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11901 Samuel, Garden Grove, CA 92840-2546

Figure 2. Current Borehole Locations with the 2005 Boreholes and 2007 Monitoring wells.

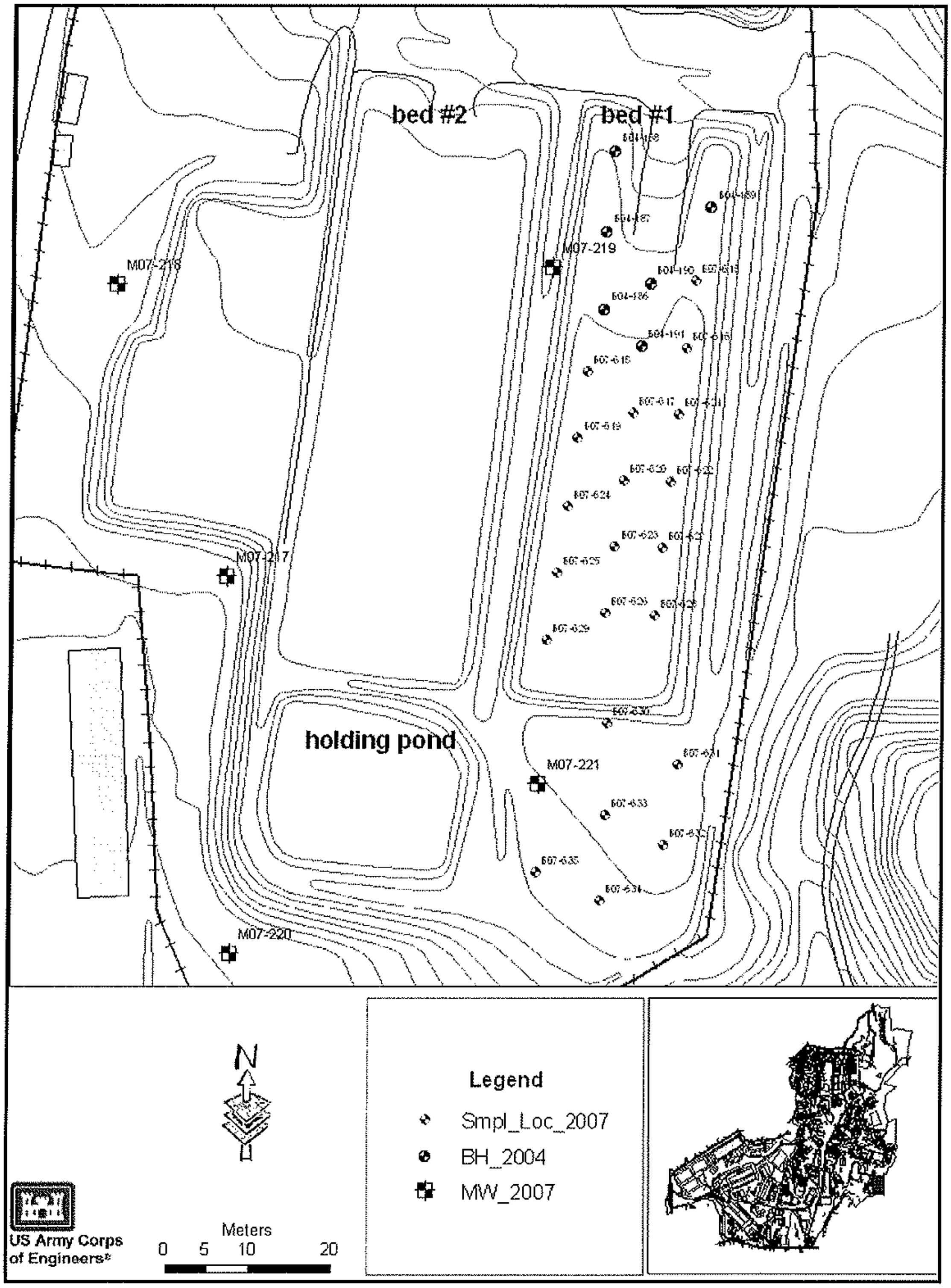

Table 1. Summary of Soil Sampling Results.

Depth	Items	Method	Year 2004* B04-186~191	Year 2007 M07-217~221	on the Bed #1 B07-615~629	Around M07-221 B07-630~635
0-2 m	VOCs	8260	O	O	O	O
	OC Pesticides	8081	O	O	O	O
	Metals/Hg	6020/7471	O	O	O	O
2-4 m	VOCs	8260				
	OC Pesticides	8081	O	O	O	O
	Metals/Hg	6020/7471	O	O	O	O
4-6 m	VOCs	8260				O
	OC Pesticides	8081		O		O
	Metals/Hg	6020/7471		O		O
6-8.4 m	VOCs	8260	O			
	OC Pesticides	8081	O			
	Metals/Hg	6020/7471	O			

* three sampling intervals: 0~2.4 m, 3~4.8 m and 6~8.4 m,

* organo phophorous pesticides were analyzed in 2004 but not dected at that time.

4. CHEMICAL TEST RESULTS.

4.1. Laboratory Analysis and Comparison Criteria.

A total of 115 soil samples were submitted to TestAmerica Inc. (formerly STL) laboratory in Seattle, United States for chemical analysis. The discussion on the chemical test results below did not include the data that appeared lower than the reporting detection limit.

The test results are compared with respect to the residential action level (calculated concentration for considering direct exposure to humans) by EPA Region IX Preliminary Remediation Goals (PRG) for Superfund Sites http://epa-prgs.ornl.gov/. The PRG's role in site "screening" is to help identify areas, contaminants, and conditions that require further attention at a particular site. Chemical concentrations above the PRG would not automatically designate a site as "dirty" or trigger a response action; however, exceeding a PRG suggests that further evaluation of the potential risks by site contaminants is appropriate. PRGs are also useful tools for identifying initial cleanup goals at a site. In this case, PRGs provide long-term targets to use during the analysis of different remedial alternatives.

The chemical test results are presented in Table 2.

Table 2. Chemical Test Result for the Land Farm Soil Samples.

Chemical Parameter	Anal. method	unit	EPA PRG$		B07-221			B07-615		B07-616		B07-617	
			Res.$$	Ind.$$$	S2	S4	S6	S1	S2	S1	S2	S1	S2
					~2m	2~4m	4~6m	~2m	2~4m	~2m	2~4m	~2m	2~4m
alpha-BHC	8081A	mg/kg			-*	x**	x	x	x	x	x	x	0.00
beta-BHC	8081A	mg/kg			-	x	x	5.10	0.23	x	x	x	0.00
delta-BHC	8081A	mg/kg			-	x	x	x	x	x	x	x	0.00
gamma-BHC (Lindane)	8081A	mg/kg	0.44	1.70	-	x	x	x	x	**1.00**	0.12	0.04	0.00
4,4'-DDD	8081A	mg/kg	2.40	10.00	-	0.12	**7.00**	**210.00**	**10.00**	0.59	0.33	0.22	0.00
4,4'-DDE	8081A	mg/kg	1.70	7.00	-	0.02	1.10	**460.00**	**22.00**	0.19	0.12	0.28	0.00
4,4'-DDT	8081A	mg/kg	1.70	7.00	-	0.02	**3.90**	**55.00**	**5.90**	**6.90**	**4.80**	**1.70**	0.00
Dieldrin	8081A	mg/kg	0.03	0.11	-	x	x	x	x	x	x	x	x
Endosulfan I	8081A	mg/kg	370	3,700	-	x	x	x	x	x	x	x	x
Endosulfan II	8081A	mg/kg			-	x	x	x	x	x	x	x	x
Endosulfan sulfate	8081A	mg/kg			-	x	x	x	x	x	x	x	x
Endrin	8081A	mg/kg	18.00	180.00	-	x	x	**86.00**	4.90	0.65	0.30	0.27	0.00
Endrin aldehyde	8081A	mg/kg			-	x	x	x	x	x	x	x	x
Heptachlor	8081A	mg/kg	31.00	310.00	-	x	x	x	x	x	x	x	x
alpha-Chlordane	8081A	mg/kg			-	x	x	x	x	x	x	x	x
gamma-Chlordane	8081A	mg/kg	1.60	6.50	-	x	x	**80.00**	**3.00**	x	x	x	0.00
Chloromethane	8260B	mg/kg	47	160	x	-	-	0.01	-	0.01	-	0.01	-
Vinyl chloride	8260B	mg/kg	39		x	-	-	0.01	-	0.03	-	x	-
1,1-Dichloroethene	8260B	mg/kg	120	410	x	-	-	0.01	-	0.00	-	x	-
Acetone	8260B	mg/kg	14,000	54,000	x	-	-	x	-	x	-	0.02	-
Methylene Chloride	8260B	mg/kg	2,000	9,300	x	-	-	x	-	x	-	x	-
trans-1,2-Dichloroethene	8260B	mg/kg	69	230	x	-	-	0.11	-	x	-	x	-
cis-1,2-Dichloroethene	8260B	mg/kg	43	150	33.00	-	-	1.60	-	1.10	-	0.04	-
Benzene	8260B	mg/kg	33	120	x	-	-	2.60	-	0.02	-	0.00	-
4-Methyl-2-pentanone	8260B	mg/kg			x	-	-	0.04	-	x	-	x	-
Toluene	8260B	mg/kg	660	2,200	1.90	-	-	90.00	-	0.00	-	x	-
Chlorobenzene	8260B	mg/kg	150	530	x	-	-	16.00	-	0.13	-	x	-
Ethylbenzene	8260B	mg/kg	1,900	7,400	2.60	-	-	23.00	-	0.19	-	x	-
m-Xylene & p-Xylene	8260B	mg/kg	270	900	12.00	-	-	130.00	-	0.28	-	x	-
o-Xylene	8260B	mg/kg	270	900	9.00	-	-	42.00	-	0.02	-	x	-
Isopropylbenzene	8260B	mg/kg			3.40	-	-	1.40	-	0.01	-	x	-
N-Propylbenzene	8260B	mg/kg			9.50	-	-	2.80	-	0.01	-	x	-
1,1,2,2-Tetrachloroethane	8260B	mg/kg	1,000	4,000	3.20	-	-	x	-	x	-	x	-
1,3,5-Trimethylbenzene	8260B	mg/kg	21	70	36.00	-	-	13.00	-	0.04	-	x	-
1,2,4-Trimethylbenzene	8260B	mg/kg	52	170	96.00	-	-	33.00	-	0.09	-	0.00	-
sec-Butylbenzene	8260B	mg/kg	450	1,600	6.10	-	-	1.70	-	0.00	-	x	-
1,3-Dichlorobenzene	8260B	mg/kg	530	2,100	x	-	-	2.50	-	0.01	-	x	-
4-Isopropyltoluene	8260B	mg/kg			8.80	-	-	3.20	-	0.00	-	x	-
Trichloroethene	8260B	mg/kg	16	110	**570.00**	-	-	**20.00**	-	0.04	-	0.04	-
1,4-Dichlorobenzene	8260B	mg/kg			x	-	-	16.00	-	0.09	-	x	-
1,2-Dichlorobenzene	8260B	mg/kg	1,600	10,000	x	-	-	11.00	-	0.02	-	x	-
1,2,4-Trichlorobenzene	8260B	mg/kg	62	220	x	-	-	**150.00**	-	0.06	-	0.00	-
1,2,3-Trichlorobenzene	8260B	mg/kg			x	-	-	13.00	-	0.01	-	x	-
Naphthalene	8260B	mg/kg			17.00	-	-	150.00	-	0.27	-	0.01	-
Tetrachloroethene	8260B	mg/kg	38	130	**45.00**	-	-	**1,300.00**	-	0.30	-	6.80	-
Arsenic	6020	mg/kg	22	260	-	6.20	3.30	6.60	6.40	7.40	7.20	5.30	4.50
Barium	6020	mg/kg	5,430	67,000	-	-	-	100.00	78.00	85.00	81.00	110.00	82.00
Cadmium	6020	mg/kg	37	450	-	0.36	0.11	0.36	0.20	0.16	0.18	0.30	0.40
Chromium	6020	mg/kg	30	64	-	7.40	4.40	**34.00**	9.70	6.40	6.10	4.50	5.20
Lead	6020	mg/kg	400	800	-	42.00	7.80	47.00	21.00	20.00	17.00	14.00	17.00
Selenium	6020	mg/kg	390	5,100	-	-	-	0.18	0.16	0.28	0.25	0.18	0.23
Silver	6020	mg/kg	390	5,100	-	-	-	0.51	0.12	0.12	0.06	0.12	0.05
Mercury	7471A	mg/kg	6.10	62.00	-	0.03	x	0.02	0.01	x	x	x	x

$- EPA Region IX preliminary remediation goal, $$- residential area, $$$- industrial area
Empty cell in PRG indicates that there has been set up no PRG concentration for the chemicals yet.
*- chemcals were not requested to analyze, ** not detected above sample reporting limit.
Highlighted ones are exceeding the concentration of the PRG residential area.

