFI and presented in Table 10.5.6, COPCs identified in surface soil include arsenic, beryllium, manganese, nickel, and thallium. Although the release resulting from spent lead bullets were the focus of this investigation, lead was not identified as a COPC. No inorganic parameters were eliminated from consideration in the risk assessment solely on the basis of background concentration.

10.5.5.3 Exposure Assessment

Exposure Setting

AOC 642 is located in an industrial setting on the formal naval base and is covered by an asphalt parking lot, with buildings to the north, and east. The paved surface would prevent direct contact with soil and would inhibit migration of potential contaminants to groundwater or air. The site is surrounded by a fence which inhibits access to potential trespassers. All potable water is provided through the city's water supply. Groundwater is not currently nor anticipated to be used in the future as potable or process water.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers, future site residents, and adolescent trespassers. Future site resident and worker exposure scenarios were addressed quantitatively in this risk assessment. Current exposure to workers is discussed qualitatively in relation to the future workers. The hypothetical future site worker scenario assumed continuous exposure to surface soil conditions. Current site workers' exposure would be less than that assumed for the hypothetical future site worker scenario because of their limited soil contact (much of the area is paved). Therefore, future worker assessment is considered to be conservatively representative of current site users. Since the site is currently surrounded by fencing, adolescent trespassers are not currently a potentially exposed population. In the event that the fence were to be removed, the child resident scenario is considered to be conservatively

Table 10.5.6
Chemicals Present in Site Samples
AOC 642 - Surface Soil
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentrations RBC	Screening Concentrations Background	Units	Number Exceeding RBC	Number Exceeding Bkgd
TCDD Equivalents													
Dioxin Equiv.		1	1	0.1749	0.1749	0.17	NA	NA	1000	NA	NG/KG		
1234678-HpCDD		1	1	7.19	7.19	7.2	NA	NA	NA	NA	NG/KG		
OCDD		1	1	103	103	103	NA	NA	NA	NA	NG/KG		
Inorganics													
Aluminum (Al)		10	10	1110	6530	2422	NA	NA	7800	18700	MG/KG		
Arsenic (As)	*	10	10	4.5	82	20.9	NA	NA	0.43	17.2	MG/KG	10	4
Barium (Ba)		10	10	5.8	92.7	43.3	NA	NA	550	109	MG/KG		
Beryllium (Be)	*	10	10	0.24	1.2	0.51	NA	NA	0.15	1.2	MG/KG	10	1
Cadmium (Cd)		9	10	0.21	2.7	1.1	0.05	0.05	3.9	1.07	MG/KG		4
Calcium (Ca)	N	10	10	4980	312000	76679	NA	NA	NA	NA	MG/KG		
Chromium (Cr)		10	10	5.3	23.5	11.2	NA	NA	39	42.8	MG/KG		
Cobalt (Co)		10	10	1.1	17.4	5.7	NA	NA	470	6.6	MG/KG		3
Copper (Cu)		9	10	5.9	58.3	29.6	1.1	1.1	27000	280	MG/KG		
Iron (Fe)	N	10	10	3080	13400	8281	NA	NA	NA	NA	MG/KG		
Lead (Pb)		10	10	2.8	70.3	35.3	NA	NA	400	181	MG/KG		
Magnesium (Mg)	N	10	10	838	33900	5104	NA	NA	NA	NA	MG/KG		
Manganese (Mn)	*	10	10	42.05	350	125	NA	NA	180	325	MG/KG	2	1
Mercury (Hg)		5	10	0.04	0.06	0.048	0.04	0.04	2.3	1.03	MG/KG		
Nickel (Ni)	*	9	10	1.9	253	44.8	16.8	16.8	160	20.6	MG/KG	1	4
Potassium (K)	N	5	10	266	596	421	236	288	NA	NA	MG/KG		
Selenium (Se)		6	10	0.46	0.8	0.70	0.35	0.4	39	1.22	MG/KG		
Sodium (Na)	N	2	10	357	1550	954	216	376	NA	NA	MG/KG		
Thallium (Tl)	*	5	10	0.4	1	0.66	0.4	0.45	0.63	0.85	MG/KG	2	2
Vanadium (V)		10	10	5.4	45.5	20.4	NA	NA	55	60.9	MG/KG		
Zinc (Zn)		10	10	10.3	822	186	NA	NA	2300	519	MG/KG		1

Notes:
* - Identified as a COPC
N - Essential nutrient
SQL - Sample quatitation limit
MG/KG - milligrams per kilogram
NG/KG - nanograms per kilogram
NA - Not applicable

representative of the adolescent trespasser. The future site resident scenario was built on the premise that existing fixtures would be removed and replaced with dwellings.

Exposure Pathways

Exposure pathways for the hypothetical future site residents are dermal contact and incidental ingestion of surface soils. The exposure pathways used for current and future site workers are the same as those for the future site resident with respect to soil. Uniform exposure was assumed for all sample locations. Table 10.5.7 presents the justification for exposure pathways assessed in this HHRA.

Exposure Point Concentrations

Section 7 of this RFI discusses the determination of exposure point concentrations. As presented on Table 10.5.8, the exposure point concentrations for soil COPCs were set equal to the 95% UCL.

Quantification of Exposure

Chronic daily intakes (CDIs) for ingestion and dermal surface soils pathways are shown on Tables 10.5.9 and 10.5.10, respectively.

10.5.5.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 7 of this report. Table 10.5.11 presents toxicological information specific to COPCs identified at AOC 642. This information was used in the quantification of risk/hazard associated with surface soil contaminants. Brief toxicological profiles for COPCs are provided below:

Arsenic exposure via the ingestion route darkens and hardens the skin in chronically exposed humans. Inhalation exposure to arsenic causes neurological deficits, anemia, and cardiovascular

Table 10.5.7
Zone G
AOC 642
Exposure Pathways Summary

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Site Workers/ Maintenance	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	Little surface soil is exposed at AOC 642, inhibiting fugitive dust generation. Therefore, this exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 642.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at AOC 642.
	Soil, Incidental ingestion	No (Qualified)	Future land use assessment is considered to be conservatively representative of current receptors.
	Soil, Dermal contact	No (Qualified)	Future land use assessment is considered to be currently representative of current receptors.
Future Land Uses			
Future Site Residents (Child and Adult) and Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Groundwater, Ingestion of contaminants during potable or general use	No	Fate and transport did not identify any COPCs for this indirect exposure pathway.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Soil, Incidental ingestion	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Soil, Dermal contact	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.

Table 10.5.7
Zone G
AOC 642
Exposure Pathways Summary

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Table 10.5.8
Summary of Statistical Analysis
Surface Soil COPCs; AOCs 642
Naval Base Charleston, Zone G
Charleston, South Carolina

COPC	Natural Log Transformed n	mean	SD	H-stat	UCL (mg/kg)	MAX (mg/kg)	EPC (mg/kg)
Inorganics							
Arsenic (As)	10	2.588	0.957	3.017	55.0	82	55.0 UCL
Beryllium (Be)	10	-0.795	0.481	2.195	0.72	1.2	0.72 UCL
Manganese (Mn)	10	4.623	0.652	2.453	215	350	215 UCL
Nickel (Ni)	10	2.761	1.378	3.930	249	253	249 UCL
Thallium (Tl)	10	-1.016	0.632	2.240	0.74	1	0.74 UCL

NOTES:

mean	Arithmetic mean of the logtransformed data
n	Number of samples analyzed
SD	Standard deviation for a sample of data
H-stat	H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with USEPA Supplemental Guidance to RAGS, Calculating the Concentration Term
NA	Not applicable
EPC	Exposure point concentration
UCL	95 percentile upper confidence level mean
MAX	Maximum reported concentration

Table 10.5.9
Chronic Daily Intakes
Incidental Ingestion of Surface Soil
AOC 642
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Chemical	Fraction Ingested from Contaminated Source *	Exposure Point Concentration (mg/kg)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Site Worker adult H-CDI (mg/kg-day)	Future Site Worker adult C-CDI (mg/kg-day)
Inorganics							
Arsenic (As)	1	55.0	7.54E-05	7.04E-04	8.62E-05	2.69E-05	9.62E-06
Beryllium (Be)	1	0.72	9.87E-07	9.22E-06	1.13E-06	3.53E-07	1.26E-07
Manganese (Mn)	1	215	2.94E-04	2.74E-03	3.36E-04	1.05E-04	3.75E-05
Nickel (Ni)	1	249	3.40E-04	3.18E-03	3.89E-04	1.22E-04	4.34E-05
Thallium (Tl)	1	0.74	1.01E-06	9.41E-06	1.15E-06	3.60E-07	1.29E-07

NOTES:

lwa Lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B

CDI Chronic Daily Intake in mg/kg-day

H-CDI CDI for hazard quotient

C-CDI CDI for excess cancer risk

* Reflects the estimated fraction of the site impacted by the corresponding COPC.

Table 10.5.10
Chronic Daily Intakes
Dermal Contact with Surface Soil
AOC 642
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Chemical	Exposure Point Concentration (mg/kg)	Fraction Contacted from Contaminated Source *	Dermal Absorption Factor (unitless)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Site Worker adult H-CDI (mg/kg-day)	Future Site Worker adult C-CDI (mg/kg-day)
Inorganics								
Arsenic (As)	55.0	1	0.001	3.09E-06	1.02E-05	1.93E-06	2.21E-06	7.89E-07
Beryllium (Be)	0.72	1	0.001	4.05E-08	1.34E-07	2.53E-08	2.89E-08	1.03E-08
Manganese (Mn)	215	1	0.001	1.21E-05	3.98E-05	7.54E-06	8.61E-06	3.07E-06
Nickel (Ni)	249	1	0.001	1.40E-05	4.61E-05	8.74E-06	9.97E-06	3.56E-06
Thallium (Tl)	0.74	1	0.001	4.13E-08	1.36E-07	2.59E-08	2.95E-08	1.05E-08

NOTES:

CDI Chronic Daily Intake in mg/kg-day

H-CDI CDI for hazard quotient

C-CDI CDI for excess cancer risk

\- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals

* Reflects the estimated fraction of the site impacted by the corresponding COPC.

Table 10.5.11
Toxicological Reference Information
for Chemicals of Potential Concern
AOC 642
Naval Base, Charleston, Zone G
Charleston, South Carolina

	Non-Carcinogenic Toxicity Data										*Carcinogenic Toxicity Data*				
Chemical	Oral Reference Dose (mg/kg-day)		Confidence Level	Critical Effect	Uncertainty Factor Oral	Inhalation Reference Dose (mg/kg-day)		Confidence Level	Critical Effect	Uncertainty Factor Inhalation	Oral Slope Factor (kg-day/mg)		Inhalation Slope Factor (kg-day/mg)		Weight of Evidence
Arsenic	0.0003	a	M	hyperpigmentation	3	NA		NA	NA	NA	1.5	a	15.1	a	A
Beryllium	0.005	a	L	microscopic organ changes	100	NA		NA	NA	NA	4.3	a	8.4	a	B2
Manganese	0.047	a	NA	neurological effects	1	0.0000143	a	M	neurological effects	1000	NA		NA		D
Nickel	0.02	a	M	decreased body and organ weight	300	NA		NA	NA	NA	NA		NA		D
Thallium	8E-05	a	L	increased SGOT (liver) increased serum LDH	3000	NA		NA	NA	NA	NA		NA		D

Notes:

a = Integrated Risk Information System (IRIS)
b = Health Effects Assessment Summary Tables (HEAST)
c = HEAST alternative method
NA = Not applicable or not available
H = High confidence
L = Low confidence
M = Medium confidence

effects (Klaassen et al., 1986). USEPA set 0.3 μg/kg-day as the RfD for arsenic based on a no observed adverse effects level (NOAEL) of 0.8 μg/kg-day in a human exposure study. Arsenic's effects on the nervous and cardiovascular systems are primarily associated with acute exposure to higher concentrations. Exposure to arsenic-containing materials has been shown to cause cancer in humans. Inhaling these materials can lead to increased lung cancer risk, and ingestion is associated with increased skin cancer rates. Arsenic has been classified as a group A carcinogen by USEPA, which set the 1.5 $(mg/kg\text{-}day)^{-1}$ SF for arsenic. As listed in IRIS, the classification is based on sufficient evidence from human data. An increased lung cancer mortality was observed in multiple human populations exposed primarily through inhalation. Also, increased mortality from multiple internal organ cancers (liver, kidney, lung, and bladder) and an increased incidence of skin cancer were observed in populations consuming drinking water high in inorganic arsenic. Human milk contains about 3 μg/L arsenic. The RBC for arsenic in tap water is 0.045 μg/L. As listed in IRIS, the critical effect of this chemical is hyperpigmentation, keratosis, and possible vascular complications. The uncertainty factor was 3 and the modifying factor was 1.

Beryllium exposure via the inhalation route can inflame the lungs, a condition known as acute beryllium disease, as a result of short-term exposure to high concentrations. Removal from exposure reverses the symptoms. Chronic exposure to much lower concentrations of beryllium or beryllium oxide by inhalation has been reported to cause chronic beryllium disease, with symptoms including shortness of breath, scarring of the lungs, and berylliosis, which is noncancerous growths in the lungs of humans. Both forms of beryllium disease can be fatal, depending on the severity of the exposure. Additionally, a skin allergy may develop when soluble beryllium compounds come into contact with the skin of sensitized individuals (Gradient, 1991). An oral RfD of 0.0054 mg/kg-day has been set for beryllium based on a chronic oral bioassay (rats were the study species) which determined an NOAEL of 0.54 mg/kg-day. Beryllium has been classified by USEPA as a group B2 carcinogen based on animal studies. Human epidemiology

studies of beryllium are inadequate. As listed in IRIS, classification is based on beryllium being shown to induce lung cancer via inhalation in rats and monkeys and to induce osteosarcomas in rabbits via intravenous or intramedullary injection. An inhalation SF of 8.4 $(mg/kg\text{-}day)^{-1}$ and an oral SF of 4.3 $(mg/kg\text{-}day)^{-1}$ have been set by USEPA. As listed in IRIS, the critical effect of this chemical is no adverse effect. The uncertainty factor was 100 and the modifying factor was 1. The IRIS RfD in drinking water is 0.005 mg/kg-day.

Manganese is an essential nutrient, but chronic exposure (0.8 mg/kg-day) causes mental disturbances. Studies have shown that manganese uptake from water is greater than manganese uptake from food, and the elderly appear to be more sensitive than children (Klaassen et al., 1986; Dreisbach et al., 1987). USEPA determined the RfD to be 0.14 mg/kg-day based on dietary uptake. USEPA recommended using a modifying factor of 3 when estimating intake from soil and water. In addition, the body is roughly twice as efficient absorbing manganese in water compared to manganese in food. Because of the different uptake rates in water and food, two RfDs were used in this HHRA — one for water and one for food. The RfDs used are 0.047 and 0.023 mg/kg-day. Inhalation of manganese dust causes neurological effects and increased incidence of pneumonia. An inhalation RfD was set to 0.0000143 mg/kg-day. According to USEPA, manganese cannot be classified as to its carcinogenicity. Therefore, the cancer class for manganese is group D. As listed in IRIS, the classification is based on studies that are inadequate to assess the carcinogenicity of manganese. Manganese is an element considered essential to human health. The typical vitamin supplement dose of manganese is 2.5 mg/day. As listed in IRIS, the critical effects of this chemical in water in the oral summary are CNS effects. The uncertainty factor was 1 and the recommended modifying factor of 3 was used to estimate soil and groundwater intake. The critical effects of this chemical are CNS effects. As listed in IRIS, the critical effect of this chemical in the inhalation summary is impairment of neuro-behavioral function. For inhalation uptake, the uncertainty factor was 1,000 and the modifying factor was 1. The IRIS RfC is 0.00005 mg/m^3.

Nickel is also an essential nutrient; a five microgram dose is typical of supplemental vitamins. USEPA set the oral RfD to 0.02 mg/kg-day. Chronic exposure of rats to nickel caused decreased body and organ weights. For a chronically exposed individual, nickel salts would affect the gastro-intestinal system, and would also target the liver and kidney. This element has been shown to be a sensitizer, an element that can produce allergic reactions. Sensitization of skin to nickel dust has been shown to occur in industry (Dreisbach, et al., 1987).

Thallium is readily absorbed through the gut and skin. Primary effects are stomach and bowel disturbances, kidney and liver damage, and neurological disturbances. Thallium was used in the past as a rodenticide and ant killer, and its use for these purposes is now prohibited. This element remains in the body for a relatively long time, and could accumulate if the chronic dose is large. USEPA's oral RfD for thallium is 0.00008 mg/kg-day (Klaassen, et al., 1986) (Dreisbach, et al., 1987). The uncertainty factor used for thallium is 3000.

10.5.5.5 Risk Characterization

Surface Soil Pathways

Exposure to surface soil onsite was evaluated under both residential and site worker scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. Hazard was computed separately to address child and adult exposure. Tables 10.5.12 and 10.5.13 present the computed risk/hazard associated with the incidental ingestion of and dermal contact with site surface soils, respectively.

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime weighted average) for AOC 642 surface soils is 1E-04. The dermal pathway ILCR is 2E-05. Arsenic was the primary contributor to ILCR projections for the ingestion and dermal pathways. Beryllium was a secondary contributor to the ingestion pathway. Though the adolescent trespasser was not quantitatively addressed for

Table 10.5.12
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC 642
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident lwa ILCR	Future Site Worker adult Hazard Quotient	Future Site Worker adult ILCR
Inorganics							
Arsenic (As)	0.0003	1.5	0.25	2.3	1.3E-04	0.090	1.4E-05
Beryllium (Be)	0.005	4.3	0.00020	0.0018	4.9E-06	0.000071	5.4E-07
Manganese (Mn)	0.047	NA	0.0063	0.058	ND	0.0022	ND
Nickel (Ni)	0.02	NA	0.017	0.16	ND	0.0061	ND
Thallium (Tl)	8E-05	NA	0.013	0.12	ND	0.0045	ND
SUM Hazard Index/ILCR			0.3	3	1E-04	0.1	1E-05

NOTES:
NA Not available
ND Not Determined due to lack of available information
lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime Cancer Risk

Table 10.5.13
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC 642
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident lwa ILCR	Future Site Worker adult Hazard Quotient	Future Site Worker adult ILCR
Inorganics								
Arsenic (As)	0.2	6E-05	7.5	0.052	0.17	1.5E-05	0.037	5.9E-06
Beryllium (Be)	0.2	0.001	21.5	0.000040	0.00013	5.4E-07	0.000029	2.2E-07
Manganese (Mn)	0.2	0.0094	NA	0.0013	0.0042	ND	0.00092	ND
Nickel (Ni)	0.2	0.004	NA	0.0035	0.012	ND	0.0025	ND
Thallium (Tl)	0.2	1.6E-05	NA	0.0026	0.0085	ND	0.0018	ND
SUM Hazard Index/ILCR				0.06	0.2	2E-05	0.04	6E-06

NOTES:

NA Not available

ND Not Determined due to lack of available information

lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A

ILCR Incremental Lifetime Cancer Risk

- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

this site, the following semiquantitative analysis was performed using the results of the residential risk analysis. Exposure frequency and duration under the residential scenario are 350 days/year and 30 years, respectively, compared to 52 day/year and 7 years for the adolescent trespasser. Substituting the trespasser exposure frequency and duration into the CDI equation would result in a risk estimate approximately 98% below the residential risk estimate. Assuming that the fencing and pavement are removed from the site, the cumulative soil pathway (both ingestion and dermal) risk for the adolescent trespasser was estimated to be approximately 3E-06.

The computed hazard indices for the adult resident were 0.3 for the soil ingestion pathway and 0.06 for the dermal contact pathway. The computed hazard indices for the child ingestion and dermal contact pathways were 3 and 0.2, respectively. Arsenic was the primary contributor to HI projections for the ingestion and dermal pathways. Nickel and thallium were secondary contributors to the ingestion pathway. The semiquantitative analysis for adolescent trespasser hazard index is similar to the risk estimate detailed the paragraph above. Exposure frequency and duration for the child resident are 350 days/year and 6 years, respectively, compared to 52 days/year and 7 years for the trespasser. Substituting the trespasser exposure frequency and duration into the CDI equation would result in a hazard estimate approximately 83% below the residential hazard estimate. Assuming that the fencing and pavement are removed from the site, the cumulative soil pathway (both ingestion and dermal) hazard for the adolescent trespasser was estimated to be approximately 0.5.

Hypothetical Site Workers

Site worker ILCRs are 1E-05 for the ingestion pathway and 6E-06 for the dermal contact pathway. Arsenic was the primary contributor to ILCR projections. Hazard indices for the ingestion and dermal pathways were projected to be 0.1 and 0.04 for the hypothetical site worker scenario, respectively.

COCs Identified

Chemicals of concern were identified based on cumulative (all pathway) risk and hazard projected for this site on a medium-specific basis. USEPA has established a generally acceptable risk range of 1E-4 to 1E-6, and a hazard index threshold of 1.0 (unity). As recommended by SCDHEC, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-6 or greater and/or a cumulative hazard index above 1.0, and whose individual ILCR exceeds 1E-6 or whose hazard quotient exceeds 0.1. For carcinogens, this approach is relatively conservative, because a cumulative risk level of 1E-4 (and individual ILCR of 1E-6) is recommended by USEPA Region IV as the trigger for establishing COCs. The COC selection method presented was used in order to provide a more comprehensive evaluation of chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the remedial goal options development process. Table 10.5.14 presents the COCs identified for AOC 642 surface soil.

Future Site Residents

Arsenic and beryllium were identified as soil pathway COCs based on their contribution to cumulative residential ILCR projections. Arsenic, nickel, and thallium were identified as soil pathway COCs based on their contribution to cumulative residential HI projections.

Future Site Workers

Arsenic was identified as soil pathway COCs based on its contribution to cumulative industrial ILCR projections.

The extent of the COCs identified in surface soil is briefly discussed below. To facilitate this discussion, residential soil RBCs and background concentrations were compared to each reported COC concentration. Arsenic was detected at concentrations exceeding its RBC (0.43 mg/kg) in all ten surface soil samples; arsenic exceeded its background value (17.2 mg/kg) in four surface soil samples. Beryllium was detected at a concentration exceeding its RBC (0.15 mg/kg) in all

Table 10.5.14
Summary of Risk and Hazard-based COCs
AOC 642
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Medium	Exposure Pathway		Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident Iwa ILCR	Future Site Worker Hazard Quotient	Future Site Worker ILCR	Identification of COCs
Surface Soil	Incidental Ingestion	**Inorganics**						
		Arsenic (As)	0.25	2.3	1.3E-04	0.090	1.4E-05	1 2 4
		Beryllium (Be)	0.00020	0.0018	4.9E-06	0.000071	5.4E-07	2
		Manganese (Mn)	0.0063	0.058	ND	0.0022	ND	
		Nickel (Ni)	0.017	0.16	ND	0.0061	ND	1
		Thallium (Tl)	0.013	0.12	ND	0.0045	ND	1
	Dermal Contact	**Inorganics**						
		Arsenic (As)	0.052	0.17	1.5E-05	0.037	5.9E-06	1 2 4
		Beryllium (Be)	0.000040	0.00013	5.4E-07	0.000029	2.2E-07	
		Manganese (Mn)	0.0013	0.0042	ND	0.00092	ND	
		Nickel (Ni)	0.0035	0.012	ND	0.0025	ND	
		Thallium (Tl)	0.0026	0.0085	ND	0.0018	ND	
Surface Soil Pathway Sum			0.3	2.9	1E-04	0.14	2E-05	

Notes:
ND Indicates not determined due to the lack of available risk information.
NA Not applicable
ILCR Indicates incremental excess lifetime cancer risk
HI Indicates hazard index
1- Chemical is a COC by virtue of projected child residence non-carcinogenic hazard.
2- Chemical is a COC by virtue of projected future resident lifetime ILCR.
3- Chemical is a COC by virtue of projected site worker non-carcinogenic hazard.
4- Chemical is a COC by virtue of projected site worker ILCR.

ten surface soil sample and equaled its background value (1.2 mg/kg) in 1 surface soil sample (642SB006). Nickel exceeded its RBC (160 mg/kg) in one of ten surface soil samples (642SB007). Thallium exceed its both its background value (0.85 mg/kg) and its RBC (0.63 mg/kg) in 2 surface soil samples (642SB004 and 642SB006).

10.5.5.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure. Residential use of the site would not be expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued commercial/industrial use of Zone G or alternatively recreational use. If this area were to be redeveloped as a residential site or a recreational park, the surface coverings and other structures would be demolished, and the surface soil conditions would likely change — the soils could be covered with landscaping soil and/or a house. Consequently, exposure to surface soil conditions as represented by samples collected during the CSI would not be likely under a true future use scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current and future site workers and future site residents.

Determination of Exposure Point Concentrations

Exposure point concentrations for soil were set equal to the 95% UCL on the arithmetic mean for each COPC. Use of 95% UCLs represent conservative assumptions when applied as the EPC, such that it is unlikely that the UCL would be exceeded by the true mean site concentration of each COPC. The EPCs used for beryllium (0.72 mg/kg) and thallium (0.74 mg/kg) were both below their background concentrations (1.2 mg/kg for beryllium and 0.85 mg/kg for thallium).

Frequency of Detection and Spatial Distribution

Beryllium and thallium were each detected in only one or two surface soil samples at concentrations marginally exceeding their background concentrations, giving an indication that the presence of these metals is related to ambient conditions. Nickel was detected in only one surface soil sample at a concentration exceeding its RBC, however its mean concentration (44.8 mg/kg) is well below its RBC (160 mg/kg). Conversely, arsenic was detected in all ten samples at concentrations exceeding its RBC and in four of ten samples at concentrations exceeding its background concentration. The mean arsenic concentration for surface soil is 20.9 mg/kg which exceeds its background concentration of 17.2 mg/kg.

Quantification of Risk/Hazard

As indicated by the discussions above, the uncertainty inherent in the risk assessment process is great. In addition, many site-specific factors have affected the uncertainty of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

A conservative screening process was used to identify COPCs for AOC 642. The potential for eliminating CPSSs with the potential for cumulative HI greater than one was addressed for noncarcinogens through the use of RBCs that were reduced one order of magnitude. For carcinogens, the RBCs are based on a conservative target risk of 1E-06. Use of conservative RBCs in combination with the use of maximum detected concentrations minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment, none was reported at a concentration close to its RBC (e.g. within 10% of its RBC). No inorganic parameters were eliminated solely on comparison to their corresponding background concentrations.

Background-related Risk

It is not unusual for naturally occurring or background concentrations of some elements to exceed risk-based concentrations. It is the risk assessment's function to identify excess risk and/or hazard, or that which is above background levels. The following is a discussion of the residential scenario risk/hazard associated with background concentrations of AOC 642 COCs.

Residential risks associated with the background concentration of arsenic and beryllium for the surface soil pathway are approximately 4E-05 and 9E-06, respectively, with a cumulative risk of 5E-05. Resident child hazard indices associated with background concentrations of arsenic, beryllium, nickel, and thallium are approximately 0.8, 0.003, 0.014, and 0.1, respectively, with a cumulative hazard index of 0.9. The cumulative residential risk and resident child hazard index calculated in the HHRA were 1E-04 and 3, respectively.

10.5.5.7 Risk Summary

The risk and hazard posed by contaminants at AOC 642 were assessed for the site worker and the future site resident under reasonable maximum exposure assumptions. In surface soils, the incidental ingestion and dermal contact pathways were assessed in this HHRA. Table 10.5.15 presents the risk summary for each soil pathway/receptor group evaluated for AOC 642.

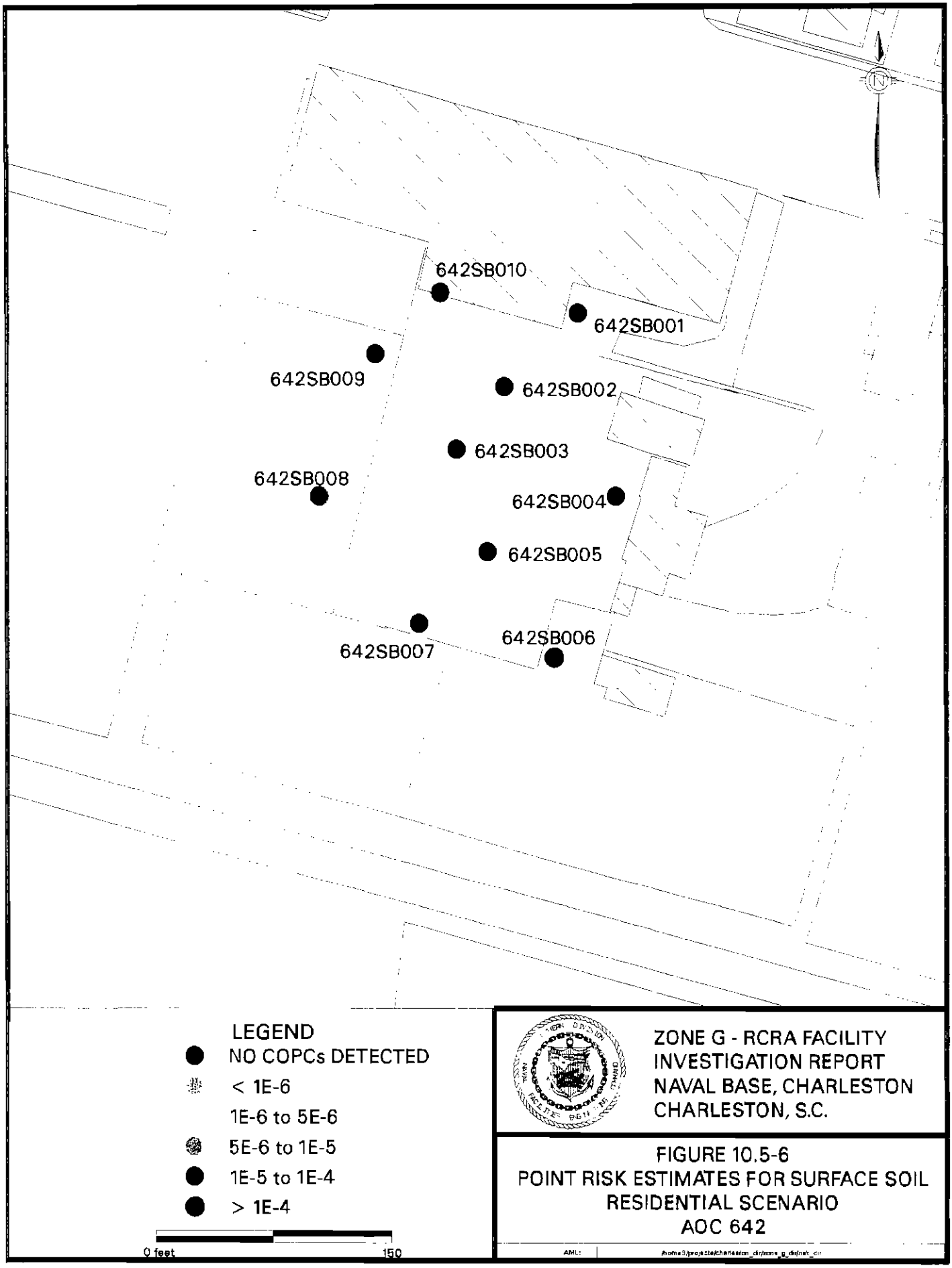
Soil — Residential Scenario

Residential soil pathway COCs identified for AOC 642 are arsenic, beryllium, nickel, and thallium. Figure 10.5-6 illustrates point risk estimates for AOC 642 based on surface soil exposure pathways under a future residential scenario. Table 10.5.16 summarizes the risk and hazard contribution of each COPC at each sample location. This point risk map is based on the

Table 10.5.15
Summary of Risk and Hazard
AOC 642
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	0.3	3	1E-04	0.1	1E-05
	Dermal Contact	0.06	0.2	2E-05	0.04	6E-06
Sum of All Pathways		0.3	3	1E-04	0.1	2E-05

Notes:
ND Indicates not determined due to the lack of available risk information.
ILCR Indicates incremental lifetime cancer risk
HI Indicates hazard index



ZONE G - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 10.5-6
POINT RISK ESTIMATES FOR SURFACE SOIL
RESIDENTIAL SCENARIO
AOC 642

Table 10.5.16
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOC 642
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
642	001	Arsenic (As)	6.5	MG/KG	0.2971	75.03	16.9760	89.36
642	001	Beryllium (Be)	0.27	MG/KG	0.0007	0.19	2.0217	10.64
642	001	Manganese (Mn)	42.05	MG/KG	0.0251	6.33	NA	
642	001	Nickel (Ni)	6.6	MG/KG	0.0045	1.14	NA	
642	001	Thallium (Tl)	0.4	MG/KG	0.0686	17.31	NA	
		Total			0.3960		18.9997	
642	002	Arsenic (As)	4.5	MG/KG	0.2057	79.91	11.7540	86.74
642	002	Beryllium (Be)	0.24	MG/KG	0.0007	0.26	1.7971	13.26
642	002	Manganese (Mn)	80.2	MG/KG	0.0478	18.58	NA	
642	002	Nickel (Ni)	4.7	MG/KG	0.0032	1.25	NA	
642	002	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.2574		13.5511	
642	003	Arsenic (As)	19.4	MG/KG	0.8867	82.97	50.6728	90.02
642	003	Beryllium (Be)	0.75	MG/KG	0.0021	0.19	5.6158	9.98
642	003	Manganese (Mn)	135	MG/KG	0.0805	7.53	NA	
642	003	Nickel (Ni)	27.6	MG/KG	0.0189	1.77	NA	
642	003	Thallium (Tl)	0.47	MG/KG	0.0806	7.54	NA	
		Total			1.0688		56.2886	
642	004	Arsenic (As)	31.7	MG/KG	1.4489	86.19	82.8004	96.01
642	004	Beryllium (Be)	0.46	MG/KG	0.0013	0.08	3.4444	3.99
642	004	Manganese (Mn)	80	MG/KG	0.0477	2.84	NA	
642	004	Nickel (Ni)	17.2	MG/KG	0.0118	0.70	NA	
642	004	Thallium (Tl)	1	MG/KG	0.1714	10.20	NA	
		Total			1.6811		86.2448	
642	005	Arsenic (As)	8.9	MG/KG	0.4068	80.64	23.2468	88.59
642	005	Beryllium (Be)	0.4	MG/KG	0.0011	0.22	2.9951	11.41
642	005	Manganese (Mn)	162	MG/KG	0.0966	19.15	NA	
642	005	Nickel (Ni)	ND	MG/KG	NA		NA	
642	005	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.5045		26.2419	
642	006	Arsenic (As)	82	MG/KG	3.7480	94.17	214.1841	95.97
642	006	Beryllium (Be)	1.2	MG/KG	0.0033	0.08	8.9853	4.03
642	006	Manganese (Mn)	72.7	MG/KG	0.0433	1.09	NA	
642	006	Nickel (Ni)	53.2	MG/KG	0.0365	0.92	NA	
642	006	Thallium (Tl)	0.87	MG/KG	0.1491	3.75	NA	
		Total			3.9803		223.1694	
642	007	Arsenic (As)	30.7	MG/KG	1.4032	77.96	80.1884	94.86
642	007	Beryllium (Be)	0.58	MG/KG	0.0016	0.09	4.3429	5.14
642	007	Manganese (Mn)	205	MG/KG	0.1222	6.79	NA	
642	007	Nickel (Ni)	253	MG/KG	0.1735	9.64	NA	
642	007	Thallium (Tl)	0.58	MG/KG	0.0994	5.52	NA	
		Total			1.7999		84.5313	
642	008	Arsenic (As)	5	MG/KG	0.2285	84.16	13.0600	84.50
642	008	Beryllium (Be)	0.32	MG/KG	0.0009	0.32	2.3961	15.50
642	008	Manganese (Mn)	68.5	MG/KG	0.0408	15.04	NA	
642	008	Nickel (Ni)	1.9	MG/KG	0.0013	0.48	NA	
642	008	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.2716		15.4561	
642	009	Arsenic (As)	6.4	MG/KG	0.2925	56.05	16.7168	84.48
642	009	Beryllium (Be)	0.41	MG/KG	0.0011	0.22	3.0700	15.52
642	009	Manganese (Mn)	350	MG/KG	0.2087	39.98	NA	
642	009	Nickel (Ni)	28.6	MG/KG	0.0196	3.76	NA	
642	009	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.5219		19.7868	
642	010	Arsenic (As)	13.5	MG/KG	0.6171	93.59	35.2620	91.63
642	010	Beryllium (Be)	0.43	MG/KG	0.0012	0.18	3.2197	8.37
642	010	Manganese (Mn)	56.5	MG/KG	0.0337	5.11	NA	
642	010	Nickel (Ni)	10.8	MG/KG	0.0074	1.12	NA	
842	010	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.6593		38.4817	

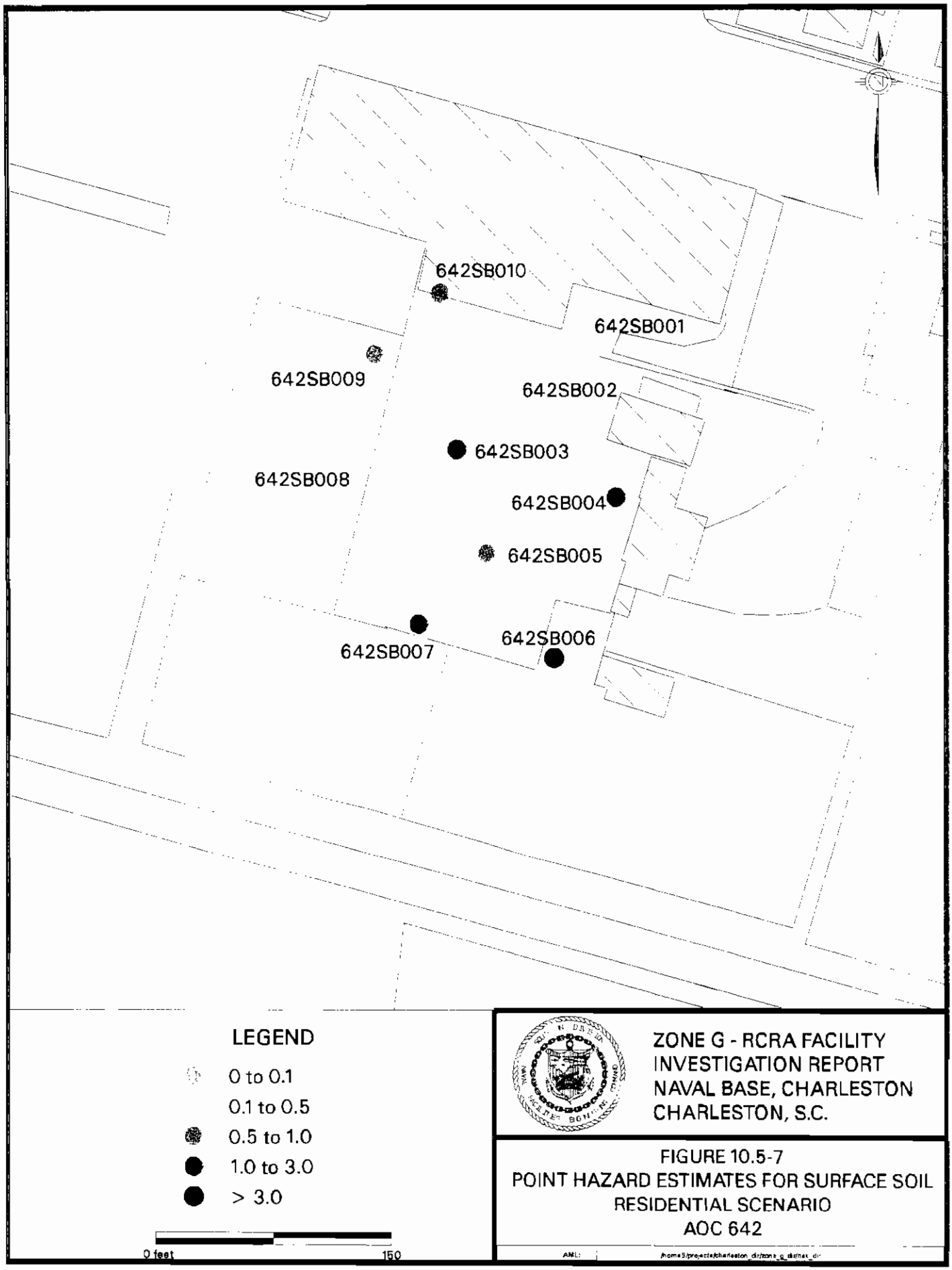
unlikely assumption that a potential future site resident will be chronically exposed to specific points. Exposure to surface soil conditions is more likely the result of uniform exposure to the soil conditions of the entire site (or exposure unit area) rather than specific points. With this in mind, risk maps supplemented by the tables are useful in that they allow the reader to visualize how chemicals driving risk estimates are spatially distributed across the site.

Arsenic is the primary contributor to risk estimates contributing 85 to 95% of the risk at each of the ten surface soil sample location. Beryllium was a secondary contributor to risk estimates at each of the ten surface soil sample locations, although in all ten surface soil samples beryllium was detected at concentrations either below or equal to its background concentration. Risk estimates ranged from 1E-05 (642SB002) to 2E-04 (642SB006).

Figure 10.5-7 illustrates point estimates for hazard at AOC 642 based on soil exposure pathways under a future residential scenario. Out of ten surface soil samples, four were associated with hazard indices above unity. Arsenic was the primary contributor to hazard estimates. Secondary contributors consisted of manganese (not identified as a COC), nickel, and thallium. Hazard index estimates ranged from 0.3 (642SB002) to 4 (642SB006).

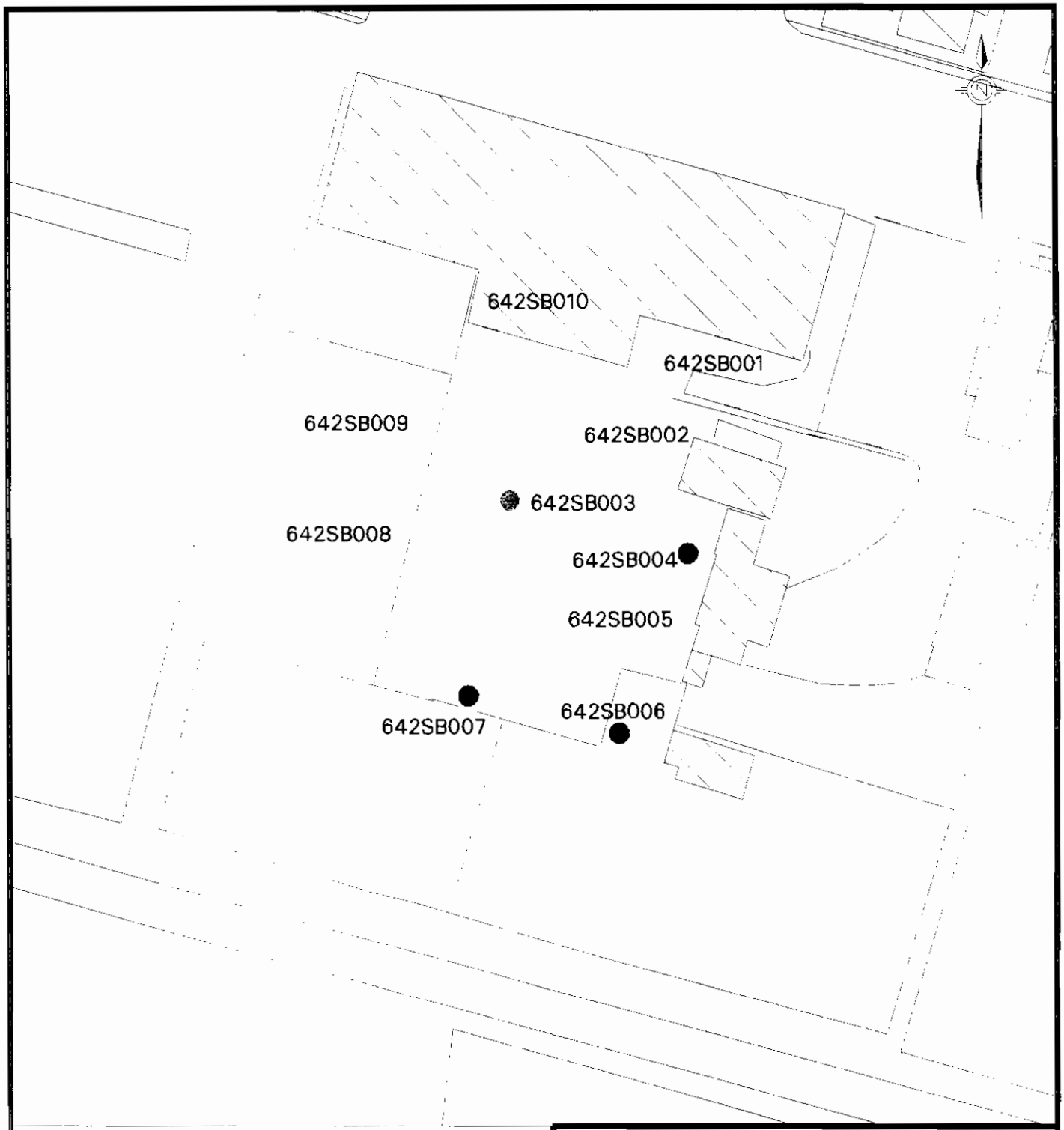
Soil — Site Worker Scenario

Arsenic was identified as the only COC for the site worker surface soil pathway. Figure 10.5-8 illustrates point risk estimates for AOC 642 based on soil exposure pathways under a future industrial (site worker) scenario. Table 10.5.17 summarizes the risk and hazard contribution of arsenic at each sample location. Risk estimates ranged from 2E-06 (642SB002) to 3E-05 (642SB006). Hazard estimates ranged from 0.01 (642SB002) to 0.2 (642SB006).



ZONE G - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 10.5-7
POINT HAZARD ESTIMATES FOR SURFACE SOIL
RESIDENTIAL SCENARIO
AOC 642



LEGEND

- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

0 feet 150

ZONE G - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 10.5-8
POINT RISK ESTIMATES FOR SURFACE SOIL
INDUSTRIAL SCENARIO
AOC 642

AML /home3/projects/charleston_dir/zone_g_dir/risk_dir

Table 10.5.17
Point Estimates of Risk and Hazard - Surface Soil Pathways
Industrial Scenario
AOC 642
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
642	001	Arsenic (As)	6.5	MG/KG	0.015	100	2.40	100
642	002	Arsenic (As)	4.5	MG/KG	0.010	100	1.66	100
642	003	Arsenic (As)	19.4	MG/KG	0.045	100	7.17	100
642	004	Arsenic (As)	31.7	MG/KG	0.073	100	11.71	100
642	005	Arsenic (As)	8.9	MG/KG	0.020	100	3.29	100
642	006	Arsenic (As)	82	MG/KG	0.189	100	30.30	100
642	007	Arsenic (As)	30.7	MG/KG	0.071	100	11.34	100
642	008	Arsenic (As)	5	MG/KG	0.011	100	1.85	100
642	009	Arsenic (As)	6.4	MG/KG	0.015	100	2.36	100
642	010	Arsenic (As)	13.5	MG/KG	0.031	100	4.99	100

10.5.5.8 Remedial Goal Options

Soil

RGOs for carcinogens were based on the lifetime weighted average site resident or site worker as presented in Table 10.5.18 for surface soils. Hazard-based RGOs were calculated based on the hypothetical child resident or site worker, as noted in the table.

10.5.6 Corrective Measures Considerations

Based on the analytical results and the human health risk assessment for AOC 642, COCs requiring further evaluation through the CMS process have been identified for surface soil. The site is currently in an industrial setting, however risk to human health was evaluated under both the residential and industrial (site worker) scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. Hazard was evaluated for noncarcinogenic contaminants through incidental ingestion and dermal contact scenarios as well.

As recommended by SCDHEC, a COC is considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, and whose individual risk exceeds 1E-06 or whose hazard quotient exceeds 0.1.

Arsenic, beryllium, nickel, and thallium were identified as soil pathway COCs for AOC 642. Table 10.5.19 presents cumulative and COC-specific exposure risks and hazard quotients.

Risk-based remedial goals for surface soil are presented in Table 10.5.18. Potential corrective measures for soil are presented in Table 10.5.20.

Table 10.5.18
Remedial Goal Options Surface Soil
AOC 642
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Residential-Based Remedial Goal Options

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	EPC mg/kg	Hazard-Based Remedial Goal Options 3 mg/kg	1 mg/kg	0.1 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Inorganics										
Arsenic (As)	1.5	0.0003	55.0	66	22	2.2	0.38	3.8	38	17.2
Beryllium (Be)	4.3	0.005	0.72	1094	365	36	0.13	1.3	13	1.2
Nickel (Ni)	NA	0.02	249	4376	1459	146	ND	ND	ND	20.6
Thallium (Tl)	NA	8E-05	0.74	18	5.8	0.58	ND	ND	ND	0.85

Worker-Based Remedial Goal Options

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	EPC mg/kg	Hazard-Based Remedial Goal Options 3 mg/kg	1 mg/kg	0.1 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Inorganics										
Arsenic (As)	1.5	0.0003	55.0	1305	435	43	2.7	27	271	17.2

NOTES:
EPC Exposure point concentration
NA Not applicable
ND Not determined
- Remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident or site worker for noncarcinogens

Table 10.5.19
Zone G
AOC 642
Cumulative and Chemical-Specific Exposure Risks and Hazard

	Risk		Hazard	
Chemical	**Industrial**	**Residential**	**Industrial**	**Residential**
Soil				
Arsenic	2.0E-05	1.45E-04	0.127	2.47
Beryllium	7.6E-07	5.4E-06	.0001	0.002
Nickel	ND	ND	0.009	0.172
Thallium	ND	ND	0.006	0.129
Cumulative	2.1E-05	1.5E-04	0.15	2.83

Notes:
ND = Not Determined

Table 10.5.20
Zone G
AOC 642
Potential Corrective Measures

Medium	Compounds	Potential Corrective Measures
Soil	Arsenic, Beryllium, Nickel, and Thallium	a) No Action b) Excavate, offsite disposal, and monitoring c) Containment/Capping

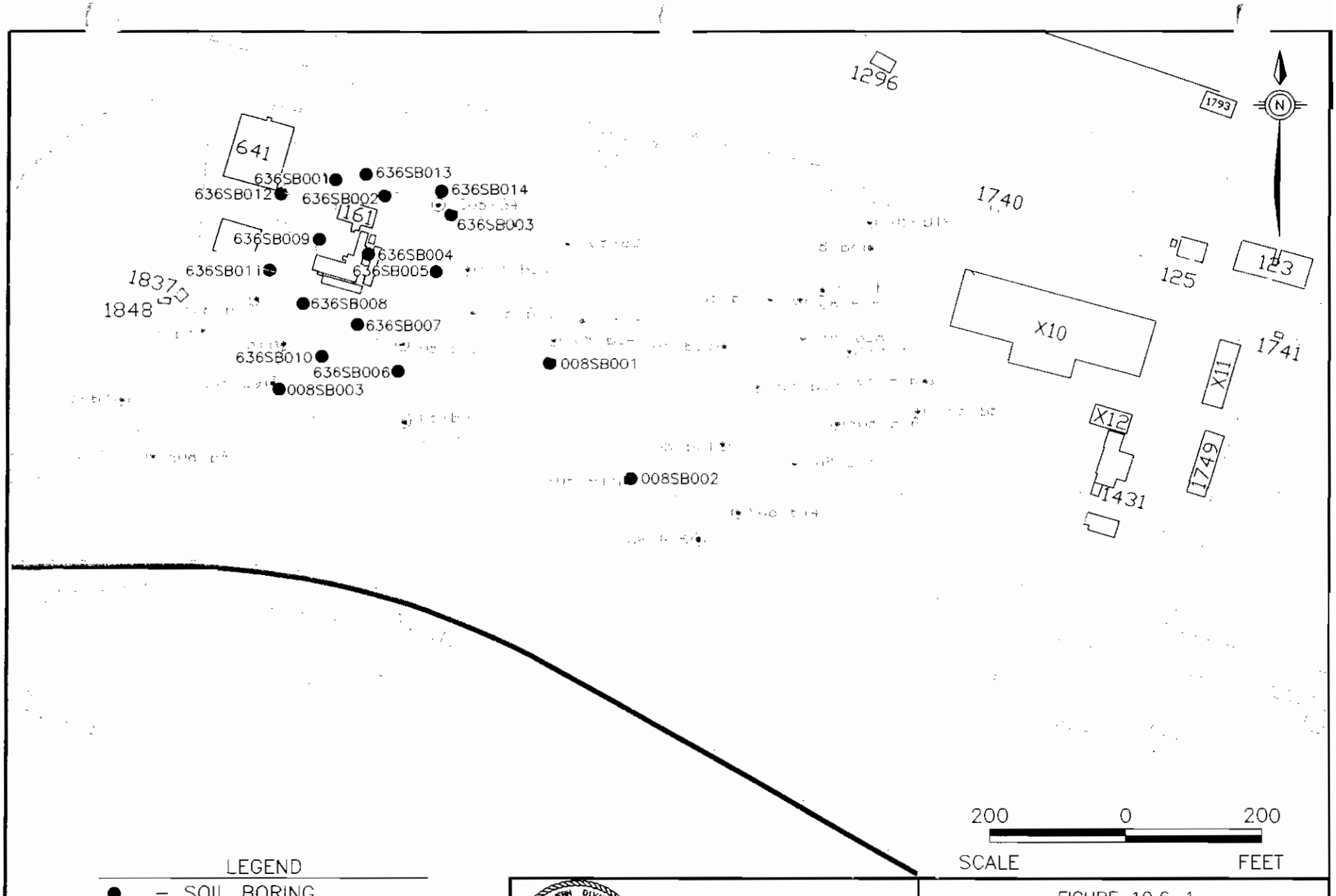
10.6 SWMU 8, Oil Sludge Pit; AOC 636, Torpedo Magazine, Building 161 Area

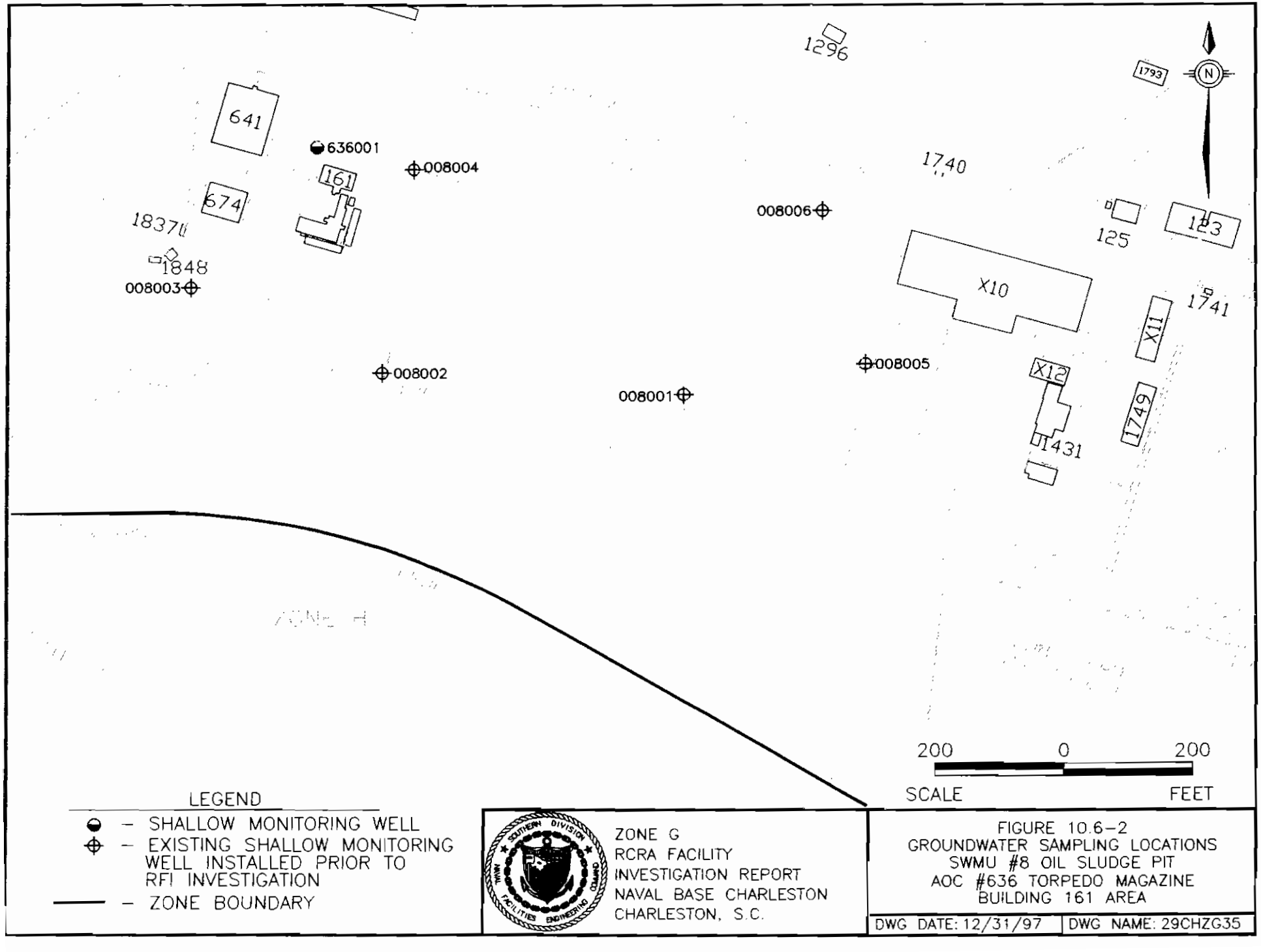
These sites were combined into one investigation due to their close proximity and their potential for similar COPCs. The approved final RFI work plan also grouped AOC 637 into this combined SWMU 8 and AOC 636 investigation. AOC 637 was investigated separately because subsurface conditions are different at this site. SWMU 8 (a RFI site) and AOC 636 (a CSI site) are located in an area bound by Hobson Avenue to the north, Dyess Avenue to the south, Brumby Street to the west, and the Building X-10 compound (AOC 642) to the east. The SWMU 8 area contained three unlined pits which were used to dispose of oil sludge from 1944 to 1977. The pits have since been filled. The area is currently a gravel paved parking area. AOC 636 is the former torpedo magazine where subsurface disposal of unused torpedoes and munitions alledgedly occurred prior to 1944. The AOC 636 area was primarily marshlands at the time. This area has since been filled with dredged materials. Currently, the AOC 636 area contain Building 161 and an asphalt paved parking lot.

10.6.1 Site Geology and Hydrogeology

Figures 10.6-1 and 10.6-2 present the soil and groundwater sampling locations within this area respectively. Appendix A contains the boring logs and the monitoring well construction diagrams for the wells installed at SWMU 8 and AOC 636 in 1993.

Based on soil descriptions from six monitoring well borings, the stratigraphy at SWMU 8 and AOC 636 generally consists of several feet of sand and clay fill material containing metal, wood, plastic, and brick debris underlain by alternating native deposits of silt and sandy clay, to a depth of approximately 20 ft bgs. The native deposits are representative of the Qm and Qc units described in Section 2.2.3.2. Several intervals contained petroleum odors, stains, and/or sheen.


641
636SB001
636SB013
636SB012
636SB002
636SB014
636SB003
161
636SB009
636SB004
636SB011
636SB005
1837
1848
636SB008
636SB007
636SB010
636SB006
008SB003
008SB001
008SB002
1296
1793
1740
125
123
X10
1741
X11
X12
1749
1431
N
200 0 200
SCALE FEET
LEGEND
● – SOIL BORING
– 1993 BORING
– ZONE BOUNDARY
ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 10.6-1
SOIL SAMPLING LOCATION MAP
SWMU #8 OIL SLUDGE PIT
AOC #636 TORPEDO MAGAZINE
BUILDING 161 AREA
DWG DATE: 02/04/98
DWG NAME: 29CHZG37



LEGEND

- ◒ – SHALLOW MONITORING WELL
- ⊕ – EXISTING SHALLOW MONITORING WELL INSTALLED PRIOR TO RFI INVESTIGATION
- —— – ZONE BOUNDARY

ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.6-2
GROUNDWATER SAMPLING LOCATIONS
SWMU #8 OIL SLUDGE PIT
AOC #636 TORPEDO MAGAZINE
BUILDING 161 AREA

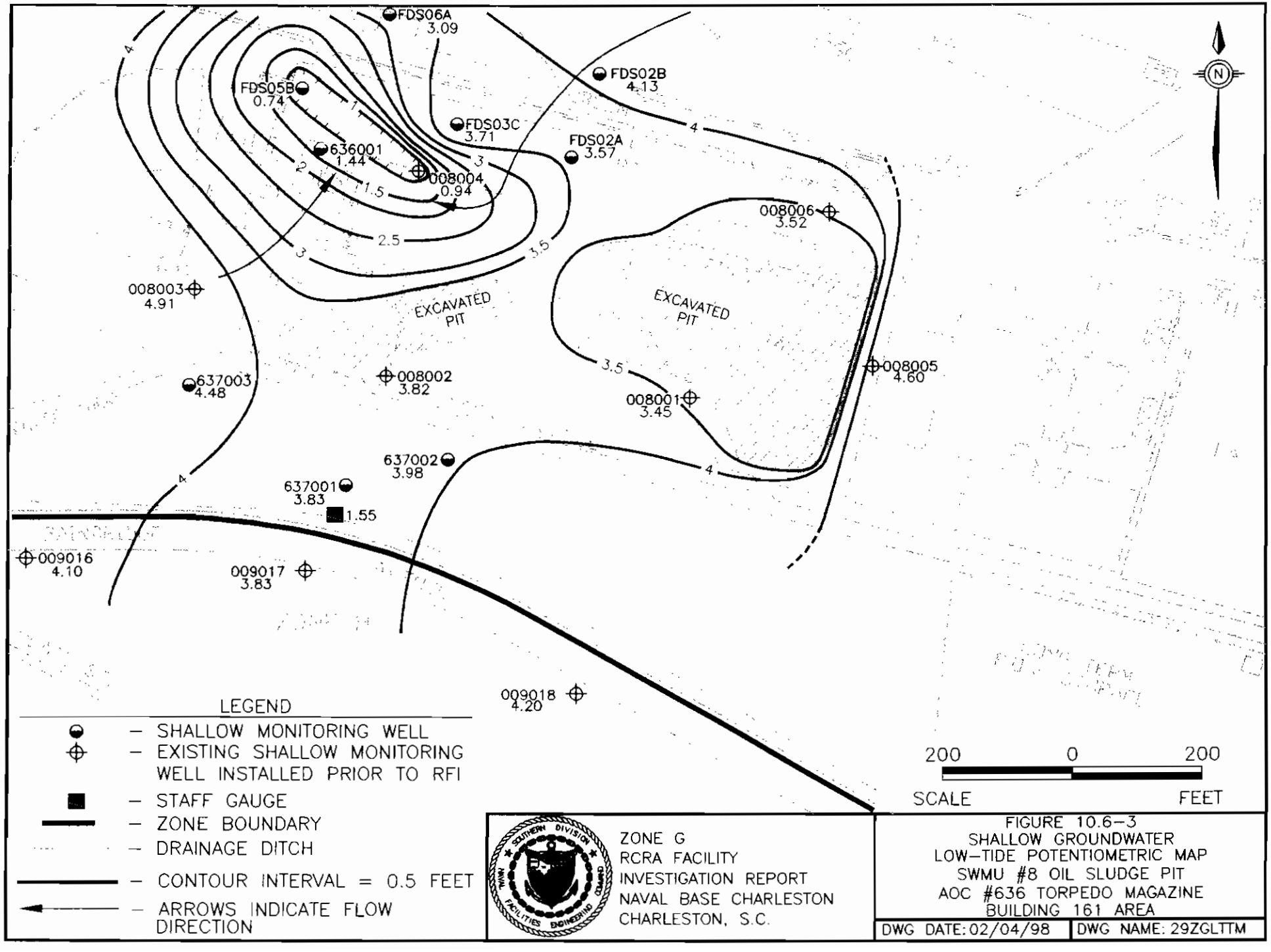
DWG DATE: 12/31/97 | DWG NAME: 29CHZG35

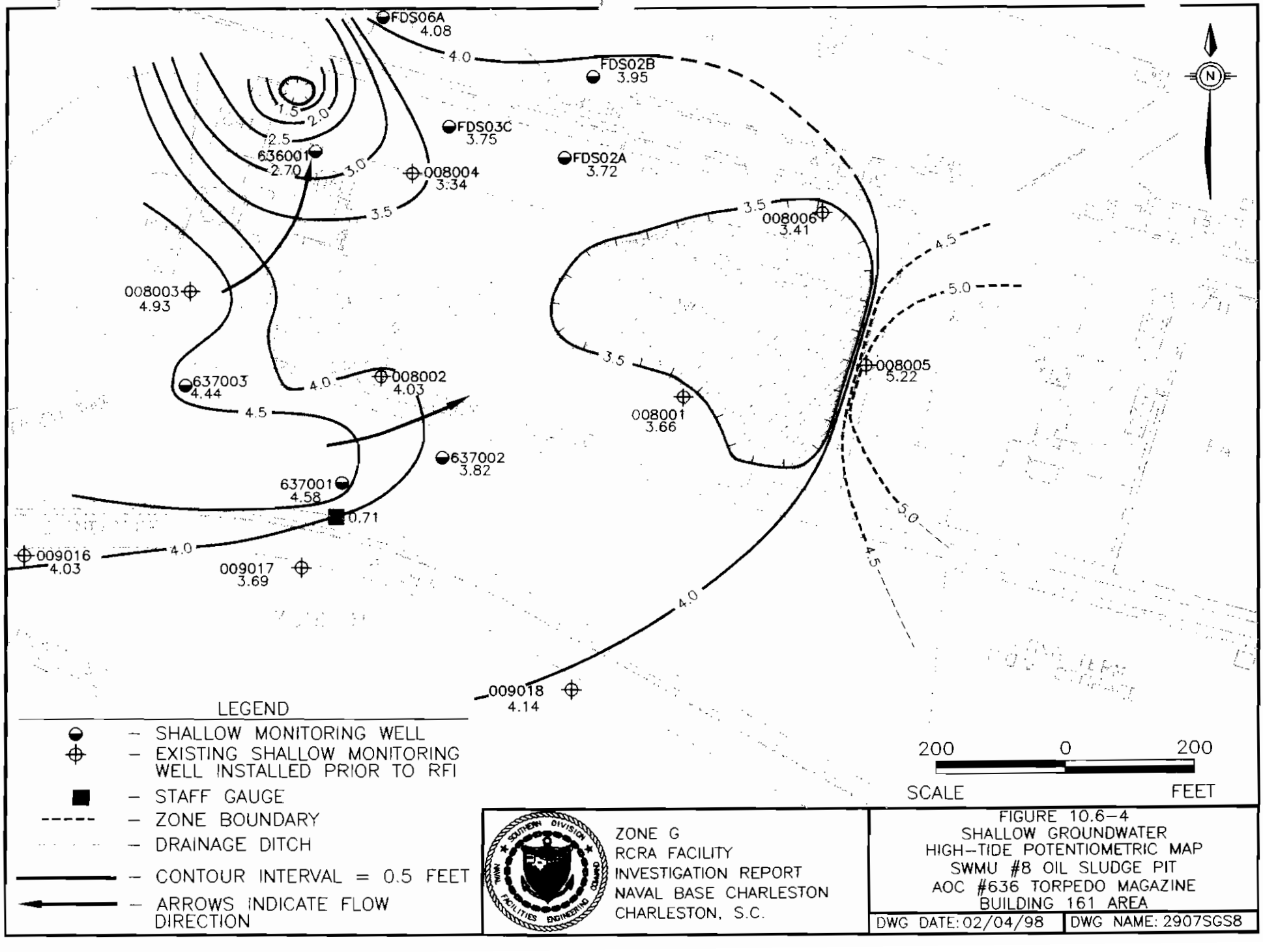
No samples were collected for grain size analysis from the Qm unit in the SWMU 8 and AOC 636 area. A Qm soil sample collected from 9-11 ft bgs from boring 636001 exhibited a grain size distribution of 46% sand, 16% silt, and 38% clay. The total depths of the 1993 monitoring wells range from approximately 14 to 20 ft bgs.

The groundwater elevation varies greatly across the site between approximately 1 and 5 ft msl. Figures 10.6-3 and 10.6-4 depict the shallow groundwater potentiometric surface and the inferred flow direction at low- and high-tide respectively. Differences in the static water levels and the overall flow pattern at the SWMU 8 and AOC 636 area were observed between high- and low-tide. Slug tests were performed on two of the existing wells and the newly installed well at AOC 636. The geometric mean horizontal hydraulic conductivity ranged from .37 to 7.7 ft/day. The horizontal hydraulic gradient is also highly variable, ranging from 1.1E-02 on the site's west side, to 5.4E-03 on the site's east side. The horizontal groundwater flow velocity was calculated. The horizontal flow velocity ranged from 1.0E-01 ft/day in the west to 5.0E-02 ft/day on the east side of the site.

10.6.2 Field Investigation Approach

The objective of the field investigation at SWMU 8 and AOC 636 was to: (1) confirm the presence or absence of contamination in the site area; (2) delineate any contamination found; and (3) provide sufficient data to support a detailed evaluation of treatment alternatives, if required. Media sampled within the investigation area included soil and groundwater. Section 3 of this report details the methods used during the field investigation. Included in this section are descriptions of the hollow stem auger drilling procedures used for shallow well installation; the hand-auger procedures used for soil sampling; groundwater sampling procedures; and miscellaneous procedures used during the field investigation. Also discussed are the analytical protocols for sample analyses. Appendix D contains the analytical data report for samples collected in Zone G.


FDS06A
3.09
FDS02B
4.13
FDS05B
0.74
FDS03C
3.71
FDS02A
3.57
636001
1.44
008004
0.94
008006
3.52
008003
4.91
EXCAVATED PIT
EXCAVATED PIT
008005
4.60
637003
4.48
008002
3.82
008001
3.45
637002
3.98
637001
3.83
1.55
009016
4.10
009017
3.83
009018
4.20
4
3.5
3
2.5
2
1.5
1
N
200 0 200
SCALE FEET
LEGEND
– SHALLOW MONITORING WELL
– EXISTING SHALLOW MONITORING WELL INSTALLED PRIOR TO RFI
– STAFF GAUGE
– ZONE BOUNDARY
– DRAINAGE DITCH
– CONTOUR INTERVAL = 0.5 FEET
– ARROWS INDICATE FLOW DIRECTION
ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 10.6-3
SHALLOW GROUNDWATER
LOW-TIDE POTENTIOMETRIC MAP
SWMU #8 OIL SLUDGE PIT
AOC #636 TORPEDO MAGAZINE
BUILDING 161 AREA
DWG DATE: 02/04/98
DWG NAME: 29ZGLTTM


FDS06A
4.08
FDS02B
3.95
FDS03C
3.75
FDS02A
3.72
636001
2.70
008004
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008006
3.41
008003
4.93
008005
5.22
637003
4.44
008002
4.03
008001
3.66
637002
3.82
637001
4.58
0.71
009016
4.03
009017
3.69
009018
4.14
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
N
200
0
200
SCALE
FEET
LEGEND
– SHALLOW MONITORING WELL
– EXISTING SHALLOW MONITORING WELL INSTALLED PRIOR TO RFI
– STAFF GAUGE
– ZONE BOUNDARY
– DRAINAGE DITCH
– CONTOUR INTERVAL = 0.5 FEET
– ARROWS INDICATE FLOW DIRECTION
SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 10.6–4
SHALLOW GROUNDWATER
HIGH–TIDE POTENTIOMETRIC MAP
SWMU #8 OIL SLUDGE PIT
AOC #636 TORPEDO MAGAZINE
BUILDING 161 AREA
DWG DATE: 02/04/98
DWG NAME: 2907SGS8

10.6.3 Soil Sampling and Analysis

Pre-RFI soil sampling took place in 1993 and included advancing 31 borings throughout the combined SWMU 8 area. The approved final RFI work plan proposed advancing three soil borings within the SWMU 8 area to confirm the previous soil results. Nine borings were proposed and advanced within the AOC 636 area to detect the presence of any soil contamination from this site. Upper and lower interval soil samples were proposed from each boring. During the field investigation, three soil borings were advanced within the site area for SWMU 8, as depicted in Figure 10.6-1. These borings included the upper sampling interval only. At AOC 636, fourteen soil borings were advanced during the field investigation, in two phases (Figure 10.6-1). Nine first round-borings were advanced at AOC 636, as proposed in the approved final RFI work plan. Five first phase borings at AOC 636 included both upper and lower sampling intervals, while four borings included the upper interval only. Where not collected, the lower interval sample was not collected due to the shallow water table. In accordance with the approved final RFI work plan, the SWMU 8 and AOC 636 first-round soil samples were analyzed for metals, pesticides/PCBs, SVOCs, VOCs, and propellants/explosives at DQO Level III. Additionally, one upper interval duplicate soil sample was collected at AOC 636 for Appendix IX analyses at DQO Level IV. During the second-round sampling, five additional borings were advanced at AOC 636 to further delineate SVOC, BEQ, VOC, and subsurface metals contamination identified during the first sampling round. Two AOC 636 second-round borings included both upper and lower sampling intervals, while three borings included the upper interval only. Second-round samples were analyzed for metals, pesticide/PCBs, and SVOCs at DQO Level III. Table 10.6.1 summarizes the 1993 SWMU 8 and AOC 636 soil samples and analyses (pre-RFI samples). Table 10.6.2 summarizes the RFI soil samples and analyses.

10.6.3.1 Nature of Contamination in Soil

The following tables and discussion include 1993 and RFI soil sample results. Organic compound analytical results for soil are summarized in Table 10.6.3. Inorganic analytical results for soil are summarized in Table 10.6.4. Table 10.6.5 summarizes all analytes detected in soil at SWMU 8 and AOC 636. Appendix D contains a complete analytical data report for all Zone G samples collected.

Table 10.6.1
Zone G
SWMU 8 and AOC 636
1993 Soil Samples and Analyses
(Pre-RFI Samples)

Boring Location	Sample Identifier	Sample Interval	Date Collected	Analyses	Remarks
S08B01	S08B0101	Upper	9/24/93	Note 1	
S08B02	S08B0201	Upper	9/25/93	Note 1	
	S08B0202	Lower			
S08B03	S08B0301	Upper	9/25/93	Note 1	
	S08B031D*				*Duplicate sample
	S08B0302	Lower			
S08B04	S08B0401	Upper	9/27/93	Note 1	
S08B05	S08B0501	Upper	9/30/93	Note 1	
S08B06	S08B0601	Upper	9/30/93	Note 1	
S08B07	S08B0701	Upper	10/18/93	Note 1	
S08B08	S08B0801	Upper	10/18/93	Note 1	
S08B09	S08B0901	Upper	10/18/93	Note 1	
S08B10	S08B1001	Upper	10/18/93	Note 1	
S08B11	S08B1101	Upper	10/19/93	Note 1	
	S08B111D*				* Duplicate Sample
	S08B1102	Lower			
S08B12	S08B1201	Upper	10/19/93	Note 1	
	S08B1202	Lower			
S08B13	S08B1301	Upper	10/19/93	Note 1	
S08B14	S08B1401	Upper	10/19/93	Note 1	
S08B15	S08B1501	Upper	10/19/93	Note 1	
S08B16	S08B1601	Upper	10/20/93	Note 1	

Table 10.6.1
Zone G
SWMU 8 and AOC 636
1993 Soil Samples and Analyses
(Pre-RFI Samples)

Boring Location	Sample Identifier	Sample Interval	Date Collected	Analyses	Remarks
S08B17	S08B1701	Upper	10/20/93	Note 1	
	S08B171D*				* Duplicate Sample
S08B18	S08B1801	Upper	10/20/93	Note 1	
S08B19	S08B1901	Upper	10/20/93	Note 1	
	S08B1902	Lower			
S08B20	S08B2001	Upper	10/21/93	Note 1	
	S08B2002	Lower			
S08B21	S08B2101	Upper	10/26/93	Note 1	
	S08B2102	Lower			
S08B22	S08B2201	Upper	10/26/93	Note 1	
	S08B2202	Lower			
S08B23	S08B2301	Upper	10/26/93	Note 1	
	S08B2302	Lower			
S08B24	S08B2401	Upper	10/26/93	Note 1	
	S08B2402	Lower			
S08B25	S08B2501	Upper	10/27/93	Note 1	
	S08B251D*				* Duplicate Sample
	S08B2502	Lower			
S08B26	S08B2601	Upper	10/27/93	Note 1	
	S08B2602	Lower			
S08B27	S08B2701	Upper	10/27/93	Note 1	
	S08B2702	Lower			
S08B28	S08B2801	Upper	10/27/93	Note 1	
	S08B2802	Lower			
S08B29	S08B2901	Upper	10/27/93	Note 1	
S08B30	S08B3001	Upper	10/27/93	Note 1	
	S08B3002	Lower			
	S08B302D*				* Duplicate Sample
S08B31	S08B3101	Upper	10/27/93	Note 1	
	S08B311D*				* Duplicate Sample
	S08B3102	Lower			

Notes:
1 = SW-846 (metals, pesticides/PCBs, SVOCs, VOCs)
* = Duplicate sample

Table 10.6.2
Zone G
SWMU 8 and AOC 636
Soil Samples and Analyses
(RFI Samples)

Boring Location	Sample Identifier	Sample Interval	Date Collected	Analyses	Remarks
008SB01	008SB00101	Upper	9/12/96	Note 1/cyanide	Lower interval not sampled due to water table
008SB02	008SB00201	Upper	9/16/96	Note 1/cyanide	Lower interval not sampled due to water table
008SB03	008SB00301	Upper	9/13/96	Note 1/cyanide	Lower interval not sampled due to water table
636SB001	636SB00101	Upper	9/11/96	Note 1	Lower interval not sampled due to water table
636SB002	636SB00201 636CB00201* 636SB00202	Upper Lower	9/11/96	Note 1 Note 3 Note 1	* Duplicate Sample
636SB003	636SB00301 636SB00302	Upper Lower	9/11/96	Note 1	
636SB004	636SB00401 636SB00402	Upper Lower	9/11/96	Note 1	
636SB005	636SB00501 636SB00502	Upper Lower	9/11/96	Note 1	
636SB006	636SB00601	Upper	9/12/96	Note 1	Lower interval not sampled due to water table
636SB007	636SB00701	Upper	9/12/96	Note 1	Lower interval not sampled due to water table
636SB008	636SB00801	Upper	9/12/96	Note 1	Lower interval not sampled due to water table
636SB009	636SB00901 636SB00902	Upper Lower	9/12/96	Note 1	
636SB010	636SB01001	Upper	1/07/97	Note 2	Lower interval not sampled due to water table. Second-round sample
636SB011	636SB01101	Upper	1/07/97	Note 2	Lower interval not sampled due to water table. Second-round sample
636SB012	636SB01201	Upper	1/07/97	Note 2	Lower interval not sampled due to water table. Second-round sample
636SB013	636SB01301 636SB01302	Upper Lower	1/07/97	Note 2	Second-round sample

Table 10.6.2
Zone G
SWMU 8 and AOC 636
Soil Samples and Analyses
(RFI Samples)

Boring Location	Sample Identifier	Sample Interval	Date Collected	Analyses	Remarks
636SB014	636SB01401	Upper	1/07/97	Note 2	Second-round sample
	636SB01402	Lower			

Notes:

1 = SW-846 (metals, pesticides/PCBs, SVOCs, VOCs); explosives/propellants at DQO Level III

2 = SW-846 (metals, pesticides/PCBs, SVOCs) at DQO Level III

3 = Appendix IX suite: Appendix IX (pesticides/PCBs, herbicides, SVOCs, VOCs); SW-846 (metals, dioxins, OP-pesticides) cyanide; hex-chrome at DQO Level IV

* = Duplicate sample

Table 10.6.3
Zone G
SWMU 8, AOC 636
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (µg/kg)	Mean of Detections (µg/kg)	Reference Conc.* (µg/kg)	Number of Samples Exceeding Reference
Volatile Organic Compounds	**(Upper Interval - 43 Samples plus 6 Duplicate Samples (includes 31 Samples plus 6 Duplicate Samples from 1993)/Lower Interval - 21 Samples plus 1 Duplicate Sample (includes 16 Samples plus 1 Duplicate Sample from 1993) (µg/kg)**					
Acetone	Upper	5/43	53 - 220	116	780000	0
	Lower	12/21	29 - 1100	229	16000	0
2-Butanone (MEK)	Upper	5/43	2.00 - 30.0	11.6	4700000	0
	Lower	1/21	10	10	7900	0
Carbon Disulfide	Upper	1/43	2.1	2.1	780000	0
	Lower	1/21	7.9	7.9	32000	0
Chlorobenzene	Upper	21/43	6.6 - 185	30	160000	0
	Lower	7/21	7.3 - 50	34	1000	0
Ethylbenzene	Upper	1/43	840	840	780000	0
	Lower	1/21	6.6	6.6	13000	0
1,1,2,2-Tetrachloroethane	Upper	0/43	ND	ND	3200	0
	Lower	1/21	10.0	10.00	3	1
Toluene	Upper	5/43	1.5 - 580	121	1600000	0
	Lower	2/21	5.8 - 6	5.9	12000	0
1,1,1-Trichloroethane	Upper	5/43	1.4 - 1600	323	160000	0
	Lower	1/21	3.8	3.8	2000	0
1,1,2-Trichloroethane	Upper	0/43	ND	ND	11	0
	Lower	1/21	92	92	20	1

Table 10.6.3
Zone G
SWMU 8, AOC 636
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (µg/kg)	Mean of Detections (µg/kg)	Reference Conc.* (µg/kg)	Number of Samples Exceeding Reference
Vinyl Acetate	Upper	0/43	ND	ND	7800000	0
	Lower	2/21	17	17	170000	0
Xylene	Upper	3/43	1.7 - 3400	1135	16000000	0
	Lower	1/21	14	14	148000	0
Semivolatile Organic Compounds	**(Upper Interval - 48 Samples plus 6 Duplicate Samples (includes 31 Samples plus 5 Duplicate Samples from 1993)/Lower Interval - 23 Samples plus 1 Duplicate Sample (includes 16 Samples plus 1 Duplicate Sample from 1993) (µg/kg)**					
BEQs[1]	Upper	30/48	0.045 - 85437	4095	88	17
	Lower	14/23	8.4 - 3860	672	NA	NA
Benzo(a)anthracene	Upper	16/48	39.0 - 430200	28684	880	5
	Lower	9/23	49.0 - 2400	452	2000	1
Benzo(b)fluoranthene	Upper	23/48	27 - 41750	3360	880	5
	Lower	11/23	84 - 2400	537	5000	0
Benzo(k)fluoranthene	Upper	17/48	40.0 - 20750	2052	8800	1
	Lower	8/23	56.0 - 5100	826	49000	0
Benzo(a)pyrene	Upper	22/48	36 - 31600	2606	88	16
	Lower	13/23	35 - 3800	630	8000	0
Chrysene	Upper	25/48	38.0 - 45000	3255	88000	0
	Lower	11/23	65.0 - 9300	1252	160000	0
Dibenz(a,h)anthracene	Upper	7/48	42.0 - 4555	1174	88	4
	Lower	1/23	150	130	2000	0

Table 10.6.3
Zone G
SWMU 8, AOC 636
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (µg/kg)	Mean of Detections (µg/kg)	Reference Conc.* (µg/kg)	Number of Samples Exceeding Reference
Indeno(1,2,3-cd)pyrene	Upper	14/48	38.0 - 18400	2148	880	3
	Lower	5/23	45.0 - 760	331	14000	0
Acenaphthene	Upper	8/48	51.0 - 5800	1704	470000	0
	Lower	2/23	93 - 830	461	570000	0
Acenaphthylene	Upper	1/48	100	100	230000	0
	Lower	0/23	ND	ND	293000	0
Anthracene	Upper	13/48	36 - 16600	2660	2300000	0
	Lower	8/23	32 - 7100	1220	12000000	0
Benzo(g,h,i)perylene	Upper	15/48	38.0 - 15850	1725	230000	0
	Lower	5/23	44 - 750	317	4.66E08	0
Benzoic acid	Upper	1/48	40.0	40.0	31000000	0
	Lower	2/23	63.0 - 64.0	63.5	400000	0
Butylbenzylphthalate	Upper	3/48	52 - 130	81	1600000	0
	Lower	0/23	ND	ND	930000	0
Carbazole	Upper	5/48	190 - 3595	1429	32000	0
	Lower	2/23	93 - 320	206	600	0
4-Chloroaniline	Upper	1/48	780	780	31000	0
	Lower	0/23	ND	ND	700	0
Dibenzofuran	Upper	10/48	42 - 2065	525	31000	0
	Lower	1/23	52	52	50000	0

Table 10.6.3
Zone G
SWMU 8, AOC 636
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (µg/kg)	Mean of Detections (µg/kg)	Reference Conc.* (µg/kg)	Number of Samples Exceeding Reference
2,4-Dinitrotoluene	Upper	1/48	130	130	16000	0
	Lower	0/23	ND	ND	0.8	0
bis(2-Ethylhexyl)phthalate	Upper	8/48	50 - 420	196	46000	0
	Lower	0/23	ND	ND	3600000	0
Fluoranthene	Upper	34/48	39 - 110500	5015	310000	0
	Lower	15/23	24 - 7500	1035	4300000	0
Fluorene	Upper	8/48	52.0 - 5380	1305	310000	0
	Lower	2/23	52 - 780	416	560000	0
2-Methylnaphthalene	Upper	12/48	37 - 510	211	310000	0
	Lower	7/23	46 - 63000	9293	126000	0
Naphthalene	Upper	11/48	43.0 - 430	170	310000	0
	Lower	6/23	72 - 12000	2224	84000	0
Phenanthrene	Upper	28/48	30 - 65000	3952	230000	0
	Lower	12/23	39 - 42000	4251	1380000	0
Pyrene	Upper	35/48	42.0 - 30000	4856	230000	0
	Lower	18/23	53 - 107500	2620	4200000	0
Pesticides and PCBs	**[Upper Interval - 43 Samples plus 6 Duplicate Samples (include 31 Samples plus 5 Duplicate Samples from 1993)/Lower Interval - 23 Samples plus 1 Duplicate Sample (includes 16 Samples plus 1 Duplicate Sample from 1993)] (µg/kg)**					
alpha-Chlordane	Upper	12/43	2.20 - 11	5.5	1800	0
	Lower	3/23	4.2 - 240	88	10000	0

Table 10.6.3
Zone G
SWMU 8, AOC 636
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (µg/kg)	Mean of Detections (µg/kg)	Reference Conc.* (µg/kg)	Number of Samples Exceeding Reference
gamma-Chlordane	Upper	22/43	2.10 - 95.5	17	1800	0
	Lower	7/23	2.8 - 34	16	10000	0
Aldrin	Upper	1/43	41	41	380000	0
	Lower	1/23	7.6	7.6	500	0
4,4'DDD	Upper	14/43	3.10 - 179	29	2700	0
	Lower	5/23	23 - 180	92	16000	0
4,4'-DDE	Upper	18/43	3.10 - 118	25	1900	0
	Lower	7/23	4.4 - 120	56	54000	0
4,4'-DDT	Upper	10/43	3.80 - 38.0	16	1900	0
	Lower	2/23	34.0 - 200	117	32000	0
Dieldrin	Upper	3/43	5.20 - 46	20	40	1
	Lower	3/23	7.9 - 610	228	4	3
Endosulfan II	Upper	0/43	ND	ND	47000	0
	Lower	1/23	19	19	18000	0
Endrin	Upper	0/43	ND	ND	2300	0
	Lower	3/23	8.70 - 47	28	1000	0
Endrin aldehyde	Upper	1/43	4	4	2300	0
	Lower	3/23	25 - 71	50	1000	0
Endrin ketone	Upper	1/43	4.5	4.5	2300	0
	Lower	1/23	6	6	1000	0

Table 10.6.3
Zone G
SWMU 8, AOC 636
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (µg/kg)	Mean of Detections (µg/kg)	Reference Conc.* (µg/kg)	Number of Samples Exceeding Reference
Heptachlor	Upper	1/43	3.9	3.9	140	0
	Lower	0/23	ND	ND	23000	0
Heptachlor epoxide	Upper	5/43	1.8 - 11	4.5	70	0
	Lower	1/23	250	250	700	0
Aroclor-1260	Upper	9/43	8.50 - 920	202	320	2
	Lower	2/23	410 - 570	490	1000	0
Dioxins (Upper Interval - 1 Sample)						
Dioxin(2,3,7,8-TCDD TEQ)[1]	Upper	1/1	3.88	3.88	1000	0
	Lower	NA	NA	NA	1900	0
Hydrazine (Upper Interval - 12 Samples plus 1 Duplicate Sample/Lower Interval - 5 Samples) (µg/kg)						
Hydrazine	Upper	7/12	12.8 - 274	72	210	1
	Lower	3/5	13.9 - 67.0	33	.088	3

Notes:
1 = Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995b)
* = Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil to groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as a reference concentration for lower interval samples
ND = Not detected
NA = Not applicable
mg/kg = Milligrams per kilogram
µg/kg = Micrograms per kilogram

Table 10.6.4
Zone G
SWMU 8, AOC 636
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Inorganics (Upper Interval - 48 Samples plus 7 Duplicate Samples (includes 31 Samples plus 6 Duplicate Samples from 1993)/Lower Interval - 23 Samples plus 1 Duplicate Sample (includes 16 Samples plus 1 Duplicate Sample from 1993) (mg/kg)						
Aluminum (Al)	Upper	48/48	600 - 12100	4218	7800	6
	Lower	23/23	820 - 36500	9252	1000000	0
Antimony (Sb)	Upper	5/48	0.66 - 7.6	4.7	3.10	3
	Lower	5/23	0.65 - 32	16.8	5	4
Arsenic (As)	Upper	47/48	1.20 - 150	9.6	0.430	47
	Lower	21/23	1.45 - 21	8.9	29	0
Barium (Ba)	Upper	48/48	3.7 - 120	29	550	0
	Lower	23/23	4.8 - 500	61	1600	0
Beryllium (Be)	Upper	18/48	0.13 - 1.00	0.42	0.150	16
	Lower	10/23	0.28 - 1.60	0.85	63	0
Cadmium (Cd)	Upper	21/48	0.11 - 1.85	0.50	3.90	0
	Lower	13/23	0.11 - 5.9	1.31	8	0
Calcium (Ca)	Upper	48/48	4090 - 257500	80065	NL	NA
	Lower	23/23	1660 - 170000	36756	NL	NA
Chromium (Cr)	Upper	48/48	4.1 - 103	16.8	39.0	5
	Lower	23/23	5.1 - 103	30	1000000	0
Cobalt (Co)	Upper	39/48	0.55 - 14.0	3.5	470	0
	Lower	19/23	1.5 - 12	4.5	2000	0

Table 10.6.4
Zone G
SWMU 8, AOC 636
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Copper (Cu)	Upper	45/48	0.22 - 1330	93	27000	0
	Lower	21/23	2.40 - 14000	865	920	2
Cyanide (CN)	Upper	2/48	0.22 - 0.30	0.26	160	0
	Lower	0/23	NA	NA	40	0
Iron (Fe)	Upper	48/48	1600 - 26900	5611	2300	39
	Lower	23/23	1600 - 78000	19489	NL	NA
Lead (Pb)	Upper	48/48	4.4 - 453.5	73	400	1
	Lower	23/23	2.4 - 1400	155	400	2
Magnesium (Mg)	Upper	48/48	140 - 4100	1428	NL	NA
	Lower	23/23	320 - 4500	2551	NL	NA
Manganese (Mn)	Upper	48/48	5.7 - 282	89	180	4
	Lower	23/23	18 - 1600	233	1100	1
Mercury (Hg)	Upper	41/48	0.012 - 0.63	0.14	2.30	0
	Lower	20/23	0.058 - 6.9	0.95	2.1	2
Nickel (Ni)	Upper	41/48	1.90 - 34.4	10.4	160	0
	Lower	20/23	1.60 - 79	16.0	130	0
Potassium (K)	Upper	42/48	110 - 1365	403	NL	NA
	Lower	21/23	159 - 3970	1131	NL	NA
Selenium (Se)	Upper	10/48	0.35 - 0.89	0.60	39.0	0
	Lower	7/23	0.59 - 2.20	0.97	5	0

Table 10.6.4
Zone G
SWMU 8, AOC 636
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Silver (Ag)	Upper	1/48	1.2	1.2	39	0
	Lower	2/23	0.81 - 3.4	2.1	34	0
Sodium (Na)	Upper	40/48	110 - 1580	458	NL	NA
	Lower	22/23	190 - 11600	2353	NL	NA
Thallium (Tl)	Upper	6/48	0.42 - 0.92	0.69	0.630	4
	Lower	5/23	0.54 - 1.00	0.79	0.95	1
Tin (Sn)	Upper	5/48	0.75 - 34.2	8.27	4700	0
	Lower	0/23	ND	ND	11000	0
Vanadium (V)	Upper	48/48	4 - 30.4	12.25	55.0	0
	Lower	23/23	4 - 96	28.6	6000	0
Zinc (Zn)	Upper	48/48	2.8 - 1270	128.6	2300	0
	Lower	23/23	4.9 - 3300	369	12000	0

Notes:
* = Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil to groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as a reference concentration for lower interval samples
ND = Not detected
NL = Not listed
NA = Not applicable
mg/kg = Milligrams per kilogram

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Volatile Organic Compounds (µg/kg)							
Acetone	S08B01	130	780000	NA	NT	16000	NA
	S08B03	ND			160		
	S08B11	ND			170		
	S08B17	53			ND		
	S08B19	ND			29		
	S08B20	ND			170		
	S08B21	ND			76		
	S08B22	ND			200		
	S08B23	ND			1100		
	S08B24	ND			220		
	S08B25	56			140		
	S08B26	220			220		
	S08B30	ND			100		
	S08B31	120			160		
Carbon disulfide	S08B11	ND	780000	NA	7.9	32000	NA
	S08B31	2.1			ND		
2-Butanone	S08B25	7.8	4700000	NA	ND	7900	NA
	S08B30	ND			10		
	S08B31	12			ND		
	008SB001	2			NT		
	008SB003	6			NT		
	636SB002	30			ND		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Chlorobenzene	S08B01	18	160000	NA	ND	1000	NA
	S08B02	ND			50		
	S08B03	ND			7.3		
	S08B05	53			NT		
	S08B07	11			NT		
	S08B09	8.5			NT		
	S08B11	185			35		
	S08B12	14			NT		
	S08B13	66			NT		
	S08B14	16			NT		
	S08B15	56			NT		
	S08B16	30			NT		
	S08B17	19			NT		
	S08B18	12			NT		
	S08B19	17			ND		
	S08B20	19			41		
	S08B22	9.2			28		
	S08B24	33			ND		
	S08B25	7.6			ND		
	S08B26	26			ND		
	S08B27	6.6			ND		
	S08B28	9.1			ND		
	S08B30	ND			46		
	S08B31	20			33		
Ethylbenzene	S08B11	840	780000	NA	ND	13000	NA
	S08B30	ND			6.6		
1,1,2,2-Tetrachloroethene	636SB009	ND	3200	NA	**10**	3	NA

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
1,1,2-Trichloroethane	S08B22	ND	11	NA	92	20	NA
1,1,1-Trichloroethane	S08B11	1600	160000	NA	ND	2000	NA
	S08B17	1.4			NT		
	S08B24	8.7			ND		
	S08B25	2.9			ND		
	S08B30	ND			3.8		
	S08B31	3.9			ND		
Toluene	S08B01	8.2	1600000	NA	NT	12000	NA
	S08B05	9.3			NT		
	S08B11	580			ND		
	S08B22	ND			5.8		
	S08B24	8.6			ND		
	S08B25	1.5			ND		
	S08B30	ND			6		
Vinyl acetate	S08B22	ND	7800000	NA	17	170000	NA
Xylene (total)	S08B11	3400	16000000	NA	ND	148000	NA
	S08B25	1.7			ND		
	S08B30	ND			14		
	S08B31	2.2			ND		
Semivolatile Organic Compounds (µg/kg)							
2,4-Dinitrotoluene	S08B12	130	16000	NA	ND	0.8	NA

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
BEQs[1]	S08B01	**450.0**	88.0	NA	NA	NA	NA
	S08B02	2.7			NA		
	S08B03	5.51			NA		
	S08B04	50.40			NA		
	S08B05	44.70			NA		
	S08B09	**133.20**			NA		
	S08B11	**85437.50**			NA		
	S08B12	**826.20**			NA		
	S08B14	**120.86**			NA		
	S08B15	**182.42**			NA		
	S08B16	78.38			NA		
	S08B17	**2309.90**			NA		
	S08B18	**9515.60**			NA		
	S08B19	68.86			NA		
	S08B25	0.68			NA		
	S08B26	**172.32**			NA		
	S08B27	1.33			NA		
	S08B28	ND			NA		
	S08B30	66.15			NA		
	S08B31	**20588.50**			NA		
	008SB003	**942.40**			NA		
	636SB001	**296.78**			NA		
	636SB002	**327.81**			NA		
	636SB003	**509.06**			NA		
	636SB004	ND			NA		
	636SB005	8.15			NA		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
BEQs[1] (continued)	636SB006	71.84	88.0	NA	NA	NA	NA
	636SB007	**127.62**			NA		
	636SB008	**273.79**			NA		
	636SB009	46.84			NA		
	636SB010	0.045			NA		
	636SB011	**180.70**			NA		
	636SB014	ND			NA		
Benzoic acid	636SB003	ND	31000000	NA	64	400000	NA
	636SB004	ND			63		
	636SB009	40			ND		
Naphthalene	S08B02	110	310000	NA	ND	84000	NA
	S08B03	ND			72		
	S08B04	38			NT		
	S08B12	ND			12000		
	S08B14	200			NT		
	S08B17	130			NT		
	S08B18	430			NT		
	S08B20	90			ND		
	S08B21	ND			670		
	S08B24	130			220		
	S08B28	ND			250		
	008SB001	320			ND		
	636SB004	77			130		
	636SB005	300			ND		
	636SB008	43			NT		
4-Chloroaniline	S08B14	780	31000	NA	NT	700	NA
Acenaphthylene	S08B12	100	230000	NA	ND	293000	NA

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
2-Methylnapthalene	S08B02	160	310000	NA	ND	126000	NA
	S08B03	ND			46		
	S08B04	60			ND		
	S08B12	ND			63000		
	S08B13	37			NT		
	S08B14	330			NT		
	S08B17	180			NT		
	S08B18	500			NT		
	S08B20	110			ND		
	S08B21	ND			1000		
	S08B22	ND			380		
	S08B24	180			320		
	S08B26	ND			180		
	S08B30	ND			125		
	008SB001	370			NT		
	636SB002	42			ND		
	636SB005	510			ND		
	636SB010	52			NT		
Acenaphthene	S08B11	5800	470000	NA	ND	570000	NA
	S08B12	130			ND		
	S08B15	140			NT		
	S08B17	530			NT		
	S08B18	2200			NT		
	S08B28	ND			830		
	S08B30	ND			93		
	S08B31	4700			ND		
	008SB003	51			NT		
	636SB008	81			NT		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Dibenzofuran	S08B03	ND	31000	NA	52	50000	NA
	S08B11	2065			ND		
	S08B14	68			NT		
	S08B15	280			NT		
	S08B17	190.5			NT		
	S08B18	950			NT		
	S08B24	42			ND		
	S08B31	1400			ND		
	008SB001	62			NT		
	636SB005	120			ND		
	636SB008	76			NT		
Fluorene	S08B03	ND	310000	NA	52	560000	NA
	S08B11	5380			NT		
	S08B12	240			ND		
	S08B15	150			NT		
	S08B17	445			NT		
	S08B18	1900			NT		
	S08B28	ND			780		
	S08B31	3700			ND		
	008SB003	52			NT		
	636SB008	170			NT		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Phenanthrene	S08B02	94	230000	NA	ND	1380000	NA
	S08B03	30			810		
	S08B04	67			NT		
	S08B06	46			NT		
	S08B09	110			NT		
	S08B11	65000			110		
	S08B12	3500			42000		
	S08B13	78			NT		
	S08B14	220			NT		
	S08B15	3000			NT		
	S08B17	2600			NT		
	S08B18	10000			NT		
	S08B19	44			NT		
	S08B20	55			ND		
	S08B21	ND			1700		
	S08B22	ND			790		
	S08B24	95			300		
	S08B25	87.5			39		
	S08B28	ND			4500		
	S08B30	140			590		
	S08B31	21500			ND		
	008SB001	130			NT		
	008SB003	1200			NT		
	636SB001	200			NT		
	636SB002	99			ND		
	636SB003	140			52		
	636SB004	ND			75		
	636SB005	270			48		
	636SB007	47			NT		
	636SB008	1700			NT		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Anthracene	S08B03	ND	2300000	NA	180	12000000	NA
	S08B11	16600			32		
	S08B12	210			7100		
	S08B14	36			NT		
	S08B15	90			NT		
	S08B17	1200			NT		
	S08B18	3500			NT		
	S08B21	ND			600		
	S08B22	ND			480		
	S08B24	ND			73		
	S08B28	ND			1200		
	S08B30	ND			110		
	S08B31	7200			ND		
	008SB003	220			NT		
	636SB001	79			NT		
	636SB002	51			ND		
	636SB003	50			ND		
	636SB008	100			NT		
	636SB011	48			NT		
Carbazole	S08B03	ND	32000	NA	93	600	NA
	S08B11	3595			NT		
	S08B15	190			NT		
	S08B17	260			NT		
	S08B18	1200			NT		
	S08B28	ND			320		
	S08B31	1900			ND		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Fluoranthene	S08B03	59.5	310000	NA	1100	4300000	NA
	S08B04	44			NT		
	S08B05	130			NT		
	S08B06	39			NT		
	S08B07	46			NT		
	S08B09	310			NT		
	S08B10	46			NT		
	S08B11	110500			400		
	S08B12	5300			7500		
	S08B13	60			NT		
	S08B14	290			NT		
	S08B15	2200			NT		
	S08B16	210			NT		
	S08B17	2750			NT		
	S08B18	12000			NT		
	S08B19	69			24		
	S08B20	ND			78		
	S08B21	ND			350		
	S08B22	ND			1100		
	S08B23	ND			68		
	S08B24	ND			670		
	S08B25	195			ND		
	S08B26	35			ND		
	S08B27	150			ND		
	S08B28	64			3700		
	S08B29	41			NT		
	S08B30	170			83		
	S08B31	29500			42		
	008SB003	1900			NT		
	636SB001	270			NT		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Fluoranthene (continued)	636SB002	275	310000	NA	ND	4300000	NA
	636SB003	480			130		
	636SB004	ND			150		
	636SB005	53			130		
	636SB006	57			NT		
	636SB007	130			NT		
	636SB008	2700			NT		
	636SB009	41			ND		
	636SB010	42			NT		
	636SB011	370			NT		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Pyrene	S08B01	490	230000	NA	NT	4200000	NA
	S08B03	49			1100		
	S08B04	88			NT		
	S08B05	140			NT		
	S08B07	48			NT		
	S08B09	310			NT		
	S08B10	49			NT		
	S08B11	107500			400		
	S08B12	5600			30000		
	S08B13	180			NT		
	S08B14	620			NT		
	S08B15	3700			NT		
	S08B16	360			NT		
	S08B17	3000			NT		
	S08B18	13000			NT		
	S08B19	150			64		
	S08B21	ND			2300		
	S08B22	ND			2900		
	S08B23	ND			53		
	S08B24	ND			2300		
	S08B25	210			54		
	S08B26	49			1300		
	S08B27	280			67		
	S08B28	64			5800		
	S08B29	47			NT		
	S08B30	150			290		
	S08B31	27000			53		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Pyrene (continued)	008SB001	42	230000	NA	NT	4200000	NA
	008SB003	2500			NT		
	636SB001	220			NT		
	636SB002	280			ND		
	636SB003	550			120		
	636SB004	ND			130		
	636SB005	52			110		
	636SB006	120			NT		
	636SB007	180			NT		
	636SB008	2600			NT		
	636SB009	49			120		
	636SB010	47			NT		
	636SB011	250			NT		
Butylbenzylphthalate	S08B05	62	1600000	NA	NT	930000	NA
	S08B14	52			NT		
	636SB006	130			NT		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Benzo(a)anthracene	S08B03	ND	880	NA	590	2000	NA
	S08B09	140			NT		
	S08B11	**430200**			180		
	S08B12	660			ND		
	S08B15	200			NT		
	S08B17	**1950**			NT		
	S08B18	**7700**			NT		
	S08B21	ND			200		
	S08B24	ND			460		
	S08B28	ND			**2400**		
	S08B31	**16000**			ND		
	008SB003	**940**			NT		
	636SB001	130			NT		
	636SB002	182			ND		
	636SB003	270			62		
	636SB004	ND			67		
	636SB005	39			56		
	636SB006	47			NT		
	636SB007	83			NT		
	636SB008	240			NT		
	636SB011	170			NT		
	636SB014	ND			**49**		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Chrysene	S08B03	55.5	88000	NA	660	160000	NA
	S08B05	100			NT		
	S08B09	200			NT		
	S08B11	45000			ND		
	S08B12	2600			9300		
	S08B14	260			NT		
	S08B15	620			NT		
	S08B16	380			NT		
	S08B17	2150			NT		
	S08B18	7600			NT		
	S08B19	64			ND		
	S08B23	ND			46		
	S08B24	ND			670		
	S08B25	68			ND		
	S08B26	ND			320		
	S08B27	130			ND		
	S08B28	ND			2300		
	S08B30	ND			120		
	S08B31	19000			ND		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Chrysene (continued)	008SB003	1100	88000	NA	NT	160000	NA
	636SB001	180			NT		
	636SB002	210			ND		
	636SB003	360			76		
	636SB004	ND			130		
	636SB005	52			88		
	636SB006	62			NT		
	636SB007	120			NT		
	636SB008	790			NT		
	636SB009	38			ND		
	636SB010	45			NT		
	636SB011	200			NT		
	636SB014	ND			65		
bis(2-Ethylhexyl)phthalate	S08B04	50	46000	NA	NT	3600000	NA
	S08B05	320			NT		
	S08B07	80			NT		
	S08B10	110			NT		
	S08B14	370			NT		
	S08B16	140			NT		
	S08B19	78			ND		
	636SB002	420			NT		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Benzo(b)fluoranthene	S08B02	27	880	NA	ND	5000	NA
	S08B03	54.5			1300		
	S08B04	44			NT		
	S08B05	86			NT		
	S08B09	190			NT		
	S08B11	**41750**			210		
	S08B12	**2700**			ND		
	S08B15	400			NT		
	S08B16	130			NT		
	S08B17	**2000**			NT		
	S08B18	**9200**			NT		
	S08B19	98			84		
	S08B22	ND			760		
	S08B23	ND			67		
	S08B24	ND			630		
	S08B26	ND			120		
	S08B28	ND			2400		
	S08B31	**18000**			ND		
	008SB003	800			NT		
	636SB001	270			NT		
	636SB002	215			ND		
	636SB003	490			85		
	636SB004	ND			130		
	636SB005	42			120		
	636SB006	54			NT		
	636SB007	120			NT		
	636SB008	420			NT		
	636SB009	46			ND		
	636SB011	140			NT		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Benzo(k)fluoranthene	S08B03	ND	8800	NA	370	49000	NA
	S08B11	**20750**			100		
	S08B12	760			5100		
	S08B14	70			NT		
	S08B15	180			NT		
	S08B17	775			NT		
	S08B18	2800			NT		
	S08B27	120			ND		
	S08B28	ND			730		
	S08B31	7400			ND		
	008SB003	830			NT		
	636SB001	160			NT		
	636SB002	180			ND		
	636SB003	270			70		
	636SB004	ND			110		
	636SB005	ND			71		
	636SB006	48			NT		
	636SB007	100			NT		
	636SB008	300			NT		
	636SB009	40			ND		
	636SB011	100			NT		
	636SB014	ND			56		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Benzo(a)pyrene	S08B01	**450**	88	NA	NT	8000	NA
	S08B03	ND			790		
	S08B04	46			NT		
	S08B05	36			NT		
	S08B09	**100**			NT		
	S08B11	**31600**			140		
	S08B12	**480**			3800		
	S08B14	**110**			NT		
	S08B15	**120**			NT		
	S08B16	65			NT		
	S08B17	**1560**			NT		
	S08B18	**6700**			NT		
	S08B19	59			ND		
	S08B21	ND			490		
	S08B22	ND			850		
	S08B23	ND			35		
	S08B26	ND			160		
	S08B28	ND			1600		
	S08B30	ND			57.5		
	S08B31	**14000**			ND		
	008SB003	**730**			NT		
	636SB001	**200**			NT		
	636SB002	**187**			ND		
	636SB003	**360**			78		
	636SB004	ND			72		
	636SB005	ND			69		
	636SB006	56			NT		
	636SB007	**98**			NT		
	636SB008	**190**			NT		
	636SB009	38			ND		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Benzo(a)pyrene (continued)	636SB011	**140**	88	NA	NT	8000	NA
	636SB014	ND			50		
Indeno(1,2,3-cd)pyrene	S08B03	ND	880	NA	540	14000	NA
	S08B11	**18400**			ND		
	S08B14	99			NT		
	S08B17	850			NT		
	S08B18	**2600**			NT		
	S08B24	ND			250		
	S08B28	ND			760		
	S08B31	**6950**			ND		
	008SB003	290			NT		
	636SB001	130			NT		
	636SB002	190			ND		
	636SB003	170			ND		
	636SB004	ND			58		
	636SB005	ND			45		
	636SB006	52			NT		
	636SB007	82			NT		
	636SB008	140			NT		
	636SB009	38			ND		
	636SB011	85			NT		
Dibenz(a,h)anthracene	S08B03	ND	88	NA	150	2000	NA
	S08B11	**4555**			ND		
	S08B17	**260**			NT		
	S08B18	**830**			NT		
	S08B31	**2400**			ND		
	636SB001	42			NT		
	636SB002	80			ND		
	636SB003	53			ND		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Benzo(g,h,i)perylene	S08B03	ND	230000	NA	570	4.66E08	NA
	S08B11	15850			ND		
	S08B14	120			NT		
	S08B15	94			NT		
	S08B17	740			NT		
	S08B18	2100			NT		
	S08B24	ND			160		
	S08B28	ND			750		
	S08B31	5750			ND		
	008SB003	320			NT		
	636SB001	120			NT		
	636SB002	175			ND		
	636SB003	160			ND		
	636SB004	ND			60		
	636SB005	ND			44		
	636SB006	89			NT		
	636SB007	87			NT		
	636SB008	150			NT		
	636SB009	38			ND		
	636SB011	90			NT		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Pesticides/PCBs (µg/kg)							
Dieldrin	S08B01	8.5	40	NA	NT	4	NA
	S08B03	ND			**610**		
	S08B11	**46**			ND		
	S08B22	ND			**66**		
	S08B28	ND			**7.9**		
	008SB002	5.2			NT		
Aldrin	S08B11	41	380000	NA	ND	500	NA
	S08B12	ND			7.6		
Heptachlor	S08B09	3.9	140	NA	NT	23000	NA
Heptachlor epoxide	S08B01	5.1	70	NA	NT	700	NA
	S08B03	ND			250		
	S08B06	2.2			NT		
	S08B09	11			NT		
	S08B19	1.8			ND		
	S08B31	2.6			ND		
Endrin	S08B21	ND	2300	NA	47	1000	NA
	636SB005	ND			8.7		
Endrin aldehyde	S08B12	ND	2300	NA	71	1000	NA
	S08B14	4			NT		
	S08B22	ND			55		
	S08B24	ND			25		
Endrin ketone	S08B01	4.5	2300	NA	NT	1000	NA
	S08B28	ND			6		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Endosulfan II	S08B22	ND	47000	NA	19	18000	NA
4,4'-DDE	S08B01	13	1900.0	NA	NT	54000	NA
	S08B03	ND			43		
	S08B06	15			NT		
	S08B14	12			NT		
	S08B16	28			NT		
	S08B17	17			NT		
	S08B18	5.2			NT		
	S08B19	35			110		
	S08B22	ND			38		
	S08B24	ND			47		
	S08B27	ND			4.4		
	S08B28	ND			27		
	S08B31	77			ND		
	636SB001	11			NT		
	636SB002	117.5			ND		
	636SB003	5.7			ND		
	636SB004	ND			120		
	636SB005	14			ND		
	636SB006	45			NT		
	636SB007	5.2			NT		
	636SB008	22			NT		
	636SB009	17			ND		
	636SB011	6.5			NT		
	636SB013	3.1			ND		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
4,4'-DDD	S08B01	45	2700	NA	NT	16000	NA
	S08B04	8.4			NT		
	S08B14	38			NT		
	S08B16	24			NT		
	S08B17	7.8			NT		
	S08B22	ND			71		
	S08B24	ND			130		
	S08B26	ND			23		
	S08B28	ND			58		
	S08B31	28.5			ND		
	636SB001	7.3			NT		
	636SB002	179			ND		
	636SB004	ND			180		
	636SB006	12			NT		
	636SB007	9.6			NT		
	636SB008	20			NT		
	636SB009	24			NT		
	636SB011	5			NT		
	636SB014	3.1			ND		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
4,4'-DDT	S08B06	6.6	1900	NA	NT	32000	NA
	S08B19	29			200		
	S08B31	25			ND		
	008SB003	6.3			NT		
	636SB002	16			ND		
	636SB003	3.8			ND		
	636SB004	ND			34		
	636SB006	8.7			NT		
	636SB007	15			NT		
	636SB008	38			NT		
	636SB011	8.7			NT		
alpha-Chlordane	S08B03	ND	1800	NA	240	10000	NA
	S08B09	11			NT		
	S08B12	2.8			21		
	S08B16	7.3			NT		
	S08B17	7.3			NT		
	S08B24	ND			4.2		
	S08B31	11			ND		
	636SB002	3.2			ND		
	636SB005	3.8			ND		
	636SB006	3.4			NT		
	636SB007	2.2			NT		
	636SB008	3.1			NT		
	636SB009	6.3			ND		
	636SB011	4.2			NT		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
gamma-Chlordane	S08B01	3.7	1800	NA	NT	10000	NA
	S08B03	3			ND		
	S08B06	4.4			NT		
	S08B07	2.8			NT		
	S08B08	4.5			NT		
	S08B09	51			NT		
	S08B12	4.4			ND		
	S08B16	22			NT		
	S08B17	33			NT		
	S08B19	5.1			8.4		
	S08B22	ND			34		
	S08B24	ND			19		
	S08B26	ND			8		
	S08B27	ND			2.8		
	S08B28	ND			14		
	S08B31	95.5			ND		
	008SB003	9.2			NT		
	636SB001	5.4			NT		
	636SB002	11.8			ND		
	636SB003	2.1			ND		
	636SB004	3.6			24		
	636SB005	20			ND		
	636SB006	4.6			NT		
	636SB007	11			NT		
	636SB008	19			NT		
	636SB009	51			ND		
	636SB011	5.3			NT		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Aroclor-1260	S08B08	77	320	NA	NT	1000	NA
	S08B12	ND			570		
	636SB004	ND			410		
	636SB005	320			ND		
	636SB007	**350**			NT		
	636SB008	**920**			NT		
	636SB009	69			ND		
	636SB010	12			NT		
	636SB011	36			NT		
	636SB012	8.5			NT		
	636SB013	28			ND		
Explosives/Propellants (µg/kg)							
Hydrazine	008SB001	**274**	210	NA	NT	0.088	NA
	008SB002	88.4			NT		
	008SB003	76.4			NT		
	636SB002	19.1			**67**		
	636SB003	19.3			ND		
	636SB004	ND			**13.9**		
	636SB005	ND			**19.1**		
	636SB006	12.8			NT		
	636SB008	14.4			NT		
Dioxins (ng/kg)							
Dioxin (2,3,7,8-TCDD TEQs)[1]	636SB002	3.8765	1000	NA	NT	1900	NA

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Inorganics (mg/kg)							
Aluminium (Al)	S08B01	1700	7800.0	18700	NA	1000000	23600
	S08B02	4500			5600		
	S08B03	3650			8700		
	S08B04	2700			NT		
	S08B05	4000			NT		
	S08B06	2500			NT		
	S08B07	3900			NT		
	S08B08	4400			NT		
	S08B09	5100			NT		
	S08B10	2600			NT		
	S08B11	6705			9400		
	S08B12	2200			4700		
	S08B13	8100			NT		
	S08B14	1300			NT		
	S08B15	2400			NT		
	S08B16	1900			NT		
	S08B17	3625			NT		
	S08B18	2200			NT		
	S08B19	3100			3700		
	S08B20	2000			9900		
	S08B21	3900			7700		
	S08B22	2800			3400		
	S08B23	4200			17000		
	S08B24	1300			3600		
	S08B25	1130			3200		
	S08B26	12000			3900		
	S08B27	860			820		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Aluminum (Al) (continued)	S08B28	600	7800.0	18700	5900	1000000	23600
	S08B29	640			NT		
	S08B30	710			3175		
	S08B31	4605			14000		
	008SB001	3970			NT		
	008SB002	5230			NT		
	008SB003	5440			NT		
	636SB001	5900			NT		
	636SB002	6435			8110		
	636SB003	12100			12300		
	636SB004	2690			10100		
	636SB005	2200			11700		
	636SB006	3950			NT		
	636SB007	7450			NT		
	636SB008	10100			NT		
	636SB009	5360			36500		
	636SB010	6770			NT		
	636SB011	3890			NT		
	636SB012	1840			NT		
	636SB013	9510			12800		
	636SB014	8330			16600		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Antimony (Sb)	S08B03	ND	3.1	2.89	**32**	5	NL
	S08B11	**7.4**			ND		
	S08B14	**7.6**			NT		
	S08B22	ND			**23**		
	S08B24	ND			**21**		
	S08B31	ND			**7.6**		
	636SB009	**6.4**			ND		
	636SB010	0.66			NT		
	636SB011	1.5			NT		
	636SB013	ND			0.65		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Arsenic (As)	S08B01	10	0.43	17.2[a]	NT	29	15.5[a]
	S08B02	**20**			8		
	S08B03	2.95			21		
	S08B04	5.6			NT		
	S08B05	1.6			NT		
	S08B06	5			NT		
	S08B07	1.9			NT		
	S08B08	6.9			NT		
	S08B09	5.9			NT		
	S08B10	3.1			NT		
	S08B11	9.3			9.6		
	S08B12	2.2			2.2		
	S08B13	8.6			NT		
	S08B14	6.2			NT		
	S08B15	2.2			NT		
	S08B16	3.5			NT		
	S08B17	7.05			NT		
	S08B18	3.8			NT		
	S08B19	5.9			5.7		
	S08B20	8.4			12		
	S08B21	3.6			ND		
	S08B22	2.6			6.6		
	S08B23	ND			12		
	S08B24	**150**			7.9		
	S08B25	7.9			ND		
	S08B26	7.6			2.8		
	S08B27	4			3		
	S08B28	3.8			6.5		
	S08B29	2.1			NT		
	S08B30	3			1.45		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Arsenic (As) (continued)	S08B31	8.85	0.43	17.2[a]	7.6	29	15.5[a]
	008SB001	12.7			NT		
	008SB002	1.5			NT		
	008SB003	6.7			NT		
	636SB001	7.1			NT		
	636SB002	7.05			5.1		
	636SB003	11.4			13.5		
	636SB004	2.7			9.2		
	636SB005	22.8			12.3		
	636SB006	2.3			NT		
	636SB007	5.1			NT		
	636SB008	6.7			NT		
	636SB009	5.5			18.4		
	636SB010	22.4			NT		
	636SB011	4.7			NT		
	636SB012	2.1			NT		
	636SB013	17.2			13.2		
	636SB014	1.2			8.4		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Barium (Ba)	S08B01	29	550.0	109	NT	1600	64.5
	S08B02	63			27		
	S08B03	11.15			500		
	S08B04	15			NT		
	S08B05	7.6			NT		
	S08B06	52			NT		
	S08B07	9.1			NT		
	S08B08	28			NT		
	S08B09	28			NT		
	S08B10	14			NT		
	S08B11	58.1			93		
	S08B12	14			69		
	S08B13	28			NT		
	S08B14	36			NT		
	S08B15	13			NT		
	S08B16	13			NT		
	S08B17	50.6			NT		
	S08B18	34			NT		
	S08B19	45			13		
	S08B20	42			40		
	S08B21	12			35		
	S08B22	15			100		
	S08B23	3.7			39		
	S08B24	120			77		
	S08B25	7.0			4.8		
	S08B26	20			12		
	S08B27	4.8			5.6		
	S08B28	4.3			62		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Barium (Ba) (continued)	S08B29	5	550.0	109	NT	1600	64.5
	S08B30	5			7.1		
	S08B31	67.1			40		
	008SB001	16.2			NT		
	008SB002	7.9			NT		
	008SB003	24.5			NT		
	636SB001	35.7			NT		
	636SB002	48.1			25.7		
	636SB003	26.3			35.8		
	636SB004	10.4			37.6		
	636SB005	52.4			29.4		
	636SB006	10.9			NT		
	636SB007	99.1			NT		
	636SB008	48.0			NT		
	636SB009	39.0			43.6		
	636SB010	43.7			NT		
	636SB011	28.8			NT		
	636SB012	11.9			NT		
	636SB013	34.3			40.7		
	636SB014	7.1			72.2		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Beryllium (Be)	S08B11	ND	0.15	1.20	1.0	63	1.63
	S08B22	ND			0.6		
	S08B23	ND			1.2		
	S08B24	0.69			ND		
	008SB001	0.23			ND		
	008SB002	0.13			ND		
	008SB003	0.35			ND		
	636SB001	0.38			ND		
	636SB002	0.41			0.28		
	636SB003	0.66			0.71		
	636SB004	0.25			0.57		
	636SB005	0.51			0.82		
	636SB006	0.18			NT		
	636SB007	0.35			NT		
	636SB008	0.48			NT		
	636SB009	1.0			1.6		
	636SB010	0.53			NT		
	636SB011	0.22			NT		
	636SB012	0.18			NT		
	636SB013	0.85			0.91		
	636SB014	0.14			0.77		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Cadmium (Cd)	S08B03	ND	3.9	1.07	5.9	8	0.48
	S08B08	0.7			NT		
	S08B11	1.85			ND		
	S08B12	0.63			2.0		
	S08B14	1.1			NT		
	S08B17	0.77			NT		
	S08B19	0.59			ND		
	S08B20	ND			1.6		
	S08B21	ND			1.0		
	S08B22	ND			1.2		
	S08B23	ND			2.0		
	S08B24	ND			1.2		
	S08B29	0.6			NT		
	008SB003	0.21			NT		
	636SB001	0.56			NT		
	636SB002	0.33			ND		
	636SB003	0.20			0.29		
	636SB004	0.26			0.39		
	636SB005	0.12			0.67		
	636SB006	0.22			NT		
	636SB007	0.41			NT		
	636SB008	0.41			NT		
	636SB009	0.49			0.46		
	636SB010	0.24			NT		
	636SB011	0.32			NT		
	636SB012	0.37			NT		
	636SB013	0.11			0.1		
	636SB014	ND			0.19		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Calcium (Ca)	S08B01	11000	NL	NL	NT	NL	NL
	S08B02	11000			170000		
	S08B03	23500			11000		
	S08B04	190000			NT		
	S08B05	10000			NT		
	S08B06	88000			NT		
	S08B07	7500			NT		
	S08B08	19000			NT		
	S08B09	18000			NT		
	S08B10	43000			NT		
	S08B11	9950			5000		
	S08B12	210000			74000		
	S08B13	58000			NT		
	S08B14	38000			NT		
	S08B15	140000			NT		
	S08B16	65000			NT		
	S08B17	43850			NT		
	S08B18	160000			NT		
	S08B19	57000			39000		
	S08B20	79000			45000		
	S08B21	8800			43000		
	S08B22	56000			47000		
	S08B23	5800			16000		
	S08B24	50000			20000		
	S08B25	257500			8700		
	S08B26	41000			24000		
	S08B27	330000			18000		
	S08B28	320000			81000		
	S08B29	330000			NT		
	S08B30	330000			35450		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Calcium (Ca) (continued)	S08B3101	98500	NL	NL	55000	NL	NL
	008SB001	4760			NT		
	008SB002	6270			NT		
	008SB003	9470			NT		
	636SB001	39400			NT		
	636SB002	23900			1660		
	636SB003	35900			32000		
	636SB004	156000			25300		
	636SB005	7920			51300		
	636SB006	34300			NT		
	636SB007	10000			NT		
	636SB008	26500			NT		
	636SB009	15700			14700		
	636SB010	54400			NT		
	636SB011	50700			NT		
	636SB012	236000			NT		
	636SB013	18400			18400		
	636SB014	4090			9890		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Chromium (Cr)	S08B01	21	39 VI	42.8	NT	1000000	43.4[a]
	S08B02	6.5	7800 III		34		
	S08B03	6.1			103		
	S08B04	6.6			NT		
	S08B05	8			NT		
	S08B06	7.8			NT		
	S08B07	6.5			NT		
	S08B08	20			NT		
	S08B09	17			NT		
	S08B10	8.2			NT		
	S08B11	40.9			23		
	S08B12	18			22		
	S08B13	27			NT		
	S08B14	37			NT		
	S08B15	11			NT		
	S08B17	**52**			NT		
	S08B18	**48**			NT		
	S08B19	25			14		
	S08B20	4.2			33		
	S08B21	4.5			35		
	S08B22	3.7			26		
	S08B23	4.5			49		
	S08B24	5.4			32		
	S08B25	6.25			5.1		
	S08B26	24			9.9		
	S08B27	11			5.1		
	S08B28	5.6			60		
	S08B29	4.1			NT		
	S08B30	5			5.75		
	S08B31	**103**			29		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Chromium (Cr) (continued)	008SB001	4.9	39 VI	42.8	NT	1000000	43.4[a]
	008SB002	5.8	7800 III		NT		
	008SB003	12.3			NT		
	636SB001	19.2			NT		
	636SB002	13.25			12.4		
	636SB003	24.2			24.1		
	636SB004	5.8			23.1		
	636SB005	4.6			36.4		
	636SB006	6.5			NT		
	636SB007	13.8			NT		
	636SB008	26.0			NT		
	636SB009	**64.2**			54.4		
	636SB010	15.9			NT		
	636SB011	8.6			NT		
	636SB012	5.0			NT		
	636SB013	19.2			27.0		
	636SB014	7.3			25.4		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Cobalt (Co)	S08B01	7.3	470.0	6.60	NT	2000	8.14
	S08B02	1.4			1.5		
	S08B03	1.2			12		
	S08B04	2.1			NT		
	S08B06	1.4			NT		
	S08B08	1.9			NT		
	S08B09	1.5			NT		
	S08B11	4.95			4.7		
	S08B12	3.4			3.5		
	S08B13	3.2			NT		
	S08B14	3.2			NT		
	S08B15	2.2			NT		
	S08B17	2.9			NT		
	S08B20	1.9			3.9		
	S08B21	ND			2.8		
	S08B22	ND			7		
	S08B23	1.2			7.9		
	S08B24	3			3.5		
	S08B25	2.35			ND		
	S08B26	3.6			ND		
	S08B27	2.4			ND		
	S08B28	2.3			3.6		
	S08B29	2.7			NT		
	S08B30	2.1			1.5		
	S08B31	7.35			4.3		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Cobalt (Co) (continued)	008SB002	0.55	470.0	6.60	NT	2000	8.14
	008SB003	2.20			NT		
	636SB001	1.8			NT		
	636SB002	9.95			1.9		
	636SB003	3.1			3.2		
	636SB004	14.0			2.7		
	636SB005	3.0			2.9		
	636SB006	0.95			NT		
	636SB007	1.5			NT		
	636SB008	5.7			NT		
	636SB009	11.9			9.4		
	636SB010	2.6			NT		
	636SB011	1.6			NT		
	636SB012	2.1			NT		
	636SB013	9.6			4.2		
	636SB014	0.96			4.2		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Copper (Cu)	S08B01	400	27000	260	NT	920	32.6
	S08B02	11			40		
	S08B03	20.5			**2700**		
	S08B04	17			NT		
	S08B05	7.9			NT		
	S08B06	12			NT		
	S08B07	4.7			NT		
	S08B08	120			NT		
	S08B09	96			NT		
	S08B10	33			NT		
	S08B11	159			84		
	S08B12	39			**14000**		
	S08B13	250			NT		
	S08B14	150			NT		
	S08B15	37			NT		
	S08B17	74.7			NT		
	S08B20	9.1			27		
	S08B21	ND			46		
	S08B22	ND			400		
	S08B23	ND			64		
	S08B24	17			350		
	S08B25	9.3			ND		
	S08B26	13			9.7		
	S08B27	3.1			ND		
	S08B28	3.5			71		
	S08B29	4.4			ND		
	S08B30	6.6			3.2		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Copper (Cu) (continued)	S08B31	81.55	27000	260	13	920	32.6
	008SB001	5.0			NT		
	008SB002	6.5			NT		
	008SB003	60.4			NT		
	636SB001	1330			NT		
	636SB002	19.5			2.4		
	636SB003	18.0			30.6		
	636SB004	15.3			109.0		
	636SB005	12.8			134.0		
	636SB006	45.7			NT		
	636SB007	515.0			NT		
	636SB008	68.5			NT		
	636SB009	235			33.7		
	636SB010	13.6			NT		
	636SB011	60.4			NT		
	636SB012	10.6			NT		
	636SB013	160			15.6		
	636SB014	0.76			26.6		
Cyanide (CN)	008SB003	0.3	160	0.38	NT	40	0.22
	636SB002	0.22			NT		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Iron (Fe)	S08B01	**8600**	2300	NL	NT	NL	NL
	S08B02	2200			53000		
	S08B03	**2900**			78000		
	S08B04	**3600**			NT		
	S08B05	1700			NT		
	S08B06	**3800**			NT		
	S08B07	**3400**			NT		
	S08B08	**7700**			NT		
	S08B09	**7900**			NT		
	S08B10	**2900**			NT		
	S08B11	**26900**			16000		
	S08B12	**4100**			15000		
	S08B13	**8800**			NT		
	S08B14	**5500**			NT		
	S08B15	**3500**			NT		
	S08B16	**4100**			NT		
	S08B17	**6065**			NT		
	S08B18	**4200**			NT		
	S08B19	**5700**			6100		
	S08B20	**3300**			76000		
	S08B21	2100			9400		
	S08B22	1600			11000		
	S08B23	1900			37000		
	S08B24	**3400**			7500		
	S08B25	**3325**			2300		
	S08B26	**14000**			3000		
	S08B27	**3800**			3500		
	S08B28	**2900**			6900		
	S08B29	2100			NT		
	S08B30	**2500**			3365		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Iron (Fe) (continued)	S08B31	**6730**	2300.0	NL	15000	NL	NL
	008SB001	1650			NT		
	008SB002	2070			NT		
	008SB003	**6760**			NT		
	636SB001	**7560**			NT		
	636SB002	**7400**			11300		
	636SB003	**14600**			14700		
	636SB004	**3460**			10800		
	636SB005	**4470**			14100		
	636SB006	**2770**			NT		
	636SB007	**8600**			NT		
	636SB008	**10500**			NT		
	636SB009	**12200**			37500		
	636SB010	**6730**			NT		
	636SB011	**4900**			NT		
	636SB012	**2450**			NT		
	636SB013	**10200**			16800		
	636SB014	1790			14400		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Lead (Pb)	S08B01	310	400.0	181	NT	400	66.3
	S08B02	11			9.8		
	S08B03	8.15			**1400**		
	S08B04	19			NT		
	S08B05	19			NT		
	S08B06	41			NT		
	S08B07	6.8			NT		
	S08B08	76			NT		
	S08B09	53			NT		
	S08B10	21			NT		
	S08B11	187			40		
	S08B12	29			**630**		
	S08B13	34			NT		
	S08B14	230			NT		
	S08B15	41			NT		
	S08B16	340			NT		
	S08B17	160			NT		
	S08B18	23			NT		
	S08B19	180			120		
	S08B20	6.3			47		
	S08B21	6.1			37		
	S08B22	2.3			390		
	S08B23	29			38		
	S08B24	11			310		
	S08B25	11.4			3		
	S08B26	56			19		
	S08B27	15			2.4		
	S08B28	9.4			140		
	S08B29	4.4			NT		
	S08B30	8.5			7.0		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Lead (Pb) (continued)	S08B31	95.1	400.0	181	20	400	66.3
	008SB001	10.6			NT		
	008SB002	6.6			NT		
	008SB003	48.3			NT		
	636SB001	102			NT		
	636SB002	**453.5**			13.7		
	636SB003	42.2			40.1		
	636SB004	14.1			93.2		
	636SB005	6.9			19.0		
	636SB006	16.3			NT		
	636SB007	97.1			NT		
	636SB008	87.5			NT		
	636SB009	394			60.1		
	636SB010	51.8			NT		
	636SB011	43.9			NT		
	636SB012	5.9			NT		
	636SB013	66.2			42.1		
	636SB014	4.9			78.0		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Magnesium (Mg)	S08B01	420	NL	NL	NT	NL	NL
	S08B02	270			4400		
	S08B03	405			3800		
	S08B04	2000			NT		
	S08B05	260			NT		
	S08B06	1200			NT		
	S08B07	440			NT		
	S08B08	1400			NT		
	S08B09	1200			ND		
	S08B10	550			NT		
	S08B11	1570			2800		
	S08B12	2300			1000		
	S08B13	2200			NT		
	S08B14	610			NT		
	S08B15	2600			NT		
	S08B16	800			NT		
	S08B17	1890			NT		
	S08B18	3200			NT		
	S08B19	1100			2200		
	S08B20	990			2400		
	S08B21	260			1900		
	S08B22	670			1300		
	S08B23	140			4700		
	S08B24	620			1000		
	S08B25	2450			320		
	S08B26	2300			1000		
	S08B27	3200			420		
	S08B28	3100			3100		
	S08B29	3300			ND		
	S08B30	3100			669.5		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Magnesium (Mg) (continued)	S08B31	4100	NL	NL	4500	NL	NL
	008SB001	218			NT		
	008SB002	300			NT		
	008SB003	774			NT		
	636SB001	1700			NT		
	636SB002	1073.5			522		
	636SB003	2350			3090		
	636SB004	1610			2010		
	636SB005	250			3940		
	636SB006	830			NT		
	636SB007	1070			NT		
	636SB008	1990			NT		
	636SB009	1330			7770		
	636SB010	1530			NT		
	636SB011	702			NT		
	636SB012	2550			NT		
	636SB013	1370			2980		
	636SB014	262			2860		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Manganese (Mn)	S08B01	41	180.0	325	NT	1100	291
	S08B02	13			81		
	S08B03	25.5			520		
	S08B04	90			NT		
	S08B05	22			NT		
	S08B06	79			NT		
	S08B07	24			NT		
	S08B08	78			NT		
	S08B09	50			NT		
	S08B10	29			NT		
	S08B11	282			130		
	S08B12	150			90		
	S08B13	130			NT		
	S08B14	54			NT		
	S08B15	150			NT		
	S08B16	52			NT		
	S08B17	53.3			NT		
	S08B18	110			NT		
	S08B19	82			140		
	S08B20	69			210		
	S08B21	13			120		
	S08B22	36			100		
	S08B23	5.7			**1600**		
	S08B24	33			72		
	S08B25	133			18		
	S08B26	270			42		
	S08B27	180			69		
	S08B28	160			80		
	S08B29	270			NT		
	S08B30	170			30.4		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Manganese (Mn) (continued)	S08B31	113	180.0	325	140	1100	291
	008SB001	16.0			NT		
	008SB002	19.5			NT		
	008SB003	113			NT		
	636SB001	86.8			NT		
	636SB002	60.95			23.0		
	636SB003	253			186		
	636SB004	86.4			107		
	636SB005	21.8			425		
	636SB006	40.8			NT		
	636SB007	71.4			NT		
	636SB008	82.5			NT		
	636SB009	106			706		
	636SB010	80.7			NT		
	636SB011	75.9			NT		
	636SB012	154			NT		
	636SB013	37.3			229		
	636SB014	7.2			244		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Mercury (Hg)	S08B01	0.63	2.3	1.03	NT	2.1	0.31
	S08B02	0.03			0.067		
	S08B03	0.075			**6.9**		
	S08B04	0.023			NT		
	S08B05	0.044			NT		
	S08B06	0.065			NT		
	S08B07	0.042			NT		
	S08B08	0.62			NT		
	S08B09	0.2			NT		
	S08B10	0.086			NT		
	S08B11	0.63			0.12		
	S08B12	0.021			**5.1**		
	S08B13	0.13			NT		
	S08B14	0.19			NT		
	S08B15	0.11			NT		
	S08B16	0.033			NT		
	S08B17	0.14			NT		
	S08B18	0.027			NT		
	S08B19	0.037			0.056		
	S08B20	0.014			0.15		
	S08B21	0.027			0.073		
	S08B22	0.018			0.25		
	S08B23	0.017			0.15		
	S08B24	0.012			2.1		
	S08B25	0.03			ND		
	S08B26	0.074			0.058		
	S08B28	ND			0.13		
	S08B30	0.012			0.435		
	S08B31	0.15			0.058		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Mercury (Hg) (continued)	636SB001	0.07	2.3	1.03	NT	2.1	0.31
	636SB002	0.085			ND		
	636SB003	0.12			1.1		
	636SB004	0.13			0.35		
	636SB005	ND			0.19		
	636SB006	0.04			NT		
	636SB007	0.34			NT		
	636SB008	0.41			NT		
	636SB009	0.21			0.31		
	636SB010	0.26			NT		
	636SB011	0.32			NT		
	636SB012	0.25			NT		
	636SB013	0.06			0.21		
	636SB014	0.04			1.1		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Nickel (Ni)	S08B01	13	160.0	20.6	NT	130	18.3
	S08B02	ND			16		
	S08B03	ND			79		
	S08B04	6.9			NT		
	S08B06	5.8			NT		
	S08B08	8.1			NT		
	S08B09	9.3			ND		
	S08B11	20.15			8.9		
	S08B12	13			22		
	S08B13	25			NT		
	S08B14	13			NT		
	S08B15	8.5			NT		
	S08B16	5.6			NT		
	S08B17	13.95			NT		
	S08B18	9.9			NT		
	S08B19	13			5.8		
	S08B20	5.3			11		
	S08B21	ND			14		
	S08B22	ND			32		
	S08B23	ND			16		
	S08B24	6.5			21		
	S08B25	7.3			ND		
	S08B26	8.8			ND		
	S08B27	8.4			ND		
	S08B28	7.7			14		
	S08B29	8			NT		
	S08B30	7.4			5.1		
	S08B31	25.1			10		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Nickel (Ni) (continued)	008SB001	2.7	160.0	20.6	NT	130	18.3
	008SB002	2.2			NT		
	008SB003	8.2			NT		
	636SB001	7.8			NT		
	636SB002	5.9			1.6		
	636SB003	9.2			9.0		
	636SB004	5.5			9.0		
	636SB005	8.1			11.9		
	636SB006	27.0			NT		
	636SB007	5.1			NT		
	636SB008	8.4			NT		
	636SB009	34.4			17.1		
	636SB010	8.8			NT		
	636SB011	5.1			NT		
	636SB012	6.3			NT		
	636SB013	20.1			8.3		
	636SB014	1.9			8.7		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Baekground
Potassium (K)	S08B01	130	NL	NL	NT	NL	NL
	S08B02	110			730		
	S08B03	130			1200		
	S08B04	270			NT		
	S08B06	210			NT		
	S08B07	140			NT		
	S08B08	540			NT		
	S08B09	410			NT		
	S08B10	140			NT		
	S08B11	545			1400		
	S08B12	290			780		
	S08B13	630			NT		
	S08B14	150			NT		
	S08B15	320			NT		
	S08B16	160			NT		
	S08B17	603.5			NT		
	S08B18	660			NT		
	S08B19	230			330		
	S08B20	210			840		
	S08B21	120			1000		
	S08B22	140			410		
	S08B23	ND			2300		
	S08B24	190			390		
	S08B25	309			ND		
	S08B26	990			330		
	S08B27	440			170		
	S08B28	310			1200		
	S08B29	320			ND		
	S08B30	280			159		
	S08B31	1365			1700		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Potassium (K) (continued)	008SB003	318	NL	NL	NT	NL	NL
	636SB001	510			NT		
	636SB002	274			ND		
	636SB003	990			1420		
	636SB004	313			923		
	636SB005	ND			1260		
	636SB006	247			NT		
	636SB007	463			NT		
	636SB008	599			NT		
	636SB009	634			3970		
	636SB010	652			NT		
	636SB011	264			NT		
	636SB012	522			NT		
	636SB013	709			1560		
	636SB014	ND			1690		
Selenium (Se)	008SB001	0.48	39.0	1.22	NT	5	1.26
	008SB003	0.51			NT		
	636SB001	0.38			NT		
	636SB002	0.56			0.66		
	636SB003	0.73			0.59		
	636SB004	ND			0.81		
	636SB005	0.50			0.79		
	636SB008	0.74			ND		
	636SB009	ND			2.2		
	636SB010	0.35			NT		
	636SB013	0.85			0.90		
	636SB014	0.89			0.84		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Silver	S08B01	1.2	39	NL	NT	34	NL
	S08B03	ND			3.4		
	636SB009	ND			0.81		
Sodium (Na)	S08B01	110	NL	NL	NT	NL	NL
	S08B02	ND			1100		
	S08B03	435			3200		
	S08B04	290			NT		
	S08B06	170			NT		
	S08B07	370			NT		
	S08B08	650			NT		
	S08B09	310			NT		
	S08B10	690			NT		
	S08B11	301.5			3300		
	S08B12	240			450		
	S08B13	950			NT		
	S08B14	210			NT		
	S08B15	220			NT		
	S08B16	370			NT		
	S08B17	176.5			NT		
	S08B18	410			NT		
	S08B19	150			190		
	S08B20	150			2700		
	S08B21	220			1400		
	S08B22	150			920		
	S08B23	ND			3900		
	S08B24	140			710		
	S08B25	422			170		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Sodium (Na) (continued)	S08B26	1000	NL	NL	1200	NL	NL
	S08B27	240			870		
	S08B28	240			1100		
	S08B29	220			NT		
	S08B30	310			399		
	S08B31	662.5			4200		
	008SB002	240			NT		
	008SB003	275			NT		
	636SB001	635			NT		
	636SB003	748			3700		
	636SB004	ND			2260		
	636SB005	ND			2770		
	636SB007	1180			NT		
	636SB008	802			NT		
	636SB009	1580			11600		
	636SB010	553			NT		
	636SB011	793			NT		
	636SB012	342			NT		
	636SB013	646			3470		
	636SB014	723			2160		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Thallium (Tl)	008SB003	0.65	0.63	0.85	NT	0.95	0.95
	636SB001	0.82			NT		
	636SB002	0.42			ND		
	636SB003	**0.92**			0.61		
	636SB005	ND			0.88		
	636SB009	0.73			**1.0**		
	636SB010	0.59			NT		
	636SB013	ND			0.90		
	636SB014	ND			0.54		
Tin (Sn)	636SB009	34.2	4700	9.67	ND	11000	2.96
	636SB010	1.1			NT		
	636SB011	4.2			NT		
	636SB012	1.1			NT		
	636SB014	0.75			ND		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Vanadium (V)	S08B01	6.5	55.0	60.9	NT	6000	72.5
	S08B02	8.4			22		
	S08B03	6.7			96		
	S08B04	6.1			NT		
	S08B05	13			NT		
	S08B06	6.9			NT		
	S08B07	6.3			NT		
	S08B08	18			NT		
	S08B09	13			NT		
	S08B10	6.2			NT		
	S08B11	28.3			25		
	S08B12	14			15		
	S08B13	28			NT		
	S08B14	8			NT		
	S08B15	20			NT		
	S08B16	15			NT		
	S08B17	24.25			NT		
	S08B18	9			NT		
	S08B19	13			13		
	S08B20	6.8			30		
	S08B21	4.3			27		
	S08B22	3.3			58		
	S08B23	4.2			16		
	S08B24	8.7			26		
	S08B25	5.25			4		
	S08B26	28			9.3		
	S08B27	8.1			4.9		
	S08B28	4.4			20		
	S08B29	5.8			NT		
	S08B30	4			5.15		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Vanadium (V) (continued)	S08B31	17.75	55.0	60.9	33	6000	72.5
	008SB001	4.2			NT		
	008SB002	5.0			NT		
	008SB003	13.3			NT		
	636SB001	20.7			NT		
	636SB002	15.6			19.6		
	636SB003	30.4			31.7		
	636SB004	5.5			25.7		
	636SB005	12.7			30.8		
	636SB006	7.6			NT		
	636SB007	16.8			NT		
	636SB008	21.2			NT		
	636SB009	15.8			82.0		
	636SB010	18.5			NT		
	636SB011	9.5			NT		
	636SB012	9.5			NT		
	636SB013	23.6			30.6		
	636SB014	6.9			33.7		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Zinc (Zn)	S08B01	500	2300.0	519	NT	12000	145
	S08B02	8.7			110		
	S08B03	27.5			2300		
	S08B04	19			NT		
	S08B05	39			NT		
	S08B06	53			NT		
	S08B07	13			NT		
	S08B08	190			NT		
	S08B09	120			NT		
	S08B10	44			NT		
	S08B11	609.5			130		
	S08B12	110			3300		
	S08B13	170			NT		
	S08B14	640			NT		
	S08B15	54			NT		
	S08B16	87			NT		
	S08B17	157			NT		
	S08B18	93			NT		
	S08B19	130			50		
	S08B20	16			62		
	S08B21	2.8			69		
	S08B22	4.9			810		
	S08B23	5.7			110		
	S08B24	9.7			550		
	S08B25	23.9			4.9		
	S08B26	40			26		
	S08B27	23			6.7		
	S08B28	16			160		
	S08B29	14			NT		
	S08B30	18			10.4		

Table 10.6.5
Zone G
SWMU 8 and AOC 636
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Zinc (Zn) (continued)	S08B31	223	2300.0	519	54	12000	145
	008SB001	6.5			NT		
	008SB002	13.4			NT		
	008SB003	124			NT		
	636SB001	179			NT		
	636SB002	271.5			15.7		
	636SB003	50.6			88.1		
	636SB004	33.7			231		
	636SB005	15.7			87.5		
	636SB006	38.3			NT		
	636SB007	196			NT		
	636SB008	140			NT		
	636SB009	1270			150		
	636SB010	35.9			NT		
	636SB011	195			NT		
	636SB012	30.5			NT		
	636SB013	109			75.7		
	636SB014	3.1			98.6		

Notes:

a	=	Background value for non-clay samples
*	=	Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil to groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as a reference concentration for lower interval samples
1	=	Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995c)
ND	=	Not detected
NT	=	Not taken
NL	=	Not listed
NA	=	Not applicable
µg/kg	=	Micrograms per kilogram
mg/kg	=	Milligrams per kilogram

Bolded concentrations exceed both the reference concentration (RBC or SSL) and the zone background
All background values for Zone G are based on twice the means of the grid sample concentrations

Volatile Organic Compounds in Soil

Eight VOCs were detected in surface soil samples at SWMU 8 and AOC 636. No surface soil VOC concentrations exceeded their respective RBCs. Eleven VOCs were detected in subsurface soil samples at SWMU 8 and AOC 636. 1,1,2,2-trichloroethane and 1,1,2-trichloroethane exceeded their respective SSL in subsurface soil samples at this site. Figure 10.6-5 presents subsurface soil 1,1,2,2-tetrachloroethane at SWMU 8 and AOC 636, while Figure 10.6-6 presents subsurface soil 1,1,2-trichloroethane at the site.

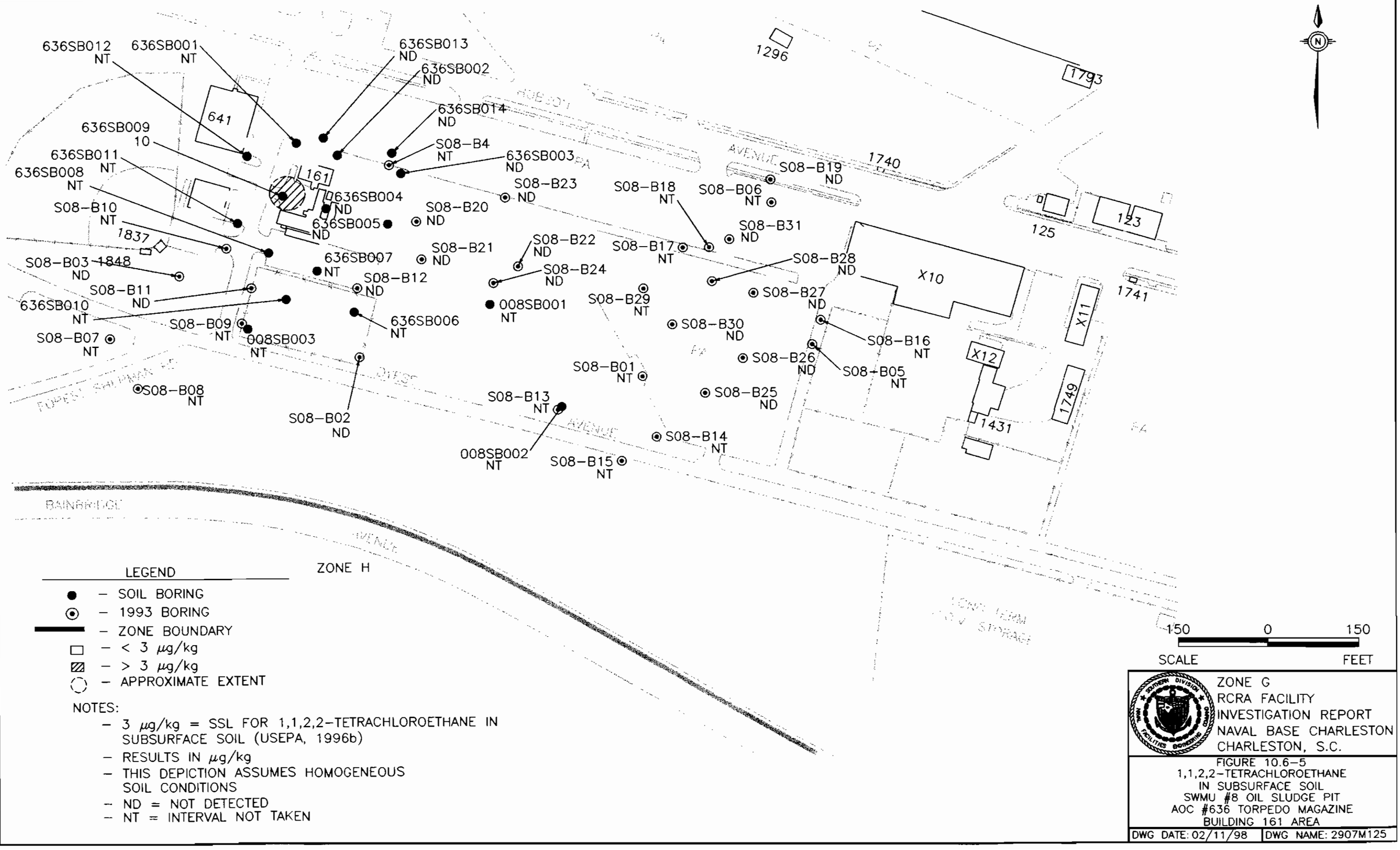
Semivolatile Organic Compounds in Soil

Twenty-four SVOCs were detected in surface soil samples at SWMU 8 and AOC 636. Benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, and dibenz(a,h)anthracene exceeded their respective RBCs in surface soil samples at this AOC. Figure 10.6-7 presents total BEQ concentrations detected in surface soil at SWMU 8 and AOC 636.

Nineteen SVOCs were detected in subsurface soil samples at SWMU 8 and AOC 636. Benzo(a)anthracene exceeded its respective SSL in subsurface soil samples at this site. Figure 10.6-8 presents benzo(a)anthracene in subsurface soil at SWMU 8 and AOC 636.

Pesticides and PCBs in Soil

Eleven pesticides were detected in surface soil samples at SWMU 8 and AOC 636. Dieldrin was detected at a concentration exceeding its respective RBC. Figure 10.6-9 presents dieldrin in surface soil at SWMU 8 and AOC 636. Aroclor-1260 was also detected in surface soil at concentrations above its RBC. Figure 10.6-10 shows Aroclor-1260 in surface soil at SWMU 8 and AOC 636.



LEGEND

- ● – SOIL BORING
- ⊙ – 1993 BORING
- ▬ – ZONE BOUNDARY
- □ – < 3 µg/kg
- ▨ – > 3 µg/kg
- ◌ – APPROXIMATE EXTENT

NOTES:

- 3 µg/kg = SSL FOR 1,1,2,2–TETRACHLOROETHANE IN SUBSURFACE SOIL (USEPA, 1996b)
- RESULTS IN µg/kg
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- ND = NOT DETECTED
- NT = INTERVAL NOT TAKEN

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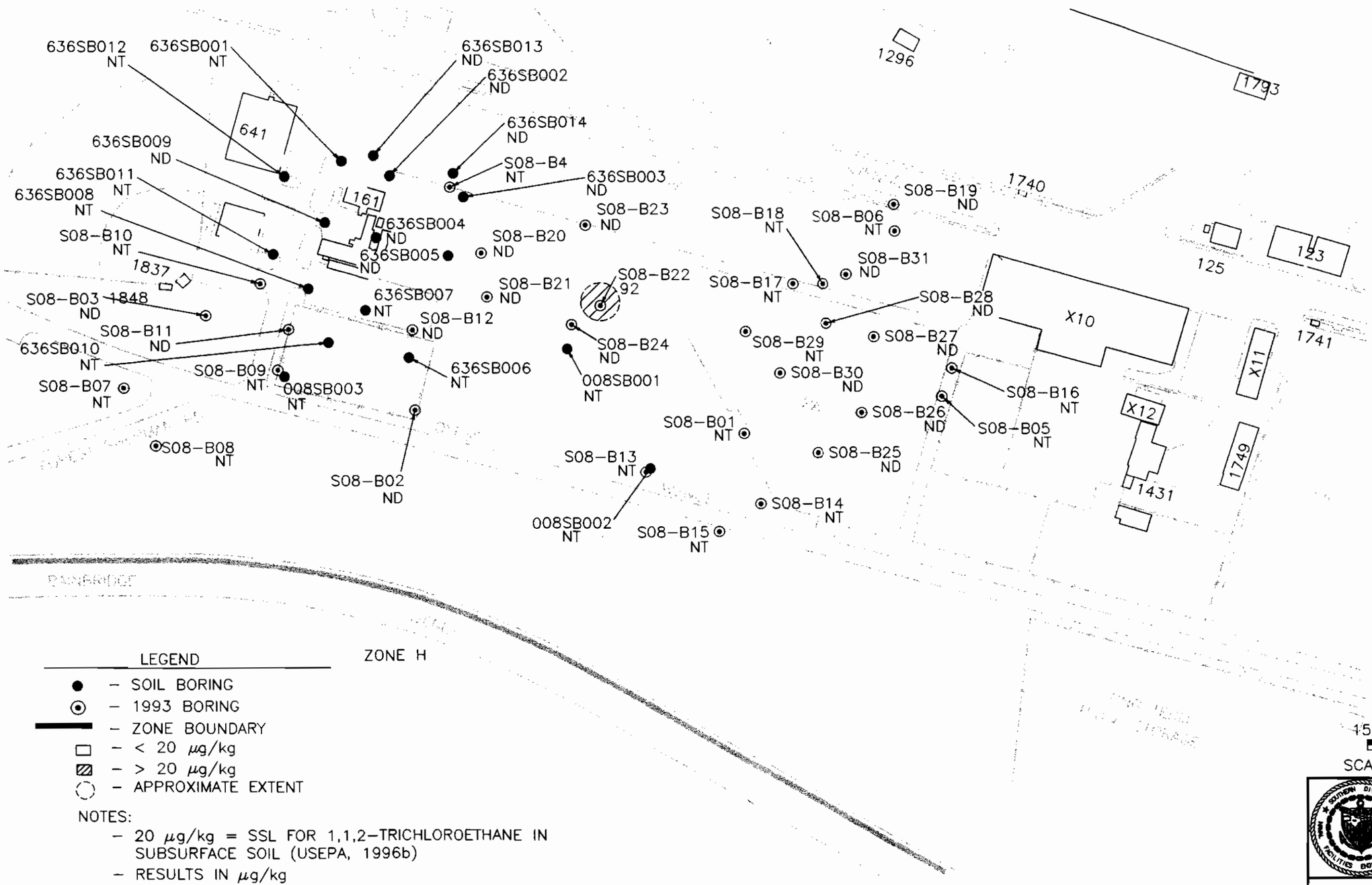
FIGURE 10.6–5
1,1,2,2–TETRACHLOROETHANE
IN SUBSURFACE SOIL
SWMU #8 OIL SLUDGE PIT
AOC #636 TORPEDO MAGAZINE
BUILDING 161 AREA

DWG DATE: 02/11/98 | DWG NAME: 2907M125



LEGEND

- ● – SOIL BORING
- ⊙ – 1993 BORING
- ▬ – ZONE BOUNDARY
- □ – < 20 µg/kg
- ▨ – > 20 µg/kg
- ◌ – APPROXIMATE EXTENT

NOTES:

- 20 µg/kg = SSL FOR 1,1,2–TRICHLOROETHANE IN SUBSURFACE SOIL (USEPA, 1996b)
- RESULTS IN µg/kg
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- ND = NOT DETECTED
- NT = INTERVAL NOT TAKEN

150 0 150

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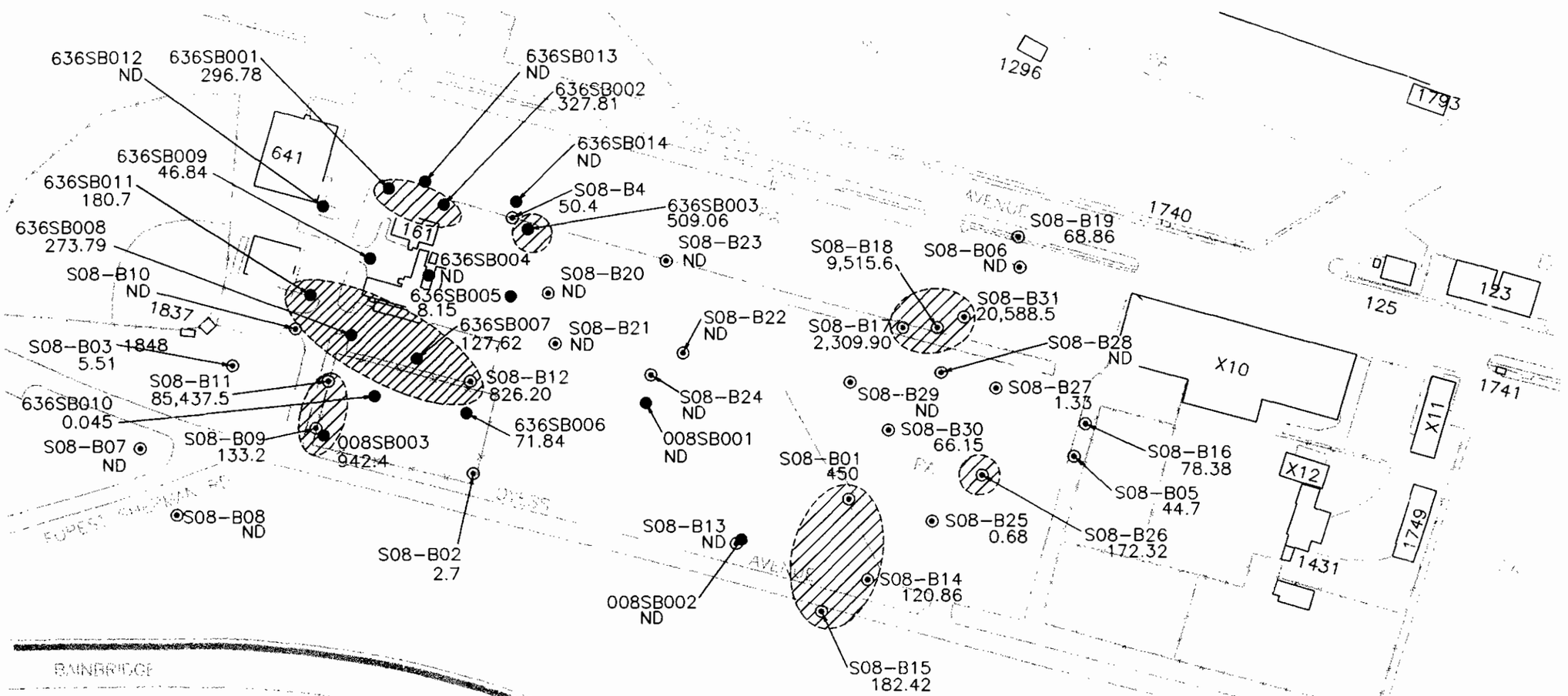
FIGURE 10.6–6
1,1,2–TRICHLOROETHANE IN
SUBSURFACE SOIL
SWMU #8 OIL SLUDGE PIT
AOC #636 TORPEDO MAGAZINE
BUILDING 161 AREA

DWG DATE: 02/12/98 DWG NAME: 2907M126



LEGEND

- ● – SOIL BORING
- ⊙ – 1993 BORING
- ▬ – ZONE BOUNDARY
- □ – < 88 μg/kg
- ▨ – > 88 μg/kg
- ◌ – APPROXIMATE EXTENT

NOTES:

- 88 μg/kg = RBC FOR BEQs IN SURFACE SOIL (USEPA, OCTOBER 22, 1997)
- RESULTS IN μg/kg
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- ND = NOT DETECTED

150 0 150

SCALE FEET

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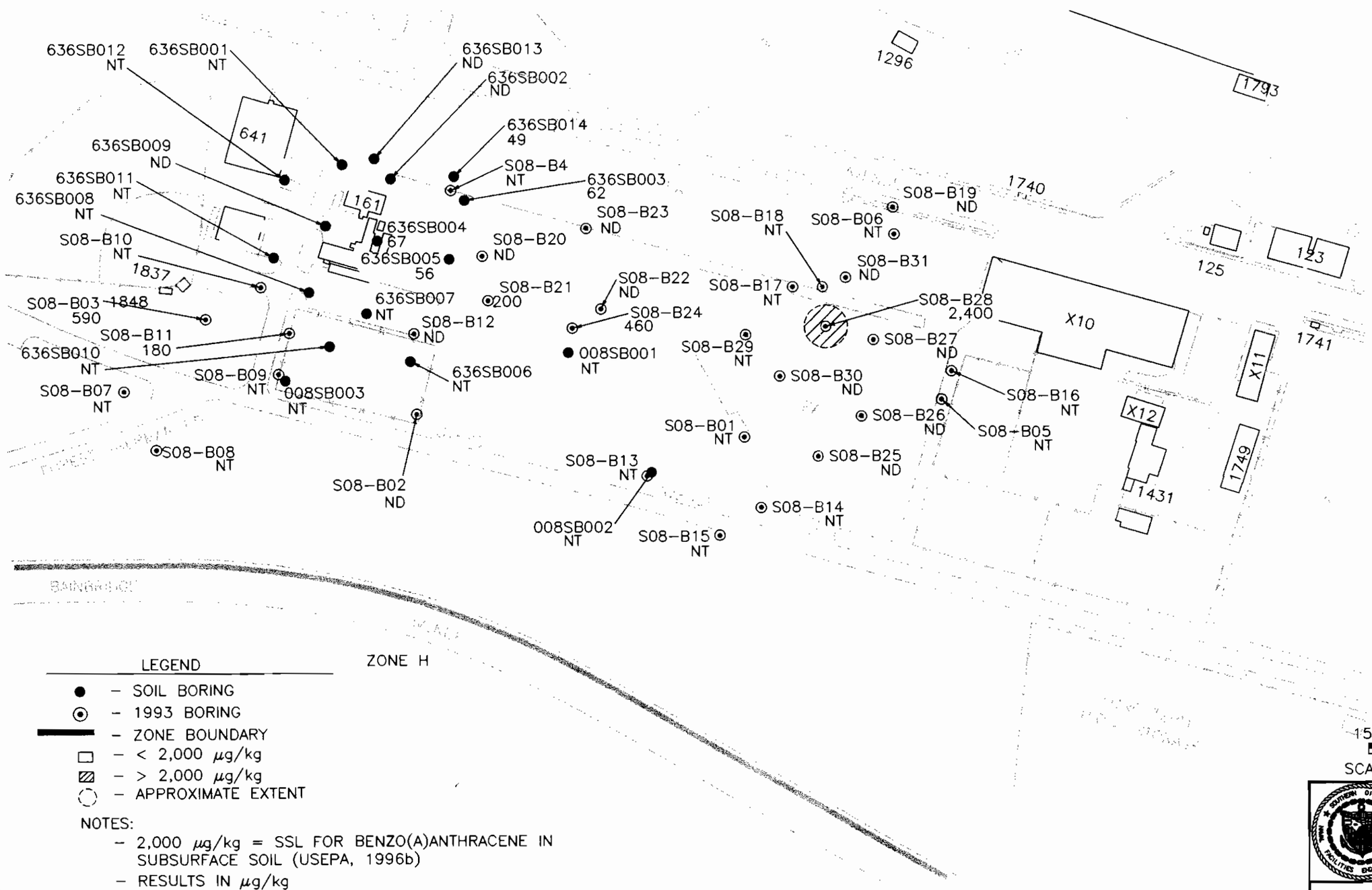
FIGURE 10.6-7
BEQs IN SURFACE SOIL
SWMU #8 OIL SLUDGE PIT
AOC #636 TORPEDO MAGAZINE
BUILDING 161 AREA

DWG DATE: 02/12/98 | DWG NAME: 2907M127



LEGEND

- ● – SOIL BORING
- ⊙ – 1993 BORING
- ▬ – ZONE BOUNDARY
- □ – < 2,000 μg/kg
- ▨ – > 2,000 μg/kg
- ◌ – APPROXIMATE EXTENT

NOTES:

- – 2,000 μg/kg = SSL FOR BENZO(A)ANTHRACENE IN SUBSURFACE SOIL (USEPA, 1996b)
- – RESULTS IN μg/kg
- – THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- – ND = NOT DETECTED
- – NT = INTERVAL NOT TAKEN

150 0 150

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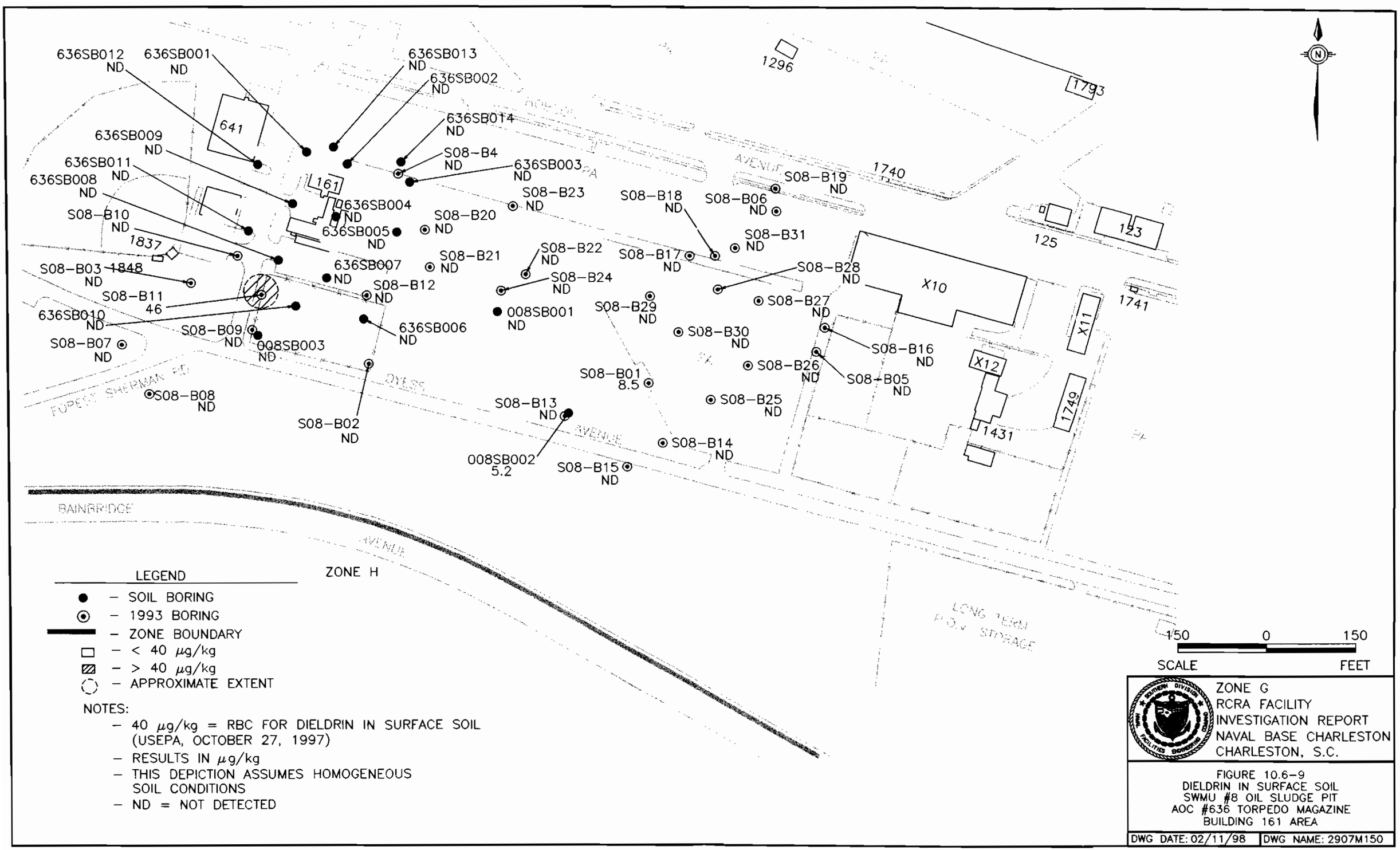
FIGURE 10.6-8
BENZO(A)ANTHRACENE IN SUBSURFACE SOIL
SWMU #8 OIL SLUDGE PIT
AOC #636 TORPEDO MAGAZINE
BUILDING 161 AREA

DWG DATE: 02/11/98 | DWG NAME: 2907M128



LEGEND

- ● – SOIL BORING
- ⊙ – 1993 BORING
- ▬ – ZONE BOUNDARY
- □ – < 40 μg/kg
- ▨ – > 40 μg/kg
- ◌ – APPROXIMATE EXTENT

NOTES:

- 40 μg/kg = RBC FOR DIELDRIN IN SURFACE SOIL (USEPA, OCTOBER 27, 1997)
- RESULTS IN μg/kg
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- ND = NOT DETECTED

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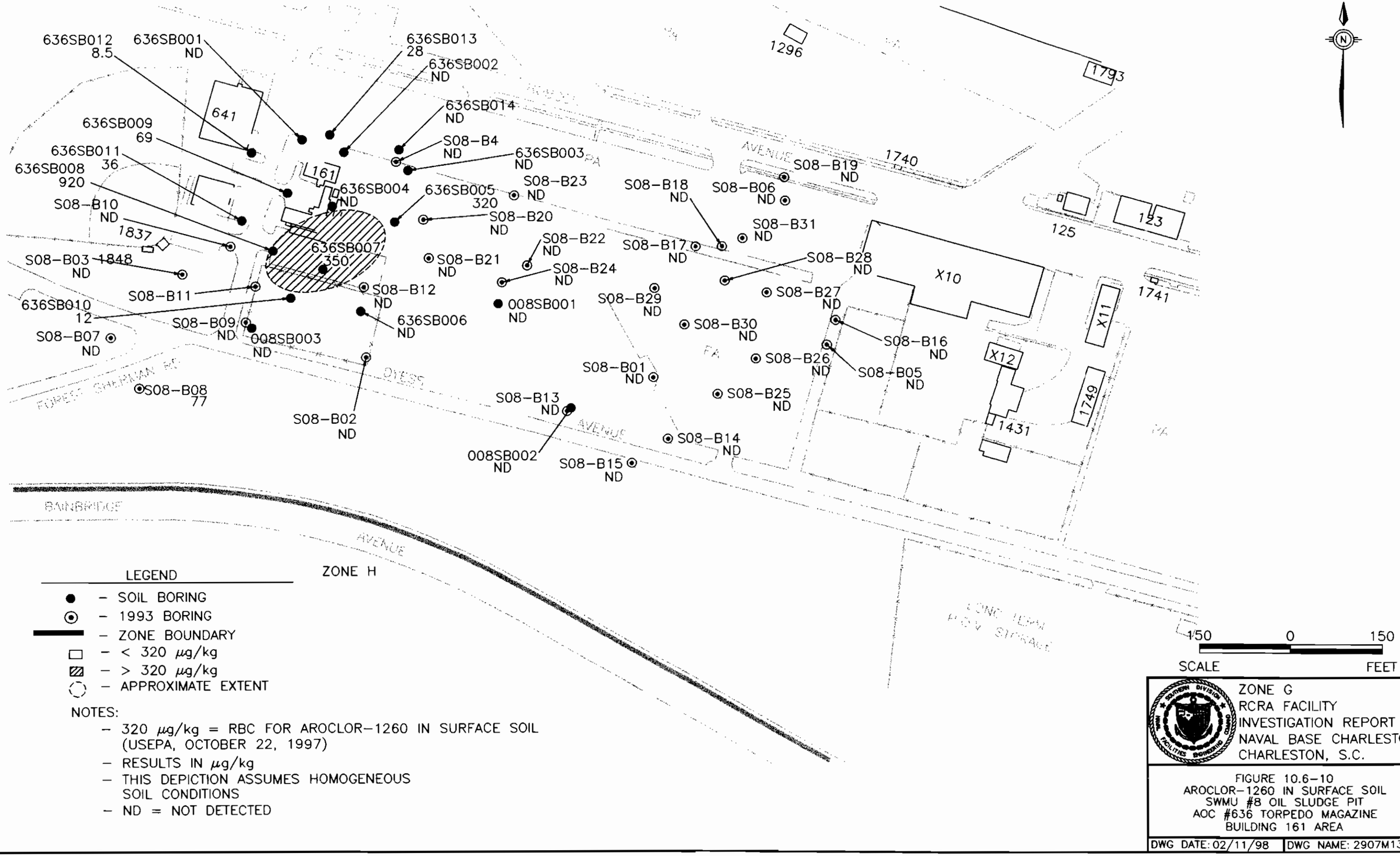
FIGURE 10.6-9
DIELDRIN IN SURFACE SOIL
SWMU #8 OIL SLUDGE PIT
AOC #636 TORPEDO MAGAZINE
BUILDING 161 AREA

DWG DATE: 02/11/98 | DWG NAME: 2907M150



LEGEND

- ● – SOIL BORING
- ⊙ – 1993 BORING
- ▬ – ZONE BOUNDARY
- □ – < 320 µg/kg
- ▨ – > 320 µg/kg
- ◌ – APPROXIMATE EXTENT

NOTES:

- 320 µg/kg = RBC FOR AROCLOR–1260 IN SURFACE SOIL (USEPA, OCTOBER 22, 1997)
- RESULTS IN µg/kg
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- ND = NOT DETECTED

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FIGURE 10.6–10
AROCLOR–1260 IN SURFACE SOIL
SWMU #8 OIL SLUDGE PIT
AOC #636 TORPEDO MAGAZINE
BUILDING 161 AREA

DWG DATE: 02/11/98 | DWG NAME: 2907M130

Twelve pesticides were detected in subsurface soil samples at SWMU 8 and AOC 636. Dieldrin was detected in subsurface soil at a concentration above its respective SSL. Figure 10.6-11 shows dieldrin in subsurface soil at the site. Aroclor-1260 was detected in subsurface soil at concentrations below its respective SSL.

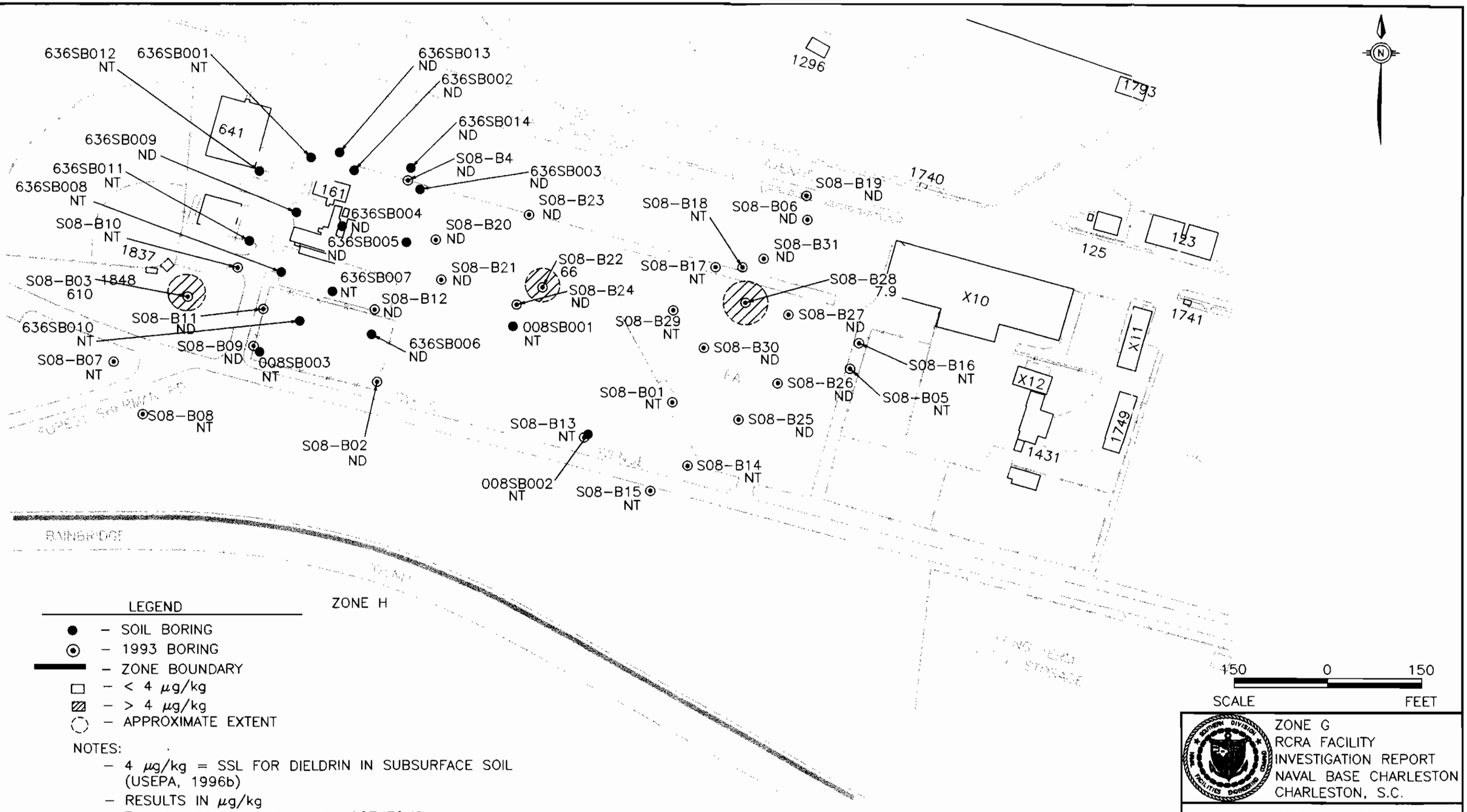
Other Organic Compounds in Soil

Dioxin (2,3,7,8-TCDD TEQ) was detected in SWMU 8 and AOC 636 surface soil samples at a concentration far below its respective RBC. Hydrazine was detected in both surface soil and subsurface soil at concentrations exceeding their respective RBC and SSL. Figure 10.6-12 presents hydrazine concentrations detected in surface soil at SWMU 8 and AOC 636. Figure 10.6-13 presents hydrazine concentrations in subsurface soil.

Inorganic Elements in Soil

Twenty-four metals, plus cyanide were detected in surface soil samples at SWMU 8 and AOC 636. Antimony, arsenic, chromium, lead, and thallium were detected at concentrations exceeding their respective RBCs and Zone G background concentrations. Figures 10.6-14 through 10.6-18 show antimony, arsenic, chromium, lead and thallium in surface soil, respectively, at SWMU 8 and AOC 636. Iron was also detected above its RBC, however because iron is considered an essential nutrient no background was established.

Twenty-three metals were detected in subsurface soil samples at SWMU 8 and AOC 636. Antimony, copper, lead, manganese, mercury, and thallium were detected at concentrations exceeding their respective SSLs and Zone G background concentrations. Figures 10.6-19 through 10.6-24 present antimony, copper, lead, manganese, mercury, and thallium concentrations detected in subsurface soil, respectively, at the combined SWMU 8.



LEGEND

- ● – SOIL BORING
- ⊙ – 1993 BORING
- ▬ – ZONE BOUNDARY
- □ – < 4 µg/kg
- ▨ – > 4 µg/kg
- ◌ – APPROXIMATE EXTENT

NOTES:

- 4 µg/kg = SSL FOR DIELDRIN IN SUBSURFACE SOIL (USEPA, 1996b)
- RESULTS IN µg/kg
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- ND = NOT DETECTED
- NT = INTERVAL NOT TAKEN

150 0 150

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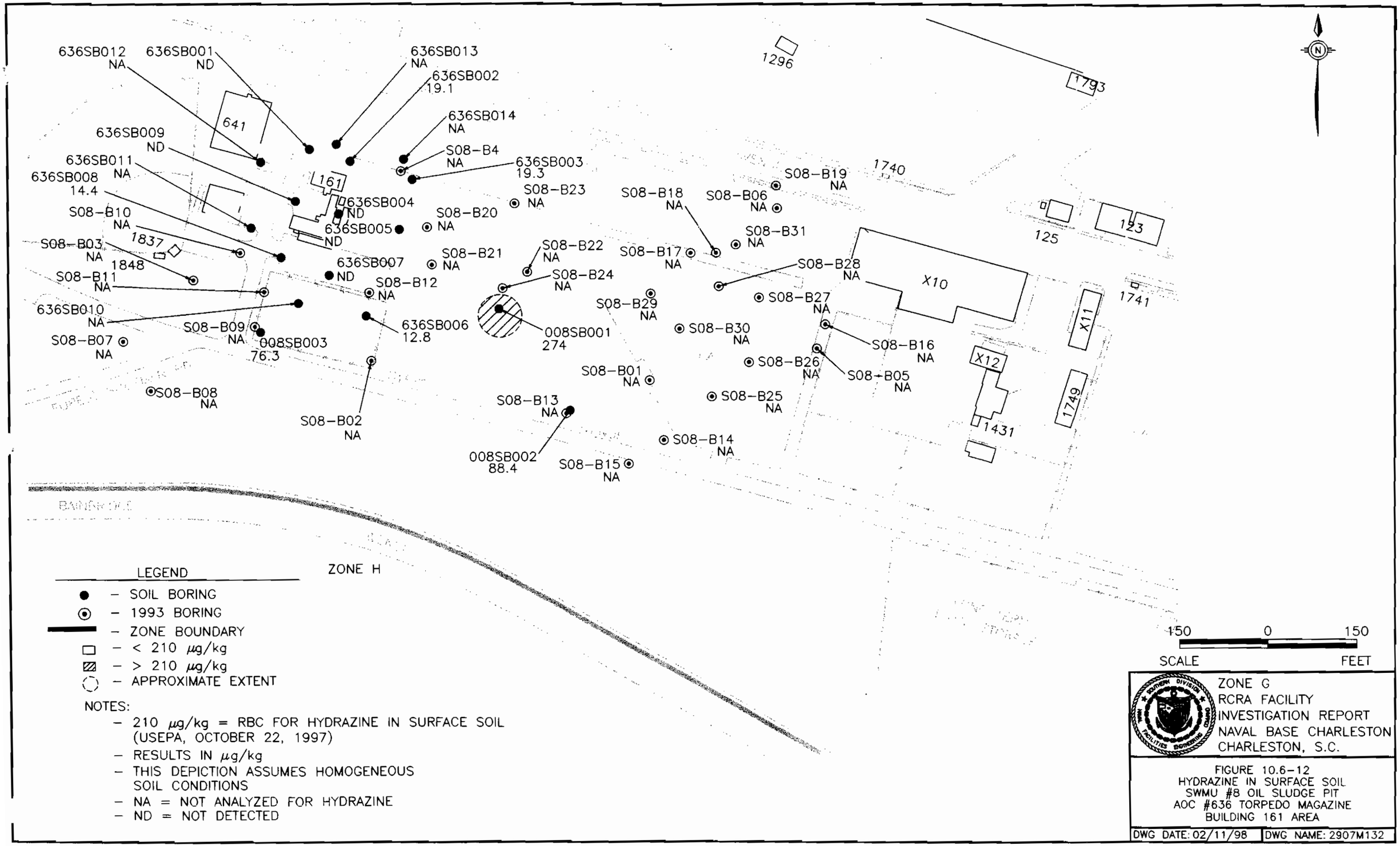
FIGURE 10.6-11
DIELDRIN IN SUBSURFACE SOIL
SWMU #8 OIL SLUDGE PIT
AOC #636 TORPEDO MAGAZINE
BUILDING 161 AREA

DWG DATE: 02/11/98 | DWG NAME: 2907M131



LEGEND

- ● – SOIL BORING
- ⊙ – 1993 BORING
- ▬ – ZONE BOUNDARY
- □ – < 210 µg/kg
- ▨ – > 210 µg/kg
- ◌ – APPROXIMATE EXTENT

NOTES:

- 210 µg/kg = RBC FOR HYDRAZINE IN SURFACE SOIL (USEPA, OCTOBER 22, 1997)
- RESULTS IN µg/kg
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- NA = NOT ANALYZED FOR HYDRAZINE
- ND = NOT DETECTED

150 0 150

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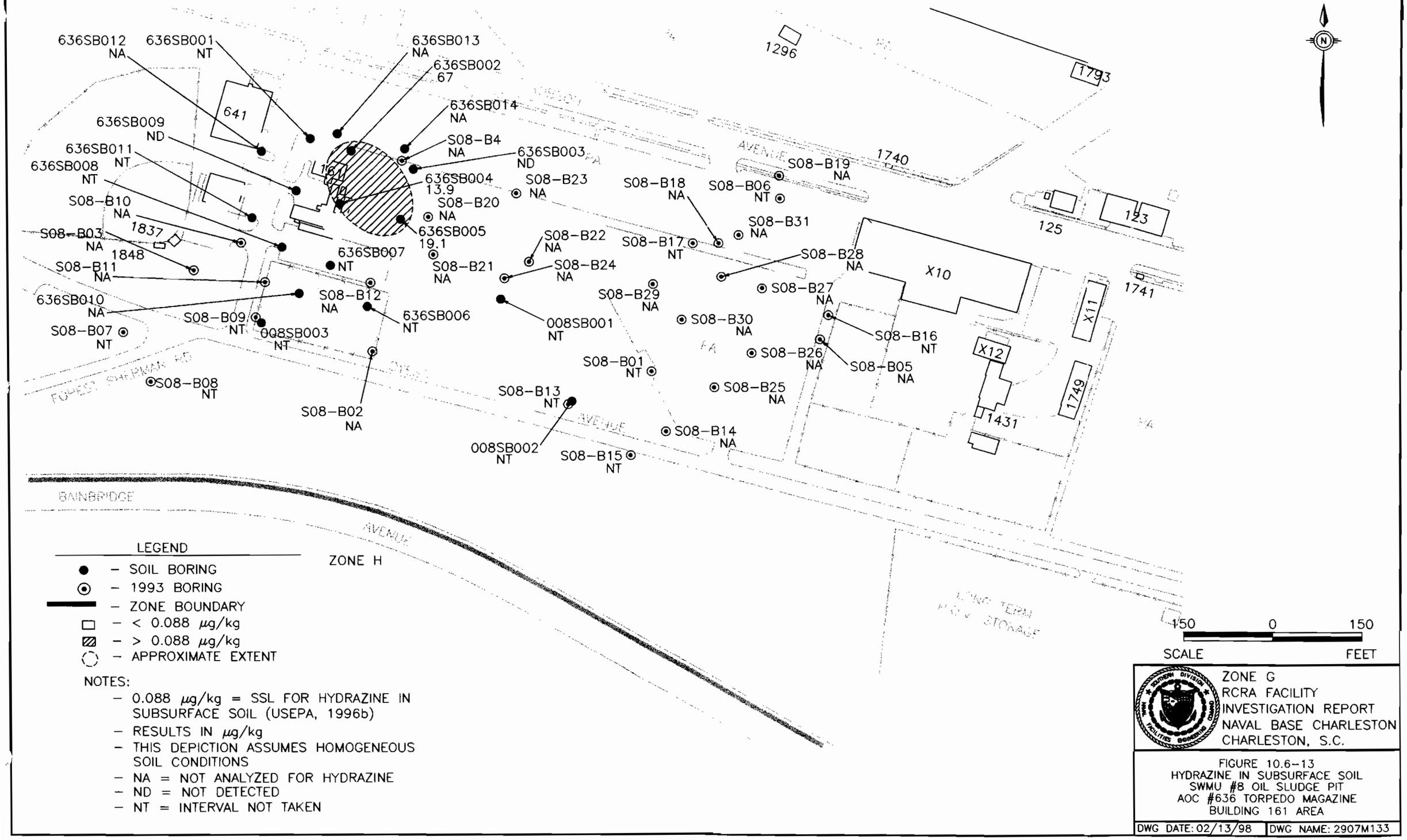
FIGURE 10.6-12
HYDRAZINE IN SURFACE SOIL
SWMU #8 OIL SLUDGE PIT
AOC #636 TORPEDO MAGAZINE
BUILDING 161 AREA

DWG DATE: 02/11/98 | DWG NAME: 2907M132



LEGEND

- ● – SOIL BORING
- ⊙ – 1993 BORING
- ▬ – ZONE BOUNDARY
- □ – < 0.088 μg/kg
- ▨ – > 0.088 μg/kg
- ◌ – APPROXIMATE EXTENT

NOTES:

- 0.088 μg/kg = SSL FOR HYDRAZINE IN SUBSURFACE SOIL (USEPA, 1996b)
- RESULTS IN μg/kg
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- NA = NOT ANALYZED FOR HYDRAZINE
- ND = NOT DETECTED
- NT = INTERVAL NOT TAKEN

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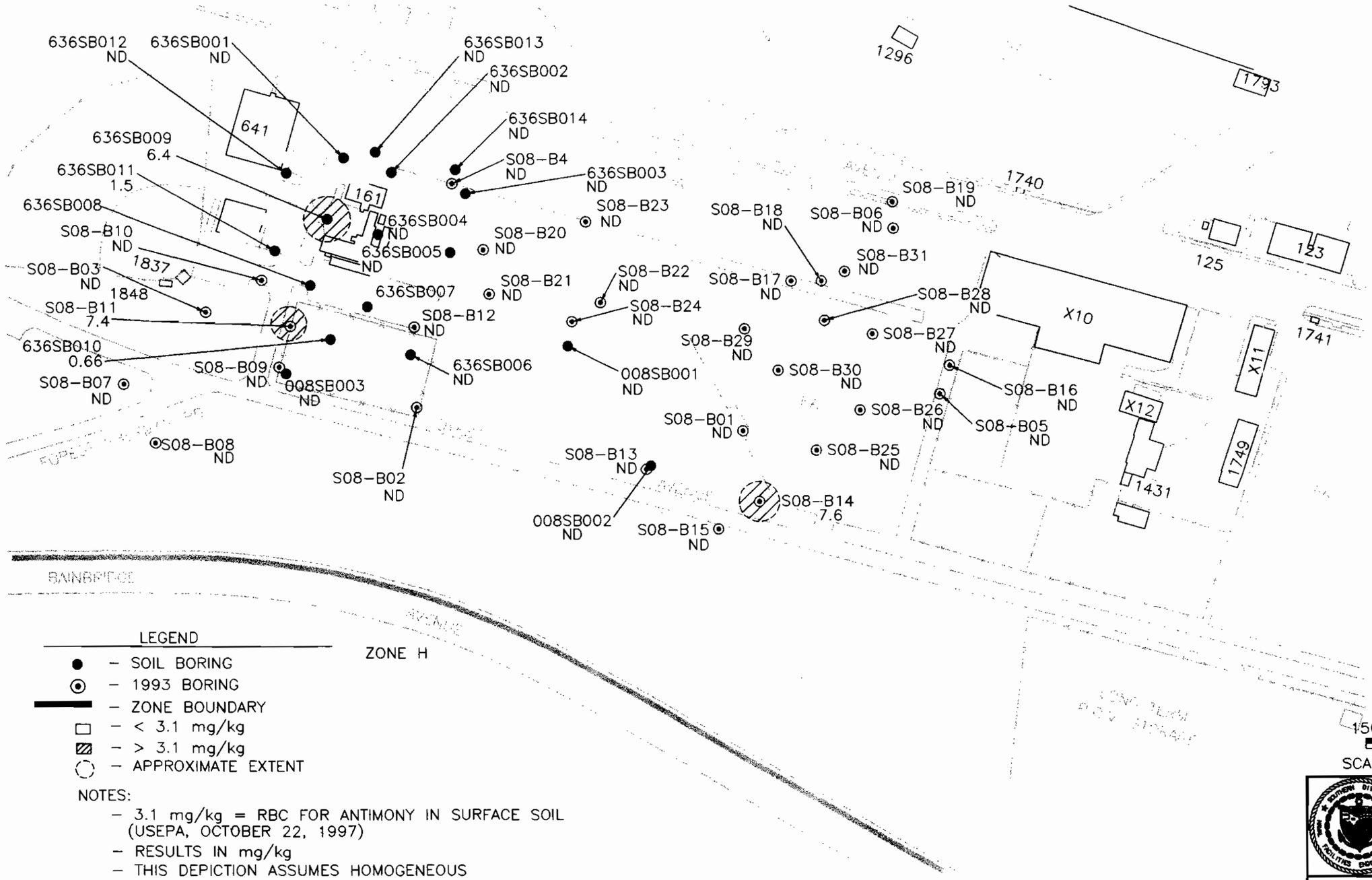
FIGURE 10.6-13
HYDRAZINE IN SUBSURFACE SOIL
SWMU #8 OIL SLUDGE PIT
AOC #636 TORPEDO MAGAZINE
BUILDING 161 AREA

DWG DATE: 02/13/98 | DWG NAME: 2907M133



LEGEND

- ● – SOIL BORING
- ⊙ – 1993 BORING
- ▬ – ZONE BOUNDARY
- □ – < 3.1 mg/kg
- ▨ – > 3.1 mg/kg
- ◌ – APPROXIMATE EXTENT

NOTES:

- 3.1 mg/kg = RBC FOR ANTIMONY IN SURFACE SOIL (USEPA, OCTOBER 22, 1997)
- RESULTS IN mg/kg
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- ND = NOT DETECTED

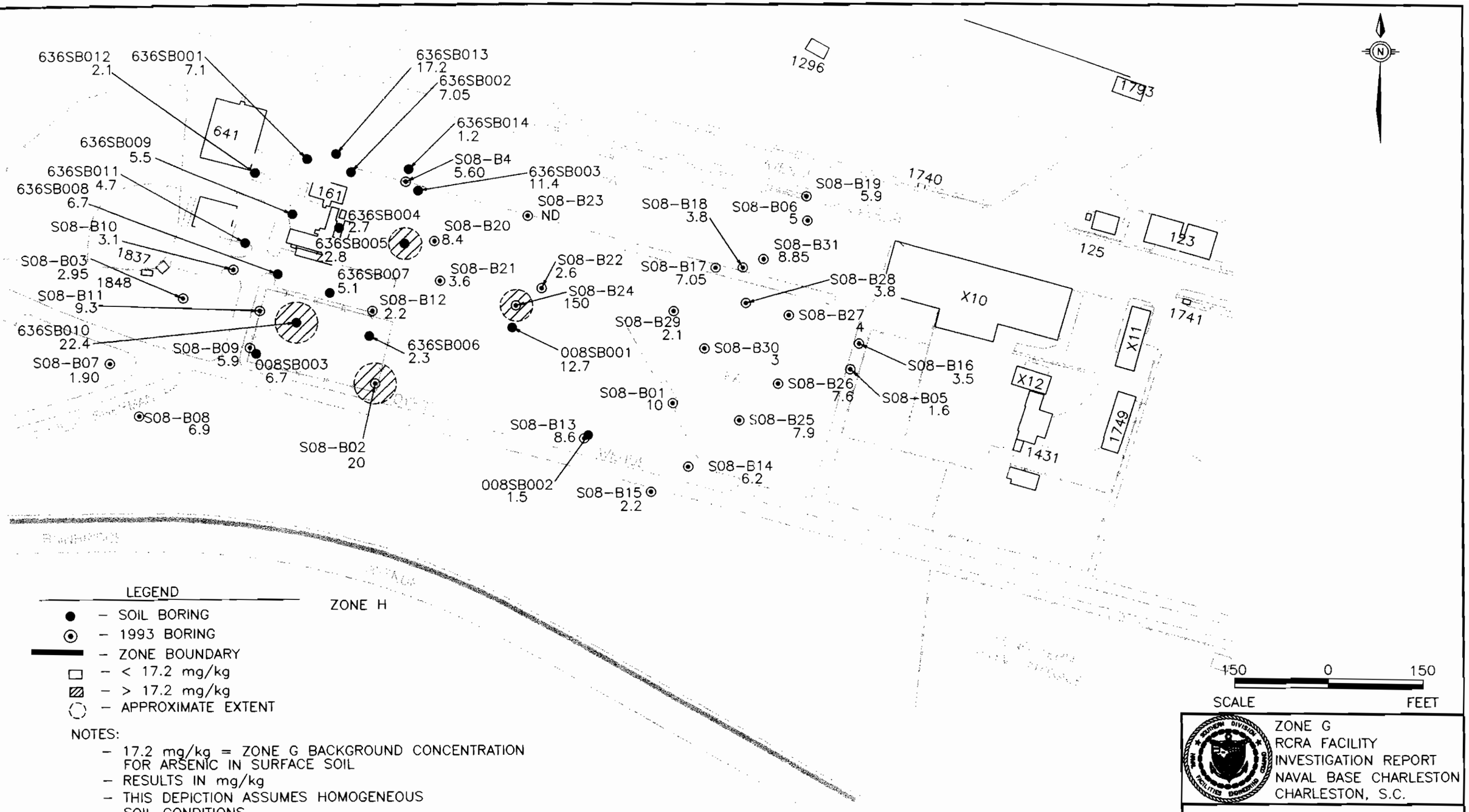
150 0 150

SCALE FEET

ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.6-14
ANTIMONY IN SURFACE SOIL
SWMU #8 OIL SLUDGE PIT
AOC #636 TORPEDO MAGAZINE
BUILDING 161 AREA

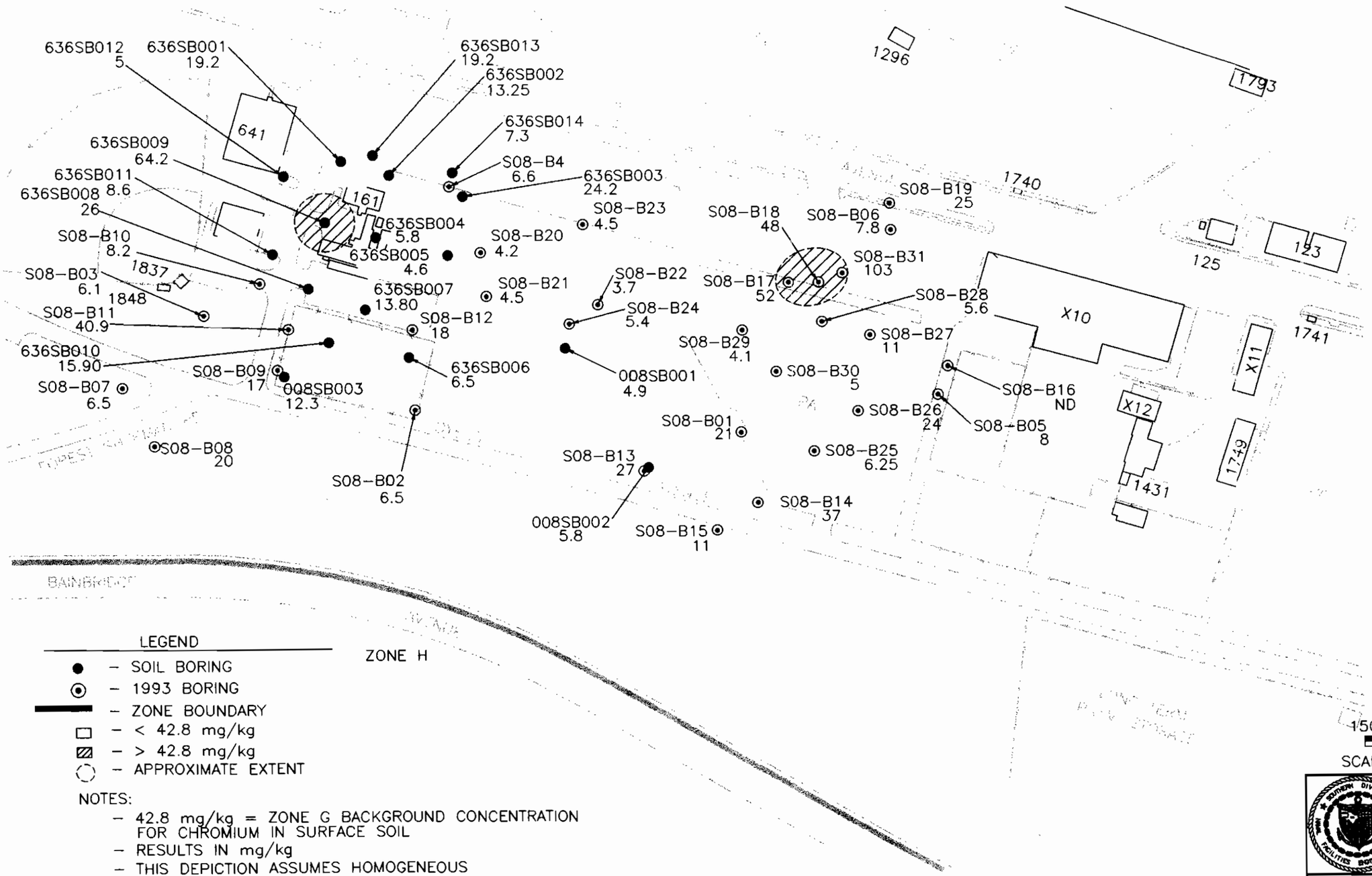
DWG DATE: 02/11/98 | DWG NAME: 2907M134



ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.6–15
ARSENIC IN SURFACE SOIL
SWMU #8 OIL SLUDGE PIT
AOC #636 TORPEDO MAGAZINE
BUILDING 161 AREA

DWG DATE: 02/11/98 | DWG NAME: 2907M135



LEGEND

- ● – SOIL BORING
- ⊙ – 1993 BORING
- ▬ – ZONE BOUNDARY
- □ – < 42.8 mg/kg
- ▨ – > 42.8 mg/kg
- ◌ – APPROXIMATE EXTENT

NOTES:

- 42.8 mg/kg = ZONE G BACKGROUND CONCENTRATION FOR CHROMIUM IN SURFACE SOIL
- RESULTS IN mg/kg
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- ND = NOT DETECTED

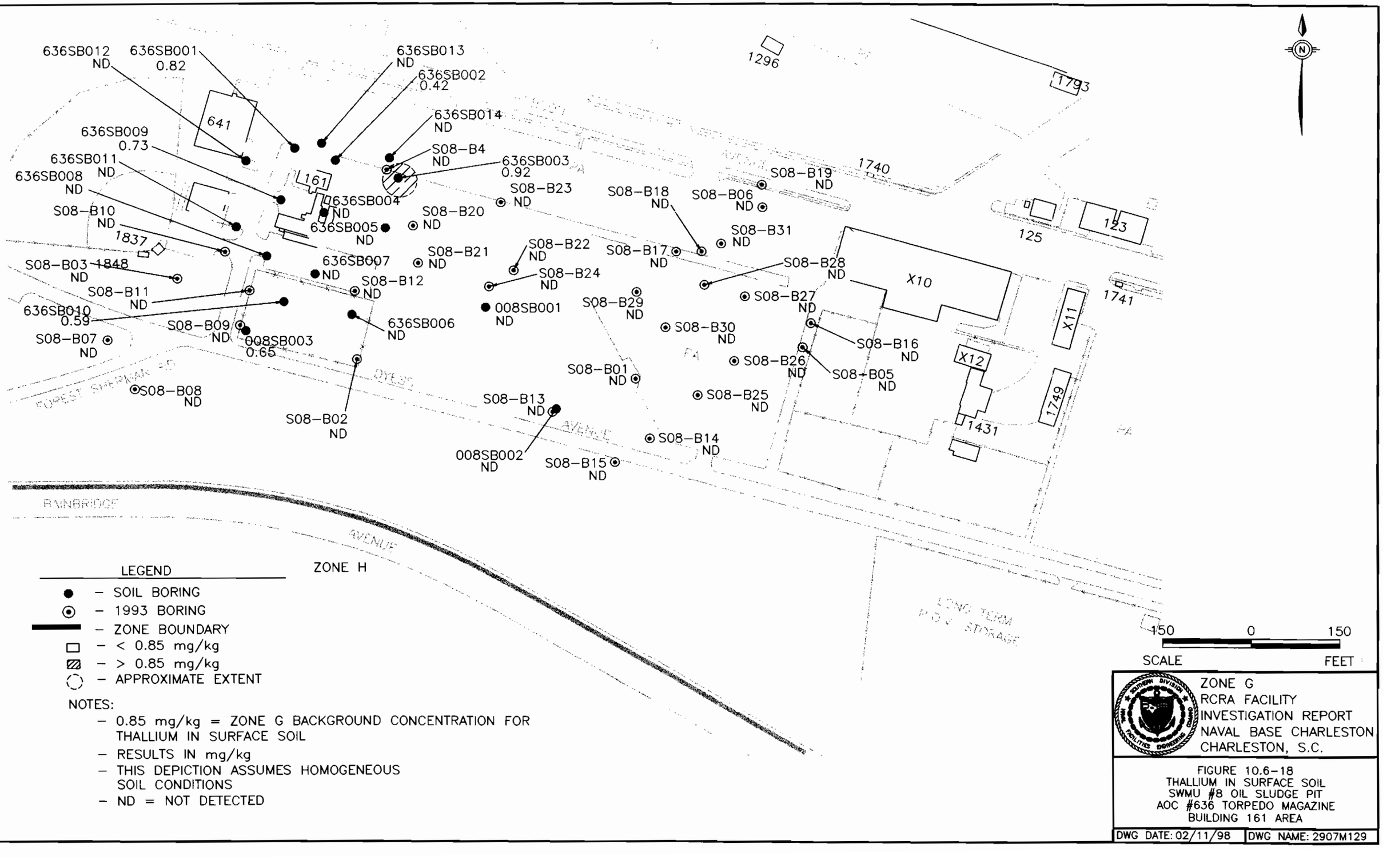
150 0 150

SCALE FEET

ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.6-16
CHROMIUM IN SURFACE SOIL
SWMU #8 OIL SLUDGE PIT
AOC #636 TORPEDO MAGAZINE
BUILDING 161 AREA