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Table 2 (Continued)

Chemical Parameter	Anal. method	unit	EPA PRG		B07-618		B07-619		B07-620		B07-621	
			Res.	Ind.	S1 ~2m	S2 2~4m	S1 ~2m	S2 2~4m	S1 ~2m	S2 2~4m	S1 ~2m	S2 2~4m
alpha-BHC	8081A	mg/kg			x	x	x	x	x	x	x	0.00
beta-BHC	8081A	mg/kg			0.00	0.64	x	0.00	0.00	0.00	0.00	0.00
delta-BHC	8081A	mg/kg			x	x	x	0.00	x	0.00	0.00	0.00
gamma-BHC (Lindane)	8081A	mg/kg	0.44	1.70	0.00	x	0.00	0.00	0.00	0.00	0.00	0.00
4,4'-DDD	8081A	mg/kg	2.40	10.00	0.00	2.30	0.00	x	x	0.00	0.02	0.00
4,4'-DDE	8081A	mg/kg	1.70	7.00	0.00	**3.50**	0.00	x	0.00	0.00	0.00	x
4,4'-DDT	8081A	mg/kg	1.70	7.00	0.05	1.00	0.00	x	0.00	0.00	0.01	0.00
Dieldrin	8081A	mg/kg	0.03	0.11	0.00	x	0.00	x	0.00	x	0.00	x
Endosulfan I	8081A	mg/kg	370	3,700	x	x	x	x	x	x	x	x
Endosulfan II	8081A	mg/kg			x	x	x	x	x	x	x	x
Endosulfan sulfate	8081A	mg/kg			x	x	x	x	x	x	x	x
Endrin	8081A	mg/kg	18.00	180.00	x	x	x	x	x	0.00	0.00	x
Endrin aldehyde	8081A	mg/kg			x	x	x	x	x	x	x	x
Heptachlor	8081A	mg/kg	31.00	310.00	x	0.45	x	x	x	x	0.00	x
alpha-Chlordane	8081A	mg/kg			x	x	x	x	x	x	0.00	x
gamma-Chlordane	8081A	mg/kg	1.60	6.50	x	x	x	x	x	x	0.00	x
Chloromethane	8260B	mg/kg	47	160	0.01	-	x	-	0.00	-	0.01	-
Vinyl chloride	8260B	mg/kg	39		x	-	x	-	x	-	x	-
1,1-Dichloroethene	8260B	mg/kg	120	410	x	-	x	-	x	-	x	-
Acetone	8260B	mg/kg	14,000	54,000	x	-	x	-	x	-	x	-
Methylene Chloride	8260B	mg/kg	2,000	9,300	x	-	x	-	x	-	x	-
trans-1,2-Dichloroethene	8260B	mg/kg	69	230	x	-	x	-	x	-	x	-
cis-1,2-Dichloroethene	8260B	mg/kg	43	150	x	-	x	-	x	-	0.01	-
Benzene	8260B	mg/kg	33	120	x	-	x	-	x	-	x	-
4-Methyl-2-pentanone	8260B	mg/kg			x	-	x	-	x	-	x	-
Toluene	8260B	mg/kg	660	2,200	6.10	-	x	-	x	-	x	-
Chlorobenzene	8260B	mg/kg	150	530	x	-	x	-	x	-	x	-
Ethylbenzene	8260B	mg/kg	1,900	7,400	x	-	x	-	x	-	x	-
m-Xylene & p-Xylene	8260B	mg/kg	270	900	x	-	x	-	x	-	x	-
o-Xylene	8260B	mg/kg	270	900	x	-	x	-	x	-	x	-
Isopropylbenzene	8260B	mg/kg			0.01	-	x	-	x	-	x	-
N-Propylbenzene	8260B	mg/kg			x	-	x	-	x	-	x	-
1,1,2,2-Tetrachloroethane	8260B	mg/kg	1,000	4,000	x	-	x	-	x	-	x	-
1,3,5-Trimethylbenzene	8260B	mg/kg	21	70	x	-	x	-	x	-	x	-
1,2,4-Trimethylbenzene	8260B	mg/kg	52	170	x	-	x	-	x	-	x	-
sec-Butylbenzene	8260B	mg/kg	450	1,600	x	-	x	-	x	-	x	-
1,3-Dichlorobenzene	8260B	mg/kg	530	2,100	x	-	x	-	x	-	x	-
4-Isopropyltoluene	8260B	mg/kg			x	-	x	-	x	-	x	-
Trichloroethene	8260B	mg/kg	16	110	x	-	x	-	x	-	x	-
1,4-Dichlorobenzene	8260B	mg/kg			x	-	x	-	x	-	x	-
1,2-Dichlorobenzene	8260B	mg/kg	1,600	10,000	x	-	x	-	x	-	x	-
1,2,4-Trichlorobenzene	8260B	mg/kg	62	220	x	-	x	-	x	-	0.00	-
1,2,3-Trichlorobenzene	8260B	mg/kg			x	-	x	-	x	-	x	-
Naphthalene	8260B	mg/kg			x	-	x	-	x	-	x	-
Tetrachloroethene	8260B	mg/kg	38	130	0.02	-	0.01	-	x	-	0.01	-
Arsenic	6020	mg/kg	22	260	**27.00**	8.80	2.60	8.50	4.90	4.50	4.80	4.90
Barium	6020	mg/kg	5,430	67,000	88.00	74.00	81.00	81.00	100.00	92.00	120.00	84.00
Cadmium	6020	mg/kg	37	450	0.15	0.40	0.05	0.32	0.07	0.06	0.18	0.14
Chromium	6020	mg/kg	30	64	5.00	4.50	4.50	3.00	4.70	5.10	4.40	5.30
Lead	6020	mg/kg	400	800	12.00	17.00	8.70	17.00	17.00	14.00	15.00	14.00
Selenium	6020	mg/kg	390	5,100	0.16	0.20	0.21	0.21	0.16	0.27	0.22	0.15
Silver	6020	mg/kg	390	5,100	0.03	0.09	0.02	0.03	0.02	0.02	0.05	0.06
Mercury	7471A	mg/kg	6.10	62.00	x	x	x	x	x	x	x	x

Table 2 (Continued)

Chemical Parameter	Anal. method	unit	EPA PRG		B07-622		B07-623		B07-624		B07-625	
			Res.	Ind.	S1 ~2m	S2 2~4m	S1 ~2m	S2 2~4m	S1 ~2m	S2 2~4m	S1 ~2m	S2 2~4m
alpha-BHC	8081A	mg/kg			x	0.00	0.00	x	x	x	x	x
beta-BHC	8081A	mg/kg			x	0.00	0.00	0.00	0.00	0.00	0.00	0.00
delta-BHC	8081A	mg/kg			x	0.00	0.00	x	x	0.00	0.00	x
gamma-BHC (Lindane)	8081A	mg/kg	0.44	1.70	x	0.01	0.02	0.00	0.00	0.00	0.00	x
4,4'-DDD	8081A	mg/kg	2.40	10.00	0.00	x	0.04	0.00	0.01	0.00	0.00	x
4,4'-DDE	8081A	mg/kg	1.70	7.00	0.00	0.00	0.03	0.00	0.01	x	0.01	0.00
4,4'-DDT	8081A	mg/kg	1.70	7.00	x	0.00	0.01	0.01	0.28	0.00	0.04	x
Dieldrin	8081A	mg/kg	0.03	0.11	x	x	0.00	x	0.01	x	0.01	x
Endosulfan I	8081A	mg/kg	370	3,700	x	x	x	x	0.00	x	x	x
Endosulfan II	8081A	mg/kg			x	x	0.01	x	x	x	x	x
Endosulfan sulfate	8081A	mg/kg			x	x	x	x	x	x	x	x
Endrin	8081A	mg/kg	18.00	180.00	x	x	x	x	0.05	x	0.01	x
Endrin aldehyde	8081A	mg/kg			x	x	x	x	x	x	x	x
Heptachlor	8081A	mg/kg	31.00	310.00	x	x	x	x	x	x	x	x
alpha-Chlordane	8081A	mg/kg			x	x	0.65	x	0.00	x	0.00	x
gamma-Chlordane	8081A	mg/kg	1.60	6.50	x	x	0.11	x	0.00	x	0.00	x
Chloromethane	8260B	mg/kg	47	160	0.01	-	0.01	-	0.00	-	x	-
Vinyl chloride	8260B	mg/kg	39		x	-	x	-	x	-	x	-
1,1-Dichloroethene	8260B	mg/kg	120	410	x	-	x	-	x	-	x	-
Acetone	8260B	mg/kg	14,000	54,000	x	-	x	-	x	-	x	-
Methylene Chloride	8260B	mg/kg	2,000	9,300	x	-	x	-	x	-	x	-
trans-1,2-Dichloroethene	8260B	mg/kg	69	230	x	-	x	-	x	-	x	-
cis-1,2-Dichloroethene	8260B	mg/kg	43	150	x	-	x	-	x	-	x	-
Benzene	8260B	mg/kg	33	120	x	-	x	-	x	-	x	-
4-Methyl-2-pentanone	8260B	mg/kg			x	-	x	-	x	-	x	-
Toluene	8260B	mg/kg	660	2,200	0.01	-	x	-	x	-	x	-
Chlorobenzene	8260B	mg/kg	150	530	x	-	x	-	x	-	x	-
Ethylbenzene	8260B	mg/kg	1,900	7,400	x	-	x	-	x	-	x	-
m-Xylene & p-Xylene	8260B	mg/kg	270	900	x		x		x	-	x	-
o-Xylene	8260B	mg/kg	270	900	x	-	x	-	x	-	x	-
Isopropylbenzene	8260B	mg/kg			x	-	x	-	x	-	x	-
N-Propylbenzene	8260B	mg/kg			x	-	x	-	x	-	x	-
1,1,2,2-Tetrachloroethane	8260B	mg/kg	1,000	4,000	x	-	x	-	x	-	x	-
1,3,5-Trimethylbenzene	8260B	mg/kg	21	70	x	-	x	-	x	-	x	-
1,2,4-Trimethylbenzene	8260B	mg/kg	52	170	x	-	x	-	x	-	x	-
sec-Butylbenzene	8260B	mg/kg	450	1,600	x	-	x	-	x	-	x	-
1,3-Dichlorobenzene	8260B	mg/kg	530	2,100	x	-	x	-	x	-	x	-
4-Isopropyltoluene	8260B	mg/kg			x	-	x	-	x	-	x	-
Trichloroethene	8260B	mg/kg	16	110	x	-	x	-	x	-	x	-
1,4-Dichlorobenzene	8260B	mg/kg			x	-	x	-	x	-	x	-
1,2-Dichlorobenzene	8260B	mg/kg	1,600	10,000	x	-	x	-	x	-	x	-
1,2,4-Trichlorobenzene	8260B	mg/kg	62	220	x	-	x	-	x	-	x	-
1,2,3-Trichlorobenzene	8260B	mg/kg			x	-	x	-	x	-	x	-
Naphthalene	8260B	mg/kg			x	-	x	-	x	-	x	-
Tetrachloroethene	8260B	mg/kg	38	130	x	-	x	-	0.01	-	x	-
Arsenic	6020	mg/kg	22	260	3.70	7.90	4.80	6.00	3.90	8.30	3.90	9.60
Barium	6020	mg/kg	5,430	67,000	58.00	84.00	83.00	76.00	90.00	100.00	120.00	99.00
Cadmium	6020	mg/kg	37	450	0.03	0.65	0.08	0.19	0.07	0.81	0.13	0.79
Chromium	6020	mg/kg	30	64	15.00	2.80	4.60	3.70	5.20	3.80	5.00	2.20
Lead	6020	mg/kg	400	800	7.90	24.00	11.00	19.00	13.00	29.00	11.00	36.00
Selenium	6020	mg/kg	390	5,100	0.16	0.19	0.15	0.16	0.36	0.19	0.20	0.22
Silver	6020	mg/kg	390	5,100	0.02	0.05	0.03	0.04	0.03	0.05	0.05	0.12
Mercury	7471A	mg/kg	6.10	62.00	x	0.01	0.01	x	x	x	x	0.01

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Table 2 (Continued)

Chemical Parameter	Anal. method	unit	EPA PRG		B07-626		B07-627		B07-628		B07-629	
			Res.	Ind.	S1	S2	S1	S2	S1	S2	S1	S2
					~2m	2~4m	~2m	2~4m	~2m	2~4m	~2m	2~4m
alpha-BHC	8081A	mg/kg			0.00	x	0.00	0.00	x	x	x	x
beta-BHC	8081A	mg/kg			0.03	0.00	0.00	0.00	x	0.00	x	0.00
delta-BHC	8081A	mg/kg			0.00	x	0.00	x	x	x	x	0.00
gamma-BHC (Lindane)	8081A	mg/kg	0.44	1.70	0.00	0.00	0.00	0.00	0.00	0.00	x	0.00
4,4'-DDD	8081A	mg/kg	2.40	10.00	0.08	x	0.00	x	x	0.00	0.00	x
4,4'-DDE	8081A	mg/kg	1.70	7.00	0.09	x	x	x	0.00	0.00	0.00	0.00
4,4'-DDT	8081A	mg/kg	1.70	7.00	1.40	x	0.00	x	x	0.01	0.01	0.00
Dieldrin	8081A	mg/kg	0.03	0.11	0.02	x	x	x	x	0.00	0.00	0.00
Endosulfan I	8081A	mg/kg	370	3,700	0.00	x	x	x	x	x	x	x
Endosulfan II	8081A	mg/kg			x	x	x	x	x	x	x	x
Endosulfan sulfate	8081A	mg/kg			x	x	0.00	x	x	x	x	x
Endrin	8081A	mg/kg	18.00	180.00	0.19	x	x	x	x	0.00	0.00	x
Endrin aldehyde	8081A	mg/kg			0.00	x	x	x	0.00	x	x	x
Heptachlor	8081A	mg/kg	31.00	310.00	x	x	0.00	x	x	x	x	x
alpha-Chlordane	8081A	mg/kg			0.00	x	x	x	x	x	x	x
gamma-Chlordane	8081A	mg/kg	1.60	6.50	0.00	x	x	x	x	x	x	x
Chloromethane	8260B	mg/kg	47	160	0.01	-	0.00	-	0.00	-	0.00	-
Vinyl chloride	8260B	mg/kg	39		x	-	x	-	x	-	x	-
1,1-Dichloroethene	8260B	mg/kg	120	410	x	-	x	-	x	-	x	-
Acetone	8260B	mg/kg	14,000	54,000	x	-	x	-	x	-	x	-
Methylene Chloride	8260B	mg/kg	2,000	9,300	x	-	x	-	x	-	x	-
trans-1,2-Dichloroethene	8260B	mg/kg	69	230	x	-	x	-	x	-	x	-
cis-1,2-Dichloroethene	8260B	mg/kg	43	150	x	-	x	-	x	-	x	-
Benzene	8260B	mg/kg	33	120	x	-	x	-	x	-	x	-
4-Methyl-2-pentanone	8260B	mg/kg			x	-	x	-	x	-	x	-
Toluene	8260B	mg/kg	660	2,200	0.01	-	x	-	x	-	x	-
Chlorobenzene	8260B	mg/kg	150	530	x	-	x	-	x	-	x	-
Ethylbenzene	8260B	mg/kg	1,900	7,400	x	-	x	-	x	-	x	-
m-Xylene & p-Xylene	8260B	mg/kg	270	900	x	-	x	-	x	-	x	-
o-Xylene	8260B	mg/kg	270	900	x	-	x	-	x	-	x	-
Isopropylbenzene	8260B	mg/kg			x	-	x	-	x	-	x	-
N-Propylbenzene	8260B	mg/kg			x	-	x	-	x	-	x	-
1,1,2,2-Tetrachloroethane	8260B	mg/kg	1,000	4,000	x	-	x	-	x	-	x	-
1,3,5-Trimethylbenzene	8260B	mg/kg	21	70	x	-	x	-	x	-	x	-
1,2,4-Trimethylbenzene	8260B	mg/kg	52	170	x	-	x	-	x	-	x	-
sec-Butylbenzene	8260B	mg/kg	450	1,600	x	-	x	-	x	-	x	-
1,3-Dichlorobenzene	8260B	mg/kg	530	2,100	x	-	x	-	x	-	x	-
4-Isopropyltoluene	8260B	mg/kg			x	-	x	-	x		x	-
Trichloroethene	8260B	mg/kg	16	110	0.00	-	x	-	x	-	x	-
1,4-Dichlorobenzene	8260B	mg/kg			x	-	x	-	x	-	x	-
1,2-Dichlorobenzene	8260B	mg/kg	1,600	10,000	x	-	x	-	x	-	x	-
1,2,4-Trichlorobenzene	8260B	mg/kg	62	220	x	-	x	-	x	-	x	-
1,2,3-Trichlorobenzene	8260B	mg/kg			x	-	x	-	x	-	x	-
Naphthalene	8260B	mg/kg			x	-	x	-	x	-	x	-
Tetrachloroethene	8260B	mg/kg	38	130	0.01	-	x	-	x	-	x	-
Arsenic	6020	mg/kg	22	260	6.10	12.00	3.30	18.00	3.70	7.60	3.50	11.00
Barium	6020	mg/kg	5,430	67,000	99.00	97.00	73.00	88.00	74.00	86.00	110.00	87.00
Cadmium	6020	mg/kg	37	450	0.15	0.34	0.07	0.28	0.15	0.17	0.19	0.59
Chromium	6020	mg/kg	30	64	4.30	5.30	6.70	3.90	4.20	4.80	3.90	4.60
Lead	6020	mg/kg	400	800	13.00	27.00	9.80	24.00	15.00	15.00	8.80	13.00
Selenium	6020	mg/kg	390	5,100	0.15	0.27	0.20	0.32	0.21	0.25	0.20	0.18
Silver	6020	mg/kg	390	5,100	0.61	0.05	0.02	0.04	0.02	0.05	0.03	0.05
Mercury	7471A	mg/kg	6.10	62.00	0.02	x	x	x	x	x	0.03	x

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Table 2 (Continued)

Chemical Parameter	Anal. method	unit	EPA PRG		B07-630			B07-631			B07-632		
			Res.	Ind.	S1 ~2m	S2 2~4m	S3 4~6m	S1 ~2m	S2 2~4m	S3 4~6m	S1 ~2m	S2 2~4m	S3 4~6m
alpha-BHC	8081A	mg/kg			-	x	x	-	x	x	-	x	x
beta-BHC	8081A	mg/kg			-	x	0.00	-	0.00	x	-	x	x
delta-BHC	8081A	mg/kg			-	x	x	-	x	x	-	x	x
gamma-BHC (Lindane)	8081A	mg/kg	0.44	1.70	-	0.00	0.00	-	x	x	-	x	x
4,4'-DDD	8081A	mg/kg	2.40	10.00	-	0.02	x	-	x	x	-	x	x
4,4'-DDE	8081A	mg/kg	1.70	7.00	-	0.03	x	-	x	0.00	-	x	x
4,4'-DDT	8081A	mg/kg	1.70	7.00	-	0.10	x	-	0.00	x	-	x	x
Dieldrin	8081A	mg/kg	0.03	0.11	-	x	x	-	x	x	-	x	x
Endosulfan I	8081A	mg/kg	370	3,700	-	x	x	-	x	x	-	x	x
Endosulfan II	8081A	mg/kg			-	x	x	-	x	x	-	x	x
Endosulfan sulfate	8081A	mg/kg			-	x	x	-	x	x	-	x	x
Endrin	8081A	mg/kg	18.00	180.00	-	0.03	x	-	x	x	-	x	x
Endrin aldehyde	8081A	mg/kg			-	x	x	-	x	x	-	x	x
Heptachlor	8081A	mg/kg	31.00	310.00	-	x	x	-	x	0.00	-	x	x
alpha-Chlordane	8081A	mg/kg			-	x	x	-	x	x	-	x	x
gamma-Chlordane	8081A	mg/kg	1.60	6.50	-	x	x	-	x	x	-	x	x
Chloromethane	8260B	mg/kg	47	160	0.01	0.00	0.01	0.01	0.00	0.01	0.00	0.00	0.00
Vinyl chloride	8260B	mg/kg	39		x	x	x	x	x	x	x	x	x
1,1-Dichloroethene	8260B	mg/kg	120	410	x	x	x	x	x	x	x	x	x
Acetone	8260B	mg/kg	14,000	54,000	x	x	0.02	x	x	0.02	x	x	0.01
Methylene Chloride	8260B	mg/kg	2,000	9,300	x	x	0.00	x	x	x	x	x	x
trans-1,2-Dichloroethene	8260B	mg/kg	69	230	x	x	x	x	x	x	x	x	x
cis-1,2-Dichloroethene	8260B	mg/kg	43	150	x	x	x	x	x	x	x	x	x
Benzene	8260B	mg/kg	33	120	x	x	x	x	x	x	x	x	x
4-Methyl-2-pentanone	8260B	mg/kg			x	x	x	x	x	x	x	x	x
Toluene	8260B	mg/kg	660	2,200	0.01	x	0.01	0.05	0.01	0.01	0.00	0.00	x
Chlorobenzene	8260B	mg/kg	150	530	x	x	x	x	x	x	x	x	x
Ethylbenzene	8260B	mg/kg	1,900	7,400	x	x	x	x	x	x	x	x	x
m-Xylene & p-Xylene	8260B	mg/kg	270	900	x	x	x	x	x	x	x	x	x
o-Xylene	8260B	mg/kg	270	900	x	x	x	x	x	x	x	x	x
Isopropylbenzene	8260B	mg/kg			x	x	x	x	x	x	x	x	x
N-Propylbenzene	8260B	mg/kg			x	x	x	x	x	x	x	x	x
1,1,2,2-Tetrachloroethane	8260B	mg/kg	1,000	4,000	x	x	x	x	x	x	x	x	x
1,3,5-Trimethylbenzene	8260B	mg/kg	21	70	x	x	x	x	x	x	x	x	x
1,2,4-Trimethylbenzene	8260B	mg/kg	52	170	x	x	x	x	x	x	x	x	x
sec-Butylbenzene	8260B	mg/kg	450	1,600	x	x	x	x	x	x	x	x	x
1,3-Dichlorobenzene	8260B	mg/kg	530	2,100	x	x	x	x	x	x	x	x	x
4-Isopropyltoluene	8260B	mg/kg			x	x	x	x	x	x	x	x	x
Trichloroethene	8260B	mg/kg	16	110	0.05	x	0.00	0.02	x	x	x	x	x
1,4-Dichlorobenzene	8260B	mg/kg			x	x	x	x	x	x	x	x	x
1,2-Dichlorobenzene	8260B	mg/kg	1,600	10,000	x	x	x	x	x	x	x	x	x
1,2,4-Trichlorobenzene	8260B	mg/kg	62	220	0.01	x	x	0.01	x	x	x	x	x
1,2,3-Trichlorobenzene	8260B	mg/kg			x	x	x	x	x	x	x	x	x
Naphthalene	8260B	mg/kg			x	x	x	x	x	x	x	x	x
Tetrachloroethene	8260B	mg/kg	38	130	0.02	x	x	0.03	x	x	0.02	x	x
Arsenic	6020	mg/kg	22	260	-	8.80	4.60	-	3.60	3.20	-	5.00	4.50
Barium	6020	mg/kg	5,430	67,000	-	93.00	83.00	-	110.00	77.00	-	93.00	74.00
Cadmium	6020	mg/kg	37	450	-	0.39	0.10	-	0.23	1.20	-	0.33	0.21
Chromium	6020	mg/kg	30	64	-	3.60	3.90	-	3.90	6.30	-	3.40	4.40
Lead	6020	mg/kg	400	800	-	12.00	9.50	-	15.00	11.00	-	12.00	13.00
Selenium	6020	mg/kg	390	5,100	-	0.25	0.16	-	0.12	0.11	-	0.12	0.14
Silver	6020	mg/kg	390	5,100	-	0.09	0.04	-	0.03	0.04	-	0.05	0.05
Mercury	7471A	mg/kg	6.10	62.00	-	0.05	x	-	x	x	-	x	x