DWG DATE: 02/11/98 | DWG NAME: 2907M136



LEGEND

- ● – SOIL BORING
- ⊙ – 1993 BORING
- ▬ – ZONE BOUNDARY
- □ – < 0.85 mg/kg
- ▨ – > 0.85 mg/kg
- ◌ – APPROXIMATE EXTENT

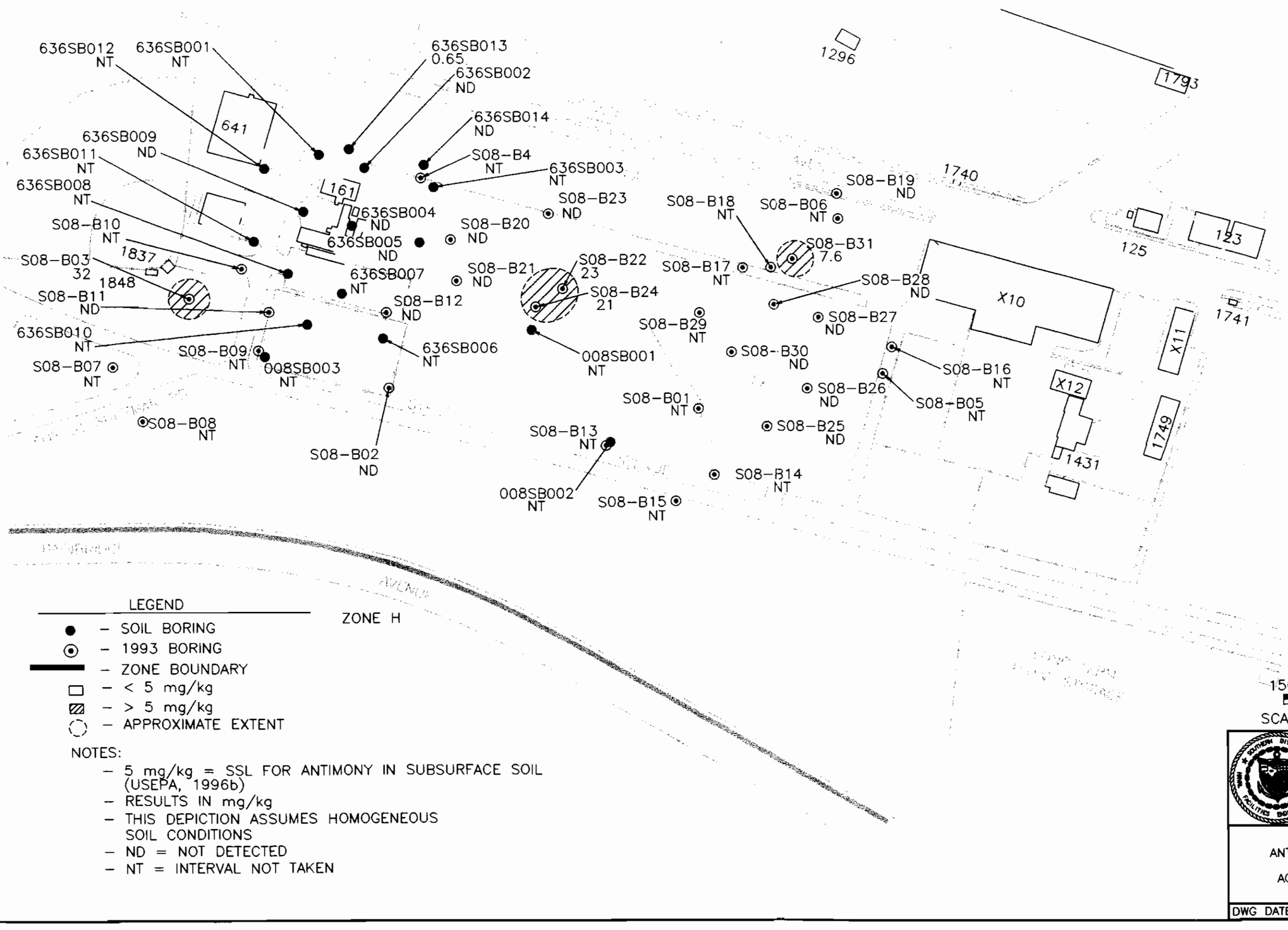
NOTES:

- 0.85 mg/kg = ZONE G BACKGROUND CONCENTRATION FOR THALLIUM IN SURFACE SOIL
- RESULTS IN mg/kg
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- ND = NOT DETECTED

ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.6-18
THALLIUM IN SURFACE SOIL
SWMU #8 OIL SLUDGE PIT
AOC #636 TORPEDO MAGAZINE
BUILDING 161 AREA

DWG DATE: 02/11/98 | DWG NAME: 2907M129



LEGEND

- ● – SOIL BORING
- ⊙ – 1993 BORING
- ▬ – ZONE BOUNDARY
- □ – < 5 mg/kg
- ▨ – > 5 mg/kg
- ◌ – APPROXIMATE EXTENT

NOTES:

- – 5 mg/kg = SSL FOR ANTIMONY IN SUBSURFACE SOIL (USEPA, 1996b)
- – RESULTS IN mg/kg
- – THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- – ND = NOT DETECTED
- – NT = INTERVAL NOT TAKEN

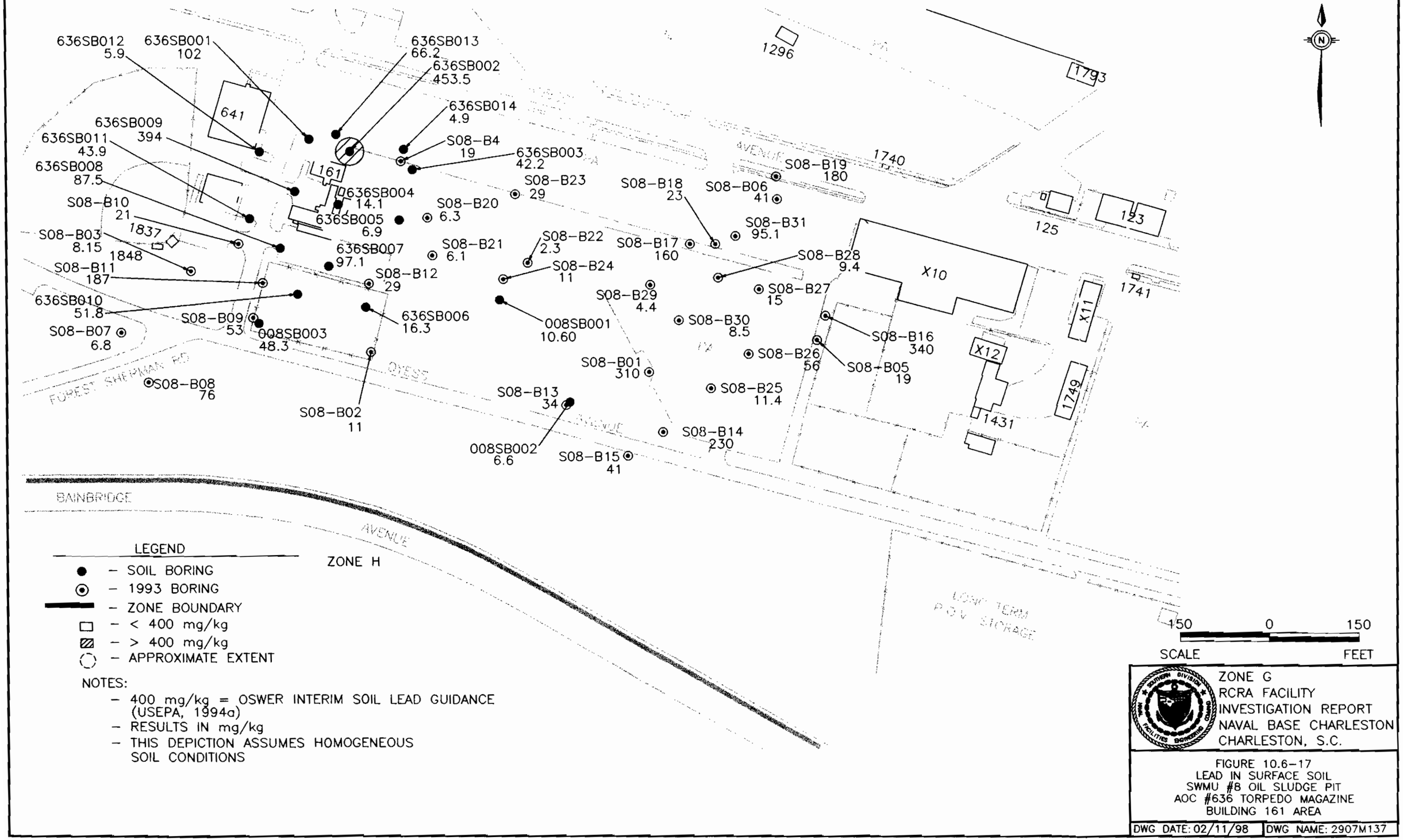
150 0 150

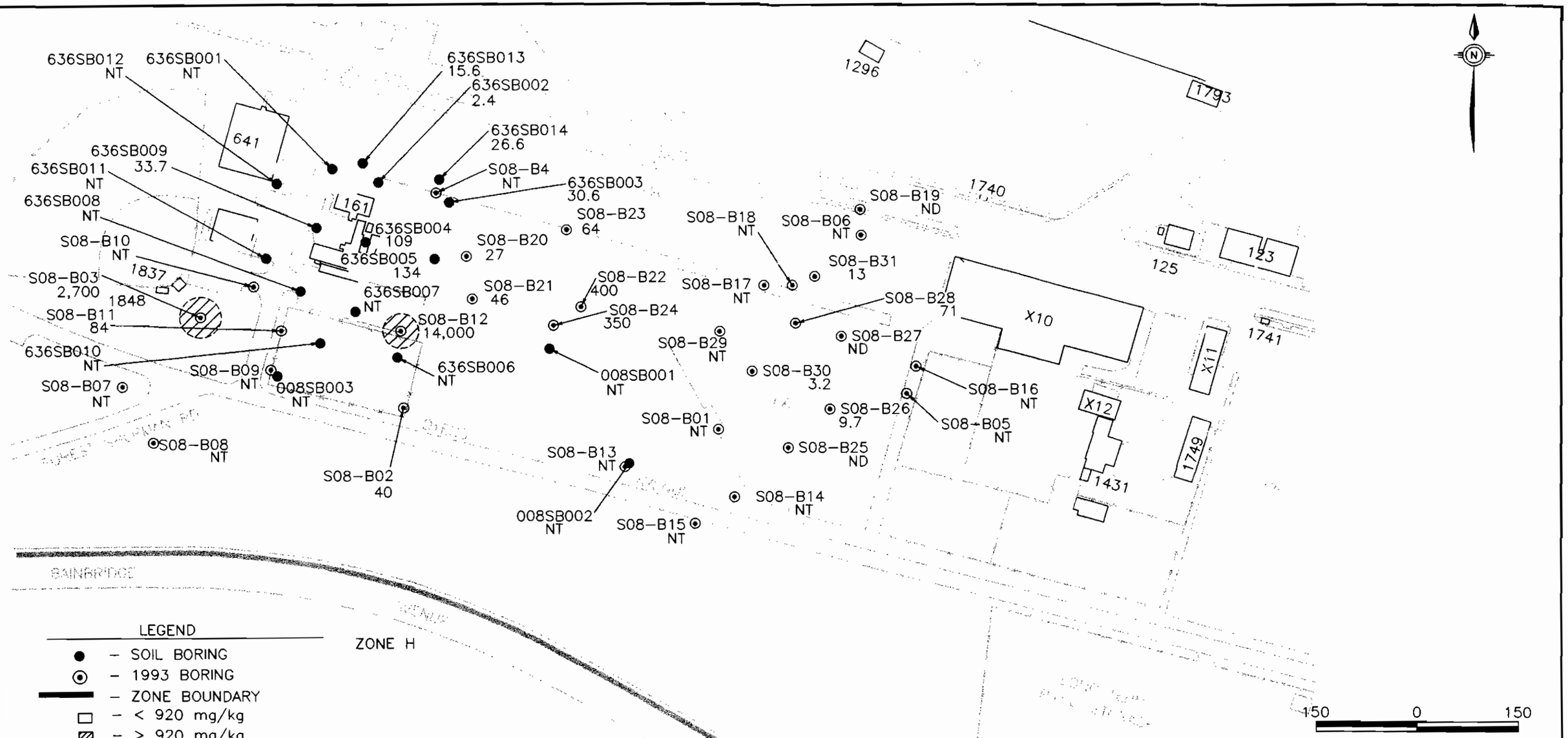
SCALE FEET

ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.6-19
ANTIMONY IN SURBSURFACE SOIL
SWMU #8 OIL SLUDGE PIT
AOC #636 TORPEDO MAGAZINE
BUILDING 161 AREA

DWG DATE: 02/11/98 | DWG NAME: 2907M138


636SB012
5.9
636SB001
102
636SB013
66.2
636SB002
453.5
636SB014
4.9
S08-B4
19
636SB003
42.2
636SB009
394
636SB011
43.9
636SB008
87.5
S08-B10
21
S08-B03
8.15
S08-B11
187
636SB010
51.8
S08-B07
6.8
S08-B09
53
S08-B08
76
S08-B02
11
008SB003
48.3
636SB004
14.1
636SB005
6.9
636SB007
97.1
S08-B12
29
636SB006
16.3
S08-B20
6.3
S08-B21
6.1
S08-B22
2.3
S08-B24
11
S08-B23
29
008SB001
10.60
S08-B13
34
008SB002
6.6
S08-B15
41
S08-B14
230
S08-B29
4.4
S08-B01
310
S08-B30
8.5
S08-B25
11.4
S08-B18
23
S08-B17
160
S08-B19
180
S08-B06
41
S08-B31
95.1
S08-B28
9.4
S08-B27
15
S08-B26
56
S08-B16
340
S08-B05
19
641
161
1837
1848
1296
1793
1740
125
123
1741
X10
X11
X12
1749
1431
FOREST SHERMAN RD
AVENUE
BAINBRIDGE
AVENUE
LONG TERM POV STORAGE
LEGEND
– SOIL BORING
– 1993 BORING
– ZONE BOUNDARY
– < 400 mg/kg
– > 400 mg/kg
– APPROXIMATE EXTENT
ZONE H
NOTES:
– 400 mg/kg = OSWER INTERIM SOIL LEAD GUIDANCE (USEPA, 1994a)
– RESULTS IN mg/kg
– THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
150 0 150
SCALE FEET
ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 10.6-17
LEAD IN SURFACE SOIL
SWMU #8 OIL SLUDGE PIT
AOC #636 TORPEDO MAGAZINE
BUILDING 161 AREA
DWG DATE: 02/11/98
DWG NAME: 2907M137



LEGEND

- ● – SOIL BORING
- ◉ – 1993 BORING
- ▬ – ZONE BOUNDARY
- □ – < 920 mg/kg
- ▨ – > 920 mg/kg
- ◌ – APPROXIMATE EXTENT

NOTES:

- 920 mg/kg = SSL FOR COPPER IN SUBSURFACE SOIL (USEPA, 1996b)
- RESULTS IN mg/kg
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- ND = NOT DETECTED
- NT = INTERVAL NOT TAKEN

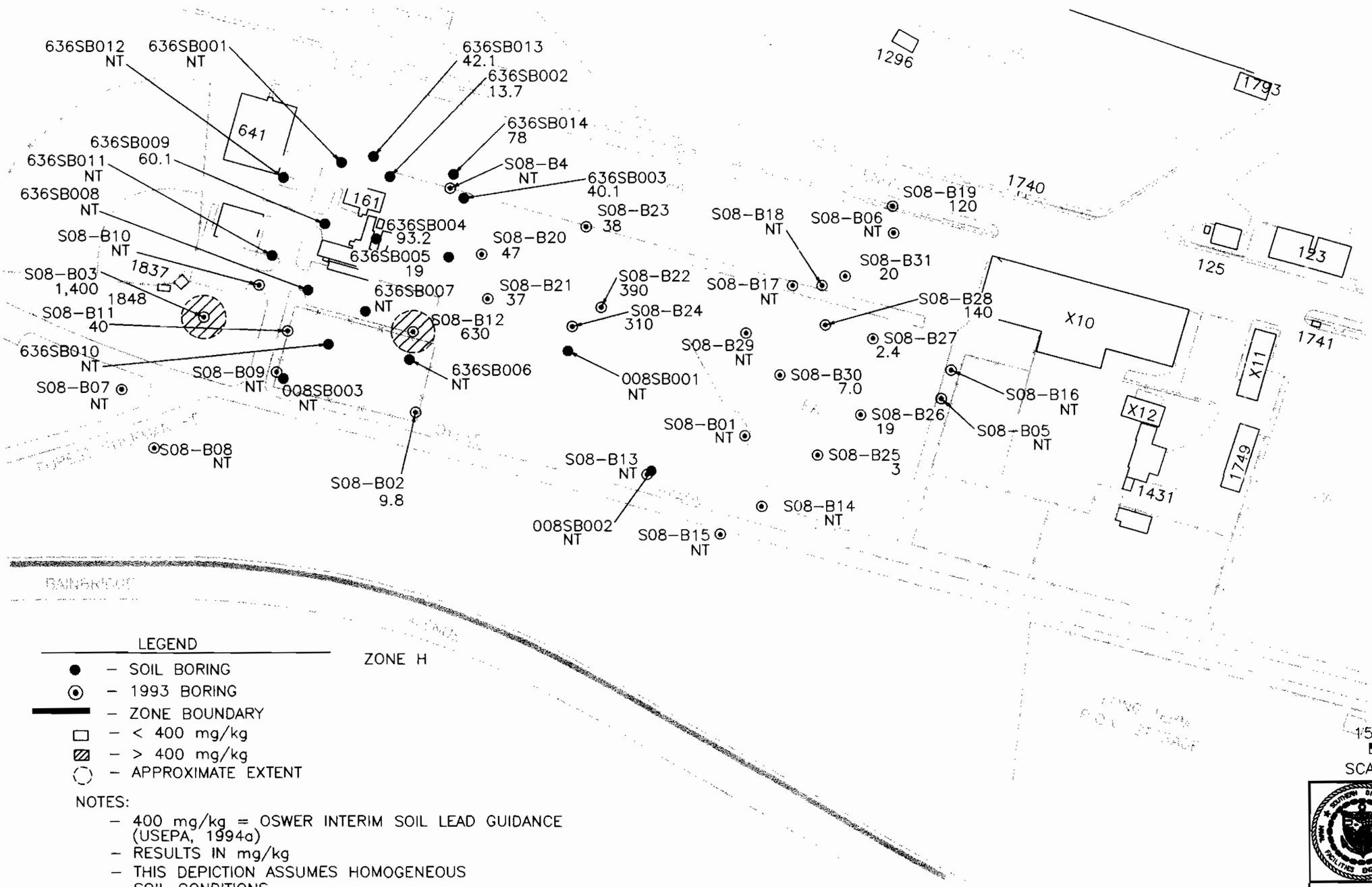
150 0 150

SCALE FEET

ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.6-20
COPPER IN SUBSURFACE SOIL
SWMU #8 OIL SLUDGE PIT
AOC #636 TORPEDO MAGAZINE
BUILDING 161 AREA

DWG DATE: 02/11/98 | DWG NAME: 2907M139



LEGEND

- ● – SOIL BORING
- ⊙ – 1993 BORING
- ▬ – ZONE BOUNDARY
- ▭ – < 400 mg/kg
- ▨ – > 400 mg/kg
- ◌ – APPROXIMATE EXTENT

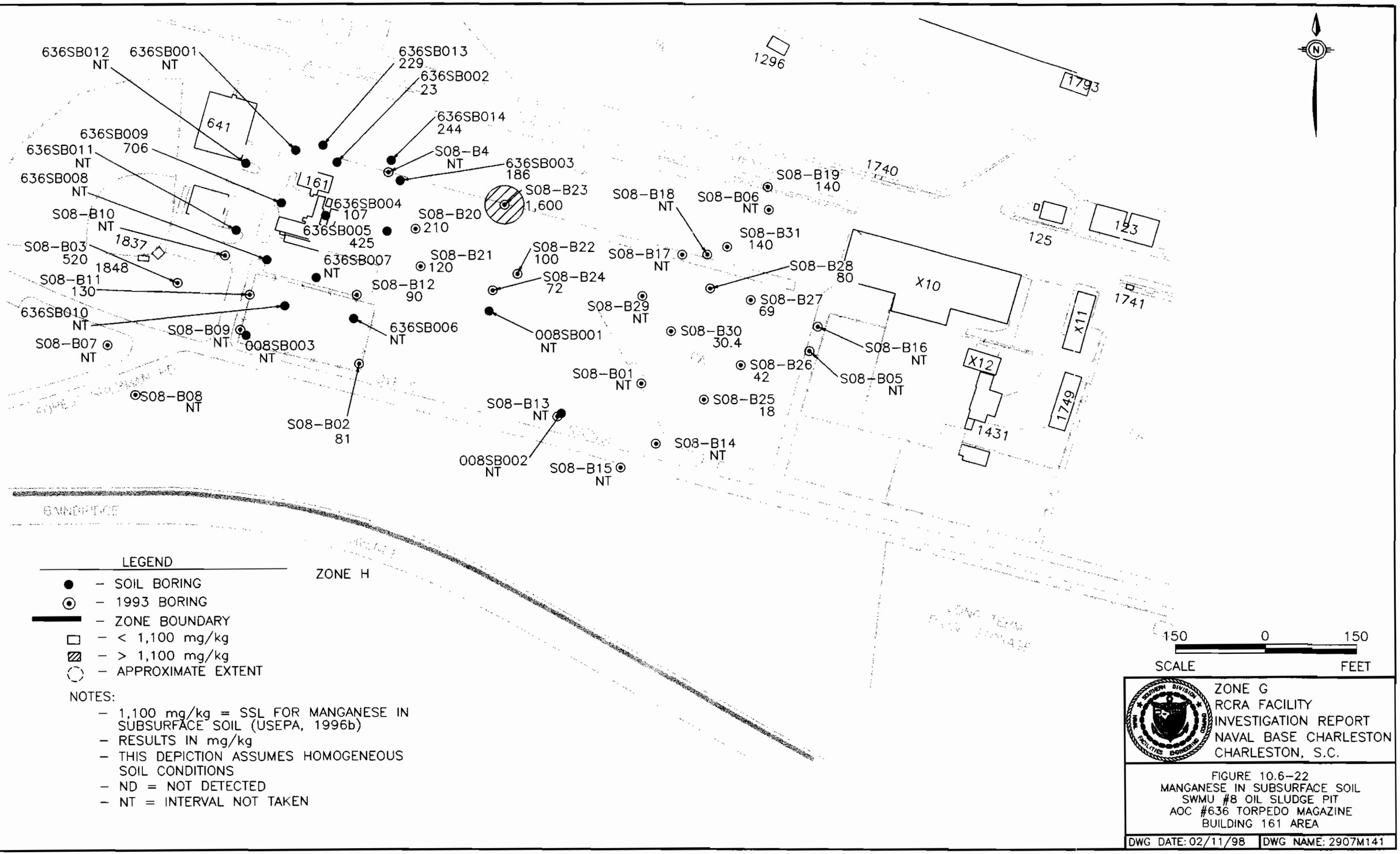
NOTES:

- 400 mg/kg = OSWER INTERIM SOIL LEAD GUIDANCE (USEPA, 1994a)
- RESULTS IN mg/kg
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- ND = NOT DETECTED
- NT = INTERVAL NOT TAKEN

ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.6–21
LEAD IN SUBSURFACE SOIL
SWMU #8 OIL SLUDGE PIT
AOC #636 TORPEDO MAGAZINE
BUILDING 161 AREA

DWG DATE: 02/11/98 | DWG NAME: 2907M140



LEGEND

- ● – SOIL BORING
- ⊙ – 1993 BORING
- ▬ – ZONE BOUNDARY
- □ – < 1,100 mg/kg
- ▨ – > 1,100 mg/kg
- ◌ – APPROXIMATE EXTENT

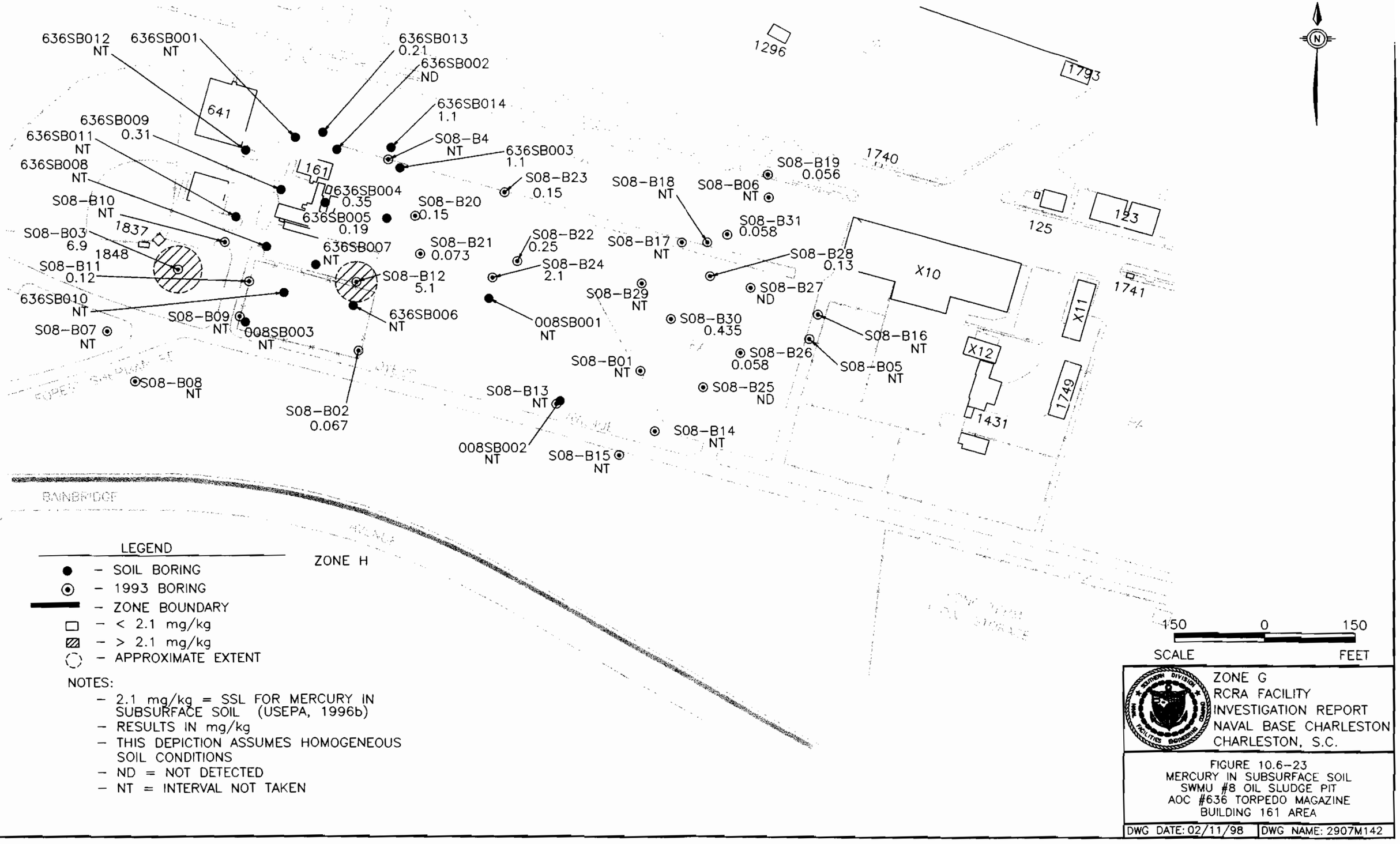
NOTES:

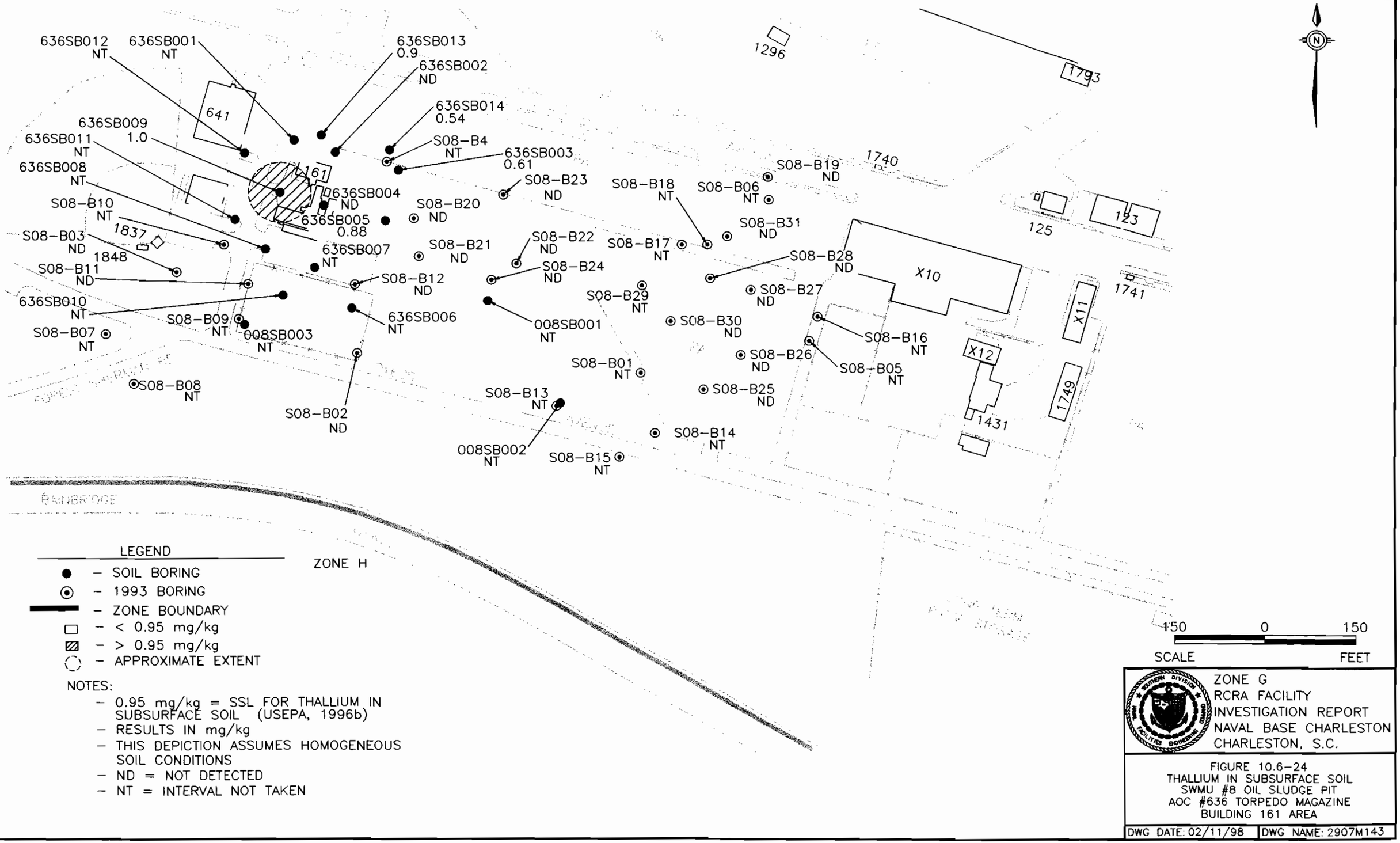
- 1,100 mg/kg = SSL FOR MANGANESE IN SUBSURFACE SOIL (USEPA, 1996b)
- RESULTS IN mg/kg
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- ND = NOT DETECTED
- NT = INTERVAL NOT TAKEN

ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.6-22
MANGANESE IN SUBSURFACE SOIL
SWMU #8 OIL SLUDGE PIT
AOC #636 TORPEDO MAGAZINE
BUILDING 161 AREA

DWG DATE: 02/11/98 | DWG NAME: 2907M141


636SB012
NT
636SB001
NT
636SB013
0.21
636SB002
ND
636SB014
1.1
636SB009
0.31
636SB011
NT
S08-B4
NT
636SB003
1.1
636SB008
NT
S08-B23
0.15
S08-B10
NT
636SB004
0.35
S08-B20
0.15
636SB005
0.19
S08-B03
6.9
S08-B21
0.073
S08-B22
0.25
636SB007
NT
S08-B11
0.12
S08-B24
2.1
S08-B12
5.1
636SB010
NT
S08-B09
NT
008SB003
NT
636SB006
NT
S08-B07
NT
008SB001
NT
S08-B08
NT
S08-B02
0.067
S08-B13
NT
008SB002
NT
S08-B15
NT
S08-B14
NT
S08-B18
NT
S08-B19
0.056
S08-B06
NT
S08-B31
0.058
S08-B17
NT
S08-B28
0.13
S08-B29
NT
S08-B27
ND
S08-B30
0.435
S08-B16
NT
S08-B26
0.058
S08-B05
NT
S08-B01
NT
S08-B25
ND
1296
1793
1740
125
123
1741
X10
X11
X12
1749
1431
641
161
1837
1848
BAINBRIDGE
ZONE H
LEGEND
● – SOIL BORING
⊙ – 1993 BORING
– ZONE BOUNDARY
□ – < 2.1 mg/kg
▨ – > 2.1 mg/kg
◌ – APPROXIMATE EXTENT
NOTES:
– 2.1 mg/kg = SSL FOR MERCURY IN SUBSURFACE SOIL (USEPA, 1996b)
– RESULTS IN mg/kg
– THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
– ND = NOT DETECTED
– NT = INTERVAL NOT TAKEN
150 0 150
SCALE FEET
ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 10.6-23
MERCURY IN SUBSURFACE SOIL
SWMU #8 OIL SLUDGE PIT
AOC #636 TORPEDO MAGAZINE
BUILDING 161 AREA
DWG DATE: 02/11/98
DWG NAME: 2907M142



LEGEND

- ● – SOIL BORING
- ⊙ – 1993 BORING
- ▬ – ZONE BOUNDARY
- □ – < 0.95 mg/kg
- ▨ – > 0.95 mg/kg
- ◌ – APPROXIMATE EXTENT

NOTES:

- 0.95 mg/kg = SSL FOR THALLIUM IN SUBSURFACE SOIL (USEPA, 1996b)
- RESULTS IN mg/kg
- THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
- ND = NOT DETECTED
- NT = INTERVAL NOT TAKEN

ZONE G
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NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.6-24
THALLIUM IN SUBSURFACE SOIL
SWMU #8 OIL SLUDGE PIT
AOC #636 TORPEDO MAGAZINE
BUILDING 161 AREA

DWG DATE: 02/11/98 | DWG NAME: 2907M143

10.6.4 Groundwater Sampling and Analysis

The approved final RFI work plan proposed sampling of one new installed shallow monitoring well at AOC 636 and redevelopment and sampling the six shallow monitoring wells previously installed at SWMU 8. Groundwater was sampled within the SWMU 8 and AOC 636 area to: (1) assess groundwater quality, and (2) identify contaminants which may be migrating from the site in the shallow aquifer. During the field investigation, the six previously installed wells were redeveloped and sampled (Figure 10.6-2). In accordance with the approved final RFI work plan, groundwater samples were analyzed for metals, pesticides/PCBs, SVOCs, and VOCs at DQO Level III. The AOC 636 well was also sampled for explosives and propellants. Table 10.6.6 summarizes the groundwater sampling and analyses of the previously installed (1993) SWMU 8 wells. Table 10.6.7 summarizes the RFI groundwater samples and analyses.

10.6.4.1 Nature of Contamination in Groundwater

Organic analytical results for groundwater samples are summarized in Table 10.6.8. Inorganic analytical results for groundwater samples are summarized in Table 10.6.9. Table 10.6.10 summarizes all analytes detected in groundwater at SWMU 8 and AOC 636 for both investigations. Appendix D contains a complete analytical data report for all Zone G samples collected. The 1993 analytical results are presented for comparative purposes and are not included in the following nature discussions, fate and transport and the HHRA.

Volatile Organic Compounds in Groundwater

One VOC was detected in shallow groundwater samples from SWMU 8 and AOC 636. Ethylbenzene was detected at a concentration far below its respective tap water RBC at this site.

Semivolatile Organic Compounds in Groundwater

Four SVOCs, benzoic acid, bis(2-ethylhexyl)phthalate, 2,4-dimethylphenol, and napthalene were detected in shallow groundwater samples at SWMU 8 and AOC 636. Of these, bis(2-

ethylhexyl)phthalate was detected at a concentration exceeding its respective tap water RBC. Figure 10.6-25 shows bis(2-ethylhexyl)phthalate in groundwater at SWMU 8 and AOC 636.

Table 10.6.6
Zone G
SWMU 8 and AOC 636
1993 Groundwater Samples and Analyses
(Pre-RFI Samples)

Well Number	Well Depth	Sample Identifier	Date Sampled	Analyses	Remarks
008001 (S08W01)	Shallow	S08W0101	11/10/93	Note 1	
008002 (S08W02)	Shallow	S08W0201	11/10/93	Note 1	
008003 (S08W03)	Shallow	S08W0301	11/10/93	Note 1	
008004 (S08W03)	Shallow	S08W0401	11/10/93	Note 1	
008005 (S08W03)	Shallow	S08W0501 S08W051D*	11/11/93	Note 1	
008006 (S08W03)	Shallow	S08W0601	11/11/93	Note 1	

Note :
1 = SW-846 (metals, pesticides/PCBs, SVOCs, VOCs) at DQO Level III.
* = Duplicate sample.

Table 10.6.7
Zone G
SWMU 8 and AOC 636
Groundwater Samples and Analyses
(RFI Samples)

Well Number	Well Depth	Sample Identifier	Date Sampled	Analyses	Remarks
008001	Shallow	00800101	11/15/96	See note	
008002	Shallow	00800201	11/15/96	See note	
008003	Shallow	00800301	11/15/96	See note	
008004	Shallow	00800401	11/15/96	See note	
008005	Shallow	00800501	11/15/96	See note	
008006	Shallow	00800601	11/15/96	See note	
636001	Shallow	63600101	11/15/96	See note explosives/propellants	

Note :
SW-846 (metals, pesticides/PCBs, SVOCs, VOCs) at DQO Level III

Table 10.6.8
Zone G
SWMU 8, AOC 636
Organic Analytical Results for Groundwater

Parameters	Interval	Frequency of Detection	Range of Detections (µG/L)	Mean of Detections (µg/L)	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Number of Samples Exceeding Reference
Volatile Organic Compound (13 Shallow Samples) (µg/L)							
Ethylbenzene	Shallow	2/13	2.00 - 3.00	2.50	130	700	0
Semivolatile Organic Compounds (13 Shallow Samples) (µg/L)							
Benzoic acid	Shallow	1/13	2.00	2.00	15000	NL	0
bis(2-Ethylhexyl)phthalate (BEHP)	Shallow	1/13	46.0	46.0	4.8	NL	1
2,4-Dimethylphenol	Shallow	1/13	1.00	1.00	73	NL	0
Naphthalene	Shallow	1/13	2.00	2.00	150	NL	0

Notes:
NL = Not listed
* = Tap Water RBCs (THQ=0.1) from *Risk-Based Concentration Table* (USEPA, October 22, 1997), and MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996d)
µg/L = Micrograms per liter

Table 10.6.9
Zone G
SWMU 8, AOC 636
Inorganic Analytical Results for Groundwater

Parameters	Interval	Frequency of Detection	Range of Detections (µg/L)	Mean of Detections (µg/L)	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Number of Samples Exceeding RBC
Inorganics (13 Shallow Samples including 6 Shallow 1993 Samples) (µg/L)							
Aluminum (Al)	Shallow	10/13	34.0 - 1400	477.5	3700	50	0
Antimony (Sb)	Shallow	1/13	22.6	22.6	1.5	6	1
Arsenic (As)	Shallow	7/13	4.30 - 17.7	9.9	0.045	50	7
Barium (Ba)	Shallow	13/13	11.0 - 1520	194	260	2000	2
Calcium (Ca)	Shallow	13/13	93000 - 282000	160000	NL	NL	NA
Chromium (Cr)	Shallow	1/13	4.60	4.60	18	100	0
Cobalt (Co)	Shallow	5/13	0.910 - 1.80	1.36	220	NL	0
Copper (Cu)	Shallow	2/13	22.3 - 44.8	33.6	13000	1300	0
Iron (Fe)	Shallow	13/13	1100 - 22700	6978	1100	300	12
Lead (Pb)	Shallow	3/13	3.00 - 10.2	7.43	15	15	0
Magnesium (Mg)	Shallow	13/13	75000 - 1060000	538154	NL	NL	NA
Manganese (Mn)	Shallow	13/13	39.0 - 1620	488	84	50	12
Nickel (Ni)	Shallow	4/13	2.00 - 3.00	2.53	73	100	0
Potassium (K)	Shallow	13/13	33000 - 322000	171838	NL	NL	NA

Table 10.6.9
Zone G
SWMU 8, AOC 636
Inorganic Analytical Results for Groundwater

Parameters	Interval	Frequency of Detection	Range of Detections (µg/L)	Mean of Detections (µg/L)	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Number of Samples Exceeding RBC
Selenium (Se)	Shallow	1/13	2.90	2.90	18	50	0
Silver (Ag)	Shallow	2/13	1.40 - 1.70	1.55	18	100	0
Sodium (Na)	Shallow	13/13	650000 - 8850000	4722308	NL	NL	NA
Thallium (Tl)	Shallow	2/13	3.90 - 4.60	4.25	0.29	2	2
Tin (Sn)	Shallow	1/13	3.40	3.40	2200	NL	0
Vanadium (V)	Shallow	8/13	1.30 - 49.0	13.4	26	NL	1
Zinc (Zn)	Shallow	3/13	29 - 181	83	1100	5000	0

Notes:
* = Tap Water RBCs (THQ=0.1) from *Risk-Based Concentration Table* (USEPA, October 22, 1997), and MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996d)
µg/L = Micrograms per liter
NL = Not listed
NA = Not applicable

Table 10.6.10
Zone G
SWMU 8, AOC 636
Analytes Detected in Groundwater

Name	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Shallow Background
Volatile Organic Compounds (µg/L)							
Carbon disulfide	008003	ND	6.00	ND	100	NL	NA
Ethylbenzene	008002	3.00	3.00	ND	130	700	NA
	008003	2.00	ND	ND			
Xylene (Total)	008002	ND	8.000	ND	1200	10000	NA
Semivolatile Organic Compounds (µg/L)							
Benzoic Acid	008006	ND	1.000	ND	15000	NL	NA
	636001	2.000	1.000	ND			
bis(2-Ethylhexyl)phthalate (BEHP)	008004	**46.000**	ND	ND	4.8	NL	NA
Butylbenzylphthalate	008003	ND	2.000	ND	730	NL	NA
	008004	ND	3.000	ND			
1,4-Dichlorobenzene	008006	ND	ND	**1.000**	0.44	75	NA
Diethylphthalate	008005	ND	ND	1.00	2900	NL	NA
2,4-Dimethylphenol	008002	1.000	1.000	ND	73	NL	NA
	008006	ND	ND	6.000			
Di-n-butylphthalate	008003	ND	ND	2.00	370	NL	NA
	008004	ND	ND	1.00			
2-Methylphenol (o-Cresol)	008006	ND	ND	2.000	180	NL	NA

Table 10.6.10
Zone G
SWMU 8, AOC 636
Analytes Detected in Groundwater

Name	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Shallow Background
4-Methylphenol (p-Cresol)	008003	ND	3.000	ND	18	NL	NA
Naphthalene	008002	2.000	1.000	ND	150	NL	NA
	008006	ND	ND	5.000			
Explosives/Propellant (µg/L)							
Hydrazine	008001	NT	ND	**16.700**	0.022	NL	NA
	008002	NT	**7.300**	ND			
	008003	NT	**23.600**	ND			
	008004	NT	ND	**9.090**			
	008005	NT	ND	**10.200**			
	008006	NT	ND	**5.100**			
	636001	ND	ND	**16.000**			
Inorganics (µg/L)							
Aluminum (Al)	S08W01	1000.000	NT	NT	3700	50	692
	S08W03	710.000	NT	NT			
	S08W05	1400.000	NT	NT			
	008001	129.000	ND	509.000			
	008002	34.000	43.900	ND			
	008003	720.000	750.000	888.000			
	008004	49.500	61.300	ND			
	008005	120.000	113.000	130.000			
	008006	144.000	ND	ND			
	636001	468.000	45.100	1200.000			
Antimony (Sb)	008003	**22.600**	**12.600**	ND	1.5	6	4.85

Table 10.6.10
Zone G
SWMU 8, AOC 636
Analytes Detected in Groundwater

Name	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Shallow Background
Arsenic (As)	S08W03	15.000	NT	NT	0.045	50	17.8
	S08W06	11.000	NT	NT			
	008001	6.400	5.000	5.600			
	008003	8.000	13.000	10.200			
	008004	4.330	9.400	2.300			
	008005	6.800	2.800	4.500			
	008006	17.700	17.200	**31.700**			
	636001	ND	10.200	3.600			
Barium (Ba)	S08W01	33.000	NT	NT	260	2000	31
	S08W02	**530.000**	NT	NT			
	S08W03	68.000	NT	NT			
	S08W04	70.000	NT	NT			
	S08W05	12.000	NT	NT			
	S08W06	11.000	NT	NT			
	008001	40.600	66.800	38.300			
	008002	**1520.000**	**739.000**	**645.000**			
	008003	67.500	69.600	93.900			
	008004	74.500	70.000	78.800			
	008005	23.500	18.900	23.800			
	008006	11.900	12.500	ND			
	636001	56.700	35.500	106.000			
Beryllium (Be)	008001	ND	**0.710**	**1.190**	0.016	4	NL
	008002	ND	ND	**0.230**			
	008003	ND	**3.700**	**1.300**			
	008004	ND	**0.670**	**1.100**			
	008005	ND	ND	**0.280**			
	008006	ND	**0.270**	ND			
	636001	ND	**0.410**	ND			

Table 10.6.10
Zone G
SWMU 8, AOC 636
Analytes Detected in Groundwater

Name	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Shallow Background
Cadmium (Cd)	636001	ND	0.710	1.400	1.8	5	0.53
Calcium (Ca)	S08W01	120000.000	NT	NT	NL	NL	NL
	S08W02	110000.000	NT	NT			
	S08W03	280000.000	NT	NT			
	S08W04	110000.000	NT	NT			
	S08W05	94000.000	NT	NT			
	S08W06	93000.000	NT	NT			
	008001	127000.000	110000.000	124000.000			
	008002	206000.000	117000.000	230000.000			
	008003	282000.000	221000.000	242000.000			
	008004	159000.000	152000.000	131000.000			
	008005	182000.000	99800.000	100000.000			
	008006	160000.000	107000.000	123000.000			
	636001	157000.000	83400.000	165000.000			
Chromium (Cr)	008001	4.600	1.700	2.770	18	100	3.88
	008002	ND	1.300	ND			
	008003	ND	9.400	6.700			
	008004	ND	2.600	ND			
	008005	ND	1.500	1.100			
	636001	ND	1.700	3.200			
Cobalt (Co)	008001	1.500	ND	1.260	220	NL	1.45
	008003	ND	ND	0.990			
	008004	1.300	ND	1.900			
	008005	0.910	ND	0.880			
	008006	1.300	ND	1.100			
	636001	1.800	ND	1.000			

Table 10.6.10
Zone G
SWMU 8, AOC 636
Analytes Detected in Groundwater

Name	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Shallow Background
Copper (Cu)	008001	ND	ND	3.300	13000	1300	8.33
	008002	22.300	10.900	7.000			
	008003	44.800	14.100	18.100			
Iron (Fe)	S08W01	**2600.000**	NT	NT	1100	300	NL
	S08W02	**5800.000**	NT	NT			
	S08W03	**2600.000**	NT	NT			
	S08W04	**7000.000**	NT	NT			
	S08W05	***3200.000***	*NT*	*NT*			
	S08W06	**2300.000**	NT	NT			
	008001	**6200.000**	**1400.000**	**2000.000**			
	008002	**3830.000**	**1380.000**	**3090.000**			
	008003	1100.000	**1250.000**	**1530.000**			
	008004	**11400.000**	**14400.000**	**7620.000**			
	008005	**15800.000**	**8760.000**	**8330.000**			
	008006	**6190.000**	**6010.000**	**10400.000**			
	636001	**22700.000**	**56100.000**	**27300.000**			
Lead (Pb)	008002	9.100	5.200	ND	15	15	4.6
	008003	3.000	7.400	ND			
	008006	10.200	ND	ND			

Table 10.6.10
Zone G
SWMU 8, AOC 636
Analytes Detected in Groundwater

Name	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Shallow Background
Magnesium (Mg)	S08W01	820000.000	NT	NT	NL	NL	NL
	S08W02	78000.000	NT	NT			
	S08W03	920000.000	NT	NT			
	S08W04	920000.000	NT	NT			
	S08W05	250000.000	NT	NT			
	S08W06	75000.000	NT	NT			
	008001	867000.000	760000.000	740000.000			
	008002	159000.000	78600.000	120000.000			
	008003	1060000.000	945000.000	921000.000			
	008004	836000.000	719000.000	733000.000			
	008005	190000.000	165000.000	185000.000			
	008006	107000.000	80700.000	139000.000			
	636001	714000.000	146000.000	380000.000			
Manganese (Mn)	S08W01	87.000	NT	NT	84	50	2906
	S08W02	120.000	NT	NT			
	S08W03	84.000	NT	NT			
	S08W04	140.000	NT	NT			
	S08W05	1100.000	NT	NT			
	S08W06	750.000	NT	NT			
	008001	180.000	186.000	90.600			
	008002	217.000	183.000	258.000			
	008003	39.000	ND	ND			
	008004	239.000	201.000	162.000			
	008005	1120.000	809.000	774.000			
	008006	1620.000	885.000	1470.000			
	636001	648.000	679.000	487.000			
Mercury (Hg)	636001	ND	ND	0.280	1.1	2.0	NL

Table 10.6.10
Zone G
SWMU 8, AOC 636
Analytes Detected in Groundwater

Name	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Shallow Background
Nickel (Ni)	008001	3.000	1.600	1.010	73	100	4.08
	008002	2.000	1.400	0.910			
	008003	ND	4.300	2.000			
	008004	ND	0.770	ND			
	008005	2.200	1.900	1.200			
	008006	2.900	1.200	2.000			
	636001	ND	ND	1.900			
Potassium (K)	S08W01	270000.000	NT	NT	NL	NL	NL
	S08W02	33000.000	NT	NT			
	S08W03	280000.000	NT	NT			
	S08W04	260000.000	NT	NT			
	S08W05	90000.000	NT	NT			
	S08W06	36000.000	NT	NT			
	008001	288000.000	260000.000	261000.000			
	008002	56400.000	58600.000	39400.000			
	008003	322000.000	284000.000	276000.000			
	008004	253000.000	211000.000	235000.000			
	008005	71400.000	102000.000	87600.000			
	008006	50100.000	47700.000	60700.000			
	636001	224000.000	66700.000	120000.000			
Selenium (Se)	636001	2.900	3.500	ND	18	50	4.3
Silver (Ag)	008001	1.400	ND	ND	18	100	1.65
	008003	ND	ND	1.200			
	008005	1.700	ND	ND			
	008006	ND	ND	1.500			

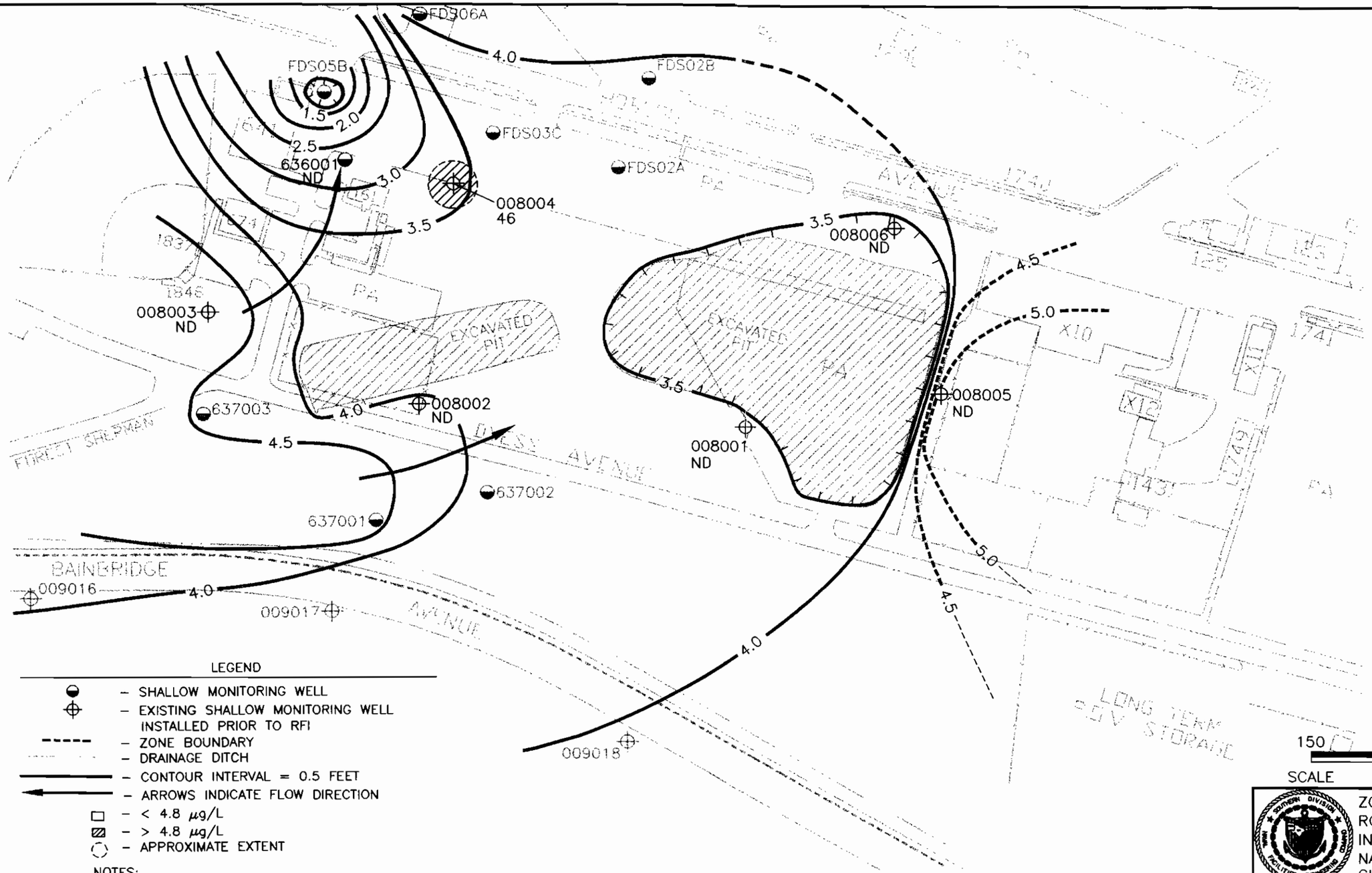
Table 10.6.10
Zone G
SWMU 8, AOC 636
Analytes Detected in Groundwater

Name	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Shallow Background
Sodium (Na)	S08W01	6500000.000	NT	NT	NL	NL	NL
	S08W02	650000.000	NT	NT			
	S08W03	7700000.000	NT	NT			
	S08W04	7500000.000	NT	NT			
	S08W05	2300000.000	NT	NT			
	S08W06	790000.000	NT	NT			
	008001	8420000.000	7510000.000	7760000.000			
	008002	1400000.000	1080000.000	1030000.000			
	008003	8850000.000	8170000.000	8010000.000			
	008004	7880000.000	6840000.000	7400000.000			
	008005	2050000.000	2280000.000	2140000.000			
	008006	1040000.000	804000.000	1380000.000			
	636001	6310000.000	1510000.000	3590000.000			
Thallium (Tl)	008002	**3.900**	ND	ND	0.29	2	NL
	008003	ND	**7.400**	ND			
	008004	**4.600**	**6.400**	ND			
	008005	ND	**5.800**	ND			
Tin (Sn)	008003	3.400	ND	ND	2200	NL	NL
Vanadium (V)	S08W01	17.000	NT	NT	26	NL	15.4
	S08W03	25.000	NT	NT			
	008001	6.800	18.300	24.000			
	008002	1.300	1.900	3.100			
	008003	**49.000**	12.400	19.500			
	008004	ND	1.600	1.700			
	008005	2.500	3.600	5.200			
	008006	2.900	2.200	3.500			
	636001	2.900	5.000	5.700			

Table 10.6.10
Zone G
SWMU 8, AOC 636
Analytes Detected in Groundwater

Name	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Shallow Background
Zinc (Zn)	S08W01	40.000	NT	NT	1100	5000	15.6
	S08W03	29.000	NT	NT			
	008002	ND	18.400	ND			
	008003	181.000	14.800	ND			
	636001	ND	ND	9.000			

Notes:
NL = Not listed
NA = Not applicable
NT = Not taken
µg/L = Micrograms per liter
* = Tap Water RBCs (THQ=0.1) from *Risk-Based Concentration Table* (USEPA, October 22, 1997), and MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996d)
Bolded concentrations exceed both the RBC and the zone background
All background values for Zone G are based on twice the means of the grid sample concentrations. Background values for groundwater are based on two sampling rounds in two wells at each depth



LEGEND

- ● – SHALLOW MONITORING WELL
- ⊕ – EXISTING SHALLOW MONITORING WELL INSTALLED PRIOR TO RFI
- ----- – ZONE BOUNDARY
- ····· – DRAINAGE DITCH
- ——— – CONTOUR INTERVAL = 0.5 FEET
- ←——— – ARROWS INDICATE FLOW DIRECTION
- □ – < 4.8 µg/L
- ▨ – > 4.8 µg/L
- ◌ – APPROXIMATE EXTENT

NOTES:

- 4.8 µg/L = TAP WATER RBC FOR BIS(2-ETHYLHEXYL)PHTHALATE (USEPA, OCTOBER 22, 1997)
- RESULTS IN µg/L
- ND = NOT DETECTED

ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.6-25
BIS(2-ETHYLHEXYL)PHTHALATE
IN SHALLOW GROUNDWATER
SWMU #8 OIL SLUDGE
AOC #636 TORPEDO MAGAZINE
BUILDING 161 AREA

DWG DATE:02/12/98 | DWG NAME:2907M144

Pesticides and PCBs in Groundwater

No pesticides or PCBs were detected in shallow groundwater samples at SWMU 8 and AOC 636.

Other Organics in Groundwater

Hydrazine was not detected during the first-quarter above its respective tap water RBC in shallow groundwater samples collected from AOC 636. Figure 10.6-26 presents hydrazine concentrations detected in second-quarter shallow groundwater samples at the site.

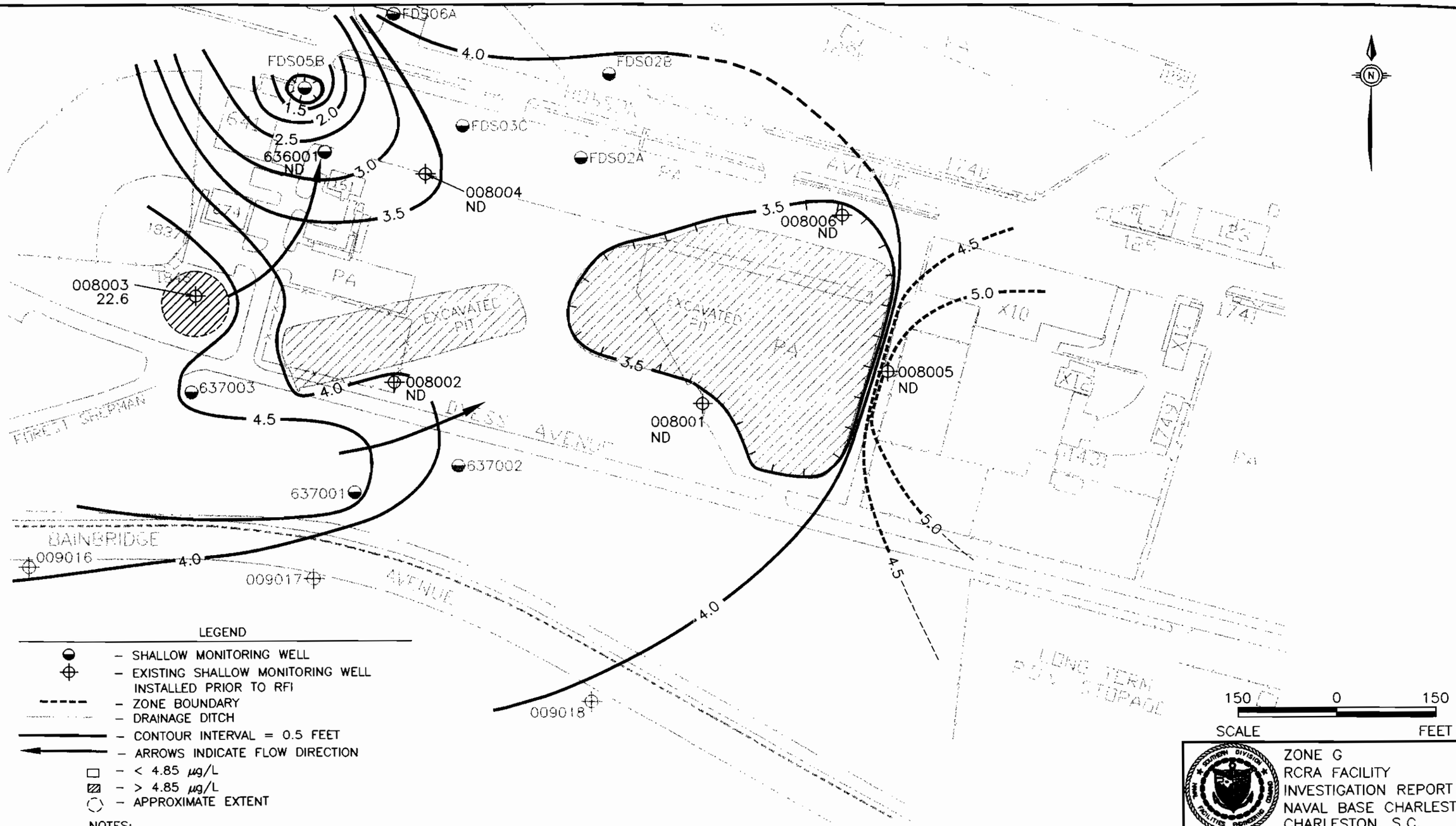
Inorganic Elements in Groundwater

Twenty-one metals were detected in shallow groundwater at SWMU 8 and AOC 636. Of these, antimony, barium, thallium, and vanadium exceeded their respective tap water RBCs and Zone G shallow groundwater background concentrations. Figures 10.6-27 through 10.6-30 present antimony, barium, thallium and vanadium concentrations detected in shallow groundwater at SWMU 8 and AOC 636. Iron was also detected at concentrations exceeding its tap water RBC. However, because iron is considered an essential nutrient, no background was established for iron in shallow groundwater.

10.6.5 Fate and Transport Assessment

These sites were combined into one investigation due to their close proximity and their potential for similar contaminants. Environmental media sampled as part of the SWMU 8 and AOC 636 investigation included surface soil, subsurface soil, and shallow groundwater. Potential constituent migration pathways investigated for SWMU 8 and AOC 636 include soil-to-groundwater, groundwater-to-surface water, and emission of volatile organic compounds from surface soil to air.

FIGURE 10.6-26
HYDRAZINE IN SHALLOW GROUNDWATER
SWMU #8 OIL SLUDGE
AOC #636 TORPEDO MAGAZINE
BUILDING 161 AREA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FDS05B
FDS02B
FDS03C
FDS02A
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
636001
ND
008004
ND
008006
ND
008003
22.6
008005
ND
008002
ND
008001
ND
637003
637002
637001
009016
009017
009018
EXCAVATED PIT
EXCAVATED PIT
P4
P4
FOREST SHERMAN
DIXIE AVENUE
BAINBRIDGE
AVENUE
AVENUE
LONG TERM
PETROLEUM STORAGE
X10
X11
X12
X13
X14
X15
X16
X17
X18
X19
X20
X21
X22
X23
X24
X25
X26
X27
X28
X29
X30
X31
X32
X33
X34
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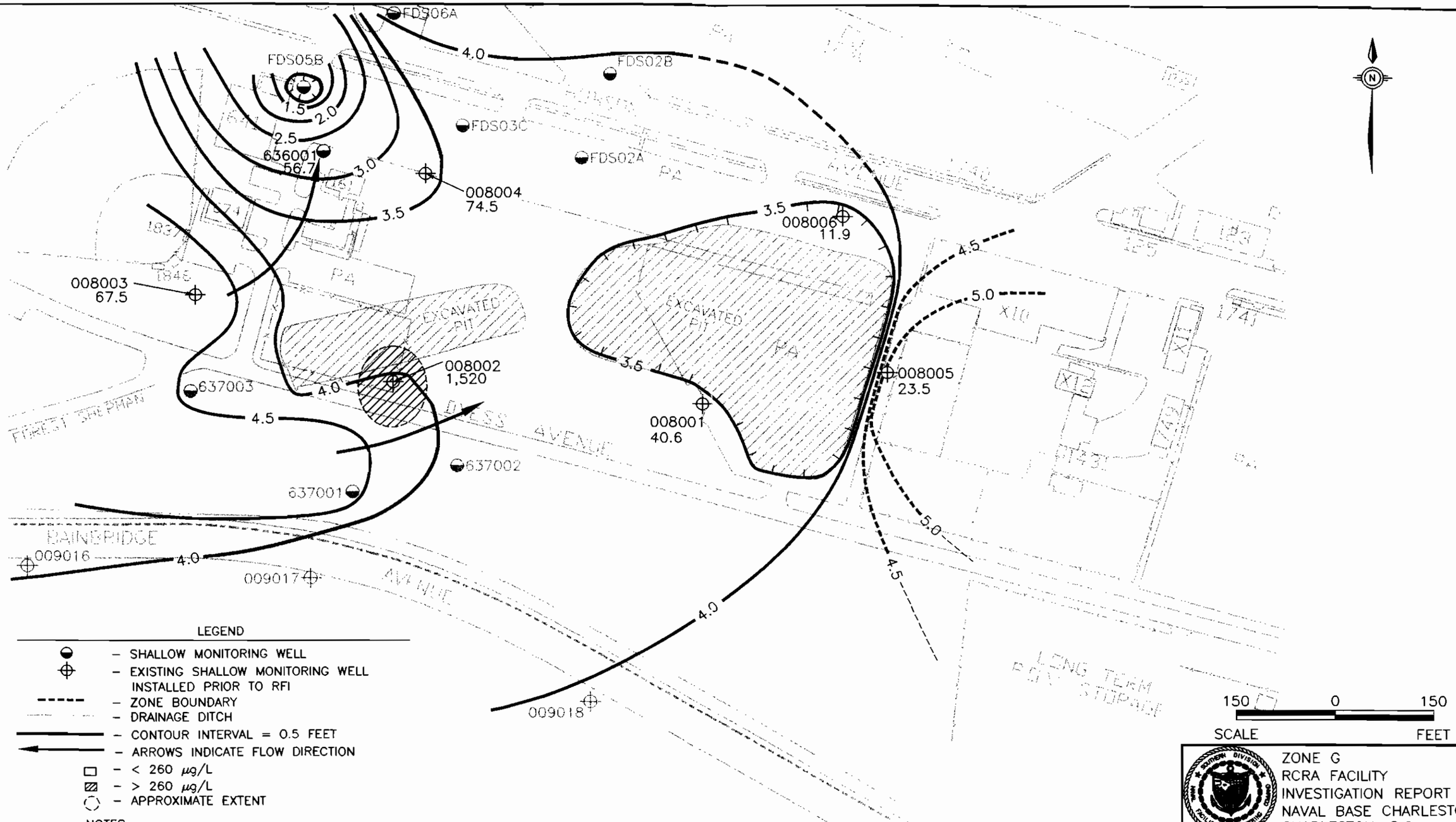
X45
X46
X47
X48
X49



LEGEND

- ● – SHALLOW MONITORING WELL
- ⊕ – EXISTING SHALLOW MONITORING WELL INSTALLED PRIOR TO RFI
- ----- – ZONE BOUNDARY
- ——— – DRAINAGE DITCH
- ——— – CONTOUR INTERVAL = 0.5 FEET
- ←——— – ARROWS INDICATE FLOW DIRECTION
- □ – < 260 µg/L
- ▨ – > 260 µg/L
- ◌ – APPROXIMATE EXTENT

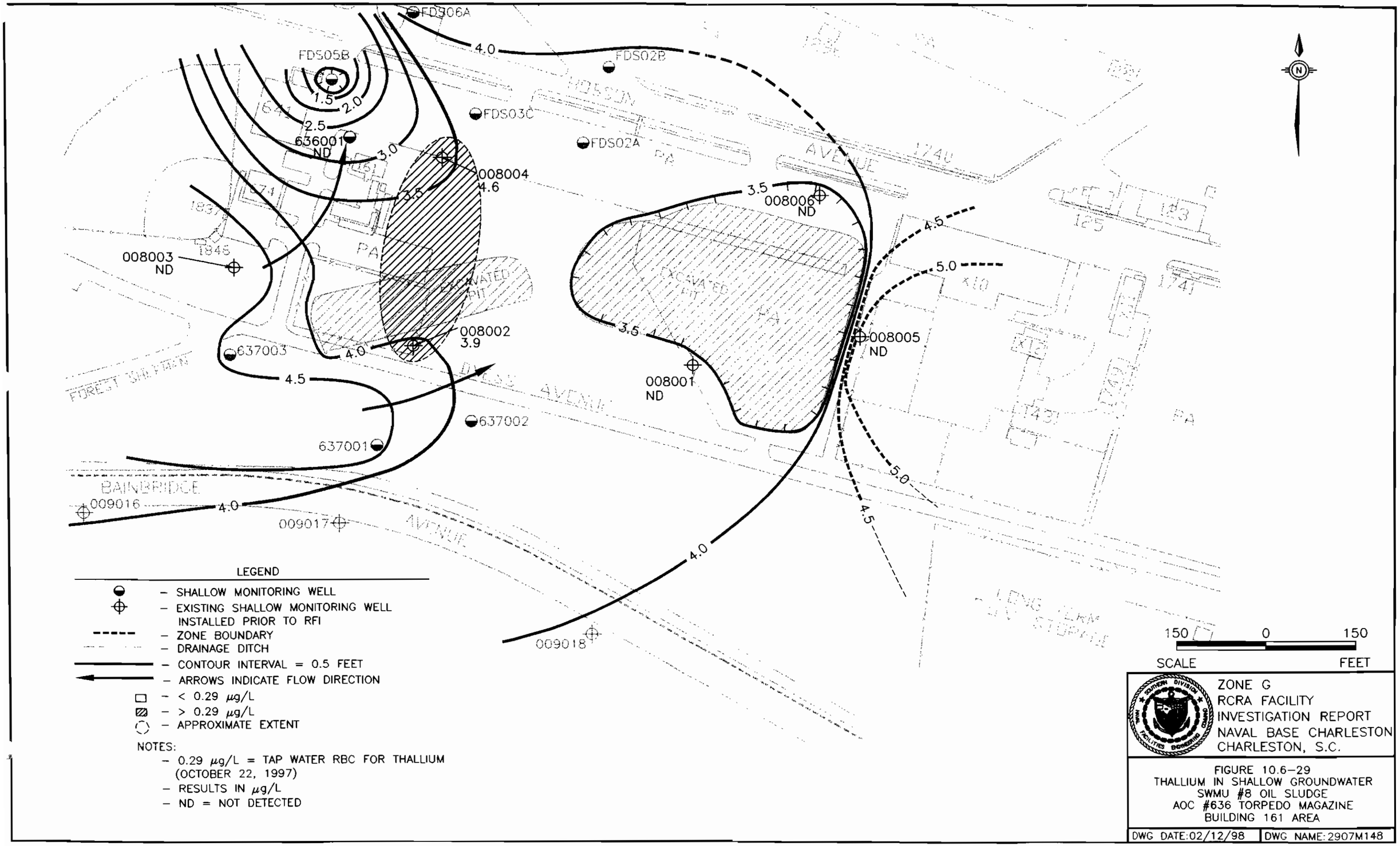
NOTES:

- 260 µg/L = TAP WATER RBC FOR BARIUM (OCTOBER 22, 1997)
- RESULTS IN µg/L

ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.6-28
BARIUM IN SHALLOW GROUNDWATER
SWMU #8 OIL SLUDGE
AOC #636 TORPEDO MAGAZINE
BUILDING 161 AREA

DWG DATE:02/12/98 | DWG NAME: 2907M147



ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.6–29
THALLIUM IN SHALLOW GROUNDWATER
SWMU #8 OIL SLUDGE
AOC #636 TORPEDO MAGAZINE
BUILDING 161 AREA

DWG DATE:02/12/98 | DWG NAME:2907M148

FDS06A
FDS05B
FDS02B
FDS03C
FDS02A
636001
2.9
008004
ND
008006
2.9
008003
49
008002
1.3
008001
6.8
008005
2.5
637003
637002
637001
009016
009017
009018
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
EXCAVATED PIT
PA
DYESS AVENUE
BAINBRIDGE AVENUE
FOREST SHERMAN
LEGEND
– SHALLOW MONITORING WELL
– EXISTING SHALLOW MONITORING WELL INSTALLED PRIOR TO RFI
– ZONE BOUNDARY
– DRAINAGE DITCH
– CONTOUR INTERVAL = 0.5 FEET
– ARROWS INDICATE FLOW DIRECTION
– < 26 µg/L
– > 26 µg/L
– APPROXIMATE EXTENT
NOTES:
– 26 µg/L = TAP WATER RBC FOR VANADIUM (OCTOBER 22, 1997)
– RESULTS IN µg/L
– ND = NOT DETECTED
150 0 150
SCALE FEET
ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 10.6-30
VANADIUM IN SHALLOW GROUNDWATER
SWMU #8 OIL SLUDGE
AOC #636 TORPEDO MAGAZINE
BUILDING 161 AREA
DWG DATE: 02/12/98
DWG NAME: 2907M149

10.6.5.1 Soil-to-Groundwater Cross-Media Transport

Table 10.6.11 compares maximum detected organic compound concentrations in surface soil and subsurface soil samples to risk-based soil screening levels considered protective of groundwater.

For inorganic analytes, maximum concentrations in soil are compared to the greater of (a) risk-based soil screening levels or (b) background concentrations. To provide a conservative screen, generic soil screening levels are used; leachate entering the aquifer is assumed to be diluted by a ratio of 20:1, with no attenuation of constituents in soil (DAF=20).

Thirteen organic compounds were detected in SWMU 8 and AOC 636 surface or subsurface soil at concentrations exceeding groundwater protection SSLs. With the exception of hydrazine, most of the organic exceedances are limited to the SWMU 8 area. VOCs exceeding applicable SSLs include 1,1,2,2-tetrachloroethane and 1,1,2-trichloroethane. Both of the VOCs exceeded applicable SSLs in the subsurface soil. The dominant chemical group exhibiting concentrations above SSLs are the SVOCs. Eight SVOCs were found to exceed their respective screening levels at the combined site. Additionally, most of the SVOC exceedances are noted in the surface soil. These compounds are common constituents of waste oil as primary ingredients and degradation products. Being of high molecular weight, these organic compounds tend to become immobile quite rapidly (through adsorption onto soil media), as evidenced at the site by their vertical distribution (lower concentrations with depth). The presence of one pesticide - dieldrin - at SWMU 8 exhibiting SSL exceedances in both surface soil and subsurface soil may potentially be a residual from normal application, or possibly wastes containing dieldrin may have been disposed of with the oil sludge during previous operations. The vertical distribution of dieldrin is consistent with a surface application of dieldrin. This pesticide has a strong affinity to adsorb to soil media, thereby limiting its mobility and attenuating its concentrations with depth in the soil column.

Table 10 6 11
Chemicals Detected in Surface Soil, Subsurface Soil, and Shallow Groundwater
Comparison to SSLs, Tap Water RBCs, Saltwater Surface Water Chronic Screening Levels, and Background Concentrations
NAVBASE Charleston, Zone G SWMU 8 and AOC 636
Charleston, South Carolina

Parameter	Max. Concentration		Max. Concentration		Screening Concentration *					Ground-Water	Surface Water
	Surface Soil	Subsurface Soil	Shallow GW	Deep GW	Soil to GW SSL	Tap Water RBC	Saltwater Surf Wtr Chronic	Soil Units	Water Units	Leaching Potential	Migration Concern	Migration Concern
Volatile Organic Compounds												
Acetone	220	1100	ND	NA	16000	3700	NA	UG/KG	UG/L	NO	NO	NO
2-Butanone (MEK)	30	10	ND	NA	7900	1900	NA	UG/KG	UG/L	NO	NO	NO
Carbon disulfide	2 1	7 9	ND	NA	32000	1000	NA	UG/KG	UG/L	NO	NO	NO
Chlorobenzene	185	50	ND	NA	1000	39	105	UG/KG	UG/L	NO	NO	NO
Ethylbenzene	840	6 6	3	NA	13000	1300	4.3	UG/KG	UG/L	NO	NO	NO
1,1,2,2-Tetrachloroethane	ND	10	ND	NA	3	0.052	90.2	UG/KG	UG/L	YES	NO	NO
Toluene	580	6	ND	NA	12000	750	37	UG/KG	UG/L	NO	NO	NO
1,1,1-Trichloroethane	1600	3 8	ND	NA	2000	540	NA	UG/KG	UG/L	NO	NO	NO
1,1,2-Trichloroethane	ND	92	ND	NA	20	0.19	NA	UG/KG	UG/L	YES	NO	NO
Vinyl Acetate	ND	17	ND	NA	170000	37000	NA	UG/KG	UG/L	NO	NO	NO
Xylene (total)	3400	14	ND	NA	148000	12000	NA	UG/KG	UG/L	NO	NO	NO
Semivolatile Organic Compounds												
Acenaphthene	5800	830	ND	NA	570000	2200	9 7	UG/KG	UG/L	NO	NO	NO
Acenaphthylene	100	ND	ND	NA	293000	1500	NA	UG/KG	UG/L	NO	NO	NO
Anthracene	16600	7100	ND	NA	12000000	11000	NA	UG/KG	UG/L	NO	NO	NO
Benzoic acid	40	64	2	NA	400000	150000	NA	UG/KG	UG/L	NO	NO	NO
Benzo(g,h,i)perylene	15850	750	ND	NA	4.66E+08	1500	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene equivalents												
Benzo(a)anthracene	430200	2400	ND	NA	2000	0 092	NA	UG/KG	UG/L	YES	NO	NO
Benzo(a)pyrene	31600	3800	ND	NA	8000	0 0092	NA	UG/KG	UG/L	YES	NO	NO
Benzo(b)fluoranthene	41750	2400	ND	NA	5000	0 092	NA	UG/KG	UG/L	YES	NO	NO
Benzo(k)fluoranthene	20750	5100	ND	NA	49000	0.92	NA	UG/KG	UG/L	NO	NO	NO
Chrysene	45000	9300	ND	NA	160000	9 2	NA	UG/KG	UG/L	NO	NO	NO
Dibenzo(a,h)anthracene	4555	150	ND	NA	2000	0 0092	NA	UG/KG	UG/L	YES	NO	NO
Indeno(1,2,3-cd)pyrene	18400	760	ND	NA	14000	0 092	NA	UG/KG	UG/L	YES	NO	NO
	130	ND	ND	NA	930000	7300	29.4	UG/KG	UG/L	NO	NO	NO
Butylbenzylphthalate	3595	320	ND	NA	600	3 4	NA	UG/KG	UG/L	YES	NO	NO
Carbazole	780	NA	ND	NA	700	150	NA	UG/KG	UG/L	YES	NO	NO
4-Chloroaniline	2065	52	ND	NA	50000	150	NA	UG/KG	UG/L	NO	NO	NO
Dibenzofuran	ND	ND	1	NA	9000	730	NA	UG/KG	UG/L	NO	NO	NO
2,4-Dimethylphenol	130	ND	ND	NA	0 8	0 099	NA	UG/KG	UG/L	YES	NO	NO
2,4-Dinitrotoluene	420	ND	46	NA	3600000	4.8	NA	UG/KG	UG/L	NO	YES	NO
bis(2-Ethylhexyl)phthalate (BEHP)	110500	7500	ND	NA	4300000	1500	1.6	UG/KG	UG/L	NO	NO	NO
Fluoranthene	5380	780	ND	NA	560000	1500	NA	UG/KG	UG/L	NO	NO	NO
Fluorene	510	63000	ND	NA	126000	1500	NA	UG/KG	UG/L	NO	NO	NO
2-Methylnaphthalene	ND	ND	ND	NA	1380	180	NA	UG/KG	UG/L	NO	NO	NO
4-Methylphenol (p-cresol)	430	12000	2	NA	84000	1500	23.5	UG/KG	UG/L	NO	NO	NO
Naphthalene	65000	42000	ND	NA	1380000	1500	NA	UG/KG	UG/L	NO	NO	NO
Phenanthrene	107500	30000	ND	NA	4200000	1100	NA	UG/KG	UG/L	NO	NO	NO
Pyrene												
Pesticides/PCB Compounds												
Aldrin	41	7 6	ND	NA	500	0 004	0 13	UG/KG	UG/L	NO	NO	NO
Aroclor-1260	920	570	ND	NA	1000	0 034	0 03	UG/KG	UG/L	NO	NO	NO
alpha-Chlordane	11	240	ND	NA	10000	0 19	0 004	UG/KG	UG/L	NO	NO	NO
gamma-Chlordane	95 5	34	ND	NA	10000	0 19	0 004	UG/KG	UG/L	NO	NO	NO
4,4'-DDD	179	180	ND	NA	16000	0 28	0 025	UG/KG	UG/L	NO	NO	NO
4,4'-DDE	117 5	120	ND	NA	54000	0 2	0 14	UG/KG	UG/L	NO	NO	NO
4,4'-DDT	38	200	ND	NA	32000	0 2	0 001	UG/KG	UG/L	NO	NO	NO
Dieldrin	46	610	ND	NA	4	0 0042	0 0019	UG/KG	UG/L	YES	NO	NO
Endosulfan II	ND	19	ND	NA	18000	220	0 0087	UG/KG	UG/L	NO	NO	NO
Endrin	ND	47	ND	NA	1000	11	0.0023	UG/KG	UG/L	NO	NO	NO
Endrin Aldehyde	4	71	ND	NA	1000	11	NA	UG/KG	UG/L	NO	NO	NO
Endrin Ketone	4 5	6	ND	NA	1000	11	NA	UG/KG	UG/L	NO	NO	NO
Heptachlor	3 9	ND	ND	NA	23000	0 0023	0 0036	UG/KG	UG/L	NO	NO	NO
Heptachlor Epoxide	11	250	ND	NA	700	0 0012	0 0036	UG/KG	UG/L	NO	NO	NO
Dioxin Compounds												
Dioxin (TCDD TEQ)	3 88	NA	NA	NA	1900	0 45	10	NG/KG	PG/L	NO	NO	NO
Hydrazine												
Hydrazine	274	67	23 6	NA	0 088	0 022	NA	UG/KG	UG/L	YES	YES	NO
Inorganic Compounds												
Aluminum	12100	36500	1400	NA	1000000	37000	NA	MG/KG	UG/L	NO	NO	NO
Antimony	7 6	32	22 6	NA	5	15	NA	MG/KG	UG/L	YES	YES	NO
Arsenic	150	21	17 7	NA	29	18 7	36	MG/KG	UG/L	YES	NO	NO
Barium	120	500	1520	NA	1600	2600	NA	MG/KG	UG/L	NO	NO	NO
Beryllium	1	1 6	ND	NA	63	1 2	NA	MG/KG	UG/L	NO	NO	NO
Cadmium	1 85	5 9	ND	NA	8	18	9 3	MG/KG	UG/L	NO	NO	NO
Chromium (total)	103	103	4 6	NA	1000000	180	50	MG/KG	UG/L	NO	NO	NO
Cobalt	14	12	1 8	NA	2000	2200	NA	MG/KG	UG/L	NO	NO	NO
Copper	1330	14000	44 8	NA	920	130000	8 33	MG/KG	UG/L	YES	NO	YES
Cyanide	0 3	NA	NA	NA	40	730	3 8	MG/KG	UG/L	NO	NO	NO
Lead	454	1400	10 2	NA	400	15	8.5	MG/KG	UG/L	YES	NO	YES
Manganese	270	1600	1620	NA	1100	2560	NA	MG/KG	UG/L	YES	NO	NO
Mercury	0 63	6 9	ND	NA	2 1	11	0.025	MG/KG	UG/L	YES	NO	NO
Nickel	34.4	79	3	NA	130	730	21 7	MG/KG	UG/L	NO	NO	NO
Selenium	0 89	2 2	2 9	NA	5	180	71	MG/KG	UG/L	NO	NO	NO
Silver	1 2	3 4	1 7	NA	34	180	2 9	MG/KG	UG/L	NO	NO	NO
Thallium	0 92	1	4 6	NA	0 95	2 9	21 3	MG/KG	UG/L	YES	YES	NO
Tin	34.2	ND	3400	NA	11000	22000	NA	MG/KG	UG/L	NO	NO	NO
Vanadium	30	96	49	NA	6000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	1270	3300	181	NA	12000	11000	86	MG/KG	UG/L	NO	NO	YES

* Screening Concentrations.
Soil to GW - Generic SSLs based on DAF = 20, from 1996 Soil Screening Guidance or calculated using values from Table 6 4
Tap Water RBC - From EPA Region III Risk-Based Concentration Table, October 22, 1997
Salt Water Surface Water Chronic - From EPA Supplemental Guidance to RAGS Region IV Bulletins, Ecological Risk Assessment, November, 1995, Table 2
For inorganics, the value shown is the greater of the relevant screening value or the corresponding background value

NA - Not available/Not applicable
ND - Not detected
RBC - Risk based concentration
SSL - Soil screening level
MG/KG - Milligrams per kilogram
NG/KG - Nanograms per kilogram
PG/L - Picograms per liter
UG/KG - Micrograms per kilogram
UG/L - Micrograms per liter

Hydrazine was detected in both surface and subsurface soil at SWMU 8 as well as at AOC 636 at concentrations exceeding groundwater protection SSLs. The exceedances for hydrazine noted at this site are primarily in soil samples taken at AOC 636 locations. Hydrazine is commonly associated with torpedo propellant fuels, and its presence at this site is consistent with historical activities at AOC 636. The majority of organic compounds detected above SSLs in the soil were either not detected in the shallow groundwater or were detected at concentrations not exceeding applicable groundwater protection screening criteria. Two organic constituents were detected in concentrations above applicable screening levels in shallow groundwater at SWMU 8 - bis(2-ethylhexyl)pthalate and hydrazine -thus the soil-to-groundwater migration pathway for those two organic compounds at this site is considered valid.

Seven inorganic analytes were detected in surface or subsurface soil at concentrations exceeding groundwater protection SSLs. Specifically, antimony, arsenic, copper, lead, manganese, mercury, and thallium were found to exceed their respective screening levels at this site. Similar to the organic compounds, most of the inorganic constituents detected above applicable screening levels are limited to the SWMU 8 soil samples. The presence of some of these inorganic may be consistent with historical activities at this site as metals are common constituents in waste oil. The widespread occurrence of antimony relative to other inorganic constituents is unusual, and its attribution to past activities is conjectural. The presence of antimony at the concentrations and locations noted may possibly be associated with the fill material used following cessation of site activities. Two inorganic constituents - antimony and thallium - that were noted to exceed applicable SSLs were also present in groundwater at concentrations exceeding groundwater risk-based migration screening levels; copper, lead, and zinc were present in shallow groundwater at concentrations exceeding saltwater surface water chronic values. The presence of these constituents in concentrations above applicable groundwater screening levels indicate that the soil-to-groundwater pathway for inorganic constituents is valid.

10.6.5.2 Groundwater-to-Surface Water Cross-Media Transport

Table 10.6.11 also compares maximum detected organic constituent concentrations in shallow groundwater samples to risk-based concentrations for drinking water, and to chronic ambient saltwater quality criteria values for the protection of aquatic life (saltwater surface water chronic screening values). For inorganic constituents, maximum concentrations in groundwater are compared to the greater of (a) risk-based drinking water concentrations, or (b) background concentrations for groundwater, as well as to the saltwater surface water chronic values. To provide a conservative screening, no attenuation or dilution of constituents in groundwater is assumed before comparison to the relevant standards.

Two organic compounds - bis(2-ethylhexyl)pthalate and hydrazine - were present in groundwater at concentrations exceeding the applicable tap water RBC screening levels. Shallow groundwater exceedances for organic compounds at the site are limited to the SWMU 8 area. Two inorganic analytes - antimony and thallium - were detected at concentration that exceeded the applicable RBC screening levels. No organic constituents were present at concentrations exceeding their respective saltwater surface water chronic screening values. Three inorganic analytes - copper, lead, and zinc - were present at concentrations exceeding their respective saltwater surface water chronic screening values. Additionally, all saltwater surface water chronic screening exceedances noted for this site were found at SWMU 8. Based on the first-quarter groundwater sampling results, the pathways for a number of both organic and inorganic analytes appears to be valid. However, third quarter groundwater sampling results indicate that hydrazine is the only organic that exceeds the applicable RBC, and copper is the only inorganic that exceeds the applicable saltwater surface water chronic screening value. Further, the risk-based pathway is incomplete due to the absence of a potential receptor. The groundwater flow direction at SWMU 8 and AOC 636 is inconsistent with discharge to a nearby surface water receptor. As a result, from a fate and transport perspective, both of these pathways are considered invalid.

10.6.5.3 Soil-to-Air Cross-Media Transport

Table 10.6.12 lists the VOCs which were detected in surface soil samples collected at SWMU 8 and AOC 636 along with the corresponding soil-to-air volatilization screening criteria. Eight VOCs were detected in surface soil but none exceeded the soil-to-air volatilization screening levels, consequently, the soil-to-air migration pathway is not considered valid.

10.6.5.4 Fate and Transport Summary

With the exception of hydrazine, most of the organic compound exceedances at SWMU 8 and AOC 636 soil are limited to the SWMU 8 area. The dominant chemical group exhibiting concentrations above applicable SSLs are the SVOCs, which were noted primarily in surface soil at the site. These high molecular weight compounds tend to become immobile quite rapidly as they move downward through the soil column, as evidenced by their vertical distribution at SWMU 8. The presence of dieldrin is inconsistent with historical practices at the site. However its presence in site soil may be attributable to either a previous application at the site and surrounding area or as a waste that was disposed of in the disposal area. The presence of hydrazine in soil is consistent with AOC 636 historical activities. Concentrations of hydrazine exceed applicable SSLs most prominently at AOC 636. The majority of organic constituents detected in site soil which exceed applicable SSLs were either not detected in shallow groundwater or were below applicable groundwater screening levels. However, the soil-to-groundwater pathway is validated by the presence of bis(2-ethylhexyl)pthalate and hydrazine, both of which were present above applicable screening concentrations in shallow groundwater. Similar to the organic compounds detected at SWMU 8 and AOC 636, most of the inorganic analytes exceeding groundwater protection SSLs are limited to the SWMU 8 area. Although some of the inorganic constituents detected may be associated with past activities at the site, the widespread occurrence of antimony relative to other inorganic constituents is notable, and may be associated with the fill material used to reclaim the area. Thallium and antimony were detected in soil at concentrations exceeding groundwater protection SSLs. These analytes were also present in groundwater at

Table 10.6.12
Soil-to-Air Volatilization Screening Analysis
NAVBASE Charleston, Zone G: SWMU 8 and AOC 636
Charleston, South Carolina

VOCs	Maximum Concentration in Surface Soil	Soil to Air SSL*	Units	Exceeds SSL
Acetone	220	100000000	UG/KG	NO
2-Butanone (MEK)	30	10000	UG/KG	NO
Carbon Disulfide	2.1	720000	UG/KG	NO
Chlorobenzene	310	130000	UG/KG	NO
Ethylbenzene	840	400000	UG/KG	NO
Toluene	580	650000	UG/KG	NO
1,1,1-Trichloroethane	1600	1200000	UG/KG	NO
Xylene (total)	3400	410000	UG/KG	NO

* - Soil screening levels for transfers from soil to air were obtained from USEPA Soil Screening Guidance, Technical Background Document Appendix A, May 1996 (first preference) or from Soil Screening Levels - Transfers from Soil to Air, USEPA Region III Risk-Based Concentration Table, June 1996. Value for 2-butanone was estimated.

NA - Not available

concentrations exceeding their risk-based screening criteria. Copper, lead, and zinc were present at concentrations exceeding saltwater surface water chronic screening levels. The presence of these constituents at concentrations exceeding applicable groundwater protection screening levels also supports the velocity of the soil-to-groundwater migration pathway. Shallow groundwater screening exceedances are limited to the SWMU 8 area. Based on the first-quarter of groundwater sample results, the pathways for several organics and inorganics appear valid, however, third-quarter results indicate that only hydrazine and copper exceed the RBC and saltwater surface water chronic screening levels, respectively. The risk-based groundwater-to-surface water pathway is incomplete due to the absence of a potential receptor. In addition, the groundwater flow direction is inconsistent with discharge to a nearby surface water receptor, thus, from a fate and transport perspective, both of these pathways are considered invalid. No VOCs were detected in surface soil at concentrations above the soil-to-air volatilization screening levels, thus the soil-to-air pathway is not considered valid.

10.6.6 Human Health Risk Assessment

10.6.6.1 Site Background and Investigative Approach

SWMU 8 contained three unlined pits which were used to dispose of oil sludge from 1944 to 1977. The pits were filled at one time, and the area was converted to a parking area. AOC 636 is the former torpedo magazine where subsurface disposal of unused torpedoes and munitions occurred prior to 1944. The AOC 636 area was primarily marshland at the time, but has since been filled with dredged materials. Due to their proximity, data from the SWMU 8 and AOC 636 investigations were combined; and the site will be referred to as combined SWMU 8 throughout this HHRA.

During the RFI, 17 soil samples were collected from the upper interval and 7 soil samples were collected from the lower interval to identify potential impacts resulting from the activities listed above. An additional 31 surface soils samples and 16 subsurface soil samples were previously

collected in 1993. Surface soil samples from all 48 boring locations were used to quantitatively assess the direct contact soil exposure pathways. Subsurface soil is addressed relative to indirect exposure pathways in the previous section, Fate and Transport Assessment for combined SWMU 8. Seven monitoring wells were installed in the shallow aquifer. Data from the initial RFI sampling event were used to quantitatively assess groundwater exposure pathways. Sections 10.6.3 and 10.6.4 provide summaries of the sampling effort for combined SWMU 8 soil and groundwater.

10.6.6.2 COPC Identification

Soil

Based on the screening comparisons described in Section 7 of this RFI and presented in Tables 10.6.13 and 10.6.14, Aroclor-1260, benzo(a)pyrene equivalents, antimony, arsenic, chromium, lead, thallium, aldrin, dieldrin, and hydrazine were identified as COPCs in surface soil.

Groundwater

As shown in Table 10.6.15, antimony, barium, thallium, vanadium, and bis(2-ethylhexyl)phthalate were identified as COPCs for shallow groundwater at combined SWMU 8.