Table 2 (Continued)

Chemical Parameter	Anal. method	unit	EPA PRG		B07-633			B07-634			B07-635		
			Res.	Ind.	S1	S2	S3	S1	S2	S3	S1	S2	S3
					~2m	2~4m	4~6m	~2m	2~4m	4~6m	~2m	2~4m	4~6m
alpha-BHC	8081A	mg/kg			-	x	x	-	x	x	-	x	x
beta-BHC	8081A	mg/kg			-	x	0.00	-	0.00	0.00	-	0.00	0.00
delta-BHC	8081A	mg/kg			-	x	0.00	-	x	x	-	0.00	x
gamma-BHC (Lindane)	8081A	mg/kg	0.44	1.70	-	0.01	0.00	-	0.00	0.00	-	0.00	x
4,4'-DDD	8081A	mg/kg	2.40	10.00	-	0.14	0.00	-	x	0.00	-	0.00	0.00
4,4'-DDE	8081A	mg/kg	1.70	7.00	-	0.01	x	-	0.00	0.00	-	0.00	0.00
4,4'-DDT	8081A	mg/kg	1.70	7.00	-	0.03	0.00	-	0.00	0.01	-	0.00	0.00
Dieldrin	8081A	mg/kg	0.03	0.11	-	x	x	-	x	x	-	0.00	0.00
Endosulfan I	8081A	mg/kg	370	3,700	-	x	x	-	x	x	-	x	x
Endosulfan II	8081A	mg/kg			-	x	x	-	x	x	-	x	x
Endosulfan sulfate	8081A	mg/kg			-	x	x	-	x	x	-	x	x
Endrin	8081A	mg/kg	18.00	180.00	-	0.01	x	-	x	0.00	-	x	x
Endrin aldehyde	8081A	mg/kg			-	x	x	-	x	x	-	x	x
Heptachlor	8081A	mg/kg	31.00	310.00	-	x	x	-	x	x	-	x	x
alpha-Chlordane	8081A	mg/kg			-	x	x	-	x	x	-	x	x
gamma-Chlordane	8081A	mg/kg	1.60	6.50	-	x	x	-	x	x	-	x	x
Chloromethane	8260B	mg/kg	47	160	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
Vinyl chloride	8260B	mg/kg	39		x	x	x	x	x	x	x	x	x
1,1-Dichloroethene	8260B	mg/kg	120	410	x	x	x	x	x	x	x	x	x
Acetone	8260B	mg/kg	14,000	54,000	0.04	x	x	x	x	x	x	x	x
Methylene Chloride	8260B	mg/kg	2,000	9,300	0.00	x	x	x	0.00	x	0.00	x	x
trans-1,2-Dichloroethene	8260B	mg/kg	69	230	x	x	x	x	x	x	x	x	x
cis-1,2-Dichloroethene	8260B	mg/kg	43	150	0.18	x	x	x	x	x	x	x	x
Benzene	8260B	mg/kg	33	120	0.00	x	x	x	x	x	x	x	x
4-Methyl-2-pentanone	8260B	mg/kg			x	x	x	x	x	x	x	x	x
Toluene	8260B	mg/kg	660	2,200	0.15	0.00	0.01	x	x	x	0.00	x	0.01
Chlorobenzene	8260B	mg/kg	150	530	0.05	x	x	x	x	x	x	x	x
Ethylbenzene	8260B	mg/kg	1,900	7,400	0.00	x	x	x	x	x	x	x	x
m-Xylene & p-Xylene	8260B	mg/kg	270	900	0.01	x	x	x	x	x	x	x	x
o-Xylene	8260B	mg/kg	270	900	x	x	x	x	x	x	x	x	x
Isopropylbenzene	8260B	mg/kg			x	0.00	x	x	x	x	x	x	x
N-Propylbenzene	8260B	mg/kg			0.01	x	x	x	x	x	x	x	x
1,1,2,2-Tetrachloroethane	8260B	mg/kg	1,000	4,000	x	x	x	x	x	x	x	0.00	x
1,3,5-Trimethylbenzene	8260B	mg/kg	21	70	0.03	0.00	x	x	x	x	x	x	x
1,2,4-Trimethylbenzene	8260B	mg/kg	52	170	0.05	0.00	x	x	x	x	x	x	x
sec-Butylbenzene	8260B	mg/kg	450	1,600	0.01	0.00	x	x	x	x	x	x	x
1,3-Dichlorobenzene	8260B	mg/kg	530	2,100	0.00	x	x	x	x	x	x	x	x
4-Isopropyltoluene	8260B	mg/kg			0.01	x	x	x	x	x	x	x	x
Trichloroethene	8260B	mg/kg	16	110	0.19	0.01	x	x	1.90	x	x	0.00	0.00
1,4-Dichlorobenzene	8260B	mg/kg			0.06	x	x	x	x	x	x	0.00	x
1,2-Dichlorobenzene	8260B	mg/kg	1,600	10,000	0.01	x	x	x	x	x	x	x	x
1,2,4-Trichlorobenzene	8260B	mg/kg	62	220	0.01	x	x	x	x	x	x	x	x
1,2,3-Trichlorobenzene	8260B	mg/kg			x	x	x	x	x	x	x	x	x
Naphthalene	8260B	mg/kg			0.02	x	x	x	x	x	x	x	0.00
Tetrachloroethene	8260B	mg/kg	38	130	0.07	0.02	x	x	x	x	0.02	x	x
Arsenic	6020	mg/kg	22	260	-	4.10	3.50	-	7.00	3.50	-	4.50	5.40
Barium	6020	mg/kg	5,430	67,000	-	100.00	81.00	-	110.00	89.00	-	99.00	100.00
Cadmium	6020	mg/kg	37	450	-	0.17	0.08	-	0.37	0.15	-	0.18	0.10
Chromium	6020	mg/kg	30	64	-	4.30	6.30	-	4.90	5.00	-	3.60	6.70
Lead	6020	mg/kg	400	800	-	10.00	12.00	-	13.00	9.30	-	14.00	11.00
Selenium	6020	mg/kg	390	5,100	-	0.11	0.19	-	0.24	0.17	-	0.09	0.14
Silver	6020	mg/kg	390	5,100	-	0.04	0.04	-	0.05	0.06	-	0.04	0.04
Mercury	7471A	mg/kg	6.10	62.00	-	x	x	-	x	x	-	x	0.01

4.2. OC Pesticides (By EPA Method 8081A)

Pesticides were identified in 21 out of total 22 boreholes. The only exception was borehole B07-632. From the samples submitted to the laboratory, sixteen varieties of pesticides were determined to be above the sample reporting limit. Out of the sixteen identified pesticides, six exceeded the EPA PRG residential criteria in 5 out of total 22 boreholes. The borehole and chemicals exceeding the PRG are presented in Table 2, and summarized as follows:

M07-221: 4,4'- DDD and 4,4'-DDT
B07-615: 4,4'- DDD, 4,4'-DDE, 4,4'-DDT, Endrin, gamma-Chlordane
B07-616: Lindane, 4,4' DDT
B07-617: 4,4'-DDT
B07-618: 4,4'-DDE

Figure 3 shows the distribution of the pesticide exceeding the residential criteria of the EPA PRG. The concentrations above the PRG appear mostly around B07-615 and M07-221 down to 4 meters below ground surface.

4.2.2. Target Metals

All target metals were detected above the reporting limits in all samples except for mercury (Table 2). Mercury was detected in 9 out of a total of 22 boreholes. Two samples exceeded the EPA PRG (Table 2): Arsenic in B07-615 and Chromium in B07-618 (Figures 4 and 5).

Figure 4 shows a comparison of chemical test result for Arsenic. Arsenic concentration that exceeds the EPA PRG appears relatively deep, at approximately 8.4 m bgs, according to the chemical test results from 2004.

4.2.3. Volatile Organic Compounds (VOCs)

A majority of VOCs were detected from the samples taken at B07-221, B07-615 and B07-616. Out of all the VOCs detected, three compounds exceeded the EPA PRG criteria (Table 2): Trichloroethene (TCE), 1,2,4-Trichlorobenzene and Tetrachloroethene (PCE).

Figure 6 shows the horizontal and vertical extension of PCE in association with the EPA PRG criterion of 0.48 mg/kg. The high concentration above the PRG criteria appeared generally limited within 2 m bgs, while TCE concentrations above the criteria extended down to 8.4 m bgs (Figure 7).

Figure 3. DDT/DDD/DDE Distribution at the Land Farm Bed#1 of Camp Carroll.

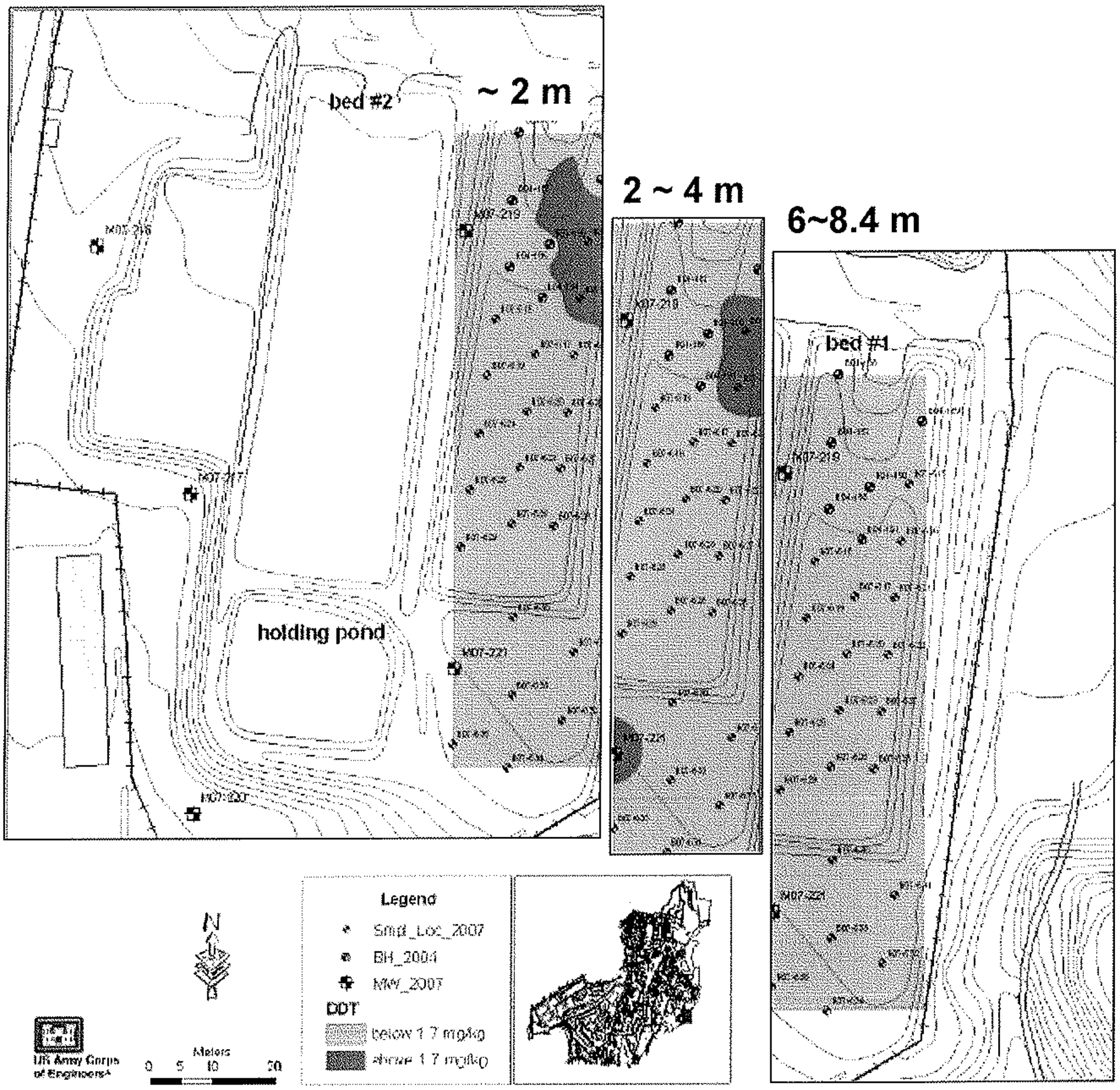

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Figure 4. Arsenic Distribution at the Land Farm Bed#1 of Camp Carroll.

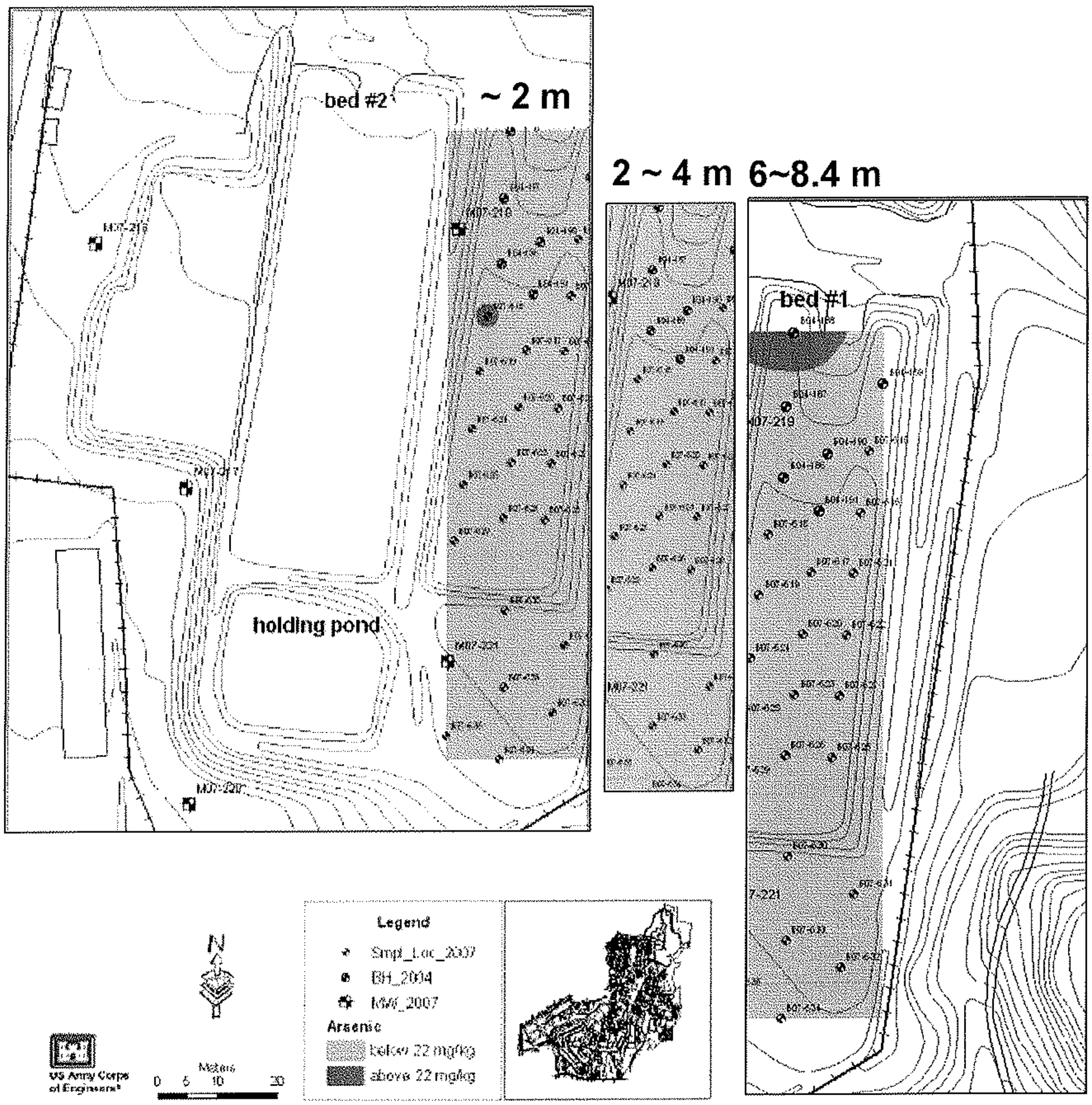

Figure 5. Chromium Distribution at the Land Farm Bed#1 of Camp Carroll.

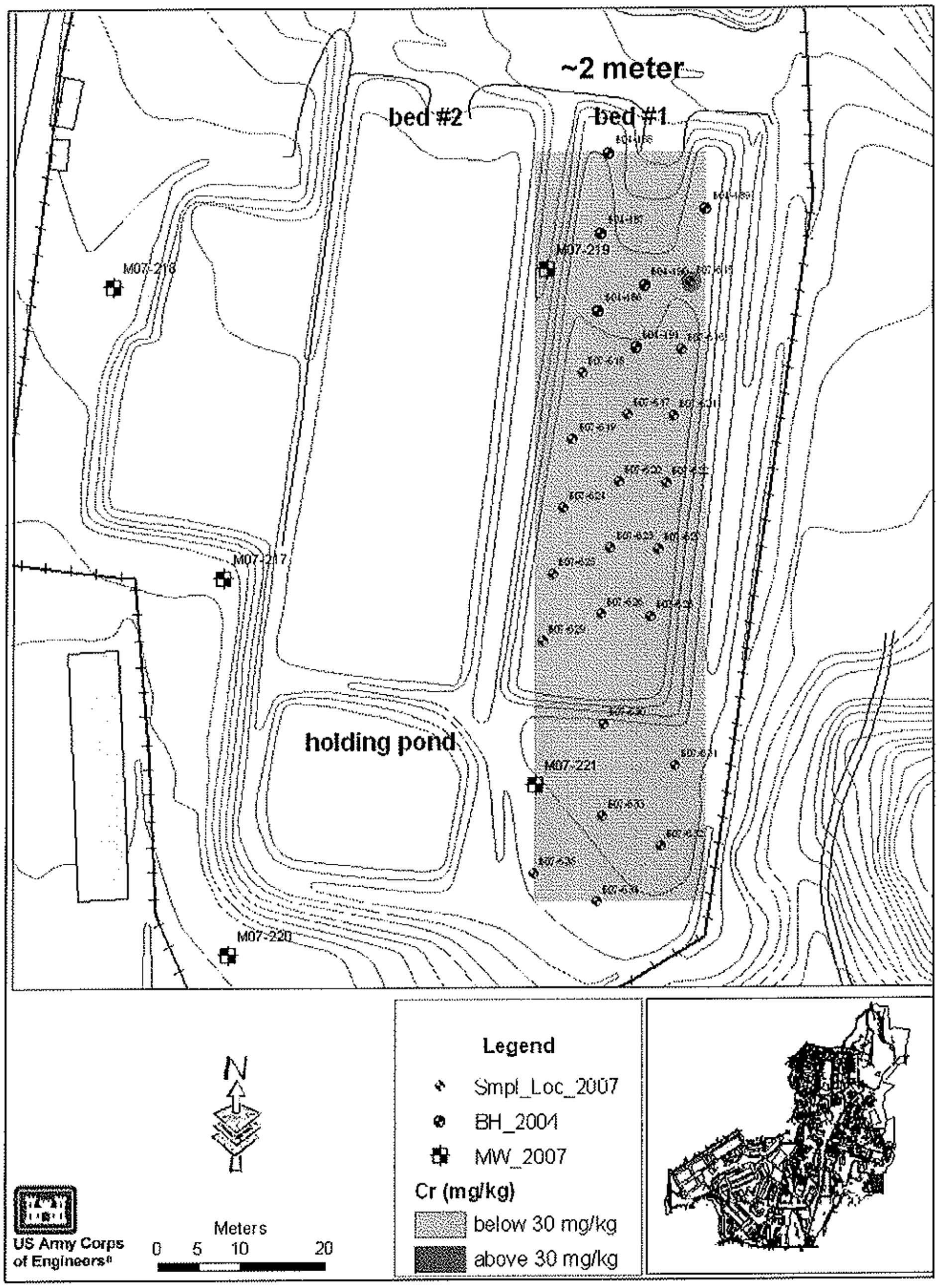

Figure 6. Tetrachloroehene (PCE) Distribution at the Land Farm Bed#1 of Camp Carroll.