10.6.6.3 Exposure Assessment

Exposure Setting

Combined SWMU 8 is located in an open area. The area is partially asphalt paved, the remaining area is gravel paved.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers, hypothetical future site residents, and adolescent site trespassers. Future site resident and worker exposure scenarios were

Table 10.6.13
Chemicals Present in Site Samples
SWMU 8 and AOC 636 - Surface Soil
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentrations RBC	Screening Concentrations Background	Units	Number Exceeding RBC	Number Exceeding Bkgd
PCBs													
Aroclor-1260	*	8	17	8.5	920	218	78	92	320	NA	UG/KG	3	
Carcinogenic PAHs													
B(a)P Equiv.	*	11	17	0.045	942.4	253	878.18	924.4	88	NA	UG/KG	7	
Benzo(a)anthracene	*	9	17	39	940	234	370	400	880	NA	UG/KG	1	
Benzo(b)fluoranthene		10	17	42	800	260	370	400	880	NA	UG/KG		
Chrysene		11	17	38	1100	267	380	400	88000	NA	UG/KG		
Dibenz(a,h)anthracene		3	17	42	80	58.3	370	410	88	NA	UG/KG		
Indeno(1,2,3-cd)pyrene		9	17	38	290	131	370	400	880	NA	UG/KG		
Benzo(k)fluoranthene		9	17	40	830	225	370	400	8800	NA	UG/KG		
Benzo(a)pyrene	*	9	17	38	730	222	370	400	88	NA	UG/KG	7	
TCDD Equivalents													
Dioxin Equiv.		1	1	3.88	3.88	3.88	NA	NA	1000	NA	NG/KG		
1234678-HpCDD		1	1	20.4	20.4	20.4	NA	NA	NA	NA	NG/KG		
1234678-HpCDF		1	1	6.98	6.98	7.0	NA	NA	NA	NA	NG/KG		
123478-HxCDF		1	1	5.44	5.44	5.4	NA	NA	NA	NA	NG/KG		
123678-HxCDF		1	1	0.901	0.901	0.90	NA	NA	NA	NA	NG/KG		
234678-HxCDF		1	1	1.12	1.12	1.1	NA	NA	NA	NA	NG/KG		
OCDD		1	1	148	148	148	NA	NA	NA	NA	NG/KG		
OCDF		1	1	7.09	7.09	7.1	NA	NA	NA	NA	NG/KG		
12378-PeCDF		1	1	1.87	1.87	1.9	NA	NA	NA	NA	NG/KG		
23478-PeCDF		1	1	0.586	0.586	0.59	NA	NA	NA	NA	NG/KG		
2378-TCDD		1	1	1.68	1.68	1.7	NA	NA	NA	NA	NG/KG		
2378-TCDF		1	1	6.35	6.35	6.4	NA	NA	NA	NA	NG/KG		
Inorganics													
Aluminum (Al)		17	17	1840	12100	5951	NA	NA	7800	18700	MG/KG	4	
Antimony (Sb)	*	3	17	0.66	6.4	2.9	0.34	1.1	3.1	2.89	MG/KG	1	1
Arsenic (As)	*	17	17	1.2	22.8	8.2	NA	NA	0.43	17.2	MG/KG	17	3
Barium (Ba)		17	17	7.1	99.1	32.0	NA	NA	550	109	MG/KG		
Beryllium (Be)		17	17	0.13	1	0.40	NA	NA	0.15	1.2	MG/KG	15	
Cadmium (Cd)		14	17	0.11	0.56	0.30	0.05	0.05	3.9	1.07	MG/KG		
Calcium (Ca)	N	17	17	4090	236000	43159	NA	NA	NA	NA	MG/KG		
Chromium (Cr)	*	17	17	4.6	84.2	15.1	NA	NA	39	42.8	MG/KG	1	1
Cobalt (Co)		16	17	0.55	14	4.5	0.77	0.77	470	6.6	MG/KG		4
Copper (Cu)		17	17	0.76	1330	152	NA	NA	27000	260	MG/KG	2	2
Cyanide (CN)		2	3	0.22	0.3	0.26	0.12	0.12	160	0.38	MG/KG		
Iron (Fe)	N	17	17	1650	14600	6359	NA	NA	NA	NA	MG/KG		
Lead (Pb)	*	17	17	4.9	453.5	85.4	NA	NA	400	181	MG/KG	1	2
Magnesium (Mg)	N	17	17	218	2550	1171	NA	NA	NA	NA	MG/KG		
Manganese (Mn)		17	17	7.2	253	77.3	NA	NA	180	325	MG/KG	1	
Mercury (Hg)		13	17	0.04	0.41	0.18	0.04	0.14	2.3	1.03	MG/KG		
Nickel (Ni)		17	17	1.9	34.4	9.8	NA	NA	160	20.6	MG/KG		2
Potassium (K)	N	13	17	247	990	500	232	252	NA	NA	MG/KG		
Selenium (Se)		10	17	0.35	0.89	0.60	0.34	0.48	39	1.22	MG/KG		
Sodium (Na)	N	12	17	240	1580	710	226	357	NA	NA	MG/KG		
Thallium (Tl)	*	6	17	0.42	0.92	0.69	0.39	0.54	0.63	0.85	MG/KG	4	1
Tin (Sn)		5	17	0.75	34.2	8.3	0.97	4.8	4700	9.67	MG/KG		1
Vanadium (V)		17	17	4.2	30.4	13.9	NA	NA	55	60.9	MG/KG		
Zinc (Zn)		17	17	3.1	1270	160	NA	NA	2300	519	MG/KG		1
Pesticidss													
alpha-Chlordane		7	17	2.2	6.3	3.7	1.4	1.8	1800	NA	UG/KG		
gamma-Chlordane		11	17	2.1	51	13.0	1.4	2.5	1800	NA	UG/KG		
4,4'-DDD		8	17	3.1	179	32.5	2.8	8.9	2700	NA	UG/KG		
4,4'-DDE		10	17	3.1	117.5	24.7	2.8	3	1900	NA	UG/KG		
4,4'-DDT		7	17	3.8	38	13.9	2.8	13	1900	NA	UG/KG		
Dieldrin		1	17	5.2	5.2	5.2	2.8	3.3	40	NA	UG/KG		

Table 10.6.13
Chemicals Present in Site Samples
SWMU 8 and AOC 636 - Surface Soil
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Parameter	Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentrations RBC	Screening Concentrations Background	Units	Number Exceeding RBC	Number Exceeding Bkgd
Semivolatile Organics												
Acenaphthene	2	17	51	81	66.0	370	430	470000	NA	UG/KG		
Anthracene	6	17	48	220	91.3	370	410	2300000	NA	UG/KG		
Benzo(g,h,i)perylene	9	17	38	320	137	370	400	230000	NA	UG/KG		
Benzoic acid	1	17	40	40	40.0	1800	2100	31000000	NA	UG/KG		
bis(2-Ethylhexyl)phthalate	1	17	420	420	420	370	430	46000	NA	UG/KG		
Butylbenzylphthalate	1	17	130	130	130	370	430	1600000	NA	UG/KG		
Dibenzofuran	3	17	62	120	86.0	370	430	31000	NA	UG/KG		
Fluoranthene	11	17	41	2700	574	380	400	310000	NA	UG/KG		
Fluorene	2	17	52	170	111	370	430	310000	NA	UG/KG		
2-Methylnaphthalene	4	17	42	510	244	370	430	310000	NA	UG/KG		
Naphthalene	4	17	43	320	185	370	430	310000	NA	UG/KG		
Phenanthrene	10	17	47	1700	400	370	400	230000	NA	UG/KG		
Pyrene	12	17	42	2600	574	380	400	230000	NA	UG/KG		
Volatile Organics												
2-Butanone (MEK)	3	12	2	30	12.7	4	28	4700000	NA	UG/KG		
Miscellaneous												
Hydrazine *	7	12	12.8	274	72.1	11.6	16	210	NA	UG/KG	1	

Notes:
* - Identified as a COPC
N - Essential nutrient
SQL - Sample quantitation limit
MG/KG - milligram per kilogram
UG/KG - microgram per kilogram
NG/KG - nanogram per kilogram
NA - Not applicable

Table 10.6.14
Chemicals Present in Site Samples - 93 Data
SWMU 8 and AOC 636 - Surface Soil
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Concentration	Range of SQL		Screening Concentrations RBC	Screening Concentrations Background	Units	Number Exceeding RBC	Number Exceeding Bkgd
Carcinogenic PAHs													
B(a)P Equiv.	*	17	31	0.068	85.443	7050	404.43	508.42	88	NA	UG/KG	9	
Benzo(a)anthracene	*	7	31	140	430200	65264	340	3800	880	NA	UG/KG	4	
Benzo(a)pyrene	*	13	31	36	31600	4256	350	440	88	NA	UG/KG	9	
Benzo(b)fluoranthene	*	13	31	27	41750	5745	350	3800	880	NA	UG/KG	5	
Benzo(k)fluoranthene	*	8	31	70	20750	4107	340	3800	8800	NA	UG/KG	1	
Chrysene		14	31	55.5	45000	5588	350	3800	88000	NA	UG/KG		
Dibenz(a,h)anthracene	*	4	31	260	4555	2011	340	3800	88	NA	UG/KG	4	
Indeno(1,2,3-cd)pyrene	*	5	31	99	18400	5780	340	3800	880	NA	UG/KG	3	
Inorganics													
Aluminum (Al)		31	31	600	12000	3269	NA	NA	7600	18700	MG/KG	2	
Antimony (Sb)	*	2	31	7.4	7.8	7.5	4.8	7	3.1	2.89	MG/KG	2	2
Arsenic (As)	*	30	31	1.6	150	10.5	1.1	1.1	0.43	17.2	MG/KG	30	2
Barium (Ba)		31	31	3.7	120	27.6	NA	NA	550	109	MG/KG		1
Beryllium (Be)		1	31	0.69	0.69	0.69	0.53	0.7	0.15	1.2	MG/KG	1	
Cadmium (Cd)		7	31	0.59	1.85	0.89	0.54	0.7	3.9	1.07	MG/KG		2
Calcium (Ca)	N	31	31	5800	330000	100303	NA	NA	NA	NA	MG/KG		
Chromium (Cr)	*	30	31	3.7	103	18.3	10	10	39	42.8	MG/KG	4	3
Cobalt (Co)		23	31	1.2	7.35	2.85	1.1	3.1	470	6.6	MG/KG		2
Copper (Cu)		25	31	3.1	400	63.2	2.7	27	27000	260	MG/KG		1
Iron (Fe)	N	31	31	1600	26900	5201	NA	NA	NA	NA	MG/KG		
Lead (Pb)		31	31	2.3	340	65.9	NA	NA	400	181	MG/KG		4
Magnesium (Mg)	N	31	31	140	4100	1569	NA	NA	NA	NA	MG/KG		
Manganese (Mn)		31	31	5.7	282	95.7	NA	NA	180	325	MG/KG	4	
Mercury (Hg)		28	31	0.012	0.63	0.12	0.011	0.011	2.3	1.03	MG/KG		
Nickel (Ni)		23	31	5.3	25.1	10.9	4.3	5.6	160	20.6	MG/KG		2
Potassium (K)	N	29	31	110	1365	357	110	140	NA	NA	MG/KG		
Silver (Ag)		1	31	1.2	1.2	1.2	1.1	1.4	39	NA	MG/KG		
Sodium (Na)	N	28	31	110	1000	350	57	70	NA	NA	MG/KG		
Vanadium (V)		31	31	3.3	28.3	11.3	NA	NA	55	60.9	MG/KG		
Zinc (Zn)		31	31	2.8	840	112	NA	NA	2300	519	MG/KG		2
Pesticides/PCBs													
4,4'-DDD		6	31	7.8	45	25.3	3.5	42	2700	NA	UG/KG		
4,4'-DDE		8	31	5.2	77	25.3	3.5	42	1900	NA	UG/KG		
4,4'-DDT		3	31	6.6	29	20.2	3.5	42	1900	NA	UG/KG		
Aldrin	*	1	31	41	41	41	1.8	4.3	38	NA	UG/KG	1	
alpha-Chlordane		5	31	2.8	11	7.88	1.8	22	1800	NA	UG/KG		
Aroclor-1260		1	31	77	77	77	35	420	320	NA	UG/KG		
Dieldrin	*	2	31	8.5	46	27.3	3.5	8.4	40	NA	UG/KG	1	
Endrin aldehyde		1	31	4	4	4	3.5	42	2300	NA	UG/KG		
Endrin ketone		1	31	4.5	4.5	4.5	3.5	42	2300	NA	UG/KG		
gamma-Chlordane		11	31	2.8	95.5	20.9	1.8	22	1800	NA	UG/KG		
Heptachlor		1	31	3.9	3.9	3.9	1.8	22	140	NA	UG/KG		
Heptachlor epoxide		5	31	1.8	11	4.54	1.8	22	70	NA	UG/KG		
Semivolatile Organics													
2,4-Dinitrotoluene		1	31	130	130	130	340	4000	16000	NA	UG/KG		
2-Methylnaphthalene		8	31	37	500	195	340	4000	310000	NA	UG/KG		
4-Chloroaniline		1	31	760	780	780	880	8000	31000	NA	UG/KG		
Acenaphthene		6	31	130	5800	2250	340	3800	470000	NA	UG/KG		
Acenaphthylene		1	31	100	100	100	340	4000	230000	NA	UG/KG		
Anthracene		7	31	36	16600	4119	340	3800	2300000	NA	UG/KG		
Benzo(g,h,i)perylene		6	31	94	15850	4109	340	3800	230000	NA	UG/KG		
bis(2-Ethylhexyl)phthalate (BEHP)		7	31	50	370	164	350	4000	46000	NA	UG/KG		
Butylbenzylphthalate		2	31	52	62	57	340	4000	1600000	NA	UG/KG		
Carbazole		5	31	190	3595	1429	270	3800	32000	NA	UG/KG		
Dibenzofuran		7	31	42	2065	714	340	3800	31000	NA	UG/KG		
Fluoranthene		23	31	35	110500	7140	350	3800	310000	NA	UG/KG		
Fluorene		6	31	150	5380	1969	340	3800	310000	NA	UG/KG		
Naphthalene		7	31	38	430	161	340	4000	310000	NA	UG/KG		
Phenanthrene		18	31	30	65000	5926	360	3800	230000	NA	UG/KG		
Pyrene		23	31	47	107500	7091	350	430	230000	NA	UG/KG		
Volatile Organics													
1,1,1-Trichloroethane		5	31	1.4	1600	323	5.3	7	16000	NA	UG/KG		
2-Butanone (MEK)		2	31	7.8	12	9.9	5.9	70	4700000	NA	UG/KG		
Acetone		5	31	53	220	116	53	70	780000	NA	UG/KG		
Carbon disulfide		1	31	2.1	2.1	2.1	5.3	7	780000	NA	UG/KG		
Chlorobenzene		20	31	6.6	185	30.9	5.4	6.5	180000	NA	UG/KG		
Ethylbenzene		1	31	840	840	840	5.3	7	780000	NA	UG/KG		
Toluene		5	31	1.5	580	122	5.3	6.7	1600000	NA	UG/KG		
Xylene (Total)		3	31	1.7	3400	1135	5.3	7	16000000	NA	UG/KG		

Notes:
* - Identified as a COPC
N - Essential nutrient
SQL - Sample quantitation limit
MG/KG - milligrams per kilogram
UG/KG - micrograms per kilogram

Table 10.6.15
Chemicals Present in Site Samples
SWMU 8 and AOC 636 - Groundwater
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentration RBC	Screening Concentration Background	Units	Number Exceeding RBC	Number Exceeding Bkgd
Inorganics													
Aluminum (Al)		7	7	34	720	238	NA	NA	3700	692	UG/L		1
Antimony (Sb)	*	1	7	22.6	22.6	22.6	2.1	2.1	1.5	4.85	UG/L	1	1
Arsenic (As)		5	7	4.3	17.7	8.6	2.5	2.5	0.045	17.8	UG/L	5	
Barium (Ba)	*	7	7	11.9	1520	256	NA	NA	260	31	UG/L	1	5
Calcium (Ca)	N	7	7	127000	282000	181857	NA	NA	NA	NA	UG/L		
Chromium (Cr)		1	7	4.6	4.6	4.6	0.8	4.1	18	3.88	UG/L		1
Cobalt (Co)		5	7	0.91	1.8	1.4	0.9	0.9	220	1.45	UG/L		2
Copper (Cu)		2	7	22.3	44.8	33.6	0.6	0.6	13000	8.33	UG/L		2
Iron (Fe)	N	7	7	1100	22700	9603	NA	NA	NA	NA	UG/L		
Lead (Pb)		3	7	3	10.2	7.4	1.7	1.7	15	4.6	UG/L		2
Magnesium (Mg)	N	7	7	107000	1060000	561857	NA	NA	NA	NA	UG/L		
Manganese (Mn)		7	7	39	1620	580	NA	NA	84	2906	UG/L	6	
Nickel (Ni)		4	7	2	3	2.5	0.8	0.8	73	4.08	UG/L		
Potassium (K)	N	7	7	50100	322000	180700	NA	NA	NA	NA	UG/L		
Selenium (Se)		1	7	2.9	2.9	2.9	2.8	2.8	18	4.3	UG/L		
Silver (Ag)		2	7	1.4	1.7	1.6	1.2	1.2	18	1.65	UG/L		1
Sodium (Na)	N	7	7	1040000	8850000	5135714	NA	NA	NA	NA	UG/L		
Thallium (Tl)	*	2	7	3.9	4.6	4.3	2.7	2.7	0.29	NA	UG/L	2	
Tin (Sn)		1	7	3.4	3.4	3.4	2.6	2.6	2200	NA	UG/L		
Vanadium (V)	*	6	7	1.3	49	10.9	0.5	0.5	26	15.4	UG/L	1	1
Zinc (Zn)		1	7	181	181	181	5.3	38	1100	15.6	UG/L		1
Semivolatile Organics													
Benzoic acid		1	7	2	2	2.0	50	50	15000	NA	UG/L		
bis(2-Ethylhexyl)phthalate	*	1	7	46	46	46.0	10	14	4.8	NA	UG/L	1	
2,4-Dimethylphenol		1	7	1	1	1.0	10	10	73	NA	UG/L		
Naphthalene		1	7	2	2	2.0	10	10	150	NA	UG/L		
Volatile Organics													
Ethylbenzene		2	7	2	3	2.5	5	5	130	NA	UG/L		

* - Identified as a COPC
N - Essential nutrient
SQL - Sample quantitation limit
UG/L - microgram per liter
NA - Not applicable

addressed quantitatively in this risk assessment. Current exposure to workers is discussed qualitatively in relation to the future site workers and future residents. The hypothetical future site worker scenario assumes continuous exposure to surface soil conditions. Current site workers exposure would be less than that assumed for the hypothetical future site worker scenario because of their limited soil contact. Therefore, the future site worker assessment is considered to be conservatively representative of current site users. Additionally, the location of SWMU 8 on the base would deter potential adolescent trespassers under a current use scenario. Since future use of the site is uncertain, the adolescent trespasser was qualitatively addressed relative to the child resident. The future site resident scenario was built on the premise that existing features would be removed and replaced with dwellings.

Exposure Pathways

Exposure pathways for the hypothetical future site residents are dermal contact, incidental ingestion, and inhalation of surface soil resulting from dust emission. The exposure pathways for future site workers are the same as those for the future site residents with respect to soil. Uniform exposure was assumed for all sample locations. The groundwater pathway for the hypothetical future site residents and site workers is incidental ingestion of groundwater. No VOCs were reported in combined SWMU 8 first-quarter groundwater samples at concentrations exceeding residential RBCs; therefore the inhalation of volatiles pathway was not addressed for this site. Table 10.6.16 presents the justification for exposure pathways assessed in this HHRA.

Exposure Point Concentrations

Forty-eight surface soil samples were analyzed for this site. Table 10.6.17 presents the EPCs for the COPCs identified in surface soil, by using the 95% UCL as discussed in Section 7 of this RFI. SWMU 8 comprises greater than 10 acres, and as a result, COPC data were evaluated relative to potential areas of higher concentration encompassing more reasonable exposure unit areas (one-half acre to one acre in size). Except for Aroclor-1260 and chromium, no areas of higher

Table 10.6.16
Zone G
Combined SWMU 8
Exposure Pathways Summary

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Users (Site Workers)	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No (Qualified)	Future land use assessment was considered conservatively representative of current receptors.
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or non-residential water at combined SWMU 8.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or non-residential water at combined SWMU 8.
	Soil, Incidental ingestion	No (Qualified)	Future site use is considered conservatively representative of current site use.
	Soil, Dermal contact	No (Qualified)	Future site use is considered conservatively representative of current site use.
Future Land Uses			
Future Site Residents (Child and Adult), Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	Yes	This exposure pathway was considered insignificant compared to the other pathways, but was included as a conservative measure.
	Shallow groundwater, Ingestion of contaminants during potable or general use	Yes	Shallow groundwater is not likely to be used as a source of potable or non-residential water at combined SWMU 8. This pathway was addressed as a conservative measure.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	No	Volatile COPCs were not identified subsequent to risk-based screening comparisons.
	Soil, Incidental ingestion	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Soil, Dermal contact	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.

Table 10.6.16
Zone G
Combined SWMU 8
Exposure Pathways Summary

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

concentration were identified for combined SWMU 8 COPCs. As a result, the site-wide EPCs were considered representative of any potential exposure unit area within the combined SWMU 8 area (except for Aroclor-1260 and chromium). Aroclor-1260 was reported in three adjacent surface soil samples at higher concentrations relative to other surface soil samples (636SB005, 636SB007, and 636SB008, representing an area of approximately one-half acre. Likewise, chromium was reported in three adjacent surface soil samples at higher concentrations relative to other surface soil samples (008SB171, 008SB181, and 008SB311, representing an area of approximately one-half acre). Alternative EPCs for Aroclor-1260 and chromium were set equal to the arithmetic mean of the samples representing their respective one-half acre subparcels. Aroclor-1260 and chromium were considered elevated within their respective subparcels relative to other potential exposure unit area within combined SWMU 8.

Since there were less than 10 groundwater data points for combined SWMU 8, the maximum concentrations reported for the initial RFI samples were used as EPCs for groundwater.

Quantification of Exposure

Soil

CDIs for ingestion of soils, dermal contact with soils, calculated as described in Section 7, are shown in Tables 10.6.18 and 10.6.19, respectively. The CDIs for inhalation of dust borne contaminants emanating for surface soil are shown in Table 10.6.20 and were calculated as follows.

Table 10.6.17
Summary of Statistical Analysis
Surface Soil COPCs; SWMU 8 and AOCs 636
Naval Base Charleston, Zone G
Charleston, South Carolina

COPC	Natural Log Transformed n	mean	SD	H-stat	UCL (mg/kg)	MAX (mg/kg)	EPC (mg/kg)	
Inorganics								
Antimony (Sb)	48	0.338	1.245	2.598	4.9	7.6	4.9	UCL
Arsenic (As)	48	1.650	0.923	2.245	10.8	150	10.8	UCL
Chromium (Cr)	48	2.429	0.843	2.167	21.1	103	67 7	Alternative EPC
Lead (Pb)	48	3.411	1.352	2.729	129	453.5	129	UCL
Thallium (Tl)	48	-0.302	0.983	2.306	1.67	5.5	1 67	UCL
Carcinogenic PAHs								
Benzo(a)pyrene equivalents	48	6.543	1.095	2.43	1.86	85 4	1.86	UCL
Pesticides/PCBs								
Aroclor-1260	48	3.429	0.896	2.218	0.06	0.92	0.53	Alternative EPC
Aldrin	48	0.007	0 589	1.948	0.0014	0.041	0.0014	UCL
Dieldrin	48	0.716	0.574	1 937	0 0028	0.046	0.0028	UCL
Miscellaneous								
Hydrazine	12	2.902	1.267	3.423	0.15	0.274	0.15	UCL

NOTES:

mean Arithmetic mean of the logtransformed data
n Number of samples analyzed
SD Standard deviation for a sample of data
H-stat "H" statistic from Gilbert 1987; cuboidal interpolation was used to determine the value in accordance with USEPA Supplemental Guidance to RAGS, Calculating the Concentration Term
NA Not applicable
EPC Exposure point concentration
UCL 95 percentile upper confidence level mean
MAX Maximum reported concentration
Alternative EPC For chromium, the alternative EPC is the mean of samples 008SB171, 008SB181, and 008SB311
For Aroclor 1260, the alternative EPC is the mean of samples 636SB005, 636SB007, and 636SB008

Table 10 6 18
Chronic Daily Intakes
Incidental Ingestion of Surfaee Soil
SWMU 8 and AOC 636
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Chemical	Fraction Ingested from Contaminated Source *	Exposure Point Concentration (mg/kg)	Future Resident adult H-CDI (mg/kg-day)	Future Resident ehild H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Site Worker adult H-CDI (mg/kg-day)	Future Site Worker adult C-CDI (mg/kg-day)
Inorganics							
Antimony (Sb)	1	4.9	6.68E-06	6.23E-05	7.63E-06	2.38E-06	8.52E-07
Arsenic (As)	1	10.8	1.48E-05	1.38E-04	1.69E-05	5.28E-06	1.88E-06
Chromium (Cr)	1	67.7	9.27E-05	8.65E-04	1.06E-04	3.31E-05	1.18E-05
Lead (Pb)	1	129	1.77E-04	1.65E-03	2.03E-04	6.33E-05	2.26E-05
Thallium (Tl)	1	1.67	2.29E-06	2.13E-05	2.61E-06	8.16E-07	2.92E-07
Carcinogenic PAHs							
Benzo(a)pyrene equivalent	1	1.86	2.55E-06	2.38E-05	2.92E-06	9.12E-07	3.26E-07
PCBs							
Aroclor-1260	1	0 53	7.26E-07	6.78E-06	8.30E-07	2.59E-07	9.26E-08
Aldrin	1	0.0014	1.94E-09	1.81E-08	2.22E-09	6.92E-10	2.47E-10
Dieldrin	1	0.0028	3.89E-09	3.63E-08	4.44E-09	1.39E-09	4.96E-10
Miscellaneous							
Hydrazine	1	0.15	2.05E-07	1.92E-06	2.35E-07	7.34E-08	2.62E-08

NOTES.

lwa Lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
* Reflects the estimated fraction of the site impacted by the corresponding COPC.

Table 10.6.19
Chronic Daily Intakes
Dermal Contact with Surface Soil
SWMU 8 and AOC 636
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Chemical	Exposure Point Concentration (mg/kg)	Fraction Contacted from Contaminated Source *	Dermal Absorption Factor (unitless)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Site Worker adult H-CDI (mg/kg-day)	Future Site Worker adult C-CDI (mg/kg-day)
Inorganics								
Antimony (Sb)	4 9	1	0.001	2.74E-07	9.04E-07	1.71E-07	1.96E-07	6.98E-08
Arsenic (As)	10 8	1	0.001	6.06E-07	2.00E-06	3.79E-07	4.33E-07	1.55E-07
Chromium (Cr)	67 7	1	0.001	3.80E-06	1.25E-05	2.38E-06	2.71E-06	9.70E-07
Lead (Pb)	129	1	0.001	7.27E-06	2.40E-05	4.55E-06	5.19E-06	1.85E-06
Thallium (Tl)	1.67	1	0.001	9.37E-08	3.09E-07	5.86E-08	6.69E-08	2.39E-08
Carcinogenic PAHs								
Benzo(a)pyrene equivalent	1.86	1	0.01	1.05E-06	3.46E-06	6.55E-07	7.48E-07	2.67E-07
PCBs								
Aroclor -1260	0 53	1	0.01	2.98E-07	9.83E-07	1.86E-07	2.13E-07	7.59E-08
Aldrin	0.0014	1	0.01	7 95E-10	2.62E-09	4.97E-10	5.68E-10	2.03E-10
Dieldrin	0.0028	1	0.01	1.59E-09	5.26E-09	9.97E-10	1.14E-09	4.07E-10
Miscellaneous								
Hydrazine	0 15	1	0.01	8.42E-08	2.78E-07	5.27E-08	6.02E-08	2.15E-08

NOTES:
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals
* Reflects the estimated fraction of the site impacted by the corresponding COPC.

Table 10.6.20
Chronic Daily Intakes
Inhalation of Surface Soil COPCs Resulting from Dust Emission
SWMU 8 and AOC 636
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Chemical	Fraction Contacted from Contaminated Source *	Exposure Point Concentration (mg/kg)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Site Worker adult H-CDI (mg/kg-day)	Future Site Worker adult C-CDI (mg/kg-day)
Inorganics							
Antimony (Sb)	1	4.9	1.01E-09	2.83E-09	5.89E-10	7.23E-10	2.58E-10
Arsenic (As)	1	10.8	2.24E-09	6.27E-09	1.30E-09	1.60E-09	5.71E-10
Chromium (Cr)	1	67.7	1.40E-08	3.93E-08	8.18E-09	1.00E-08	3.58E-09
Lead (Pb)	1	129	2.69E-08	7.52E-08	1.56E-08	1.92E-08	6.85E-09
Thallium (Tl)	1	1.67	3.46E-10	9.70E-10	2.02E-10	2.47E-10	8.83E-11
Carcinogenic PAHs							
Benzo(a)pyrene equivalent	1	1.86	3.87E-10	1.08E-09	2.25E-10	2.76E-10	9.87E-11
PCBs							
Aroclor 1260	1	0.53	1.10E-10	3.08E-10	6.41E-11	7.86E-11	2.81E-11
Aldrin	1	0.0014	2.94E-13	8.22E-13	1.71E-13	2.10E-13	7.49E-14
Dieldrin	1	0.0028	5.89E-13	1.65E-12	3.43E-13	4.21E-13	1.50E-13
Miscellaneous							
Hydrazine	1	0.15	3.11E-11	8.72E-11	1.81E-11	2.22E-11	7.94E-12

NOTES:

lwa Lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
* Reflects the estimated fraction of the site impacted by the corresponding COPC.

Inhalation of Dust Borne Contaminants Emanating from Soil:

Noncarcinogens:

$$CDI_{child} = \frac{C_S * IR_{child} * EF_{res} * ED_{child} * 1/PEF * FC}{BW_{child} * AT_{NC-child}}$$

$$CDI_{adult} = \frac{C_S * IR_{adult} * EF_{res} * ED_{adult} * 1/PEF * FC}{AT_{NC-adult} * BW_{adult}}$$

Carcinogens:

$$CDI_{res} = \frac{C_S * IRadj * EF_{res} * 1/PEF * FC}{AT_C}$$

$$CDI_{w} = \frac{C_S * IR_{adult} * EF_{w} * ED_{w} * 1/PEF}{AT_C * BW_{adult}}$$

Variable	Description
BW_{adult}	average adult body weight (70 kg)
BW_{child}	average child body weight-ages 1 to 6 years (15 kg)
Ed_{child}	residential child exposure duration (6 yr)
ED_{adult}	residential adult exposure duration (24 yr)
ED_w	site worker exposure duration (25 yr)
Ef_{res}	residential exposure frequency (350 days/year)
Ef_w	worker exposure frequency (250 days/year)
Ir_{child}	child inhalation rate (12 m^3/day)
IR_{adj}	lifetime weighted average inhalation rate (11.66 m^3-yr/kg-day)
IR_{adult}	adult inhalation rate (20 m^3/day)
$AT_{NC-child}$	averaging time - noncarcinogen, child (2,190 days)
$AT_{NC-adult}$	averaging time - noncarcinogen, adult (8,760 days)
AT_{NC-w}	averaging time - noncarcinogen, site worker (9,125 days)
AT_C	averaging time - carcinogen (25,550 days)
C_s	chemical concentration in surface soil - EPC (mg/kg)

PEF	particulate emission factor (1.32E+09 m^3/kg) — Soil Screening Guidance
FC	Fraction contacted (1)

Groundwater

CDIs for the groundwater pathway are shown in Table 10.6.21.

10.6.6.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 7 of this report. Table 10.6.22 presents toxicological information specific to each COPC identified at combined SWMU 8. This information was used in the quantification of risk/hazard associated with soil contaminants. Brief toxicological profiles for each COPC are provided in the following paragraphs.

Aldrin is a man-made insecticide which was used widely by farmers from the 1950s to the early 1970s. Aldrin was also used for soil treatment as well as by exterminators to kill termites through the treatment of soil under houses. The main effects of short-term exposure to high levels of aldrin are headaches, dizziness, irritability, loss of appetite, nausea, muscle twitching, convulsions, and loss of consciousness and death. Most symptoms disappear with time after removal from exposure. The effects of long-term exposure to aldrin in humans have not been clearly demonstrated. Aldrin fed to mice caused liver cancer.

There is inconclusive evidence in humans, but more evidence in animals, that aldrin exposure of a pregnant mother may be associated with harm to the fetus. Aldrin is absorbed into the blood from the gastrointestinal tract, through the skin, or by inhalation. The percentage of an oral dose absorbed has not been accurately determined because of the enterohepatic circulation system. In humans, 20 to 50% of inhaled aldrin is retained, and about 8% of a dermal dose of aldrin is absorbed (5 days). There is rapid conversion of aldrin to the epoxide dieldrin, which results in

Table 10.6.21
Chronic Daily Intakes
Ingestion of COPCs in Groundwater
SWMU 8 and AOC 636
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Chemical	Exposure Point Concentration (mg/liter)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Worker adult H-CDI (mg/kg-day)	Future Worker adult C-CDI (mg/kg-day)
Inorganics						
Antimony (Sb)	0.0226	6.19E-04	1 44E-03	3.41E-04	2.21E-04	7.90E-05
Barium (Ba)	1.52	4.16E-02	9.72E-02	2.29E-02	1.49E-02	5.31E-03
Thallium (Tl)	0.0046	1.26E-04	2.94E-04	6 93E-05	4.50E-05	1.61E-05
Vanadium (V)	0.049	1 34E-03	3.13E-03	7.38E-04	4.79E-04	1.71E-04
Semivolatile Organics						
bis(2-Ethylhexyl)phthalate	0.046	1.26E-03	2.94E-03	6.93E-04	4.50E-04	1.61E-04

NOTES:
lwa Lifetime weighted average
CDI Chronic Daily Intake
H-CDI Noncarcinogenic hazard based Chronic Daily Intake
C-CDI Carcinogenic risk based Chronic Daily Intake

Table 10.6.22
Toxicological Reference Information
for Chemicals of Potential Concern
SWMU 8 and AOC 636
Naval Base, Charleston, Zone G
Charleston, South Carolina

	Non-Carcinogenic Toxicity Data										*Carcinogenic Toxicity Data*							
ical	Oral Reference Dose (mg/kg-day)		Confidence Level	Critical Effect	Uncertainty Factor Oral	Inhalation Reference Dose (mg/kg-day)		Confidence Level	Critical Effect	Uncertainty Factor Inhalation	Oral Slope Factor (kg-day/mg)		Inhalation Slope Factor (kg-day/mg)		Weight of Evidence	Tumor Type
n	3E-05	a	M	liver toxicity	1,000	NA		NA	NA	NA	17	a	17.1	a	B2	liver carcinoma
ony	0.0004	a	L	whole body/blood increased mortality	1,000	NA		NA	NA	NA	NA		NA		D	NA
ic	0.0003	a	M	hyperpigmentation	3	NA		NA	NA	NA	1.5	a	15.1	a	A	various
(a)pyrene equivalents	NA		NA	NA	NA	NA		NA	NA	NA	7.3	a	3.1	d	B2	mutagen
m	0.07	a	M	increased blood pressure	3	0.000143	h	NA	NA	NA	NA		NA		D	NA
Ethylhexyl)phthalate	0.02	a	M	increased liver weight	1,000	NA		NA	NA	NA	0.014	a	0.014	d	B2	hepatoma
nium III	1	a	L	NA	100/10	5.71E-07	e	NA	NA	NA	NA		NA	a	D	NA
nium VI	0.005	a	L	NA	500	NA		NA	NA	NA	NA		42	a	A	lung
rin	5E-05	a	M	liver lesions	100	NA		NA	NA	NA	16	a	16.1	a	B2	hepatocarcinoma
azine	NA		NA	NA	NA	NA		NA	NA	NA	3	a	17.1	a	B2	hepatoma, adenocarcinoma
	NA		NA	NA	NA	NA		NA	NA	NA	NA		NA		B2	various
Aroclor-1260 (soil)	NA		NA	NA	NA	NA		NA	NA	NA	2	a	2	a	B2	hepatocellular carcinoma
um	8E-05	a	L	increased SGOT (liver) increased serum LDH	3000	NA		NA	NA	NA	NA		NA		D	NA
dium	0.007	a	NA	unclear	100	NA		NA	NA	NA	NA		NA		D	NA

= Integrated Risk Information System (IRIS)
= Health Effects Assessment Summary Tables (HEAST)
= HEAST alternative method
= EPA NCEA - Cincinnati (provisional)
= Withdrawn from IRIS/HEAST
= Not applicable or not available
= High confidence
= Low confidence
= Medium confidence

aldrin rarely being found in the blood or tissues. Excretion is primarily in the feces via the bile. In humans and animals, urinary excretion is minor. An oral RfD for aldrin has been determined as 3.0E-05 mg/kg-day using based on a LOAEL of 0.5ppm and an uncertainty factor of 1000 in a hepatic effects study performed on rats. The modifying factor is 1. Carcinogenic slope factors have also been determined for aldrin. The oral SF is 17 $(mg/kg\text{-}day)^{-1}$, and the inhalation SF is 17.1 $(mg/kg\text{-}day)^{-1}$.

Antimony belongs to the same periodic group as arsenic. This element is absorbed slowly through the gastrointestinal tract, which is the target of this element. Another target is the blood, where antimony concentrates. The primary exposure route for antimony to the general population is ingestion. Antimony is also a common air pollutant from industrial emissions. USEPA has not classified antimony as a carcinogen, and the oral RfD is 0.0004 mg/kg-day (Klaassen, et al, 1986). The oral RfD is based on a LOAEL of 0.35 mg/kg-day, an uncertainty factor of 1000, and a modifying factor of 1 (IRIS).

Arsenic exposure via the ingestion route darkens and hardens the skin in chronically exposed humans. Inhalation exposure to arsenic causes neurological deficits, anemia, and cardiovascular effects (Klaassen et al., 1986). USEPA set 0.3 μg/kg-day as the RfD for arsenic based on a NOAEL of 0.8 μg/kg-day in a human exposure study. Arsenic's effects on the nervous and cardiovascular systems are primarily associated with acute exposure to higher concentrations. Exposure to arsenic-containing materials has been shown to cause cancer in humans. Inhaling these materials can lead to increased lung cancer risk, and ingestion is associated with increased skin cancer rates. Arsenic has been classified as a group A carcinogen by USEPA, which set the 1.5 $(mg/kg\text{-}day)^{-1}$ oral SF for arsenic. As listed in IRIS, the classification is based on sufficient evidence from human data. An increased lung cancer mortality was observed in multiple human populations exposed primarily through inhalation. Also, increased mortality from multiple internal organ cancers (liver, kidney, lung, and bladder) and an increased incidence of skin cancer were

observed in populations consuming drinking water high in arsenic. Human milk contains about 3 μg/L arsenic. The RBC for arsenic in tap water is 0.045 μg/L. As listed in IRIS, the critical effect of this chemical is hyperpigmentation, keratosis, and possible vascular complications. The oral uncertainty factor used for arsenic was 3 and the modifying factor was 1.

Barium is used in various alloys, paints, soap, and manufacturing processes. Barium sulfate is used to aid x-ray diagnosis. This element is relatively abundant in nature and is commonly found in plant and animal tissue. Brazil nuts contain 3 to 4 mg barium per gram nuts. The fatal absorbed dose of barium is approximately 1000 mg (for humans). Assuming an absorption efficiency of five percent for barium, 20,000 mg ingested barium could be fatal. Major toxic effects of this element are muscle stimulation, central nervous system effects, and effects on the heart. The major critical effect is increased blood pressure. USEPA determined the oral RfD and inhalation RfD to be 0.07 and 1.43E-4 mg/kg-day, respectively (Dreisbach, et al, 1987) (Klaassen, et al, 1986), based on a medium confidence level. The oral uncertainty factor for barium is 3 and the oral modifying factor is 1. Barium has been issued a carcinogenic weight-of-evidence classification of "D".

Benzo(a)pyrene equivalents include the following list of PAHs:

Benzo(a)anthracene	TEF	0.1
Benzo(b)fluoranthene	TEF	0.1
Dibenz(a,h)anthracene	TEF	1.0
Benzo(k)fluoranthene	TEF	0.01
Benzo(a)pyrene	TEF	1.0
Indeno(1,2,3-cd)pyrene	TEF	0.1
Chrysene	TEF	0.001

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of these PAHs have not been well established. There are no RfDs for the PAHs above due to a lack of data. All PAHs listed are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of benzo(a)pyrene, having an oral SF 7.3 $(mg/kg/day)^{-1}$. Toxicity Equivalency Factors, also set by USEPA, are multipliers that are applied to the detected concentrations, which are subsequently used to calculate excess cancer risk. These multipliers are discussed further in the exposure and toxicity assessment sections. Most carcinogenic PAHs have been classified as such due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soot, cigarette smoke, etc.). As listed in IRIS, the basis for the benzo(a)pyrene B2 classification is human data specifically linking benzo(a)pyrene to a carcinogenic effect are lacking. There are, however, multiple animal studies in many species demonstrating benzo(a)pyrene to be carcinogenic by numerous routes.

Benzo(a)pyrene has produced positive results in numerous genotoxicity assays. At the June 1992 CRAVE Work Group meeting, a revised risk estimate for benzo(a)pyrene was verified. This section provides information on three aspects of the carcinogenic risk assessment for the agent in question. The USEPA classification and quantitative estimates of exposure reflects a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in application of a low-dose extrapolation procedure and presented as the risk per (mg/kg)/day. The unit risk is the quantitative estimate in terms of either risk per $\mu g/L$ drinking water or risk per $\mu g/m^3$ air breathed. The third form in which risk is presented is drinking water or air concentration providing cancer risks of 1 in 10,000 or 1 in 1,000,000. The Carcinogenicity Background Document provides details on the carcinogenicity values found in IRIS. Users are referred to the Oral Reference Dose and Reference Concentration sections for information on long-term toxic effects other than carcinogenicity.

The basis for the dibenz(a,h)anthracene and benzo(b)fluoranthene B2 classification is listed in IRIS as no human data and sufficient data from animal bioassays. Benzo(b)fluoranthene produced tumors in mice after lung implantation, intraperitoneal or subcutaneous injection, and skin painting. The basis for the benzo(a)anthracene B2 classification is listed in IRIS as no human data and sufficient data from animal bioassays. Benzo(a)anthracene produced tumors in mice exposed by gavage; intraperitoneal, subcutaneous or intramuscular injection; and topical application. Benzo(a)anthracene produced mutations in bacteria and in mammalian cells, and transformed mammalian cells in culture. The basis for the benzo(k)fluoranthene B2 classification is listed in IRIS as no human data and sufficient data from animal bioassays. Benzo(k)fluoranthene produced tumors after lung implantation in mice and when administered with a promoting agent in skin-painting studies. Equivocal results have been found in a lung adenoma assay in mice. Benzo(k)fluoranthene is mutagenic in bacteria. (Klaassen, et al., 1986).

bis(2-Ethylhexyl)phthalate, otherwise known as BEHP, is a plasticizer used in virtually every major product category. Phthalate esters are ubiquitously distributed in the environment. Although the toxicity of this compound is relatively low, it is a carcinogen. Reproductive effects are also possible (indicated in animal studies) due to chronic exposure to BEHP. This compound is classified as a B2 carcinogen, and USEPA set the oral RfD and oral SF to 0.02 mg/kg-day and 0.014 $(mg/kg\text{-}day)^{-1}$, respectively (Klaassen et al., 1986). The uncertainty factor used for bis(2-Ethylhexy)phthalate is 1000.

Chromium exists in two stable, natural forms: CrIII and hexavalent CrVI. Acute exposure to chromium can result in kidney damage following oral exposure or damage to the nasal mucosa and septum following inhalation exposure. Chronic inhalation exposure to CrVI has resulted in kidney and respiratory tract damage, as well as excess lung cancer in both animals and humans following occupational exposure. Only CrVI is believed to be carcinogenic by inhalation (IRIS). Oral RfD values for CrIII and CrVI are 1.0 and 5E-3 (mg/kg-day), respectively. For CrVI, the RfD is

based on liver toxicity in rats. For CrVI, the RfD is based on unspecified pathological changes observed in rat studies. In addition, CrVI is considered a group A carcinogen for inhalation exposures, and an oral SF of 42 $(mg/kg\text{-}day)^{-1}$ has been established for the hexavalent form. Vitamin supplements contain approximately 0.025 mg of chromium. As listed in IRIS, no critical effects were observed for CrIII. The uncertainty factor was 100 and the modifying factor was 10. As listed in IRIS, no critical effects were observed for CrVI. The uncertainty factor was 500 and the modifying factor was 1.

Dieldrin is a polycyclic chlorinated pesticide. Short-term exposure to high doses of dieldrin causes tremors and convulsions. Chronic exposure can cause emotional and neuromuscular disturbances. Exposed individuals revert to normal approximately one week after the dieldrin source is removed. Dieldrin is classified as a B2 carcinogen by USEPA; the oral SF, inhalation SF, and oral RfD were set to 16 $(mg/kg\text{-}day)^{-1}$, 16.1 $(mg/kg\text{-}day)^{-1}$, and 0.00005 mg/kg-day, respectively (Dreisbach et al., 1987).

Hydrazine is a reducing agent used in nuclear fuel reprocessing, polymerization catalysis, corrosion inhibition in boiler feedwater & reactor cooling water, wastewater treatment, electrolytic plating of metals on glass & plastics, and rocket propellants. Toxic effects of hydrazine include conjunctivitis, pulmonary edema, anemia (hemolytic), ataxia, convulsions, kidney toxicity, and liver toxicity (HSDB). USEPA has given hydrazine a B2, probable human carcinogen, rating based on inadequate human data and the induction of tumors in mice, rats and hamsters following oral, inhalation or intraperitoneal administration of hydrazine and hydrazine sulfate. An oral slope factor of 3 $(mg/kg\text{-}day)^{-1}$ and an inhalation slope factor of 17.1 $(mg/kg\text{-}day)^{-1}$ have been set by USEPA (IRIS).

Lead has been classified as a group B2 carcinogen by USEPA based on animal data. No RfD or SF has been set by USEPA. However, an action level of 400 mg/kg for soil protective of child

residents has been proposed by USEPA Region IV. USEPA's Office of Water has established a treatment technique action level of 15 μg/L. The classification as listed in IRIS, is based on sufficient animal evidence. Ten rat bioassays and one mouse assay have shown statistically significant increases in renal tumors with dietary and subcutaneous exposure to several soluble lead salts. Animal assays provide reproducible results in several laboratories, in multiple rat strains with some evidence of multiple tumor sites. Short-term studies show that lead affects gene expression. Human evidence is inadequate. An RfD and SF have not been set because of the confounding nature of lead toxicity. Lead can accumulate in bone marrow, and effects have been observed in the CNS, blood, and mental development of children. RfDs are based on the assumption that a threshold must be exceeded to result in toxic effects (other than carcinogenicity). Once lead accumulates in the body, other influences cause the actual levels in the blood to fluctuate — sometimes the lead is attached to binding sites; sometimes lead is free flowing. If an exposed individual has previously been exposed to lead, this individual could lose weight and set fat-bound lead free. This fluctuation and lack of previous lead exposure data are two of the reasons lead effects are difficult to predict (Klaassen et al., 1986).

PCB Aroclors are a group of chlorinated hydrocarbons (such as Aroclors-1248, 1254, and 1260) that accumulate in fat tissue. Occupational exposure (both inhalation and dermal) to PCBs causes eye and lung irritation, loss of appetite, liver enlargement, increased serum liver enzyme levels, rashes and chloracne, and decreased birth weight of infants in heavily exposed worker/mothers. Of the effects listed above, the liver is the primary target organ (Klaassen, et al., 1986) (Dreisbach, et al., 1987). USEPA classified PCB aroclors as group B2 probable human carcinogens, primarily based on animal data. Oral ingestion of PCBs causes liver and stomach tumors in rat studies. The cancer potency of PCB mixtures is determined using a tiered approach. The high risk and persistence tier uses an upper-bound slope factor of 2.0 $(mg/kg\text{-}day)^{-1}$ and is appropriate for food chain exposures, sediment and soil ingestion, dust or aerosol inhalation, and dermal exposure. The low risk and persistence tier uses an upper-bound slope factor of

0.4 $(mg/kg\text{-}day)^{-1}$ and is appropriate for ingestion of water soluble congeners and inhalation of evaporated congeners. The lowest risk and persistence tier uses an upper-bound slope factor of 0.07 $(mg/kg\text{-}day)^{-1}$ and is appropriate for PCB congener mixtures with congeners having more than four chlorines comprising less than 1/2% of the mixture.

Thallium is readily absorbed through the gut and skin. Primary effects are stomach and bowel disturbances, kidney and liver damage, and neurological disturbances. Thallium was used in the past as a rodenticide and ant killer, and its use for these purposes is now prohibited. This element remains in the body for a relatively long time, and could accumulate if the chronic dose is large. USEPA's oral RfD for thallium is 0.00008 mg/kg-day (Klaassen, et al., 1986) (Dreisbach, et al., 1987). The uncertainty factor used for thallium is 3000.

Vanadium is not readily absorbed through the skin or oral ingestion and is a ubiquitous element. It is also a by-product of petroleum refining. Vanadium is soluble in fats and oils (Klaassen et al., 1986). Municipal water supplies contain 0.001 to 0.006 mg/L. The target organ is unclear, and the primary focus of toxicological information is inhalation of vanadium dust. Typical vitamin supplements contain approximately 0.010 mg in a daily dose. The oral RfD set by USEPA is 0.007 mg/kg-day.

10.6.6.5 Risk Characterization

Surface Soil Pathways

Exposure to surface soil onsite was evaluated under residential and site worker scenarios. For these scenarios, the incidental ingestion, dermal contact, and inhalation exposure pathways were evaluated. For noncarcinogenic contaminants evaluated for future site residents, hazard was computed separately to address child and adult exposure. Tables 10.6.23, 10.6.24, and 10.6.25 present the computed carcinogenic risks and/or HQs associated with the incidental ingestion, dermal contact, and inhalation of site surface soils, respectively.

Table 10.6.23
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
SWMU 8 and AOC 636
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident adult Hazard Quotient	Future Resident ehild Hazard Quotient	Future Resident lwa ILCR	Future Site Worker adult Hazard Quotient	Future Site Worker adult ILCR
Inorganics							
Antimony (Sb)	0 0004	NA	0.017	0 16	ND	0.0060	ND
Arsenic (As)	0.0003	1 5	0.049	0.46	2.5E-05	0.018	2 8E-06
Chromium (Cr)	0 005	NA	0 019	0.17	ND	0.0066	ND
Lead (Pb)	NA	NA	ND	ND	ND	ND	ND
Thallium (Tl)	8E-05	NA	0.029	0.27	ND	0.010	ND
Carcinogenic PAHs							
Benzo(a)pyrene equivalent	NA	7.3	ND	ND	2.1E-05	ND	2.4E-06
PCBs							
Aroelor-1260	NA	2	ND	ND	1.7E-06	ND	1.9E-07
Aldrin	3E-05	17	0.000065	0.00060	3.8E-08	0.000023	4.2E-09
Dieldrin	5E-05	16	0.000078	0.00073	7.1E-08	0.000028	7.9E-09
Miscellaneous							
Hydrazine	NA	3	ND	ND	7.0E-07	ND	7 9E-08
SUM Hazard Index/ILCR			0.1	1	5E-05	0.04	5E-06

NOTES:
NA Not available
ND Not Determined due to laek of available information
lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime Cancer Risk

Table 10.6.24
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
SWMU 8 and AOC 636
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident lwa ILCR	Future Site Worker adult Hazard Quotient	Futuer Site Worker adult ILCR
Inorganics								
Antimony (Sb)	0.2	8E-05	NA	0.0034	0.011	ND	0.0024	ND
Arsenic (As)	0.2	6E-05	7.5	0.010	0.033	2.8E-06	0.007	1.2E-06
Chromium (Cr)	0.2	0.001	NA	0.0038	0.013	ND	0.0027	ND
Lead (Pb)	0.2	NA	NA	ND	ND	ND	ND	ND
Thallium (Tl)	0.2	1.6E-05	NA	0.0059	0.019	ND	0.0042	ND
Carcinogenic PAHs								
Benzo(a)pyrene equivalent	0.5	NA	14.6	ND	ND	9.6E-06	ND	3.9E-06
PCBs								
Aroclor 1260	0.5	NA	4	ND	ND	7.5E-07	ND	3.0E-07
Aldrin	0.5	1.5E-05	34	0.000053	0.00017	1.7E-08	0.000038	6.9E-09
Dieldrin	0.5	2.5E-05	32	0.000064	0.00021	3.2E-08	0.000046	1.3E-08
Miscellaneous								
Hydrazine	0.5	NA	6	ND	ND	3.2E-07	ND	1.3E-07
SUM Hazard Index/ILCR				0.02	0.08	1E-05	0.02	6E-06

NOTES:

NA Not available

ND Not Determined due to lack of available information

lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A

ILCR Incremental Lifetime Cancer Risk

- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

Table 10.6.25
Hazard Quotients and Incremental Lifetime Cancer Risks
Inhalation of Surface Soil COPCs Resulting from Dust Emission
SWMU 8 and AOC 636
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Chemical	Inhalation RfD Used (mg/kg-day)	Inhalation SF Used (mg/kg-day)-1	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident lwa ILCR	Future Site Worker adult Hazard Quotient	Future Site Worker adult ILCR
Inorganics							
Antimony (Sb)	NA	NA	ND	ND	ND	ND	ND
Arsenic (As)	NA	15.1	ND	ND	2.0E-08	ND	8.6E-09
Chromium (Cr)	5.71E-07	42	0.025	0.069	3.4E-07	0.018	1.5E-07
Lead (Pb)	NA	NA	ND	ND	ND	ND	ND
Thallium (Tl)	NA	NA	ND	ND	ND	ND	ND
Carcinogenic PAHs							
Benzo(a)pyrene equivalent	NA	3.1	ND	ND	7.0E-10	ND	3.1E-10
PCBs							
Aroclor 1260	NA	2	ND	ND	1.3E-10	ND	5.6E-11
Aldrin	NA	17.1	ND	ND	2.9E-12	ND	1.3E-12
Dieldrin	NA	16.1	ND	ND	5.5E-12	ND	2.4E-12
Miscellaneous							
Hydrazinc	NA	17.1	ND	ND	3.1E-10	ND	1.4E-10
SUM Hazard Index/ILCR			0.02	0.07	4E-07	0.02	2E-07

NOTES:
NA Not available
ND Not Determined due to lack of available information
lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime Cancer Risk

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime weighted average) for combined SWMU 8 surface soils is 5E-05; the dermal pathway ILCR is 1E-05; the inhalation pathway ILCR is 4E-07. Arsenic and benzo(a)pyrene equivalents were the primary contributors to ILCR projections for the ingestion and dermal pathways, while Aroclor-1260 and hydrazine were secondary contributors.

The ingestion HIs projected for the adult and child receptors are 0.1 and 1, respectively; the dermal pathway HIs were 0.02 for the adult resident receptor and 0.08 for the child resident receptor; the inhalation pathway HIs projected for the adult and child receptors are 0.02 and 0.07, respectively. Antimony, arsenic, chromium, and thallium contributed to a cumulative hazard index of 1.

Hypothetical Site Workers

Site worker ILCRs are 5E-06 for the ingestion pathway, 6E-06 for the dermal contact pathway, and 2E-07 for the inhalation pathway. Arsenic and benzo(a)pyrene equivalents were the primary contributors to ILCR projections for the ingestion and dermal pathways.

Site worker HIs were 0.04 for the ingestion pathway, 0.02 for the dermal pathway, and 0.02 for the inhalation pathway.

Groundwater Pathways

Exposure to shallow groundwater onsite was evaluated under a residential scenario based on the results of the first-quarter sampling event. The ingestion exposure pathway was evaluated assuming the site groundwater will be used for potable and/or domestic purposes and that an unfiltered well, drawing from the corresponding water bearing zone, will be installed. For noncarcinogenic contaminants evaluated relative to future site residents, hazard was computed

separately for child and adult receptors. Table 10.6.26 presents the risk and hazard for the ingestion pathway. Since no VOCs were identified as COPCs in combined SWMU 8 groundwater samples at concentrations exceeding their corresponding RBCs, the inhalation pathway was not addressed for groundwater at this site.

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime weighted average) for combined SWMU 8 groundwater is 1E-05. The sole contributor to ILCR projections for the ingestion pathway is bis(2-ethylhexyl)phthalate.

The ingestion HIs projected for the adult and child receptors are 4 and 9, respectively. Antimony, barium, and thallium were primary contributors to HI projections for the ingestion pathway. Vanadium and bis(2-ethylhexyl)phthalate were secondary contributors.

Hypothetical Site Workers

The site worker ILCR is 2E-06 for the ingestion pathway , and bis(2-ethylhexyl)phthalate was the sole contributor to ILCR projections.

The site worker HI is 1 for the ingestion pathway. Antimony and thallium were the primary contributors to HI projections for the ingestion pathway. Barium, vanadium, and bis(2-ethylhexyl)phthalate were secondary contributors.

Current Site Workers

Shallow groundwater is not currently used as a potable water source for combined SWMU 8 or other areas of Zone G. In the absence of a completed exposure pathway, no threat to human health is posed by reported shallow groundwater quality.

Ta 3.6 26
Hazard Quotients and Incremental Lifetime Cancer Risks
Groundwater Ingestion
SWMU 8 and AOC 636
Naval Base Charleston, Zone G
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident lwa ILCR	Future Worker adult Hazard Quotient	Future Worker adult ILCR
Inorganics							
Antimony (Sb)	0.0004	NA	1 5	3 6	ND	0.55	ND
Barium (Ba)	0.07	NA	0 59	1 4	ND	0.21	ND
Thallium (Tl)	8E-05	NA	1.6	3.7	ND	0.56	ND
Vanadium (V)	0.007	NA	0.19	0 45	ND	0.068	ND
Semivolatile Organics							
bis(2-Ethylhexyl)phthalate	0.02	0.014	0 063	0.15	9.7E-06	0.023	2.3E-06
SUM Hazard Index/ILCR			4	9	1E-05	1	2E-06

Notes:
NA Not available
ND Not Determined due to lack of available information
lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime Cancer Risk

Lead

Lead was identified as a COPC based on screening comparisons summarized on Table 10.6.13. The reported soil lead concentration only exceeded the 400 mg/kg AL in one of 48 samples collected (453.5 mg/kg in 636SB002). The 95% UCL for lead determined using surface soil data generated during both the 1993 and RFI sampling events is 129 mg/kg which is below the AL for lead (summarized on Table 10.6.17). As a result, lead was not addressed further in this assessment.

COCs Identified

Chemicals of concern were identified based on cumulative (all pathway) risk and hazard projections for this site on a medium-specific basis. USEPA has established a generally acceptable risk range of 1E-04 to 1E-06, and a hazard index threshold of 1.0 (unity). As recommended by SCDHEC, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, and whose individual ILCR exceeds 1E-06 or whose hazard quotient exceeds 0.1. For carcinogens, this approach is relatively conservative, because a cumulative risk level of 1E-04 (and individual ILCR of 1E-06) is recommended by USEPA Region IV as the trigger for establishing COCs. The COC selection method presented was used in order to provide a more comprehensive evaluation of chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the remedial goal options development process. Table 10.6.27 presents the COCs identified for combined SWMU 8 surface soil and groundwater.

Surface Soils

Future Site Residents

Aroclor-1260, arsenic, benzo(a)pyrene equivalents, and hydrazine were identified as soil pathway COCs based on their contribution to cumulative residential ILCR projections. Hydrazine did not exceed USEPA's acceptable threshold of 1E-06 in any of the individual exposure pathways, and

Table 10.6.27
Summary of Risk and Hazard-based COCs
SWMU 8 and AOC 636
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Medium	Exposure Pathway		Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident Iwa ILCR	Site Worker Hazard Quotient	Site Worker ILCR	Identification of COCs		
Surface Soil	Incidental Ingestion	**Inorganics**								
		Antimony (Sb)	0.017	0.16	ND	0.0060	ND	1		
		Arsenic (As)	0.049	0.46	2.5E-05	0.018	2.8E-06	1	2	4
		Chromium (Cr)	0.019	0.17	ND	0.0066	ND	1		
		Lead (Pb)	ND	ND	ND	ND	ND			
		Thallium (Tl)	0.029	0.27	ND	0.010	ND	1		
		Carcinogenic PAHs								
		Benzo(a)pyrene equivalents	ND	ND	2.1E-05	ND	2.4E-06		2	4
		Pesticides/PCBs								
		Aroclor-1260	ND	ND	1.7E-06	ND	1.9E-07		2	
		Aldrin	0.000065	0.00060	3.8E-08	0.000023	4.2E-09			
		Dieldrin	0.000078	0.00073	7.1E-08	0.000028	7.9E-09			
		Miscellaneous								
		Hydrazine	ND	ND	7.0E-07	ND	7.9E-08			
	Dermal Contact	**Inorganics**								
		Antimony (Sb)	0.0034	0.011	ND	0.0024	ND			
		Arsenic (As)	0.010	0.033	2.8E-06	0.007	1.2E-06		2	4
		Chromium (Cr)	0.0038	0.013	ND	0.0027	ND			
		Lead (Pb)	ND	ND	ND	ND	ND			
		Thallium (Tl)	0.0059	0.019	ND	0.0042	ND			
		Carcinogenic PAHs								
		Benzo(a)pyrene equivalents	ND	ND	9.6E-06	ND	3.9E-06		2	4
		Pesticides/PCBs								
		Aroclor 1260	ND	ND	7.5E-07	ND	3E-07			
		Aldrin	0.000053	0.00017	1.7E-08	0.000038	6.9E-09			
		Dieldrin	0.000064	0.00021	3.2E-08	0.000046	1.3E-08			
		Miscellaneous								
		Hydrazine	ND	ND	3.2E-07	ND	1.3E-07			
	Inhalation	**Inorganics**								
		Antimony (Sb)	ND	ND	ND	ND	ND			
		Arsenic (As)	ND	ND	2.0E-08	ND	8.6E-09			
		Chromium (Cr)	0.025	0.069	3.4E-07	0.018	1.5E-07			
		Lead (Pb)	ND	ND	ND	ND	ND			
		Thallium (Tl)	ND	ND	ND	ND	ND			
		Carcinogenic PAHs								
		Benzo(a)pyrene equivalents	ND	ND	7.0E-10	ND	3.1E-10			
		Pesticides/PCBs								
		Aroclor 1260	ND	ND	1.3E-10	ND	5.6E-11			
		Aldrin	ND	ND	2.9E-12	ND	1.3E-12			
		Dieldrin	ND	ND	5.5E-12	ND	2.4E-12			
		Miscellaneous								
		Hydrazine	ND	ND	3.1E-10	ND	1.4E-10			

Surface Soil Pathway Sum		0.2	1	6E-05	0.07	1E-05			
Groundwater Ingestion Pathways	**Inorganics**								
	Antimony (Sb)	1.5	3.6	ND	0.55	ND	1		3
	Barium (Ba)	0.59	1.4	ND	0.21	ND	1		3
	Thallium (Tl)	1.6	3.7	ND	0.56	ND	1		3
	Vanadium (V)	0.19	0.45	ND	0.068	ND	1		
	Semivolatile Organics								
	bis(2-Ethylhexyl)phthalate	0.063	0.15	9.7E-06	0.023	2.3E-06	1	2	4
Groundwater Pathway Sum		4	9	1E-05	1	2E-06			
Sum of All Pathways		4	10	7E-05	1	1E-05			

Notes:

ND Indicates not determined due to the lack of available risk information.

NA Not applicable

ILCR Indicates incremental excess lifetime cancer risk

HI Indicates hazard index

1- Chemical is a COC by virtue of projected child residence non-carcinogenic hazard.

2- Chemical is a COC by virtue of projected future resident lifetime ILCR.

3- Chemieal is a COC by virtue of projected site worker non-carcinogenic hazard.

4- Chemical is a COC by virtue of projected site worker ILCR

therefore was not identified as a COC on Table 10.6.27. However, ILCR projections for hydrazine in all three exposure pathways yielded a cumulative ILCR exceeding 1E-06, identifying hydrazine as a COC.

Antimony, arsenic, chromium, and thallium were identified as soil pathways COCs based on their contribution to cumulative residential HI projections.

Future Site Workers

Arsenic and benzo(a)pyrene equivalents were identified as soil pathway COCs based on their contribution to cumulative industrial ILCR projections.

The extent of the COCs identified in surface soil is briefly discussed below. To facilitate this discussion, residential soil RBCs and background concentrations were compared to each reported COC concentration. Arsenic was detected in 47 of 48 surface soil samples at a concentration above its residential RBC (0.43 mg/kg). Arsenic exceeded its background concentration (17.2 mg/kg) in 4 surface soil samples (S08B02, S08B24, 636SB005, and 636SB010) and equalled its background concentration in one surface soil sample (636SB013). Antimony was detected in 5 of 48 surface soil samples, exceeding its residential RBC (3.1 mg/kg) in 3 surface soil samples (S08B11, S08B14, and 636SB009), and its background value (2.89 mg/kg) in the same 3 surface soil samples. Chromium was detected in 47 of 48 surface soil samples, exceeding its residential RBC (39 mg/kg) in five surface soil samples (636SB009, S08B11, S08B17, S08B18, and S08B31), and its background value (42.8 mg/kg) in the four of those five surface soil samples (except for S08B11). Thallium was detected in 6 of 48 surface soil samples. Thallium exceeded its residential RBC (0.63 mg/kg) in 4 surface soil samples, yet only exceeded its background value (0.85 mg/kg) in 1 surface soil sample (636SB003). Hydrazine was detected in 7 of 12 surface soil samples, yet only exceeded its residential RBC (210 μg/kg) at one sample location (008SB001). Benzo(a)pyrene equivalents were detected in 30 of 48 surface soil samples, and exceeded their

residential RBC (88 μg/kg) at 17 surface soil sample locations. Aroclor-1260 was detected in nine of 48 surface soil samples, and exceeded its residential RBC (320 μg/kg) at two surface soil sample locations and equaled the RBC in one surface soil sample.

First-quarter Groundwater

Future Site Residents

The only groundwater pathway COC identified, based on its contribution to cumulative residential ILCR projections, was bis(2-ethylhexyl)phthalate.

Antimony, barium, thallium, vanadium, and bis(2-ethylhexyl)phthalate were identified as groundwater pathway COCs based on their contribution to cumulative residential HI projections.

Future Site Workers

The only groundwater pathway COC identified, based on its contribution to cumulative industrial ILCR projections, was bis(2-ethylhexyl)phthalate.

Antimony, barium, and thallium were identified as groundwater pathway COCs based on their contribution to cumulative industrial HI projections.

During the RFI, bis(2-ethylhexyl)phthalate was detected at a concentration exceeding its tap water RBC (4.8 μg/L) in 1 of 7 first-quarter groundwater samples (008004). Antimony was detected at a concentration exceeding its tap water RBC (1.5 μg/L) and its background value (4.85 μg/L) in 1 of 7 first-quarter groundwater samples (008003). Barium was detected at a concentration exceeding its tap water RBC (260 μg/L) in 1 of 7 first-quarter groundwater samples (008002), and its background value (31 μg/L) in 5 of 7 first-quarter groundwater samples. Barium was not, however, detected at a concentration exceeding its corresponding MCL of 2,000 μg/L during the first-quarter RFI sampling. Thallium was detected at a concentration exceeding its tap water RBC

(0.29 μg/L) in 2 of 7 first-quarter groundwater samples. A background value has not been determined for thallium in groundwater at Zone G, but thallium did exceed its MCL of 2 μg/L in both samples in which it was detected. Vanadium was detected at a concentration exceeding its tap water RBC (26 μg/L) and its background value (15.4 μg/L) in 1 of 7 first-quarter groundwater samples (008003).

10.6.6.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure.

Residential use of the site would not be expected, based on current site uses and the nature of surrounding buildings. If this area were to be used as a residential site, the surface soil conditions would likely change — the soils could be covered with landscaping soil and/or a house. Consequently, exposure to surface soil conditions as represented by samples collected during the RFI would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current site workers and future site residents.

Groundwater is not currently used at combined SWMU 8 for potable or industrial purposes. A base-wide system provides drinking and process water to buildings throughout Zone G. This system is slated to remain in operation under the current base reuse plan. As a result, shallow groundwater would not be expected to be used under future site use scenarios, and associated pathways are not expected to be completed in the future.

An interim action has occurred at this site which resulted in a partial excavation of the disposal pits. The excavated pit was constantly flooded which may have redistributed sludge components throughout the area. Additionally, the disturbance of the subsurface soil may have mobilized contaminants in groundwater. During the interim action, the site consisted of open pits with variable floating oil and sheen layers. The excavations have since been backfilled and the area is used for parking. The conclusions of this risk assessment are based on soil and groundwater data collected prior to the interim action activity. Any CMS considerations based on this risk assessment should also include an evaluation of the interim action activities.

Determination of Exposure Point Concentrations

Exposure point concentrations for soil were set equal to the 95% UCL calculated on the combined dataset assembled from both the 1993 and RFI sampling events. Use of 95% UCLs represent conservative assumptions when applied as EPCs, such that it is unlikely that the 95% UCLs underestimate the true mean site concentrations. Although combined SWMU 8 comprises greater than 10 acres, and with the exception of Aroclor-1260 and chromium, EPCs were considered to be adequately representative of any potential exposure unit areas within combined SWMU 8. Alternative EPCs were calculated for Aroclor-1260 and chromium based on their respective worst-case one-half acre exposure unit areas. Groundwater risk/hazard was calculated using the maximum detected concentration of each COPC as an EPC. It is unlikely that the maximum concentration detected in first-quarter groundwater samples underestimates the true mean concentration, and would generally overestimate risk and/or hazard.

Frequency of Detection and Spatial Distribution

Surface Soil

Benzo(a)pyrene equivalents were detected in most of the surface soil samples collected for combined SWMU 8, and were well characterized within the sampling grid. Antimony, arsenic, chromium, lead, and thallium each exceeded their background concentrations in only a few

samples which suggests a relation to ambient soil conditions. Hydrazine was detected in 7 of 12 surface soil samples, but only marginally exceeded its RBC in one surface soil sample.

Quantification of Risk/Hazard

As indicated by the discussions above, the uncertainty inherent in the risk assessment process is great. In addition, many site-specific factors have affected the uncertainty of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

Soil

A conservative screening process was used to identify COPCs for combined SWMU 8. The potential for eliminating CPSSs with the potential for cumulative HI greater than one was addressed for noncarcinogens through the use of RBCs that were reduced one order of magnitude. For carcinogens, the RBCs are based on a conservative target risk of 1E-06. Use of conservative RBCs in combination with the use of maximum detected concentrations minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment (except for aluminum, beryllium, and manganese), none was reported at a concentration near its RBC (e.g. within 10% of its RBC). Aluminum, beryllium, and manganese were detected at concentrations exceeding their RBCs, however, their maximum concentrations did not exceed their corresponding background concentrations. As a result, each chemical was eliminated from consideration in the risk assessment.

Groundwater

The same conservative screening process used for soil is also used for groundwater. Of the CPSSs screened and eliminated from formal assessment (except for arsenic and manganese) none was reported at a concentration close to its corresponding RBC (e.g. within 10% of its RBC). Arsenic and manganese were detected at concentrations exceeding their tap water RBCs, however, their

maximum concentrations did not exceed their corresponding background concentrations. As a result, each chemical was eliminated from consideration in the risk assessment.

Groundwater is not currently used as a potable water source at combined SWMU 8, nor is it used at NAVBASE or in the surrounding area. Municipal water is readily available. As previously mentioned, it is highly unlikely that the site will be developed as a residential area, and it is unlikely that a potable-use well would be installed onsite. It is probable that, if residences were constructed onsite and an unfiltered well were installed, the salinity and dissolved solids would preclude this aquifer from being an acceptable potable water source.

Background-related Risk

Soil

Aluminum, beryllium, and manganese were detected in combined SWMU 8 surface soil at concentrations above their respective RBCs. These elements were eliminated from consideration in the risk assessment based on comparison to corresponding background values. It is not unusual for naturally occurring or background concentrations of some elements to exceed risk-based concentrations. It is the risk assessment's function to identify excess risk and/or hazard, or that which is above background levels. The following is a discussion of the residential scenario risk/hazard associated with background concentrations of aluminum, arsenic, and beryllium.

The maximum surface soil concentration of aluminum (12,100 mg/kg) for combined SWMU 8 equates with hazard quotients of 0.2 and 0.008 for the residential child and site worker, respectively. The background value for aluminum (18,700 mg/kg) results in hazard quotients of 0.3 and 0.01 for the residential child and site worker, respectively. The maximum reported concentration of beryllium (1 mg/kg) yielded ILCRs of 7E-06 and 1E-06 for the residential and site worker scenarios, respectively. Hazard quotients resulting from the maximum reported concentration of beryllium were 0.003 and 0.0001 for the residential child and the site worker,

respectively. The background value for beryllium (1.2 mg/kg) yielded ILCRs of 9E-06 and 1E-06, and hazard quotients of 0.0003 and 0.0002 for the residential and site worker scenarios, respectively. The maximum surface soil concentration of manganese (282 mg/kg) for combined SWMU 8 equates with hazard quotients of 0.08 and 0.004 for the residential child and site worker, respectively. The background value for manganese (325 mg/kg) results in hazard quotients of 0.09 and 0.005 for the residential child and site worker, respectively.

First-quarter Groundwater

Arsenic and manganese were detected in first-quarter groundwater samples at concentrations exceeding their respective RBCs. These inorganics were eliminated from consideration in the risk assessment based on comparison to corresponding background values. The following is a discussion of the residential scenario risk/hazard associated with background concentrations of arsenic and manganese.

The maximum groundwater concentration of arsenic (17.7 μg/L) for combined SWMU 8 equates with ILCRs of 4E-04 and 1E-04 for the residential child and site worker, respectively. The maximum reported concentration of arsenic also equates with hazard quotients of 4 and 0.6 for the residential child and site worker, respectively. The background value for arsenic (17.8 μg/L) equates with ILCRs of 4E-04 and 1E-04, respectively, for the residential child and site worker; it also equates with hazard quotients of 4 and 0.6 for the residential child and site worker, respectively. The maximum reported concentration of manganese (1,620 μg/L) yielded hazard quotients of 5 and 0.7 for the residential and site worker scenarios, respectively. Hazard quotients resulting from the background value for manganese (2,906 μg/L) were 8 and 1 for the residential child and the site worker, respectively.

10.6.6.7 Risk Summary

The risk and hazard posed by contaminants at combined SWMU 8 were assessed for future site workers and future site residents under reasonable maximum exposure assumptions. For surface soils, the incidental ingestion, dermal contact, and inhalation pathways were assessed in this HHRA. For groundwater the ingestion pathway was assessed. Table 10.6.28 presents the risk summary for each pathway/receptor group evaluated for combined SWMU 8.

Soil — Residential Scenario

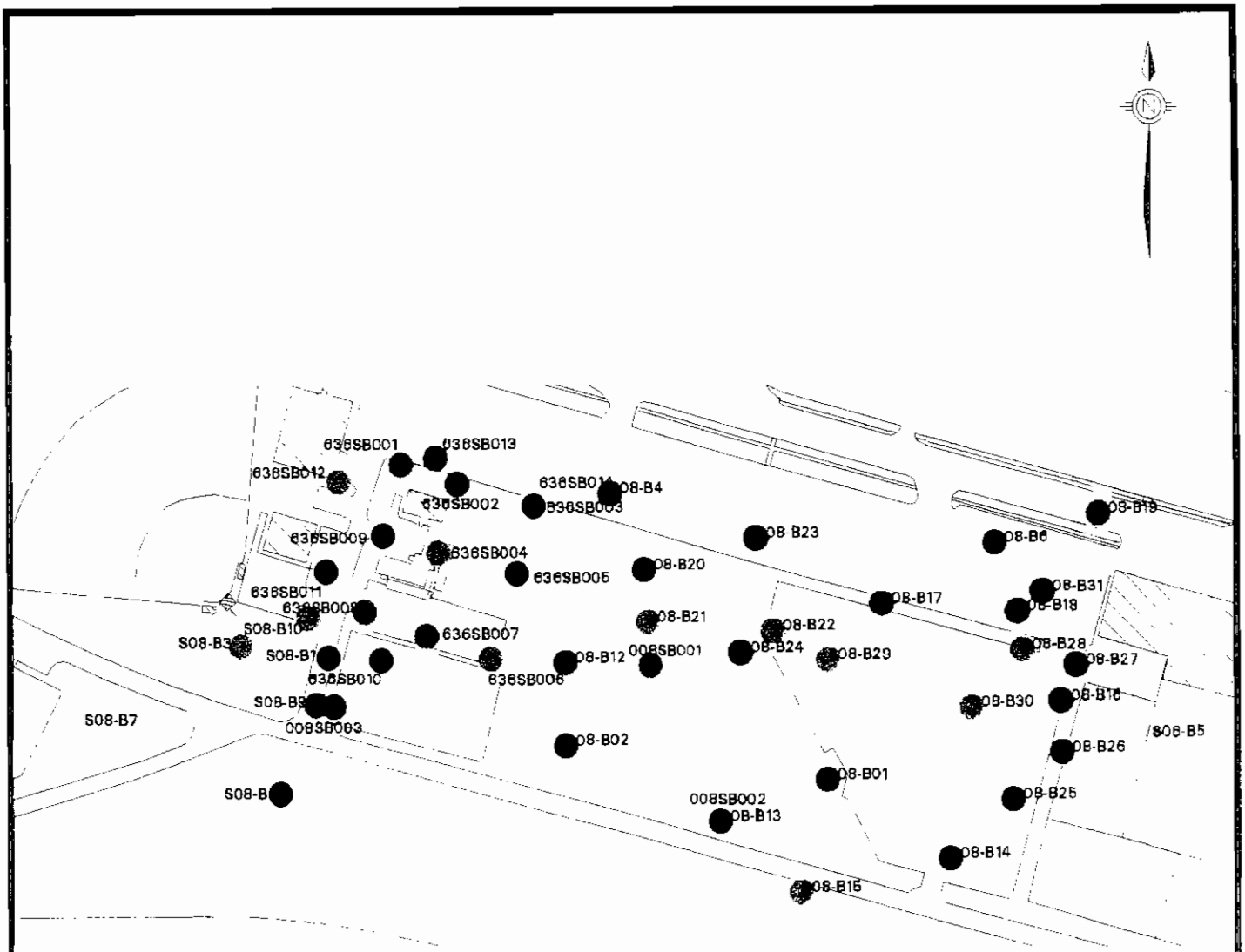
Residential soil pathway COCs identified for combined SWMU 8 are antimony, Aroclor-1260, arsenic, benzo(a)pyrene equivalents, chromium, hydrazine, and thallium. Figures 10.6-31 and 10.6-32 illustrates point risk and hazard estimates respectively for combined SWMU 8 based on soil exposure pathways under a future residential scenario. Table 10.6.29 summarizes the risk and hazard contribution of each COPC at each sample location. This point risk map is based on the unlikely assumption that a potential future site resident will be chronically exposed to specific points. Exposure to surface soil conditions is more likely the result of uniform exposure to the soil conditions of the entire site (or exposure unit area) rather than specific points. Risk maps supplemented by the tables are useful because they allow the reader to visualize how chemicals driving risk estimates are spatially distributed across the site.

With the exception of S08B23, all sample locations yielded ILCRs that were greater than 1E-06. Arsenic was the primary contributor to risk at most sample locations, while benzo(a)pyrene equivalents, Aroclor-1260, aldrin, dieldrin, and hydrazine were secondary contributors. Benzo(a)pyrene equivalents were the primary contributors to risk at 5 sample locations (S08B11, S08B12, S08B17, S08B18, and S08B31) and arsenic was a secondary contributor at these locations. Risk estimates at combined SWMU 8 ranged from 3E-06 (636SB014) to 1E-03 (S08B11), with a mean risk estimate of 7E-05. Neither of these COCs were detected in S08B23.

Table 10.6.28
Summary of Risk and Hazard
SWMU 8 and AOC 636
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	0.1	1	5E-05	0.04	5E-06
	Dermal Contact	0.02	0.08	1E-05	0.02	6E-06
	Inhalation	0.02	0.07	4E-07	0.02	2E-07
Groundwater	Ingestion	4	9	1E-05	1	2E-06
Sum of All Pathways		4	10	7E-05	1	1E-05

Notes:
ND Indicates not determined due to the lack of available risk information.
ILCR Indicates incremental lifetime cancer risk
HI Indicates hazard index



LEGEND

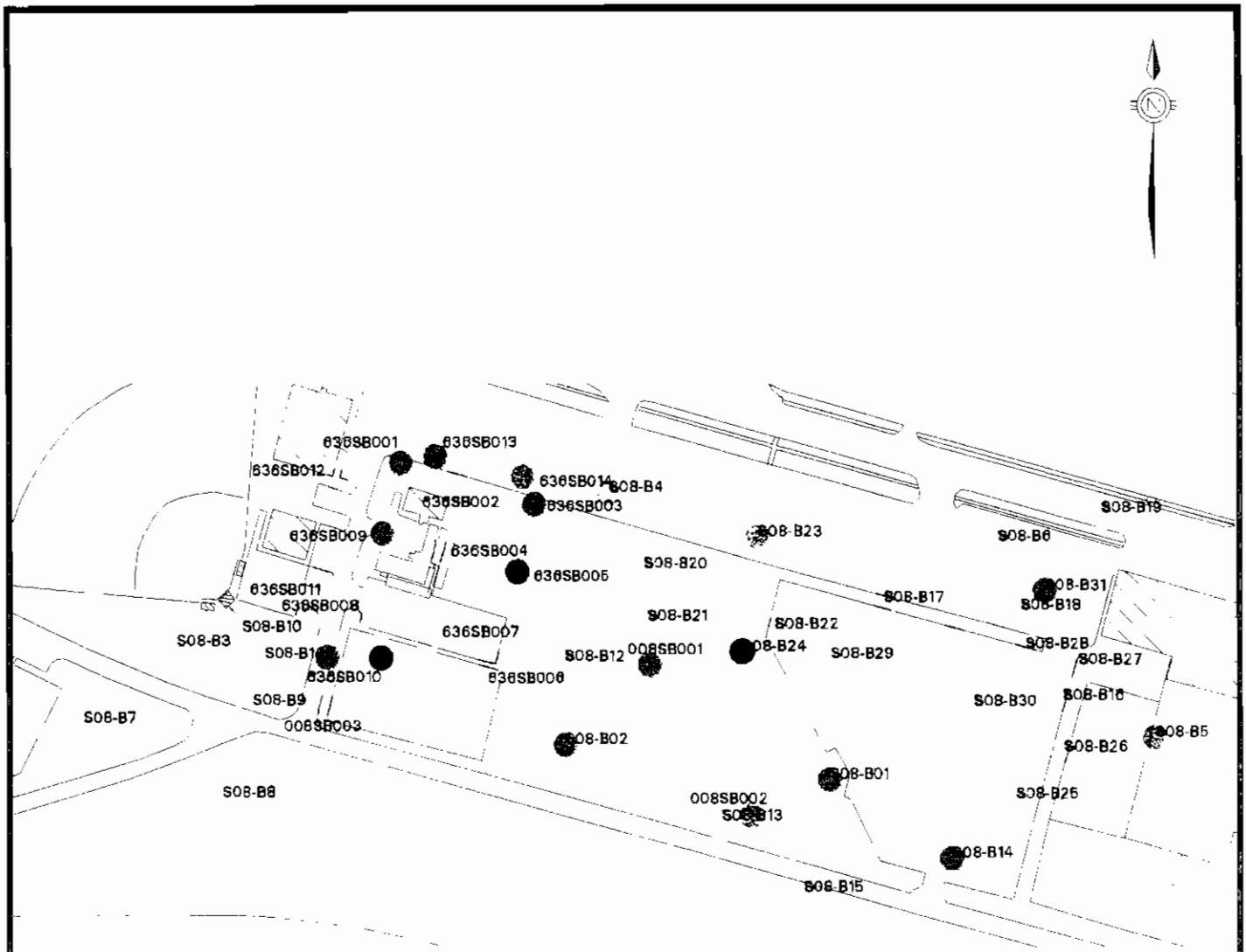
- NO COPCs DETECTED
- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

0 feet 250

ZONE G - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 10.6-31
POINT RISK ESTIMATES FOR SURFACE SOIL
RESIDENTIAL SCENARIO
SWMU 8, AOC 636

ARLL: /home3/projects/charleston_dir/zone_g_dir/net_dir



LEGEND

- 0 to 0.1
- 0.1 to 0.5
- 0.5 to 1.0
- 1.0 to 3.0
- > 3.0

0 feet 250

ZONE G - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 10.6-32
POINT HAZARD ESTIMATES FOR SURFACE SOIL
RESIDENTIAL SCENARIO
SWMU 8, AOC 636

AML /home3/projects/charleston_dir/zone_g_dd/risk_dir

Table 10.6.29
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
SWMU 8 and AOC 636
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
008	001	Aldrin	ND	UG/KG	NA		NA	
008	001	Antimony (Sb)	ND	MG/KG	NA		NA	
008	001	Aroclor-1260	ND	UG/KG	NA		NA	
008	001	Arsenic (As)	12.7	MG/KG	0.5805	97.74	33.1724	94.68
008	001	B(a)P Equiv.	ND	UG/KG	NA		NA	
008	001	Chromium (Cr)	4.9	MG/KG	0.0134	2.26	NA	
008	001	Dieldrin	ND	UG/KG	NA		NA	
008	001	Hydrazine	274	UG/KG	NA		1.8647	5.32
008	001	Lead (Pb)	10.6	MG/KG	NA		NA	
008	001	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.5939		35.0371	
008	002	Aldrin	ND	UG/KG	NA		NA	
008	002	Antimony (Sb)	ND	MG/KG	NA		NA	
008	002	Aroclor-1260	ND	UG/KG	NA		NA	
008	002	Arsenic (As)	1.5	MG/KG	0.0686	79.55	3.9180	83.21
008	002	B(a)P Equiv.	ND	UG/KG	NA		NA	
008	002	Chromium (Cr)	5.8	MG/KG	0.0159	18.46	NA	
008	002	Dieldrin	5.2	UG/KG	0.0017	1.99	0.1887	4.01
008	002	Hydrazine	88.4	UG/KG	NA		0.6016	12.78
008	002	Lead (Pb)	6.6	MG/KG	NA		NA	
008	002	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.0862		4.7084	
008	003	Aldrin	ND	UG/KG	NA		NA	
008	003	Antimony (Sb)	ND	MG/KG	NA		NA	
008	003	Aroclor-1260	ND	UG/KG	NA		NA	
008	003	Arsenic (As)	6.7	MG/KG	0.3062	67.84	17.5004	52.04
008	003	B(a)P Equiv.	942.4	UG/KG	NA		15.6064	46.41
008	003	Chromium (Cr)	12.3	MG/KG	0.0337	7.47	NA	
008	003	Dieldrin	ND	UG/KG	NA		NA	
008	003	Hydrazine	76.4	UG/KG	NA		0.5199	1.55
008	003	Lead (Pb)	48.3	MG/KG	NA		NA	
008	003	Thallium (Tl)	0.65	MG/KG	0.1114	24.68	NA	
		Total			0.4514		33.6268	
636	001	Aldrin	ND	UG/KG	NA		NA	
636	001	Antimony (Sb)	ND	MG/KG	NA		NA	
636	001	Aroclor-1260	ND	UG/KG	NA		NA	
636	001	Arsenic (As)	7.1	MG/KG	0.3245	62.68	18.5452	79.05
636	001	B(a)P Equiv.	296.78	UG/KG	NA		4.9148	20.95
636	001	Chromium (Cr)	19.2	MG/KG	0.0527	10.17	NA	
636	001	Dieldrin	ND	UG/KG	NA		NA	
636	001	Hydrazine	ND	UG/KG	NA		NA	
636	001	Lead (Pb)	102	MG/KG	NA		NA	
636	001	Thallium (Tl)	0.82	MG/KG	0.1406	27.15	NA	
		Total			0.5177		23.4600	
636	002	Aldrin	ND	UG/KG	NA		NA	
636	002	Antimony (Sb)	ND	MG/KG	NA		NA	
636	002	Aroclor-1260	ND	UG/KG	NA		NA	
636	002	Arsenic (As)	7.05	MG/KG	0.3222	74.84	18.4146	76.82
636	002	B(a)P Equiv.	327.76	UG/KG	NA		5.4278	22.64
636	002	Chromium (Cr)	13.25	MG/KG	0.0363	8.44	NA	

636	002	Dieldrin	ND	UG/KG	NA		NA	
636	002	Hydrazine	19.1	UG/KG	NA		0.1300	0.54
636	002	Lead (Pb)	453.5	MG/KG	NA		NA	
636	002	Thallium (Tl)	0.42	MG/KG	0.0720	16.72	NA	
		Total			0.4306		23.9724	
636	003	Aldrin	ND	UG/KG	NA		NA	
636	003	Antimony (Sb)	ND	MG/KG	NA		NA	
636	003	Aroclor-1260	ND	UG/KG	NA		NA	
636	003	Arsenic (As)	11.4	MG/KG	0.5211	69.93	29.7768	77.67
636	003	B(a)P Equiv.	509.06	UG/KG	NA		8.4302	21.99
636	003	Chromium (Cr)	24.2	MG/KG	0.0664	8.91	NA	
636	003	Dieldrin	ND	UG/KG	NA		NA	
636	003	Hydrazine	19.3	UG/KG	NA		0.1313	0.34
636	003	Lead (Pb)	42.2	MG/KG	NA		NA	
636	003	Thallium (Tl)	0.92	MG/KG	0.1577	21.16	NA	
		Total			0.7451		38.3384	
636	004	Aldrin	ND	UG/KG	NA		NA	
636	004	Antimony (Sb)	ND	MG/KG	NA		NA	
636	004	Aroclor-1260	ND	UG/KG	NA		NA	
636	004	Arsenic (As)	2.7	MG/KG	0.1234	88.58	7.0524	100.00
636	004	B(a)P Equiv.	ND	UG/KG	NA		NA	
636	004	Chromium (Cr)	5.8	MG/KG	0.0159	11.42	NA	
636	004	Dieldrin	ND	UG/KG	NA		NA	
636	004	Hydrazine	ND	UG/KG	NA		NA	
636	004	Lead (Pb)	14.1	MG/KG	NA		NA	
636	004	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.1393		7.0524	
636	005	Aldrin	ND	UG/KG	NA		NA	
636	005	Antimony (Sb)	ND	MG/KG	NA		NA	
636	005	Aroclor-1260	320	UG/KG	NA		1.4519	2.37
636	005	Arsenic (As)	22.8	MG/KG	1.0421	98.80	59.5536	97.40
636	005	B(a)P Equiv.	8.152	UG/KG	NA		0.1350	0.22
636	005	Dieldrin	ND	UG/KG	NA		NA	
636	005	Chromium (Cr)	4.6	MG/KG	0.0126	1.20	NA	
636	005	Hydrazine	ND	UG/KG	NA		NA	
636	005	Lead (Pb)	6.9	MG/KG	NA		NA	
636	005	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			1.0548		61.1405	
636	006	Aldrin	ND	UG/KG	NA		NA	
636	006	Antimony (Sb)	ND	MG/KG	NA		NA	
636	006	Aroclor-1260	ND	UG/KG	NA		NA	
636	006	Arsenic (As)	2.3	MG/KG	0.1051	85.50	6.0076	82.47
636	006	B(a)P Equiv.	71.842	UG/KG	NA		1.1897	16.33
636	006	Chromium (Cr)	6.5	MG/KG	0.0178	14.50	NA	
636	006	Dieldrin	ND	UG/KG	NA		NA	
636	006	Hydrazine	12.8	UG/KG	NA		0.0871	1.20
636	006	Lead (Pb)	16.3	MG/KG	NA		NA	
636	006	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.1230		7.2844	
636	007	Aldrin	ND	UG/KG	NA		NA	
636	007	Antimony (Sb)	ND	MG/KG	NA		NA	
636	007	Aroclor-1260	350	UG/KG	NA		1.5880	9.33
636	007	Arsenic (As)	5.1	MG/KG	0.2331	86.03	13.3212	78.26
636	007	B(a)P Equiv.	127.62	UG/KG	NA		2.1134	12.42
636	007	Chromium (Cr)	13.8	MG/KG	0.0378	13.97	NA	
636	007	Dieldrin	ND	UG/KG	NA		NA	
636	007	Hydrazine	ND	UG/KG	NA		NA	
636	007	Lead (Pb)	97.1	MG/KG	NA		NA	

636	007	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.2710		17.0226	
636	008	Aldrin	ND	UG/KG	NA		NA	
636	008	Antimony (Sb)	ND	MG/KG	NA		NA	
636	008	Aroclor-1260	920	UG/KG	NA		4.1741	15.87
636	008	Arsenic (As)	6.7	MG/KG	0.3062	81.11	17.5004	66.52
636	008	B(a)P Equiv.	273.79	UG/KG	NA		4.5340	17.24
636	008	Chromium (Cr)	26	MG/KG	0.0713	18.89	NA	
636	008	Dieldrin	ND	UG/KG	NA		NA	
636	008	Hydrazine	14.4	UG/KG	NA		0.0980	0.37
636	008	Lead (Pb)	87.5	MG/KG	NA		NA	
636	008	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.3775		26.3066	
636	009	Aldrin	ND	UG/KG	NA		NA	
636	009	Antimony (Sb)	6.4	MG/KG	0.2194	28.42	NA	
636	009	Aroclor-1260	69	UG/KG	NA		0.3131	2.03
636	009	Arsenic (As)	5.5	MG/KG	0.2514	32.56	14.3660	92.96
636	009	B(a)P Equiv.	46.838	UG/KG	NA		0.7757	5.02
636	009	Chromium (Cr)	64.2	MG/KG	0.1761	22.81	NA	
636	009	Dieldrin	ND	UG/KG	NA		NA	
636	009	Hydrazine	ND	UG/KG	NA		NA	
636	009	Lead (Pb)	394	MG/KG	NA		NA	
636	009	Thallium (Tl)	0.73	MG/KG	0.1251	16.21	NA	
		Total			0.7720		15.4547	
636	010	Aldrin	ND	UG/KG	NA		NA	
636	010	Antimony (Sb)	0.66	MG/KG	0.0226	1.90	NA	
636	010	Aroclor-1260	12	UG/KG	NA		0.0544	0.09
636	010	Arsenic (As)	22.4	MG/KG	1.0239	85.95	58.5088	99.91
636	010	B(a)P Equiv.	0.045	UG/KG	NA		0.0007	0.00
636	010	Chromium (Cr)	15.9	MG/KG	0.0436	3.66	NA	
636	010	Dieldrin	ND	UG/KG	NA		NA	
636	010	Lead (Pb)	51.8	MG/KG	NA		NA	
636	010	Thallium (Tl)	0.59	MG/KG	0.1011	8.49	NA	
		Total			1.1912		58.5640	
636	011	Aldrin	ND	UG/KG	NA		NA	
636	011	Antimony (Sb)	1.5	MG/KG	0.0514	17.74	NA	
636	011	Aroclor-1260	36	UG/KG	NA		0.1633	1.06
636	011	Arsenic (As)	4.7	MG/KG	0.2148	74.12	12.2764	79.55
636	011	B(a)P Equiv.	180.7	UG/KG	NA		2.9924	19.39
636	011	Chromium (Cr)	8.6	MG/KG	0.0236	8.14	NA	
636	011	Dieldrin	ND	UG/KG	NA		NA	
636	011	Lead (Pb)	43.9	MG/KG	NA		NA	
636	011	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.2898		15.4322	
636	012	Aldrin	ND	UG/KG	NA		NA	
636	012	Antimony (Sb)	ND	MG/KG	NA		NA	
636	012	Aroclor-1260	8.5	UG/KG	NA		0.0386	0.70
636	012	Arsenic (As)	2.1	MG/KG	0.0960	87.50	5.4852	99.30
636	012	B(a)P Equiv.	ND	UG/KG	NA		NA	
636	012	Chromium (Cr)	5	MG/KG	0.0137	12.50	NA	
636	012	Dieldrin	ND	UG/KG	NA		NA	
636	012	Lead (Pb)	5.9	MG/KG	NA		NA	
636	012	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.1097		5.5238	
636	013	Aldrin	ND	UG/KG	NA		NA	
636	013	Antimony (Sb)	ND	MG/KG	NA		NA	
636	013	Aroclor-1260	28	UG/KG	NA		0.1270	0.28

636	013	Arsenic (As)	17.2	MG/KG	0.7862	93.72	44.9264	99.72
636	013	B(a)P Equiv.	ND	UG/KG	NA		NA	
636	013	Chromium (Cr)	19.2	MG/KG	0.0527	6.28	NA	
636	013	Dieldrin	ND	UG/KG	NA		NA	
636	013	Lead (Pb)	66.2	MG/KG	NA		NA	
636	013	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.8388		45.0535	
636	014	Aldrin	ND	UG/KG	NA		NA	
636	014	Antimony (Sb)	ND	MG/KG	NA		NA	
636	014	Aroclor-1260	ND	UG/KG	NA		NA	
636	014	Arsenic (As)	1.2	MG/KG	0.0548	73.26	3.1344	100.00
636	014	B(a)P Equiv.	ND	UG/KG	NA		NA	
636	014	Chromium (Cr)	7.3	MG/KG	0.0200	26.74	NA	
636	014	Dieldrin	ND	UG/KG	NA		NA	
636	014	Lead (Pb)	4.9	MG/KG	NA		NA	
636	014	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.0749		3.1344	
008	011	Aldrin	ND	UG/KG	NA		NA	
008	011	Antimony (Sb)	ND	MG/KG	NA		NA	
008	011	Aroclor-1260	ND	UG/KG	NA		NA	
008	011	Arsenic (As)	10	MG/KG	0.4571	88.33	26.1200	77.09
008	011	B(a)P Equiv.	450	UG/KG	NA		7.4521	22.00
008	011	Chromium (Cr)	21	MG/KG	0.0576	11.13	NA	
008	011	Dieldrin	8.5	UG/KG	0.0028	0.54	0.3085	0.91
008	011	Lead (Pb)	310	MG/KG	NA		NA	
008	011	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.5175		33.8807	
008	021	Aldrin	ND	UG/KG	NA		NA	
008	021	Antimony (Sb)	ND	MG/KG	NA		NA	
008	021	Aroclor-1260	ND	UG/KG	NA		NA	
008	021	Arsenic (As)	20	MG/KG	0.9142	98.09	52.2400	99.91
008	021	B(a)P Equiv.	2.7	UG/KG	NA		0.0447	0.09
008	021	Chromium (Cr)	6.5	MG/KG	0.0178	1.91	NA	
008	021	Dieldrin	ND	UG/KG	NA		NA	
008	021	Lead (Pb)	11	MG/KG	NA		NA	
008	021	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.9320		52.2847	
008	031	Aldrin	ND	UG/KG	NA		NA	
008	031	Antimony (Sb)	ND	MG/KG	NA		NA	
008	031	Aroclor-1260	ND	UG/KG	NA		NA	
008	031	Arsenic (As)	2.95	MG/KG	0.1348	88.96	7.7054	98.83
008	031	B(a)P Equiv.	5.5055	UG/KG	NA		0.0912	1.17
008	031	Chromium (Cr)	6.1	MG/KG	0.0167	11.04	NA	
008	031	Dieldrin	ND	UG/KG	NA		NA	
008	031	Lead (Pb)	8.15	MG/KG	NA		NA	
008	031	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.1516		7.7966	
008	041	Aldrin	ND	UG/KG	NA		NA	
008	041	Antimony (Sb)	ND	MG/KG	NA		NA	
008	041	Aroclor-1260	ND	UG/KG	NA		NA	
008	041	Arsenic (As)	5.6	MG/KG	0.2560	93.40	14.6272	94.60
008	041	B(a)P Equiv.	50.4	UG/KG	NA		0.8346	5.40
008	041	Chromium (Cr)	6.6	MG/KG	0.0181	6.60	NA	
008	041	Dieldrin	ND	UG/KG	NA		NA	
008	041	Lead (Pb)	19	MG/KG	NA		NA	
008	041	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.2741		15.4618	

008	051	Aldrin	ND	UG/KG	NA		NA	
008	051	Antimony (Sb)	ND	MG/KG	NA		NA	
008	051	Aroclor-1260	ND	UG/KG	NA		NA	
008	051	Arsenic (As)	1.6	MG/KG	0.0731	76.92	4.1792	84.95
008	051	B(a)P Equiv.	44.7	UG/KG	NA		0.7402	15.05
008	051	Chromium (Cr)	8	MG/KG	0.0219	23.08	NA	
008	051	Dieldrin	ND	UG/KG	NA		NA	
008	051	Lead (Pb)	19	MG/KG	NA		NA	
008	051	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.0951		4.9194	
008	061	Aldrin	ND	UG/KG	NA		NA	
008	061	Antimony (Sb)	ND	MG/KG	NA		NA	
008	061	Aroclor-1260	ND	UG/KG	NA		NA	
008	061	Arsenic (As)	5	MG/KG	0.2285	91.44	13.0600	100.00
008	061	B(a)P Equiv.	ND	UG/KG	NA		NA	
008	061	Chromium (Cr)	7.8	MG/KG	0.0214	8.56	NA	
008	061	Dieldrin	ND	UG/KG	NA		NA	
008	061	Lead (Pb)	41	MG/KG	NA		NA	
008	061	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.2499		13.0600	
008	071	Aldrin	ND	UG/KG	NA		NA	
008	071	Antimony (Sb)	ND	MG/KG	NA		NA	
008	071	Aroclor-1260	ND	UG/KG	NA		NA	
008	071	Arsenic (As)	1.9	MG/KG	0.0868	82.97	4.9628	100.00
008	071	B(a)P Equiv.	ND	UG/KG	NA		NA	
008	071	Chromium (Cr)	6.5	MG/KG	0.0178	17.03	NA	
008	071	Dieldrin	ND	UG/KG	NA		NA	
008	071	Lead (Pb)	6.8	MG/KG	NA		NA	
008	071	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.1047		4.9628	
008	081	Aldrin	ND	UG/KG	NA		NA	
008	081	Antimony (Sb)	ND	MG/KG	NA		NA	
008	081	Aroclor-1260	77	UG/KG	NA		0.3494	1.90
008	081	Arsenic (As)	6.9	MG/KG	0.3154	85.19	18.0228	98.10
008	081	B(a)P Equiv.	ND	UG/KG	NA		NA	
008	081	Chromium (Cr)	20	MG/KG	0.0548	14.81	NA	
008	081	Dieldrin	ND	UG/KG	NA		NA	
008	081	Lead (Pb)	76	MG/KG	NA		NA	
008	081	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.3702		18.3722	
008	091	Aldrin	ND	UG/KG	NA		NA	
008	091	Antimony (Sb)	ND	MG/KG	NA		NA	
008	091	Aroclor-1260	ND	UG/KG	NA		NA	
008	091	Arsenic (As)	5.9	MG/KG	0.2697	85.26	15.4108	87.48
008	091	B(a)P Equiv.	133.2	UG/KG	NA		2.2058	12.52
008	091	Chromium (Cr)	17	MG/KG	0.0466	14.74	NA	
008	091	Dieldrin	ND	UG/KG	NA		NA	
008	091	Lead (Pb)	53	MG/KG	NA		NA	
008	091	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.3163		17.6166	
008	101	Aldrin	ND	UG/KG	NA		NA	
008	101	Antimony (Sb)	ND	MG/KG	NA		NA	
008	101	Aroclor-1260	ND	UG/KG	NA		NA	
008	101	Arsenic (As)	3.1	MG/KG	0.1417	86.30	8.0972	100.00
008	101	B(a)P Equiv.	ND	UG/KG	NA		NA	
008	101	Chromium (Cr)	8.2	MG/KG	0.0225	13.70	NA	
008	101	Dieldrin	ND	UG/KG	NA		NA	
008	101	Lead (Pb)	21	MG/KG	NA		NA	

008	101	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.1642		8.0972	
008	111	Aldrin	41	UG/KG	0.0225	2.72	1.5812	0.11
008	111	Antimony (Sb)	7.4	MG/KG	0.2537	30.61	NA	
008	111	Aroclor-1260	ND	UG/KG	NA		NA	
008	111	Arsenic (As)	9.3	MG/KG	0.4251	51.30	24.2916	1.68
008	111	B(a)P Equiv.	85442.5	UG/KG	NA		1414.9545	98.09
008	111	Chromium (Cr)	40.9	MG/KG	0.1122	13.54	NA	
008	111	Dieldrin	46	UG/KG	0.0152	1.83	1.6696	0.12
008	111	Lead (Pb)	187	MG/KG	NA		NA	
008	111	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.8286		1442.4969	
008	121	Aldrin	ND	UG/KG	NA		NA	
008	121	Antimony (Sb)	ND	MG/KG	NA		NA	
008	121	Aroclor-1260	ND	UG/KG	NA		NA	
008	121	Arsenic (As)	2.2	MG/KG	0.1006	67.07	5.7464	29.58
008	121	B(a)P Equiv.	826.2	UG/KG	NA		13.6821	70.42
008	121	Chromium (Cr)	18	MG/KG	0.0494	32.93	NA	
008	121	Dieldrin	ND	UG/KG	NA		NA	
008	121	Lead (Pb)	29	MG/KG	NA		NA	
008	121	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.1499		19.4285	
008	131	Aldrin	ND	UG/KG	NA		NA	
008	131	Antimony (Sb)	ND	MG/KG	NA		NA	
008	131	Aroclor-1260	ND	UG/KG	NA		NA	
008	131	Arsenic (As)	8.6	MG/KG	0.3931	84.15	22.4632	100.00
008	131	B(a)P Equiv.	ND	UG/KG	NA		NA	
008	131	Chromium (Cr)	27	MG/KG	0.0740	15.85	NA	
008	131	Dieldrin	ND	UG/KG	NA		NA	
008	131	Lead (Pb)	34	MG/KG	NA		NA	
008	131	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.4671		22.4632	
008	141	Aldrin	ND	UG/KG	NA		NA	
008	141	Antimony (Sb)	7.6	MG/KG	0.2605	40.37	NA	
008	141	Aroclor-1260	ND	UG/KG	NA		NA	
008	141	Arsenic (As)	6.2	MG/KG	0.2834	43.91	16.1944	89.00
008	141	B(a)P Equiv.	120.86	UG/KG	NA		2.0015	11.00
008	141	Chromium (Cr)	37	MG/KG	0.1015	15.72	NA	
008	141	Dieldrin	ND	UG/KG	NA		NA	
008	141	Lead (Pb)	230	MG/KG	NA		NA	
008	141	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.6454		18.1959	
008	151	Aldrin	ND	UG/KG	NA		NA	
008	151	Antimony (Sb)	ND	MG/KG	NA		NA	
008	151	Aroclor-1260	ND	UG/KG	NA		NA	
008	151	Arsenic (As)	2.2	MG/KG	0.1006	76.92	5.7464	65.54
008	151	B(a)P Equiv.	182.42	UG/KG	NA		3.0209	34.46
008	151	Chromium (Cr)	11	MG/KG	0.0302	23.08	NA	
008	151	Dieldrin	ND	UG/KG	NA		NA	
008	151	Lead (Pb)	41	MG/KG	NA		NA	
008	151	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.1307		8.7673	
008	161	Aldrin	ND	UG/KG	NA		NA	
008	161	Antimony (Sb)	ND	MG/KG	NA		NA	
008	161	Aroclor-1260	ND	UG/KG	NA		NA	
008	161	Arsenic (As)	3.5	MG/KG	0.1600	100.00	9.1420	87.57
008	161	B(a)P Equiv.	78.38	UG/KG	NA		1.2980	12.43

008	161	Chromium (Cr)	ND	MG/KG	NA		NA	
008	161	Dieldrin	ND	UG/KG	NA		NA	
008	161	Lead (Pb)	340	MG/KG	NA		NA	
008	161	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.1600		10.4400	
008	171	Aldrin	ND	UG/KG	NA		NA	
008	171	Antimony (Sb)	ND	MG/KG	NA		NA	
008	171	Aroclor-1260	ND	UG/KG	NA		NA	
008	171	Arsenic (As)	7.05	MG/KG	0.3222	69.32	18.4146	32.50
008	171	B(a)P Equiv.	2309.9	UG/KG	NA		38.2527	67.50
008	171	Chromium (Cr)	52	MG/KG	0.1426	30.68	NA	
008	171	Dieldrin	ND	UG/KG	NA		NA	
008	171	Lead (Pb)	160	MG/KG	NA		NA	
008	171	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.4648		56.6673	
008	181	Aldrin	ND	UG/KG	NA		NA	
008	181	Antimony (Sb)	ND	MG/KG	NA		NA	
008	181	Aroclor-1260	ND	UG/KG	NA		NA	
008	181	Arsenic (As)	3.8	MG/KG	0.1737	56.89	9.9256	5.93
008	181	B(a)P Equiv.	9515.6	UG/KG	NA		157.5813	94.07
008	181	Chromium (Cr)	48	MG/KG	0.1316	43.11	NA	
008	181	Dieldrin	ND	UG/KG	NA		NA	
008	181	Lead (Pb)	23	MG/KG	NA		NA	
008	181	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.3053		167.5069	
008	191	Aldrin	ND	UG/KG	NA		NA	
008	191	Antimony (Sb)	ND	MG/KG	NA		NA	
008	191	Aroclor-1260	ND	UG/KG	NA		NA	
008	191	Arsenic (As)	5.9	MG/KG	0.2697	79.73	15.4108	93.11
008	191	B(a)P Equiv.	68.864	UG/KG	NA		1.1404	6.89
008	191	Chromium (Cr)	25	MG/KG	0.0686	20.27	NA	
008	191	Dieldrin	ND	UG/KG	NA		NA	
008	191	Lead (Pb)	180	MG/KG	NA		NA	
008	191	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.3382		16.5512	
008	201	Aldrin	ND	UG/KG	NA		NA	
008	201	Antimony (Sb)	ND	MG/KG	NA		NA	
008	201	Aroclor-1260	ND	UG/KG	NA		NA	
008	201	Arsenic (As)	8.4	MG/KG	0.3839	97.09	21.9408	100.00
008	201	B(a)P Equiv.	ND	UG/KG	NA		NA	
008	201	Chromium (Cr)	4.2	MG/KG	0.0115	2.91	NA	
008	201	Dieldrin	ND	UG/KG	NA		NA	
008	201	Lead (Pb)	6.3	MG/KG	NA		NA	
008	201	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.3955		21.9408	
008	211	Aldrin	ND	UG/KG	NA		NA	
008	211	Antimony (Sb)	ND	MG/KG	NA		NA	
008	211	Aroclor-1260	ND	UG/KG	NA		NA	
008	211	Arsenic (As)	3.6	MG/KG	0.1645	93.02	9.4032	100.00
008	211	B(a)P Equiv.	ND	UG/KG	NA		NA	
008	211	Chromium (Cr)	4.5	MG/KG	0.0123	6.98	NA	
008	211	Dieldrin	ND	UG/KG	NA		NA	
008	211	Lead (Pb)	6.1	MG/KG	NA		NA	
008	211	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.1769		9.4032	
008	221	Aldrin	ND	UG/KG	NA		NA	
008	221	Antimony (Sb)	ND	MG/KG	NA		NA	

008	221	Aroclor-1260	ND	UG/KG	NA		NA	
008	221	Arsenic (As)	2.6	MG/KG	0.1188	92.13	6.7912	100.00
008	221	B(a)P Equiv.	ND	UG/KG	NA		NA	
008	221	Chromium (Cr)	3.7	MG/KG	0.0101	7.87	NA	
008	221	Dieldrin	ND	UG/KG	NA		NA	
008	221	Lead (Pb)	2.3	MG/KG	NA		NA	
008	221	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.1290		6.7912	
008	231	Aldrin	ND	UG/KG	NA		NA	
008	231	Antimony (Sb)	ND	MG/KG	NA		NA	
008	231	Aroclor-1260	ND	UG/KG	NA		NA	
008	231	Arsenic (As)	ND	MG/KG	NA		NA	
008	231	B(a)P Equiv.	ND	UG/KG	NA		NA	
008	231	Chromium (Cr)	4.5	MG/KG	0.0123	100.00	NA	
008	231	Dieldrin	ND	UG/KG	NA		NA	
008	231	Lead (Pb)	29	MG/KG	NA		NA	
008	231	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.0123		NA	
008	241	Aldrin	ND	UG/KG	NA		NA	
008	241	Antimony (Sb)	ND	MG/KG	NA		NA	
008	241	Aroclor-1260	ND	UG/KG	NA		NA	
008	241	Arsenic (As)	150	MG/KG	6.8562	99.78	391.8002	100.00
008	241	B(a)P Equiv.	ND	UG/KG	NA		NA	
008	241	Chromium (Cr)	5.4	MG/KG	0.0148	0.22	NA	
008	241	Dieldrin	ND	UG/KG	NA		NA	
008	241	Lead (Pb)	11	MG/KG	NA		NA	
008	241	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			6.8710		391.8002	
008	251	Aldrin	ND	UG/KG	NA		NA	
008	251	Antimony (Sb)	ND	MG/KG	NA		NA	
008	251	Aroclor-1260	ND	UG/KG	NA		NA	
008	251	Arsenic (As)	7.9	MG/KG	0.3611	95.47	20.6348	99.99
008	251	B(a)P Equiv.	0.068	UG/KG	NA		0.0011	0.01
008	251	Chromium (Cr)	6.25	MG/KG	0.0171	4.53	NA	
008	251	Dieldrin	ND	UG/KG	NA		NA	
008	251	Lead (Pb)	11.4	MG/KG	NA		NA	
008	251	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.3782		20.6359	
008	261	Aldrin	ND	UG/KG	NA		NA	
008	261	Antimony (Sb)	ND	MG/KG	NA		NA	
008	261	Aroclor-1260	ND	UG/KG	NA		NA	
008	261	Arsenic (As)	7.6	MG/KG	0.3474	84.07	19.8512	100.00
008	261	B(a)P Equiv.	ND	UG/KG	NA		NA	
008	261	Chromium (Cr)	24	MG/KG	0.0658	15.93	NA	
008	261	Dieldrin	ND	UG/KG	NA		NA	
008	261	Lead (Pb)	56	MG/KG	NA		NA	
008	261	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.4132		19.8512	
008	271	Aldrin	ND	UG/KG	NA		NA	
008	271	Antimony (Sb)	ND	MG/KG	NA		NA	
008	271	Aroclor-1260	ND	UG/KG	NA		NA	
008	271	Arsenic (As)	4	MG/KG	0.1828	85.84	10.4480	99.79
008	271	B(a)P Equiv.	1.33	UG/KG	NA		0.0220	0.21
008	271	Chromium (Cr)	11	MG/KG	0.0302	14.16	NA	
008	271	Dieldrin	ND	UG/KG	NA		NA	
008	271	Lead (Pb)	15	MG/KG	NA		NA	
008	271	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.2130		10.4700	

008	281	Aldrin	ND	UG/KG	NA		NA	
008	281	Antimony (Sb)	ND	MG/KG	NA		NA	
008	281	Aroclor-1260	ND	UG/KG	NA		NA	
008	281	Arsenic (As)	3.8	MG/KG	0.1737	91.88	9.9256	100.00
008	281	B(a)P Equiv.	ND	UG/KG	NA		NA	
008	281	Chromium (Cr)	5.6	MG/KG	0.0154	8.12	NA	
008	281	Dieldrin	ND	UG/KG	NA		NA	
008	281	Lead (Pb)	9.4	MG/KG	NA		NA	
008	281	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.1890		9.9256	
008	291	Aldrin	ND	UG/KG	NA		NA	
008	291	Antimony (Sb)	ND	MG/KG	NA		NA	
008	291	Aroclor-1260	ND	UG/KG	NA		NA	
008	291	Arsenic (As)	2.1	MG/KG	0.0960	89.51	5.4852	100.00
008	291	B(a)P Equiv.	ND	UG/KG	NA		NA	
008	291	Chromium (Cr)	4.1	MG/KG	0.0112	10.49	NA	
008	291	Dieldrin	ND	UG/KG	NA		NA	
008	291	Lead (Pb)	4.4	MG/KG	NA		NA	
008	291	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.1072		5.4852	
008	301	Aldrin	ND	UG/KG	NA		NA	
008	301	Antimony (Sb)	ND	MG/KG	NA		NA	
008	301	Aroclor-1260	ND	UG/KG	NA		NA	
008	301	Arsenic (As)	3	MG/KG	0.1371	90.91	7.8360	100.00
008	301	B(a)P Equiv.	ND	UG/KG	NA		NA	
008	301	Chromium (Cr)	5	MG/KG	0.0137	9.09	NA	
008	301	Dieldrin	ND	UG/KG	NA		NA	
008	301	Lead (Pb)	8.5	MG/KG	NA		NA	
008	301	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.1508		7.8360	
008	311	Aldrin	ND	UG/KG	NA		NA	
008	311	Antimony (Sb)	ND	MG/KG	NA		NA	
008	311	Aroclor-1260	ND	UG/KG	NA		NA	
008	311	Arsenic (As)	8.85	MG/KG	0.4045	58.88	23.1162	6.35
008	311	B(a)P Equiv.	20588	UG/KG	NA		340.9437	93.65
008	311	Chromium (Cr)	103	MG/KG	0.2825	41.12	NA	
008	311	Dieldrin	ND	UG/KG	NA		NA	
008	311	Lead (Pb)	95.1	MG/KG	NA		NA	
008	311	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.6870		364.0599	

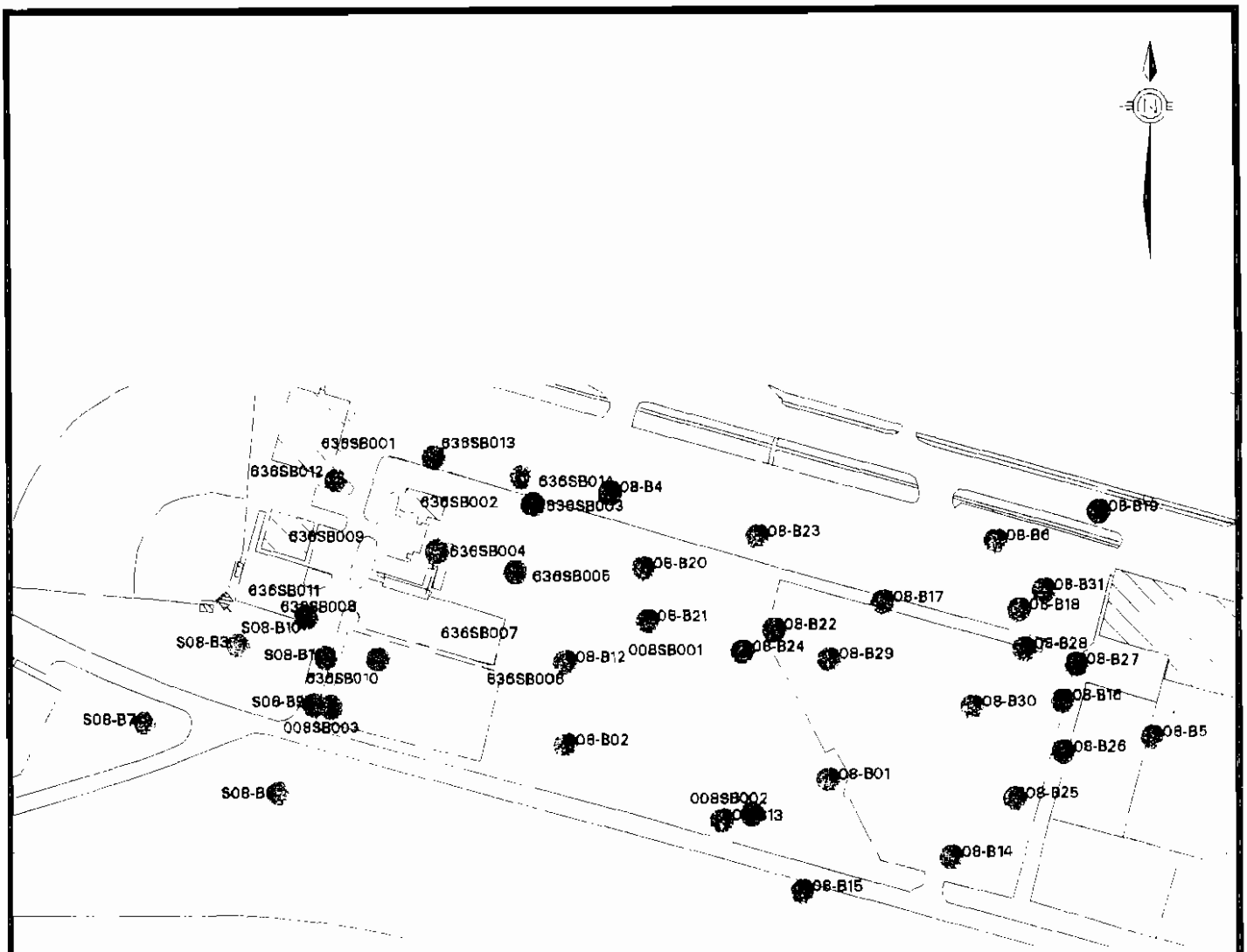
Arsenic was the primary contributor to hazard estimates at the three sample locations at combined SWMU 8 that yielded a hazard index above unity (636SB005, 636SB010, and S08B24). Antimony, chromium, and thallium were secondary contributors. Hazard index estimates ranged from 0.01 (S08B23) to 7 (S08B24), with a mean hazard estimate of 0.5.