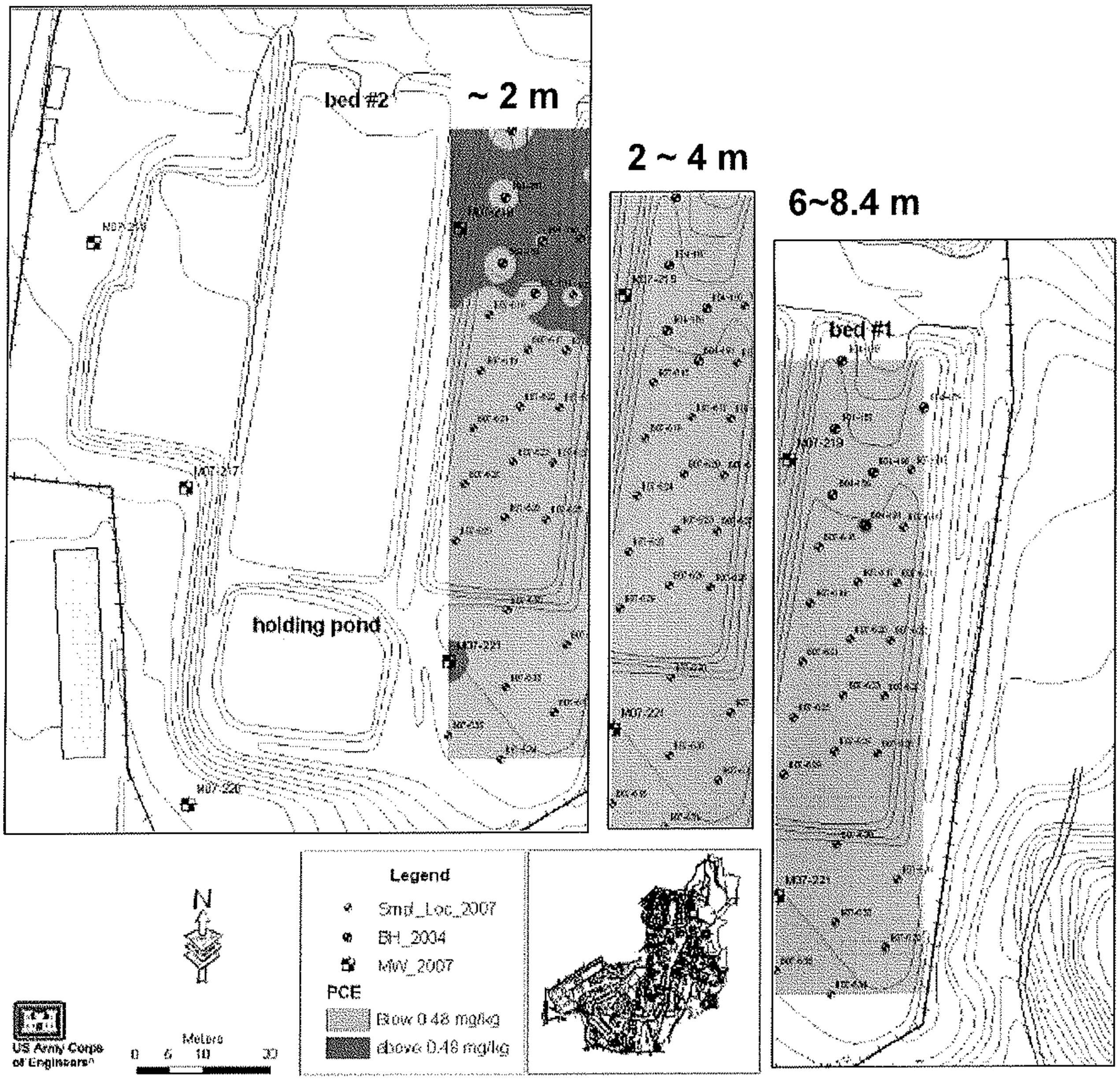

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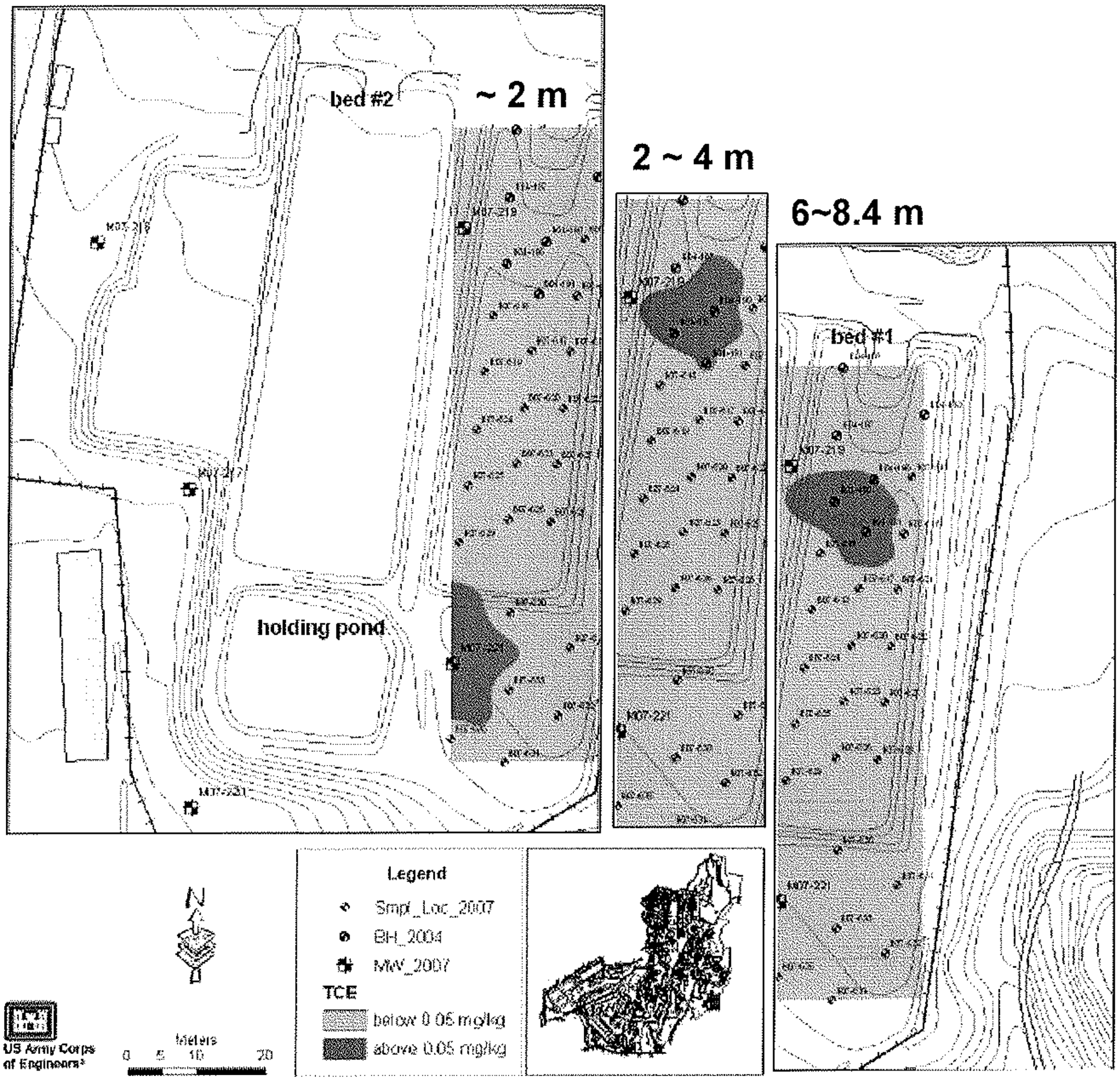
Figure 7. Trichloroethene (TCE) Distribution at the Land Farm Bed#1 of Camp Carroll.



5. CONTAMINATION STATUS OF THE CAMP CARROLL LAND FARM.

5.1. Summary of Chemical Test Results

Chemicals that exceeded the EPA PRG Region IX criteria for residential areas were identified from soil samples collected at the land farm bed #1 and around the holding pond during this ESA.

Among the target metals analyzed, the concentrations of arsenic and chromium were the only ones to exceed the EPA criteria. Chromium concentration above the EPA criteria appeared limited at the top soil layer. Arsenic concentration above the EPA criteria appeared close to the surface of the soil sample and again at 6 to 8.4 m bgs.

Among the VOCs analyzed, the concentrations of TCE, 1,2,4- Trichlorobenzene and PCE exceeded the EPA criteria. The VOCs exceeding the EPA criteria mostly appeared in the northern half of bed #1 and around the holding pond. Since the soil samples for VOCs were not retrieved from 2~4 m interval during October 2007, the vertical extension of VOCs contamination is not certain. However, having encountered a chemical odor and a chemically affected sample liner during soil sampling at B07-615, indicates the vertical extension could be deeper than 4 m bgs. Also the vertical extension of VOC contamination around the holding pond could possibly be deeper than the data presented here indicates, since a chemical odor was reported at 8 m bgs during the groundwater monitoring well construction project in 2007 (referred to Appendix 1).

Pesticides such as DDD, DDT, DDE, Endrin and gamma-chlorodane exceeding the EPA criteria were identified. Figure 8 presents the areas that exceed the EPA PRG criteria at the site.

5.2. Volume Estimation of Contaminated Soil

To estimate the volume of soil that exceeds the EPA PRG criteria, Figure 8 graphically provides a simplification based on the actual distribution diagrams. As indicated on the figure, the areas exceeding the EPA Region IX residential crieteria mostly appear at the northern half of the bed # 1 and around the M07-221. Therefore, the volume of soils that exceeds the EPA PRG criteria at bed #1 and around M07-221 is as below:

1) For the northern half of the bed #1:
   30 meter X 17 meter X 4 meter (deep) = 2,040 cubic meter

2) For the holding pond area:
   10 meter X 13 meter X 6 meter (deep) = 780 cubic meter

3) Total volume of soil that appear the EPA PRG criteria = **2,820 cubic meters**.