Soil — Site Worker Scenario

Industrial soil pathway COCs identified for combined SWMU 8 are arsenic and benzo(a)pyrene equivalents. Figure 10.6-33 illustrates point risk estimates for combined SWMU 8 based on soil exposure pathways under a future worker/industrial scenario. Table 10.6.30 summarizes the risk and hazard contribution of each COPC at each sample location.

Thirty-nine of forty-eight sample locations yielded an ILCR greater than 1E-06. Arsenic was the primary contributor to ILCR projections at most surface soil sample locations and benzo(a)pyrene equivalents were secondary contributors. However, benzo(a)pyrene equivalents were the primary contributors to risk at 5 sample locations (S08B11, S08B12, S08B17, S08B18, and S08B31), where arsenic was a secondary contributor. Risk estimates ranged from 4E-07 (636SB014) to 3E-04 (S08B11), with a mean risk estimate of 1E-05. Neither of these COCs were detected in S08B23.

Arsenic was the sole contributor to hazard estimates for the industrial pathway at combined SWMU 8; however, hazard indices did not exceed unity at any location for the industrial scenario. Hazard index estimates ranged from 0.003 (636SB014) to 0.3 (S08B24), with a mean hazard estimate of 0.02. Arsenic was not detected in S08B23.



LEGEND

- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

0 feet 250

ZONE G - RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE, CHARLESTON
CHARLESTON, S.C.

FIGURE 10.6-33
POINT RISK ESTIMATES FOR SURFACE SOIL
INDUSTRIAL SCENARIO
SWMU 8, AOC 636

Table 10.6.30
Point Estimates of Risk and Hazard - Surface Soil Pathways
Industrial Scenario
SWMU 8 and AOC 636
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
008	001	Arsenic (As)	12.7	MG/KG	0.0292	100.00	4.6927	100.00
008	001	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			0.0292		4.6927	
008	002	Arsenic (As)	1.5	MG/KG	0.0034	100.00	0.5543	100.00
008	002	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			0.0034		0.5543	
008	003	Arsenic (As)	6.7	MG/KG	0.0154	100.00	2.4757	43.83
008	003	B(a)P Equiv.	942.4	UG/KG	NA		3.1732	56.17
		Total			0.0154		5.6489	
636	001	Arsenic (As)	7.1	MG/KG	0.0163	100.00	2.6235	72.42
636	001	B(a)P Equiv.	296.78	UG/KG	NA		0.9993	27.58
		Total			0.0163		3.6228	
636	002	Arsenic (As)	7.05	MG/KG	0.0162	100.00	2.6050	70.24
636	002	B(a)P Equiv.	327.76	UG/KG	NA		1.1036	29.76
		Total			0.0162		3.7086	
636	003	Arsenic (As)	11.4	MG/KG	0.0262	100.00	4.2124	71.08
636	003	B(a)P Equiv.	509.06	UG/KG	NA		1.7141	28.92
		Total			0.0262		5.9265	
636	004	Arsenic (As)	2.7	MG/KG	0.0062	100.00	0.9977	100.00
636	004	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			0.0062		0.9977	
636	005	Arsenic (As)	22.8	MG/KG	0.0524	100.00	8.4248	99.68
636	005	B(a)P Equiv.	8.152	UG/KG	NA		0.0274	0.32
		Total			0.0524		8.4522	
636	006	Arsenic (As)	2.3	MG/KG	0.0053	100.00	0.8499	77.84
636	006	B(a)P Equiv.	71.842	UG/KG	NA		0.2419	22.16
		Total			0.0053		1.0918	
636	007	Arsenic (As)	5.1	MG/KG	0.0117	100.00	1.8845	81.43
636	007	B(a)P Equiv.	127.62	UG/KG	NA		0.4297	18.57
		Total			0.0117		2.3142	
636	008	Arsenic (As)	6.7	MG/KG	0.0154	100.00	2.4757	72.87
636	008	B(a)P Equiv.	273.79	UG/KG	NA		0.9219	27.13
		Total			0.0154		3.3976	
636	009	Arsenic (As)	5.5	MG/KG	0.0126	100.00	2.0323	92.80
636	009	B(a)P Equiv.	46.838	UG/KG	NA		0.1577	7.20
		Total			0.0126		2.1900	
636	010	Arsenic (As)	22.4	MG/KG	0.0515	100.00	8.2770	100.00
636	010	B(a)P Equiv.	0.045	UG/KG	NA		0.0002	
		Total			0.0515		8.2771	
636	011	Arsenic (As)	4.7	MG/KG	0.0108	100.00	1.7367	74.06
636	011	B(a)P Equiv.	180.7	UG/KG	NA		0.6084	25.94

		Total			0.0108		2.3451	
636	012	Arsenic (As)	2.1	MG/KG	0.0048	100.00	0.7760	100.00
636	012	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			0.0048		0.7760	
636	013	Arsenic (As)	17.2	MG/KG	0.0395	100.00	6.3555	100.00
636	013	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			0.0395		6.3555	
636	014	Arsenic (As)	1.2	MG/KG	0.0028	100.00	0.4434	100.00
636	014	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			0.0028		0.4434	
008	011	Arsenic (As)	10	MG/KG	0.0230	100.00	3.6951	70.92
008	011	B(a)P Equiv.	450	UG/KG	NA		1.5152	29.08
		Total			0.0230		5.2103	
008	021	Arsenic (As)	20	MG/KG	0.0460	100.00	7.3901	99.88
008	021	B(a)P Equiv.	2.7	UG/KG	NA		0.0091	0.12
		Total			0.0460		7.3992	
008	031	Arsenic (As)	2.95	MG/KG	0.0068	100.00	1.0900	98.33
008	031	B(a)P Equiv.	5.5055	UG/KG	NA		0.0185	1.67
		Total			0.0068		1.1086	
008	041	Arsenic (As)	5.6	MG/KG	0.0129	100.00	2.0692	92.42
008	041	B(a)P Equiv.	50.4	UG/KG	NA		0.1697	7.58
		Total			0.0129		2.2389	
008	051	Arsenic (As)	1.6	MG/KG	0.0037	100.00	0.5912	79.71
008	051	B(a)P Equiv.	44.7	UG/KG	NA		0.1505	20.29
		Total			0.0037		0.7417	
008	061	Arsenic (As)	5	MG/KG	0.0115	100.00	1.8475	100.00
008	061	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			0.0115		1.8475	
008	071	Arsenic (As)	1.9	MG/KG	0.0044	100.00	0.7021	100.00
008	071	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			0.0044		0.7021	
008	081	Arsenic (As)	6.9	MG/KG	0.0159	100.00	2.5496	100.00
008	081	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			0.0159		2.5496	
008	091	Arsenic (As)	5.9	MG/KG	0.0136	100.00	2.1801	82.94
008	091	B(a)P Equiv.	133.2	UG/KG	NA		0.4485	17.06
		Total			0.0136		2.6286	
008	101	Arsenic (As)	3.1	MG/KG	0.0071	100.00	1.1455	100.00
008	101	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			0.0071		1.1455	
008	111	Arsenic (As)	9.3	MG/KG	0.0214	100.00	3.4364	1.18
008	111	B(a)P Equiv.	85442.5	UG/KG	NA		287.6968	98.82
		Total			0.0214		291.1332	
008	121	Arsenic (As)	2.2	MG/KG	0.0051	100.00	0.8129	22.61
008	121	B(a)P Equiv.	826.2	UG/KG	NA		2.7819	77.39
		Total			0.0051		3.5948	
008	131	Arsenic (As)	8.6	MG/KG	0.0198	100.00	3.1778	100.00

008	131	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			0.0198		3.1778	
008	141	Arsenic (As)	6.2	MG/KG	0.0143	100.00	2.2909	84.92
008	141	B(a)P Equiv.	120.86	UG/KG	NA		0.4070	15.08
		Total			0.0143		2.6979	
008	151	Arsenic (As)	2.2	MG/KG	0.0051	100.00	0.8129	56.96
008	151	B(a)P Equiv.	182.42	UG/KG	NA		0.6142	43.04
		Total			0.0051		1.4271	
008	161	Arsenic (As)	3.5	MG/KG	0.0080	100.00	1.2933	83.05
008	161	B(a)P Equiv.	78.38	UG/KG	NA		0.2639	16.95
		Total			0.0080		1.5572	
008	171	Arsenic (As)	7.05	MG/KG	0.0162	100.00	2.6050	25.09
008	171	B(a)P Equiv.	2309.9	UG/KG	NA		7.7778	74.91
		Total			0.0162		10.3828	
008	181	Arsenic (As)	3.8	MG/KG	0.0087	100.00	1.4041	4.20
008	181	B(a)P Equiv.	9515.6	UG/KG	NA		32.0404	95.80
		Total			0.0087		33.4445	
008	191	Arsenic (As)	5.9	MG/KG	0.0136	100.00	2.1801	90.39
008	191	B(a)P Equiv.	68.864	UG/KG	NA		0.2319	9.61
		Total			0.0136		2.4120	
008	201	Arsenic (As)	8.4	MG/KG	0.0193	100.00	3.1039	100.00
008	201	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			0.0193		3.1039	
008	211	Arsenic (As)	3.6	MG/KG	0.0083	100.00	1.3302	100.00
008	211	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			0.0083		1.3302	
008	221	Arsenic (As)	2.6	MG/KG	0.0060	100.00	0.9607	100.00
008	221	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			0.0060		0.9607	
008	231	Arsenic (As)	ND	MG/KG	NA		NA	
008	231	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			NA		NA	
008	241	Arsenic (As)	150	MG/KG	0.3449	100.00	55.4261	100.00
008	241	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			0.3449		55.4261	
008	251	Arsenic (As)	7.9	MG/KG	0.0182	100.00	2.9191	99.99
008	251	B(a)P Equiv.	0.068	UG/KG	NA		0.0002	0.01
		Total			0.0182		2.9193	
008	261	Arsenic (As)	7.6	MG/KG	0.0175	100.00	2.8083	100.00
008	261	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			0.0175		2.8083	
008	271	Arsenic (As)	4	MG/KG	0.0092	100.00	1.4780	99.70
008	271	B(a)P Equiv.	1.33	UG/KG	NA		0.0045	0.30
		Total			0.0092		1.4825	
008	281	Arsenic (As)	3.8	MG/KG	0.0087	100.00	1.4041	100.00
008	281	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			0.0087		1.4041	

008	291	Arsenic (As)	2.1	MG/KG	0.0048	100.00	0.7760	100.00
008	291	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			0.0048		0.7760	
008	301	Arsenic (As)	3	MG/KG	0.0069	100.00	1.1085	100.00
008	301	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			0.0069		1.1085	
008	311	Arsenic (As)	8.85	MG/KG	0.0203	100.00	3.2701	4.50
008	311	B(a)P Equiv.	20588	UG/KG	NA		69.3227	95.50
		Total			0.0203		72.5928	

Groundwater — Residential Scenario

Antimony, barium, bis(2-ethylhexyl)phthalate, thallium, and vanadium were identified as groundwater pathway COCs. As shown in Table 10.6.31 and Figure 10.6-34, bis(2-ethylhexyl)phthalate was the sole contributor to risk projections for the groundwater pathway at combined SWMU 8 groundwater. Bis(2-Ethylhexyl)phthalate was only detected at one location (008004) at a concentration of 46 μg/L, producing a risk estimate of 1E-05.

Three monitoring well locations yielded hazard indices greater than unity (008002, 008003, and 008004). Thallium was the primary contributor to hazard estimates at 008002 and 008004, and antimony was the primary contributor at 008003. Point hazard estimates for groundwater residential pathway are presented on Figure 10.6-35.

Secondary contributors consisted of barium and vanadium. Hazard estimates ranged from 0.4 (008006) to 5 (008002), with a mean hazard index of 2.

10.6.6.8 Remedial Goal Options

Soil

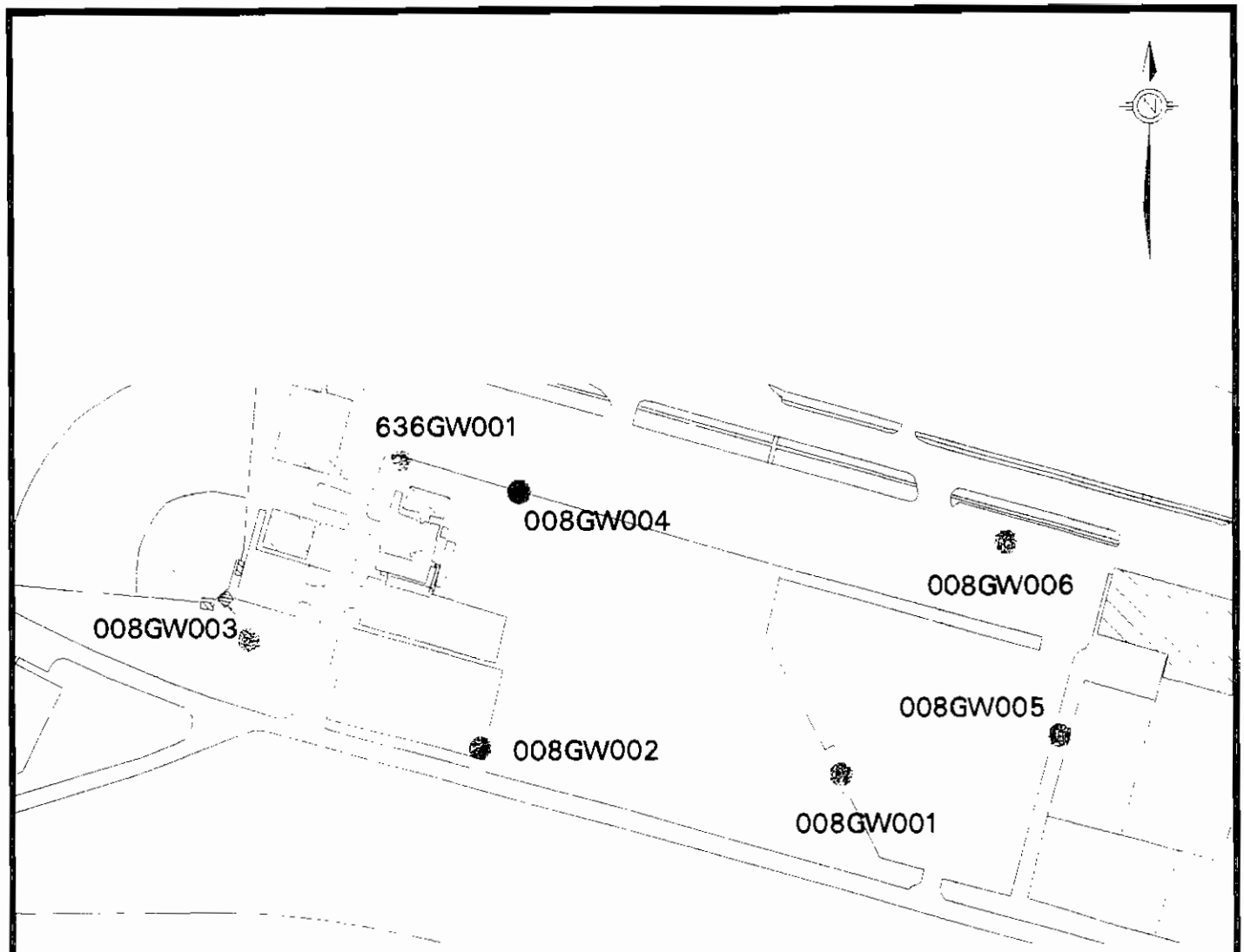
RGOs for carcinogens were based on the site resident lifetime weighted average as presented in Table 10.6.32 for surface soils. Hazard-based RGOs were calculated based on the hypothetical child resident, as noted in the table.

Groundwater

Groundwater RGOs based on the site resident scenario are shown in Table 10.6.33.

Table 10.6.31
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
SWMU 8 and AOC 636
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
008	001	Antimony (Sb)	ND	UG/L	NA		NA	
008	001	Barium (Ba)	40.6	UG/L	0.0371	37.38	NA	
008	001	Thallium (Tl)	ND	UG/L	NA		NA	
008	001	Vanadium (V)	6.8	UG/L	0.0621	62.62	NA	
008	001	bis(2-Ethylhexyl)phthalate	ND	UG/L	NA		NA	
		Total			0.0992		NA	
008	002	Antimony (Sb)	ND	UG/L	NA		NA	
008	002	Barium (Ba)	1520	UG/L	1.3881	30.74	NA	
008	002	Thallium (Tl)	3.9	UG/L	3.1164	69.00	NA	
008	002	Vanadium (V)	1.3	UG/L	0.0119	0.26	NA	
008	002	bis(2-Ethylhexyl)phthalate	ND	UG/L	NA		NA	
		Total			4.5164		NA	
008	003	Antimony (Sb)	22.6	UG/L	3.6119	87.65	NA	
008	003	Barium (Ba)	67.5	UG/L	0.0616	1.50	NA	
008	003	Thallium (Tl)	ND	UG/L	NA		NA	
008	003	Vanadium (V)	49	UG/L	0.4475	10.86	NA	
008	003	bis(2-Ethylhexyl)phthalate	ND	UG/L	NA		NA	
		Total			4.1210		NA	
008	004	Antimony (Sb)	ND	UG/L	NA		NA	
008	004	Barium (Ba)	74.5	UG/L	0.0680	1.75	NA	
008	004	Thallium (Tl)	4.6	UG/L	3.6758	94.47	NA	
008	004	Vanadium (V)	ND	UG/L	NA		NA	
008	004	bis(2-Ethylhexyl)phthalate	46	UG/L	0.1470	3.78	9.5781	100.00
		Total			3.8909		9.5781	
008	005	Antimony (Sb)	ND	UG/L	NA		NA	
008	005	Barium (Ba)	23.5	UG/L	0.0215	48.45	NA	
008	005	Thallium (Tl)	ND	UG/L	NA		NA	
008	005	Vanadium (V)	2.5	UG/L	0.0228	51.55	NA	
008	005	bis(2-Ethylhexyl)phthalate	ND	UG/L	NA		NA	
		Total			0.0443		NA	
008	006	Antimony (Sb)	ND	UG/L	NA		NA	
008	006	Barium (Ba)	11.9	UG/L	0.0109	29.10	NA	
008	006	Thallium (Tl)	ND	UG/L	NA		NA	
008	006	Vanadium (V)	2.9	UG/L	0.0265	70.90	NA	
008	006	bis(2-Ethylhexyl)phthalate	ND	UG/L	NA		NA	
		Total			0.0374		NA	
636	001	Antimony (Sb)	ND	UG/L	NA		NA	
636	001	Barium (Ba)	56.7	UG/L	0.0518	66.16	NA	
636	001	Thallium (Tl)	ND	UG/L	NA		NA	
636	001	Vanadium (V)	2.9	UG/L	0.0265	33.84	NA	
636	001	bis(2-Ethylhexyl)phthalate	ND	UG/L	NA		NA	
		Total			0.0783		NA	



LEGEND

- < 1E-6
- 1E-6 to 5E-6
- 5E-6 to 1E-5
- 1E-5 to 1E-4
- > 1E-4

0 feet 400

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INVESTIGATION REPORT
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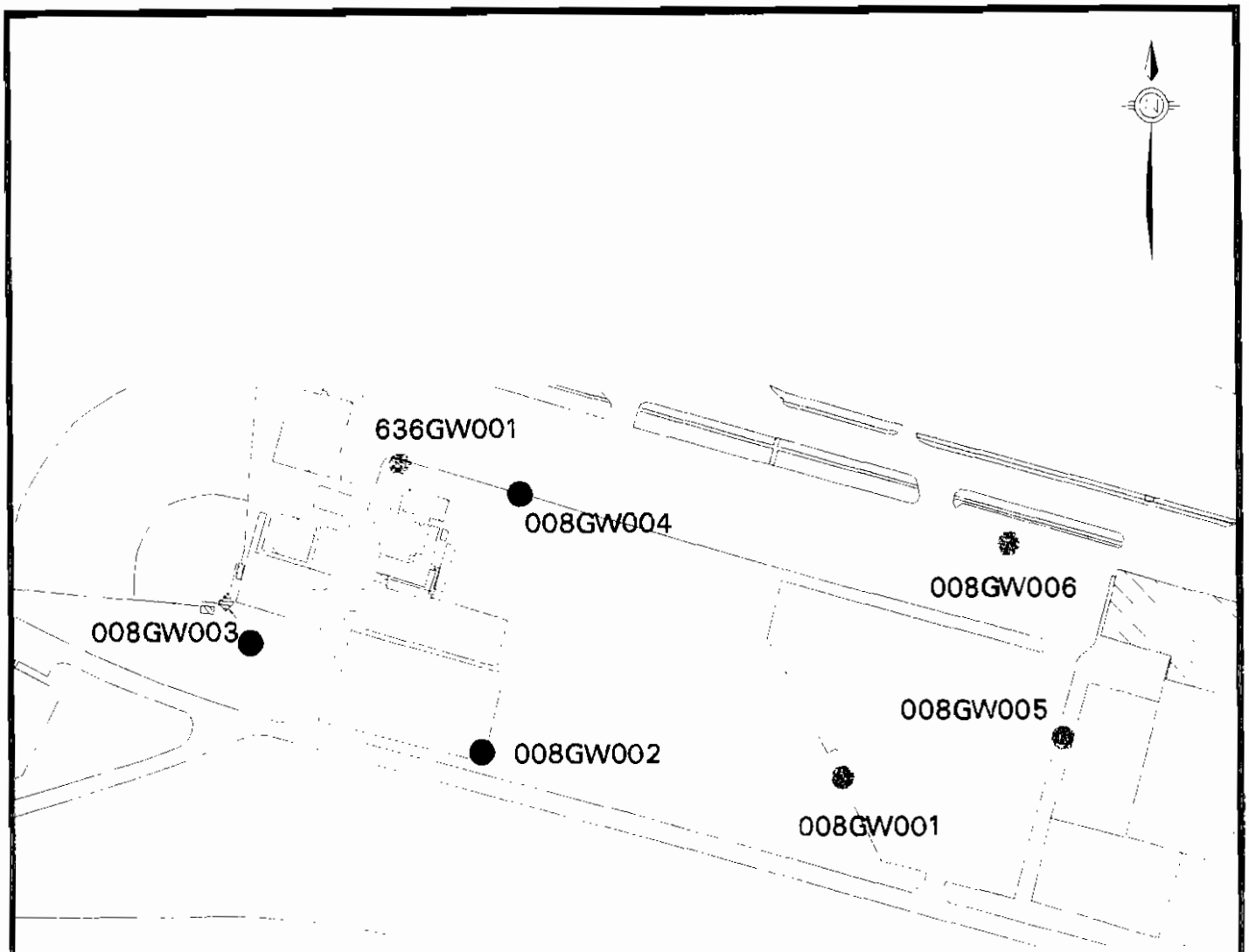
CHARLESTON, S.C.

FIGURE 10.6-34
POINT RISK ESTIMATES FOR GROUNDWATER
RESIDENTIAL SCENARIO
SWMU 8, AOC 636

AML: /home3/projects/charleston_dir/zone_g_dir/risk_dir



LEGEND

- 0 to 0.1
- 0.1 to 0.5
- 0.5 to 1.0
- 1.0 to 3.0
- > 3.0

0 feet 400

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FIGURE 10.6-35
POINT HAZARD ESTIMATES FOR GROUNDWATER
RESIDENTIAL SCENARIO
SWMU 8, AOC 636

AML: /home3/projects/charleston_div/zone_g_div/swmu_8/

Table 10.6.32
Remedial Goal Options Surface Soil
SWMU 8 and AOC 636
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Residential-Based Remedial Goal Options

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	EPC mg/kg	Hazard-Based Remedial Goal Options 3 mg/kg	1 mg/kg	0.1 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Inorganics										
Antimony (Sb)	NA	0.0004	4.9	88	29	2.9	ND	ND	ND	2.98
Arsenic (As)	1.5	0.0003	10.8	66	22	2.2	0.38	3.8	38	17.2
Chromium (Cr)	NA	0.005	67.7	798	266	27	ND	ND	ND	325
Lead (Pb)	NA	NA	129	ND	ND	ND	ND	ND	ND	181
Thallium (Tl)	NA	8E-05	1.67	18	5.8	0.58	ND	ND	ND	0 85
Carcinogenic PAHs										
Benzo(a)pyrene equivalents	7.3	NA	1 86	ND	ND	ND	0.060	0.60	6 0	NA
PCBs										
Aroclor 1260	2	NA	0.53	ND	ND	ND	0.22	2.2	22	NA
Miscellaneous										
Hydrazine	3	NA	0.15	ND	ND	ND	0.15	1.5	15	NA

Worker-Based Remedial Goal Options

Chemical	Slope Factor *(mg/kg-day)-1*	Reference Dose *(mg/kg-day)*	EPC *mg/kg*	Hazard-Based Remedial Goal Options 3 *mg/kg*	1 *mg/kg*	0.1 *mg/kg*	Risk-Based Remedial Goal Options 1E-06 *mg/kg*	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Inorganics										
Antimony (Sb)	NA	0.0004	4 9	1740	580	58	ND	ND	ND	2 89
Arsenic (As)	1.5	0.0003	10 8	1305	435	43	2.7	27	270	17.2
Chromium (Cr)	NA	0.005	67 7	7545	2515	252	ND	ND	ND	325
Lead (Pb)	NA	NA	129	ND	ND	ND	ND	ND	ND	181
Thallium (Tl)	NA	8E-05	1.67	348	116	12	ND	ND	ND	0 85
Carcinogenic PAHs										
Benzo(a)pyrene equivalents	7.3	NA	1.86	ND	ND	ND	0.3	3	30	NA
PCBs										
Aroclor 1260	2	NA	0.53	ND	ND	ND	1.1	11	108	NA
Miscellaneous										
Hydrazine	3	NA	0.15	ND	ND	ND	0 7	7	72	NA

NOTES:

EPC Exposure point concentration

NA Not applicable

ND Not determined

- Remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident or site worker for noncarcinogens

Table 10.6.33
Remedial Goal Options Groundwater
SWMU 8 and AOC 636
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Residential-Based Remedial Goal Options

Chemical	Oral SF (mg/kg-day)-1	Oral RfD (mg/kg-day)	EPC mg/l	Hazard-Based Remedial Goal Options 0.1 mg/l	1.0 mg/l	3 mg/l	Risk-Based Remedial Goal Options 1E-06 mg/l	1E-05 mg/l	1E-04 mg/l	Background Concentration mg/l	MCL mg/l
Inorganics											
Antimony (Sb)	NA	0.0004	0.0226	0.00063	0 0063	0.019	ND	ND	ND	0.00485	0.006
Barium (Ba)	NA	0.07	1 52	0.11	1.1	3.3	ND	ND	ND	0.031	2
Thallium (Tl)	NA	8E-05	0.0046	0.00013	0.0013	0.0038	ND	ND	ND	NA	0.002
Vanadium (V)	NA	0.007	0.049	0.011	0.11	0.33	ND	ND	ND	0.0154	NA
Semivolatile Organics											
bis(2-Ethylhexyl)phthalate	0.014	0.02	0.046	0.031	0 31	0.94	0.0047	0.047	0.47	NA	0.006

Worker-Based Remedial Goal Options

Chemical	Oral SF (mg/kg-day)-1	Oral RfD (mg/kg-day)	EPC mg/l	Hazard-Based Remedial Goal Options 0.1 mg/l	1.0 mg/l	3 mg/l	Risk-Based Remedial Goal Options 1E-06 mg/l	1E-05 mg/l	1E-04 mg/l	Background Concentration mg/l	MCL mg/l
Inorganics											
Antimony (Sb)	NA	0.0004	0.0226	0.0041	0.041	0.12	ND	ND	ND	0.00485	0 006
Barium (Ba)	NA	0.07	1.52	0.72	7.2	21	ND	ND	ND	0.031	2
Thallium (Tl)	NA	8E-05	0.0046	0.00082	0.0082	0.025	ND	ND	ND	NA	0.002
Vanadium (V)	NA	0.007	0 049	0.072	0.72	2.1	ND	ND	ND	0.0154	NA
Semivolatile Organics											
bis(2-Ethylhexyl)phthalate	0.014	0 02	0.046	0.20	2 0	6.1	0.020	0.20	2.0	NA	0 006

NOTES:
- EPC Exposure point concentration
- NA Not applicable
- ND Not determined
- \- Remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident or site worker for noncarcinogens

10.6.7 Corrective Measures Considerations

Based on the analytical results and the human health risk assessment for SMWU 8 and AOC 636, COCs requiring further evaluation through the CMS process have been identified for surface soil and groundwater. The site is currently in an open area and risk to human health was evaluated under both the residential and industrial (site worker) scenarios for incidental ingestion, dermal contact, and inhalation exposure pathways. Hazard was evaluated for noncarcinogenic contaminants through incidental ingestion, dermal contact, and inhalation scenarios as well.

As recommended by SCDHEC, a COC is considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, and whose individual risk exceeds 1E-06 or whose hazard quotient exceeds 0.1.

Antimony, Aroclor-1260, arsenic, BEQs, chromium, hydrazine, and thallium were identified as soil pathway COCs for the combined area of SMWU 8 and AOC 636. Antimony, barium, thallium, vanadium, and bis(2-ethylhexyl)phthalate were identified as groundwater pathway COCs for the combined area of SMWU 8 and AOC 636. Table 10.6.34 presents cumulative and COC-specific exposure risks and hazard quotients.

Table 10.6.34
Cumulative and Chemical-Specific Exposure Risks and Hazard

	Risk		Hazard	
Chemical	**Industrial**	**Residential**	**Industrial**	**Residential**
Soil				
Antimony	ND	ND	0.008	0.17
Aroclor-1260	4.9E-07	2.5E-06	ND	ND
Arsenic	4.0E-06	2.8E-05	0.025	0.49
BEQs	6.3E-06	3.1E-05	ND	ND

Table 10.6.34
Cumulative and Chemical-Specific Exposure Risks and Hazard

	Risk		Hazard	
Chemical	**Industrial**	**Residential**	**Industrial**	**Residential**
Chromium	ND	ND	0.027	0.25
Hydrazine	2.1E-07	1.0E-06	ND	ND
Thallium	ND	ND	0.014	0.29
Cumulative	1.1E-05	6.2E-05	0.075	1.21
Groundwater				
Antimony	ND	ND	0.55	3.6
Barium	ND	ND	0.21	1.4
Thallium	ND	ND	0.56	3.7
Vanadium	ND	ND	0.068	0.45
bis(2-ethylhexyl)phthalate	2.3E-06	9.7E-06	0.023	0.15
Cumulative	2.3E-06	9.7E-06	1.41	9.3

Notes:
ND = Not Determined

Risk-based remedial goals for the COCs at combined area SMWU 8 and AOC 636 for soil and groundwater are presented in Tables 10.6.32 and 10.6.33, respectively. Potential corrective measures are presented below.

Table 10.6.35
Potential Corrective Measures for SMWU 8 and AOC 636

Medium	Compounds	Potential Corrective Measures
Soil	Antimony, Aroclor-1260, Arsenic, BEQs, Chromium, Hydrazine, and Thallium	a) No Action b) Excavate, offsite disposal, and monitoring c) Containment/Capping d) Ex-situ, chemical/physical treatment

Table 10.6.35
Potential Corrective Measures for SMWU 8 and AOC 636

Medium	Compounds	Potential Corrective Measures
Groundwater	Antimony, Barium, Thallium, Vanadium, and bis(2-ethylhexyl)phthalate	a) No Action b) Monitoring c) Ex-situ physical/chemical treatment and discharge to POTW d) Ex-situ physical/chemical treatment and discharge through NPDES permitting

10.7 AOC 637, Dump Area, Building 161 Area

A CSI site, AOC 637 was grouped for investigation with SWMU 8 and AOC 636 in the approved final RFI work plan. However, because subsurface conditions are different at this site it was investigated separately. The site is a former burning dump located between Dyess Avenue and Bainbridge Avenue directly south of SWMU 8 and AOC 636. The area was used from the late 1940s to the early 1950s. Although no spills or releases were documented at this site, the burning and burial of wastes supports the possibility that contamination exists at the site. No visible evidence of the past disposal remains, as the area has since been filled with dredged spoil, and now the area is a gravel covered parking area.

10.7.1 Site Geology and Hydrogeology

The soil boring and groundwater monitoring well locations associated with the AOC 637 CSI are shown in Figure 10.7-1. Appendix A contains the boring logs and the monitoring well construction diagrams for the wells installed at AOC 637.

Based on the three monitoring well borings advanced at AOC 637 the stratigraphy consists of fill material including gravel, sand, silt, wood, plastic, metal, and other debris overlying organic silty clay. The silty clay unit was encountered near total depth of the borings, and occurred below a depth of 10 ft bgs. A sample of the fill materials exhibited a grain size distribution of 76% sand, 9% silt, and 15% clay. Site monitoring wells were completed to depths of approximately 12 to 13 ft bgs.

The groundwater elevation at AOC 637 is approximately 4.0 ft msl. Figures 10.7-2 and 10.7-3 depict the shallow groundwater potentiometric surface and inferred flow direction at low- and high-tide respectively. Subtle differences in the static water levels and the overall flow pattern at AOC 637 were observed between high and low-tide. The horizontal hydraulic conductivity of the fill materials, calculated from slug testing, was 0.37 ft/day, in well 637001. The approximate

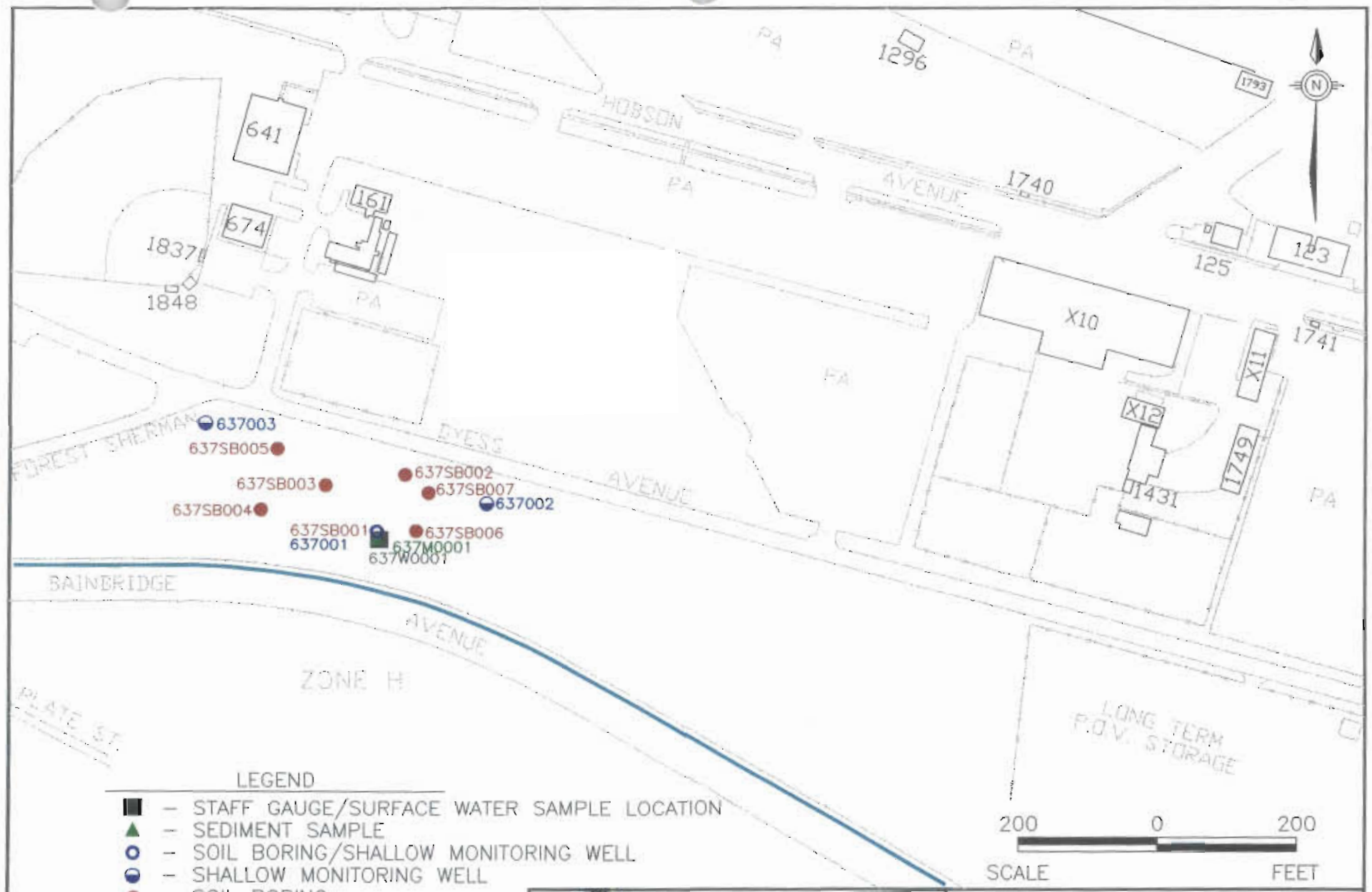

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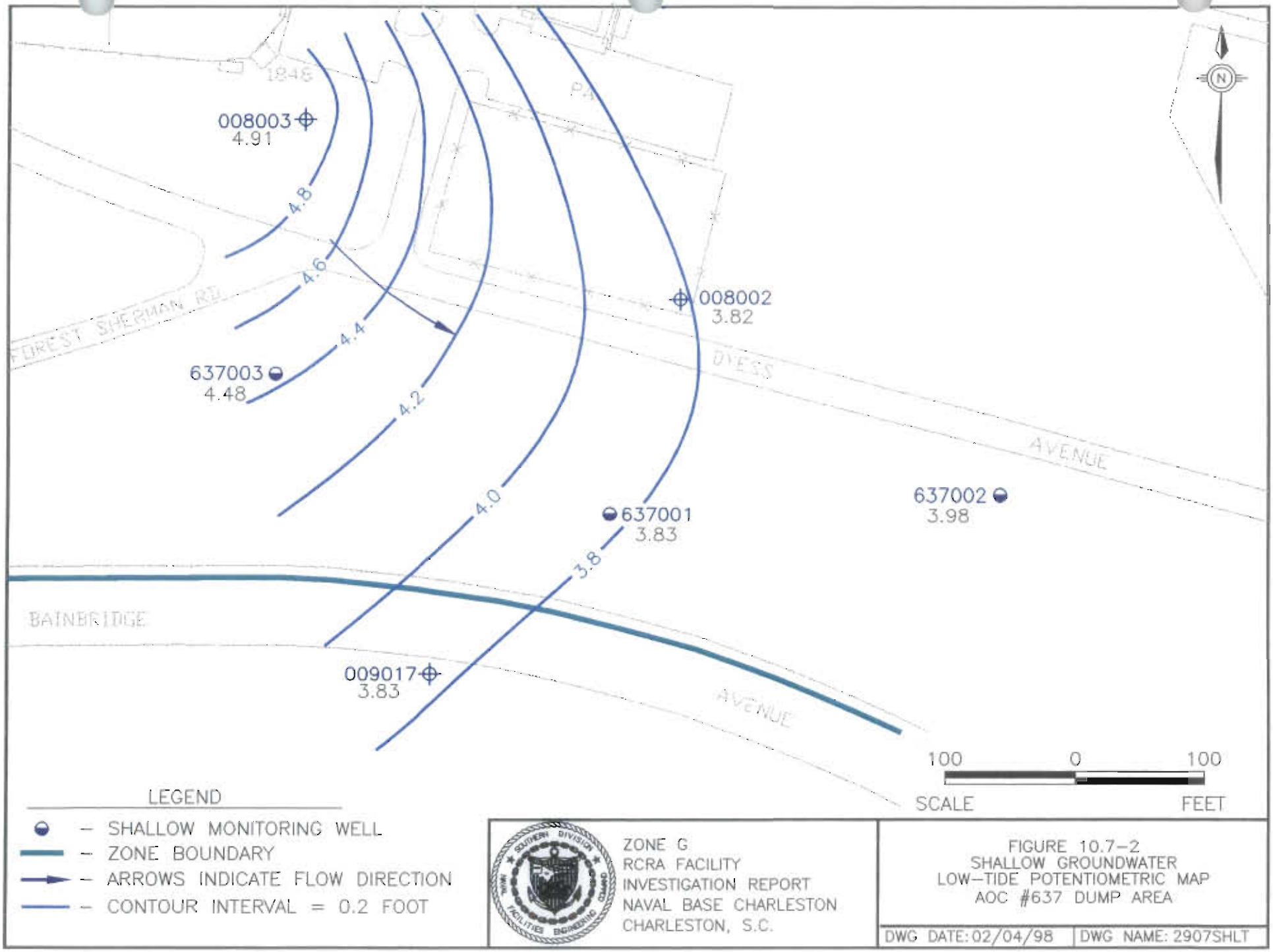
FIGURE 10.7–1
SAMPLING LOCATIONS
AOC #637 DUMP AREA

DWG DATE: 02/04/98 | DWG NAME: 29CHZG38


008003
4.91
008002
3.82
637003
4.48
637001
3.83
637002
3.98
009017
3.83
4.8
4.6
4.4
4.2
4.0
3.8
FOREST SHERMAN RD.
DYESS
AVENUE
BAINBRIDGE
AVENUE
100 0 100
SCALE FEET
LEGEND
– SHALLOW MONITORING WELL
– ZONE BOUNDARY
– ARROWS INDICATE FLOW DIRECTION
– CONTOUR INTERVAL = 0.2 FOOT
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CHARLESTON, S.C.
FIGURE 10.7-2
SHALLOW GROUNDWATER
LOW-TIDE POTENTIOMETRIC MAP
AOC #637 DUMP AREA
DWG DATE: 02/04/98
DWG NAME: 2907SHLT

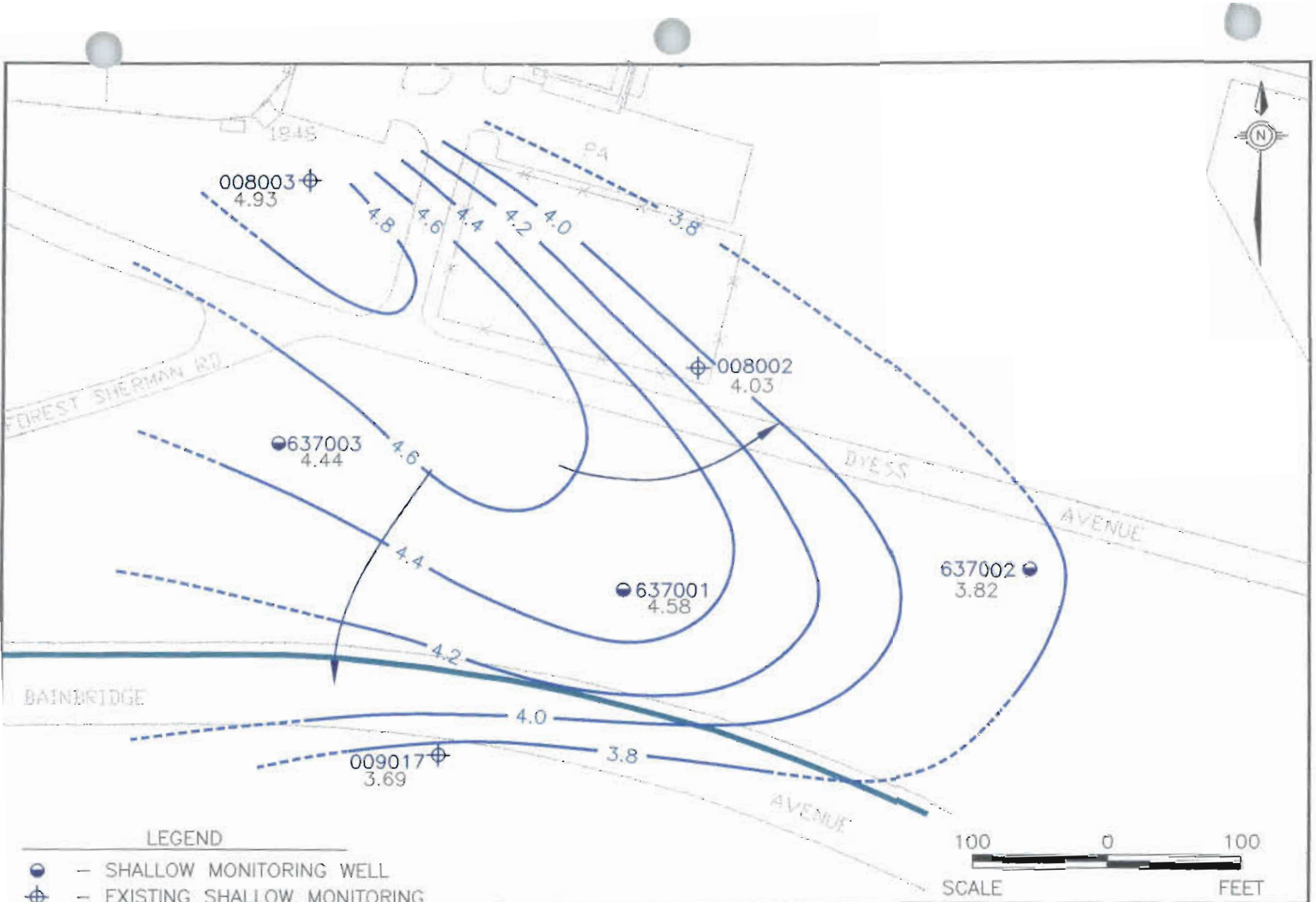

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FIGURE 10.7-3
SHALLOW GROUNDWATER
HIGH-TIDE POTENTIOMETRIC MAP
AOC #637 DUMP AREA

DWG DATE: 02/04/98 | DWG NAME: 2907SHHT

horizontal hydraulic gradient, based on Figure 10.7-2 is 2.6E-03 and slopes generally to the southeast. The horizontal flow velocity based on this gradient was 2.3E-03 ft/day.

10.7.2 Field Investigation Approach

The objective of the field investigation at AOC 637 was to: (1) confirm the presence or absence of contamination in the site area; (2) delineate any contamination found; and (3) provide sufficient data to support a detailed evaluation of treatment alternatives, if required. Media sampled within the investigation area included soil, sediment, groundwater, and surface water. Section 3 of this report details the methods used during the field investigation. Included in this section are descriptions of the hand-auger procedures used for soil sampling; sediment and surface water sampling procedures; groundwater sampling procedures; and miscellaneous procedures used during the field investigation. Also discussed are the analytical protocols for sample analyses. Appendix D contains the analytical data report for samples collected in Zone G.

10.7.3 Soil Sampling and Analysis

The approved final RFI work plan proposed advancing five soil borings within the AOC 637 area to detect the presence of any soil contamination from this site. Upper and lower interval soil samples were proposed from each boring. Seven soil borings were advanced during the field investigation, in two phases (Figure 10.7-1). Five borings were advanced during the first phase of the field investigation, as proposed in the approved final RFI work plan. One first-round boring included both upper and lower sampling intervals, while four borings included the upper interval only. First-round soil samples were analyzed for metals, cyanide, pesticides/PCBs, SVOCs, VOCs and explosives/propellants at DQO Level III. Later, two second-round borings were advanced at AOC 637 to delineate metals and SVOC contamination identified in the eastern part of the site during the first sampling round. One second-round boring included both upper and lower sampling intervals, while one boring included the upper interval only. Second-round samples were analyzed for metals, pesticides/PCBs, and SVOCs at DQO Level III. Additionally,

two upper interval duplicate soil samples were collected (one from each sampling round) at AOC 637 for Appendix IX analyses at DQO Level IV. Table 10.7.1 summarizes the AOC 637 soil samples and analyses.

Table 10.7.1
Zone G
AOC 637
Soil Samples and Analyses

Boring Location	Sample Identifier	Sample Interval	Date Collected	Analyses	Remarks
637SB001	637SB00101	Upper	9/13/96	Note 1	Lower interval not sampled due to water table
637SB002	637SB00201	Upper	9/13/96	Note 1	Lower interval not sampled due to water table
637SB003	637SB00301 637SB00302	Upper Lower	9/13/96	Note 1	
637SB004	637SB00401	Upper	9/13/96	Note 1	Lower interval not sampled due to water table
637SB005	637SB00501 637CB00501*	Upper	9/13/96	Note 1 Note 3 and explosives/ hydrazine	* Duplicate sample
637SB006	637SB00601 637SB00602	Upper Lower	1/07/97	Note 2	Second-round sample
637SB007	637SB00701 637CB00701*	Upper	1/07/97	Note 2 Note 3	Second-round sample *Duplicate sample

Notes:
1 = SW-846 (metals, pesticides/PCBs, SVOCs, VOCs), cyanide, explosives/propellants, hydrazine at DQO Level III
2 = SW-846 (metals, pesticides/PCBs, SVOCs) at DQO Level III
3 = Appendix IX suite: Appendix IX (pesticides/PCBs, herbicides, SVOCs, VOCs); SW-846 (metals, dioxins, OP-pesticides); cyanide; hex-chrome at DQO Level IV
* = Duplicate sample

10.7.3.1 Nature of Contamination in Soil

Organic compound analytical results for soil are summarized in Table 10.7.2. Inorganic analytical results for soil are summarized in Table 10.7.3. Table 10.7.4 summaries all analytes detected in soil at AOC 637. Appendix D contains a complete analytical data report for all Zone G samples.

Table 10.7.2
Zone G
AOC 637
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (µg/kg)	Mean of Detections (µg/kg)	Reference Conc.* (µg/kg)	Number of Samples Exceeding Reference
Volatile Organic Compounds (Upper Interval - 6 Samples plus 2 Duplicate Samples/Lower Interval - 1 Samples) (µg/kg)						
2-Butanone (MEK)	Upper	0/6	ND	ND	4700000	0
	Lower	1/1	81.0	81.0	7900	0
Carbon disulfide	Upper	1/6	1.00	1.00	780000	0
	Lower	1/1	4.00	4.00	32000	0
Semivolatile Organic Compounds (Upper Interval - 7 Samples plus 2 Duplicate Samples/Lower Interval - 2 Samples) (µg/kg)						
BEQs[1]	Upper	6/7	15.59 - 1507.2	654	88	4
	Lower	0/0	NA	NA	NA	NA
Benzo(a)anthracene	Upper	5/7	56.0 - 1000	553	880	1
	Lower	1/2	110	110	2000	0
Benzo(b)fluoranthene	Upper	5/7	54.0- 1400	477	880	1
	Lower	1/2	140	140	5000	0
Benzo(k)fluoranthene	Upper	5/7	40.0 - 720	367	8800	0
	Lower	1/2	120	120	49000	0
Benzo(a)pyrene	Upper	5/7	56.0 - 890	517	88	4
	Lower	1/2	140	140	8000	0
Chrysene	Upper	6/7	51.0 - 1200	562	88000	0
	Lower	1/2	160	160	160000	0
Dibenz(a,h)anthracene	Upper	3/7	160 - 320	217	88	3
	Lower	1/2	47.0	47.0	2000	0

Table 10.7.2
Zone G
AOC 637
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (µg/kg)	Mean of Detections (µg/kg)	Reference Conc.* (µg/kg)	Number of Samples Exceeding Reference
Indeno(1,2,3-cd)pyrene	Upper	4/7	168.5 - 560	375	880	0
	Lower	1/2	110	110	14000	0
Acenaphthene	Upper	4/7	100 - 200	155	470000	0
	Lower	0/2	ND	ND	570000	0
Acenaphthylene	Upper	1/7	45.0	45.0	230000	0
	Lower	0/2	ND	ND	293000	0
Anthracene	Upper	4/7	240 - 410	323	2300000	0
	Lower	1/2	46.0	46.0	12000000	0
Benzo(g,h,i)perylene	Upper	5/7	50.0 - 680	356	230000	0
	Lower	1/2	120	120	4.66E08	0
Dibenzofuran	Upper	3/7	66.0 - 100	83.7	31000	0
	Lower	0/2	ND	ND	240000	0
bis(2-Ethylhexyl)phthalate	Upper	2/7	84.0 - 100	92.0	46000	0
	Lower	0/2	ND	ND	3600000	0
Fluoranthene	Upper	7/7	59.0 - 1700	815	310000	0
	Lower	2/2	88.0 - 220	154	4300000	0
Fluorene	Upper	4/7	95.0 - 200	151	310000	0
	Lower	0/2	ND	ND	560000	0
2-Methylnaphthalene	Upper	3/7	55.0 - 120	78.3	310000	0
	Lower	0/2	ND	ND	126000	0

Table 10.7.2
Zone G
AOC 637
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (µg/kg)	Mean of Detections (µg/kg)	Reference Conc.* (µg/kg)	Number of Samples Exceeding Reference
Naphthalene	Upper	2/7	77.0 - 160	119	310000	0
	Lower	0/2	ND	ND	84000	0
Phenanthrene	Upper	6/7	82.0 - 2400	1040	230000	0
	Lower	1/2	120	120	1380000	0
Pyrene	Upper	7/7	80.0 - 2600	1010	230000	0
	Lower	2/2	120 - 180	150	4200000	0
Pesticides and PCBs (Upper Interval - 7 Samples plus 2 Duplicate Sample/Lower Interval - 2 Samples) (µg/kg)						
alpha-Chlordane	Upper	3/7	2.60 - 39.0	14.7	1800	0
	Lower	0/2	ND	ND	10000	0
gamma-Chlordane	Upper	6/7	2.20 - 73.0	15.5	1800	0
	Lower	1/2	4.70	4.70	10000	0
4,4'DDD	Upper	1/7	12.0	12.0	2700	0
	Lower	0/2	ND	ND	16000	0
4,4'-DDE	Upper	4/7	4.10 - 20.0	11.7	1900	0
	Lower	0/2	ND	ND	54000	0
4,4'-DDT	Upper	2/7	29.0 - 36.0	32.5	1900	0
	Lower	0/2	ND	ND	32000	0
Endosulfan II	Upper	1/7	3.30	3.30	47000	0
	Lower	0/2	ND	ND	18000	0
Endrin	Upper	1/7	15.0	15.0	2300	0
	Lower	0/2	ND	ND	1000	0

Table 10.7.2
Zone G
AOC 637
Organic Compound Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (µg/kg)	Mean of Detections (µg/kg)	Reference Conc.* (µg/kg)	Number of Samples Exceeding Reference
Endrin aldehyde	Upper	1/7	5.50	5.50	2300	0
	Lower	0/2	ND	ND	1000	0
Endrin ketone	Upper	1/7	11.0	11.0	2300	0
	Lower	0/2	ND	ND	1000	0
Heptachlor	Upper	2/7	3.90 - 13.0	8.45	140	0
	Lower	0/2	ND	ND	2300	0
Heptachlor epoxide	Upper	1/7	2.80	2.80	70	0
	Lower	0/2	ND	ND	700	0
Aroclor-1260	Upper	1/7	120	120	320	0
	Lower	0/2	ND	ND	1000	0
Dioxins (Upper Interval - 2 Duplicate Samples)						
Dioxin(2,3,7,8-TCDD TEQ)[1]	Upper	2/2	0.340 - 0.571	0.456	1000	0
	Lower	0/0	NA	NA	1900	0
Explosives/Propellants (Upper Interval - 5 Samples Plus 1 Duplicate Sample/Lower Interval - 1 Sample) (µg/kg)						
Hydrazine	Upper	5/5	65.5 - 213	140	210	1
	Lower	1/1	323	323	.088	1

Notes:

1 = Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995c)

* = Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil-to-groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as a reference concentration for lower interval samples

ND = Not detected

NA = Not applicable

mg/kg = Milligrams per kilogram

µg/kg = Micrograms per kilogram

Table 10.7.3
Zone G
AOC 637
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Inorganics (Upper Interval - 7 Samples plus 2 Duplicate Samples/Lower Interval - 2 Samples) (mg/kg)						
Aluminum (Al)	Upper	7/7	4010 - 14700	6600	7800	1
	Lower	2/2	5860 - 7960	6910	1000000	0
Antimony (Sb)	Upper	1/7	0.47	0.470	3.10	0
	Lower	1/2	1.50	1.50	5	0
Arsenic (As)	Upper	7/7	4.20 - 19.0	8.35	0.43	7
	Lower	2/2	5.90 - 7.50	6.70	29	0
Barium (Ba)	Upper	7/7	11.6 - 40.3	28.0	550	0
	Lower	2/2	21.6 - 23.0	22.3	1600	0
Beryllium (Be)	Upper	7/7	0.27 - 0.785	0.463	0.150	7
	Lower	2/2	0.42 - 0.56	0.490	63	0
Cadmium (Cd)	Upper	7/7	0.09 - 0.59	0.424	3.90	0
	Lower	2/2	0.18 - 0.82	0.500	8	0
Calcium (Ca)	Upper	7/7	9270 - 103000	58000	NL	NA
	Lower	2/2	25900 - 42500	34200	NL	NA
Chromium (Cr)	Upper	7/7	8.50 - 30.4	20.1	39.0	0
	Lower	2/2	18.0 - 21.4	19.7	1000000	0
Cobalt (Co)	Upper	7/7	0.92 - 4.00	2.45	470	0
	Lower	2/2	1.60 - 2.20	1.90	2000	0

Table 10.7.3
Zone G
AOC 637
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Copper (Cu)	Upper	7/7	11.1 - 107	42.8	27000	0
	Lower	2/2	12.7 - 144	78.4	920	0
Cyanide (CN)	Upper	1/6	0.27	0.270	160	0
	Lower	1/1	0.15	0.150	40	0
Iron (Fe)	Upper	7/7	4030 - 16600	7910	2300	7
	Lower	2/2	8290 - 8400	8350	NL	NA
Lead (Pb)	Upper	7/7	14.05 - 98.0	53.2	400	0
	Lower	2/2	16.9 - 340	178	400	0
Magnesium (Mg)	Upper	7/7	580 - 2990	1770	NL	NA
	Lower	2/2	1550 - 2500	2030	NL	NA
Manganese (Mn)	Upper	7/7	33.2 - 186	101	180	1
	Lower	2/2	99.4 - 100	99.7	1100	0
Mercury (Hg)	Upper	5/7	0.14 - 0.62	0.284	2.30	0
	Lower	2/2	0.07 - 0.29	0.180	2.1	0
Nickel (Ni)	Upper	7/7	4.10 - 22.1	12.3	160	0
	Lower	2/2	6.30 - 22.6	14.5	130	0
Potassium (K)	Upper	7/7	239 - 1410	686	NL	NA
	Lower	2/2	487 - 881	684	NL	NA
Selenium (Se)	Upper	4/7	0.46 - 1.10	0.750	39.0	0
	Lower	1/2	0.75	0.750	5	0

Table 10.7.3
Zone G
AOC 637
Inorganic Analytical Results for Soil

Parameters	Sample Interval	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	Reference Conc.* (mg/kg)	Number of Samples Exceeding Reference
Sodium (Na)	Upper	7/7	325 -575	413	NL	NA
	Lower	2/2	375 - 699	537	NL	NA
Thallium (Tl)	Upper	2/7	0.82 - 1.06	0.940	0.630	2
	Lower	2/2	0.64 - 0.65	0.645	0.95	0
Tin (Sn)	Upper	3/7	1.65 - 10.6	5.68	4700	0
	Lower	1/2	1.90	1.90	11000	0
Vanadium (V)	Upper	7/7	8.90 - 37.05	19.2	55.0	0
	Lower	2/2	17.8 - 18.5	18.2	6000	0
Zinc (Zn)	Upper	7/7	39.7 - 234	129	2300	0
	Lower	2/2	97.6 - 215	156	12000	0

Notes:

* = Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil-to-groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as a reference concentration for lower interval samples

ND = Not detected

NL = Not listed

NA = Not applicable

mg/kg = Milligrams per kilogram

Table 10.7.4
Zone G
AOC 637
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Volatile Organic Compounds (µg/kg)							
2-Butanone	637SB003	ND	4700000	NA	81	7900	NA
Carbon disulfide	637SB001	1	780000	NA	ND	32000	NA
	637SB003	ND			4		
Semivolatile Organic Compounds (µg/kg)							
BEQs[1]	637SB001	1507.20	88.0	NA	NA	NA	NA
	637SB002	15.59			NA		
	637SB003	874.60			NA		
	637SB005	67.45			NA		
	637SB006	866.88			NA		
	637SB007	590.90			NA		
Benzo(a)anthracene	637SB001	1000	880	NA	NT	2000	NA
	637SB003	760			ND		
	637SB005	56			NT		
	637SB006	560			110		
	637SB007	390			NT		
Benzo(b)fluoranthene	637SB001	1400	880	NA	NT	5000	NA
	637SB002	140			NT		
	637SB003	680			ND		
	637SB005	54			NT		
	637SB006	ND			140		
	637SB007	110			NT		

Table 10.7.4
Zone G
AOC 637
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Benzo(k)fluoranthene	637SB002	140	8800	NA	NT	49000	NA
	637SB003	580			ND		
	637SB005	40			NT		
	637SB006	720			120		
	637SB007	355			NT		
Benzo(a)pyrene	637SB001	890	88	NA	NT	8000	NA
	637SB003	680			ND		
	637SB005	56			NT		
	637SB006	600			140		
	637SB007	360			NT		
Chrysene	637SB001	1200	88000	NA	NT	160000	NA
	637SB002	190			NT		
	637SB003	800			ND		
	637SB005	51			NT		
	637SB006	680			160		
	637SB007	450			NT		
Dibenz(a,h)anthracene	637SB001	320	88	NA	NT	2000	NA
	637SB006	170			47		
	637SB007	160			NT		
Indeno(1,2,3-cd)pyrene	637SB001	560	880	NA	NT	14000	NA
	637SB003	440			ND		
	637SB006	330			110		
	637SB007	168.5			NT		

Table 10.7.4
Zone G
AOC 637
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Acenaphthene	637SB001	190	470000	NA	NT	570000	NA
	637SB003	200			ND		
	637SB006	130			ND		
	637SB007	100			NT		
Acenaphthylene	637SB006	45	230000	NA	ND	293000	NA
Anthracene	637SB001	380	2300000	NA	NT	12000000	NA
	637SB003	410			ND		
	637SB006	260			46		
	637SB007	240			NT		
Benzo(g,h,i)perylene	637SB001	680	230000	NA	NT	4.66E08	NA
	637SB003	440			ND		
	637SB005	50			NT		
	637SB006	400			120		
	637SB007	207.5			NT		
Dibenzofuran	637SB001	100	31000	NA	NT	50000	NA
	637SB003	85			ND		
	637SB006	66			ND		
bis(2-Ethylhexyl)phthalate	637SB002	84	46000	NA	NT	3600000	NA
	637SB005	100			NT		

Table 10.7.4
Zone G
AOC 637
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Fluoranthene	637SB001	1700	310000	NA	NT	4300000	NA
	637SB002	210			NT		
	637SB003	1400			88		
	637SB004	59			NT		
	637SB005	170			NT		
	637SB006	1400			220		
	637SB007	765			NT		
Fluorene	637SB001	200	310000	NA	NT	560000	NA
	637SB003	150			ND		
	637SB006	160			ND		
	637SB007	95			NT		
2-Methylnapthalene	637SB001	120	310000	NA	NT	126000	NA
	637SB003	60			ND		
	637SB006	55			ND		
Naphthalene	637SB001	160	310000	NA	NT	84000	NA
	637SB006	77			ND		
Phenanthrene	637SB001	2400	230000	NA	NT	1380000	NA
	637SB002	160			NT		
	637SB003	1500			ND		
	637SB005	82			NT		
	637SB006	1300			120		
	637SB007	780			NT		

Table 10.7.4
Zone G
AOC 637
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Pyrene	637SB001	2600	230000	NA	NT	4200000	NA
	637SB002	310			NT		
	637SB003	1600			120		
	637SB004	80			NT		
	637SB005	165			NT		
	637SB006	1400			180		
	637SB007	895			NT		
Pesticides and PCBs (µg/kg)							
alpha-Chlordane	637SB001	2.6	1800	NA	NT	10000	NA
	637SB003	39			ND		
	637SB006	2.6			ND		
gamma-Chlordane	637SB001	8	1800	NA	NT	10000	NA
	637SB002	2.9			NT		
	637SB003	73			4.7		
	637SB004	4.7			NT		
	637SB005	2.2			NT		
	637SB006	2.2			ND		
4,4'-DDD	637SB004	12	2700	NA	NT	16000	NA
4,4'-DDE	637SB001	14	1900.0	NA	NT	54000	NA
	637SB002	4.1			NT		
	637SB004	20			NT		
	637SB006	8.5			ND		
4,4'-DDT	637SB004	36	1900	NA	NT	32000	NA
	637SB006	29			ND		

Table 10.7.4
Zone G
AOC 637
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Endrin	637SB003	15	2300	NA	ND	1000	NA
Endrin aldehyde	637SB006	5.5	2300	NA	ND	1000	NA
Endrin ketone	637SB006	11	2300	NA	ND	1000	NA
Endosulfan II	637SB007	3.3	47000	NA	NT	18000	NA
Heptachlor	637SB003	13	140	NA	ND	23000	NA
	637SB005	3.9			NT		
Heptachlor epoxide	637SB003	2.8	70	NA	ND	700	NA
Aroclor-1260	637SB002	120	320	NA	NT	1000	NA
Dioxins (ng/kg)							
Dioxin (2,3,7,8-TCDD TEQs)[1]	637SB005	0.3401	1000	NA	NT	1900	NA
	637SB007	0.5712			NT		
Explosives/Propellants (ng/kg)							
Hydrazine	637SB001	171	210	NA	NT	0.068	NA
	637SB002	129			NT		
	637SB003	213			323		
	637SB004	120			NT		
	637SB005	65.5			NT		

Table 10.7.4
Zone G
AOC 637
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC[a] (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL[a] (DAF=20)	Subsurface Background
Inorganics (mg/kg)							
Aluminum (Al)	637SB001	4470	7800.0	18700	NT	1000000	23600
	637SB002	7160			NT		
	637SB003	5420			5860		
	637SB004	4010			NT		
	637SB005	5035			NT		
	637SB006	5390			7960		
	637SB007	14700			NT		
Antimony (Sb)	637SB003	ND	3.1	2.89	1.5	5	NL
	637SB006	0.47			ND		
Arsenic (As)	637SB001	7.3	0.43	17.2[a]	NT	29	15.5[a]
	637SB002	6.9			NT		
	637SB003	6.8			5.9		
	637SB004	4.2			NT		
	637SB005	8.25			NT		
	637SB006	6.0			7.5		
	637SB007	19.0			NT		
Barium (Ba)	637SB001	37.1	550.0	109	NT	1600	64.5
	637SB002	25			NT		
	637SB003	36.8			21.6		
	637SB004	14.6			NT		
	637SB005	11.6			NT		
	637SB006	40.3			23		
	637SB007	30.6			NT		

Table 10.7.4
Zone G
AOC 637
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Beryllium (Be)	637SB001	0.38	0.15	1.20	NT	63	1.63
	637SB002	0.45			NT		
	637SB003	0.45			0.42		
	637SB004	0.27			NT		
	637SB005	0.525			NT		
	637SB006	0.38			0.56		
	637SB007	0.785			NT		
Cadmium (Cd)	637SB001	0.5	3.9	1.07	NT	8	0.48
	637SB002	0.59			NT		
	637SB003	0.38			0.82		
	637SB004	0.09			NT		
	637SB005	0.59			NT		
	637SB006	0.44			0.18		
	637SB007	0.38			NT		
Calcium (Ca)	637SB001	92200	NL	NL	NT	NL	NL
	637SB002	46300			NT		
	637SB003	38300			42500		
	637SB004	9270			NT		
	637SB005	73050			NT		
	637SB006	103000			25900		
	637SB007	44050			NT		

Table 10.7.4
Zone G
AOC 637
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Chromium (Cr)	637SB001	20.1	39 VI	42.8	NT	1000000	43.4[a]
	637SB002	22.7	7800 III		NT		
	637SB003	19.4			21.4		
	637SB004	8.5			NT		
	637SB005	25.5			NT		
	637SB006	14.1			18		
	637SB007	30.4			NT		
Cobalt (Co)	637SB001	2.6	470.0	6.60	NT	2000	8.14
	637SB002	2.0			NT		
	637SB003	3.1			1.6		
	637SB004	0.92			NT		
	637SB005	1.7			NT		
	637SB006	2.8			2.2		
	637SB007	4.0			NT		
Copper (Cu)	637SB001	38.9	27000	260	NT	920	32.6
	637SB002	63.9			NT		
	637SB003	107			144		
	637SB004	11.1			NT		
	637SB005	11.25			NT		
	637SB006	34.1			12.7		
	637SB007	33.05			NT		
Cyanide (CN)	637SB001	0.27	160	0.38	NT	40	0.22
	637SB003	ND			0.15		

Table 10.7.4
Zone G
AOC 637
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Backgroumd
Iron (Fe)	637SB001	5840	2300	NL	NT	NL	NL
	637SB002	7770			NT		
	637SB003	8240			8290		
	637SB004	4030			NT		
	637SB005	7365			NT		
	637SB006	5520			8400		
	637SB007	16600			NT		
Lead(Pb)	637SB001	98.0	400.0	181	NT	400	66.3
	637SB002	57.9			NT		
	637SB003	93.8			340		
	637SB004	16.8			NT		
	637SB005	14.05			NT		
	637SB006	51.8			16.9		
	637SB007	40.25			NT		
Magnesium (Mg)	637SB001	1500	NL	NL	NT	NL	NL
	637SB002	1810			NT		
	637SB003	1430			1550		
	637SB004	580			NT		
	637SB005	2405			NT		
	637SB006	1680			2500		
	637SB007	2990			NT		

Table 10.7.4
Zone G
AOC 637
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Manganese (Mn)	637SB001	91.6	180.0	325	NT	1100	291
	637SB002	85.1			NT		
	637SB003	123			99.4		
	637SB004	33.2			NT		
	637SB005	75.3			NT		
	637SB006	115			100		
	637SB007	186			NT		
Mercury (Hg)	637SB001	0.17	2.3	1.03	NT	2.1	0.31
	637SB002	0.62			NT		
	637SB003	0.20			0.29		
	637SB006	0.29			0.07		
	637SB007	0.14			NT		
Nickel (Ni)	637SB001	10.4	160.0	20.6	NT	130	18.3
	637SB002	13.8			NT		
	637SB003	12.6			22.6		
	637SB004	4.1			NT		
	637SB005	12.3			NT		
	637SB006	22.1			6.3		
	637SB007	11.05			NT		
Potassium (K)	637SB001	498	NL	NL	NT	NL	NL
	637SB002	689			NT		
	637SB003	571			487		
	637SB004	239			NT		
	637SB005	694			NT		
	637SB006	702			881		
	637SB007	1410			NT		

Table 10.7.4
Zone G
AOC 637
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Selenium (Se)	637SB001	0.46	39.0	1.22	NT	5	1.26
	637SB002	0.67			NT		
	637SB003	0.77			0.75		
	637SB005	1.1			NT		
Sodium (Na)	637SB001	356	NL	NL	NT	NL	NL
	637SB002	363			NT		
	637SB003	325			375		
	637SB004	348			NT		
	637SB005	504.5			NT		
	637SB006	418			699		
	637SB007	575			NT		
Thallium (Tl)	637SB002	0.82	0.63	0.85	NT	0.95	0.95
	637SB003	ND			0.64		
	637SB006	ND			0.65		
	637SB007	1.06			NT		
Tin (Sn)	637SB003	10.6	4700	9.67	ND	11000	2.96
	637SB006	4.8			1.9		
	637SB007	1.65			NT		
Vanadium (V)	637SB001	12.9	55.0	60.9	NT	6000	72.5
	637SB002	19.9			NT		
	637SB003	20.0			17.8		
	637SB004	8.9			NT		
	637SB005	21.05			NT		
	637SB006	14.7			18.5		
	637SB007	37.05			NT		

Table 10.7.4
Zone G
AOC 637
Analytes Detected in Surface and Subsurface Soil

Parameters	Location	Surface Conc.	Residential RBC* (THQ=0.1)	Surface Background	Subsurface Conc.	Soil to Groundwater SSL* (DAF=20)	Subsurface Background
Zinc (Zn)	637SB001	173	2300.0	519	NT	12000	145
	637SB002	217			NT		
	637SB003	234			215		
	637SB004	39.7			NT		
	637SB005	52.25			NT		
	637SB006	84.3			97.6		
	637SB007	102.1			NT		

Notes:

a	=	Background value for non-clay samples
*	=	Residential RBCs (THQ=0.1) were used as a reference concentration for upper interval samples. Generic soil-to-groundwater SSLs (DAF=20) from the *Soil Screening Guidance: Technical Background Document* (USEPA, 1996b) were used as a reference concentration for lower interval samples
1	=	Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995c)
ND	=	Not detected
NT	=	Not taken
NL	=	Not listed
NA	=	Not applicable
ng/kg	=	Nanograms per kilogram
mg/kg	=	Milligrams per kilogram
µg/kg	=	Micrograms per kilogram

Bolded concentrations exceed both the reference concentration (RBC or SSL) and the zone background
All background values for Zone G are based on twice the means of the grid sample concentrations

Volatile Organic Compounds in Soil

Two VOCs were detected in AOC 637 soil samples. Carbon disulfide was detected in both, surface and subsurface soils, while 2-butanone was only detected in subsurface soil. All surface and subsurface soil VOC detections at AOC 637 were far below their respective RBC and/or SSL.

Semivolatile Organic Compounds in Soil

Nineteen SVOCs were detected in surface soil samples at AOC 637. Benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, and dibenz(a,h)anthracene exceeded their respective RBC in surface soil samples at this AOC. Figure 10.7-4 presents total BEQ concentrations detected in surface soil at AOC 637.

Twelve SVOCs were detected in subsurface soil samples at AOC 637. No SVOCs in subsurface soil exceeded their respective SSL.

Pesticides and PCBs in Soil

Eleven pesticides were detected in AOC 637 surface soil samples, while one pesticide was detected in subsurface soils. No surface or subsurface pesticide concentration exceeded a respective RBC or SSL at this AOC. Aroclor-1260 was detected in one surface soil sample at a concentration below the RBC.

Other Organic Compounds in Soil

Dioxin (2,3,7,8-TCDD TEQ) was detected in two surface soil duplicate samples below the RBC for this parameter. Hydrazine was detected in both surface and subsurface soils at concentrations above the RBC and SSL, respectively, for this parameter. Both surface and subsurface exceedances occurred at boring 637SB003. Figure 10.7-5 presents concentrations of hydrazine detected in surface soil at AOC 637, Figure 10.7-6 depicts the hydrazine distribution in subsurface soil.

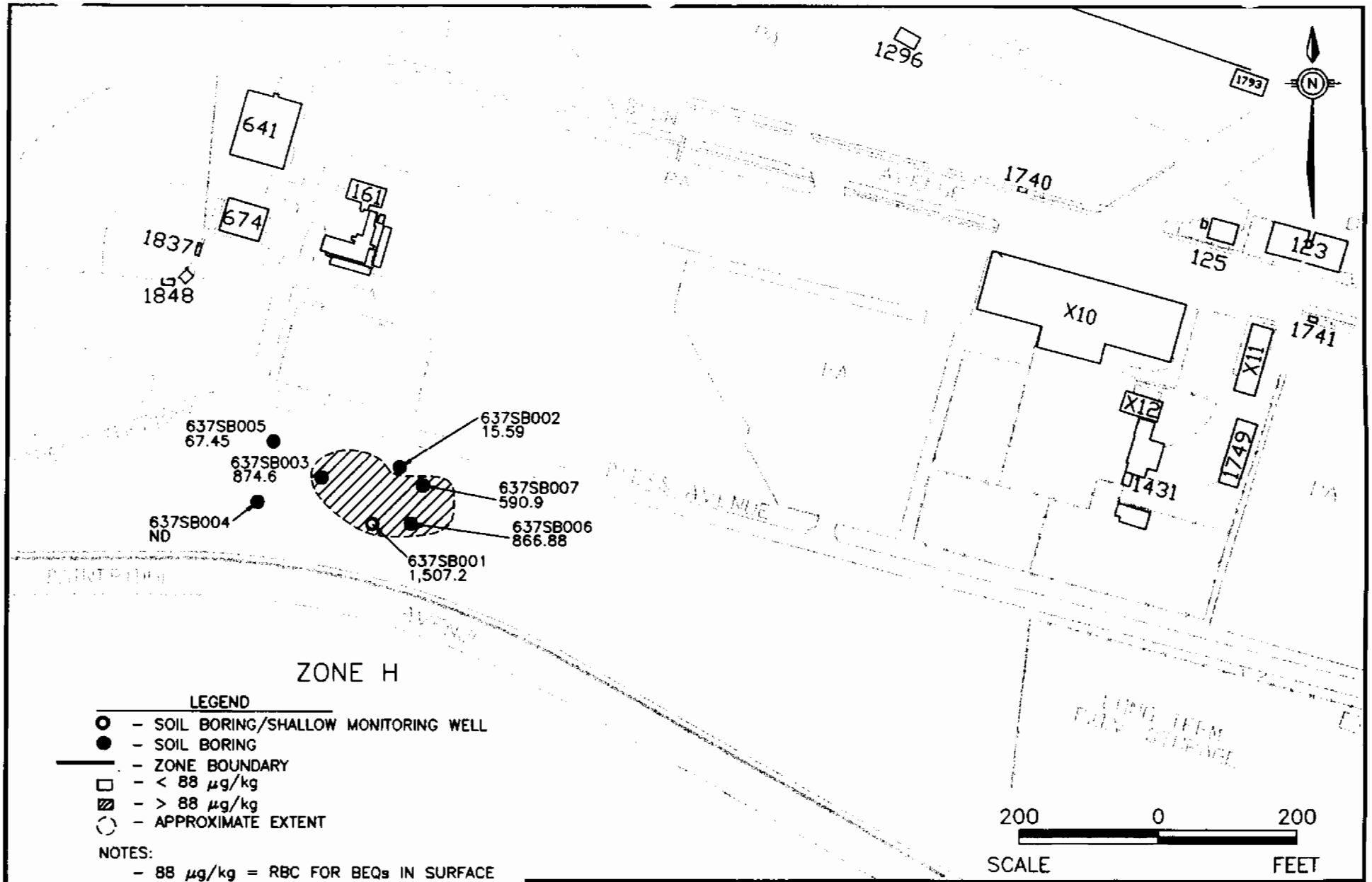
641
674
161
1837
1848
1296
1793
1740
125
123
X10
X11
X12
1741
1749
1431
637SB005
67.45
637SB003
874.6
637SB004
ND
637SB002
15.59
637SB007
590.9
637SB006
866.88
637SB001
1,507.2
ZONE H
LEGEND
– SOIL BORING/SHALLOW MONITORING WELL
– SOIL BORING
– ZONE BOUNDARY
– < 88 µg/kg
– > 88 µg/kg
– APPROXIMATE EXTENT
NOTES:
– 88 µg/kg = RBC FOR BEQs IN SURFACE SOIL (USEPA, OCTOBER 22, 1997)
– RESULTS IN µg/kg
– THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
– ND = NOT DETECTED
200 0 200
SCALE FEET
ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
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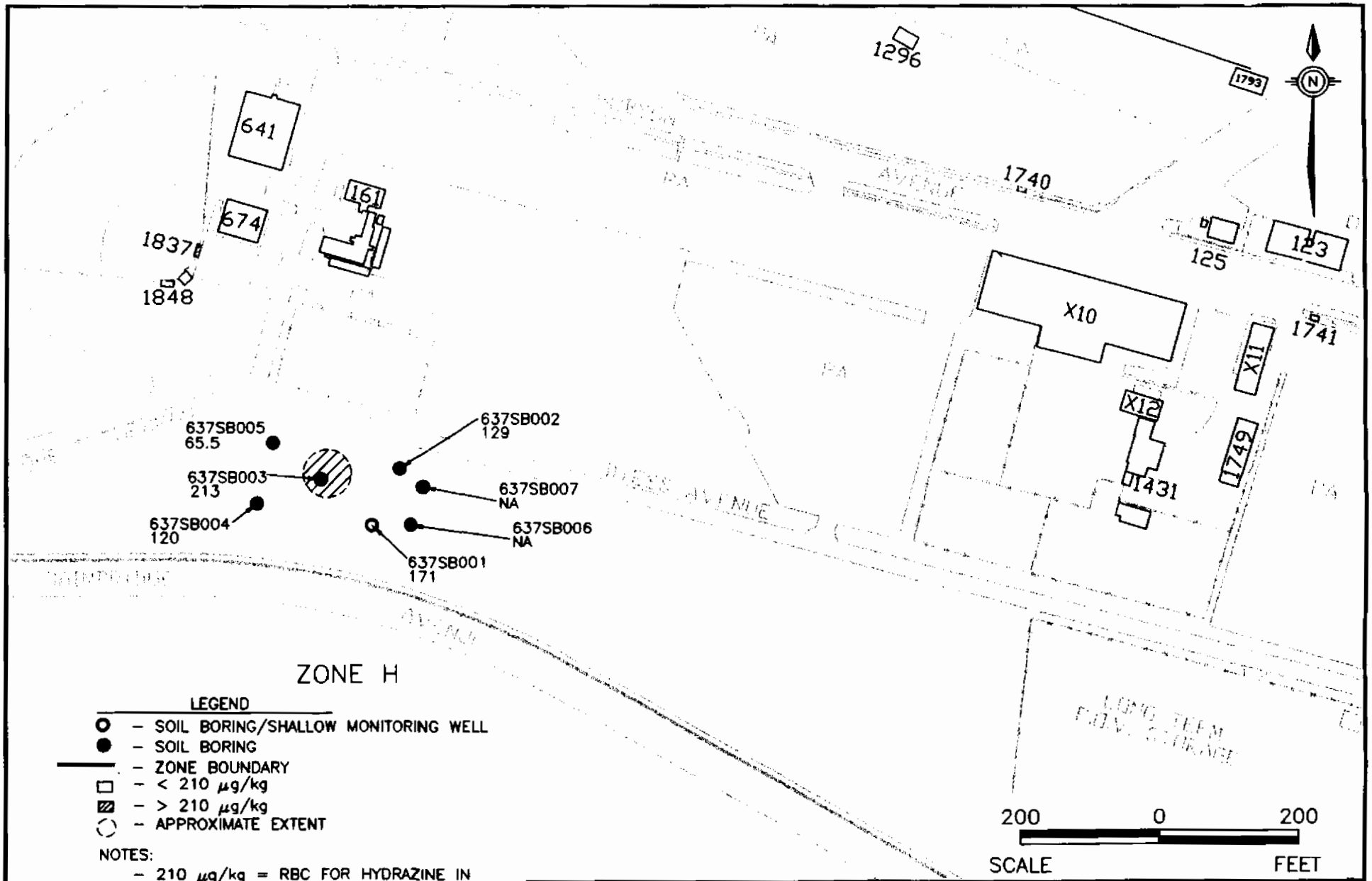
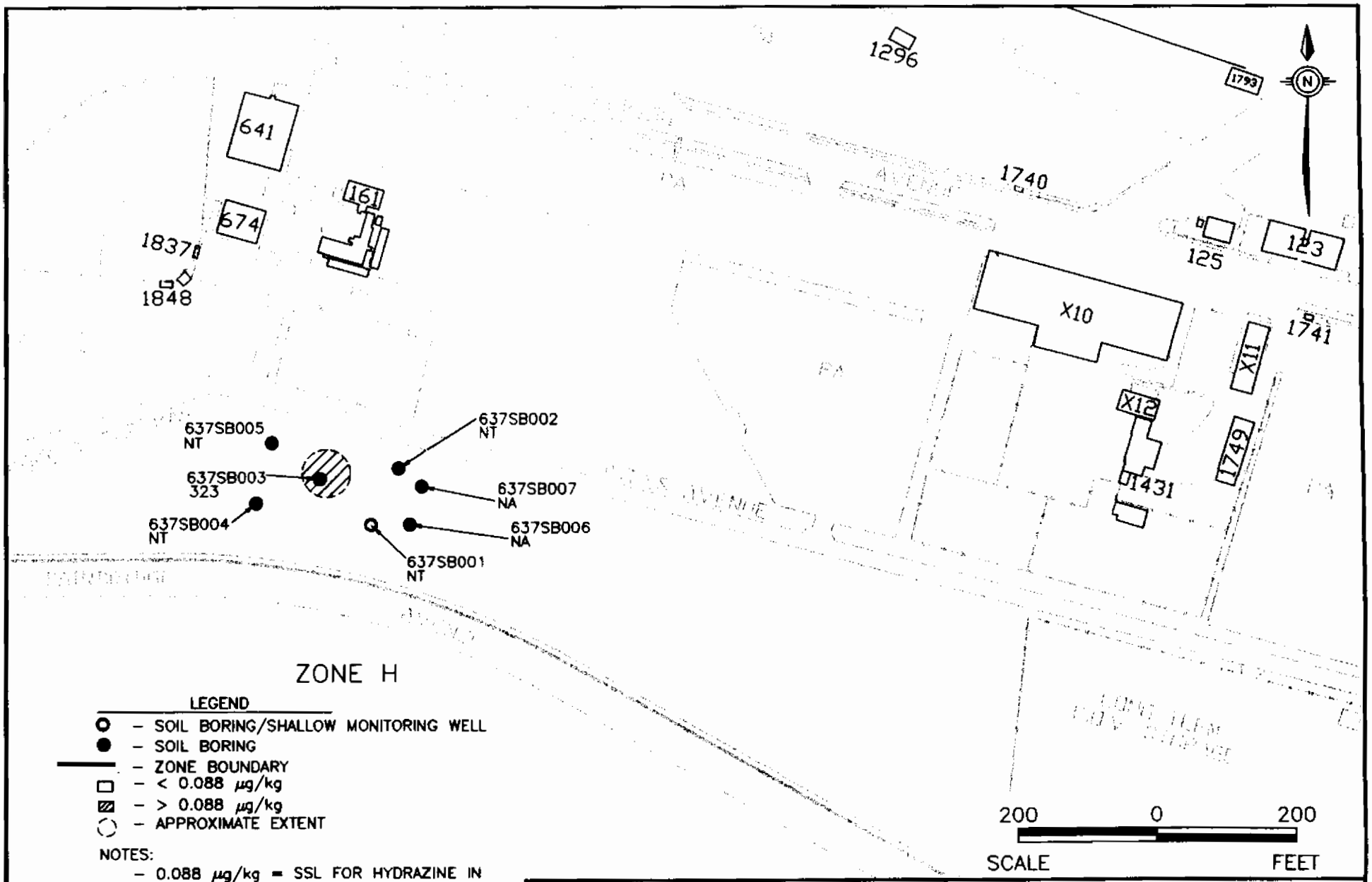
FIGURE 10.7-4
BEQs IN SURFACE SOIL
AOC #637 DUMP AREA
DWG DATE: 02/04/98
DWG NAME: 2907M071


641
674
161
1837
1848
1296
1793
1740
AVENUE
125
123
X10
X11
X12
1741
1749
1431
637SB005
65.5
637SB002
129
637SB003
213
637SB007
NA
637SB004
120
637SB006
NA
637SB001
171
ZONE H
LEGEND
– SOIL BORING/SHALLOW MONITORING WELL
– SOIL BORING
– ZONE BOUNDARY
– < 210 µg/kg
– > 210 µg/kg
– APPROXIMATE EXTENT
NOTES:
– 210 µg/kg = RBC FOR HYDRAZINE IN SURFACE SOIL (USEPA, OCTOBER 22, 1997)
– RESULTS IN µg/kg
– THIS DEPICTION ASSUMES HOMOGENEOUS SOIL CONDITIONS
– NA = NOT ANALYZED FOR HYDRAZINE
200 0 200
SCALE FEET
ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 10.7–5
HYDRAZINE IN SURFACE SOIL
AOC #637 DUMP AREA
DWG DATE: 02/04/98
DWG NAME: 2907M072



ZONE G
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FIGURE 10.7–6
HYDRAZINE IN SUBSURFACE SOIL
AOC #637 DUMP AREA

DWG DATE: 02/04/98 | DWG NAME: 2907M073

Inorganic Elements in Soil

Twenty-three metals, plus cyanide, were detected in surface soil samples collected at AOC 637. Arsenic and thallium were detected at concentrations that exceeded their respective RBCs and Zone G surface soil background concentrations. Figure 10.7-7 shows arsenic detected in surface soil at AOC 637. Figure 10.7-8 shows thallium detected in surface soil at this AOC. Twenty-four metals were detected in AOC 637 subsurface soils. No subsurface metal concentrations exceeded their respective SSL. Iron was detected in all seven surface soil samples at concentrations which exceed its RBC. No background concentration was determined for iron because it is considered an essential nutrient

10.7.4 Sediment Sampling and Analysis

A sediment sample was collected at AOC 637 to determine the impact of contaminant transport via the surface water drainage pathway from the site. This sample was not proposed in the approved final RFI work plan, and was proposed as a follow-on sample for the site (Figure 10.7-1). The sediment sample was analyzed for metals, pesticides/PCBs, OP pesticides, SVOCs, and VOCs at DQO Level III. Table 10.7.5 summarizes the AOC 637 sediment sample and analyzes.