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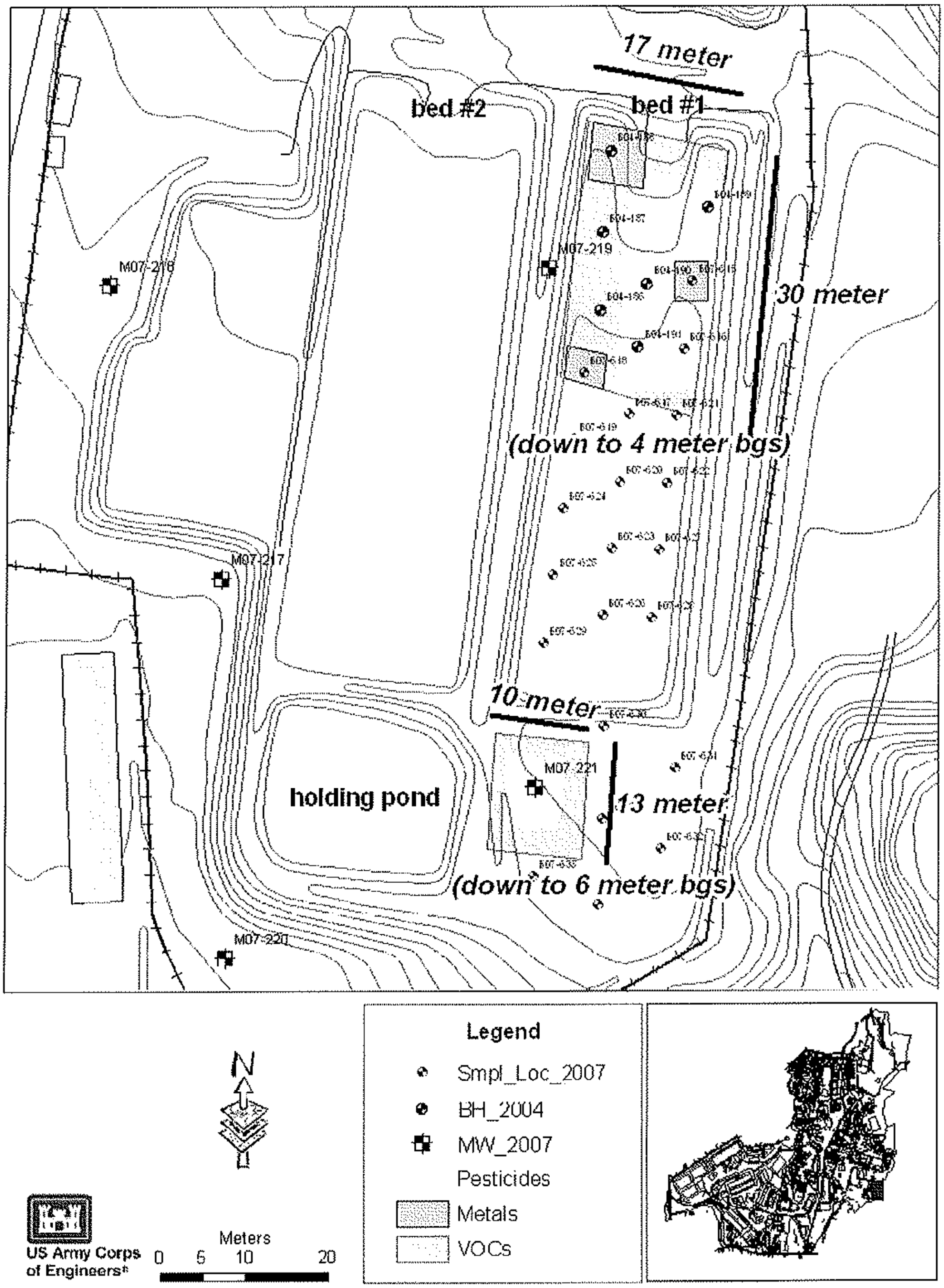
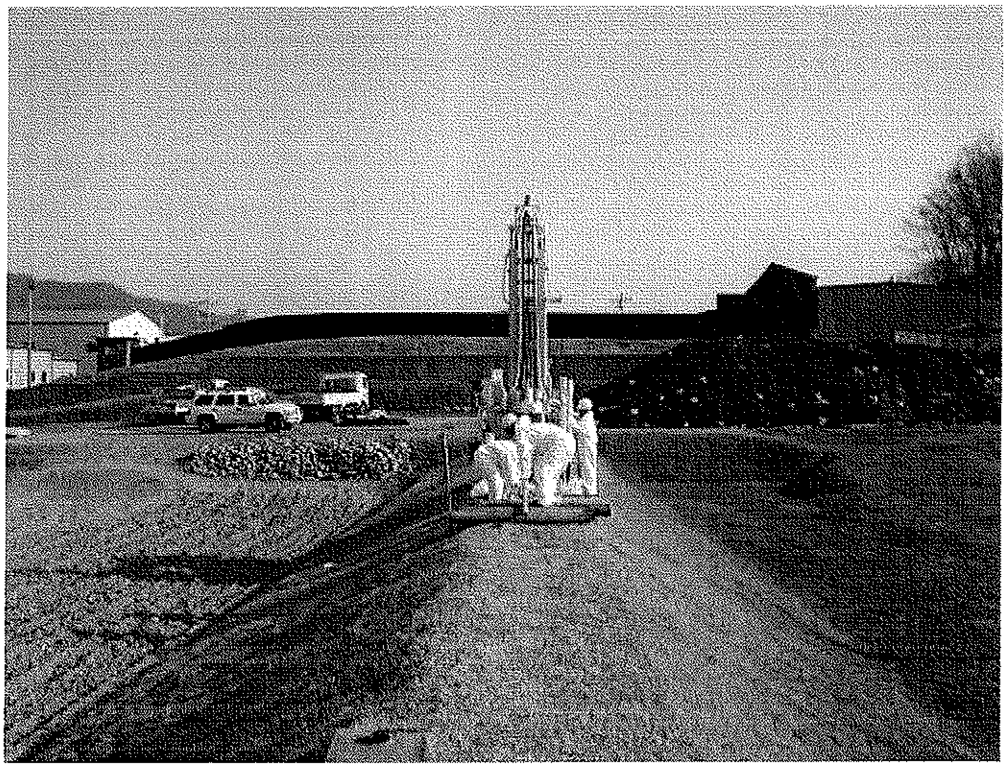
Figure 8. Summarized Presentation using in Volume Estimation of Contaminated Soil at the Land Farm Bed#1 of Camp Carroll.



Appendix 1. Report of Groundwater Monitoring Well Installation at Land Farm of Camp Carroll in 2007.

US Army Corps of Engineers
Far East District®

GROUNDWATER MONITORING WELL INSTALLATION AT LAND FARM AREA, CAMP CARROLL, KOREA (G&E 06-075E/E07-44)



AUGUST 2007

ENVIRONMENTAL SECTION

GEOTECHNICAL AND ENVIRONMENTAL ENGINEERING BRANCH

ENGINEERING DIVISION, FED

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Executive Summary
Groundwater Monitoring Well Installation at Land Farm Area, Camp Carroll, Korea G&E 06-075E/E07-44

1. PURPOSE.

The installation of five groundwater monitoring wells at Camp Carroll was initiated to determine if contaminated soils that are treated at the land farm facilities have released any chemicals of concern into the groundwater at the site that could pose a threat to human health. The scope of the project did not include the determination of any horizontal or vertical extent of the suspected contamination but only provides the information needed to evaluate if any contaminants have been released from the land farm into the groundwater. The monitoring wells were also used to determine groundwater gradients for the determination of flow directions and other hydrogeologic properties of the area.

2. SUMMARY OF FINDINGS.

The site subsurface geology consists of fairly permeable overburden soils of filled material consisting mainly of sand and gravel (clayey/silty sand, clayey sand and gravel fill material and some clayey sand) underlain by a weathered biotite granite bedrock. The thickness of the overburden soils at the site ranged between 8 and 11 meters. Wooden chips, pieces of metal and vinyl were identified from the samples at M07-221. Ground water at the site of concern occurs within the overburden soils and generally flows westward within the land farm facility.

Soil samples: Metal concentrations did not exceed U.S. Environmental Protection Agency (USEPA) Preliminary Remediation Goals (PRGs) for residential soil. Concentrations of six volatile organic compounds (VOCs) including Tetrachloroethene (PCE) and Trichloroethene (TCE) exceeded USEPA PRGs for residential soil. The detected VOCs were predominantly solvent-related chemicals. Concentrations of six organochlorinated (OC) pesticides exceeded residential USEPA PRGs. Mixed total petroleum hydrocarbons (TPH) of JP-8, diesel and oil were identified from one soil boring with the concentration of 10,000 mg/kg. Chemicals exceeding USEPA PRGs concentration were identified mostly from M07-221 which was drilled besides the water holding pond at the site of concern. As wood chips and pieces of metals were encountered while drilling M07-221, there could be a buried source for the chemicals.

Groundwater: Concentrations of five VOCs including PCE, TCE and cis-1,2-Dichloroethene (cis-1,2-DCE) exceeded the USEPA PRGs for tap water. Arsenic and lead in groundwater samples exceeded USEPA PRGs for tap water. Seven OC-pesticide concentrations exceed USEPA PRGs for tap water.

Solvent-related VOCs were detected in both soil and groundwater samples at levels that exceeded USEPA PRGs. Findings during this study indicate that VOCs, arsenic and pesticides contamination exist in site soil and groundwater and the levels could contribute to the contamination of the underlying groundwater. Site groundwater contamination could pose a threat to human health, because groundwater supply wells located down gradient are used for Camp Carroll's potable water supply. The extent of subsurface contamination has not been fully characterized at the land farm site. The findings of this assessment indicate more extensive subsurface contamination at the land farm than was originally anticipated.

3. RECOMMENDATIONS.

Since Camp Carroll utilizes the supply wells for portable water supply, current findings of site ground-water contamination at Land Farm area by PCE, TCE and heavy metals could pose a threat to human health. Following recommendations are made

1) Approximately 20 soil borings are recommended on the bed #1 to evaluate and delineate the chemicals of concern.

2) Six to eight soil borings are recommended at east of the water holding pond of the Land Farm to evaluate and delineate the source area for the chemicals of concern.

3) Based on groundwater analytical results of 2003 and 2007, it is recommended that wells with detected contamination be sampled and analyzed to identify any significant groundwater changes, especially for PCE, TCE, OC pesticides and metals.

4) It is highly recommended that the removal of the source(s) of the chemical contamination be conducted immediately, once the area has been delineated, to protect the groundwater from further release or migration of contamination.

5) Groundwater investigation for the area between the Land Farm and the six supply wells (Figure 1) at 500 m west of the Land Farm is highly recommended to identify the possible impact to the supply water by the chemicals of concern.

6) Provide this report to the appropriate medical authority to determine if the identified soil and groundwater contaminations pose a known imminent and substantial endangerment to human health (KISE).

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Groundwater Monitoring Well Installation At Land Farm Area, Camp Carroll, Korea G&E 06-075E/E07-44

1. GENERAL

1.1. Authority

On 11 Sep 2006 the United States (US) Army Support Activity, Area IV Directorate of Public Works (DPW) of US Forces Korea (USFK) requested (MIPR6MEN000001) the US Army Corps of Engineers, Far East District (FED) to install groundwater monitoring wells and collect soil/water samples for chemical analyses from the land farm area located at Camp Carroll.

1.2. Scope of Work (SOW)

This project included the installation of groundwater monitoring wells and collection of soil and groundwater samples from the land farm area located at Camp Carroll. The purpose of the groundwater monitoring wells was to determine if contaminated soils being treated at the land farm facilities have released any chemicals at the site of concern that could pose a threat to human health. The monitoring wells were also used to find groundwater gradients to determine flow directions and for hydrogeologic properties of the area. However, the complete determination of horizontal and vertical extent of ground-water contamination, if it existed at the site was beyond the scope of this project.

1.3. Project Organization, Information Gathering and Objectives

1.3.1. Field Work.

The U.S. Army Corps of Engineers Far East District (FED) personnel performed the subject project under the supervision of Dr. [redacted] which included field work and writing this Report. However, drilling and installing of some monitoring wells was conducted by Beautiful Environment Construction Company (BEC) in places where the FED's drill rig did not have access. The field work consists of soil boring, soil sample collection, monitoring well installation and groundwater sampling.

1.3.2. Laboratory Analysis.

In addition to the Environmental Testing Laboratory (ETL) of the FED, STL Environmental Services, Inc., from Seattle performed laboratory analyses. The FED's ETL analyzed total petroleum hydrocarbons (TPH) and the STL laboratory analyzed volatile organic compounds (VOCs), pesticides and metals.

1.4. Project Tasks

1.4.1. Site Visit.

On 17 October 2007, Dr. [redacted] from the FED G&E Environmental Section conducted a site visit and had a meeting with Mr. [redacted] of Camp Carroll's Department of Public Works (DPW). During the ~~site visit the SOW~~ was discussed, as well as available information relevant to the site was gathered and a visual inspection of the site was conducted. The site visit evaluated potential sources of contamination, preferred pathways for its migration and appropriateness of locating soil borings and monitoring wells. Five monitoring well locations were determined during this visit in agreement with the Camp Carroll DPW personnel.

1.4.2. Records Search.

A records search was conducted to obtain the sites facility and utility maps from the data present at the FED and the DPW. Historic documents were reviewed to gather background information identify past and current site use. Geotechnical borehole and environmental logs were also reviewed for subsurface geological and hydrogeological information.

1.4.3 Field Work, Sample Collection and Sample Analyses.

Soil boring and monitoring wells were drilled to collect soil samples, which were analyzed for chemicals of concern to address known or presumed uses of the subject site using U.S. Environmental Protection Agency (USEPA) analytical methodology. FED surveyed each borehole using a SOKKIA Set 2C Total Station survey instrument. The survey includes the coordinates, ground surface and top of well riser elevations at each monitoring well location. Groundwater samples were collected for chemical analyses after all the wells had been fully developed.

1.4.4. Report of Findings.

Finally, this report was completed focusing on the findings of the field work and laboratory analyses performed for collected soil and groundwater samples. It provides a discussion of the presence or absence of contamination by chemicals of concern in subsurface soil and groundwater samples at the site of concern. The report also discusses the possible contaminant migration direction.