Table 10.7.5
Zone G
AOC 637
Sediment Sample and Analyses

Location	Sample Identifier	Date Collected	Analyses	Remarks
637M0001	637M000101	3/19/97	See note	

Note: SW-846 (metals, pesticides/PCBs, OP-Pesticides, SVOCs, VOCs) at DQO Level III

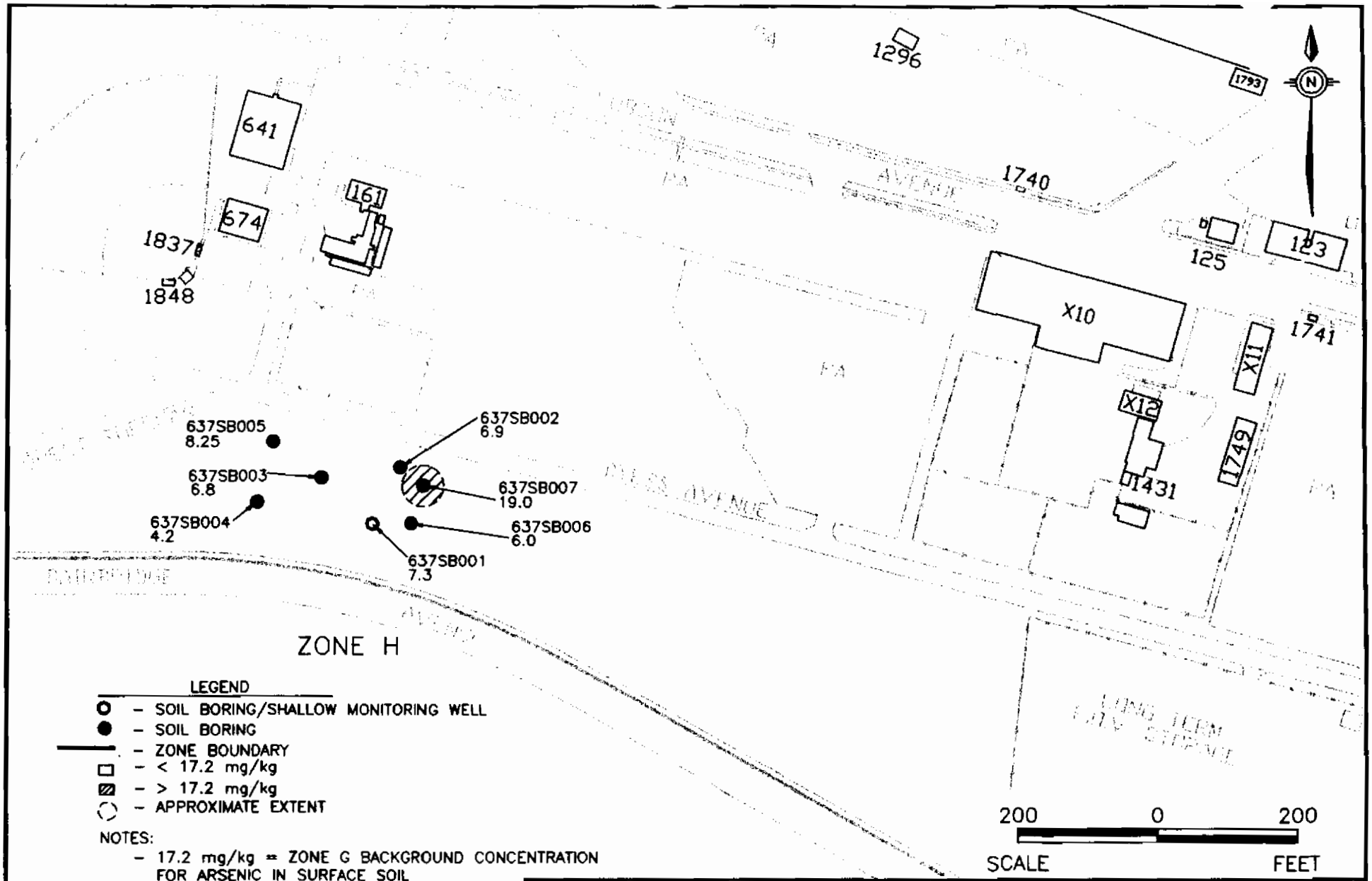
1296
1793
641
161
674
1837
1848
1740
125
123
X10
1741
X11
X12
1749
1431
637SB005
8.25
637SB002
6.9
637SB003
6.8
637SB007
19.0
637SB004
4.2
637SB006
6.0
637SB001
7.3
ZONE H
LEGEND
– SOIL BORING/SHALLOW MONITORING WELL
– SOIL BORING
– ZONE BOUNDARY
– < 17.2 mg/kg
– > 17.2 mg/kg
– APPROXIMATE EXTENT
NOTES:
– 17.2 mg/kg = ZONE G BACKGROUND CONCENTRATION FOR ARSENIC IN SURFACE SOIL
– RESULTS IN mg/kg
200 0 200
SCALE FEET
ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
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FIGURE 10.7–7
ARSENIC IN SURFACE SOIL
AOC #637 DUMP AREA
DWG DATE: 02/10/98
DWG NAME: 2907M074

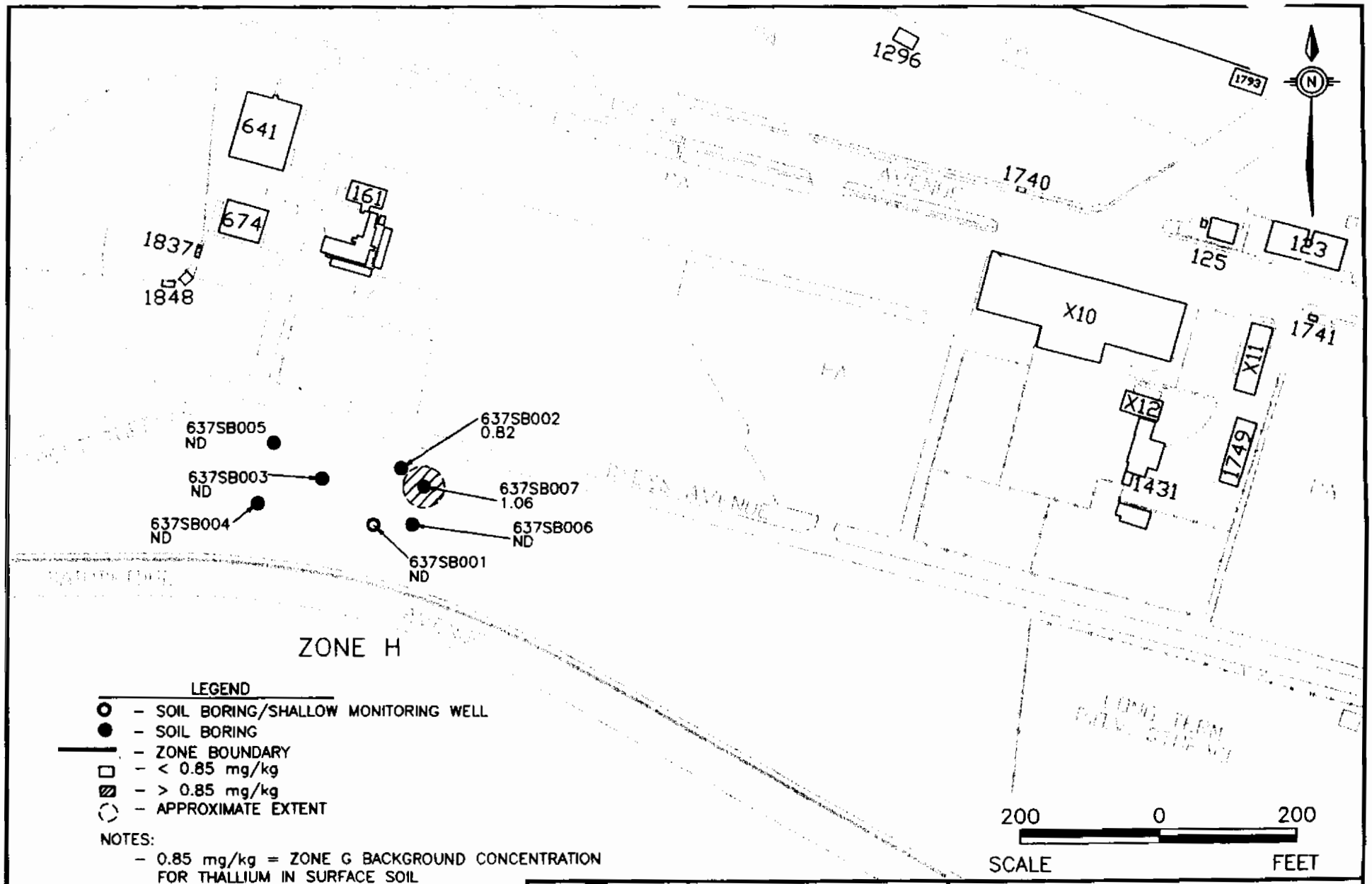
1296
1793
641
674
161
1837
1848
1740
125
123
X10
X11
X12
1741
1749
1431
637SB005
ND
637SB002
0.82
637SB003
ND
637SB007
1.06
637SB004
ND
637SB006
ND
637SB001
ND
ZONE H
LEGEND
– SOIL BORING/SHALLOW MONITORING WELL
– SOIL BORING
– ZONE BOUNDARY
– < 0.85 mg/kg
– > 0.85 mg/kg
– APPROXIMATE EXTENT
NOTES:
– 0.85 mg/kg = ZONE G BACKGROUND CONCENTRATION FOR THALLIUM IN SURFACE SOIL
– RESULTS IN mg/kg
– ND = NOT DETECTED
200 0 200
SCALE FEET
ZONE G
RCRA FACILITY
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FIGURE 10.7-8
THALLIUM IN SURFACE SOIL
AOC #637 DUMP AREA
DWG DATE: 02/04/98
DWG NAME: 2907M075

10.7.4.1 Nature of Contamination in Sediment

Organic compound analytical results for sediment are summarized in Table 10.7.6. Inorganic analytical results for sediment are summarized in Table 10.7.7. Table 10.7.8 summarizes all analytes detected in sediment at AOC 637. Appendix D contains a complete analytical data report for all Zone G samples.

Volatile Organic Compounds in Sediment

Three VOCs, 2-butanone, chlorobenzene, and trichloroethene, were detected in sediment at AOC 637. No SSVs are listed for these VOCs.

Semivolatile Organic Compounds in Sediment

Thirteen SVOCs were detected in sediment at AOC 637. Bis(2-ethylhexyl)phthalate exceeded its respective SSV in sediment at this AOC. Figure 10.7-9 presents bis(2-ethylhexyl)phthalate in sediment.

Pesticides and PCBs in Sediment

Three pesticides, gamma-chlordane, dieldrin, and endrin aldehyde were detected in AOC 637 sediment. Gamma-chlordane and Dieldrin both exceeded their respective SSV. Figure 10.7-10 presents the concentrations of gamma-chlordane in sediment at AOC 637. Figure 10.7-11 presents the distribution of dieldrin in sediment.

Two PCBs, Aroclor-1016 and Aroclor-1260 were detected at concentrations above their respective SSVs. Figure 10.7-12 shows Aroclor-1016 in sediment at AOC 637. Figure 10.7-13 shows Aroclor-1260 in sediment.

Table 10.7.6
Zone G
AOC 637
Organic Analytical Results for Sediment

Parameters	Frequency of Detection	Range of Detections (µg/kg)	Mean of Detections (µg/kg)	SSVs (µg/kg)	Number of Samples Exceeding SSVs
Volatile Organic Compounds (1 Sample) (µg/kg)					
2-Butanone (MEK)	1/1	7.00	7.00	NL	NA
Chlorobenzene	1/1	6.00	6.00	NL	NA
Trichloroethene	1/1	4.00	4.00	NL	NA
Semivolatile Organic Compounds (1 Sample) (µg/kg)					
BEQs[1]	1/1	145	145	NL	NA
Benzo(a)anthracene	1/1	120	120	330	0
Benzo(b)fluoranthene	1/1	140	140	NL	NA
Benzo(k)fluoranthene	1/1	180	180	NL	NA
Benzo(a)pyrene	1/1	110	110	330	0
Chrysene	1/1	200	200	330	0
Indeno(1,2,3-cd)pyrene	1/1	71.0	71.0	NL	NA
Benzo(g,h,i)perylene	1/1	62.0	62.0	NL	NA
1,4-Dichlorobenzene	1/1	210	210	NL	NA
bis(2-Ethylhexyl)phthalate	1/1	190	190	182	1
Fluoranthene	1/1	240	240	330	0
N-Nitrosodiphenylamine	1/1	75.0	75.0	NL	NA
Phenanthrene	1/1	94.0	94.0	330	0
Pyrene	1/1	270	270	330	0
Pesticides and PCBs (1 Sample) (µg/kg)					
gamma-Chlordane	1/1	15.0	15.0	1.7	1
Dieldrin	1/1	5.60	5.60	3.3	1
Endrin aldehyde	1/1	9.40	9.40	NL	NA
Aroclor-1016	1/1	210	210	33	1
Aroclor-1260	1/1	180	180	33	1

Notes:

1 = Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995b)

µg/kg = Micrograms per kilogram.

NL = Not listed

NA = Not available

SSV = Sediment Screening Value

SSVs from *Supplemental Guidance to RAGs: Region IV Bulletins, Ecological Risk Assessment, Bulletin 2* (USEPA, 1995a)

Table 10.7.7
Zone G
AOC 637
Inorganics Analytical Results for Sediment

Parameters	Frequency of Detection	Range of Detections (mg/kg)	Mean of Detections (mg/kg)	SSVs (mg/kg)	Number of Samples Exceeding SSVs
Inorganics (1 Samples)					
Aluminum (Al)	1/1	3950	3950	NL	NA
Antimony (Sb)	1/1	3.60	3.60	12	0
Arsenic (As)	1/1	3.20	3.20	7.24	0
Barium (Ba)	1/1	172	172	NL	NA
Beryllium (Be)	1/1	0.27	0.27	NL	NA
Cadmium (Cd)	1/1	0.66	0.66	1.0	0
Calcium (Ca)	1/1	33600	33600	NL	NA
Chromium (Cr)	1/1	32.2	32.2	52.3	0
Cobalt (Co)	1/1	3.60	3.60	NL	NA
Copper (Cu)	1/1	221	221	18.7	1
Iron (Fe)	1/1	7040	7040	NL	NA
Lead (Pb)	1/1	73.5	73.5	30.2	1
Magnesium (Mg)	1/1	1270	1270	NL	NA
Manganese (Mn)	1/1	50.6	50.6	NL	NA
Mercury (Hg)	1/1	0.17	0.17	0.13	1
Nickel (Ni)	1/1	46.4	46.4	15.9	1
Potassium (K)	1/1	443	443	NL	NA
Selenium (Se)	1/1	0.55	0.55	NL	NA
Sodium (Na)	1/1	1110	1110	NL	NA
Thallium (Tl)	1/1	0.69	0.69	NL	NA
Tin (Sn)	1/1	9.70	9.70	NL	NA
Vanadium (V)	1/1	21.3	21.3	NL	NA
Zinc (Zn)	1/1	202	202	124	1

Notes:
mg/kg = Milligrams per kilogram
NL = Not listed
NA = Not available
SSV = Sediment Screening Value
SVs from *Supplemental Guidance to RAGs: Region IV Bulletins, Ecological Risk Assessment, Bulletin 2* (USEPA, 1995a)

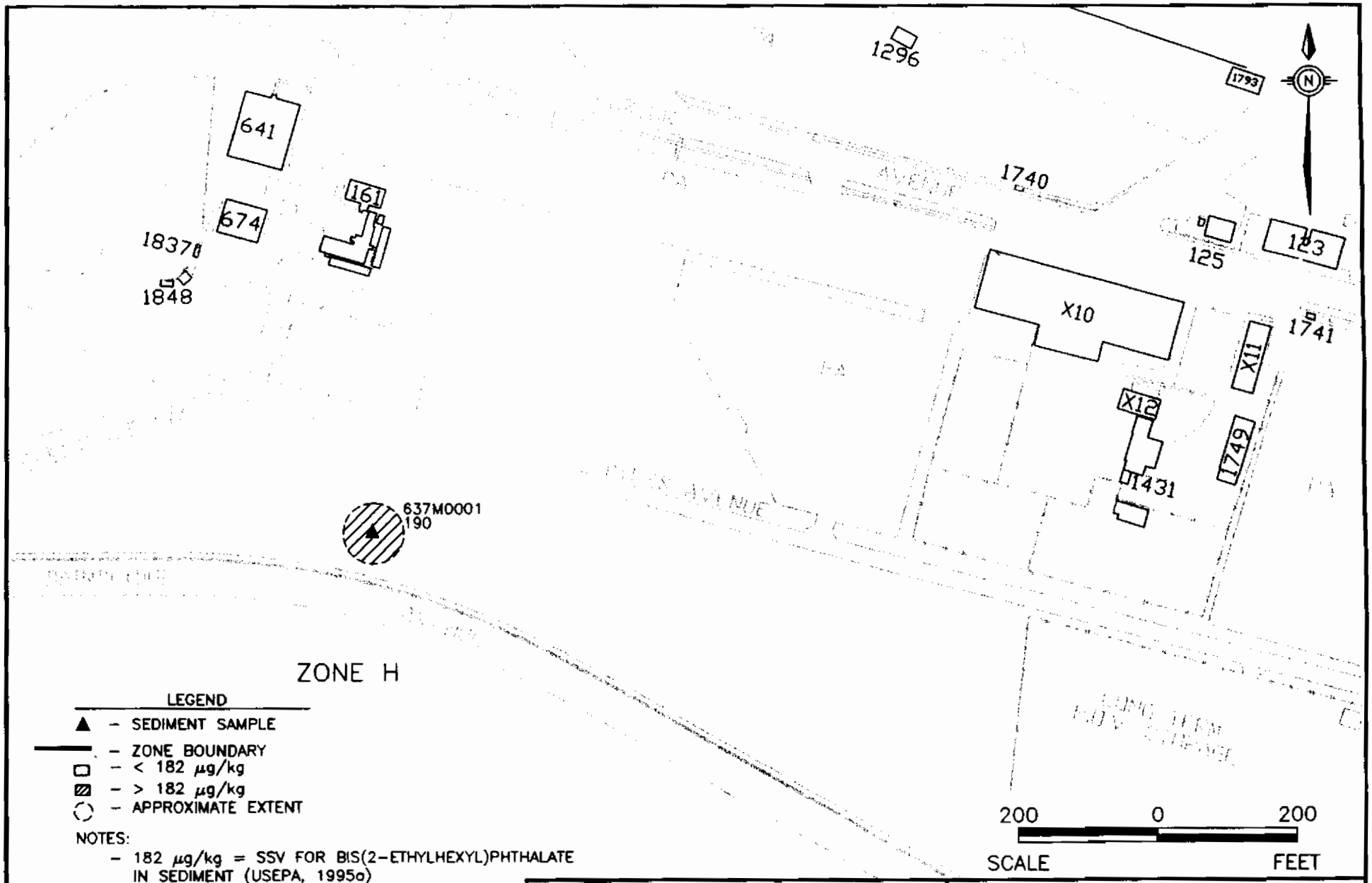
Table 10.7.8
Zone G
AOC 637
Analytes Detected in Sediment Samples

Parameters	Location	Concentration	SSVs
Volatile Organic Compounds (µg/kg)			
2-Butanone	637M0001	7	NL
Chlorobenzene	637M0001	6	NL
Trichloroethene	637M0001	4	NL
Semivolatile Organic Compounds (µg/kg)			
BEQs[1]	637M0001	145.10	NL
Benzo(a)anthracene	637M0001	120	330
Benzo(b)fluoranthene	637M0001	140	NL
Benzo(k)fluoranthene	637M0001	180	NL
Benzo(a)pyrene	637M0001	110	330
Chrysene	637M0001	200	330
Indeno(1,2,3-cd)pyrene	637M0001	71	NL
Benzo(g,h,i)perylene	637M0001	62	NL
1,4-Dichlorobenzene	637M0001	210	NL
bis(2-Ethylhexyl)phthalate	637M0001	190	182
Fluoranthene	637M0001	240	330
N-Nitrosodiphenylamine	637M0001	75	NL
Phenanthrene	637M0001	94	330
Pyrene	637M0001	270	330
Pesticides and PCBs (µg/kg)			
gamma-Chlordane	637M0001	15	1.7
Dieldrin	637M0001	5.6	3.3
Endrin aldehyde	637M0001	9.4	NL
Aroclor-1016	637M0001	210	33
Aroclor-1260	637M0001	180	33
Inorganics (mg/kg)			
Aluminum (Al)	637M0001	3950	NL

Table 10.7.8
Zone G
AOC 637
Analytes Detected in Sediment Samples

Parameters	Location	Concentration	SSVs
Antimony (Sb)	637M0001	3.6	12
Arsenic (As)	637M0001	3.2	7.24
Barium (Ba)	637M0001	172	NL
Beryllium (Be)	637M0001	0.27	NL
Cadmium (Cd)	637M0001	0.66	1.0
Calcium (Ca)	637M0001	33600	NL
Chromium (Cr)	637M0001	32.2	52.3
Cobalt (Co)	637M0001	3.6	NL
Copper (Cu)	637M0001	221	18.7
Iron (Fe)	637M0001	7040	NL
Lead (Pb)	637M0001	73.5	30.2
Magnesium (Mg)	637M0001	1270	NL
Manganese (Mn)	637M0001	50.6	NL
Mercury (Hg)	637M0001	0.17	0.13
Nickel (Ni)	637M0001	46.4	15.9
Potassium (K)	637M0001	443	NL
Selenium (Se)	637M0001	0.55	NL
Sodium (Na)	637M0001	1110	NL
Thallium (Tl)	637M0001	0.69	NL
Tin (Sb)	637M0001	9.7	NL
Vanadium (V)	637M0001	21.3	NL
Zinc (Zn)	637M0001	202	124

Notes:
1 = Calculated from methods described in USEPA Interim *Supplemental Guidance to RAGS: Human Health Risk Assessment*, Bulletin 2 (USEPA, 1995b)
µg/kg = Micrograms per kilogram
mg/kg = Milligrams per kilogram
NA = Not available
SSV = Sediment Screening Value
Bolded concentrations exceed the SSV
SSVs from *Supplemental Guidance to RAGs: Region IV Bulletins, Ecological Risk Assessment, Bulletin 2* (USEPA, 1995a)



ZONE G
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FIGURE 10.7-9
BIS(2-ETHYLHEXYL)PHTHALATE
IN SEDIMENT
AOC #637 DUMP AREA

DWG DATE: 02/04/98 | DWG NAME: 2907M076

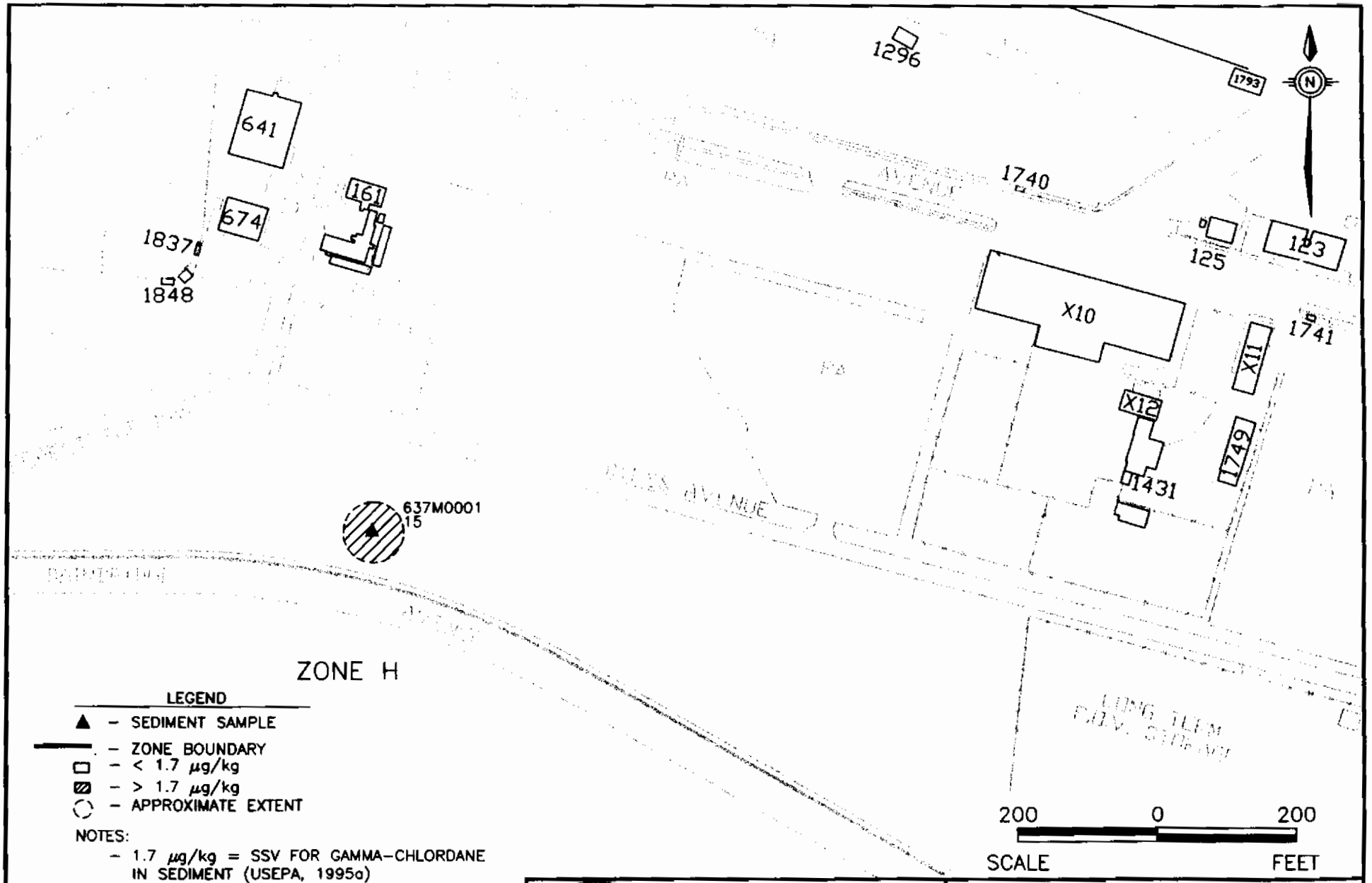

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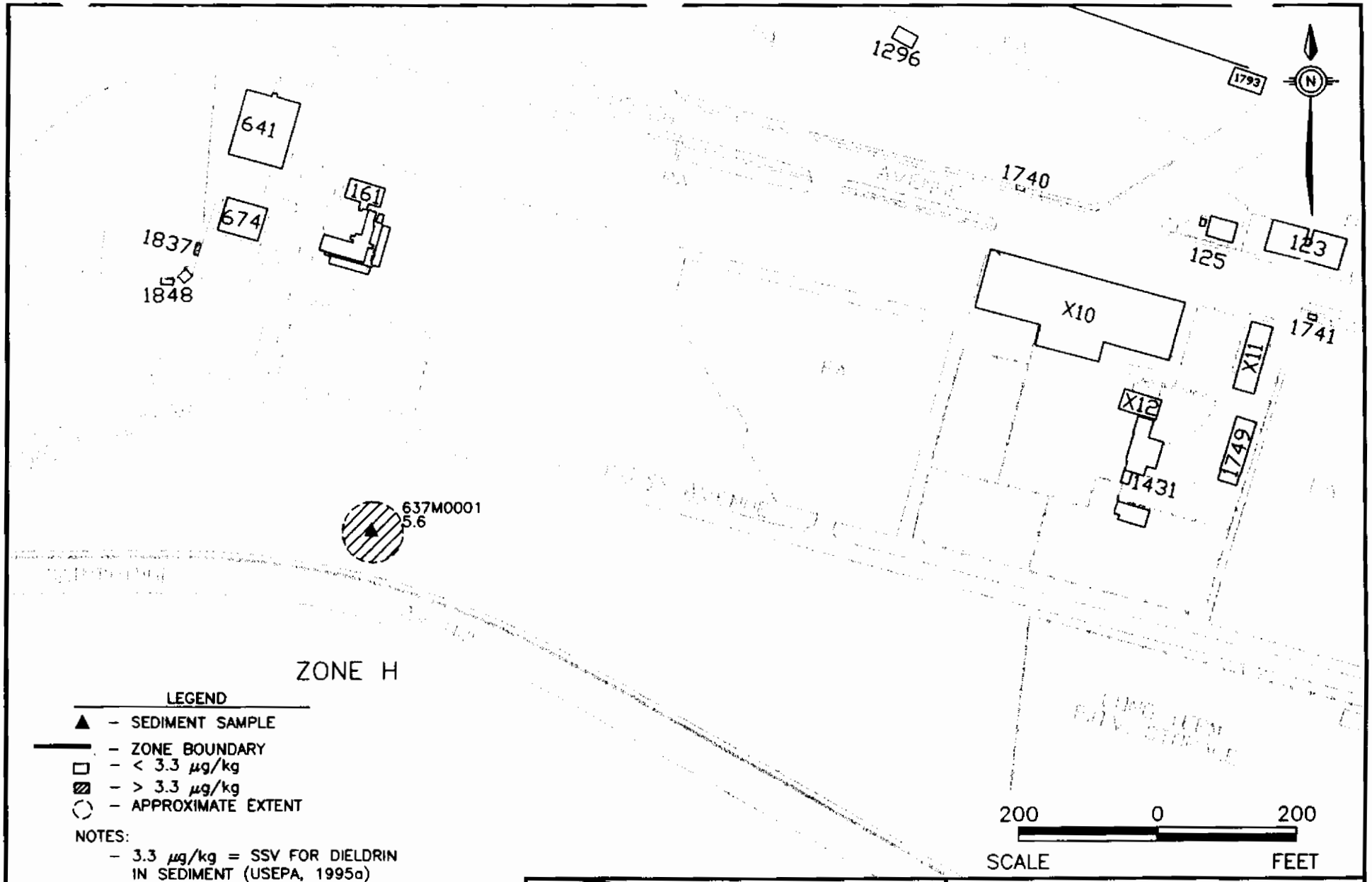
FIGURE 10.7–10
GAMMA–CHLORDANE IN SEDIMENT
AOC #637 DUMP AREA

DWG DATE: 02/04/98 | DWG NAME: 2907M077



LEGEND

- ▲ – SEDIMENT SAMPLE
- ▬ – ZONE BOUNDARY
- □ – < 3.3 µg/kg
- ▨ – > 3.3 µg/kg
- ◌ – APPROXIMATE EXTENT

NOTES:

- 3.3 µg/kg = SSV FOR DIELDRIN IN SEDIMENT (USEPA, 1995a)
- RESULTS IN µg/kg

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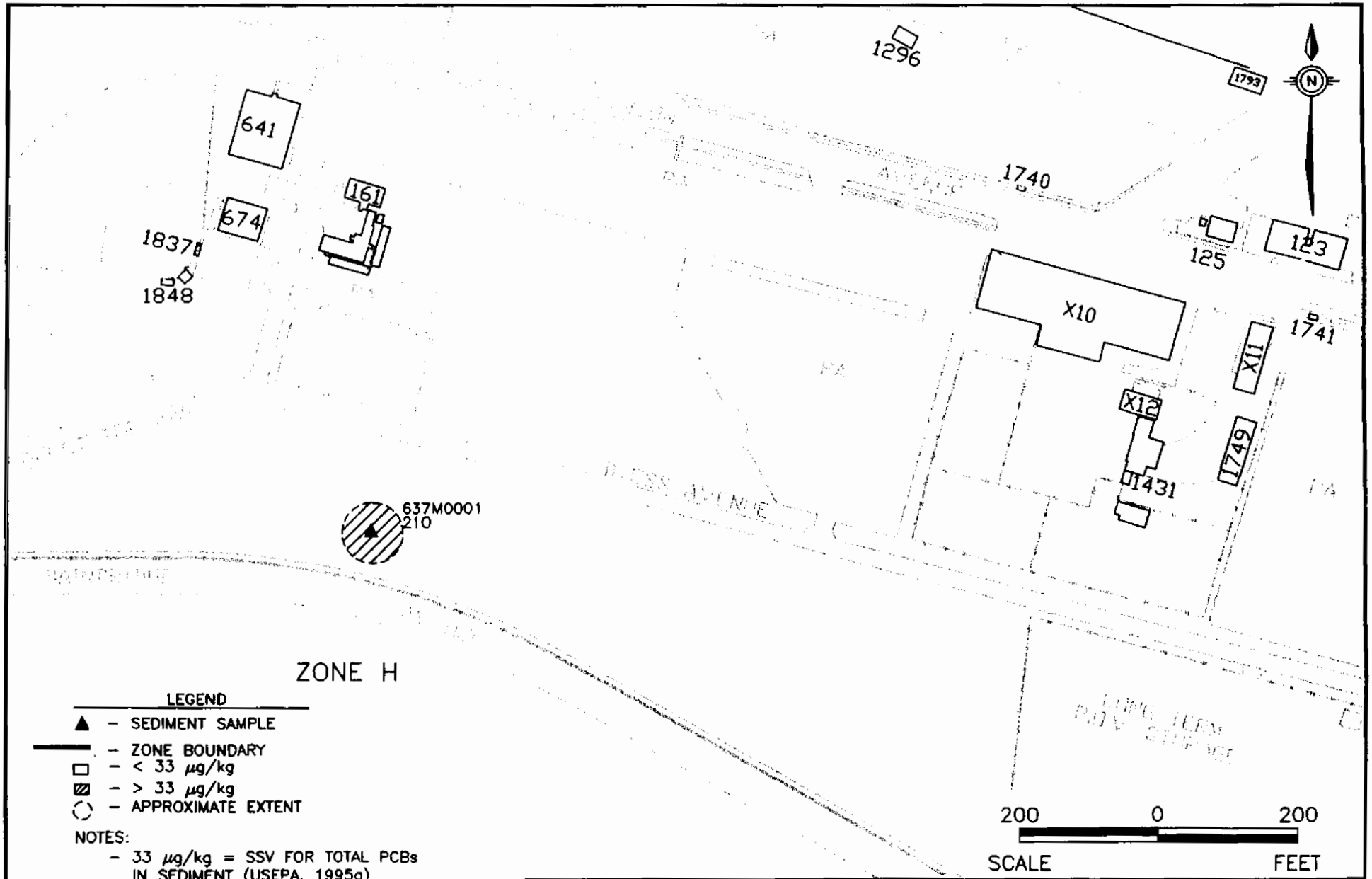
FIGURE 10.7–11
DIELDRIN IN SEDIMENT
AOC #637 DUMP AREA

DWG DATE: 02/04/98 | DWG NAME: 2907M078



ZONE G
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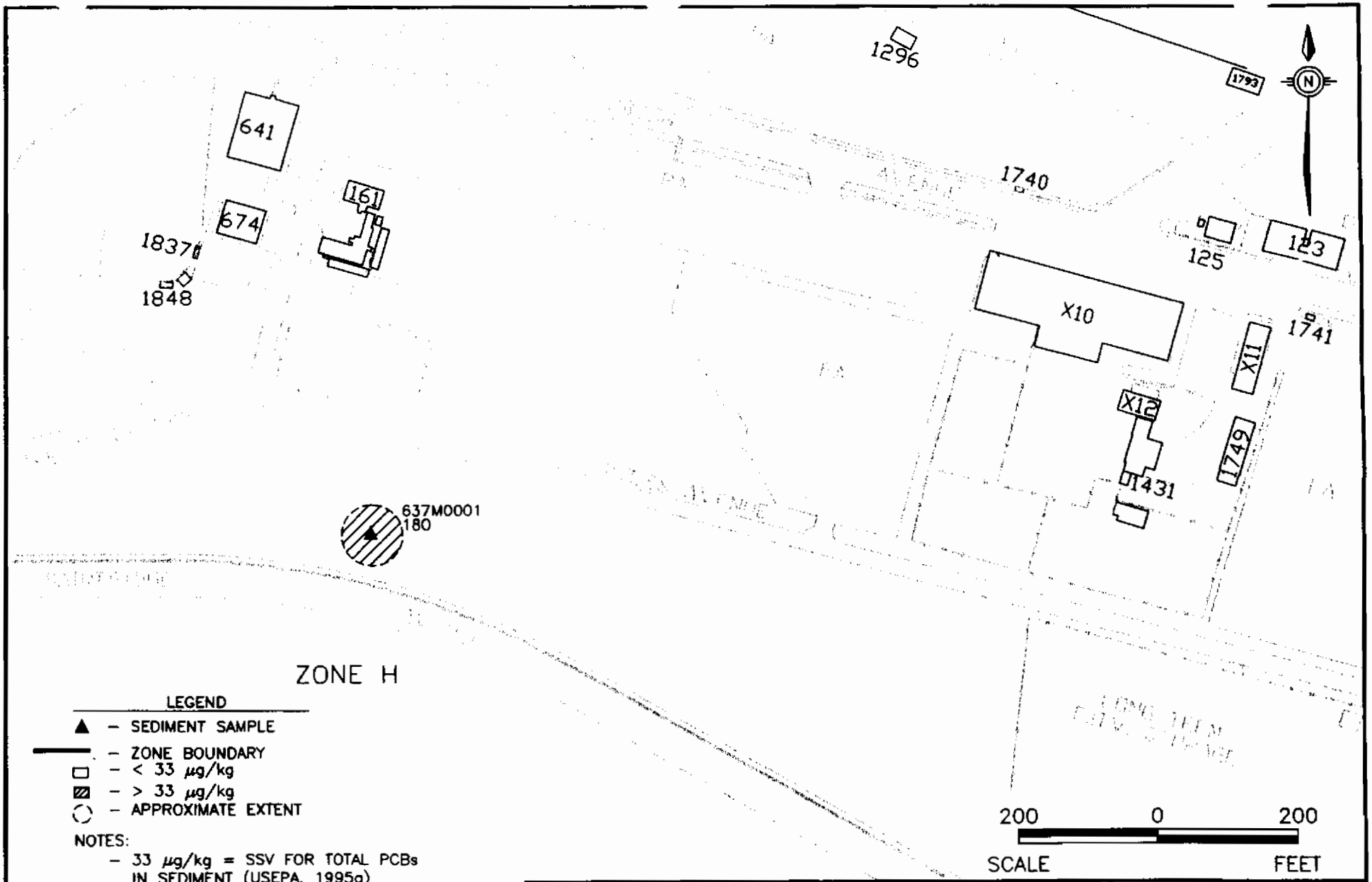
FIGURE 10.7–12
AROCLOR–1016 IN SEDIMENT
AOC #637 DUMP AREA

DWG DATE: 02/04/98 | DWG NAME: 2907M079



ZONE G
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CHARLESTON, S.C.

FIGURE 10.7–13
AROCLOR–1260 IN SEDIMENT
AOC #637 DUMP AREA

DWG DATE: 02/04/98 | DWG NAME: 2907M080

Inorganic Elements in Sediment

Twenty-three metals were detected in AOC 637 sediment. Copper, lead, mercury, nickel, and zinc were detected above their respective SSVs. Figures 10.7-14 through 10.7-18 present copper, lead, mercury, nickel, and zinc concentrations in sediment respectively, at AOC 637.

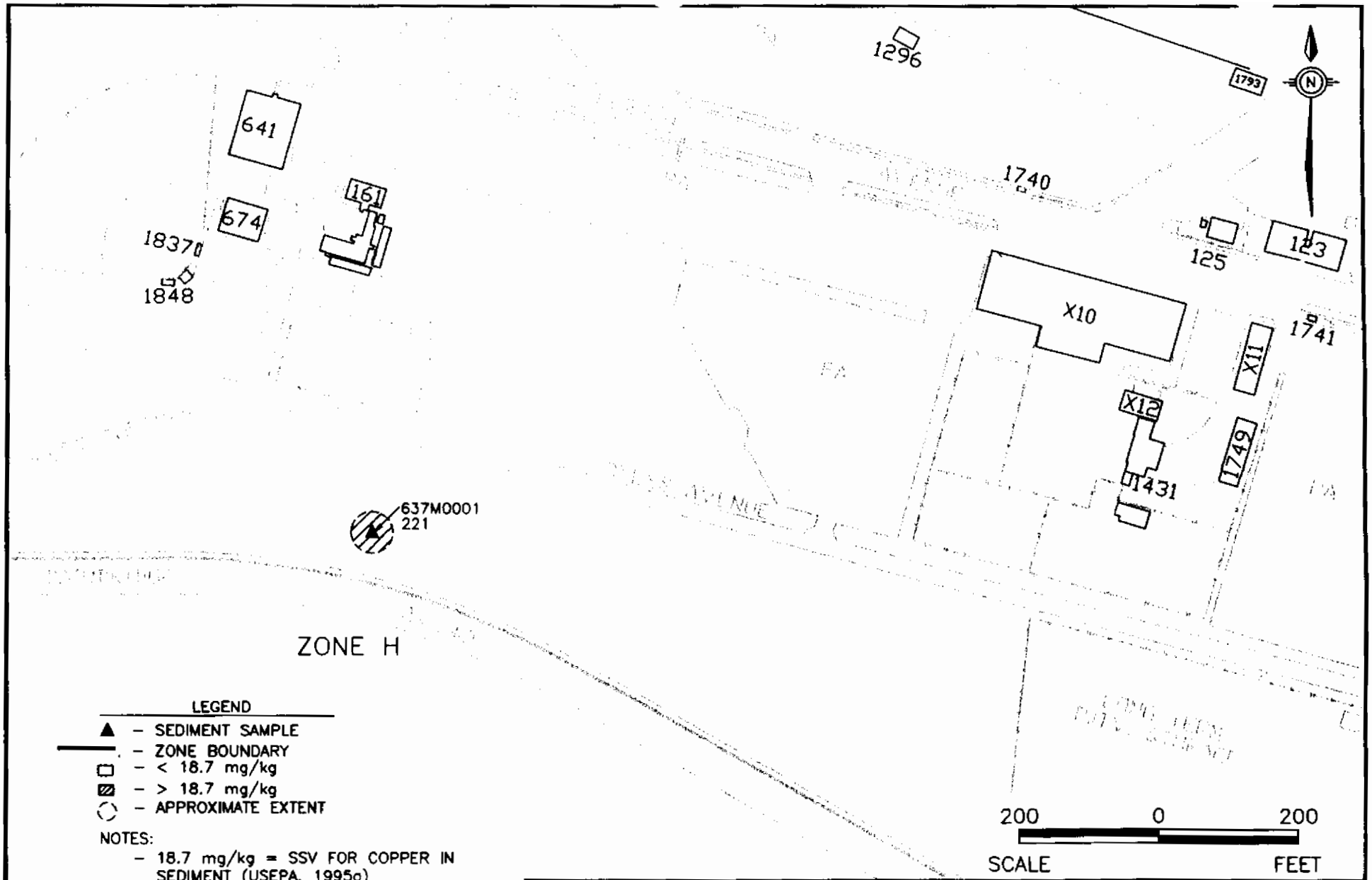
10.7.5 Groundwater Sampling and Analysis

The approved final RFI work plan proposed the installation and sampling of one shallow monitoring well within the AOC 637 area to: (1) assess groundwater quality, and (2) identify contaminants which may be migrating from the site in the shallow aquifer. During the field investigation, three shallow monitoring wells were installed at this site, in two phases (Figure 10.7-1). These wells were installed between 12 and 13 ft bgs in the fill material. The proposed shallow well was installed within the site area as specified in the approved final RFI work plan. The groundwater sample from this well was analyzed for metals, pesticides/PCB, SVOCs, and VOCs at DQO Level III. Later, two second phase wells were installed to delineate metal and VOC contamination identified during the first sampling round. Second phase well groundwater samples were analyzed for metals, pesticides/PCBs, SVOCs, VOCs, explosives, and propellants at DQO Level III. A duplicate sample was collected from a second phase monitoring well. This duplicate was analyzed for Appendix IX parameters and explosives/propellants. Table 10.7.9 summarizes groundwater sampling and analyses at these sites.

Table 10.7.9
Zone G
AOC 637
Groundwater Samples and Analyses

Well Number	Well Depth	Sample Identifier	Date Sampled	Analyses	Remarks
637001	Shallow	63700101	11/15/96	Note 1	
637002	Shallow	637002A1	4/30/97	Note 2	Second-round sample
637003	Shallow	637003A1*	4/30/97	Note 2/3*	Second-round sample

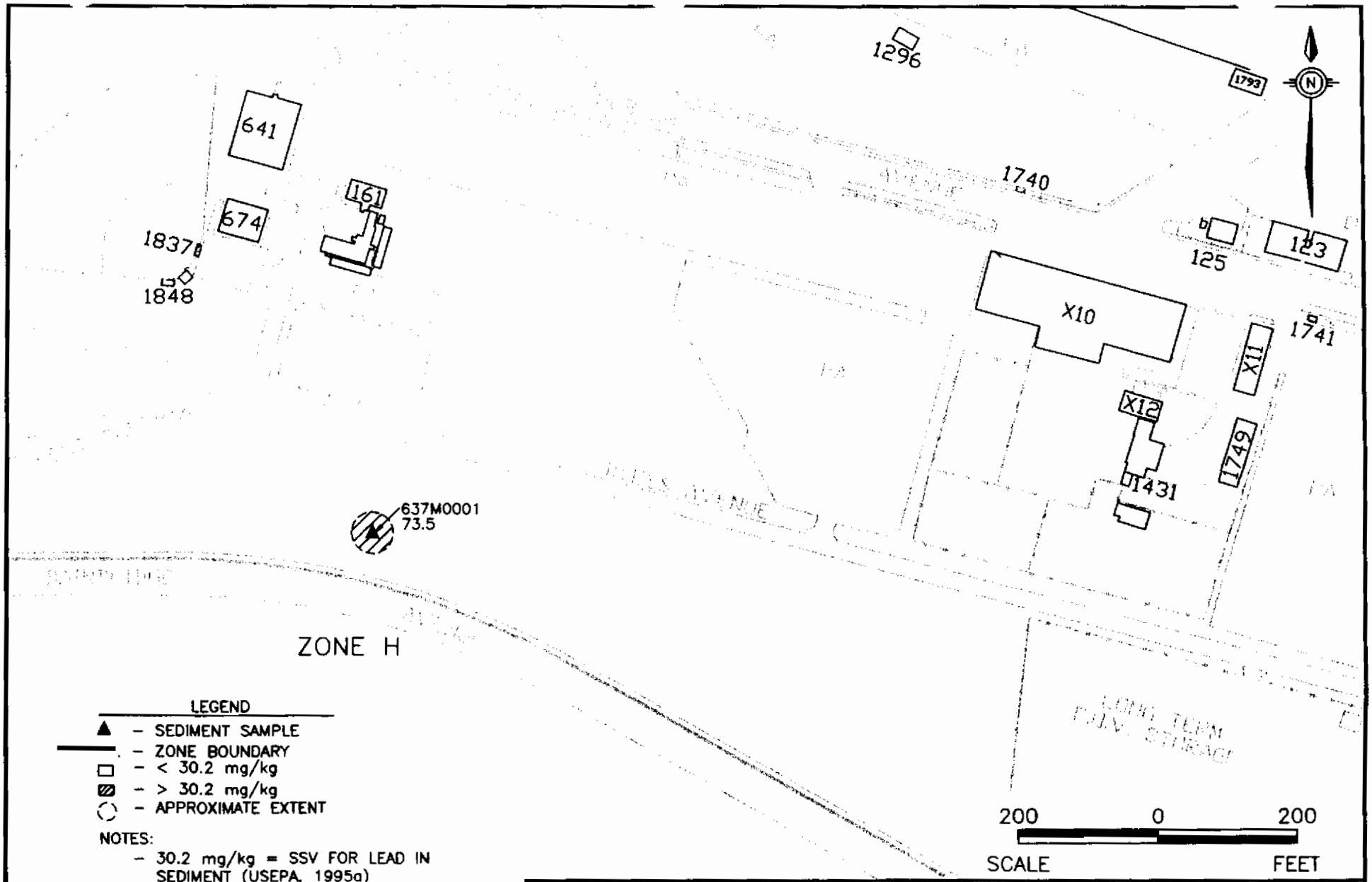
Notes:
1 = SW-846 (metals, pesticides/PCBs, SVOCs, VOCs) at DQO Level III
2 = SW-846 (metals, pesticides/PCBs, SVOCs, VOCs); explosives, propellants at DQO Level III
3 = Appendix IX suite: Appendix IX (pesticides/PCBs, herbicides, SVOCs, VOCs); SW-846 (metals, dioxins, OP-pesticides); cyanide; hexchrome and explosives/propellants at DQO Level IV
* = Duplicate sample collected



ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.7–14
COPPER IN SEDIMENT
AOC #637 DUMP AREA

DWG DATE: 02/04/98 | DWG NAME: 2907M081



ZONE G
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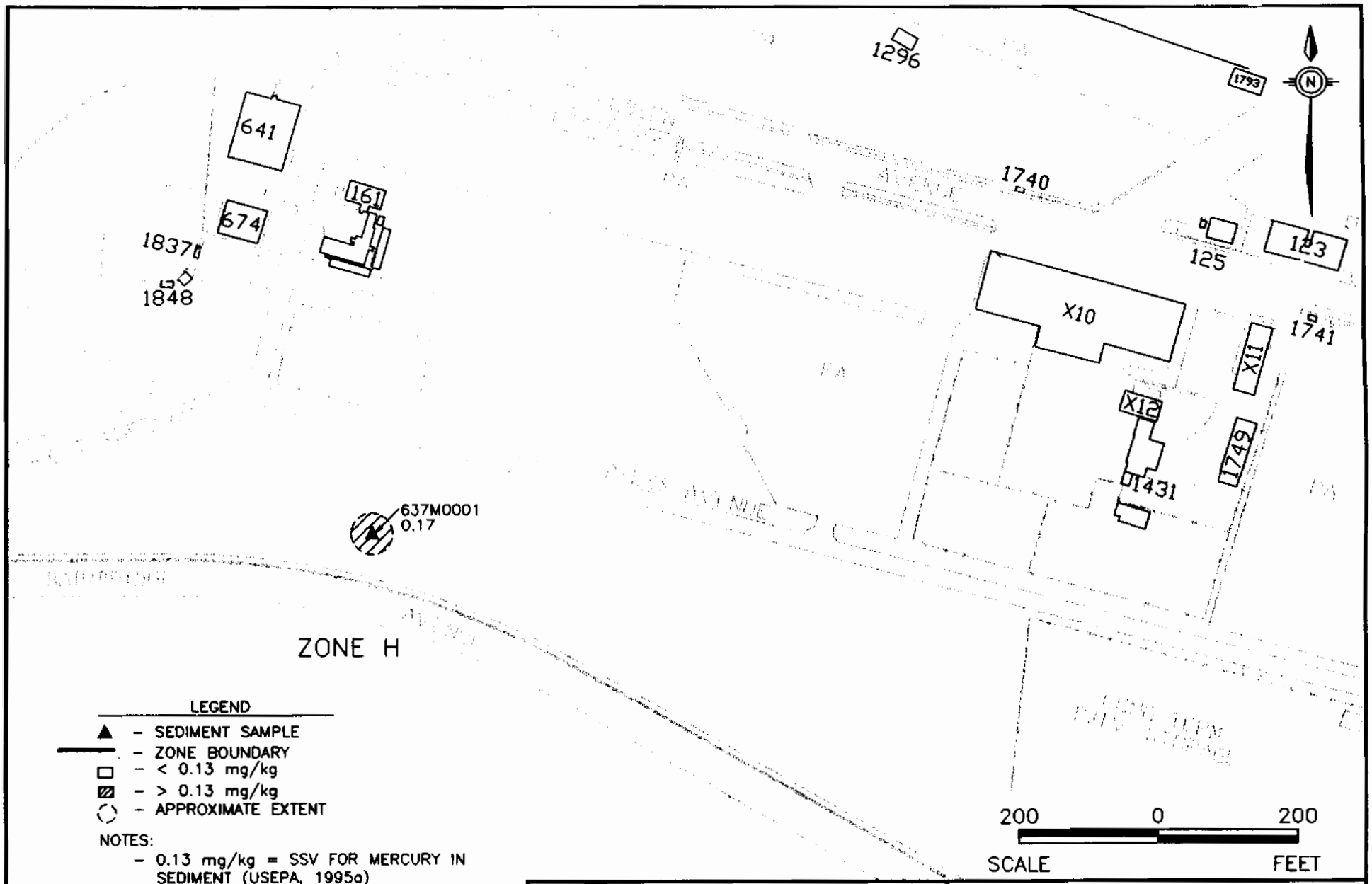
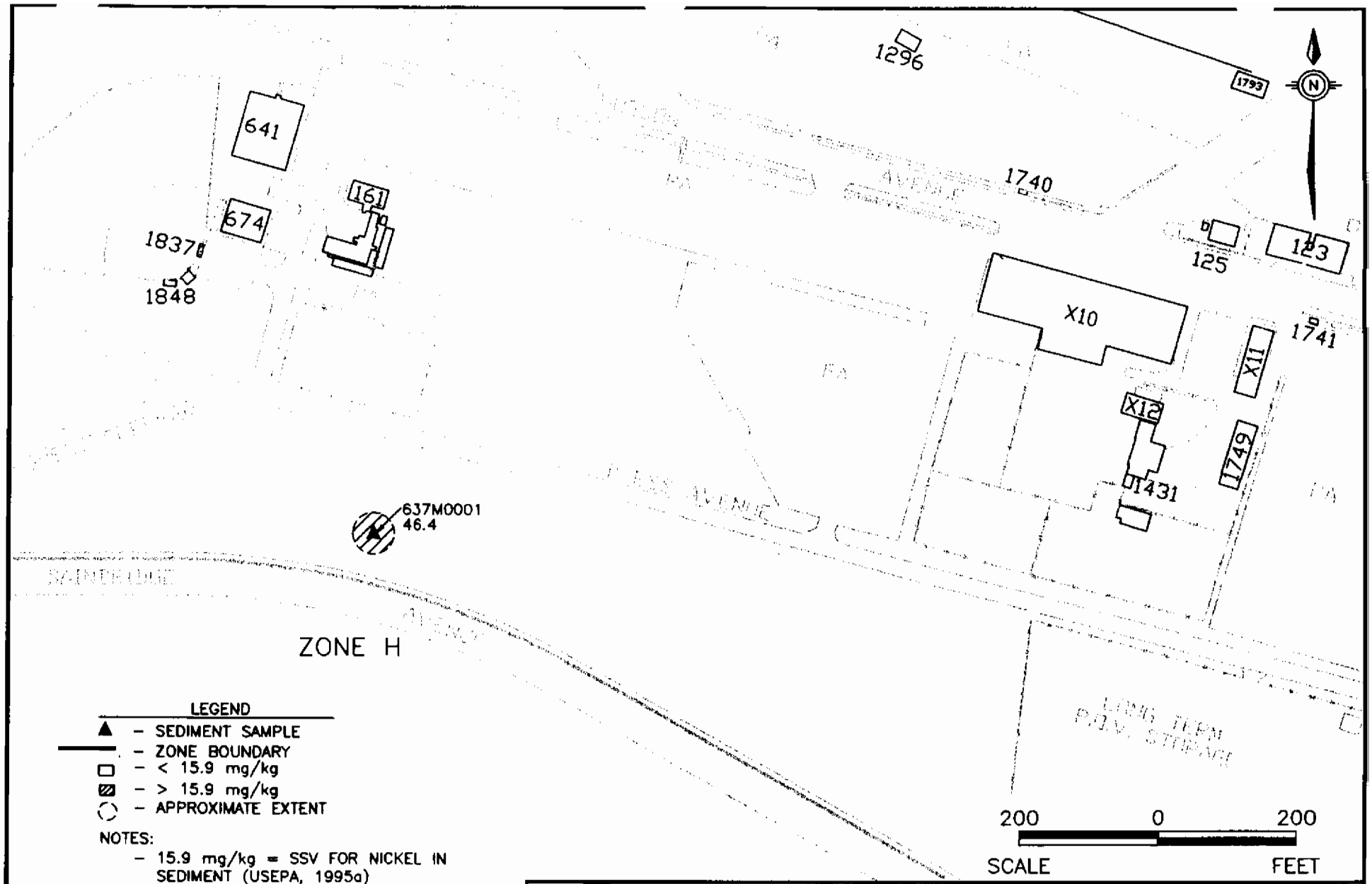
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.7-15
LEAD IN SEDIMENT
AOC #637 DUMP AREA

DWG DATE: 02/04/98 | DWG NAME: 2907M082


1296
1793
641
1740
161
674
1837
1848
125
123
X10
1741
X11
X12
1749
1431
637M0001
0.17
ZONE H
LEGEND
▲ – SEDIMENT SAMPLE
– ZONE BOUNDARY
– < 0.13 mg/kg
– > 0.13 mg/kg
– APPROXIMATE EXTENT
NOTES:
– 0.13 mg/kg = SSV FOR MERCURY IN SEDIMENT (USEPA, 1995a)
– RESULTS IN mg/kg
200 0 200
SCALE FEET
ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 10.7-16
MERCURY IN SEDIMENT
AOC #637 DUMP AREA
DWG DATE: 02/04/98
DWG NAME: 2907M083


1296
1793
641
161
674
1837
1848
1740
125
123
X10
1741
X11
X12
1749
1431
637M0001
46.4
ZONE H
LEGEND
▲ – SEDIMENT SAMPLE
– ZONE BOUNDARY
– < 15.9 mg/kg
– > 15.9 mg/kg
– APPROXIMATE EXTENT
NOTES:
– 15.9 mg/kg = SSV FOR NICKEL IN SEDIMENT (USEPA, 1995a)
– RESULTS IN mg/kg
200 0 200
SCALE FEET
ZONE G
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INVESTIGATION REPORT
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FIGURE 10.7-17
NICKEL IN SEDIMENT
AOC #637 DUMP AREA
DWG DATE: 02/10/98
DWG NAME: 2907M084

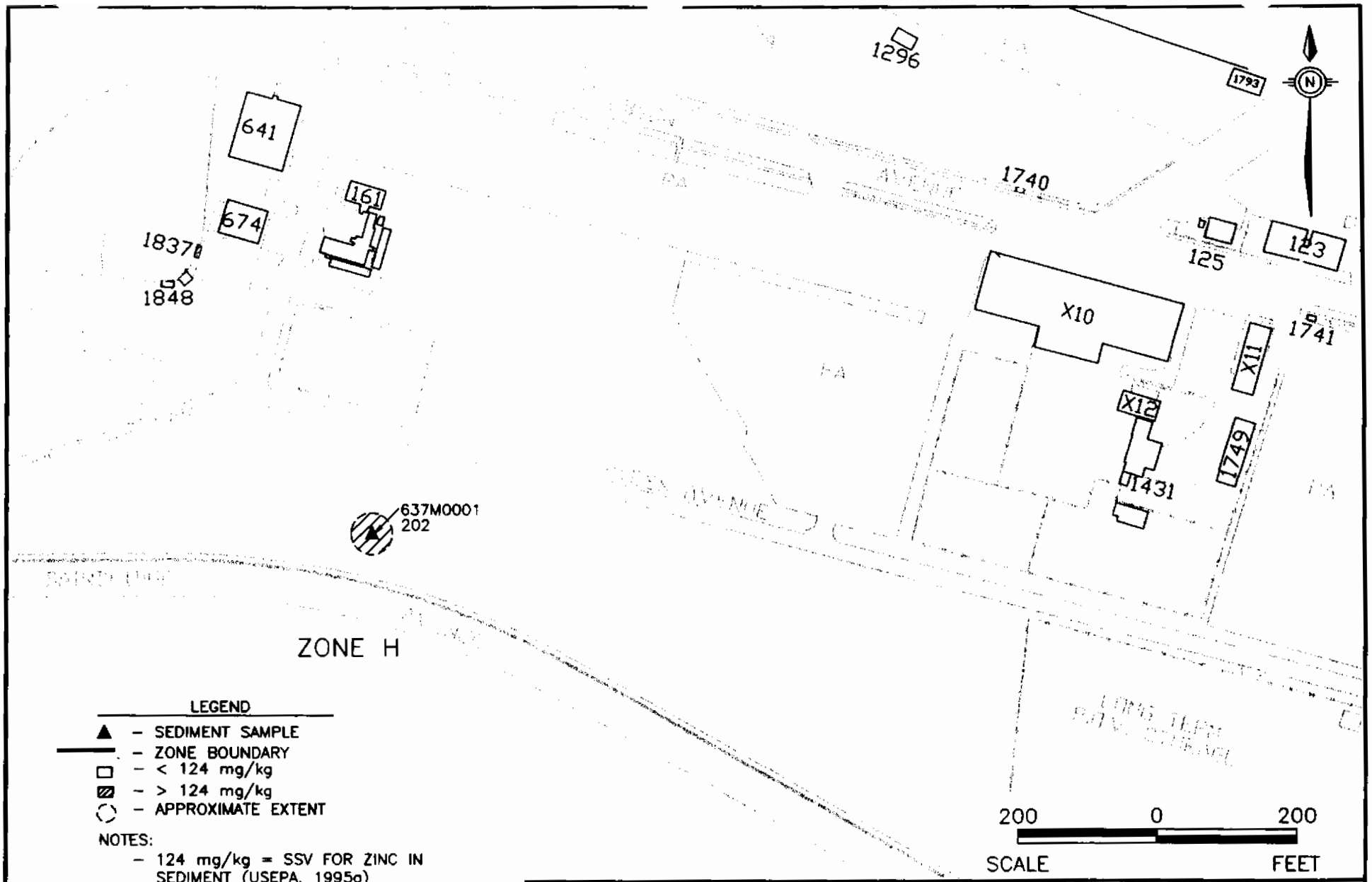
1296
1793
641
161
674
1740
18370
1848
125
123
X10
1741
X11
X12
1749
1431
637M0001
202
ZONE H
LEGEND
▲ – SEDIMENT SAMPLE
– ZONE BOUNDARY
□ – < 124 mg/kg
▨ – > 124 mg/kg
◌ – APPROXIMATE EXTENT
NOTES:
– 124 mg/kg = SSV FOR ZINC IN SEDIMENT (USEPA, 1995a)
– RESULTS IN mg/kg
200 0 200
SCALE FEET
ZONE G
RCRA FACILITY
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FIGURE 10.7-18
ZINC IN SEDIMENT
AOC #637 DUMP AREA
DWG DATE: 02/04/98
DWG NAME: 2907M085

10.7.5.1 Nature of Contamination in Groundwater

Organic analytical results for groundwater are summarized in Table 10.7.10. Inorganic analytical results for groundwater are summarized in Table 10.7.11. Table 10.7.12 summarizes all analytes detected in groundwater at AOC 637. Appendix D contains a complete analytical data report for all Zone G samples.

Volatile Organic Compounds in Groundwater

Seven VOCs were detected in shallow groundwater samples from AOC 637. Concentrations of benzene, chlorobenzene, ethylbenzene, toluene and xylene, were detected above their respective tap water RBCs. Figures 10.7-19 through 10.7-23 present these VOC concentrations in AOC 637 groundwater.

Semivolatile Organic Compounds in Groundwater

Fifteen SVOCs were detected in shallow groundwater samples from AOC 637. Concentrations of 1,4-dichlorobenzene, 4-methylphenol, and naphthalene, exceeded their respective tap water RBC. Figures 10.7-24 through 10.7-26 present 1,4-dichlorobenzene, 4-methylphenol and naphthalene concentrations in AOC 637 shallow groundwater samples respectively.

Pesticides and PCBs in Groundwater

Two pesticides, 4,4'-DDD and 4,4'-DDT were detected in AOC 637 groundwater samples at concentrations below their respective tap water RBCs.

Other Organic Compounds in Groundwater

The explosive tertyl was detected at a concentration above its respective tap water RBC at AOC 637. The propellant hydrazine was also detected above its tap water RBC in AOC 637 shallow groundwater samples. Figure 10.7-27 presents tetryl concentrations in shallow groundwater at AOC 637. Figure 10.7-28 presents hydrazine concentrations in shallow groundwater.

Table 10.7.10
Zone G
AOC 637
Organic Compound Analytical Results for Groundwater

Parameters	Interval	Frequency of Detection	Range of Detections (µg/L)	Mean of Detections (µg/L)	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Number of Samples Exceeding Reference
Volatile Organic Compounds (3 Shallow Samples plus 1 Duplicate Sample) (µg/L)							
Acetone	Shallow	2/3	6.50 - 25.0	15.8	370	NL	0
Benzene	Shallow	2/3	3.00 - 55.0	29.0	0.36	5	2
Chlorobenzene	Shallow	3/3	2.00 - 38.0	15.7	3.9	NL	2
Ethylbenzene	Shallow	1/3	440	440	130	700	1
4-Methyl-2-Pentanone (MBK)	Shallow	1/3	22.0	22.0	290	NL	0
Toluene	Shallow	2/3	2.00 - 92.0	47.0	75	1000	1
Xylene (Total)	Shallow	2/3	6.00 - 6300	3150	1200	10000	1
Semivolatile Organic Compounds (3 Shallow Samples plus 1 Duplicate Sample) (µg/L)							
Acenaphthene	Shallow	2/3	3.00- 12.5	7.75	220	NL	0
Anthracene	Shallow	1/3	11.0	11.0	1100	NL	0
Dibenzofuran	Shallow	2/3	1.00 - 13.5	7.25	15	NL	0
1,4-Dichlorobenzene	Shallow	2/3	2.00	2.00	0.44	75	2
2,4-Dichlorophenol	Shallow	1/3	4.00	4.00	11	NL	0
2,4-Dimethylphenol	Shallow	2/3	28.0 - 48.0	38.0	73	NL	0

Table 10.7.10
Zone G
AOC 637
Organic Compound Analytical Results for Groundwater

Parameters	Interval	Frequency of Detection	Range of Detections (µg/L)	Mean of Detections (µg/L)	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Number of Samples Exceeding Reference
Fluoranthene	Shallow	1/3	9.00	9.00	150	NL	0
Fluorene	Shallow	2/3	2.00 - 15.0	8.50	150	NL	0
2-Methylnaphthalene	Shallow	2/3	3.00 - 39.0	21.0	150	NL	0
2-Methylphenol (o-Cresol)	Shallow	2/3	19.0 - 25.0	22.0	180	NL	0
4-Methylphenol (p-Cresol)	Shallow	1/3	50.0	50.0	18	NL	1
Naphthalene	Shallow	2/3	20.0 - 240	130	150	NL	1
Phenanthrene	Shallow	2/3	1.00 - 55.0	28.0	150	NL	0
Phenol	Shallow	2/3	6.00 - 9.50	7.75	2200	NL	0
Pyrene	Shallow	1/3	6.0	6.0	110	NL	0
Pesticides and PCBs (3 Samples plus 1 Duplicate Sample) (µg/L)							
4,4'-DDD	Shallow	1/3	0.21	0.21	0.28	NL	0
4,4'-DDT	Shallow	1/3	0.12	0.12	0.20	NL	0
Explosive and Propellants (2 Samples plus 1 Duplicate Sample) (µg/L)							
Tetryl	Shallow	1/2	38.0	38.0	37	NL	1

Table 10.7.10
Zone G
AOC 637
Organic Compound Analytical Results for Groundwater

Parameters	Interval	Frequency of Detection	Range of Detections (µg/L)	Mean of Detections (µg/L)	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Number of Samples Exceeding Reference
Hydrazine	Shallow	2/2	5.80 - 7.65	6.73	0.022	NL	2

Notes:
NL = Not listed
* = Tap Water RBCs (THQ=0.1) from *Risk-Based Concentration Table* (USEPA, October 22, 1997), and MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996e)
µg/L = Micrograms per liter
Additional second phase wells 637002 and 637003 are included in calculations

Table 10.7.11
Zone G
AOC 637
Inorganic Analytical Results for Groundwater

Parameters	Interval	Frequency of Detection	Range of Detections (µg/L)	Mean of Detections (µg/L)	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Number of Samples Exceeding RBC
Inorganics (3 Shallow Samples plus 1 Duplicate Sample (µg/L)							
Aluminum (Al)	Shallow	3/3	67.8 - 415	196	3700	50	0
Antimony (Sb)	Shallow	2/3	6.80 - 8.70	7.75	1.5	6	2
Arsenic (As)	Shallow	2/3	7.60 - 7.90	7.75	0.045	50	2
Barium (Ba)	Shallow	3/3	211 - 6000	3230	260	2000	2
Cadmium (Cd)	Shallow	2/3	0.35 - 0.36	0.36	1.8	5	0
Calcium (Ca)	Shallow	3/3	124000 -233500	171000	NL	NL	NA
Chromium (Cr)	Shallow	3/3	1.40 - 33.6	13.4	18	100	1
Cobalt (Co)	Shallow	2/3	1.20 - 2.25	1.73	220	NL	0
Copper (Cu)	Shallow	1/3	118	118	13000	1300	0
Iron (Fe)	Shallow	3/3	6607 - 18800	13400	1100	300	3
Lead (Pb)	Shallow	3/3	1.20 - 44.1	19.5	15	15	1
Magnesium (Mg)	Shallow	3/3	38060 - 212000	107000	NL	NL	NA
Manganese (Mn)	Shallow	3/3	209 - 416	313	84	50	3
Mercury (Hg)	Shallow	1/3	0.33	0.33	1.1	2	0

Table 10.7.11
Zone G
AOC 637
Inorganic Analytical Results for Groundwater

Parameters	Interval	Frequency of Detection	Range of Detections (µg/L)	Mean of Detections (µg/L)	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Number of Samples Exceeding RBC
Nickel (Ni)	Shallow	3/3	3.30 - 12.45	6.92	73	100	0
Potassium (K)	Shallow	3/3	38000 - 205000	111000	NL	NL	NA
Silver (Ag)	Shallow	1/3	1.70	1.70	18	100	0
Sodium (Na)	Shallow	3/3	644000 - 3410000	1970000	NL	NL	NA
Thallium (Tl)	Shallow	2/3	3.00 - 5.50	4.25	0.29	2	2
Vanadium (V)	Shallow	2/3	1.50 - 5.70	3.60	26	NL	0
Zinc (Zn)	Shallow	3/3	58.4 - 363	163	1100	5000	0

Notes:
* = Tap Water RBCs (THQ=0.1) from *Risk-Based Concentration Table* (USEPA, October 22, 1997), and MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996e)
µg/L = Micrograms per liter
NL = Not listed
NA = Not applicable
Additional second phase wells 637002 and 637003 are included in calculations

Table 10.7.12
Zone G
AOC 637
Analytes Detected in Shallow Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Shallow Background
Volatile Organic Comounds (µg/L)							
Acetone	637002	NI	25	ND	370	NL	NA
	637003	NI	6.5	ND			
Benzene	637001	55	18	17	0.36	5	NA
	637003	NI	3.0	4			
Chlorobenzene	637001	38	56	53	3.9	NL	NA
	637002	NI	7	6			
	637003	NI	2	ND			
Ethylbenzene	637001	440	160	170	130	700	NA
	637003	NI	ND	3			
4-Methyl-2-Pentanone	637001	22	ND	ND	290	NL	NA
Toluene	637001	92	36	27	75	1000	NA
	637003	NI	2	3			
Xylenes	637001	6300	1500	1400	1200	10000	NA
	637003	NI	6	8			
Semivolatile Organic Compounds (µg/L)							
Acenaphthene	637001	ND	ND	2	220	NL	NA
	637002	NI	3	2			
	637003	NI	12.5	23			
Anthracene	637003	NI	11	13	1100	NL	NA
Benzoic acid	637001	ND	3	ND	15000	NL	NA

Table 10.7.12
Zone G
AOC 637
Analytes Detected in Shallow Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Shallow Background
Dibenzofuran	637002	NI	1	ND	15	NL	NA
	637003	NI	13.5	24			
1,4-Dichlorobenzene	637002	NI	2	ND	0.44	75	NA
	637003	NI	2	ND			
2,4-Dichlorophenol	637001	4	ND	ND	11	NL	NA
2,4-Dimethylphenol	637001	28	6	ND	73	NL	NA
	637003	NI	48	17			
Di-n-butylphthalate	637001	ND	ND	1	370	NL	NA
	637002	NI	ND	1			
	637003	NI	ND	1			
Fluoranthene	637003	NI	9	11	150	NL	NA
Fluorene	637002	NI	2	ND	150	NL	NA
	637003	NI	15	27			
2-Methylnaphthalene	637001	3	1	ND	150	NL	NA
	637003	NI	39	23			
2-Methylphenol (o-Creosol)	637001	19	ND	ND	180	NL	NA
	637003	NI	25	8			
4-Methylphenol (p-Creosol)	637001	ND	3	ND	18	NL	NA
	637003	NI	50	10			
Naphthalene	637001	20	6	ND	150	NL	NA
	637003	NI	240	190			

Table 10.7.12
Zone G
AOC 637
Analytes Detected in Shallow Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Shallow Background
N-Nitrosodiphenylamine	637001	ND	ND	2	14	NL	NA
	637002	NI	ND	1			
Phenanthrene	637001	1	0.9	ND	150	NL	NA
	637003	NI	55	61			
Phenol	637001	6	3	ND	2200	NL	NA
	637003	NI	9.5	ND			
Pyrene	637003	NI	6	7	110	NL	NA
Pesticides and PCBs (µg/L)							
4,4'-DDD	637003	NI	0.21	ND	0.28	NL	NA
4,4'-DDT	637003	NI	0.12	ND	0.20	NL	NA
Explosives/Propellants (µg/L)							
Tetryl	637002	NI	38	ND	37	NL	NA
Hydrazine (µg/L)							
Hydrazine	637002	NI	5.8	5.1	0.022	NL	NA
	637003	NI	7.65	ND			
Inorganics (µg/L)							
Aluminum (Al)	637001	415	96.6	150	3700	50	692
	637002	NI	67.8	171			
	637003	NI	104.35	231			

Table 10.7.12
Zone G
AOC 637
Analytes Detected in Shallow Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Shallow Background
Antimony (Sb)	637001	8.7	ND	ND	1.5	6	4.85
	637003	NI	6.8	ND			
Arsenic (As)	637001	7.6	4.3	5.1	0.045	50	17.8
	637003	NI	7.9	3.4			
Barium (Ba)	637001	6000	2840	3660	260	2000	31
	637002	NI	211	220			
	637003	NI	3471	4640			
Beryllium (Be)	637001	ND	0.39	0.23	0.016	4	NL
Cadmium (Cd)	637002	NI	0.35	0.55	1.8	5	0.53
	637003	NI	0.36	ND			
Calcium (Ca)	637001	124000	107000	135000	NL	NL	NL
	637002	NI	155000	186000			
	637003	NI	233500	133000			
Chromium (Cr)	637001	33.6	13.2	14.6	18	100	3.88
	637002	NI	1.4	1.7			
	637003	NI	5.1	1.6			
Cobalt (Co)	637001	ND	ND	1.4	220	NL	1.45
	637002	NI	1.2	ND			
	637003	NI	2.25	ND			
Copper (Cu)	637001	118	43.4	42	13000	1300	8.33
	637003	NI	ND	13.7			

Table 10.7.12
Zone G
AOC 637
Analytes Detected in Shallow Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Shallow Background
Iron (Fe)	637001	18800	15900	14400	1100	300	NL
	637002	NI	14900	12700			
	637003	NI	6607	583			
Lead (Pb)	637001	44.1	13.0	ND	15	15	4.6
	637002	NI	1.2	ND			
	637003	NI	13.3	ND			
Magnesium (Mg)	637001	212000	143000	157000	NL	NL	NL
	637002	NI	71400	70200			
	637003	NI	38060	ND			
Manganese (Mn)	637001	315	214	195	84	50	2906
	637002	NI	416	433			
	637003	NI	209	10.9			
Mercury (Hg)	637001	ND	ND	0.26	1.1	2	NL
	637003	NI	0.33	0.73			
Nickel (Ni)	637001	5.0	4.5	4.1	73	100	4.08
	637002	NI	3.3	ND			
	637003	NI	12.45	2.3			
Potassium (K)	637001	205000	111000	96800	NL	NL	NL
	637002	NI	38000	45100			
	637003	NI	90250	79400			
Selenium (Se)	637001	ND	4.2	ND	18	50	4.3
Silver (Ag)	637001	1.7	ND	ND	18	100	1.65

Table 10.7.12
Zone G
AOC 637
Analytes Detected in Shallow Groundwater

Parameters	Location	1st Quarter Conc.	2nd Quarter Conc.	3rd Quarter Conc.	Tap Water RBC* (µg/L)	MCL/SMCL* (µg/L)	Shallow Background
Sodium (Na)	637001	3410000	2070000	1940000	NL	NL	NL
	637002	NI	644000	735000			
	637003	NI	1869500	1590000			
Thallium (Tl)	637001	3	ND	ND	0.29	2	NL
	637003	NI	5.5	ND			
Vanadium (V)	637001	5.7	2.7	4.7	26	NL	15.4
	637003	NI	1.5	2.2			
Zinc (Zn)	637001	363	185	198	1100	5000	15.6
	637002	NI	68.8	84.5			
	637003	NI	58.4	ND			

Notes:
NL = Not listed
NA = Not applicable
NI = Not installed
µg/L = Micrograms per liter
* = Tap Water RBCs (THQ=0.1) from *Risk-Based Concentration Table* (USEPA, October 22, 1997), and MCLs/SMCLs from *Drinking Water Regulations and Health Advisories* (USEPA, 1996e)
Bolded concentrations exceed both the RBC and the zone background
All background values for Zone G are based on twice the means of the grid sample concentrations. Background values for groundwater are based on two sampling rounds in two wells at each depth

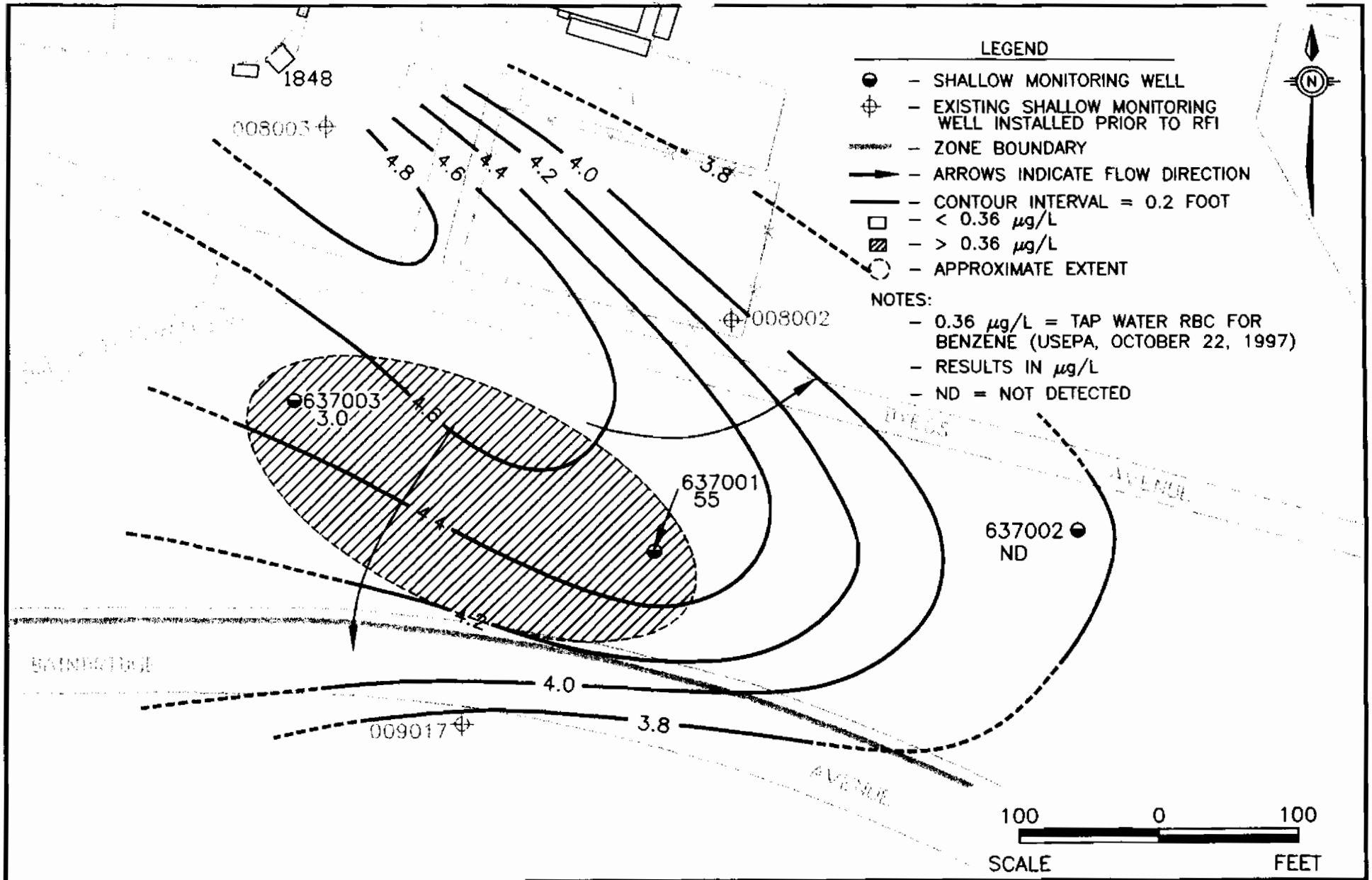

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FIGURE 10.7–19
BENZENE IN SHALLOW GROUNDWATER
AOC #637 DUMP AREA

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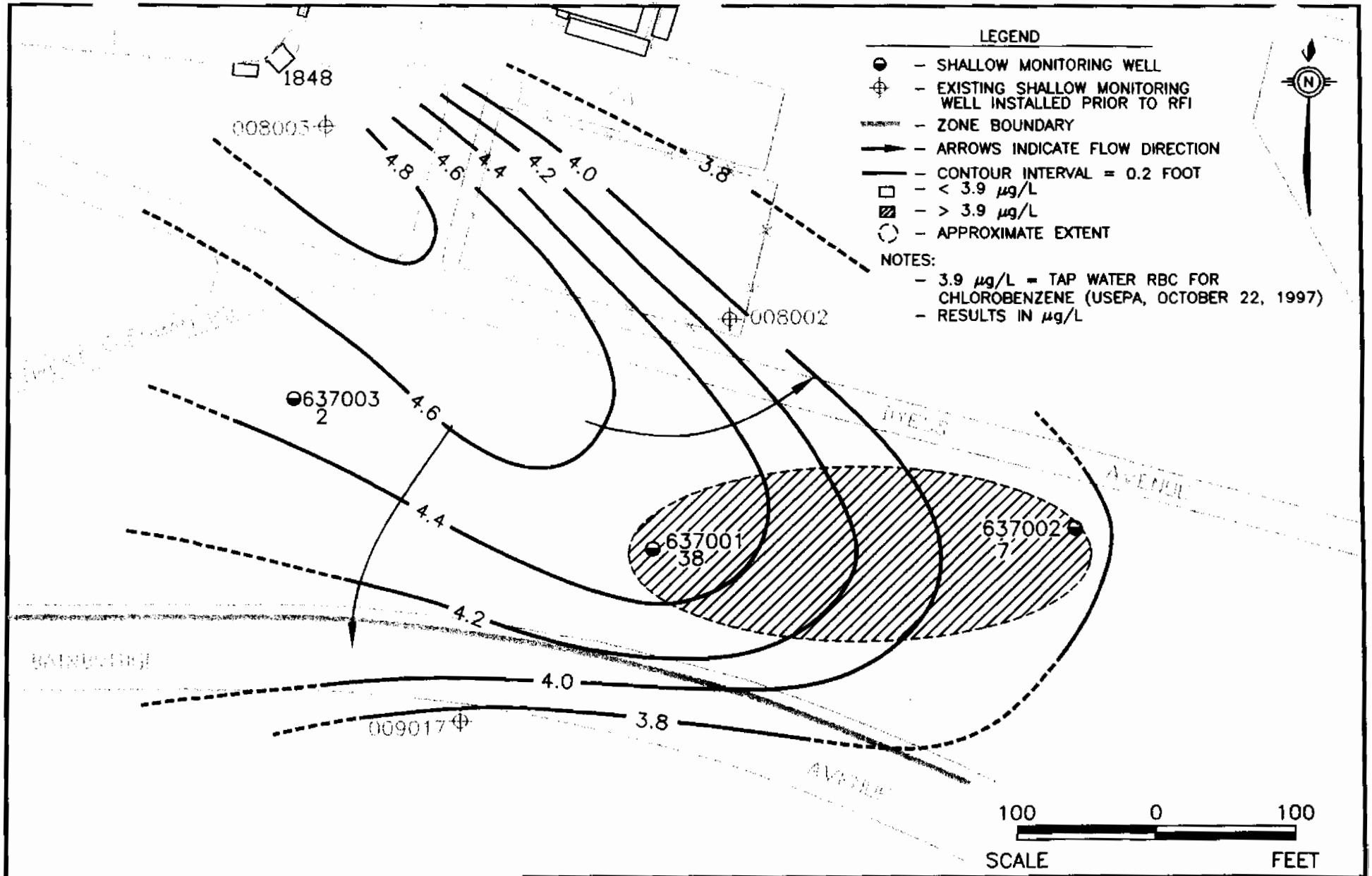

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FIGURE 10.7–20
CHLOROBENZENE IN
SHALLOW GROUNDWATER
AOC #637 DUMP AREA

DWG DATE: 02/10/98 | DWG NAME: 2907M087

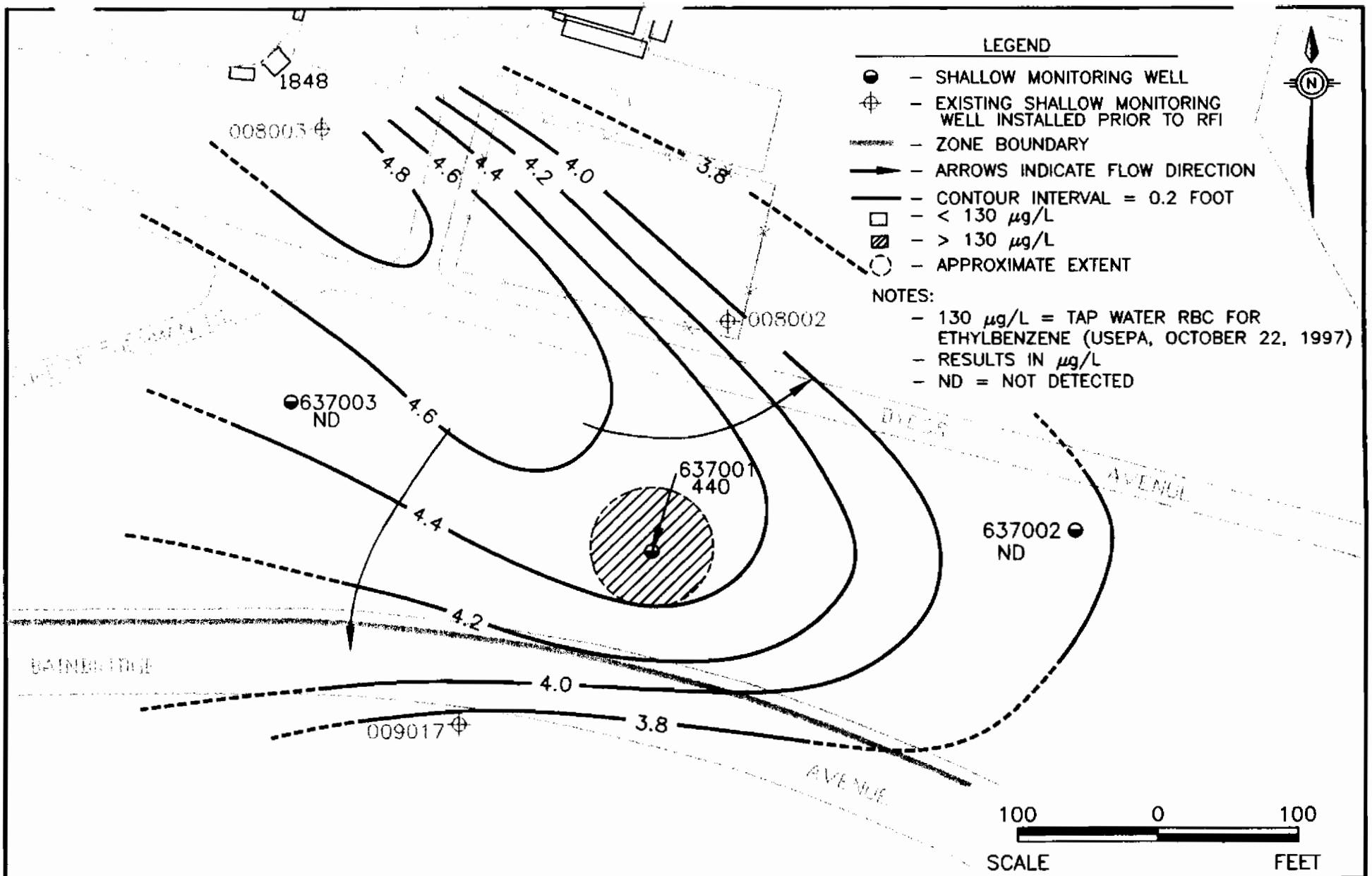

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FIGURE 10.7–21
ETHYLBENZENE IN
SHALLOW GROUNDWATER
AOC #637 DUMP AREA

DWG DATE: 02/10/98 | DWG NAME: 2907M088

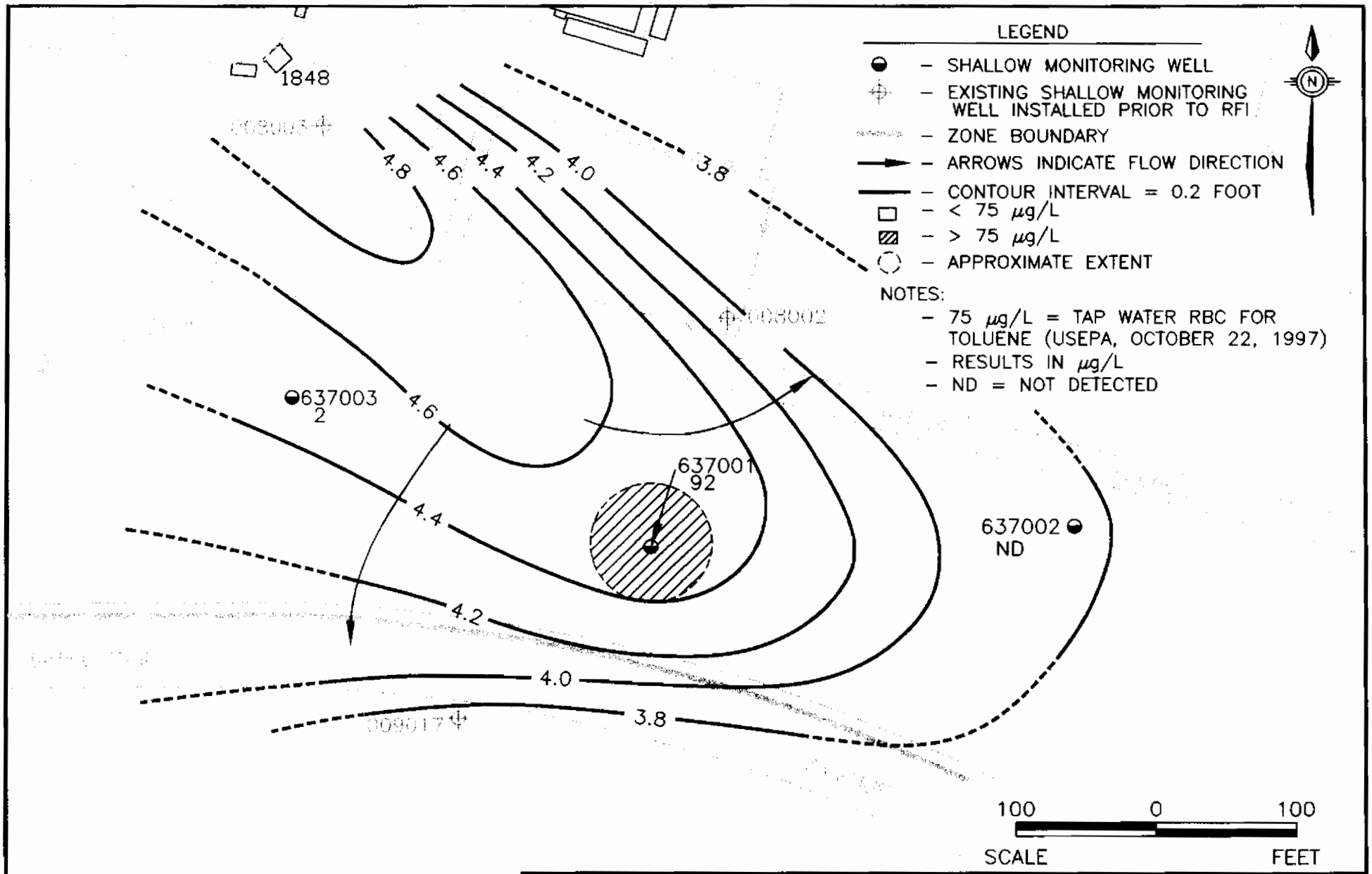

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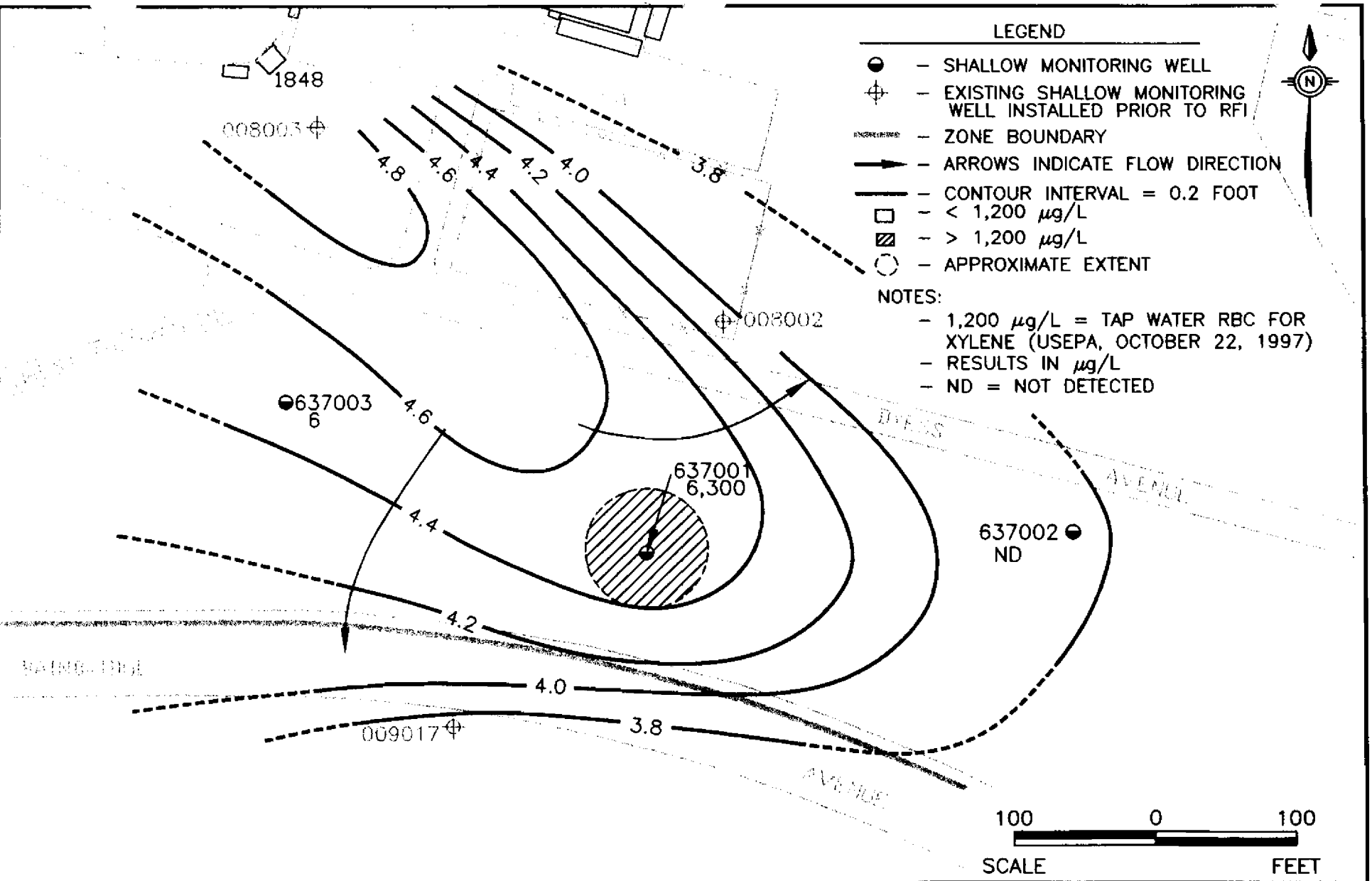
FIGURE 10.7–22
TOLUENE IN SHALLOW GROUNDWATER
AOC #637 DUMP AREA

DWG DATE: 02/10/98 | DWG NAME: 2907M089



ZONE G
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CHARLESTON, S.C.

FIGURE 10.7–23
XYLENE IN SHALLOW GROUNDWATER
AOC #637 DUMP AREA

DWG DATE: 02/10/98 | DWG NAME: 2907M090

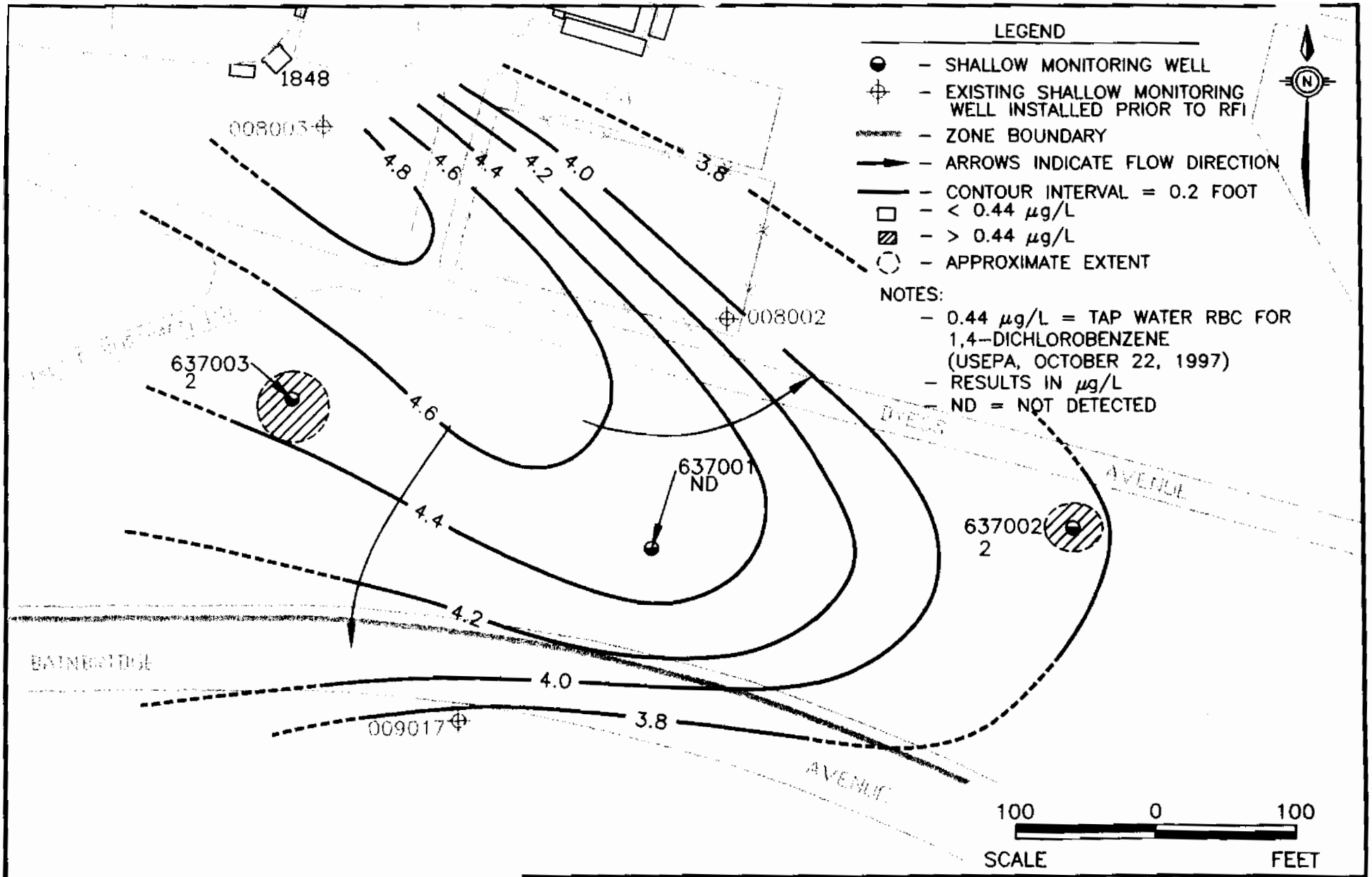

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FIGURE 10.7–24
1,4–DICHLOROBENZENE IN
SHALLOW GROUNDWATER
AOC #637 DUMP AREA

DWG DATE: 02/10/98 | DWG NAME: 2907M091

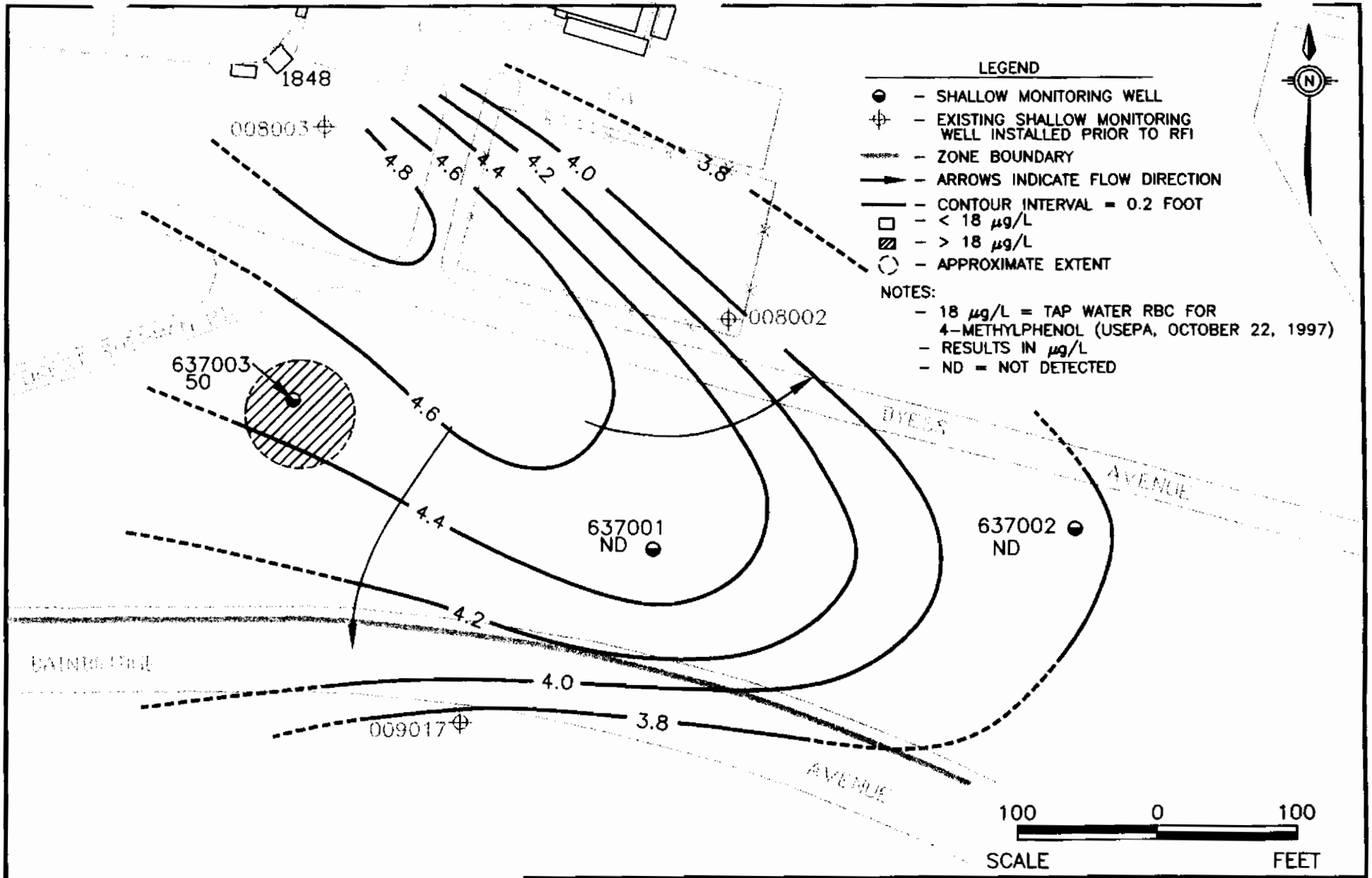

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FIGURE 10.7–25
4–METHYLPHENOL IN
SHALLOW GROUNDWATER
AOC #637 DUMP AREA

DWG DATE: 02/10/98 | DWG NAME: 2907M092

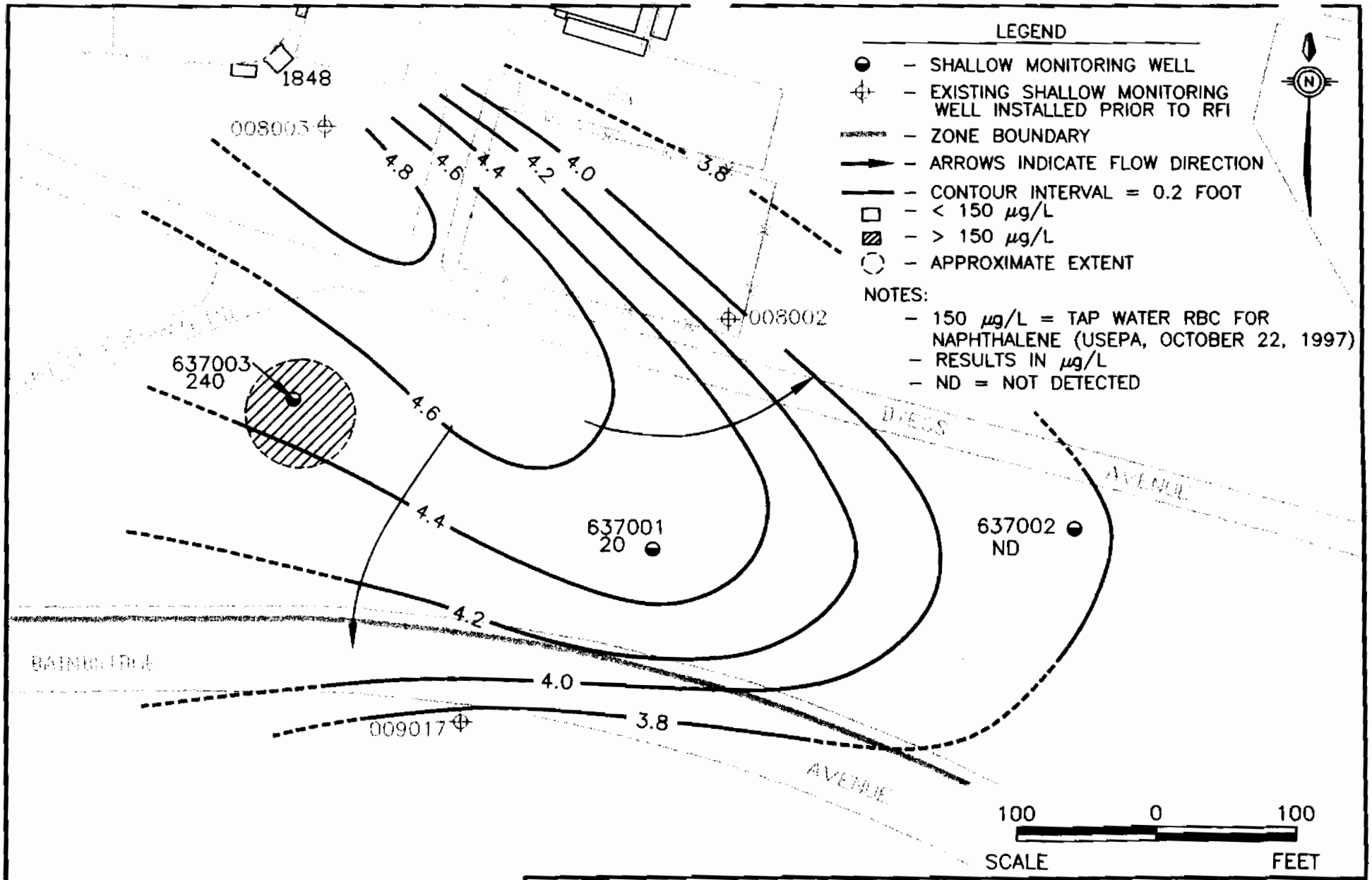

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FIGURE 10.7-26
NAPHTHALENE IN
SHALLOW GROUNDWATER
AOC #637 DUMP AREA

DWG DATE: 02/10/98 | DWG NAME: 2907M093

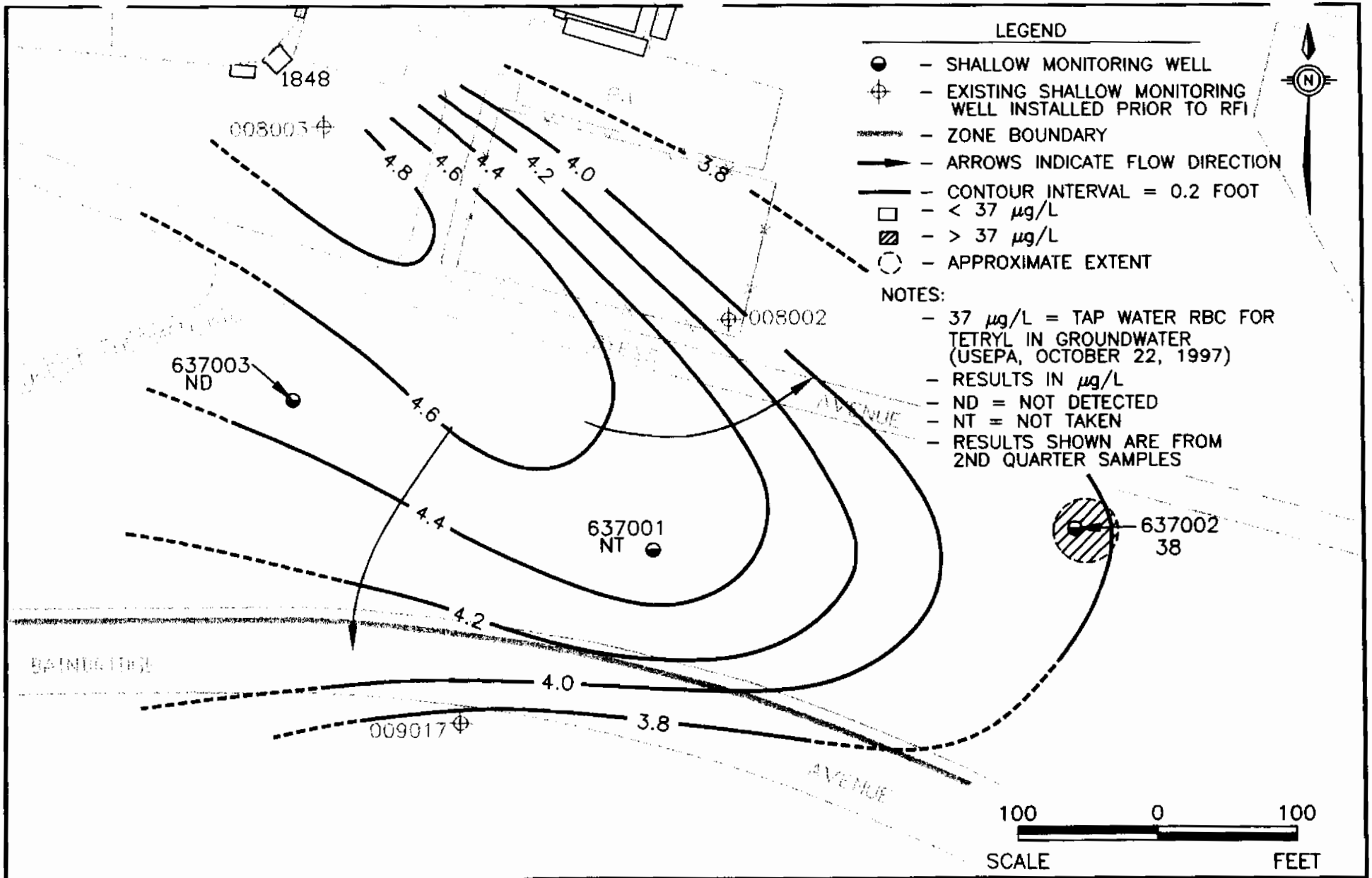

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FIGURE 10.7–27
TETRYL IN SHALLOW GROUNDWATER
AOC #637 DUMP AREA

DWG DATE: 02/10/98 | DWG NAME: 2907M094

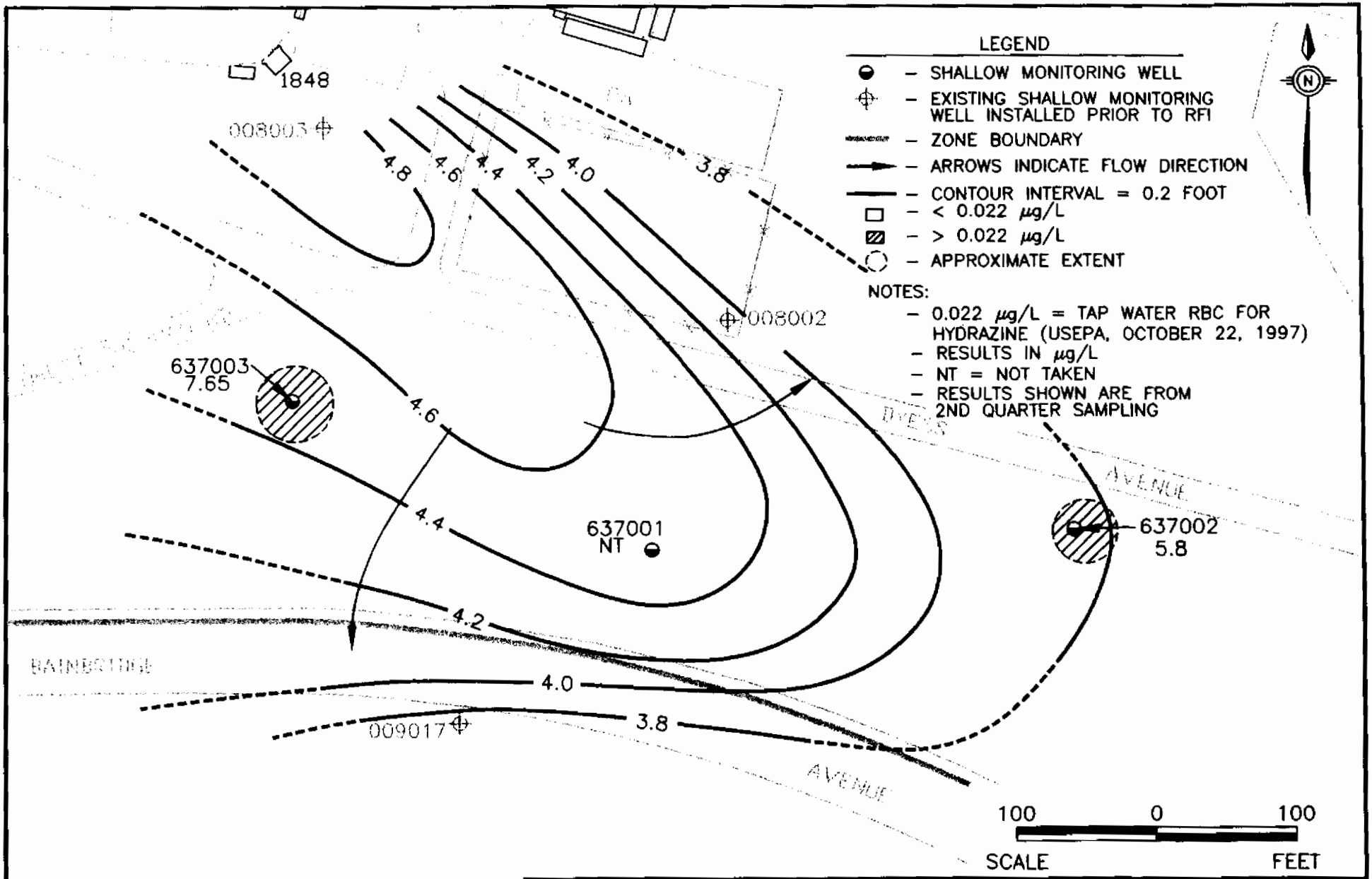

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FIGURE 10.7–28
HYDRAZINE IN SHALLOW GROUNDWATER
AOC #637 DUMP AREA

DWG DATE: 02/10/98 | DWG NAME: 2907M095

Inorganic Elements in Groundwater

Twenty-one metals were detected in shallow groundwater at AOC 637. Antimony, barium, chromium, lead, and thallium, exceeded their tap water RBCs and Zone G shallow background concentrations at AOC 637. Figures 10.7-29 through 10.7-33 show antimony, barium, chromium, lead, and thallium in AOC 637 shallow groundwater respectively. Iron was detected at concentrations exceeding its tap water RBC. Because iron is considered an essential nutrient no background was determined.

10.7.6 Surface Water Sampling and Analysis

A surface water sample was collected at AOC 637 to determine the impact of contaminant transport via the downgradient drainage pathway from the site. This sample was not called for in the approved final RFI work plan, and was proposed as a follow-on sample for the site (Figure 10.7-1). The surface water sample was analyzed for metals, pesticides/PCBs, OP pesticides, SVOCs, and VOCs at DQO Level III. Table 10.7.13 summarizes the AOC 637 surface water sampling and analyses.

Table 10.7.13
Zone G
AOC 637
Surface Water Sample and Analyses

Location	Sample Identifier	Date Collected	Analyses	Remarks
637W0001	637W000101	3/19/97	See note	

Notes:
SW-846 (metals, pesticides/PCBs, OP-Pesticides, SVOCs, VOCs) at DQO Level III

10.7.6.1 Nature of Contamination in Surface Water

Organic compound analytical results for sediment are summarized in Table 10.7.14. Inorganic analytical results for soil are summarized in Table 10.7.15. Table 10.7.16 summarizes all analytes detected in groundwater at AOC 637. Appendix D contains a complete analytical data report for all Zone G samples.

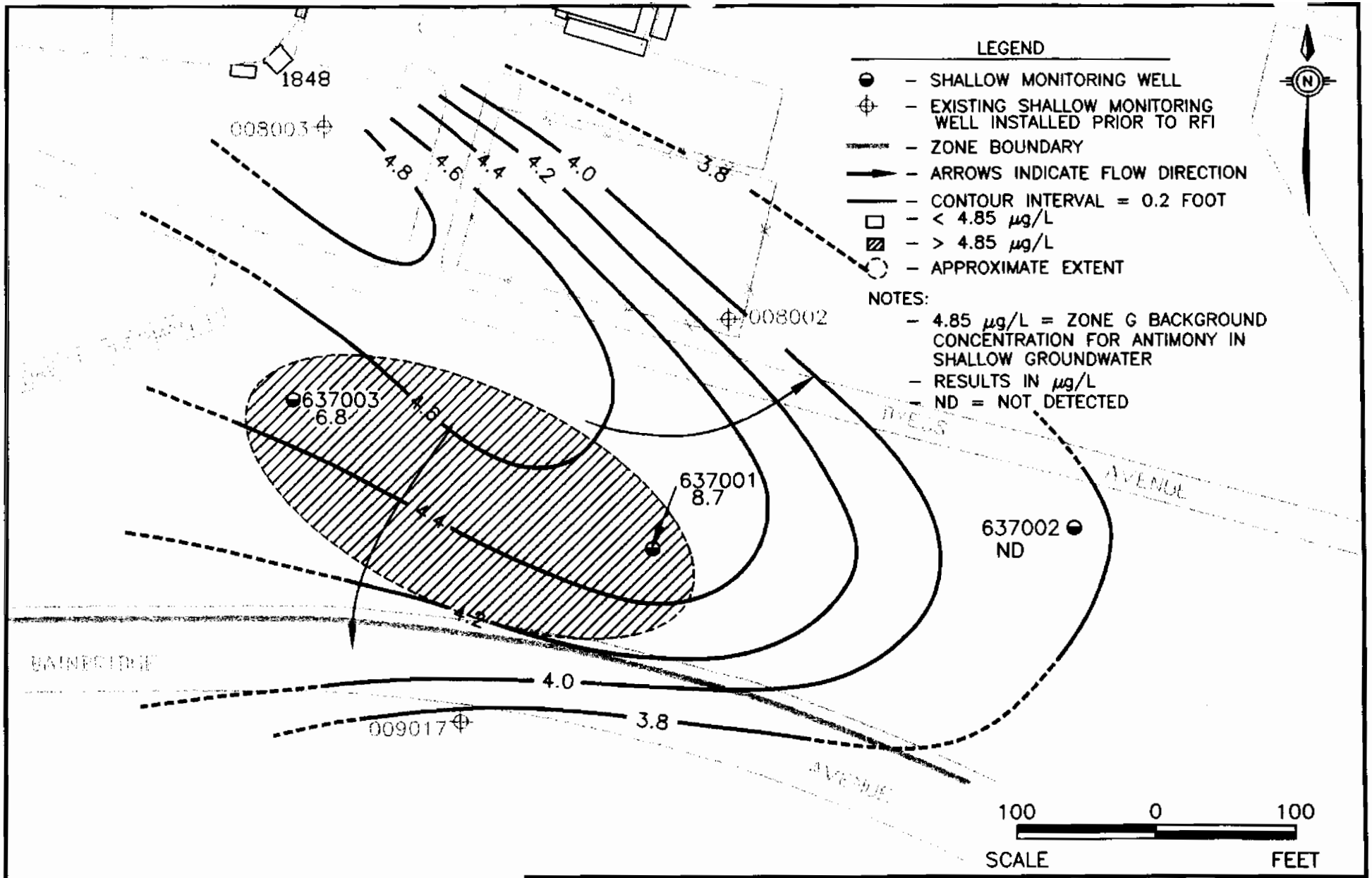

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FIGURE 10.7–29
ANTIMONY IN SHALLOW GROUNDWATER
AOC #637 DUMP AREA

DWG DATE: 02/10/98 | DWG NAME: 2907M096

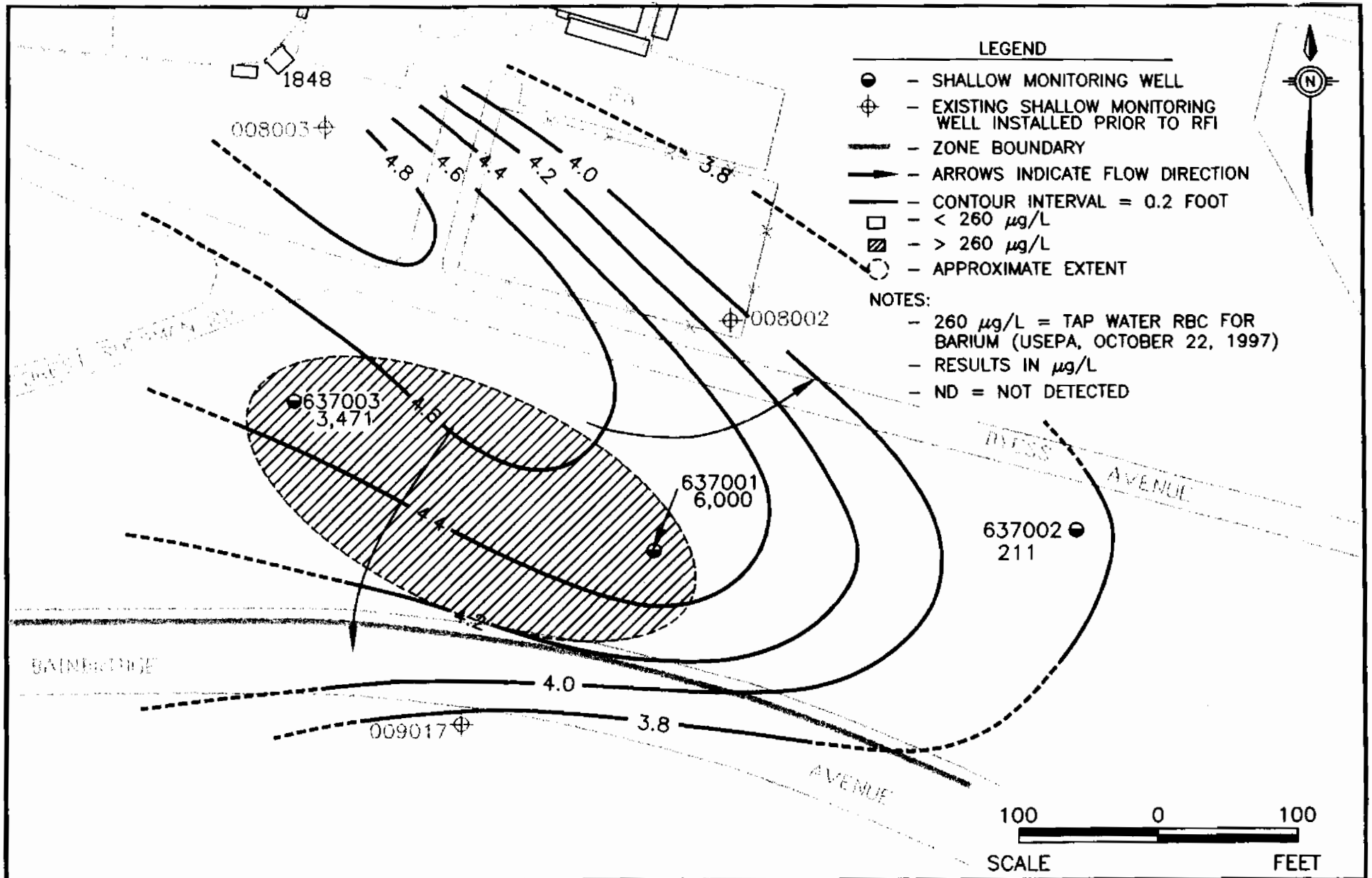

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FIGURE 10.7–30
BARIUM IN SHALLOW GROUNDWATER
AOC #637 DUMP AREA

DWG DATE: 02/10/98 | DWG NAME: 2907M097

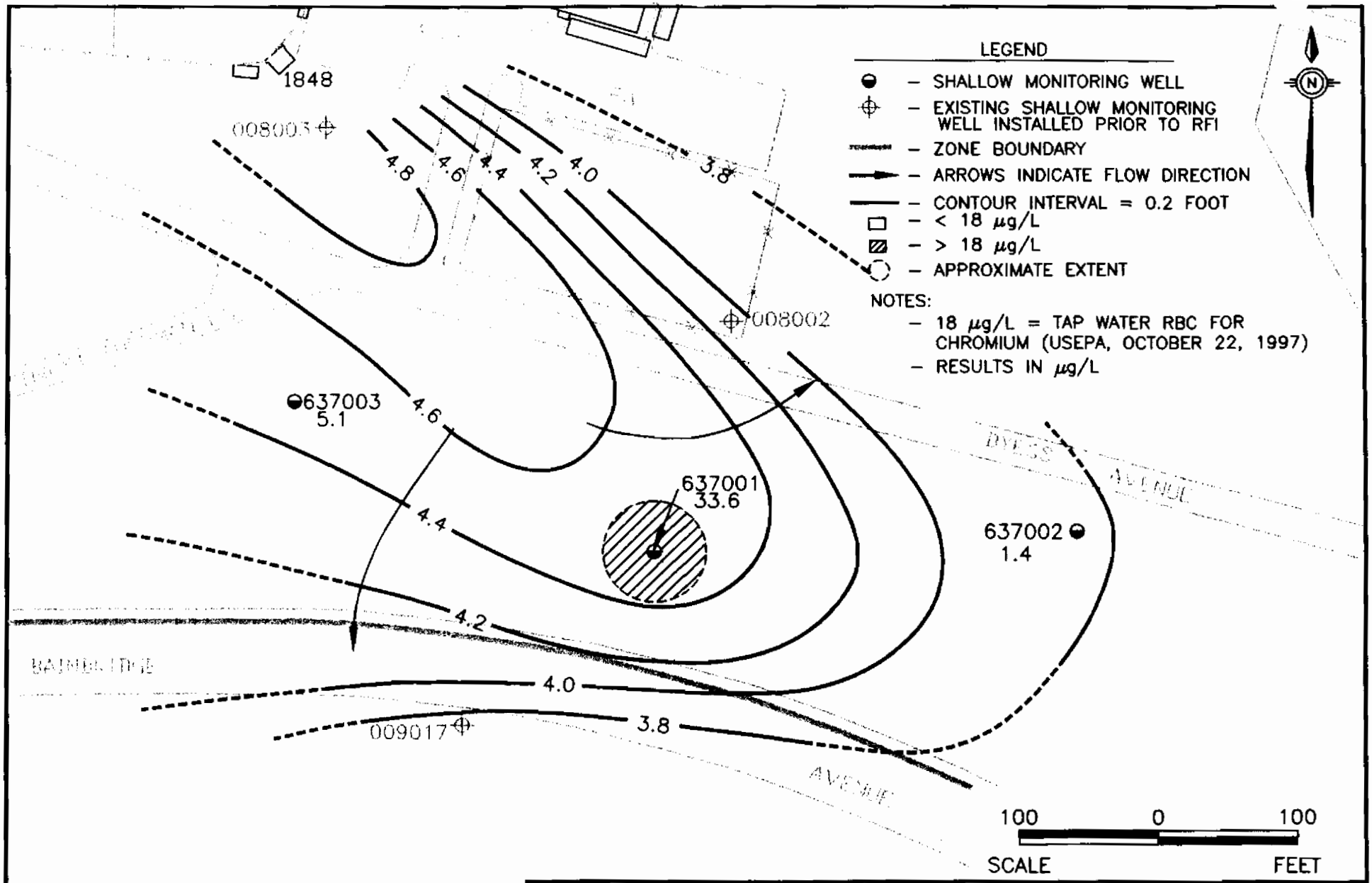

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FIGURE 10.7–31
CHROMIUM IN SHALLOW GROUNDWATER
AOC #637 DUMP AREA

DWG DATE: 02/10/98 | DWG NAME: 2907M098

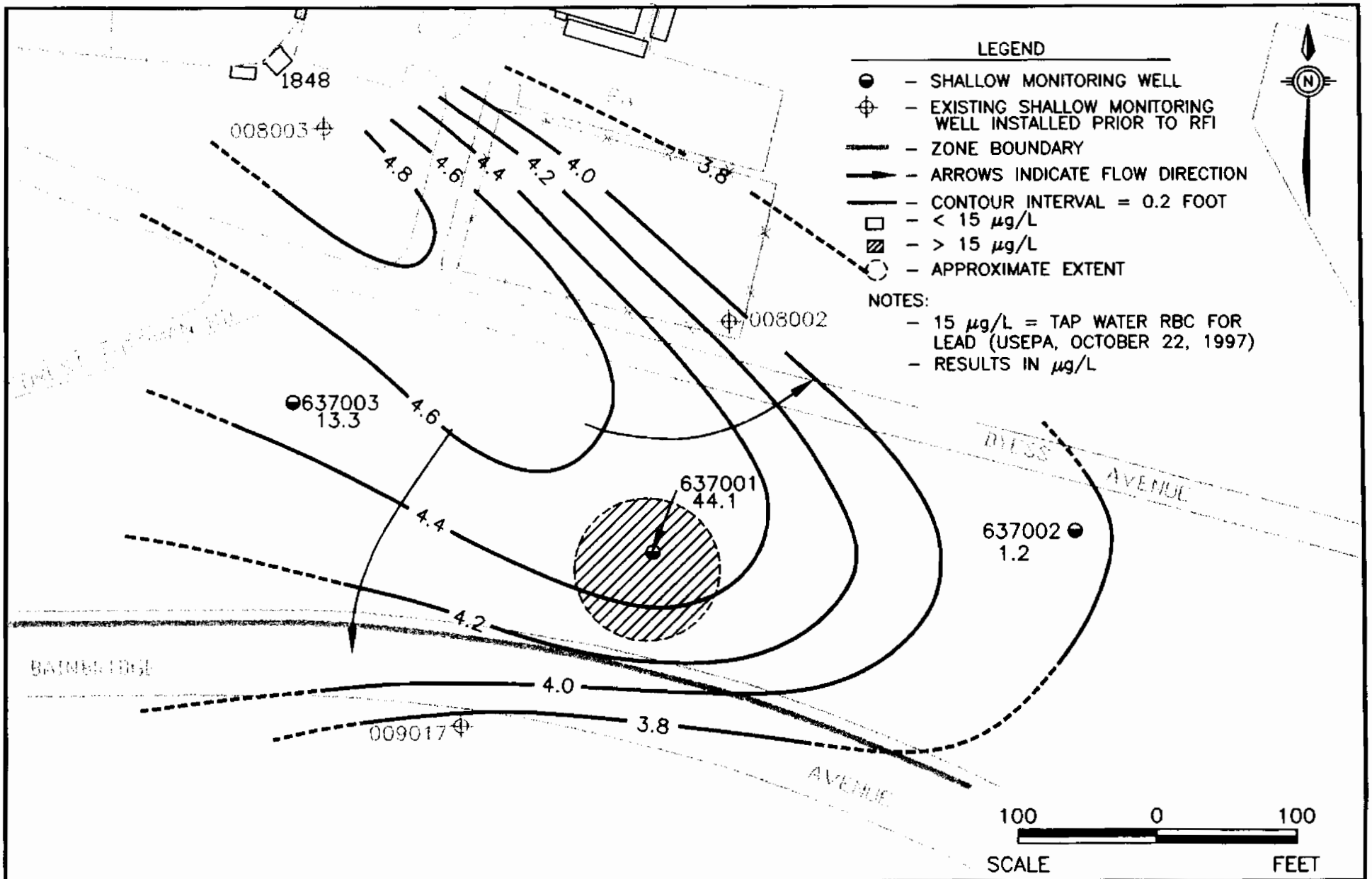

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FIGURE 10.7–32
LEAD IN SHALLOW GROUNDWATER
AOC #637 DUMP AREA

DWG DATE: 02/10/98 | DWG NAME: 2907M099

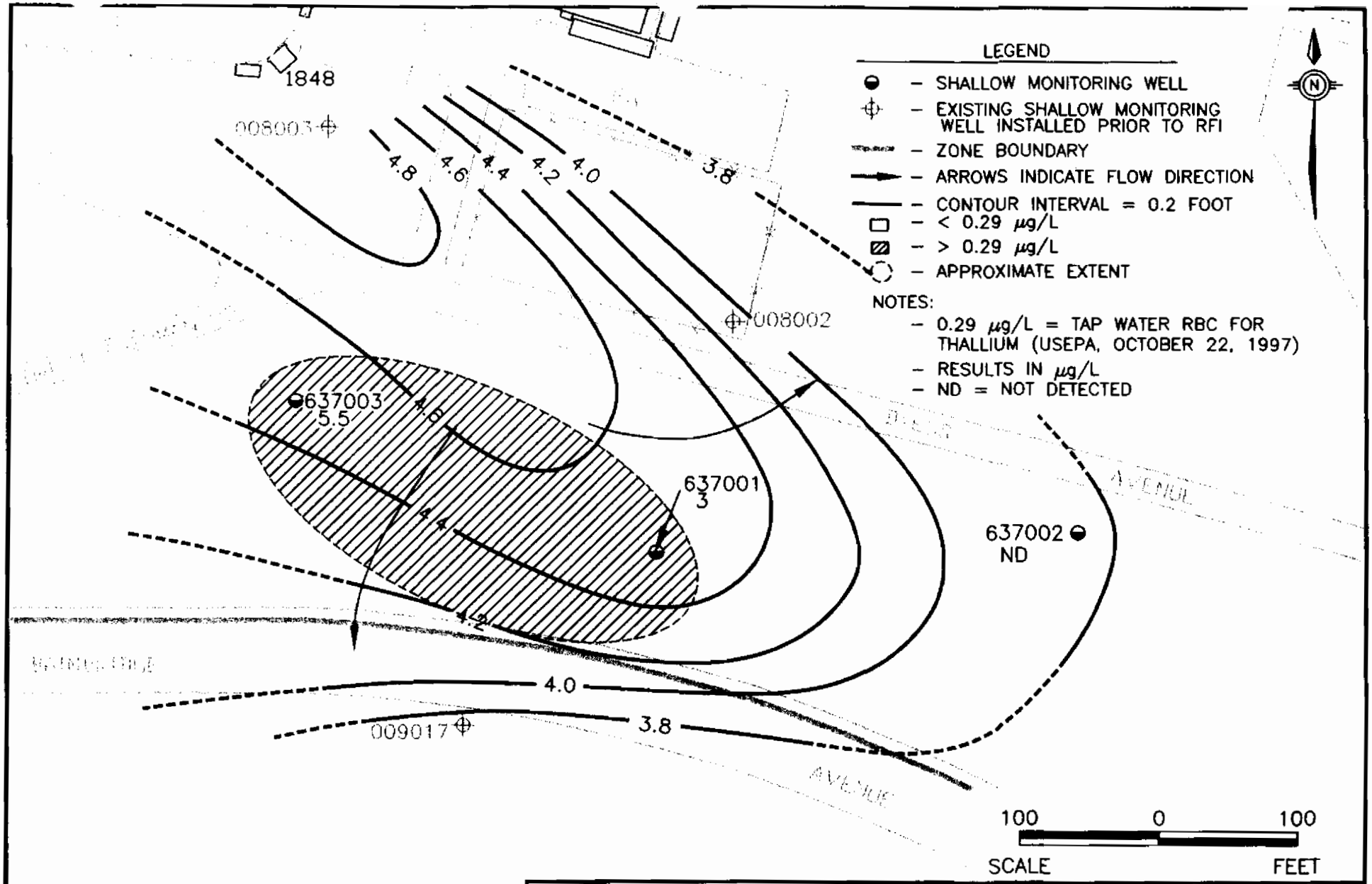

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FIGURE 10.7–33
THALLIUM IN SHALLOW GROUNDWATER
AOC #637 DUMP AREA

DWG DATE: 02/10/98 | DWG NAME: 2907M100

Table 10.7.14
Zone G
AOC 637
Organic Analytical Results for Surface Water

Parameters	Frequency of Detection	Range of Detections (µg/L)	Mean of Detections (µg/L)	Reference Conc.* (µg/L)	Number of Samples Exceeding Reference
Semivolatile Organic Compounds (1 Sample) (µg/L)					
Acenaphthene	1/1	1	1	17	0
Benzoic acid	1/1	4	4	NL	NA
bis(2-Ethylhexyl)phthalate	1/1	2	2	0.3	1
Naphthalene	1/1	3	3	62	0
Phenanthrene	1/1	1	1	NL	NA

Notes:
* = Freshwater surface water chronic screening values from *Supplemental Guidance to RAGS: Region IV Bulletins, Ecological Risk Assessment, Bulletin 2* (USEPA, 1995a) were used as reference concentrations
NL = Not listed
NA = Not applicable
µg/L = Micrograms per liter

Table 10.7.15
Zone G
AOC 637
Inorganic Analytical Results for Surface Water

Parameters	Frequency of Detection	Range of Detections (µg/L)	Mean of Detections (µg/L)	Reference Conc.* (µg/L)	Number of Samples Exceeding Reference
Inorganics (µg/L) (1 Sample)					
Aluminum (Al)	1/1	16000	16000	87	1
Antimony (Sb)	1/1	9.80	9.80	160	0
Arsenic (As)	1/1	29.0	29.0	190	0
Barium (Ba)	1/1	1720	1720	NL	NA
Beryllium (Be)	1/1	1.40	1.40	0.53	1
Cadmium (Cd)	1/1	4.20	4.20	0.66	1
Calcium (Ca)	1/1	465000	465000	NL	NA
Chromium (Cr)	1/1	131	131	11	1
Cobalt (Co)	1/1	10.9	10.9	NL	NA
Copper (Cu)	1/1	696	696	6.54	1
Iron (Fe)	1/1	35100	35100	1000	1
Lead (Pb)	1/1	283	283	1.32	1
Magnesium (Mg)	1/1	121000	121000	NL	NA
Manganese (Mn)	1/1	846	846	NL	NA

Table 10.7.15
Zone G
AOC 637
Inorganic Analytical Results for Surface Water

Parameters	Frequency of Detection	Range of Detections (µg/L)	Mean of Detections (µg/L)	Reference Conc.* (µg/L)	Number of Samples Exceeding Reference
Mercury (Hg)	1/1	2.20	2.20	0.012	1
Nickel (Ni)	1/1	70.5	70.5	87.71	0
Potassium (K)	1/1	67000	67000	NL	NA
Sodium (Na)	1/1	1070000	1070000	NL	NA
Tin (Sn)	1/1	17.7	17.7	NL	NA
Vanadium (V)	1/1	67.5	67.5	NL	NA
Zinc (Zn)	1/1	1040	1040	58.91	1

Notes:
* = Freshwater surface water chronic screening values from *Supplemental Guidance to RAGS: Region IV Bulletins, Ecological Risk Assessment, Bulletin 2* (USEPA, 1995a) were used as reference concentrations
NL = Not listed
NA = Not applicable
µg/L = Micrograms per liter

Table 10.7.16
Zone G
AOC 637
Analytes Detected in Surface Water Samples

Parameters	Location	Concentration	Reference Conc.*
Semivolatile Organic Compounds (µg/L)			
Acenaphthene	637W0001	1	17
Benzoic acid	637W0001	4	NL
bis(2-Ethylhexyl)phthalate	637W0001	2	0.3
Naphthalene	637W0001	3	62
Phenanthrene	637W0001	1	NL
Inorganics (µg/L)			
Aluminum (Al)	637W0001	16000	87
Antimony (Sb)	637W0001	9.8	160
Arsenic (As)	637W0001	29	190
Barium (Ba)	637W0001	1720	NL
Beryllium (Be)	637W0001	1.4	0.53
Cadmium (Cd)	637W0001	4.2	0.66
Calcium (Ca)	637W0001	465000	NL
Chromium (Cr)	637W0001	131	11
Cobalt (Co)	637W0001	10.9	NL
Copper (Cu)	637W0001	696	6.54
Iron (Fe)	637W0001	35100	1000
Lead (Pb)	637W0001	283	1.32
Magnesium (Mg)	637W0001	121000	NL
Manganese (Mn)	637W0001	846	NL
Mercury (Hg)	637W0001	2.2	0.012
Nickel (Ni)	637W0001	70.5	87.71
Potassium (K)	637W0001	67000	NL
Sodium (Na)	637W0001	1070000	NL
Tin (Sn)	637W0001	17.7	NL

Table 10.7.16
Zone G
AOC 637
Analytes Detected in Surface Water Samples

Parameters	Location	Concentration	Reference Conc.*
Vanadium (V)	637W0001	67.5	NL
Zinc (Zn)	637W0001	**1040**	58.91

Notes:
* = Freshwater surface water chronic screening values from *Supplemental Guidance to RAGS: Region IV Bulletins, Ecological Risk Assessment, Bulletin 2* (USEPA, 1995a) were used as reference concentrations
NL = Not listed
NA = Not applicable
µg/L = Micrograms per liter
Bolded concentrations exceed freshwater surface water chronic screening values

Volatile Organic Compounds in Surface Water

No VOCs were detected in the AOC 637 surface water sample.

Semivolatile Organic Compounds in Surface Water

Five SVOCs were detected in the AOC 637 surface water sample. Bis(2-ethylhexyl)phthalate was detected above the fresh water surface water chronic screening value. Figure 10.7-34 shows bis(2-ethylhexyl)phthalate in surface water at AOC 637.

Pesticides and PCBs in Surface Water

No pesticides or PCBs were detected in the AOC surface water sample.

Inorganic Elements in Surface Water

Twenty-one metals were detected in surface water at AOC 637. Aluminum, beryllium, cadmium, chromium, copper, iron, lead, mercury, and zinc exceeded their respective freshwater surface water chronic screening value. Figures 10.7-35 through 10.7-43 present these metals concentrations detected in AOC 637 surface water.

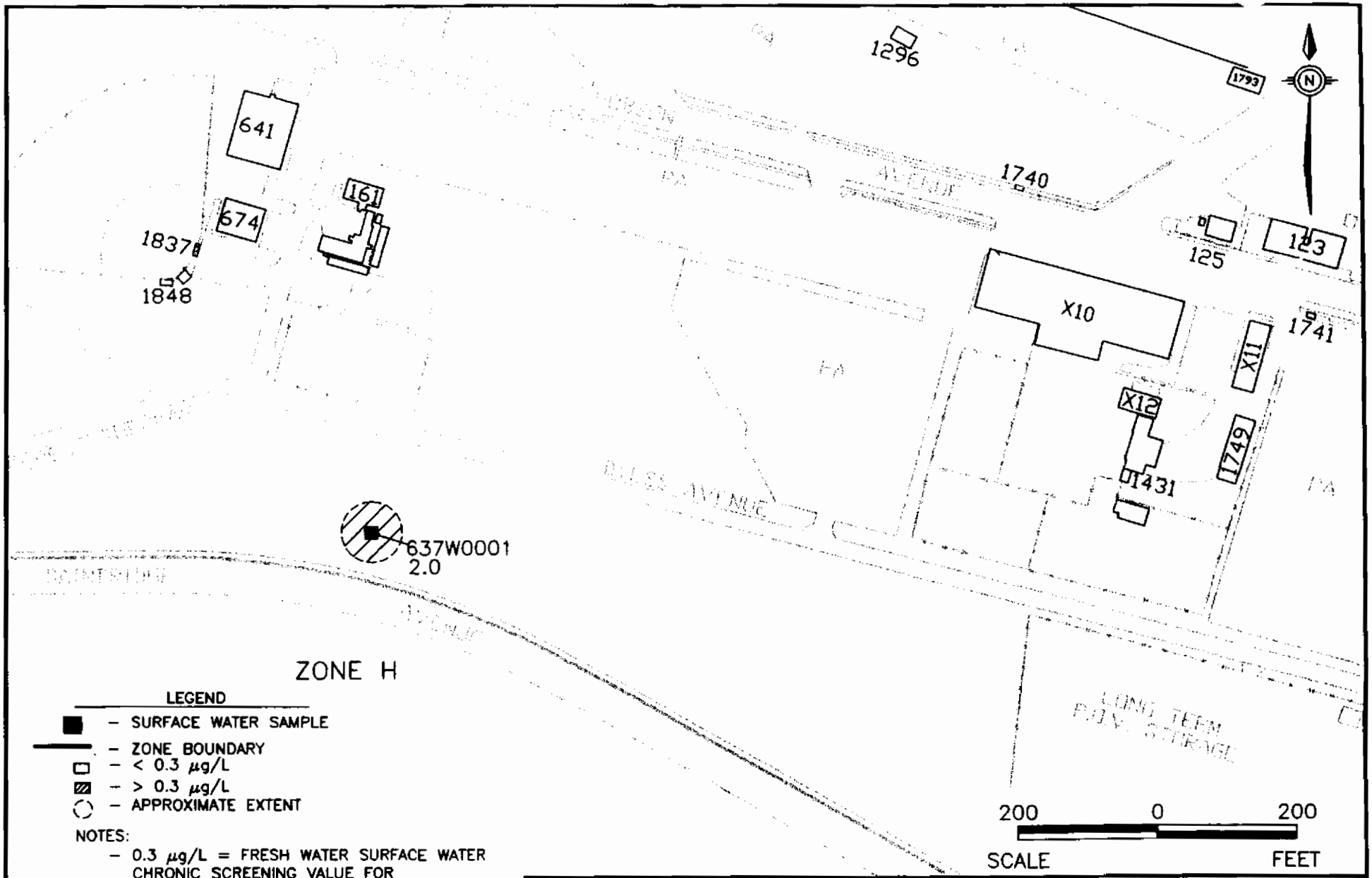

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FIGURE 10.7-34
BIS(2-ETHYLHEXYL)PHTHALATE
IN SURFACE WATER
AOC #637 DUMP AREA

DWG DATE: 02/04/98 | DWG NAME: 2907M101

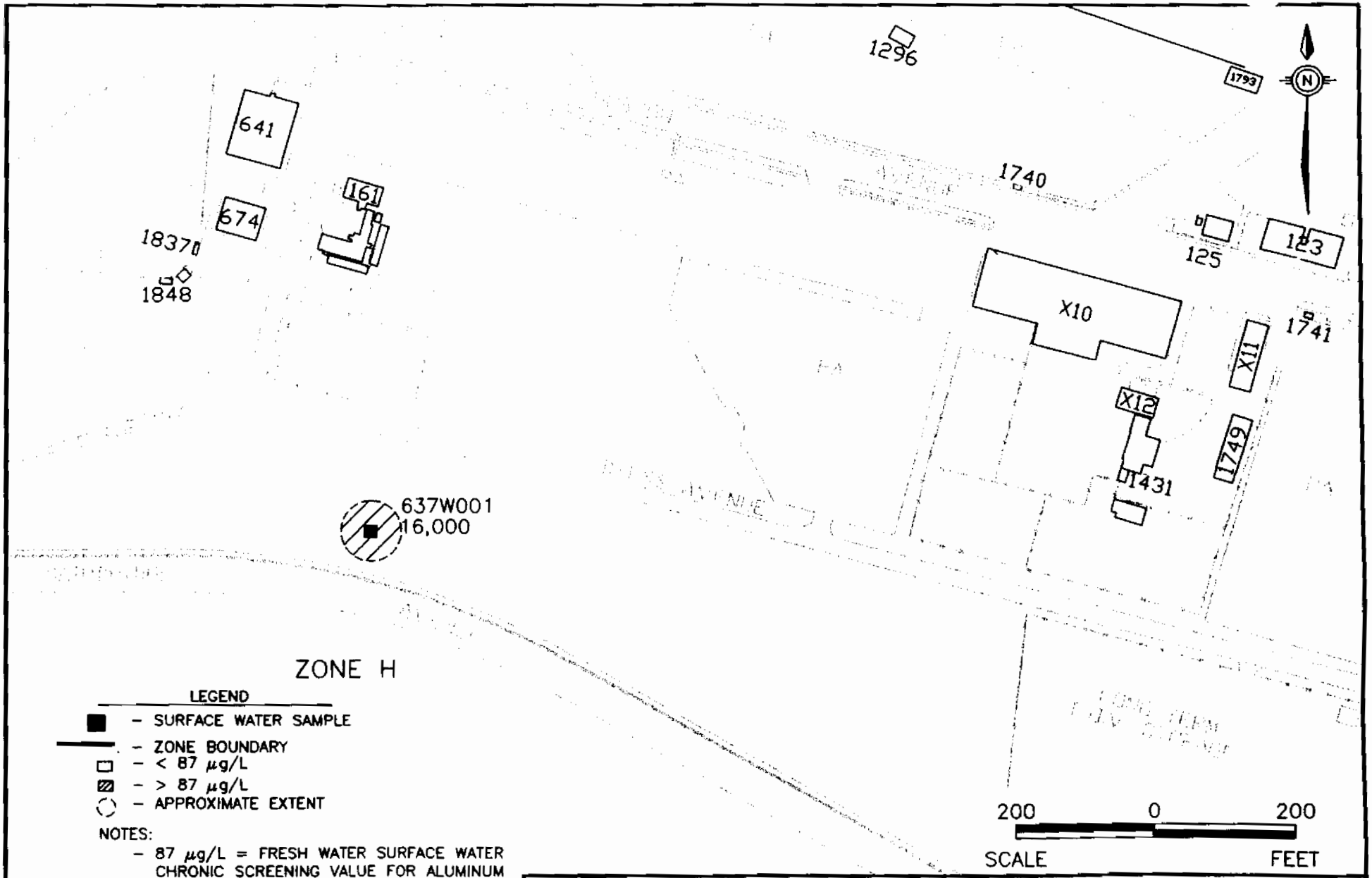

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FIGURE 10.7–35
ALUMINUM IN SURFACE WATER
AOC #637 DUMP AREA

DWG DATE: 02/04/98 | DWG NAME: 2907M102

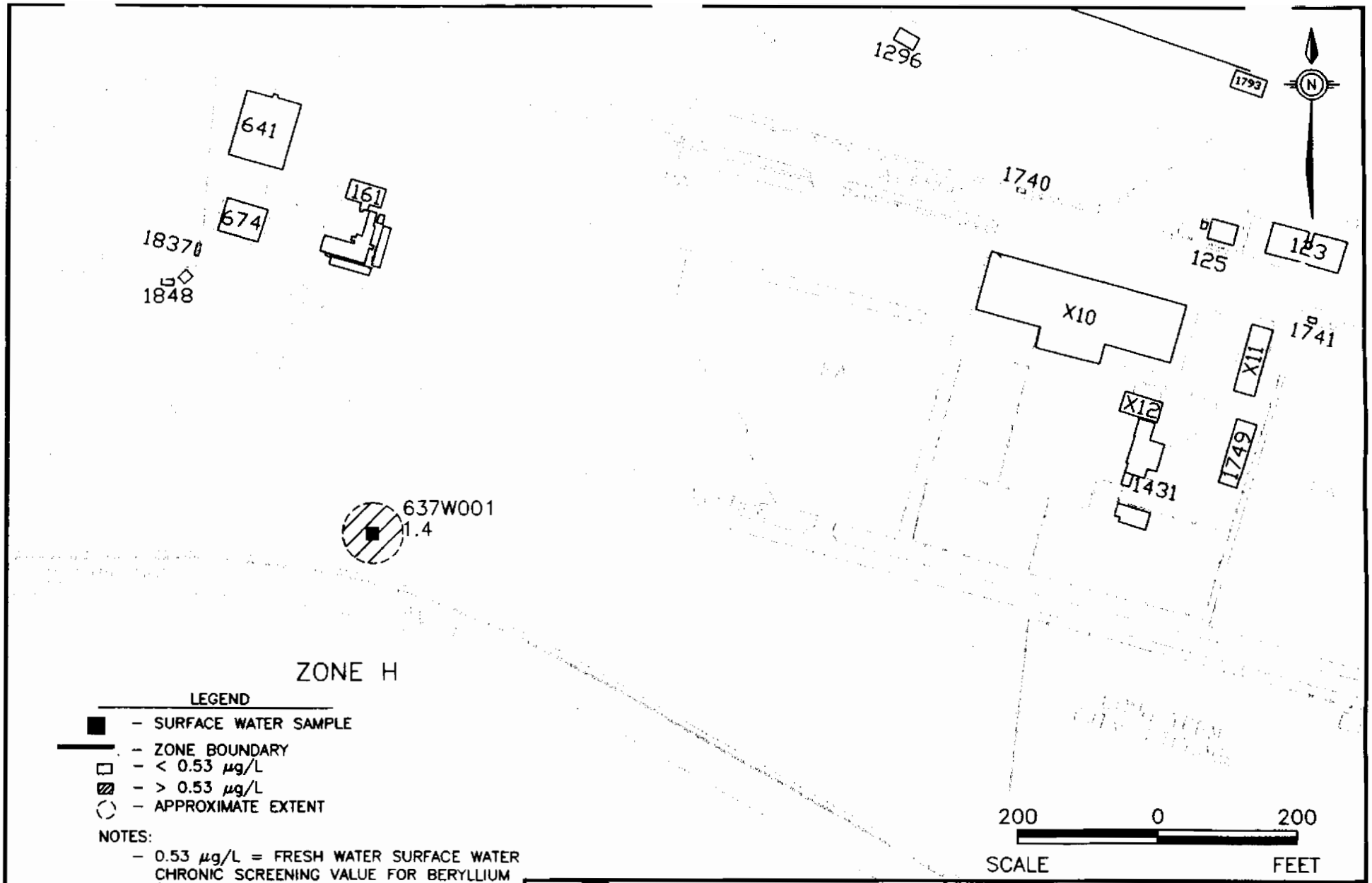
1296
1793
641
161
674
1740
18370
1848
125
123
X10
1741
X11
X12
1749
1431
637W001
1.4
ZONE H
LEGEND
– SURFACE WATER SAMPLE
– ZONE BOUNDARY
– < 0.53 µg/L
– > 0.53 µg/L
– APPROXIMATE EXTENT
NOTES:
– 0.53 µg/L = FRESH WATER SURFACE WATER CHRONIC SCREENING VALUE FOR BERYLLIUM (USEPA, 1995a)
– RESULTS IN µg/L
200 0 200
SCALE FEET
ZONE G
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FIGURE 10.7-36
BERYLLIUM IN SURFACE WATER
AOC #637 DUMP AREA
DWG DATE: 02/04/98
DWG NAME: 2907M103

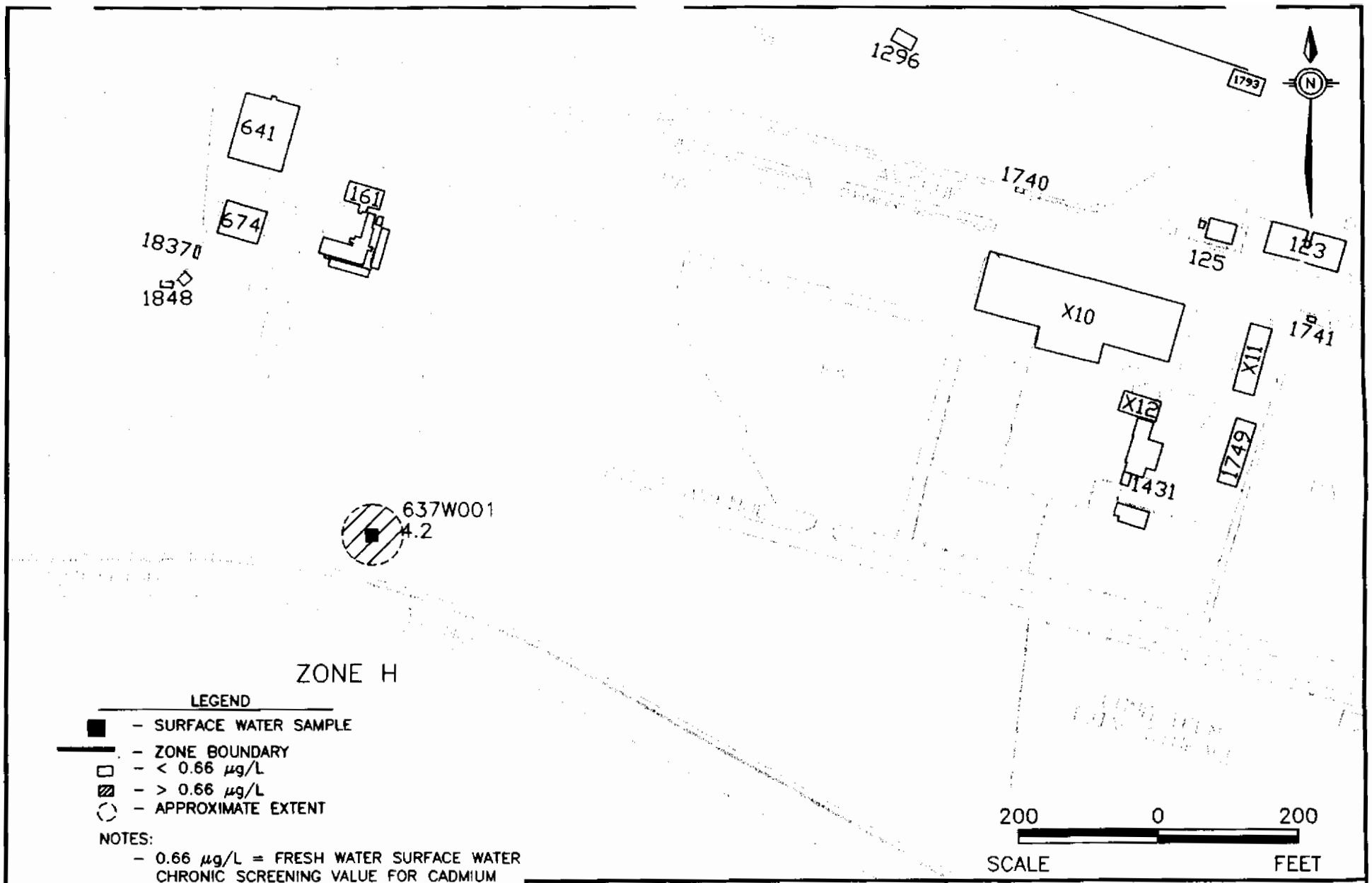

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FIGURE 10.7–37
CADMIUM IN SURFACE WATER
AOC #637 DUMP AREA

DWG DATE: 02/04/98 | DWG NAME: 2907M104

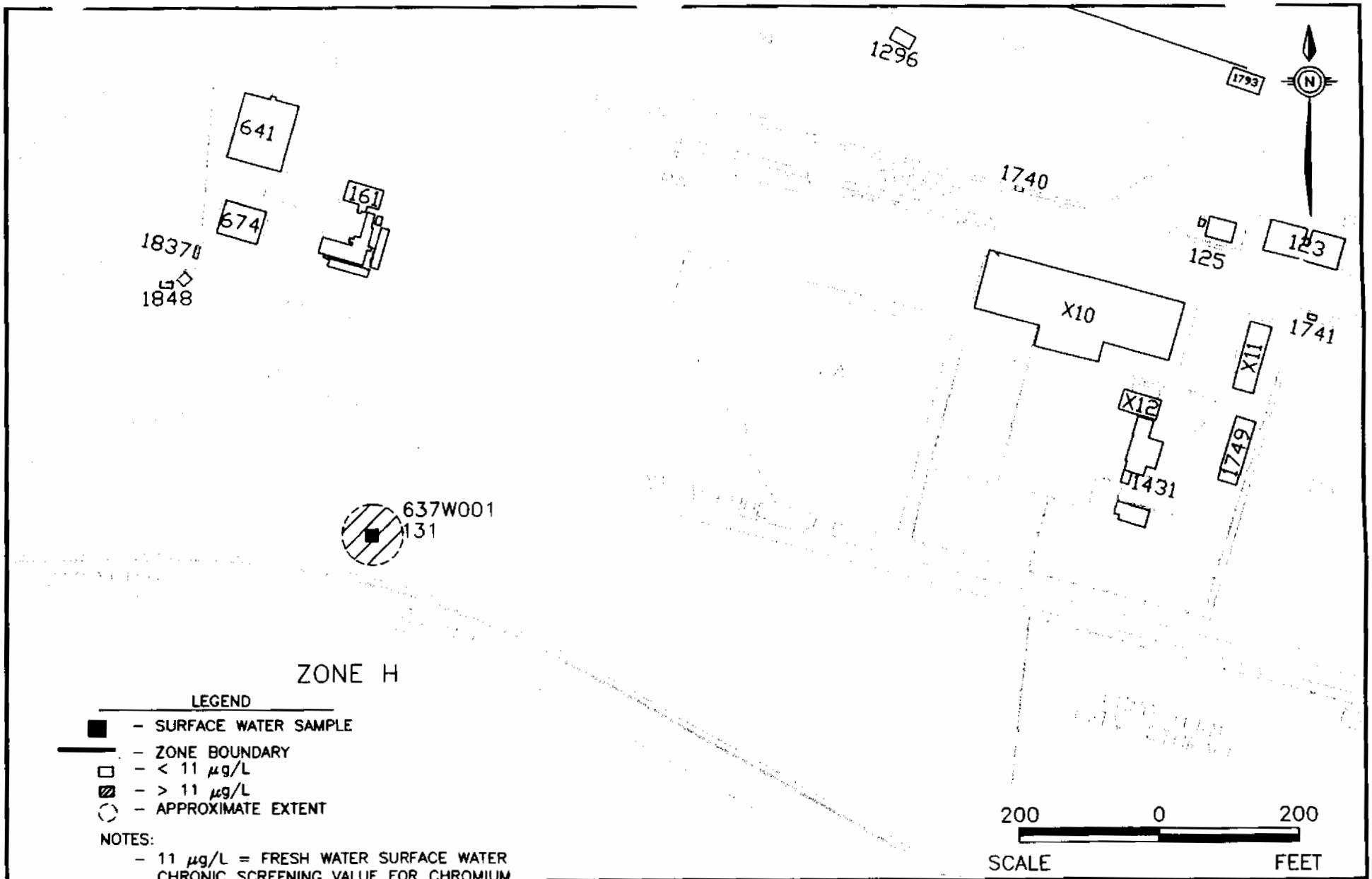

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FIGURE 10.7–38
CHROMIUM IN SURFACE WATER
AOC #637 DUMP AREA

DWG DATE: 02/04/98 | DWG NAME: 2907M105

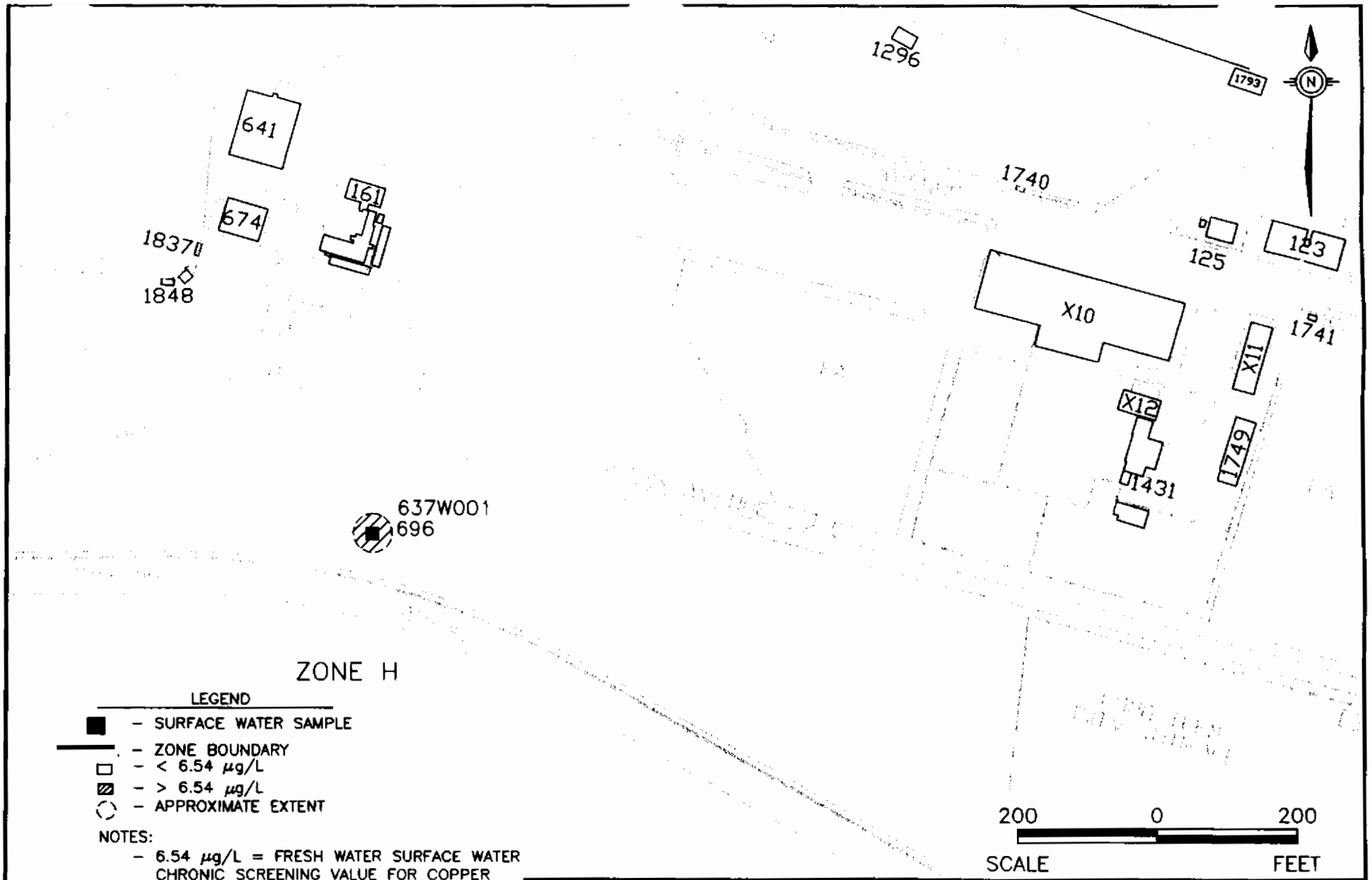

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FIGURE 10.7–39
COPPER IN SURFACE WATER
AOC #637 DUMP AREA

DWG DATE: 02/04/98 | DWG NAME: 2907M106

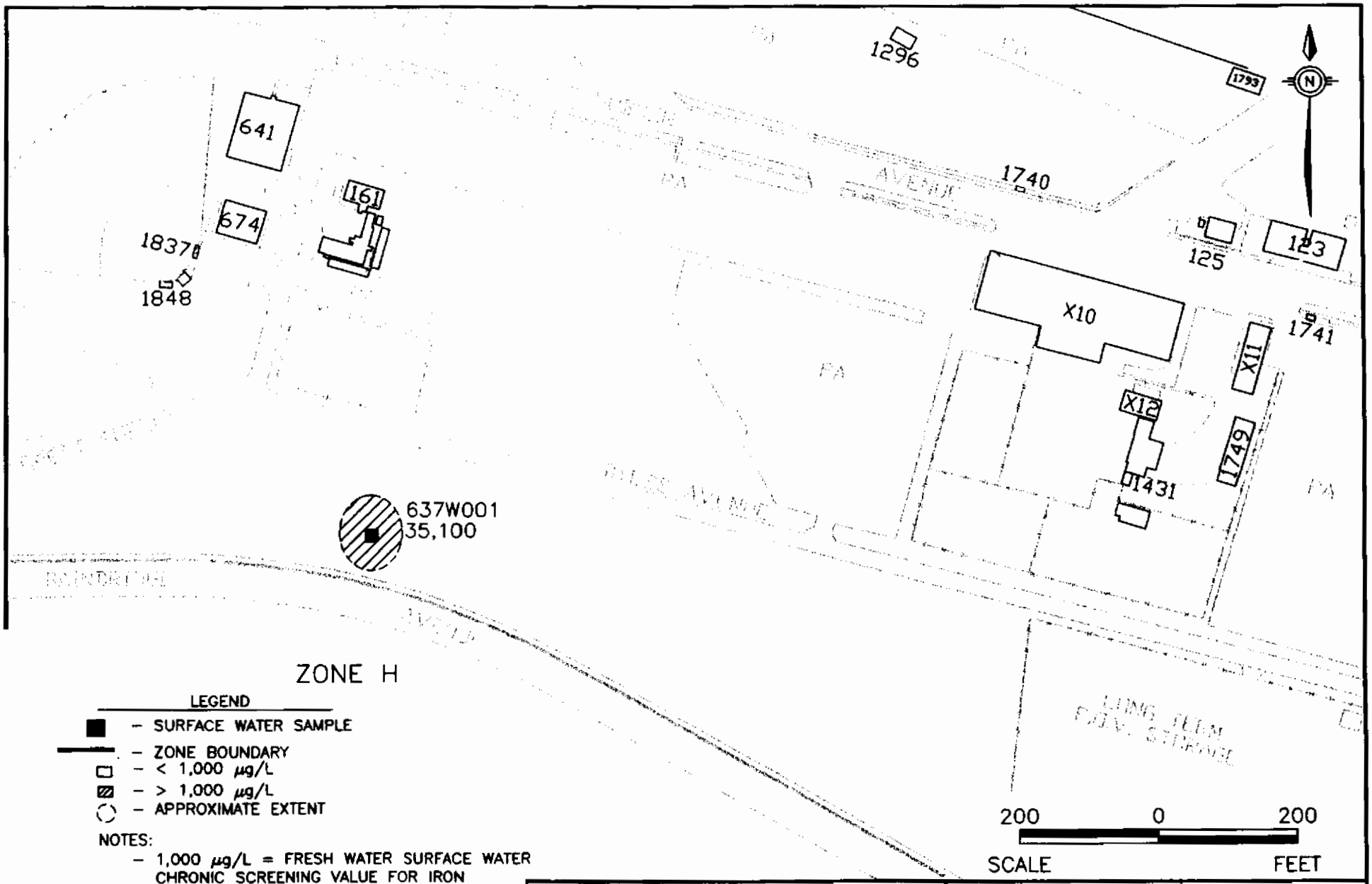

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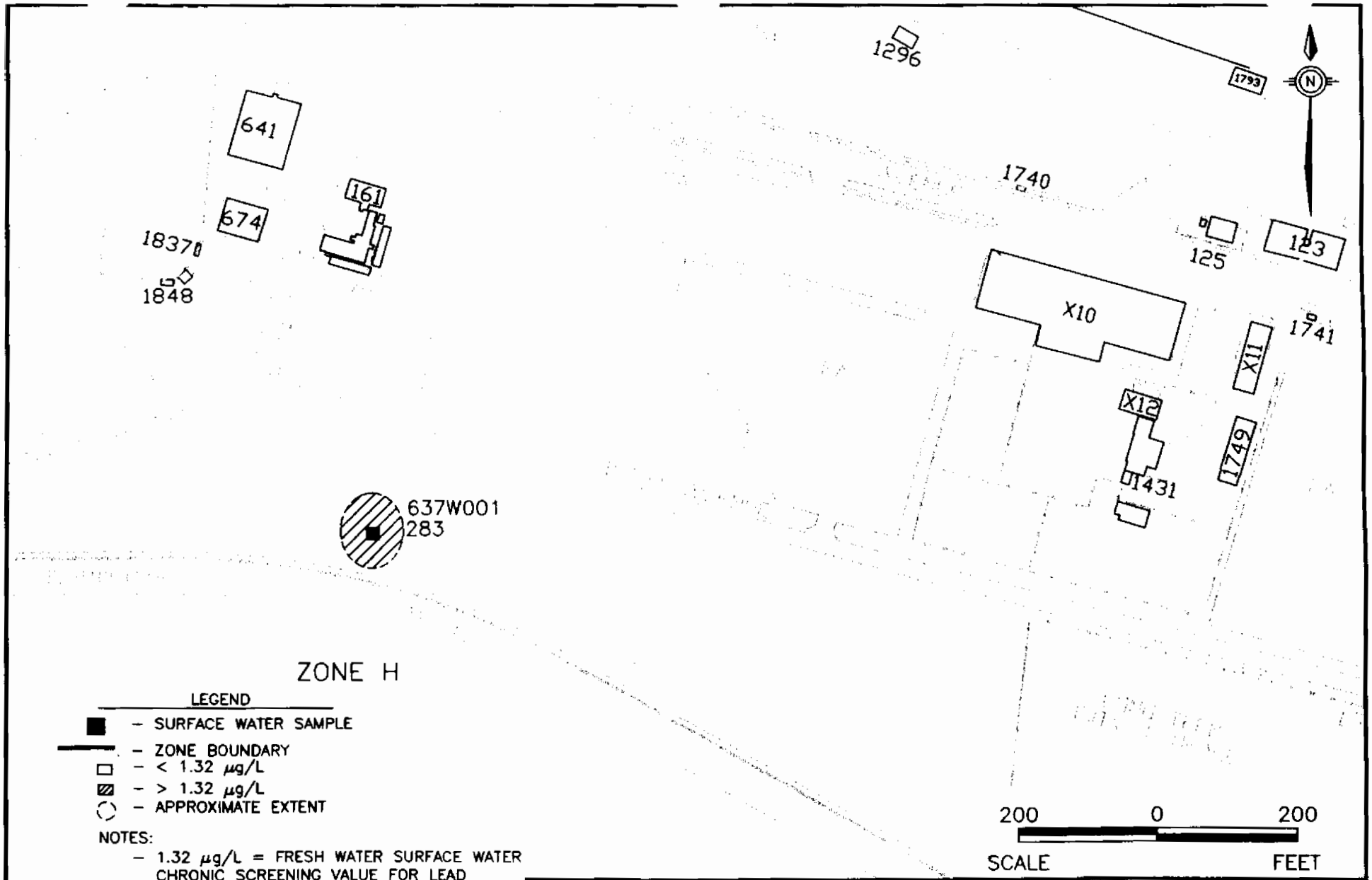
FIGURE 10.7–40
IRON IN SURFACE WATER
AOC #637 DUMP AREA

DWG DATE: 02/04/98 | DWG NAME: 2907M107



LEGEND

- ■ – SURFACE WATER SAMPLE
- ▬ – ZONE BOUNDARY
- □ – < 1.32 µg/L
- ▨ – > 1.32 µg/L
- ◌ – APPROXIMATE EXTENT

NOTES:

- 1.32 µg/L = FRESH WATER SURFACE WATER CHRONIC SCREENING VALUE FOR LEAD (USEPA, 1995a)
- RESULTS IN µg/L

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FIGURE 10.7-41
LEAD IN SURFACE WATER
AOC #637 DUMP AREA

DWG DATE: 02/04/98 | DWG NAME: 2907M108

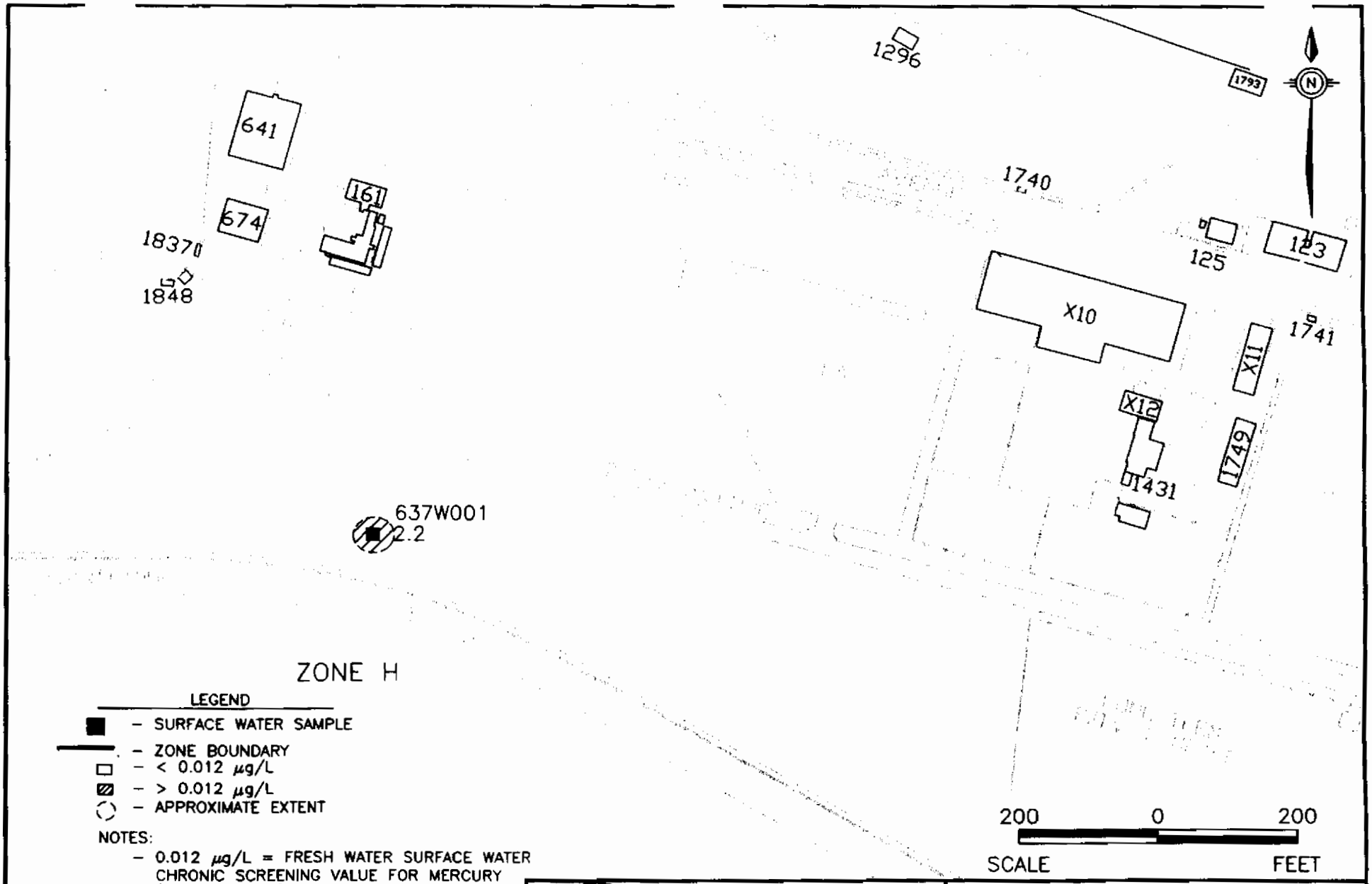

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FIGURE 10.7–42
MERCURY IN SURFACE WATER
AOC #637 DUMP AREA

DWG DATE: 02/04/98 | DWG NAME: 2907M109

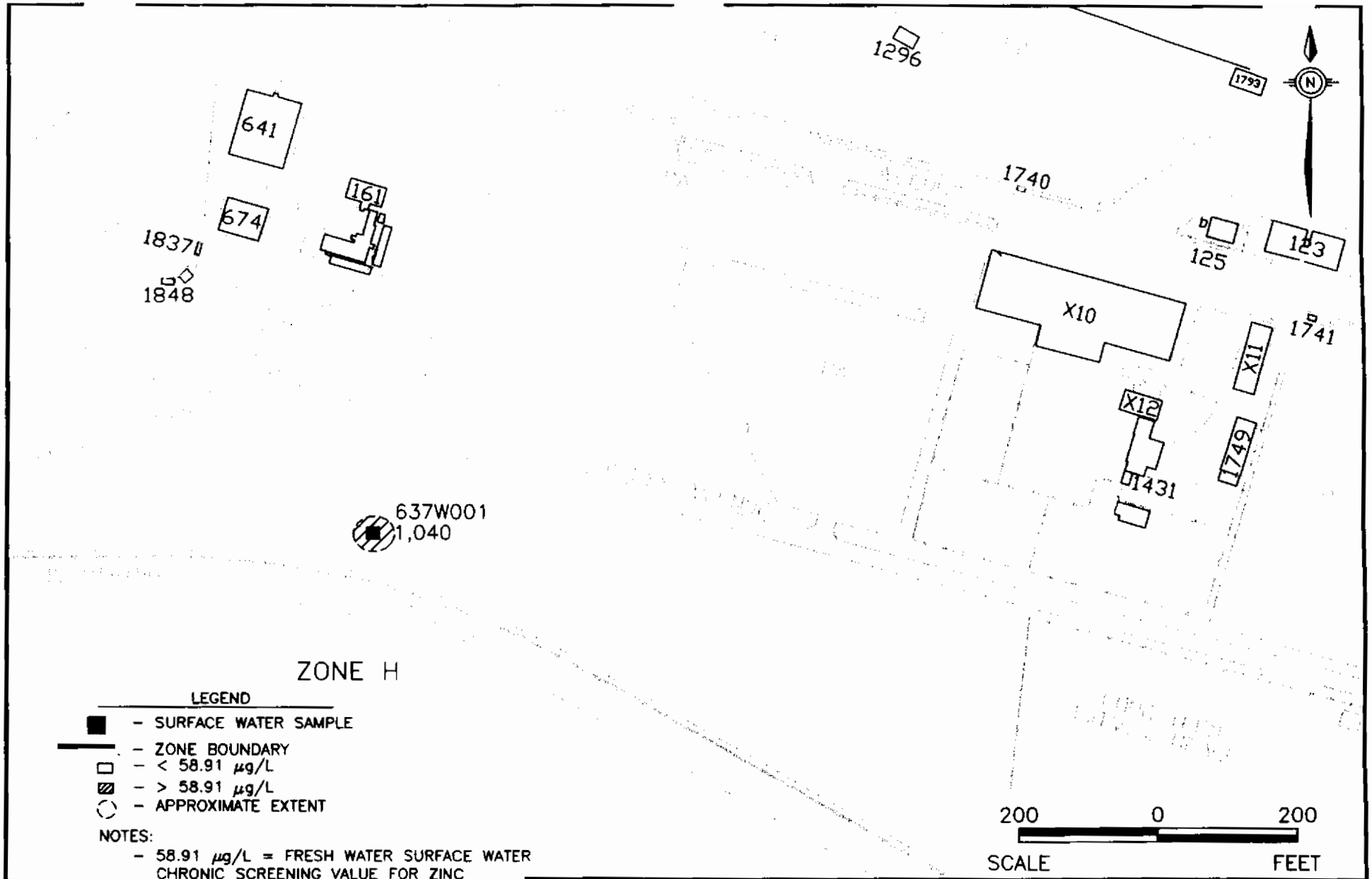

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FIGURE 10.7-43
ZINC IN SURFACE WATER
AOC #637 DUMP AREA

DWG DATE: 02/04/98 | DWG NAME: 2907M110

10.7.7 Fate and Transport Assessment

A CSI site, AOC 637 is a former burning dump located between Dyess Avenue and Bainbridge Avenue. Environmental media sampled as part of the AOC 637 investigation included surface soil, subsurfaces soil, sediments, groundwater, and surface water. Potential constituent migration pathways investigated for AOC 637 include soil-to-groundwater, groundwater-to-surface water, surface soil-to-sediment and emission of volatiles from surface soil to air.

10.7.7.1 Groundwater-to-Surface Water

Table 10.7.17 compares maximum detected organic constituent concentrations in surface soil and subsurface soil samples to risk-based soil screening levels considered protective of groundwater. For inorganics, maximum concentrations in soil are compared to the greater of (a) risk-based soil screening levels or (b) background concentrations. To provide a conservative screen, generic soil screening levels are used; leachate entering the aquifer is assumed to be diluted by a ratio of 20:1, with no attenuation of constituents in soil (DAF=20).

One organic compound - hydrazine - was detected in AOC 637 in surface and surface soil at concentrations exceeding groundwater protection SSLs. Hydrazine exceeded the SSL in five surface soil samples (637SB001, 637SB002, 637SB003, 637SB004, and 637SB005), and one subsurface soil sample (637SB003). Additionally, hydrazine was detected at AOC 637 in shallow groundwater. The presence of hydrazine at AOC 637 is consistent with the historical uses of this site. Hydrazine is associated with torpedo and rocket fuels (as a propellant) and was also probably associated with other types of wastes that were either burned or used to ignite other wastes. The presence of hydrazine in both surface soil and subsurface soil, as well as in groundwater, indicate that the soil-to-groundwater pathway for hydrazine has merit.

Table 10.7.17
Chemicals Detected in Surface Soil, Subsurface Soil, and Shallow Groundwater
Comparison to SSLs, Tap Water RBCs, Saltwater Surface Water Chronic Screening Levels, and Background Concentrations
NAVBASE Charleston, Zone G: AOC 637
Charleston, South Carolina

Parameter	Max. Concentration		Max. Concentration		Screening Concentration *								
	Surface Soil	Subsurfac Soil	Shallow GW	Deep GW	Soil to GW SSL	Tap Water RBC	Saltwater Surf. Wtr. Chronic	Soil Units	Water Units	Leaching Potential	Ground-Water Migration Concern	Surface Water Migration Concern
Volatile Organic Compounds												
Acetone	ND	ND	25	NA	16000	3700	NA	UG/KG	UG/L	NO	NO	NO
Benzene	ND	ND	55	NA	30	0.36	109	UG/KG	UG/L	NO	YES	NO
2-Butanone (MEK)	ND	81	ND	NA	7900	1900	NA	UG/KG	UG/L	NO	NO	NO
Carbon disulfide	1	4	ND	NA	32000	1000	NA	UG/KG	UG/L	NO	NO	NO
Chlorobenzene	ND	ND	38	NA	1000	39	105	UG/KG	UG/L	NO	NO	NO
Ethylbenzene	ND	ND	440	NA	13000	1300	4.3	UG/KG	UG/L	NO	NO	YES
4-Methyl-2-Pentanone (MIBK)	ND	ND	22	NA	12000	2900	NA	UG/KG	UG/L	NO	NO	NO
Toluene	ND	ND	92	NA	12000	750	37	UG/KG	UG/L	NO	NO	YES
Xylene (total)	ND	ND	6300	NA	148000	12000	NA	UG/KG	UG/L	NO	NO	NO
Semivolatile Organic Compounds												
Acenaphthene	200	ND	13	NA	570000	2200	9.7	UG/KG	UG/L	NO	NO	YES
Acenaphthylene	45	ND	ND	NA	293000	1500	NA	UG/KG	UG/L	NO	NO	NO
Anthracene	410	46	11	NA	12000000	11000	NA	UG/KG	UG/L	NO	NO	NO
Benzoic acid	ND	ND	ND	NA	400000	150000	NA	UG/KG	UG/L	NO	NO	NO
Benzo(g,h,i)perylene	680	120	ND	NA	4.66E+08	1500	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene equivalents				NA								
Benzo(a)anthracene	1000	110	ND	NA	2000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(a)pyrene	890	140	ND	NA	8000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(b)fluoranthene	1400	140	ND	NA	5000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Benzo(k)fluoranthene	720	120	ND	NA	49000	0.92	NA	UG/KG	UG/L	NO	NO	NO
Chrysene	1200	160	ND	NA	160000	9.2	NA	UG/KG	UG/L	NO	NO	NO
Dibenzo(a,h)anthracene	320	47	ND	NA	2000	0.0092	NA	UG/KG	UG/L	NO	NO	NO
Indeno(1,2,3-cd)pyrene	560	110	ND	NA	14000	0.092	NA	UG/KG	UG/L	NO	NO	NO
Dibenzofuran	100	ND	14	NA	50000	150	NA	UG/KG	UG/L	NO	NO	NO
1,4-Dichlorobenzene	ND	ND	2	NA	2000	0.44	19.9	UG/KG	UG/L	NO	YES	NO
2,4-Dichlorophenol	ND	ND	4	NA	1000	110	NA	UG/KG	UG/L	NO	NO	NO
2,4-Dimethylphenol	ND	ND	48	NA	9000	730	NA	UG/KG	UG/L	NO	NO	NO
bis(2-Ethylhexyl)phthalate (BEHP)	100	ND	ND	NA	3600000	4.8	NA	UG/KG	UG/L	NO	NO	NO
Fluoranthene	1700	220	9	NA	4300000	1500	1.6	UG/KG	UG/L	NO	NO	YES
Fluorene	200	ND	15	NA	560000	1500	NA	UG/KG	UG/L	NO	NO	NO
2-Methylnaphthalene	120	ND	39	NA	126000	1500	NA	UG/KG	UG/L	NO	NO	NO
2-Methylphenol (o-cresol)	ND	ND	25	NA	15000	1800	NA	UG/KG	UG/L	NO	NO	NO
4-Methylphenol (p-cresol)	ND	ND	50	NA	1380	180	NA	UG/KG	UG/L	NO	NO	NO
Naphthalene	160	ND	240	NA	84000	1500	23.5	UG/KG	UG/L	NO	NO	YES
Phenanthrene	2400	120	55	NA	1380000	1500	NA	UG/KG	UG/L	NO	NO	NO
Phenol	ND	ND	10	NA	100000	22000	58	UG/KG	UG/L	NO	NO	NO
Pyrene	2600	180	6	NA	4200000	1100	NA	UG/KG	UG/L	NO	NO	NO
Pesticides/PCB Compounds												
alpha-Chlordane	39	ND	ND	NA	10000	0.19	0.004	UG/KG	UG/L	NO	NO	NO
gamma-Chlordane	73	4.7	ND	NA	10000	0.19	0.004	UG/KG	UG/L	NO	NO	NO
4,4'-DDD	12	ND	0.21	NA	16000	0.28	0.025	UG/KG	UG/L	NO	NO	YES
4,4'-DDE	20	ND	ND	NA	54000	0.2	0.14	UG/KG	UG/L	NO	NO	NO
4,4'-DDT	36	ND	0.12	NA	32000	0.2	0.001	UG/KG	UG/L	NO	NO	YES
Endosulfan II	3.3	ND	ND	NA	18000	220	0.0087	UG/KG	UG/L	NO	NO	NO
Endrin	15	ND	ND	NA	1000	11	0.0023	UG/KG	UG/L	NO	NO	NO
Endrin aldehyde	5.5	ND	ND	NA	1000	11	NA	UG/KG	UG/L	NO	NO	NO
Endrin ketone	11	ND	ND	NA	1000	11	NA	UG/KG	UG/L	NO	NO	NO
Heptachlor	13	ND	ND	NA	23000	0.0023	0.0036	UG/KG	UG/L	NO	NO	NO
Heptachlor epoxide	2.8	ND	ND	NA	700	0.0012	0.0036	UG/KG	UG/L	NO	NO	NO
Aroclor-1260	120	ND	ND	NA	1000	0.034	0.03	UG/KG	UG/L	NO	NO	NO
Hydrazine												
Hydrazine	213	323	7.7	NA	0.088	0.022	NA	UG/KG	UG/L	YES	YES	NO
Explosives												
Tetryl	ND	ND	38	NA	NA	NA	NA	UG/KG	UG/L	NO	NO	NO

Inorganic Compounds												
Aluminum	14700	7960	415	NA	1000000	37000	NA	MG/KG	UG/L	NO	NO	NO
Antimony	0.47	1.5	8.7	NA	5	15	NA	MG/KG	UG/L	NO	NO	NO
Arsenic	19	7.5	7.9	NA	29	18.7	36	MG/KG	UG/L	NO	NO	NO
Barium	40.3	23	6000	NA	1600	2600	NA	MG/KG	UG/L	NO	YES	NO
Beryllium	0.79	0.56	ND	NA	63	1.2	NA	MG/KG	UG/L	NO	NO	NO
Cadmium	0.59	0.82	0.36	NA	8	18	9.3	MG/KG	UG/L	NO	NO	NO
Chromium (total)	30.4	21.4	33.6	NA	1000000	180	50	MG/KG	UG/L	NO	NO	NO
Cobalt	4	2.2	2.3	NA	2000	2200	NA	MG/KG	UG/L	NO	NO	NO
Copper	107	144	118	NA	920	130000	8.33	MG/KG	UG/L	NO	NO	YES
Cyanide	0.27	0.15	NT	NA	40	730	3.8	MG/KG	UG/L	NO	NO	NO
Lead	98	340	44.1	NA	400	15	8.5	MG/KG	UG/L	NO	YES	YES
Manganese	186	100	416	NA	1100	2560	NA	MG/KG	UG/L	NO	NO	NO
Mercury	0.62	0.29	0.33	NA	2.1	11	0.025	MG/KG	UG/L	NO	NO	YES
Nickel	22.1	22.6	12.45	NA	130	730	21.7	MG/KG	UG/L	NO	NO	NO
Selenium	1.1	0.75	4.2	NA	5	180	71	MG/KG	UG/L	NO	NO	NO
Silver	ND	ND	1.7	NA	34	180	2.9	MG/KG	UG/L	NO	NO	NO
Thallium	1.06	0.65	5.5	NA	0.95	2.9	21.3	MG/KG	UG/L	YES	YES	NO
Tin	10.6	1.9	ND	NA	11000	22000	NA	MG/KG	UG/L	NO	NO	NO
Vanadium	37.1	18.5	5.7	NA	6000	260	NA	MG/KG	UG/L	NO	NO	NO
Zinc	234	215	363	NA	12000	11000	86	MG/KG	UG/L	NO	NO	YES

Notes:

* Screening Concentrations:

  Soil to GW - Generic SSLs based on DAF = 20, from 1996 Soil Screening Guidance or calculated using values from Table 6.4

  Tap Water RBC - From EPA Region III Risk-Based Concentration Table, October 22, 1997

  Salt Water Surface Water Chronic - From EPA Supplemental Guidance to RAGS: Region IV Bulletins, Ecological Risk Assessment, November, 1995, Table 2

  For inorganics, the value shown is the greater of the relevant screening value or the corresponding background value.

NA - Not available/Not applicable
ND - Not detected
RBC - Risk based concentration
SSL - Soil screening level
MG/KG - Milligrams per kilogram
NG/KG - Nanograms per kilogram
PG/L - Picograms per liter
UG/KG - Micrograms per kilogram
UG/L - Micrograms per liter

The only inorganic analyte detected in surface soil at concentrations exceeding groundwater protection criteria is thallium. Thallium exceeded the SSL in the surface soil at only one location (637SB007). Additionally, thallium was also present in site groundwater. The presence of thallium at AOC 637 is apparently not consistent with the historical activities at this AOC. It is unlikely that its presence is associated with the historical uses of the AOC, and is probably a natural component of the dredge spoils used to fill the site. The presence of thallium above the SSL in surface soil indicates that the pathway has merit; however its absence above SSLs in subsurface soil raises some question as to the magnitude of its significance.

10.7.7.2 Groundwater-to-Surface Water Cross-Media Transport

Table 10.7.17 also compares maximum detected organic compound concentrations in shallow groundwater samples to risk-based concentrations for drinking water, and to chronic ambient saltwater quality criteria values for the protection of aquatic life (saltwater surface water chronic screening values). For inorganics, maximum concentrations in groundwater are compared to the greater of (a) risk-based drinking water concentrations, or (b) background concentrations for groundwater, as well as to the saltwater surface water chronic values. To provide a conservative screening, no attenuation or dilution of constituents in groundwater is assumed before comparison to the relevant standards.

Three organic compounds (benzene, 1,4-dichlorobenzene, and hydrazine) were present in groundwater at concentrations exceeding the applicable tap water RBC screening levels during first-quarter sampling. The exceedance for benzene, was recorded at location 637001. 1,4-dichlorobenzene was present at concentrations exceeding the applicable RBC screening levels at locations 637003 and 637002. Hydrazine was detected in groundwater at concentrations exceeding the RBC screening level at locations 637002 and 637003.

Three inorganic analytes (barium, lead, and thallium) were detected at levels that exceeded the applicable tap water RBC during the first-quarter of groundwater monitoring. Lead and thallium were present at levels that exceeded the RBCs at location 637001 and barium was detected at a concentration exceeding the tap water RBC at locations 637001 and 637003.

Based on the first-quarter groundwater sample results for AOC 637, from a chemical standpoint, the risk-based exposure pathway has merit. Each of the sampling locations can be characterized as to a particular group of contaminants - the provenance of these groups may be linked historically and simply represent the types of wastes burned/buried in proximity to that location. Each sampling location at AOC 637 has its own peculiar mix of contaminants. The interaction between these contaminants, and the consequent effect(s), if any, on overall groundwater contamination will need to be further evaluated following several quarters of groundwater monitoring. Importantly, the risk-based exposure pathway is incomplete due to the absence of a receptor group. Therefore, while it is acknowledged that contaminant concentrations are present that exceed their applicable RBC screening levels, the exposure pathway is considered invalid.

Seven organic compounds were present in groundwater at concentrations that exceed their respective saltwater surface water chronic screening values (ethylbenzene, toluene, acenapthene, fluoranthene, naphthalene, 4,4'-DDD, and 4,4'-DDT). The majority of the exceedances of the surface water chronic screening levels for ethylbenzene and toluene were recorded at location 637001. Acenapthene, fluoranthene, naphthalene, 4,4'-DDD, and 4,4'-DDT exceedances were all detected at location 637003.

Four inorganic analytes (copper, lead, mercury, and zinc) were detected at locations 637001 and 637003 at concentrations in groundwater that exceeded the applicable surface water chronic screening levels. Based on the first-quarter groundwater monitoring sampling results, the groundwater-to-surface water migration pathway does have merit purely from a chemical

standpoint. From a physical perspective, groundwater flow exhibit components that are consistent with discharge to the Cooper River (1000 feet to the northeast) and Shipyard Creek (1250 feet to the southeast). However, significant attenuation of these constituents through dispersion, retardation, and potentially biological reduction can reasonably be expected to occur over these distances. Further attenuation of concentrations through dilution will also occur upon discharge into the surface water at these receptor points. To fully evaluate the potential risk associated with this pathway, from a physico-chemical perspective, will require specialized sampling for constituents indicative of bioattenuation, as well as several quarters of data simply to establish empirical trends. Irregardless, the pathway has merit, but the level of significance associated with it requires further data and analysis.

10.7.7.3 Soil-to-Air Cross-Media Transport

Table 10.7.18 lists the VOCs that were detected in surface soil samples collected at AOC 637, along with the corresponding soil-to-air volatilization screening criteria. No VOCs were detected in surface soil at AOC 637, consequently, the soil-to-air migration pathway is not considered valid.

10.7.7.4 Fate and Transport Summary

One organic compound — hydrazine — and one inorganic analyte — thallium — were detected in surface soil at concentrations that exceeded the applicable SSLs. Hydrazine was present in surface soil, subsurface soil and groundwater. Thallium was detected in surface soil at one location at concentrations exceeding the applicable SSL. The presence of hydrazine is consistent with the historical activities at AOC 637; however, the presence of thallium is more likely a natural component of the dredged spoil used to fill the site. The presence of hydrazine in the surface soil, subsurface soil, and groundwater indicates that the soil-to-groundwater migration

Table 10.7.18
Soil to Air Volatilization Screening Analysis
NAVBASE Charleston, Zone G: AOC 637
Charleston, South Carolina

VOCs	Maximum Concentration in Surface Soil	Soil to Air SSL*	Units	Exceeds SSL
Carbon disulfide	1	720000	UG/KG	NO

Notes:
* - Soil screening levels for transfers from soil to air were obtained from USEPA Soil Screening Guidance, Technical Background Document Appendix A, May 1996 (first preference) or from Soil Screening Levels - Transfers from Soil to Air, USEPA Region III Risk-Based Concentration Table, June 1996.
NA - Not available

pathway for hydrazine has merit. The significance of the pathway for thallium is unclear due to its absence above SSLs in subsurface soil. Three organic compounds (benzene, 1,4-dichlorobenzene and hydrazine), and three inorganic analytes (barium, lead and thallium) were detected in concentrations in groundwater at AOC 637 that exceeded the tap water RBCs. Based on the first-quarter groundwater monitoring sampling results, the risk -based exposure pathways for these analytes have merit. Each of the groundwater monitoring locations has a peculiar mix of contaminants, and the interaction between these groupings of constituents and the consequent effect(s), if any, on overall groundwater contamination will need to be further evaluated following several quarters of groundwater monitoring. However, the risk-based exposure pathway is incomplete due to the absence of a receptor group; therefore, the exposure pathways are considered invalid.

Seven organic compounds - ethylbenzene, toluene, acenapthene, fluoranthene, naphthalene, 4,4'-DDD, and 4,4'-DDT- and four inorganics - copper, lead, mercury, and zinc - were present groundwater in concentrations that exceeded the surface water chronic screening values. Based on the first-quarter groundwater monitoring results and flow conditions, these pathways have merit. However, significant attenuation of these constituents through dispersion, retardation, and potentially biological reduction can reasonably be expected to occur over the distances to the nearest surface water receptors. To fully evaluate the potential risk associated with this pathway, from a physico-chemical perspective, will require specialized sampling for constituents indicative of bioattenuation, as well as several quarters of data simply to establish empirical trends and conclusive flow directions; therefore, the pathway has merit but the level of significance associated with it requires further data and analysis. No VOCs were detected above the soil-to-air volatilization screening levels, thus the soil-to-air pathway is not considered valid.

10.7.8 Human Health Risk Assessment

10.7.8.1 Site Background and Investigative Approach

AOC 637 was a former burning dump located between Dyess Avenue and Bainbridge Avene. The investigative activities centered around the waste burning activities that have occurred at this site.

During the investigation, a total of seven soil borings were advanced. Samples were collected from the upper interval at all locations and two lower intervals to identify potential impacts resulting from the activities listed above. Surface soil data was used to quantitatively assess the direct contact soil exposure pathways. Indirect exposures to contaminants reported in subsurface soil via cross media transfer were assessed in the previous section, Fate and Transport Assessment for AOC 637. Three monitoring wells were installed in the shallow aquifer. Data from the initial sampling event for each well were used to quantitatively assess groundwater exposure pathways. Sections 10.9.3 and 10.9.5 provide summaries of the sampling effort for soil and groundwater at AOC 637.

10.7.8.2 COPC Identification

Soil

Based on the screening comparisons described in Section 7 of this RFI and presented in Table 10.7.19, Arsenic, BEQs, hydrazine, and thallium were identified as COPCs for surface soil. Aluminum, beryllium, and manganese were detected at maximum concentrations exceeding their RBCs but not exceeding their background concentrations. These inorganics were therefore eliminated from further consideration in the AOC 637 HHRA. Wilcoxon rank sum test analyses did not result in the inclusion of any parameter that had been screened out on the basis of background concentration.

Table 10.7.19
Chemicals Present in Site Samples
AOC 637 - Surface Soil
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentrations RBC	Background	Units	Number Exceeding RBC	Bkgd
PCBs													
Aroclor-1260		1	7	120	120	120	73	93	320	NA	UG/KG	1	
Carcinogenic PAHs													
B(a)P Equiv.	*	6	7	15.59	1507.2	654	855.07	855.07	88	NA	UG/KG	4	
Benzo(a)anthracene	*	5	7	56	1000	553	370	390	880	NA	UG/KG	1	
Benzo(b)fluoranthene	*	5	7	54	1400	477	370	370	880	NA	UG/KG	1	
Chrysene		6	7	51	1200	562	370	370	88000	NA	UG/KG		
Dibenz(a,h)anthracene	*	3	7	160	320	217	360	390	88	NA	UG/KG	3	
Indeno(1,2,3-cd)pyrene		4	7	168.5	560	375	370	390	880	NA	UG/KG		
Benzo(k)fluoranthene		5	7	40	720	367	360	370	8800	NA	UG/KG		
Benzo(a)pyrene	*	5	7	56	890	517	370	390	88	NA	UG/KG	4	
TCDD Equivalents													
Dioxin Equiv.		2	2	0.3401	0.5712	0.46	NA	NA	1000	NA	NG/KG		
1234678-HpCDD		2	2	14.9	18.5	16.7	NA	NA	NA	NA	NG/KG		
1234678-HpCDF		1	2	1.76	1.76	1.8	2.66	2.66	NA	NA	NG/KG		
123678-HxCDD		1	2	0.738	0.738	0.74	0.398	0.398	NA	NA	NG/KG		
123789-HxCDD		1	2	1.25	1.25	1.3	0.415	0.415	NA	NA	NG/KG		
123478-HxCDF		1	2	0.572	0.572	0.57	0.319	0.319	NA	NA	NG/KG		
OCDD		2	2	115	183	149	NA	NA	NA	NA	NG/KG		
OCDF		2	2	1.3	4.35	2.8	NA	NA	NA	NA	NG/KG		
Inorganics													
Aluminum (Al)		7	7	4010	14700	6598	NA	NA	7800	18700	MG/KG	1	
Antimony (Sb)		1	7	0.47	0.47	0.47	0.32	0.37	3.1	2.89	MG/KG		
Arsenic (As)	*	7	7	4.2	19	8.4	NA	NA	0.43	17.2	MG/KG	7	1
Barium (Ba)		7	7	11.6	40.3	28.0	NA	NA	550	109	MG/KG		
Beryllium (Be)		7	7	0.27	0.785	0.46	NA	NA	0.15	1.2	MG/KG	7	
Cadmium (Cd)		7	7	0.09	0.59	0.42	NA	NA	3.9	1.07	MG/KG		
Calcium (Ca)	N	7	7	9270	103000	58024	NA	NA	NA	NA	MG/KG		
Chromium (Cr)		7	7	8.5	30.4	20.1	NA	NA	39	42.8	MG/KG		
Cobalt (Co)		7	7	0.92	4	2.4	NA	NA	470	6.6	MG/KG		
Copper (Cu)		7	7	11.1	107	42.8	NA	NA	27000	260	MG/KG		
Cyanide (CN)		1	6	0.27	0.27	0.27	0.11	0.12	160	0.38	MG/KG		
Iron (Fe)	N	7	7	4030	16600	7909	NA	NA	NA	NA	MG/KG		
Lead (Pb)		7	7	14.05	98	53.2	NA	NA	400	181	MG/KG		
Magnesium (Mg)	N	7	7	580	2990	1771	NA	NA	NA	NA	MG/KG		
Manganese (Mn)		7	7	33.2	186	101	NA	NA	180	325	MG/KG	1	
Mercury (Hg)		5	7	0.14	0.62	0.28	0.05	0.07	2.3	1.03	MG/KG		
Nickel (Ni)		7	7	4.1	22.1	12.3	NA	NA	160	20.6	MG/KG		1
Potassium (K)	N	7	7	239	1410	686	NA	NA	NA	NA	MG/KG		
Selenium (Se)		4	7	0.46	1.1	0.75	0.33	0.37	39	1.22	MG/KG		
Sodium (Na)	N	7	7	325	575	413	NA	NA	NA	NA	MG/KG		
Thallium (Tl)	*	2	7	0.82	1.06	0.94	0.37	0.4	0.63	0.85	MG/KG	2	1
Tin (Sn)		3	7	1.65	10.6	5.7	1	3.5	4700	9.67	MG/KG		1
Vanadium (V)		7	7	8.9	37.05	19.2	NA	NA	55	60.9	MG/KG		
Zinc (Zn)		7	7	39.7	234	129	NA	NA	2300	519	MG/KG		
Pesticides													
alpha-Chlordane		3	7	2.6	39	14.7	1.5	1.6	1800	NA	UG/KG		
gamma-Chlordane		6	7	2.2	73	15.5	1.6	1.6	1800	NA	UG/KG		
4,4'-DDD		1	7	12	12	12.0	2.7	3.1	2700	NA	UG/KG		
4,4'-DDE		4	7	4.1	20	11.7	2.7	3.1	1900	NA	UG/KG		
4,4'-DDT		2	7	29	36	32.5	2.7	13	1900	NA	UG/KG		
Endosulfan II		1	7	3.3	3.3	3.3	2.7	7.1	47000	NA	UG/KG		
Endrin		1	7	15	15	15.0	2.7	4.6	2300	NA	UG/KG		
Endrin aldehyde		1	7	5.5	5.5	5.5	2.7	3.1	2300	NA	UG/KG		
Endrin ketone		1	7	11	11	11.0	2.7	3.1	2300	NA	UG/KG		
Heptachlor		2	7	3.9	13	8.5	1.4	1.6	140	NA	UG/KG		
Heptachlor epoxide		1	7	2.8	2.8	2.8	1.4	5.4	70	NA	UG/KG		

Semivolatiles											
Acenaphthene	4	7	100	200	155	370	390	470000	NA	UG/KG	
Acenaphthylene	1	7	45	45	45.0	360	410	230000	NA	UG/KG	
Anthracene	4	7	240	410	323	370	390	2300000	NA	UG/KG	
Benzo(g,h,i)perylene	5	7	50	680	356	370	390	230000	NA	UG/KG	
bis(2-Ethylhexyl)phthalate	2	7	84	100	92.0	360	410	46000	NA	UG/KG	
Dibenzofuran	3	7	66	100	83.7	370	410	31000	NA	UG/KG	
Fluoranthene	7	7	59	1700	815	NA	NA	310000	NA	UG/KG	
Fluorene	4	7	95	200	151	370	390	310000	NA	UG/KG	
2-Methylnaphthalene	3	7	55	120	78.3	370	410	310000	NA	UG/KG	
Naphthalene	2	7	77	160	119	360	410	310000	NA	UG/KG	
Phenanthrene	6	7	82	2400	1037	370	370	230000	NA	UG/KG	
Pyrene	7	7	80	2600	1007	NA	NA	230000	NA	UG/KG	
Volatile Organics											
Carbon disulfide	1	6	1	1	1.0	5	6	780000	NA	UG/KG	
Propellants											
Hydrazine *	5	5	65.5	213	140	NA	NA	210	NA	UG/KG	1

Notes:
* - Identified as a COPC
N - Essential nutrient
SQL - Sample quantitation limit
MG/KG - milligram per kilogram
UG/KG - microgram per kilogram
NG/KG - nanogram per kilogram
NA - Not applicable

Groundwater

As shown in Table 10.7.20, antimony, barium, benzene, chlorobenzene, chromium, ethylbenzene 1,4-dichlorobenzene, hydrazine, lead, 4-methylphenol, naphthalene, tetryl, thallium, toluene, and xylene (total) were identified as COPCs in shallow groundwater for AOC 637. 2-Methylphenol was retained as a COPC due to its similarity with 4-methylphenol. Arsenic and manganese were detected at maximum concentrations exceeding their RBCs but not exceeding their background concentration. These inorganic parameters were therefore eliminated from further consideration in the AOC 637 HHRA. An insufficient number of groundwater samples were collected to run Wilcoxon rank sum test analyzes; therefore these analyses were not performed for AOC 637 groundwater.

10.7.8.3 Exposure Assessment

Exposure Setting

AOC 637 is a moderately developed urban setting, approximately 1,100 feet southwest of the waterfront along the Cooper River. The site is currently a gravel parking area which would prevent direct contact with soil, but would not inhibit migration of potential contaminants to groundwater or air. All potable water is provided through the city's water supply. Shallow groundwater at the site is not currently nor anticipated to be used in the future as potable or process water.

Potentially Exposed Populations

Potentially exposed populations are current and future site workers, hypothetical future site residents, and adolescent trespassers. Future site resident and site worker exposure scenarios were addressed quantitatively in this risk assessment. Current exposure to workers is discussed qualitatively in relation to the future workers and future residents. The hypothetical future site worker scenario assumes continuous exposure to surface soil conditions. Current site workers' exposure would be less than that assumed for the hypothetical future site worker scenario because

Table 10.7.20
Chemicals Present in Site Samples
AOC 637 - Groundwater
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Parameter		Frequency of Detection		Range of Detection		Average Detected Conc.	Range of SQL		Screening Concentrations RBC	Screening Concentrations Background	Units	Number Exceeding RBC	Number Exceeding Bkgd
Inorganics													
Aluminum (Al)		3	3	67.8	415	195.7	NA	NA	3700	692	UG/L		
Antimony (Sb)	*	2	3	6.8	8.7	7.8	1.6	1.6	1.5	4.85	UG/L	2	2
Arsenic (As)		2	3	7.6	7.9	7.8	2.1	2.1	0.045	17.8	UG/L	2	
Barium (Ba)	*	3	3	211	6000	3227	NA	NA	260	31	UG/L	2	3
Cadmium (Cd)		2	3	0.35	0.36	0.36	0.5	0.5	1.8	0.53	UG/L		
Calcium (Ca)	N	3	3	124000	233500	170833	NA	NA	NA	NA	UG/L		
Chromium (Cr)	*	3	3	1.4	33.6	13.4	NA	NA	18	3.88	UG/L	1	2
Cobalt (Co)		2	3	1.2	2.25	1.7	0.9	0.9	220	1.45	UG/L		1
Copper (Cu)		1	3	118	118	118	1.9	2.1	150	8.33	UG/L		1
Iron (Fe)	N	3	3	6607	18800	13436	NA	NA	NA	NA	UG/L		
Lead (Pb)	*	3	3	1.2	44.1	19.5	NA	NA	15	4.6	UG/L	1	1
Magnesium (Mg)	N	3	3	38060	212000	107153	NA	NA	NA	NA	UG/L		
Manganese (Mn)		3	3	209	416	313	NA	NA	84	2906	UG/L	3	
Mercury (Hg)		1	3	0.33	0.33	0.33	0.1	0.1	1.1	NA	UG/L		
Nickel (Ni)		3	3	3.3	12.45	6.9	NA	NA	73	4.08	UG/L		2
Potassium (K)	N	3	3	38000	205000	111083	NA	NA	NA	NA	UG/L		
Silver (Ag)		1	3	1.7	1.7	2	1.6	1.9	18	1.65	UG/L		1
Sodium (Na)	N	3	3	644000	3410000	1974500	NA	NA	NA	NA	UG/L		
Thallium (Tl)	*	2	3	3	5.5	4.3	5	5	0.29	NA	UG/L	2	
Vanadium (V)		2	3	1.5	5.7	3.6	1.1	1.1	26	15.4	UG/L		
Zinc (Zn)		3	3	58.4	363	163.4	NA	NA	1100	15.6	UG/L		3
Pesticides													
4,4'-DDD		1	3	0.21	0.21	0.21	0.08	0.08	0.28	NA	UG/L		
4,4'-DDT		1	3	0.12	0.12	0.12	0.08	0.08	0.2	NA	UG/L		
Semivolatile Organics													
Acenaphthene		2	3	3	12.5	7.8	10	10	220	NA	UG/L		
Anthracene		1	3	11	11	11.0	10	10	1100	NA	UG/L		
Dibenzofuran		2	3	1	13.5	7.3	10	10	15	NA	UG/L		
1,4-Dichlorobenzene	*	2	3	2	2	2.0	10	10	0.44	NA	UG/L	2	
2,4-Dichlorophenol		1	3	4	4	4.0	10	10	11	NA	UG/L		
2,4-Dimethylphenol		2	3	28	48	38.0	10	10	73	NA	UG/L		
Fluoranthene		1	3	9	9	9.0	10	10	150	NA	UG/L		
Fluorene		2	3	2	15	8.5	10	10	150	NA	UG/L		
2-Methylnaphthalene		2	3	3	39	21.0	10	10	150	NA	UG/L		
2-Methylphenol		2	3	19	25	22.0	10	10	180	NA	UG/L		
4-Methylphenol	*	1	3	50	50	50.0	10	10	18	NA	UG/L	1	
Naphthalene	*	2	3	20	240	130	10	10	150	NA	UG/L	1	
Phenanthrene		2	3	1	55	28.0	10	10	110	NA	UG/L		
Phenol		2	3	6	9.5	7.8	10	10	2200	NA	UG/L		
Pyrene		1	3	6	6	6.0	10	10	110	NA	UG/L		
Volatile Organics													
Acetone		2	3	6.5	25	15.8	100	100	370	NA	UG/L		
Benzene	*	2	3	3	55	29.0	5	5	0.36	NA	UG/L	2	
Chlorobenzene	*	3	3	2	38	15.7	NA	NA	3.9	NA	UG/L	2	
Ethylbenzene	*	1	3	440	440	440	5	5	130	NA	UG/L	1	
4-Methyl-2-pentanone		1	3	22	22	22.0	10	10	290	NA	UG/L		
Toluene	*	2	3	2	92	47.0	5	5	75	NA	UG/L	1	
Xylene (Total)	*	2	3	6	6300	3153	5	5	1200	NA	UG/L	1	
Propellants													
Hydrazine	*	2	2	5.8	7.65	6.7	NA	NA	0.022	NA	UG/L	2	
Tetryl	*	1	2	38	38	38.0	10	10	37	NA	UG/L	1	

Notes:
* - Identified as a COPC
N - Essential nutrient
SQL - Sample quantitation limit
UG/L - microgram per liter
NA - Not applicable

of their limited soil contact. Therefore, future worker assessment is considered to be conservatively representative of current site workers. Since future use of the site is uncertain, the adolescent trespasser was qualitatively addressed relative to the child resident. The future site resident scenario was built on the premise that existing buildings would be removed and replaced with dwellings.

Exposure Pathways

Exposure pathways for the hypothetical future site resident are dermal contact and incidental ingestion of surface soils. The exposure pathways for current and future site workers are the same as those for the future site resident with respect to soil. Uniform exposure was assumed for all sample locations. The groundwater pathway for the hypothetical future site residents and site workers is incidental ingestion of groundwater and inhalation of VOCs resulting from domestic or process use of groundwater. Table 10.7.21 presents the justification for exposure pathways assessed in this HHRA.

Exposure Point Concentrations

Since less than ten samples were collected in surface soil and groundwater, maximum detected concentrations were used as EPCs, as discussed in Section 7 of this RFI.

Table 10.7.21
Zone G
AOC 637
Exposure Pathways Summary

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
Current Land Uses			
Current Site Users/Maintenance	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	No surface soil is exposed at AOC 637, inhibiting fugitive dust generation. Therefore, this exposure pathway was considered insignificant compared to the other pathways.

Table 10.7.21
Zone G
AOC 637
Exposure Pathways Summary

Potentially Exposed Population	Medium and Exposure Pathway	Pathway Selected for Evaluation?	Reason for Selection or Exclusion
	Shallow groundwater, Ingestion of contaminants during potable or general use	No	Shallow groundwater is not currently used as a source of potable or process water at AOC 637.
	Shallow groundwater, Inhalation of volatilized shallow groundwater contaminants	No	Shallow groundwater is not currently used as a source of potable or process water at AOC 637.
	Soil, Incidental ingestion	No (Qualified)	Future land use assessment is considered to be conservatively representative of current receptors.
	Soil, Dermal contact	No (Qualified)	Future land use assessment is considered to be conservatively representative of current receptors.
Future Land Uses			
Future Site Residents (Child and Adult) and Future Site Worker	Air, Inhalation of gaseous contaminants emanating from soil	No	Fate and transport screening did not identify any COPCs for this indirect exposure pathway.
	Air, Inhalation of chemicals entrained in fugitive dust	No	This exposure pathway was considered insignificant compared to the other pathways.
	Shallow groundwater, Ingestion of contaminants during potable or general use	Yes	Shallow groundwater is not likely to be used as a source of potable water at AOC 637, however, this pathway was considered as a conservative measure.
	Shallow groundwater, Inhalation of volatilized contaminants during domestic use	Yes	Shallow groundwater is not likely to be used as a source of process water at AOC 637, however, this pathway was considered as a conservative measure.
	Soil, Incidental ingestion	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Soil, Dermal contact	Yes	COPCs were identified subsequent to risk-based and background screening comparisons.
	Wild game or domestic animals, Ingestion of tissue impacted by media contamination	No	Hunting/taking of game and/or raising livestock is prohibited within the Charleston, South Carolina city limits.
	Fruits and vegetables, Ingestion of plant tissues grown in media	No	The potential for significant exposure via this pathway is low relative to that of other exposure pathways assessed.

Quantification of Exposure

Soil

CDIs for ingestion and dermal contact with soils are shown in Tables 10.7.22 and 10.7.23, respectively.

Groundwater

The CDIs for groundwater ingestion are presented in Table 10.7.24.

10.7.8.4 Toxicity Assessment

Toxicity assessment terms and methods are discussed in Section 7 of this report. Table 10.7.25 presents toxicological information specific to each COPC identified at AOC 637. This information was used in the quantification of risk/hazard associated with soil and groundwater contaminants. Brief toxicological profiles for each COPC are provided in the following paragraphs.

Antimony belongs to the same periodic group as arsenic. This element is absorbed slowly through the gastrointestinal tract, which is the target of this element. Another target is the blood, where antimony concentrates. The primary exposure route for antimony to the general population is ingestion. Antimony is also a common air pollutant from industrial emissions. USEPA has not classified antimony as a carcinogen, and the oral RfD is 0.0004 mg/kg-day (Klaassen, et al., 1986). The oral RfD is based on a LOAEL of 0.35 mg/kg-day, an uncertainty factor of 1000, and a modifying factor of 1 (IRIS).

Arsenic exposure via the ingestion route causes darkening and hardening of the skin in chronically exposed humans. Inhalation exposure to arsenic causes neurological deficits, anemia, and cardiovascular effects (Klaassen, et al., 1986). USEPA set 0.3 μg/kg-day as the RfD for arsenic based on a NOAEL of 0.8 μg/kg-day in a human exposure study. Arsenic's effects on the nervous and cardiovascular systems are primarily associated with acute exposure to higher levels.

T[illegible]0.7.22
Chronic Daily Intakes
Incidental Ingestion of Surface Soil
AOC 637
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Chemical	Fraction Ingested from Contaminated Source *	Exposure Point Concentration (mg/kg)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Site Worker adult H-CDI (mg/kg-day)	Future Site Worker adult C-CDI (mg/kg-day)
Inorganics							
Arsenic	1	19	2.60E-05	2.43E-04	2.97E-05	9.30E-06	3.32E-06
Thallium	1	1.06	1.45E-06	1.36E-05	1.66E-06	5.19E-07	1.85E-07
Semivolatile Organics							
Benzo(a)pyrene equivalent	1	1.507	2.06E-06	1.93E-05	2.36E-06	7.37E-07	2.63E-07
Propellants							
Hydrazine	1	0.213	2.92E-07	2.72E-06	3.33E-07	1.04E-07	3.72E-08

NOTES:

lwa Lifetime weighted average; used to calculate carcinogenic CDI, RAGS Parts A and B
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
* Reflects the estimated fraction of the site impacted by the corresponding COPC.

Table 10.7.23
Chronic Daily Intakes
Dermal Contact with Surface Soil
AOC 637
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Chemical	Exposure Point Concentration (mg/kg)	Fraction Contacted from Contaminated Source *	Dermal Absorption Factor (unitless)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident Iwa C-CDI (mg/kg-day)	Future Site Worker adult H-CDI (mg/kg-day)	Futuer Site Worker adult C-CDI (mg/kg-day)
Inorganics								
Arsenic	19	1	0.001	1.07E-06	3.52E-06	6.68E-07	7.62E-07	2.72E-07
Thallium	1.06	1	0.001	5.95E-08	1.97E-07	3.73E-08	4.25E-08	1.52E-08
Semivolatile Organics								
Benzo(a)pyrene Equivalent	1.507	1	0.01	8.46E-07	2.79E-06	5.30E-07	6.05E-07	2.16E-07
Propellants								
Hydrazine	0.213	1	0.01	1.20E-07	3.95E-07	7.49E-08	8.55E-08	3.05E-08

NOTES:
CDI Chronic Daily Intake in mg/kg-day
H-CDI CDI for hazard quotient
C-CDI CDI for excess cancer risk
- The dermal absorption factor was applied to the exposure point concentration to reflect the different trans-dermal migration of inorganic versus organic chemicals
* Reflects the estimated fraction of the site impacted by the corresponding COPC.

Table 10.7.24
Chronic Daily Intakes
Ingestion of COPCs in Groundwater
AOC 637
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Chemical	Exposure Point Concentration (mg/liter)	Future Resident adult H-CDI (mg/kg-day)	Future Resident child H-CDI (mg/kg-day)	Future Resident lwa C-CDI (mg/kg-day)	Future Site Worker adult H-CDI (mg/kg-day)	Future Site Worker adult C-CDI (mg/kg-day)
Inorganics						
Antimony (Sb)	0.0087	2.38E-04	5.56E-04	1.31E-04	8.51E-05	3.04E-05
Barium (Ba)	6	1.64E-01	3.84E-01	9.04E-02	5.87E-02	2.10E-02
Chromium (Cr)	0.0336	9.21E-04	2.15E-03	5.06E-04	3.29E-04	1.17E-04
Lead (Pb)	0.0441	1.21E-03	2.82E-03	6.65E-04	4.32E-04	1.54E-04
Thallium (Tl)	0.0055	1.51E-04	3.52E-04	8.29E-05	5.38E-05	1.92E-05
Semivolatile Organics						
1,4-Dichlorobenzene	0.002	5.48E-05	1.28E-04	3.01E-05	1.96E-05	6.99E-06
2-Methylphenol	0.025	6.85E-04	1.60E-03	3.77E-04	2.45E-04	8.74E-05
4-Methylphenol	0.05	1.37E-03	3.20E-03	7.53E-04	4.89E-04	1.75E-04
Naphthalene	0.24	6.58E-03	1.53E-02	3.62E-03	2.35E-03	8.39E-04
Volatile Organics						
Benzene	0.055	1.51E-03	3.52E-03	8.29E-04	5.38E-04	1.92E-04
Chlorobenzene	0.038	1.04E-03	2.43E-03	5.73E-04	3.72E-04	1.33E-04
Ethylbenzene	0.44	1.21E-02	2.81E-02	6.63E-03	4.31E-03	1.54E-03
Toluene	0.092	2.52E-03	5.88E-03	1.39E-03	9.00E-04	3.21E-04
Xylene (total)	6.3	1.73E-01	4.03E-01	9.49E-02	6.16E-02	2.20E-02
Propellants/Explosives						
Hydrazine	0.00765	2.10E-04	4.89E-04	1.15E-04	7.49E-05	2.67E-05
Tetryl	0.038	1.04E-03	2.43E-03	5.73E-04	3.72E-04	1.33E-04

NOTES:
lwa Lifetime weighted average
CDI Chronic Daily Intake
H-CDI Noncarcinogenic hazard based Chronic Daily Intake
C-CDI Carcinogenic risk based Chronic Daily Intake

Table 10.7.2s

Toxicological Reference Information

for Chemicals of Potential Concern

AOC 637

Naval Base, Charleston, Zone G

Charleston, South Carolina

	Non-Carcinogenic Toxicity Data										*Carcinogenic Toxicity Data*					
nical	Oral Reference Dose (mg/kg-day)		Confidence Level	Critical Effect	Uncertainty Factor Oral	Inhalation Reference Dose (mg/kg-day)		Confidence Level	Critical Effect	Uncertainty Factor Inhalation	Oral Slope Factor (kg-day/mg)		Inhalation Slope Factor (kg-day/mg)		Weight of Evidence	Tumor Type
mony	0.0004	a	L	whole body/blood increased mortality	1,000	NA		NA	NA	NA	NA		NA		D	NA
nic	0.0003	a	M	hyperpigmentation	3	NA		NA	NA	NA	1.5	a	15.1	a	A	various
ım	0.07	a	M	increased blood pressure	3	0.000143	b	NA	NA	NA	NA		NA		D	NA
llium	0.005	a	L	microscopic organ changes	100	NA		NA	NA	NA	4.3	a	8.4	a	B2	osteosarcoma
mium III	1	a	L	NA	100/10	5.71E-07	d	NA	NA	NA	NA		NA	a	D	NA
mium VI	0.005	a	L	NA	500	NA		NA	NA	NA	NA		42	a	A	lung
	NA		NA	NA	NA	NA		NA	NA	NA	NA		NA		B2	various
lium	8E-05	a	L	increased SGOT (liver) increased serum LDH	3000	NA		NA	NA	NA	NA		NA		D	NA
o(a)pyrene equiv.	NA		NA	NA	NA	NA		NA	NA	NA	7.3	a	3.1	d	B2	mutagen
Dichlorobenzene	NA		NA	NA	NA	0.229	a	M	increased liver weight	100	0.024	b	NA		B2	NA
ethylphenol	0.05	a	M	whole body decreased weight/CNS	1000	NA		NA	NA	NA	NA		NA		D	NA
ethylphenol	0.005	b	NA	CNS/respiratory distress	1,000	NA		NA	NA	NA	NA		NA		D	NA
thalene	0.04	f	NA	NA	NA	NA		NA	NA	NA	NA		NA		D	NA
ene	0.003		NA	NA	NA	0.00171	d	NA	NA	NA	0.029	a	0.029	a	A	leukemia
robenzene	0.02	a	M	liver changes	1,000	0.00571	c	NA	NA	10000	NA		NA		D	NA
lbenzene	0.1	a	L	liver and kidney toxicity	1000	0.286	a	L	developmental toxicity	300	NA		NA		D	NA
ene	0.2	a	M	changes in liver and kidney weight	1,000	0.114	a	M	Neurological effects	300	NA		NA		D	NA
ne (total)	2	a	M	hyperactivity, decreased body weight	100	2		NA	NA	NA	NA		NA		D	NA
azine	NA		NA	NA	NA	NA		NA	NA	NA	3	a	17.1	a	B2	heptoma
l	0.01	b	NA	liver, spleen, kidney effects	10,000	NA		NA	NA	NA	NA		NA			NA

= Integrated Risk Information System (IRIS)

= Health Effects Assessment Summary Tables (HEAST)

= HEAST alternative method

= EPA-NCEA regional support value

= Not applicable or not available

= High confidence

= Low confidence

= Medium confidence

Exposure to arsenic-containing materials has been shown to cause cancer in humans. Inhalation of these materials can lead to increased lung cancer risk, and ingestion of these materials is associated with increased skin cancer rates. Arsenic has been classified as a group A carcinogen by USEPA, which set the 1.5 $(mg/kg\text{-}day)^{-1}$ SF. As listed in IRIS the basis for the classification is sufficient evidence from human data. An increased lung cancer mortality was observed in multiple human populations exposed primarily through inhalation. Also, increased mortality from multiple internal organ cancers (liver, kidney, lung, and bladder) and an increased incidence of skin cancer were observed in populations consuming drinking water high in inorganic arsenic. Human milk contains about 3 $\mu g/L$ arsenic. As listed in IRIS the critical effect of this chemical is hyperpigmentation, keratosis, and possible vascular complications. The uncertainty factor was determined to be 3 and the modifying factor was determined to be 1.

Barium is used in various alloys, paints, soap, and manufacture processes. Barium sulfate is used to aid x-ray diagnosis. This element is relatively abundant in nature and is found in plant and animal tissue. Brazil nuts contain 3 to 4 mg per gram of nuts. The fatal absorbed dose of barium is approximately 1000 mg (for humans). Assuming an absorption efficiency of five percent for barium, 20,000 mg ingested barium could be fatal. Major toxic effects of this element are muscle stimulation, central nervous system effects, and effects on the heart. The major critical effect is increased blood pressure. USEPA determined the oral RfD and inhalation RfD to be 0.07 and 1.43E-04 mg/kg-day, respectively (Dreisbach, et al., 1987) (Klaassen, et al., 1986), based on a medium confidence level. The oral uncertainty factor for barium is 3 and the oral modifying factor is 1. Barium has been issued a carcinogenic weight-of-evidence classification of "D".

Benzene is a VOC which has been associated with leukemia. This chemical has been used as a solvent in coal tar, naphtha, rubber, and plastic cement. USEPA lists benzene as a group A carcinogen. In large doses, benzene depresses the CNS, and chronic exposure depresses bone marrow. The oral SF for benzene was set by USEPA as 2.9E-02 $(mg/kg\text{-}day)^{-1}$; the oral RfD has

been set at 3.0E-03. Occupational inhalation exposure to benzene is acceptable by the Occupational Safety and Health Administration (OSHA) at concentrations of 3.25 milligrams per cubic meter (mg/m^3) or 1 ppm in air (Dreisbach et al., 1987; NIOSH, 1990).

BEQs include the following list of PAHs:

Benzo(a)anthracene	TEF	0.1
Benzo(b)fluoranthene	TEF	0.1
Dibenz(a,h)anthracene	TEF	1.0
Benzo(k)fluoranthene	TEF	0.01
Benzo(a)pyrene	TEF	1.0
Indeno(1,2,3-cd)pyrene	TEF	0.1
Chrysene	TEF	0.001

Some PAHs are toxic to the liver, kidney, and blood. However, the toxic effects of the PAHs above have not been well established. There are no RfDs for the PAHs above due to a lack of data. All PAHs listed above are classified by USEPA as B2 carcinogens, and their carcinogenicity is addressed relative to that of benzo(a)pyrene, having an oral SF 7.3 $(mg/kg\text{-}day)^{-1}$. TEFs, also set by USEPA, are multipliers that are applied to the detected concentrations, which are subsequently used to calculate excess cancer risk. These multipliers are discussed further in the exposure and toxicity assessment sections. Most carcinogenic PAHs have been classified as such due to animal studies using large doses of purified PAHs. There is some doubt as to the validity of these listings, and the SFs listed in USEPA's RBC table are provisional. However, these PAHs are carcinogens when the exposure involves a mixture of other carcinogenic substances (e.g., coal tar, soot, cigarette smoke, etc.). As listed in IRIS, the basis for the benzo(a)pyrene B2 classification is human data specifically linking benzo(a)pyrene to a carcinogenic effect are lacking. There are, however, multiple animal studies in many species demonstrating benzo(a)pyrene to be carcinogenic by numerous routes.

Benzo(a)pyrene has produced positive results in numerous genotoxicity assays. At the June 1992 CRAVE Work Group meeting, a revised risk estimate for benzo(a)pyrene was verified. This section provides information on three aspects of the carcinogenic risk assessment for the agent in question. The USEPA classification and quantitative estimates of exposure reflect a weight-of-evidence judgment of the likelihood that the agent is a human carcinogen. The quantitative risk estimates are presented in application of a low-dose extrapolation procedure and presented as the risk per (mg/kg-day). The unit risk is the quantitative estimate in terms of either risk per μg/L drinking water or risk per $\mu g/m^3$ air breathed. The third form in which risk is presented is drinking water or air concentration providing cancer risks of 1 in 10,000 or 1 in 1,000,000. The Carcinogenicity Background Document provides details on the carcinogenicity values found in IRIS. Users are referred to the Oral Reference Dose and Reference Concentration sections for information on long-term toxic effects other than carcinogenicity.

The basis for the dibenz(a,h)anthracene and benzo(b)fluoranthene B2 classification is listed in IRIS, as no human data and sufficient data from animal bioassays. Benzo(b)fluoranthene produced tumors in mice after lung implantation, intraperitoneal or subcutaneous injection, and skin painting. The basis for the benzo(a)anthracene B2 classification is listed in IRIS, as no human data and sufficient data from animal bioassays. Benzo(a)anthracene produced tumors in mice exposed by gavage; intraperitoneal, subcutaneous or intramuscular injection; and topical application. Benzo(a)anthracene produced mutations in bacteria and in mammalian cells, and transformed mammalian cells in culture. The basis for the benzo(k)fluoranthene B2 classification is listed in IRIS, as no human data and sufficient data from animal bioassays. Benzo(k)fluoranthene produced tumors after lung implantation in mice and when administered with a promoting agent in skin-painting studies. Equivocal results have been found in a lung adenoma assay in mice. Benzo(k)fluoranthene is mutagenic in bacteria. (Klaassen, et al., 1986).

Beryllium exposure via inhalation route can inflame the lungs, a condition known as acute beryllium disease, as a result of short-term exposure to high concentrations. Removal from exposure reverses the symptoms. Chronic exposure to much lower concentrations of beryllium or beryllium oxide by inhalation has been reported to cause chronic beryllium disease, with symptoms including shortness of breath, scarring of the lungs, and berylliosis, which is noncancerous growths in the lungs of humans. Both forms of beryllium disease can be fatal, depending on the severity of the exposure. Additionally, a skin allergy may develop when soluble beryllium compounds come nto contact with the skin of sensitized individuals (Gradient, 1991). An oral RfD of 0.0054 mg/kg-day has been set for beryllium based on a chronic oral bioassay (rats were the study species) which determined an NOAEL of 0.54 mg/kg-day. Beryllium has been classified by USEPA as a group B2 carcinogen based on animal studies. Human epidemiology studies of beryllium are inadequate. As listed in IRIS, classification is based on beryllium being shown to induce lung cancer via inhalation in rats and monkeys and to induce osteosarcomas in rabbits via intravenous or intramedullary injection. An inhalation SF of 8.4 $(mg/kg\text{-}day)^{-1}$ and an oral SF of 4.3 $(mg/kg\text{-}day)^{-1}$ have been set by USEPA. As listed in IRIS, the critical effect of this chemical is no adverse effect. The uncertainty factor was 100 and the modifying factor was 1. The IRIS RfD in drinking water is 0.005 mg/kg-day.

Chlorobenzene is a volatile organic that has been shown to cause histopathologic changes in the liver when ingested. Chlorobenzene has also been shown to cause irritation to the mucous membrane, skin, cornea, and lungs; it has also been shown to cause kidney damage and central nervous system effects. USEPA set the oral RfD and inhalation RfD to 0.02 and 0.00571 mg/kg-day, respectively, with an uncertainty factor of 1,000 (Dreisbach et al., 1987). Chlorobenzene has been classified as group "D" by USEPA's weight-of-evidence classification (IRIS).

Chromium exists in two stable, natural forms: trivalent (CrIII) and hexavalent (CrVI). Acute exposure to chromium can result in kidney damage following oral exposure or damage to the nasal mucosa and septum following inhalation exposure. Chronic inhalation exposure to hexavalent chromium has resulted in kidney and respiratory tract damage, as well as excess lung cancer in both animals and humans following occupational exposure. Only CrVI is believed to be carcinogenic by inhalation (IRIS). Oral RfD values for CrIII and CrVI are 1.0 and 5E-3 (mg/kg-day), respectively. For CrIII, the RfD is based on liver toxicity in the rat. For the hexavalent form, the RfD is based on unspecified pathological changes observed in rat studies. In addition, CrVI is considered a group A carcinogen for inhalation exposures, and an inhalation SF of 42 $(mg/kg\text{-}day)^{-1}$ has been established for the hexavalent form. Vitamin supplements contain approximately 0.025 mg of chromium. As listed in IRIS, no critical effects were observed for CrIII. The uncertainty factor for CrIII was 100 and the modifying factor was 10. As listed in IRIS, no critical effects were observed for CRVI. The uncertainty factor for CrVI was 500 and the modifying factor was 1.

1,4-Dichlorobenzene is a CLP SVOC; however, it was evaluated for the inhalation pathway as a volatile due to its Henry's Law Constant. This compound affects the CNS, causes liver and kidney damage, and irritation of the mucous membranes, skin, and eyes (Dreisbach, et al., 1987). This compound is classified by USEPA as a B2 carcinogen, with an oral SF of 0.024 $(mg/kg\text{-}day)^{-1}$. The inhalation RfD was set to 0.229 mg/kg-day. The critical effect of this chemical is listed in IRIS as increased liver weights in P1 males. The inhalation uncertainty factor was determined to be 100 and the modifying factor was determined to be 1. The IRIS RfC is 0.8 mg/m^3.

Ethylbenzene is a colorless liquid that smells like gasoline. Acute inhalation exposure of humans to ethylbenzene irritates the eyes and lungs (Angerer and Wulf, 1985; Thienes and Haley, 1972). In addition, neurological effects such as dizziness have been reported in humans following acute

inhalation exposure to this chemical. Similarly, respiratory and neurological effects have been observed in animals exposed to ethylbenzene via inhalation. No adverse health effects have been reported from a long-term (20 years) study of 200 workers occupationally exposed to ethylbenzene (Bardodej and Cirek, 1988). Laboratory tests on rats via oral exposure indicated a significant increase in total malignant tumors in females and combined male and female groups over two years (Maltoni et al., 1985). USEPA ranked ethylbenzene as unclassifiable with regard to human carcinogenicity, Group D (IRIS). Ethylbenzene has been issued an oral RfD of 1E-01 mg/kg-day and an inhalation RfD of 2.86E-01 mg/kg-day by USEPA (IRIS).

Hydrazine is a reducing agent used in nuclear fuel reprocessing, polymerization catalysis, corrosion inhibition in boiler feedwater & reactor cooling water, wastewater treatment, electrolytic plating of metals on glass & plastics, and rocket propellants. Toxic effects of hydrazine include conjunctivitis, pulmonary edema, anemia (hemolytic), ataxia, convulsions, kidney toxicity, and liver toxicity. USEPA has given hydrazine a B2, probable human carcinogen, rating based on inadequate human data and the induction of tumors in mice, rats and hamsters following oral, inhalation or intraperitoneal administration of hydrazine and hydrazine sulfate. An oral slope factor of 3 $(mg/kg\text{-}day)^{-1}$ and an inhalation slope factor of 17.1 $(mg/kg\text{-}day)^{-1}$ have been set by USEPA.

Lead has been classified as a group B2 carcinogen by USEPA based on animal data. No RfD or SF has been set by USEPA. However, an action level of 400 mg/kg for soil protective of child residents has been proposed by USEPA Region IV. USEPA's Office of Water has established a treatment technique action level of 15 $\mu g/L$. As listed in IRIS, the classification is based on sufficient animal evidence. Ten rat bioassays and one mouse assay have shown statistically significant increases in renal tumors with dietary and subcutaneous exposure to several soluble lead salts. Animal assays provide reproducible results in several laboratories, in multiple rat strains with some evidence of multiple tumor sites. Short-term studies show that lead affects gene

expression. Human evidence is inadequate. An RfD and SF have not been set because of the confounding nature of lead toxicity. Lead can accumulate in bone marrow, and effects have been observed in the CNS, blood, and mental development of children. RfDs are based on the assumption that a threshold must be exceeded to result in toxic effects (other than carcinogenicity). Once lead accumulates in the body, other influences cause the actual levels in the blood to fluctuate — sometimes the lead is attached to binding sites; sometimes lead is free flowing. If an exposed individual has previously been exposed to lead, this individual could lose weight and set fat-bound lead free. This fluctuation and lack of previous lead exposure data are two of the reasons lead effects are difficult to predict (Klaassen et al., 1986).

2-Methylphenol is one of three isomers of methyl phenol. Methyl phenol is also known as cresol, hydroxytoluene, or cresylic acid. The common name for 2-methylphenol is ortho-cresol (o-cresol). Effects associated with acute exposure to cresols in humans include irritation and burning of skin, eyes, mouth, and throat, abdominal pain and vomiting, hemolytic anemia, kidney damage, facial paralysis, coma, and death. Exposure levels associated with human deaths have not been reliably reported, however, crude estimates based on accidental or intentional ingestion of cresol, the lethal oral exposure level for humans appeared to be at or above 2 g/kg (Chan et al., 1971). Autopsies of people who died following cresol exposure revealed gross lesions in the lungs, pancreas, liver, and kidneys, although these data cannot be considered reliable indicators of target organ effects. Studies in animals have shown that cresols can be lethal when exposure is through the inhalation, oral, or dermal routes. 2-Methylphenol is classified "C" in USEPA's weight of evidence. An oral RfD of 5.0E-02 mg/kg-day has been issued for 2-methylphenol (IRIS). The oral uncertainty factor for 2-methylphenol is 1000.

4-Methylphenol is also known as p-cresol. Effects associated with acute exposure to cresols in humans include irritation and burning of skin, eyes, mouth, and throat, abdominal pain and vomiting, hemolytic anemia, kidney damage, facial paralysis, coma, and death. Exposure levels

associated with human deaths have not been reliably reported, however, crude estimates based on accidental or intentional ingestion of cresol, the lethal oral exposure level for humans appeared to be at or above 2 g/kg (Chan et al., 1971). Autopsies of people who died following cresol exposure revealed gross lesions in the lungs, pancreas, liver, and kidneys, although these data cannot be considered reliable indicators of target organ effects. Studies in animals have shown that cresols can be lethal when exposure is through the inhalation, oral, or dermal routes. 4-Methylphenol is classified "C" in USEPA's weight of evidence. An oral RfD of 5.0E-03 mg/kg-day has been issued for 4-methylphenol (HEAST, 1996).

Naphthalene causes hemolysis with subsequent blocking of renal tubules by precipitated hemoglobin. Hepatic necrosis has been reported. Hemolysis only occurs in individuals with a hereditary deficiency of glucose-6-phosphate dehydrogenase in the red cells (primarily black males), which results in a low level of reduced glutathione and increased susceptibility to hemolysis by metabolites of naphthalene. The fatal dose of ingested naphthalene is approximately 2 grams. These chemicals are most dangerous in children up to age 6, in whom absorption occurs rapidly. The exposure limit for naphthalene is 10 ppm (Dreisbach et al., 1987). The oral RfD for naphthalene is 4E-02 mg/kg-day (USEPA ,1996).

Trinitrophenylmethylnitramine or tetryl is used as an explosive in detonators and primers, as an intermediary detonating agent for other less sensitive, high explosives, and as a booster charge for military devices. HEAST list a chronic oral RfD of 0.01 calculated using as uncertainty factor of 10,000. The target organs listed in HEAST are the liver, kidney and spleen.

Thallium is readily absorbed through the gut and skin. Primary effects are stomach and bowel disturbances, kidney and liver damage, and neurological disturbances. Thallium was used in the past as a rodenticide and ant killer, and its use for these purposes is now prohibited. This element remains in the body for a relatively long time, and could accumulate if the chronic dose is large.

USEPA's oral RfD for thallium is 0.00008 mg/kg-day (Klaassen, et al., 1986; Dreisbach, et al., 1987).

Toluene is a gasoline additive, a solvent in glues, inks, adhesives, and is also used as a detergent in the manufacture of dyes, lacquers, perfumes, pharmaceuticals, and saccharin. In humans, toluene is a known respiratory irritant with central nervous system effects, and the effects can be enhanced by the ingestion of ethyl alcohol. Toluene has not been determined to be a carcinogen by USEPA, having a USEPA Classification of D. As listed in IRIS, the basis for the classification is no human data and inadequate animal data. Toluene did not produce positive results in the majority of genotoxic assays. The critical effect of this volatile organic chemical is changes in liver and kidney weights in study organisms. USEPA determined the RfC and oral RfD to be 0.114 mg/kg-day and 0.2 mg/kg-day, respectively. As listed in IRIS, the oral RFD critical effect of this chemical is changes in liver and kidney weights. The uncertainty factor was determined to be 1000 and the modifying factor was determined to be 1. The inhalation RFD critical effect of this chemical is neurological effects. The inhalation uncertainty factor was determined to be 300 and the modifying factor was determined to be 1 (Harte, et al., 1991) (IRIS).

Xylene is primarily a man-made chemical, which is a colorless liquid with a sweet odor. Chemical industries produce xylene from petroleum and to a lesser extent from coal. Xylene also occurs naturally in petroleum coal tar, and is naturally formed during forest fires. Acute exposure data in humans and/or animals indicate that the CNS and possibly the developing fetus are the major targets of acute xylene toxicity by the inhalation and oral routes. Death has been observed to occur as a result of exposure by inhalation, oral and dermal exposure (Gosselin et al., 1984; Abu al Raghep et al., 1986; Bernardelli and Gennari, 1987). Acute studies have demonstrated that xylene is an irritant to the skin and eyes. Xylene inhalation has also been shown to irritate the respiratory tract and cause dyspnea. The central nervous system and the liver appear to be the

primary targets of chronic xylene exposure. USEPA has classified mixed xylene as a Group D agent (IRIS). Xylene (mixed) has been issued an oral RfD of 2 mg/kg-day (IRIS).

10.7.8.5 Risk Characterization

Surface Soil Pathways

Exposure to surface soil onsite was evaluated under both residential and site worker scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. For noncarcinogenic contaminants evaluated for future site residents, hazard was computed separately to address child and adult exposure. Tables 10.7.26 and 10.7.27 present the computed carcinogenic risks and/or HQs associated with the incidental ingestion of and dermal contact with site surface soils, respectively.

Hypothetical Site Residents

The ingestion ILCR (based on the adult and child lifetime weighted average) for AOC 637 surface soils is 6E-05. The dermal pathway ILCR is 1E-05. Arsenic and BEQs were the primary contributors to the ingestion and dermal pathways. Though the adolescent trespasser was not quantitatively addressed for this site, the following semiquantitative analysis was performed using the results of the residential risk analysis. Exposure frequency and duration under the residential scenario are 350 days/year and 30 years, respectively, compared to 52 day/year and 7 years for the adolescent trespasser. Substituting the trespasser exposure frequency and duration into the CDI equation would result in a risk estimate approximately 98% below the residential risk estimate. Assuming that the pavement is removed from the site, the cumulative soil pathway (both ingestion and dermal) risk for the adolescent trespasser was estimated to be approximately 3E-06.

Table 10.7.26
Hazard Quotients and Incremental Lifetime Cancer Risks
Incidental Surface Soil Ingestion
AOC 637
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident lwa ILCR	Future Site Worker adult Hazard Quotient	Future Site Worker adult ILCR
Inorganics							
Arsenic	0.0003	1.5	0.087	0.81	4.5E-05	0.031	5.0E-06
Thallium	8E-05	NA	0.018	0.17	ND	0.0065	ND
Semivolatile Organics							
Benzo(a)pyrene equivalent	NA	7.3	ND	ND	1.7E-05	ND	1.9E-06
Propellants							
Hydrazine	NA	3	ND	ND	1.0E-06	ND	1.1E-07
SUM Hazard Index/ILCR			0.1	1	6E-05	0.04	7E-06

NOTES:
NA Not available
ND Not Determined due to lack of available information
lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime Cancer Risk

Table 10.7.27
Hazard Quotients and Incremental Lifetime Cancer Risks
Dermal Contact With Surface Soil
AOC 637
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Chemical	Dermal Adjustment	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident lwa ILCR	Future Site Worker adult Hazard Quotient	Future Site Worker adult ILCR
Inorganics								
Arsenic	0.2	6E-05	7.5	0.018	0.059	5.0E-06	0.013	2.0E-06
Thallium	0.2	1.6E-05	NA	0.0037	0.012	ND	0.0027	ND
Semivolatile Organics								
Benzo(a)pyrene equivalent	0.5	NA	14.6	ND	ND	7.7E-06	ND	3.2E-06
Propellants								
Hydrazine	0.5	NA	6	ND	ND	4.5E-07	ND	1.8E-07
SUM Hazard Index/ILCR				0.02	0.07	1E-05	0.02	5E-06

NOTES:

NA Not available
ND Not Determined due to lack of available information
lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime Cancer Risk
- Dermal to absorbed dose adjustment factor is applied to adjust for Oral SF and RfD (i.e., the oral RfD is based on oral absorption efficiency which should not be applied to dermal exposure and dermal CDI)

The computed hazard indices for the adult resident were 0.1 for the soil ingestion pathway and 0.02 for the dermal contact pathway. The computed hazard indices for the child ingestion and dermal contact pathways were 1 and 0.07, respectively. Arsenic was the primary contributor to HI projections for the ingestion and dermal pathways. Thallium was a secondary contributor to the ingestion pathway. The semiquantitative analysis for adolescent trespasser hazard index is similar to the risk estimate detailed the paragraph above. Exposure frequency and duration for the child resident are 350 days/year and 6 years, respectively, compared to 52 days/year and 7 years for the trespasser. Substituting the trespasser exposure frequency and duration into the CDI equation would result in a hazard estimate approximately 83% below the residential hazard estimate. Assuming that the pavement is removed from the site, the cumulative soil pathway (both ingestion and dermal) hazard for the adolescent trespasser was estimated to be approximately 0.2.

Hypothetical Site Workers

Site worker ILCRs are 7E-06 and 5E-06 for the ingestion and dermal contact pathways, respectively. Arsenic and BEQs were the primary contributors for each pathway.

Groundwater Pathways

Exposure to shallow groundwater onsite was evaluated under a residential scenario based on the results of the first-quarter sampling event. The ingestion exposure pathway was evaluated assuming the site groundwater will be used for potable and/or domestic purposes and that an unfiltered well, drawing from the corresponding water bearing zone, will be installed. For noncarcinogenic contaminants evaluated relative to future site residents, hazard was computed separately for child and adult receptors. Tables 10.7.28 and 10.7.29 presents the risk and hazard for the ingestion and inhalation pathways, respectively.

Table 10.7.28
Hazard Quotients and Incremental Lifetime Cancer Risks
Groundwater Ingestion
AOC 637
Naval Base Charleston, Zone G
Charleston, South Carolina

Chemical	Oral RfD Used (mg/kg-day)	Oral SF Used (mg/kg-day)-1	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident lwa ILCR	Future Site Worker adult Hazard Quotient	Future Site Worker adult ILCR
Inorganics							
Antimony (Sb)	0.0004	NA	0.60	1.4	ND	0.21	ND
Barium (Ba)	0.07	NA	2.3	5.5	ND	0.84	ND
Chromium (Cr)	0.005	NA	0.18	0.43	ND	0.066	ND
Lead (Pb)	NA	NA	ND	ND	ND	ND	ND
Thallium (Tl)	8E-05	NA	1.9	4.4	ND	0.67	ND
Semivolatile Organics							
1,4-Dichlorobenzene	NA	0.024	ND	ND	7.2E-07	ND	1.7E-07
2-Methylphenol	0.05	NA	0.014	0.032	ND	0.0049	ND
4-Methylphenol	0.005	NA	0.27	0.64	ND	0.10	ND
Naphthalene	0.04	NA	0.16	0.38	ND	0.059	ND
Volatile Organics							
Benzene	0.003	0.029	0.50	1.2	2.4E-05	0.18	5.6E-06
Chlorobenzene	0.02	NA	0.052	0.12	ND	0.019	ND
Ethylbenzene	0.1	NA	0.12	0.28	ND	0.043	ND
Toluene	0.2	NA	0.013	0.029	ND	0.0045	ND
Xylene (total)	2	NA	0.086	0.20	ND	0.031	ND
Propellants/Explosives							
Hydrazine	NA	3	ND	ND	3.5E-04	ND	8.0E-05
Tetryl	0.01	NA	0.10	0.24	ND	0.037	ND
SUM Hazard Index/ILCR			6	15	4E-04	2	9E-05

Notes:
NA Not available
ND Not Determined due to lack of available information
lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime Cancer Risk

Table 10.7.29
Hazard Quotients and Incremental Lifetime Cancer Risks
Inhalation of Contaminants in Groundwater Resulting from Domestic Use
AOC 637
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Chemical	Inhalation Rf Used (mg/kg-day)	Inhalation SF Used (mg/kg-day)-1	Future Resident adult Hazard Quotient	Future Resident child Hazard Quotient	Future Resident lwa ILCR	Future Site Worker adult Hazard Quotient	Future Site Worker adult ILCR
Semivolatile Organics							
1,4-Dichlorobenzene	0.229	NA	0.00024	0.00056	ND	8.5E-05	ND
Volatile Organics							
Benzene	0.00171	0.029	0.88	2.1	2.4E-05	0.31	5.6E-06
Chlorobenzene	0.00571	NA	0.18	0.43	ND	0.065	ND
Ethylbenzene	0.286	NA	0.042	0.1	ND	0.015	ND
Toluene	0.114	NA	0.022	0.052	ND	0.0079	ND
Xylene (total)	2	NA	0.086	0.2	ND	0.031	ND
SUM Hazard Index.ILCR			1	3	2E-05	0.4	6E-06

NOTES:
NA Not available
ND Not Determined due to lack of available information
lwa Lifetime weighted average; used to calculate excess carcinogenic risk derived from RAGS Part A
ILCR Incremental Lifetime Cancer Risk

Hypothetical Site Residents

The ingestion ILCR for AOC 637 shallow groundwater (based on the adult and child lifetime weighted average) is 4E-04, with hydrazine is the primary contributor and benzene was a secondary contributor to ILCR projections. The HIs for the adult and child resident are 6 and 15, respectively. Antimony, barium, benzene, and thallium were the primary contributors to ingestion HI. Chromium, chlorobenzene, 4-methylphenol, naphthalene, tetryl, and xylene were secondary contributors. The inhalation ILCR for AOC 637 shallow groundwater is 2E-05, with benzene as the sole contributor to ILCR projections for the inhalation pathway. The HIs for the adult and child resident are 1 and 3, respectively. Benzene was the primary contributor and chlorobenzene was a secondary contributor to inhalation HI projections.

Hypothetical Site Workers

The site worker ingestion ILCR for AOC 637 shallow groundwater is 9E-05, with hydrazine as the primary contributor and benzene as a secondary contributor to ILCR projections. The site worker ingestion HI is 2. Antimony, barium, benzene, 4-methylphenol, and thallium were the primary contributors to ingestion HI. The inhalation ILCR for AOC 637 shallow groundwater is 6E-06, with benzene as the sole contributor. The site worker inhalation HI is 0.4.

Current Site Workers

Shallow groundwater is not currently used as a potable water source for AOC 637 or other areas of Zone G. In the absence of a completed exposure pathway, no threat to human health is posed by reported shallow groundwater contamination.

Lead Toxicity

Background

Currently, USEPA has not established an oral SF or reference dose for lead. USEPA believes that the available studies in animals and humans do not provide sufficient quantitative information for

their calculation. Although lead is currently classified as a B2 carcinogen, USEPA considers the noncarcinogenic neurotoxic effects in children to be the critical toxic effect with respect to establishing health-based environmental cleanup objectives. The neurotoxic effects of chronic low-level lead exposure in children may occur at blood levels as low as 10 μg/dL.

In the absence of lead health criteria, USEPA Region IV's Office of Health Assessment sanctions the use of the Lead Uptake/Biokinetics Model (Version 0.99d) (Lead Model) to predict mean blood lead levels in children based on exposure to impacted environmental media. The model was used to assess the potential health effects of elevated lead levels reported in groundwater at AOC 637.

Future Residential Scenario

The Lead Model default concentrations are used for exposure to air (0.1 Pb grams per cubic meter [g/m^3]) and maternal blood lead level (2.5 Pb per μg/dL). The maximum reported soil concentration (98 mg/kg) did not exceed the 400 mg/kg cleanup level established for lead. As a conservative measure, the maximum surface soil lead concentration was used as the input for soil and house dust. The maximum groundwater concentration of lead (44.1 μg/L) was used as the input for drinking water. The Lead Model was run for a child ages 0-7 years using the inputs listed above. Table 10.7.30 summarizes the Lead Model results under these exposure conditions.

Figure 10.7-44 shows the probability percentage of blood lead levels for a child 0 to 7 years old. Based on this model output using the maximum soil lead concentration and the maximum first-quarter groundwater concentration, the geometric mean blood concentrations is estimated to be 5.5 μg/dL, and the probability of blood lead concentration exceeding 10 μg/dL is 9.36%. USEPA generally considers that media concentrations resulting in probability percentage estimates of 5% or less sufficiently protect potential child receptors. As a result, groundwater lead would require corrective action under this hypothetical exposure scenario.

Table 10.7.30
Lead Model Results - AOC 637
Future Residential Scenario
NAVBASE - Charleston, Zone G
Charleston, South Carolina

LEAD MODEL Version 0.99d
AIR CONCENTRATION: 0.100 ug Pb/m3 DEFAULT
Indoor AIR Pb Conc: 30.0 percent of outdoor.
Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m3/day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT
DRINKING WATER Conc: 44.10 ug Pb/L
WATER Consumption: DEFAULT
SOIL & DUST:
Soil: constant conc.
Dust: constant conc.

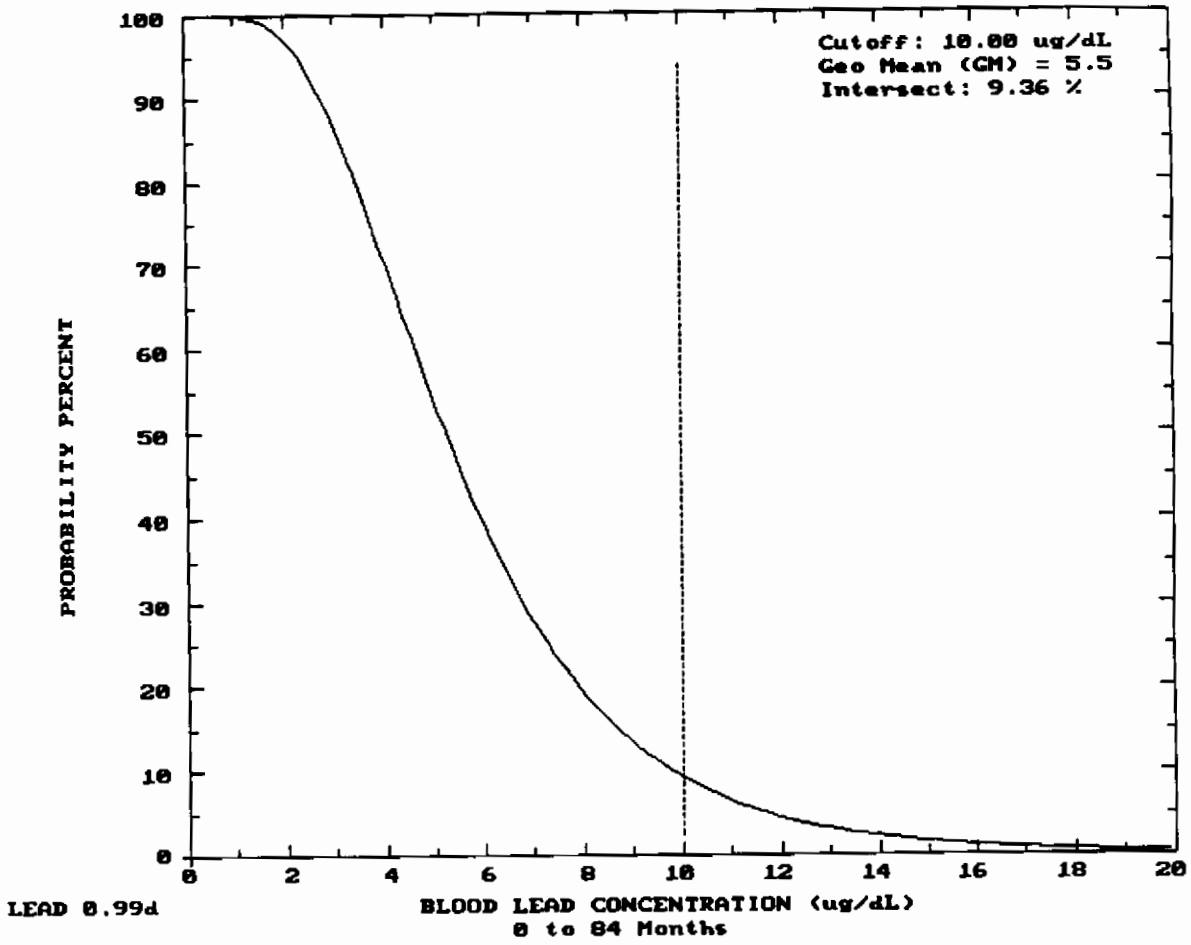
Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	98.0	98.0
1-2	98.0	98.0
2-3	98.0	98.0
3-4	98.0	98.0
4-5	98.0	98.0
5-6	98.0	98.0
6-7	98.0	98.0

Additional Dust Sources: None DEFAULT

PAINT Intake: 0.00 ug Pb/day DEFAULT
MATERNAL CONTRIBUTION: Infant Model
Maternal Blood Conc: 2.50 ug Pb/dL

CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)
0.5-1:	4.7	8.77	2.26	2.50	3.99	0.00	0.02
1-2:	6.3	15.60	3.46	2.52	9.60	0.00	0.03
2-3:	6.1	16.56	3.50	2.87	10.12	0.00	0.06
3-4:	5.9	16.91	3.56	2.80	10.49	0.00	0.07
4-5:	5.5	16.56	2.68	2.74	11.07	0.00	0.07
5-6:	5.2	17.20	2.43	2.91	11.76	0.00	0.09
6-7:	5.0	17.66	2.31	3.23	12.02	0.00	0.09



ZONE G
RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 10.7-44
PROBABILITY PERCENTAGE OF BLOOD LEAD LEVELS FOR CHILD 0-7 YEARS
AOC 637 - SURFACE SOIL
FUTURE RESIDENTIAL SCENARIO

Date: 02/06/98 | DWG Name: 2907C001

COCs Identified

COCs were identified based on cumulative (all pathway) risk and hazard projected for this site on a medium-specific basis. USEPA has established a generally acceptable risk range of 1E-04 to 1E-06, and a hazard index threshold of 1.0 (unity). As recommended by SCDHEC, a COC was considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, and whose individual ILCR exceeds 1E-06 or whose hazard quotient exceeds 0.1. For carcinogens, this approach is relatively conservative, because a cumulative risk level of 1E-04 (and individual ILCR of 1E-06) is recommended by USEPA Region IV as the trigger for establishing COCs. The COC selection method presented was used to provide a more comprehensive evaluation of chemicals contributing to carcinogenic risk or noncarcinogenic hazard during the RGO development process. Table 10.7.31 presents the COCs identified for AOC 637 surface soil and shallow groundwater.

Surface Soils

Future Site Residents

Arsenic, BEQs, and hydrazine were identified as soil pathway COCs based on their contribution to cumulative ILCR projections. Arsenic, and thallium were identified as soil pathway COC based on their contribution to cumulative HI projections.

Future Site Workers

Arsenic and BEQs were identified as soil pathway COCs based on their contribution to cumulative ILCR projections.

The extent of the COCs identified in surface soil is briefly discussed below. To facilitate this discussion of the extent of COC concentrations, residential soil RBCs were compared to each reported concentration for each COC. Arsenic was detected in all seven surface soil samples at concentration exceeding its RBC, however, it was only reported in one surface soil sample at a

Table 10.7.31
Summary of Risk and Hazard-based COCs
AOC 637
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Medium	Exposure Pathway		Future Resident Adult Hazard Quotient	Future Resident Child Hazard Quotient	Future Resident Iwa ILCR	Future Site Worker Hazard Quotient	Future Site Worker ILCR	Identification of COCs
Surface Soil	Incidental Ingestion	**Inorganics**						
		Arsenic	0.087	0.81	4.5E-05	0.031	5.0E-06	1 2 4
		Thallium	0.018	0.17	ND	0.0065	ND	1
		Semivolatile Organics						
		Benzo(a)pyrene equivalents	ND	ND	1.7E-05	ND	1.9E-06	2 4
		Propellants						
		Hydrazine	ND	ND	1.0E-06	ND	1.1E-07	2
	Dermal Contact	**Inorganics**						
		Arsenic	0.018	0.059	5.0E-06	0.013	2E-06	2 4
		Thallium	0.0037	0.012	ND	0.0027	ND	
		Semivolatile Organics						
		Benzo(a)pyrene equivalents	ND	ND	7.7E-06	ND	3.2E-06	2 4
		Propellants						
		Hydrazine	ND	ND	4.5E-07	ND	1.8E-07	
Surface Soil Pathway Sum			0.1	1	8E-05	0.05	1E-05	
Groundwater Pathways	Ingestion	**Inorganics**						
		Antimony (Sb)	0.60	1.4	ND	0.21	ND	1 3
		Barium (Ba)	2.3	5.5	ND	0.84	ND	1 3
		Chromium (Cr)	0.18	0.43	ND	0.066	ND	1
		Lead (Pb)	ND	ND	ND	ND	ND	*
		Thallium (Tl)	1.9	4.4	ND	0.67	ND	1 3
		Semivolatile Organics						
		1,4-Dichlorobenzene	ND	ND	7.2E-07	ND	1.7E-07	
		2-Methylphenol	0.014	0.032	ND	0.0049	ND	
		4-Methylphenol	0.27	0.64	ND	0.098	ND	1
		Naphthalene	0.16	0.38	ND	0.059	ND	1
		Volatile Organics						
		Benzene	0.50	1.2	2.4E-05	0.18	5.6E-06	1 2 3 4
		Chlorobenzene	0.052	0.12	ND	0.019	ND	1
		Ethylbenzene	0.12	0.28	ND	0.043	ND	1
		Toluene	0.013	0.03	ND	0.005	ND	
		Xylene (total)	0.086	0.20	ND	0.031	ND	1
		Propellants/Explosives						
		Hydrazine	ND	ND	3.5E-04	ND	8.0E-05	2 4
		Tetryl	0.10	0.24	ND	0.037	ND	1
	Inhalation	**Semivolatiles Organics**						
		1,4-Dichlorobenzene	0.00024	0.00056	ND	0.000085	ND	
		Volatile Organics						
		Benzene	0.88	2.1	2.4E-05	0.31	5.6E-06	1 2 3 4
		Chlorobenzene	0.18	0.43	ND	0.065	ND	1
		Ethylbenzene	0.042	0.10	ND	0.015	ND	
		Toluene	0.022	0.052	ND	0.0079	ND	
		Xylene (total)	0.086	0.20	ND	0.031	ND	1
Groundwater Pathway Sum			8	18	4E-04	3	9E-05	
Sum of All Pathways			8	19	5E-04	3	1E-04	

Notes:
ND Indicates not determined due to the lack of available risk information.
NA Not applicable
ILCR Indicates incremental excess lifetime cancer risk
HI Indicates hazard index
1- Chemical is a COC by virtue of projected child residence non-carcinogenic hazard.
2- Chemical is a COC by virtue of projected future resident lifetime ILCR.
3- Chemical is a COC by virtue of projected site worker non-carcinogenic hazard.
4- Chemical is a COC by virtue of projected site worker ILCR.
* - Lead was identified as a COC based on the results of the Lead Model.

concentration (19 mg/kg) slightly exceeding its background concentration (17.2 mg/kg). BEQs were detected above the residential RBC in four of seven surface soil samples collected for AOC 637. Hydrazine was detected in only one of five surface soil samples at a concentration exceeding its RBC.

Future Site Residents

Benzene and hydrazine were identified as the groundwater COCs for AOC 637, based on their contribution to ILCR projections. Antimony, barium, benzene, chlorobenzene, chromium, 4-methylphenol, naphthalene, tetryl, thallium, and xylene were identified as COCs for AOC 637, based on their contributions to HI projections. Lead was identified as a COC based on Lead Model results.

Future Site Workers

Benzene and hydrazine were identified as the groundwater COCs for AOC 637, based on their contribution to ILCR projections. Antimony, barium, benzene, and thallium were identified as COCs for AOC 637, based on their contributions to HI projections.

The extent of the COCs identified in groundwater is briefly discussed below. To facilitate this discussion of the extent of COC concentrations, tap water RBCs were compared to each reported concentration for each COC identified above. Antimony, barium, benzene, chlorobenzene, hydrazine, and thallium each exceeded their RBCs in two first-quarter groundwater samples. Chromium, 4-methylphenol, naphthalene, tetryl, toluene, and xylene exceeded their RBC in one first-quarter groundwater sample.

10.7.8.6 Risk Uncertainty

Characterization of Exposure Setting and Identification of Exposure Pathways

The potential for high bias is introduced through the exposure setting and pathway selection due to the highly conservative assumptions (i.e., future residential use) recommended by USEPA Region IV when assessing potential future and current exposure. The exposure assumptions made in the site worker scenario are highly protective and would tend to overestimate exposure. Residential use of the site would not be expected, based on current site uses and the nature of surrounding buildings. Current reuse plans call for continued commercial/industrial or recreational use of Zone G. If this area were to be used as a residential site, existing features would be demolished, and the surface soil conditions would likely change — the soils could be covered with landscaping soil and/or a house. Consequently, exposure to surface soil conditions as represented by samples collected during the RFI would not be likely under a true future residential scenario. These factors indicate that exposure pathways assessed in this HHRA would generally overestimate the risk and hazard posed to current site workers and future site residents.

Groundwater is not currently used at AOC 637 for potable or industrial purposes. A base-wide system provides drinking and process water to buildings throughout Zone G. This system is planned to remain in operation under the current base reuse plan. As a result, use of shallow groundwater would not be expected under future site use scenarios. Therefore, the scenario established to project risk/hazard associated with shallow groundwater exposure is highly conservative, and associated pathways are not expected to be completed in the future.

Determination of Exposure Point Concentrations

The maximum detected soil constituent concentrations were used as the exposure point concentrations for this site for both soil and groundwater. Use of maximum detected concentrations represent conservative assumptions when applied as the EPC, such that it is unlikely that the maximum detected concentration underestimates the true mean concentration.

Groundwater risk/hazard was calculated using the maximum detected concentration of each COPC as an EPC. As with surface soil, it is unlikely that the maximum concentration detected in first-quarter groundwater samples underestimates the true mean concentration, and would generally overestimate risk and/or hazard. Since only three monitoring wells were installed, risk and/or hazard may be either underestimated or overestimated.

Frequency of Detection and Spatial Distribution

BEQs were detected in six of seven surface soil samples and four were reported with concentrations above RBCs. Background levels of BEQs at have been detected in soil samples throughout NAVBASE and many have been reported with concentrations exceeding RBCs. Additionally, all of the soil sample locations were situated underneath the former asphalt paved surface, which may help to explain the presence and source of this group of constituents. The maximum concentration of hydrazine marginally exceeded its RBC. The maximum concentrations of arsenic and thallium each marginally exceeded their background concentrations in a single sample which suggests a relation to ambient soil conditions.

The maximum first-quarter concentrations of seven COCs [antimony (8.7 μg/L), barium (6,000 μg/L), benzene (55 μg/L), chromium (33.6 μg/L), chlorobenzene (38 μg/L), lead (44.1 μg/L), xylene (6,300 μg/L)] were reported for the sample collected from monitoring well 637001. The second-quarter sample collected from monitoring well 637001 resulted in lower concentrations of antimony (nondetect), barium (2,840 μg/L), benzene (18 μg/L), chromium (13.2 μg/L), lead (13 μg/L), and xylene (1,500 μg/L), and a higher concentration of chlorobenzene (56 μg/L). The maximum second-quarter concentrations of tetryl (38 μg/L) was reported in the second-quarter sample collected from monitoring well 637002. Tetryl was nondetect in the third-quarter sample collected from monitoring well 637002. The second-quarter maximum concentrations of four COCs [hydrazine (7.65 μg/L), 4-methylphenol (50 μg/L), naphthalene (240 μg/L), and thallium (5.5 μg/L)] were reported for the sample collected from

monitoring well 637003. The third-quarter sample collected from monitoring well 637003 resulted in lower concentrations of 4-methylphenol (10 μg/L), naphthalene (190 μg/L), hydrazine (nondetect), and thallium (nondetect).

Quantification of Risk/Hazard

As indicated by the discussions above, the uncertainty and variability inherent in the risk assessment process is great. In addition, many site-specific factors have affected the uncertainty of this assessment that would upwardly bias the risk and hazard estimates. Exposure pathway-specific sources of uncertainty are discussed below.

Soil

A conservative screening process was used to identify COPCs for AOC 637. The potential for eliminating CPSSs with the potential for cumulative HI greater than one was addressed for noncarcinogens through the use of RBCs that were reduced one order of magnitude. For carcinogens, the RBCs are based on a conservative target risk of 1E-06. Use of conservative RBCs in combination with the use of maximum detected concentrations minimizes the likelihood of a significant contribution to risk/hazard based on eliminated CPSSs. Of the CPSSs screened and eliminated from formal assessment, none was reported at a concentration close to its RBC (e.g., within 10% of its RBC).

Groundwater

The same conservative screening process used for soil was also used for groundwater. Of the CPSSs screened and eliminated from formal assessment, none was reported at a concentration close to its RBC (e.g., within 10% of its RBC).

Groundwater is not currently used as a potable water source at AOC 637, nor is it used at NAVBASE or in the surrounding area. Municipal water is readily available. As previously

mentioned, it is highly unlikely that the site will be developed as a residential area, and it is unlikely that a potable-use well would be installed onsite. It is probable that, if residences were constructed onsite and an unfiltered well were installed, the salinity and dissolved solids would preclude this aquifer from being an acceptable source of potable water.

Background-related Risk

Soil

Aluminum, beryllium, and manganese were detected in AOC 637 surface soil above their respective RBCs and arsenic and manganese were detected in AOC 637 groundwater above their respective tap water RBCs. These elements were not considered in the risk assessment based on comparison to background concentrations. It is not unusual for naturally occurring or background concentrations of some elements to exceed RBCs. It is the risk assessment's function to identify excess risk and/or hazard, or that which is above background levels. The following is a discussion of the residential scenario risk/hazard associated with background concentrations of these elements.

The beryllium background surface soil concentration (1.2 mg/kg) equates with an ILCR of 9E-06 (based on the adult and child lifetime weighted average). The cumulative soil residential risk for AOC 637 is 7E-05. The background surface soil concentrations of aluminum (18,700 mg/kg), beryllium (1.2 mg/kg), and manganese (325 mg/kg) equate with an HI of 0.5 (based on the resident child). The cumulative soil resident child HI for AOC 637 is 1. The arsenic background shallow groundwater concentration (17.8 μg/L) equates with an ILCR of 4E-04 (based on the adult and child lifetime weighted average). The cumulative groundwater residential risk for AOC 637 is 5E-04. The background shallow groundwater concentration of manganese (2,906 μg/L) equates with a an HI of 3. The cumulative groundwater resident child HI for AOC 637 is 18.

10.7.8.7 Risk Summary

The risk and hazard posed by contaminants at AOC 637 were assessed for the future site worker and the future site resident under RME assumptions. In surface soils, the incidental ingestion and dermal contact pathways were assessed in this HHRA. The groundwater pathway was based on ingestion of shallow groundwater and inhalation of contaminants resulting from domestic and or process use of shallow groundwater as represented by the initial quarter groundwater data. Table 10.7.32 presents the risk summary for each soil pathway/receptor group evaluated for AOC 637.

Soil — Residential Scenario

Residential soil pathway COCs identified for AOC 637 include arsenic, BEQs, hydrazine, and thallium. Figures 10.7-45 and 10.7-46 illustrate point risk and hazard estimates, respectively, for AOC 637 surface soil pathways under a residential scenario. Table 10.7.33 summarizes the risk and hazard contribution of each COPC at each sample location. This point risk map is based on the unlikely assumption that a potential future site resident will be chronically exposed to specific points. Exposure to surface soil conditions is more likely the result of uniform exposure to the soil conditions of the entire site (or exposure unit area) rather than specific points. Risk maps supplemented by the tables are useful to help visualize how chemicals driving risk estimates are spatially distributed across the site.

Arsenic, BEQs, and hydrazine contributed to risk estimates above 1E-06 at all seven surface soil sample locations. Arsenic and BEQs contributed 90% or greater of the risk estimate for each sample location. Risks estimates ranged from 1E-05 (637SB004) to 6E-05 (637SB007). Hazard index estimates slightly exceeded unity at one surface soil sample location (637SB007). Hazard index estimates range from 0.2 (637SB004) to 1 (637SB007).

Table 10.7.32
Summary of Risk and Hazard
AOC 637
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Medium	Exposure Pathway	HI (Adult)	HI (Child)	ILCR (LWA)	HI (Worker)	ILCR (Worker)
Surface Soil	Incidental Ingestion	0.1	1	6E-05	0.04	7E-06
	Dermal Contact	0.02	0.07	1E-05	0.02	5E-06
Groundwater	Ingestion	6	15	4E-04	2	9E-05
	Inhalation	1	3	2E-05	0.4	6E-06
Sum of All Pathways		8	19	5E-04	3	1E-04

Notes:
ND Indicates not determined due to the lack of available risk information.
ILCR Indicates incremental lifetime cancer risk
HI Indicates hazard index

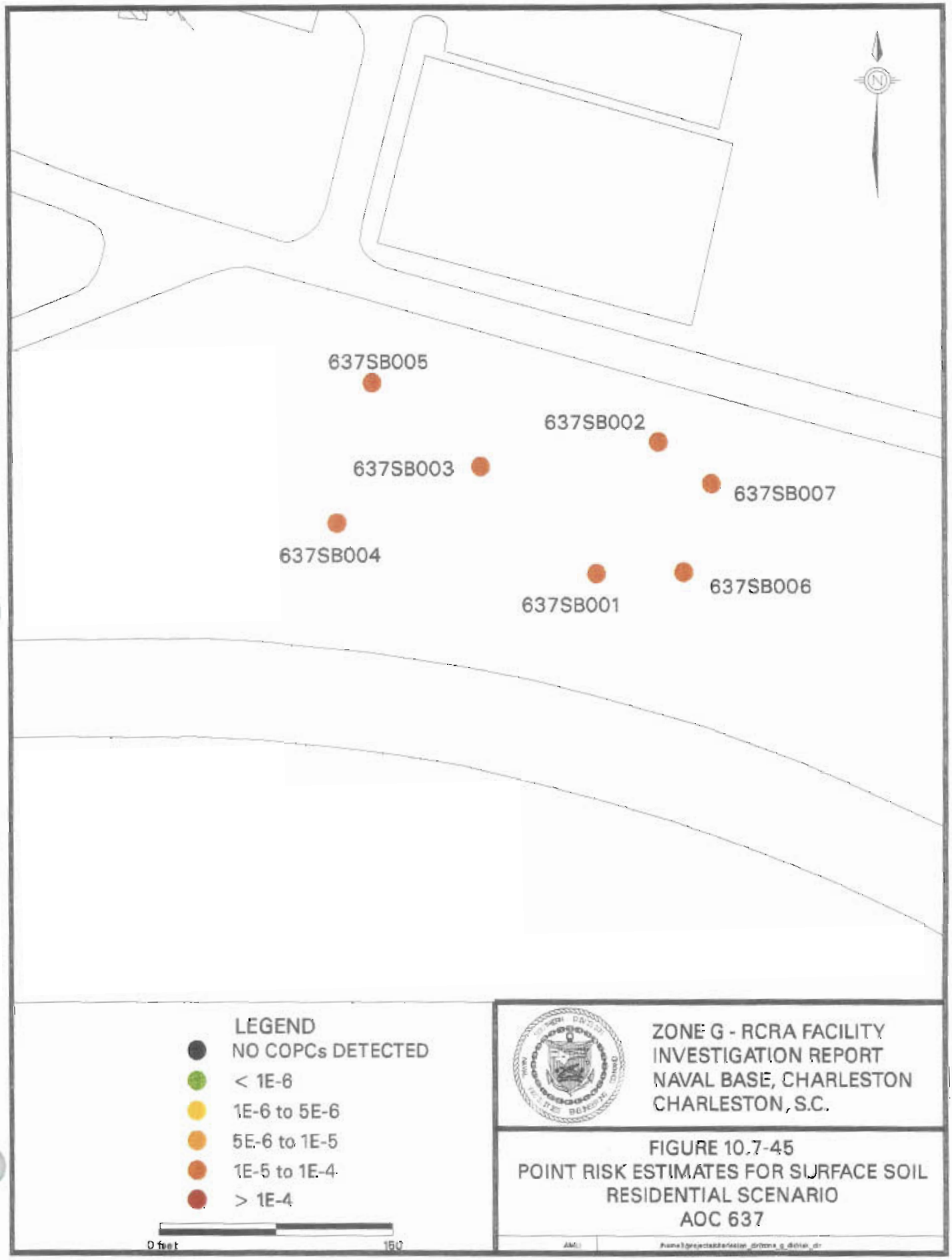


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FIGURE 10.7-45
POINT RISK ESTIMATES FOR SURFACE SOIL
RESIDENTIAL SCENARIO
AOC 637

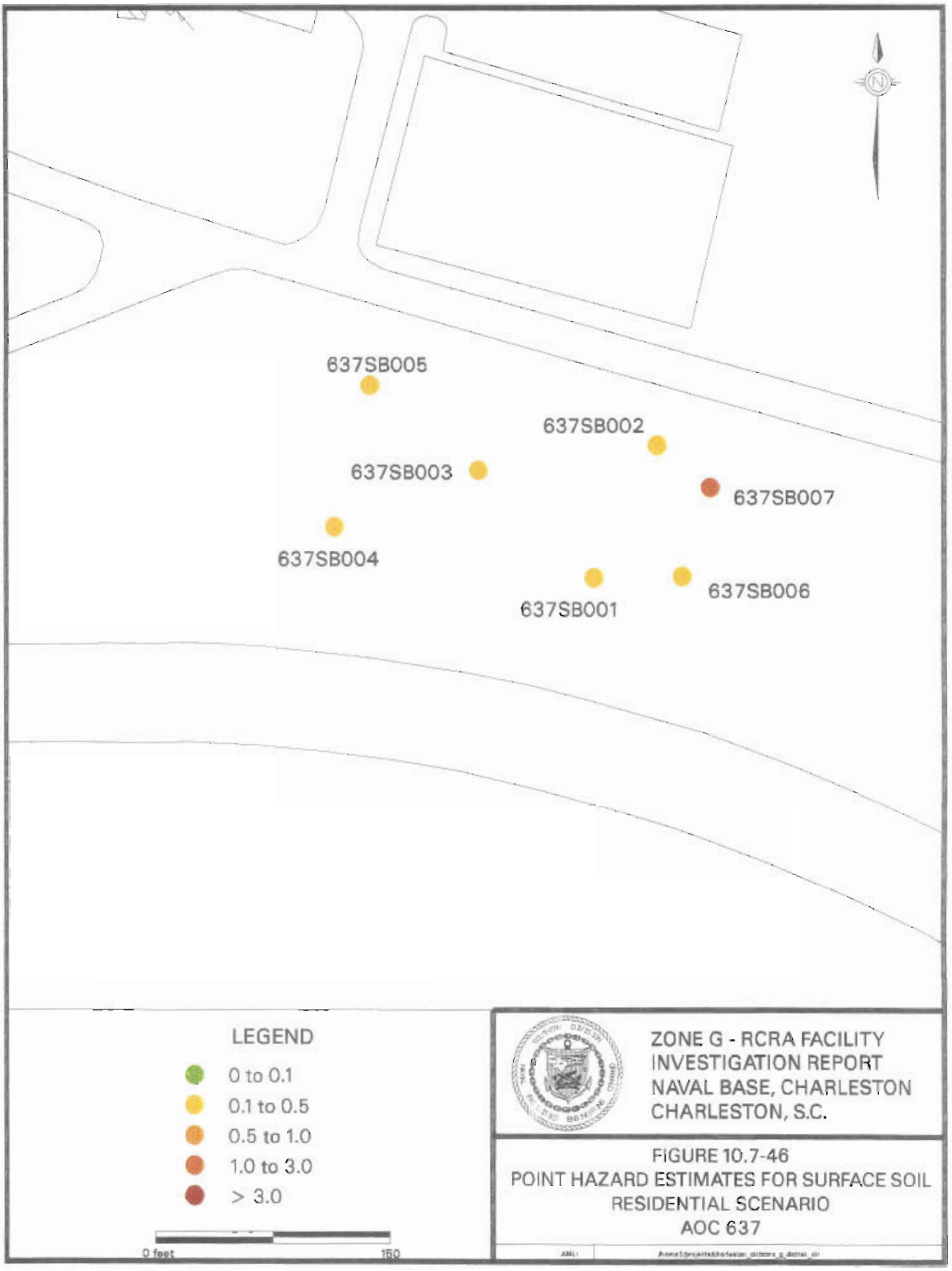

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FIGURE 10.7-46
POINT HAZARD ESTIMATES FOR SURFACE SOIL
RESIDENTIAL SCENARIO
AOC 637

Table 10.7.33
Point Estimates of Risk and Hazard - Surface Soil Pathways
Residential Scenario
AOC 637
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
637	001	Arsenic (As)	7.3	MG/KG	0.3337	100.00	19.0676	42.19
637	001	B(a)P Equiv.	1507.2	UG/KG	NA		24.9597	55.23
637	001	Hydrazine	171	UG/KG	NA		1.1638	2.58
637	001	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.3337		45.1911	
637	002	Arsenic (As)	6.9	MG/KG	0.3154	69.17	18.0228	94.07
637	002	B(a)P Equiv.	15.59	UG/KG	NA		0.2582	1.35
637	002	Hydrazine	129	UG/KG	NA		0.8779	4.58
637	002	Thallium (Tl)	0.82	MG/KG	0.1406	30.83	NA	
		Total			0.4559		19.1589	
637	003	Arsenic (As)	6.8	MG/KG	0.3108	100.00	17.7616	52.71
637	003	B(a)P Equiv.	874.6	UG/KG	NA		14.4836	42.98
637	003	Hydrazine	213	UG/KG	NA		1.4496	4.30
637	003	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.3108		33.6949	
637	004	Arsenic (As)	4.2	MG/KG	0.1920	100.00	10.9704	93.07
637	004	B(a)P Equiv.	ND	UG/KG	NA		NA	
637	004	Hydrazine	120	UG/KG	NA		0.8167	6.93
637	004	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.1920		11.7871	
637	005	Arsenic (As)	8.25	MG/KG	0.3771	100.00	21.5490	93.24
637	005	B(a)P Equiv.	67.451	UG/KG	NA		1.1170	4.83
637	005	Hydrazine	65.5	UG/KG	NA		0.4458	1.93
637	005	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.3771		23.1118	
637	006	Arsenic (As)	6	MG/KG	0.2742	100.00	15.6720	52.19
637	006	B(a)P Equiv.	866.88	UG/KG	NA		14.3558	47.81
637	006	Thallium (Tl)	ND	MG/KG	NA		NA	
		Total			0.2742		30.0278	
637	007	Arsenic (As)	19	MG/KG	0.8684	82.70	49.6280	83.53
637	007	B(a)P Equiv.	590.85	UG/KG	NA		9.7847	16.47
637	007	Thallium (Tl)	1.06	MG/KG	0.1817	17.30	NA	
		Total			1.0501		59.4127	

Soil — Site Worker Scenario

Arsenic and BEQs were identified as industrial soil pathway COCs for AOC 637. Figure 10.7-47 illustrates point risk for AOC 637 surface soil pathways under an industrial scenario. Table 10.7.34 summarizes the risk and hazard contribution of each COPC at each sample location. Arsenic and BEQs contribute to risk estimates above 1E-06 at all seven surface soil locations. Industrial risk estimates range from 2E-06 (637SB004) to 9E-06 (637SB007). Hazard index estimates did not exceed unity at any surface soil location.

Groundwater — Residential Scenario

Residential groundwater pathway COCs identified for AOC 637 include antimony, barium, benzene, chlorobenzene, chromium, hydrazine, lead, 4-methylphenol, naphthalene, thallium, tetryl, and xylene. Figures 10.7-48 and 10.7-49 illustrate point risk and hazard estimates for AOC 637 groundwater pathways under a residential scenario. Table 10.7.35 summarizes the risk and hazard contribution of each COPC at each monitoring well location. Benzene, 1,4-dichlorobenzene, and hydrazine contributed to risk estimates above 1E-06 at all three first-quarter groundwater sample locations. Benzene was the primary contributor to risk estimates associated with the groundwater sample collected from monitoring well 637001, and hydrazine was the primary contributor to risk estimates associated with 637002 and 637003. Initial groundwater samples collected from monitoring wells 637001 and 637003 were associated with hazard indices above unity. Antimony, barium, benzene, chlorobenzene, chromium, ethylbenzene, 4-methylphenol, naphthalene, thallium, and xylene were the primary contributors to hazard index projections at these two locations.

Groundwater — Site Worker Scenario

Site worker groundwater pathway COCs identified for AOC 637 include antimony, barium, benzene, hydrazine, and thallium. AOC 637 groundwater is not currently used as a source of potable or process water nor is it anticipated to be used in the future. Risk and hazard projections

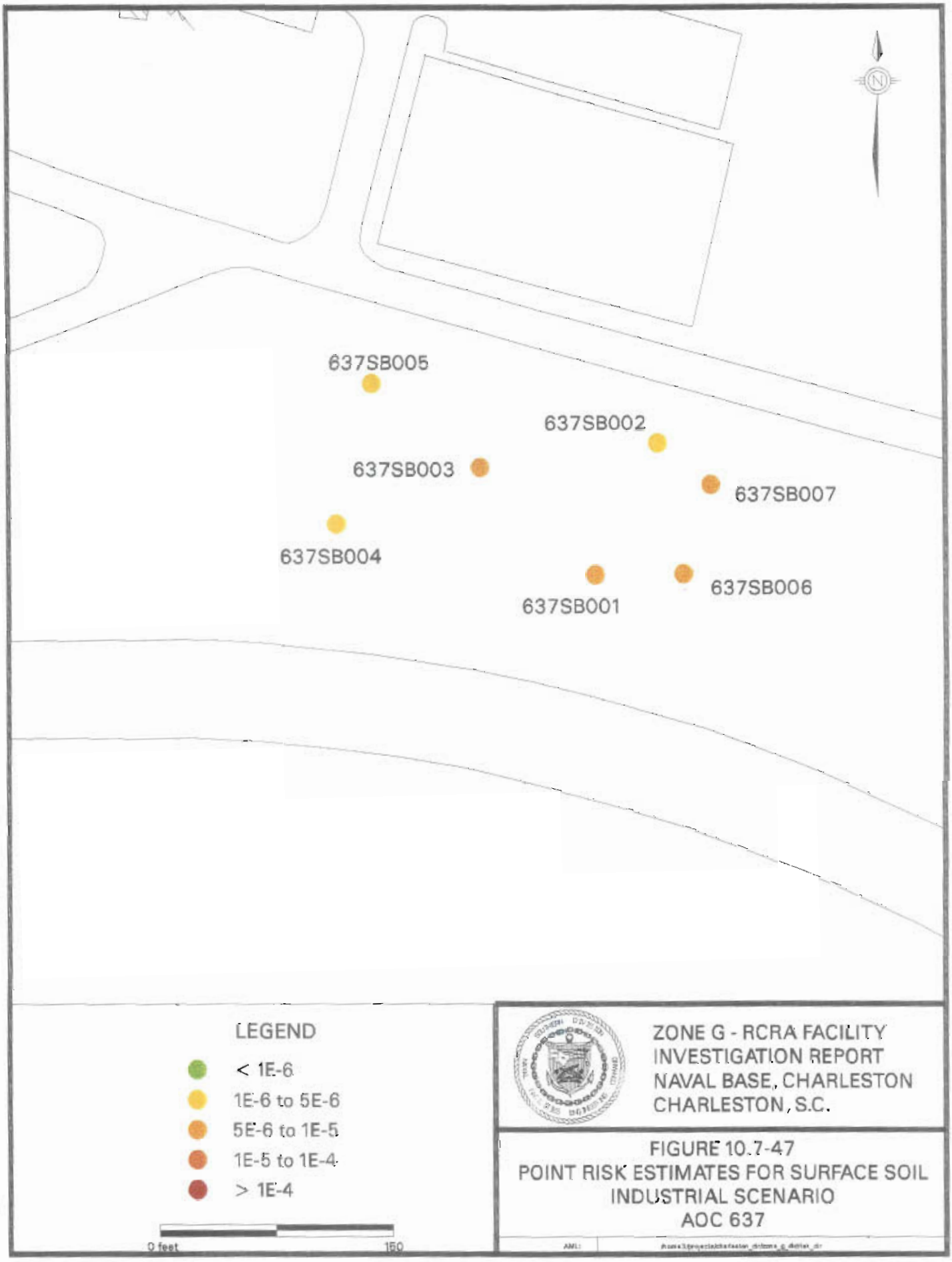

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FIGURE 10.7-47
POINT RISK ESTIMATES FOR SURFACE SOIL
INDUSTRIAL SCENARIO
AOC 637

Table 10.7.34
Point Estimates of Risk and Hazard - Surface Soil Pathways
Industrial Scenario
AOC 637
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
637	001	Arsenic (As)	7.3	MG/KG	0.0168	100.00	2.6974	34.71
637	001	B(a)P Equiv.	1507.2	UG/KG	NA		5.0750	65.29
		Total			0.0168		7.7724	
637	002	Arsenic (As)	6.9	MG/KG	0.0159	100.00	2.5496	97.98
637	002	B(a)P Equiv.	15.59	UG/KG	NA		0.0525	2.02
		Total			0.0159		2.6021	
637	003	Arsenic (As)	6.8	MG/KG	0.0156	100.00	2.5126	46.04
637	003	B(a)P Equiv.	874.6	UG/KG	NA		2.9449	53.96
		Total			0.0156		5.4575	
637	004	Arsenic (As)	4.2	MG/KG	0.0097	100.00	1.5519	100.00
637	004	B(a)P Equiv.	ND	UG/KG	NA		NA	
		Total			0.0097		1.5519	
637	005	Arsenic (As)	8.25	MG/KG	0.0190	100.00	3.0484	93.07
637	005	B(a)P Equiv.	67.451	UG/KG	NA		0.2271	6.93
		Total			0.0190		3.2755	
637	006	Arsenic (As)	6	MG/KG	0.0138	100.00	2.2170	43.17
637	006	B(a)P Equiv.	866.88	UG/KG	NA		2.9189	56.83
		Total			0.0138		5.1359	
637	007	Arsenic (As)	19	MG/KG	0.0437	100.00	7.0206	77.92
637	007	B(a)P Equiv.	590.85	UG/KG	NA		1.9895	22.08
		Total			0.0437		9.0101	

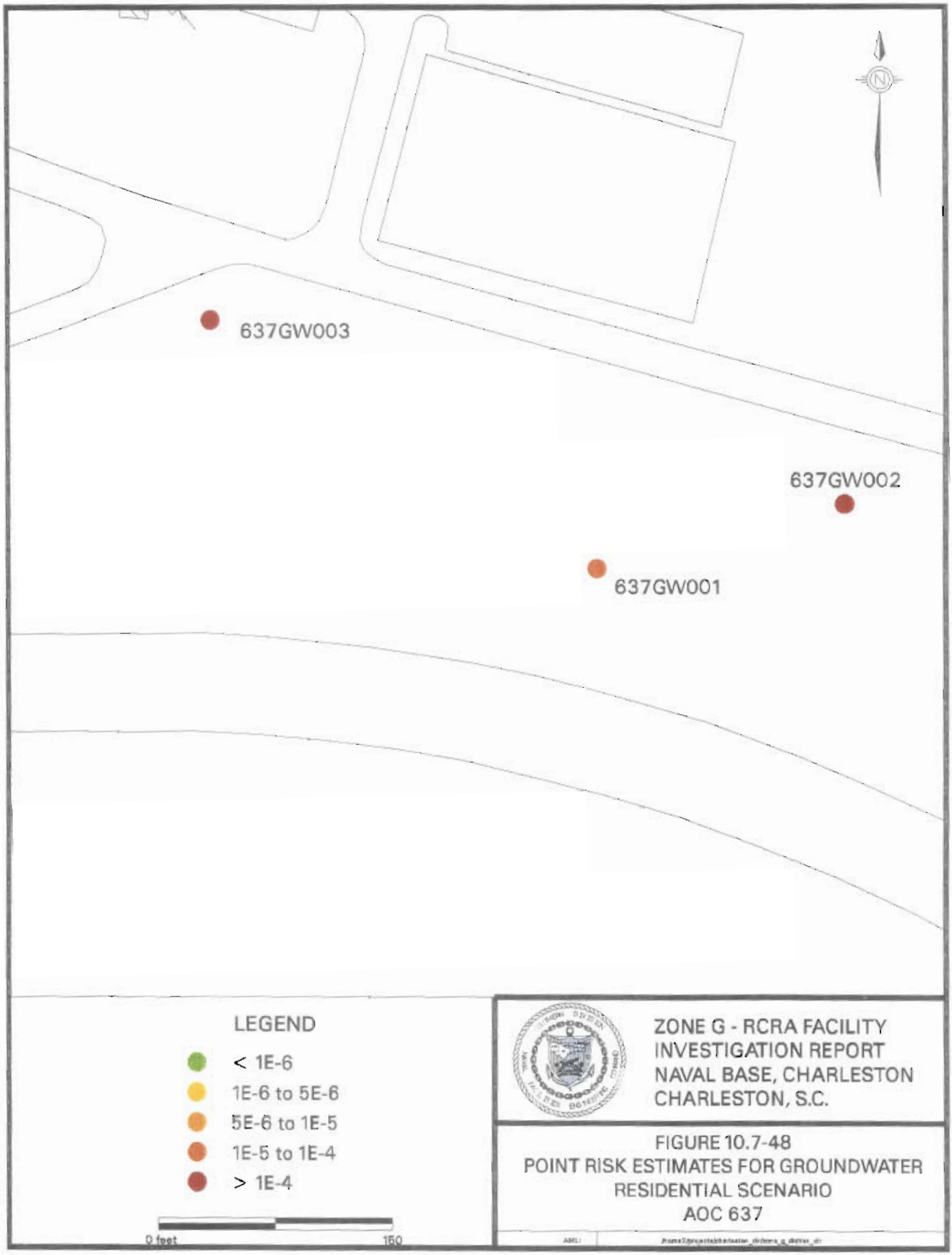

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FIGURE 10.7-48
POINT RISK ESTIMATES FOR GROUNDWATER
RESIDENTIAL SCENARIO
AOC 637

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FIGURE 10.7-49
POINT HAZARD ESTIMATES FOR GROUNDWATER
RESIDENTIAL SCENARIO
AOC 637

Table 10.7.35
Point Estimates of Risk and Hazard - Groundwater Pathways
Residential Scenario
AOC 637
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Site	Location	Parameter	Concentration	Units	Hazard Index	% HI	Risk (E-06)	% Risk
637	001	1,4-Dichlorobenzene	ND	UG/L	NA		NA	
637	001	4-Methylphenol (p-Cresol)	ND	UG/L	NA		NA	
637	001	Antimony (Sb)	8.7	UG/L	1.3904	9.12	NA	
637	001	Barium (Ba)	6000	UG/L	5.4795	35.93	NA	
637	001	Benzene	55	UG/L	4.1123	26.96	47.4442	100.00
637	001	Beryllium (Be)	ND	UG/L	NA		NA	
637	001	Chlorobenzene	38	UG/L	0.5469	3.59	NA	
637	001	Chromium (Cr)	33.6	UG/L	0.4296	2.82	NA	
637	001	Ethylbenzene	440	UG/L	0.3796	2.49	NA	
637	001	Lead (Pb)	44.1	UG/L	NA		NA	
637	001	Naphthalene	20	UG/L	0.0320	0.21	NA	
637	001	Thallium (Tl)	3	UG/L	2.3973	15.72	NA	
637	001	Toluene	92	UG/L	0.0810	0.53	NA	
637	001	Xylene (Total)	6300	UG/L	0.4027	2.64	NA	
		Total			15.2512		47.4442	
637	002	1,4-Dichlorobenzene	2	UG/L	0.0011	0.36	1.4278	0.55
637	002	4-Methylphenol (p-Cresol)	ND	UG/L	NA		NA	
637	002	Antimony (Sb)	ND	UG/L	NA		NA	
637	002	Barium (Ba)	211	UG/L	0.1927	61.89	NA	
637	002	Benzene	ND	UG/L	NA		NA	
637	002	Beryllium (Be)	ND	UG/L	NA		NA	
637	002	Chlorobenzene	7	UG/L	0.1007	32.36	NA	
637	002	Chromium (Cr)	1.4	UG/L	0.0179	5.75	NA	
637	002	Ethylbenzene	ND	UG/L	NA		NA	
637	002	Hydrazine	5.8	UG/L	NA		258.7867	100.00
637	002	Lead (Pb)	1.2	UG/L	NA		NA	
637	002	Naphthalene	ND	UG/L	NA		NA	
637	002	Thallium (Tl)	ND	UG/L	NA		NA	
637	002	Toluene	ND	UG/L	NA		NA	
637	002	Xylene (Total)	ND	UG/L	NA		NA	
		Total			0.3113		258.7867	
637	003	1,4-Dichlorobenzene	2	UG/L	0.0011	0.01	1.4278	0.42
637	003	4-Methylphenol (p-Cresol)	50	UG/L	0.6393	6.40	NA	
637	003	Antimony (Sb)	6.8	UG/L	1.0868	10.87	NA	
637	003	Barium (Ba)	3471	UG/L	3.1699	31.71	NA	
637	003	Benzene	3	UG/L	0.2243	2.24	2.5879	0.75
637	003	Beryllium (Be)	ND	UG/L	NA		NA	
637	003	Chlorobenzene	2	UG/L	0.0288	0.29	NA	
637	003	Chromium (Cr)	5.1	UG/L	0.0652	0.65	NA	
637	003	Ethylbenzene	ND	UG/L	NA		NA	
637	003	Hydrazine	7.65	UG/L	NA		341.3307	99.25
637	003	Lead (Pb)	13.3	UG/L	NA		NA	
637	003	Naphthalene	240	UG/L	0.3836	3.84	NA	
637	003	Thallium (Tl)	5.5	UG/L	4.3950	43.97	NA	
637	003	Toluene	2	UG/L	0.0018	0.02	NA	
637	003	Xylene (Total)	6	UG/L	0.0004		NA	
		Total			9.9949		343.9186	

under the site worker are less conservative than those calculated under the residential site use scenario. Therefore any remedial decisions regarding groundwater should consider the residential risk assessment.

10.7.8.8 Remedial Goal Options

Soil

RGOs for carcinogens were based on the lifetime weighted average site resident as presented in Table 10.7.36 for surface soil. Hazard-based RGOs were calculated based on the hypothetical child resident.

Groundwater

Shallow groundwater RGOs were based on the generic site resident scenario are shown in Table 10.7.37.

10.7.9 Corrective Measures Considerations

Based on the analytical results and the human health risk assessment for AOC 637, COCs requiring further evaluation through the CMS process have been identified for surface soil and groundwater. The site is currently in a moderately developed urban setting and risk to human health was evaluated under both the residential and industrial (site worker) scenarios. For these scenarios, the incidental ingestion and dermal contact exposure pathways were evaluated. Hazard was evaluated for noncarcinogenic contaminants through incidental ingestion and dermal contact scenarios as well.

As recommended by SCDHEC, a COC is considered to be any chemical contributing to a cumulative risk level of 1E-06 or greater and/or a cumulative hazard index above 1.0, and whose individual risk exceeds 1E-06 or whose hazard quotient exceeds 0.1.

Table 10.7.36
Remedial Goal Options Surface Soil
AOC 637
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Residential-Based Remedial Goal Options

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	EPC mg/kg	Hazard-Based Remedial Goal Options 3 mg/kg	1 mg/kg	0.1 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Inorganics										
Arsenic	1.5	0.0003	19	66	22	2.2	0.38	3.8	38	17.2
Thallium	NA	8E-05	1.06	ERR	ERR	ERR	ND	ND	ND	0.85
Semivolatile Organics										
Benzo(a)pyrene Equivalent	7.3	NA	1.507	ND	ND	ND	0.031	0.31	3.1	NA
Propellants										
Hydrazine	3	NA	0.213	ND	ND	ND	ERR	ERR	ERR	NA

Worker-Based Remedial Goal Options

Chemical	Slope Factor (mg/kg-day)-1	Reference Dose (mg/kg-day)	EPC mg/kg	Hazard-Based Remedial Goal Options 3 mg/kg	1 mg/kg	0.1 mg/kg	Risk-Based Remedial Goal Options 1E-06 mg/kg	1E-05 mg/kg	1E-04 mg/kg	Background Concentration mg/kg
Inorganics										
Arsenic	1.5	0.0003	19	1302	434	43	2.7	27	271	17.2
Thallium	NA	8E-05	1.06	ERR	ERR	ERR	ND	ND	ND	0.85
Semivolatile Organics										
Benzo(a)pyrene Equivalent	7.3	NA	1.507	ND	ND	ND	0.14	1.4	14	NA
Propellants										
Hydrazine	3	NA	0.213	ND	ND	ND	0.72	7.2	72	NA

NOTES:
EPC Exposure point concentration
NA Not applicable
ND Not determined
- Remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident or site worker for noncarcinogens

Table 10.7.37
Remedial Goal Options Groundwater
AOC 637
NAVBASE - Charleston, Zone G
Charleston, South Carolina

Residential-Based Remedial Goal Options

Chemical	Oral SF (mg/kg-day)-1	Oral RfD (mg/kg-day)	EPC mg/l	Hazard-Based Remedial Goal Options 0.1 mg/l	1.0 mg/l	3 mg/l	Risk-Based Remedial Goal Options 1E-06 mg/l	1E-05 mg/l	1E-04 mg/l	Background Concentration mg/l	MCL mg/l
Inorganics											
Antimony (Sb)	NA	0.0004	0.0087	0.00063	0.0063	0.019	ND	ND	ND	0.00485	0.006
Barium (Ba)	NA	0.07	6	0.11	1.1	3.3	ND	ND	ND	0.031	2
Chromium (Cr)	NA	0.005	0.0336	0.0078	0.078	0.23	ND	ND	ND	0.00388	0.1
Lead (Pb)	NA	NA	0.0441	ND	ND	ND	ND	ND	ND	0.0046	0.015
Thallium (Tl)	NA	8E-05	0.0055	0.00013	0.0013	0.0038	ND	ND	ND	NA	0.002
Semivolatile Organics											
4-Methylphenol	NA	0.005	0.05	0.0078	0.078	0.23	ND	ND	ND	NA	NA
Naphthalene	NA	0.04	0.24	0.063	0.63	1.9	ND	ND	ND	NA	NA
Volatile Organics											
Benzene	0.029	0.003	0.055	0.0017	0.017	0.051	0.0011	0.011	0.11	NA	0.005
Chlorobenzene	NA	0.02	0.038	0.0069	0.069	0.21	ND	ND	ND	NA	NA
Ethylbenzene	NA	0.1	0.44	0.13	1.3	4.0	ND	ND	ND	NA	0.7
Xylene (total)	NA	2	6.3	1.6	16	47	ND	ND	ND	NA	10
Propellants/Explosives											
Hydrazine	3	NA	0.00765	ND	ND	ND	0.000022	0.00022	0.0022	NA	NA
Tetryl	NA	0.01	0.038	0.016	0.16	0.47	ND	ND	ND	NA	NA

NOTES:

EPC Exposure point concentration
NA Not applicable
ND Not Determined
- Remedial goal options were based on the residential lifetime weighted average for carcinogens and the child resident for noncarcinogens.

Arsenic, BEQs, hydrazine, and thallium were identified as soil pathway COCs for AOC 637. Antimony, arsenic, barium, benzene, chlorobenzene, chromium, hydrazine, lead, 4-methylphenol, naphthalene, tetryl, thallium, and xylene were identified as groundwater COCs for AOC 637. Table 10.7.38 presents cumulative and COC-specific exposure risks and hazard quotients.

Risk-based remedial goals for surface soil and groundwater are presented in Tables 10.7.36 and 10.7.37, respectively. Potential corrective measures for soil are presented in Table 10.7.39.

Table 10.7.38
Zone G
AOC 637
Cumulative and Chemical-Specific Exposure Risks and Hazard

	Risk		Hazard	
Chemical	**Industrial**	**Residential**	**Industrial**	**Residential**
Soil				
Arsenic	7.0E-06	5.0E-05	0.044	0.87
BEQs	5.1E-06	2.5E-05	ND	ND
Hydrazine	2.9E-07	1.5E-06	ND	ND
Thallium	ND	ND	0.009	0.182
Cumulative	1.2E-05	7.6E-05	0.05	1.05
Groundwater				
Antimony	ND	ND	0.21	1.4
Barium	ND	ND	0.84	5.5
Benzene	1.1E-05	4.8E-05	0.49	3.3
Chlorobenzene	ND	ND	0.084	0.55
Chromium	ND	ND	0.066	0.43
Hydrazine	8.0E-05	3.5E-04	ND	ND
Lead	ND	ND	ND	ND
4-methylphenol	ND	ND	0.098	0.64
Naphthalene	ND	ND	0.059	0.38
Tetryl	ND	ND	0.037	0.24

Table 10.7.38
Zone G
AOC 637
Cumulative and Chemical-Specific Exposure Risks and Hazard

	Risk		Hazard	
Chemical	**Industrial**	**Residential**	**Industrial**	**Residential**
Thallium	ND	ND	0.67	4.4
Xylene	ND	ND	0.062	0.4
Cumulative	9.1E-05	4.0E-04	2.69	17.7

Note:
ND = Not detected

Table 10.7.39
Zone G
AOC 637
Potential Corrective Measures

Medium	Compounds	Potential Corrective Measures
Soil	Arsenic, BEQs, hydrazine, and thallium	a) No action b) Excavate, offsite disposal, and monitoring c) Containment/capping
Groundwater	Antimony, arsenic, barium, benzene, chlorobenzene, chromium, hydrazine, lead, 4-methylphenol, naphthalene, tetryl, thallium, and xylene	a) No action b) Monitoring c) Ex-situ physical/chemical treatment and discharge to POTW d) Ex-situ physical/chemical treatment and discharge through NPDES permitting