2. BACKGROUND INFORMATION

2.1. Location of Camp Carroll

Camp Carroll is an U.S. Army Installation located adjacent to the city of Waegwan, Republic of Korea (Figure 1). It is surrounded by urban areas on the northwest, west and southwest. Hilly, forested areas bound the base on the north and east. Agricultural fields (mostly rice paddies) border the camp on the northeast and the south and the Naktong River flows north-south approximately 0.5 kilometers west of Camp Carroll.

2.2. Land Farm Description and Historical Information

The land farm at Camp Carroll is located south of the Small Arms Firing Range and along the lower half of the eastern boundary of the Camp (Figure 2). The land farm consists of three engineered units. Two of the units are treatment beds, referred to as Bed #1 (East Bed) and Bed #2 (West Bed) and the third is a water retention pond (Figure 2). The dimensions of each treatment bed, which are bounded by berms, are approximately 70 meters by 30 meters. The dimensions of the water retention pond are approximately 30 meters by 20 meters. The total land farm site is approximately 9,100 square meters.

DPW environmental personnel of Camp Carroll suspect that contaminated soil and material from Area #41 (see the figure 1) were disposed of in the area now occupied by the land farm. The suspicions are based on the fact that contaminated soil and waste materials, such as 1-gallon cans were uncovered during excavation and construction of Bed #1 in 1995. The land farm is also located very close to Area D which is identified as a landfill where hazardous waste from Area #41 was disposed of between the years of 1977 and 1982, but reportedly removed between 1982 and 1983. In 1992, monitoring well MW-23 was constructed approximately 140 meters west of the land farm facility. No volatile organic compounds (VOCs), semi volatile organic compounds (SVOCs) or organophosphorus pesticides were detected in the ground-water sample collected from the monitoring well in 1992.

FED conducted an Environmental Assessment (EA) for 4 sites at Camp Carroll including the land farm area in 2004. The EA identified solvent-related VOCs, a few pesticides, metal, and dioxin/furan compounds from the subsurface soils of the land farm.

2.3. Generalized Subsurface Geology and Hydrogeologic Conditions of Camp Carroll

Eighteen borings were drilled during the 1992 baseline ground-water investigation at Camp Carroll. The depths of these borings ranged from 1.5 to 26 meters deep. Granitic rock was the type of bedrock encountered in all the borings. The bedrock was covered by less than 1 meter to as much as 10 meters of fill and colluviums throughout the camp where boring were drilled. Borings located on the valley floors within the camp typically had the greatest thickness of overburden, while borings located on ridges or hills had relatively thin overburden. A noticeable exception was encountered at the Bachelor's Enlisted Quarters (BEQ) Hill site where excavation fill provides a thick overburden immediately adjacent to a hilltop where bedrock is exposed or covered by a thin layer of unconsolidated soils. Silty sand with gravel and cobbles are commonly encountered within the first few meters of ground surface, below which the material grades into silty sand and residual soil. The overall groundwater flow direction at the camp is to the south and southwest. Groundwater occurs within the overburden in some areas of the camp; however, much of it occurs within the highly weathered bedrock and fractures within the competent bedrock.

Figure 1. Geographic Location and Background Information at Camp Carroll.

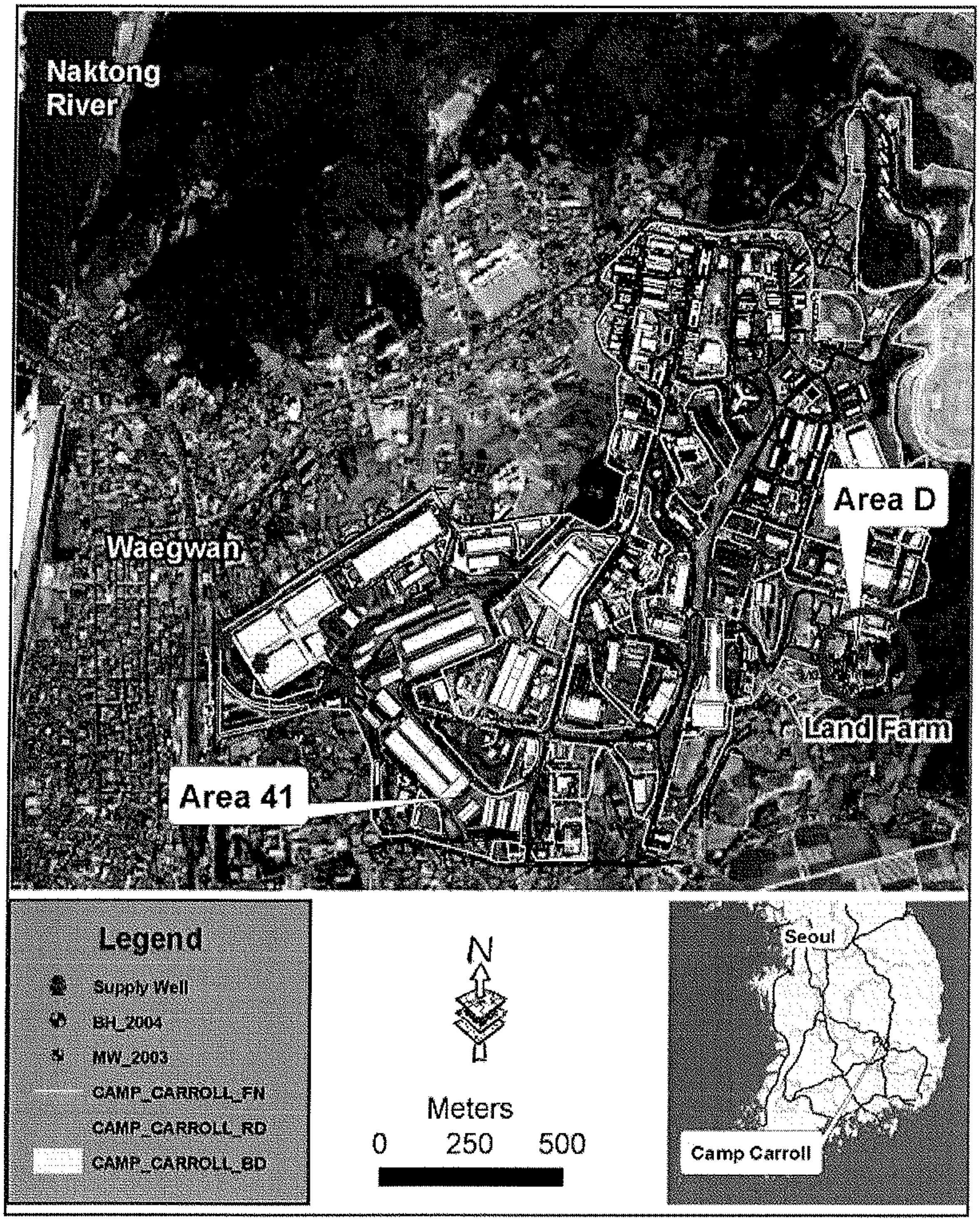
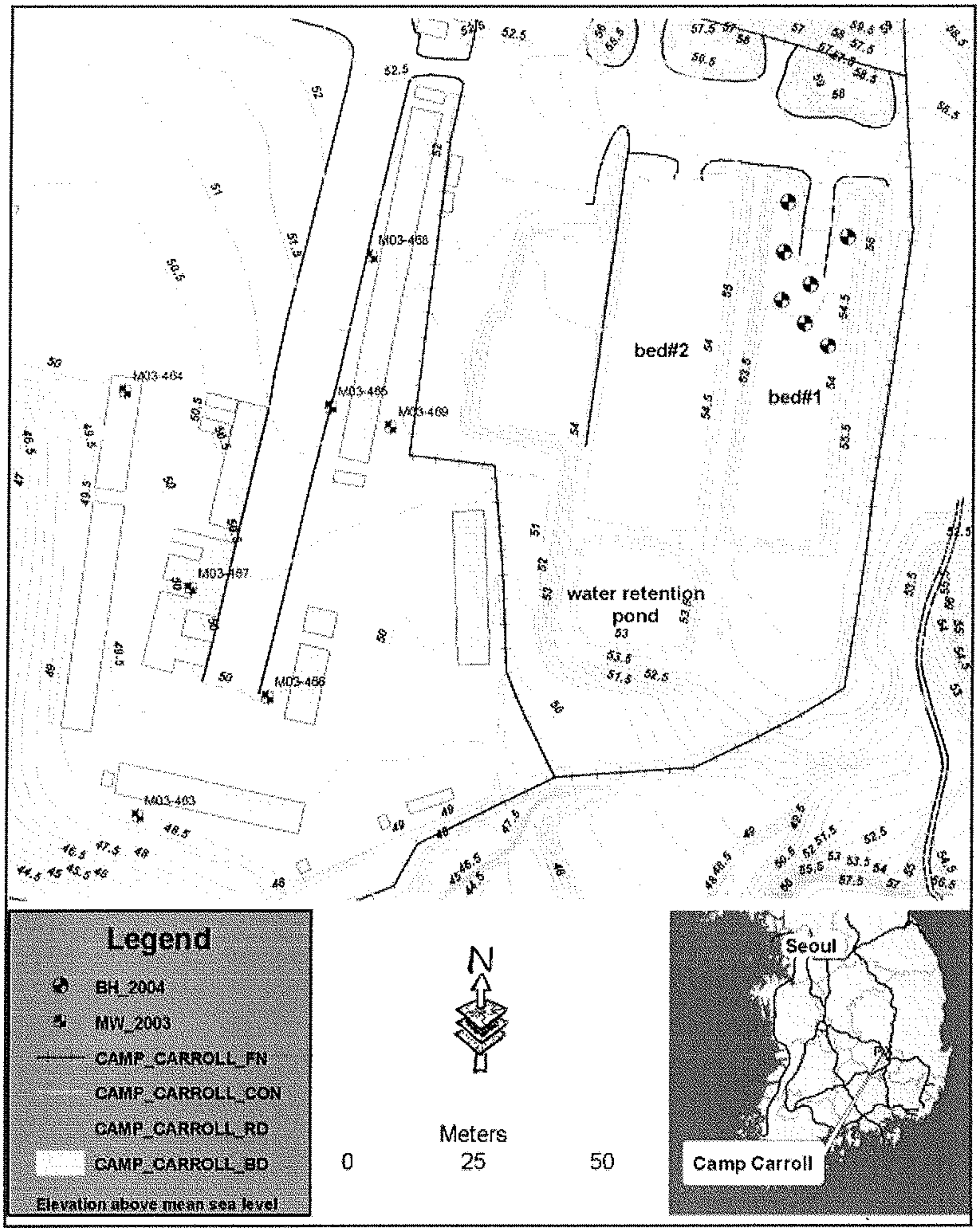


Figure 2. The Existing Monitoring Well Locations Installed in 2003 around the Land Farm Facility of Camp Carroll.



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2.4. Borehole Location Rational and Drilling Method.

2.4.1. Borehole Location Rationale.

Borehole locations were based on data developed during the scoping visit for the project. The basic rationale for each borehole location was to place them based on known information, spatial coverage, and suspected contaminant migration direction. Two boreholes were drilled on a topographically higher elevation and the other three were placed on the lower side to detect something migrating from higher side. The one borehole on the higher side is located on the boundary berm of the two beds, and the other is located on the east of the water retention pond. All the boreholes were subsequently converted to groundwater monitoring wells after soil samples were collected. The location of these boreholes (monitoring wells) is presented in Figure 3.

2.4.2. Borehole Drilling.

Two boreholes were drilled using a CME75 power auger drill rig capable of advancing 1.5-m flights of hollow-stem auger (16.8 cm outer diameter and 8.3 cm inside diameter). Three boreholes were drilled using a 6000 series GeoProbe owned by the BEC contractor capable of advancing 1 m rods (7.5-cm outer diameter). Boreholes were drilled to the depth at which weathered bedrock or groundwater was encountered. The soil borehole logs are presented in the Appendix I.

2.5. Subsurface Soil Sampling.

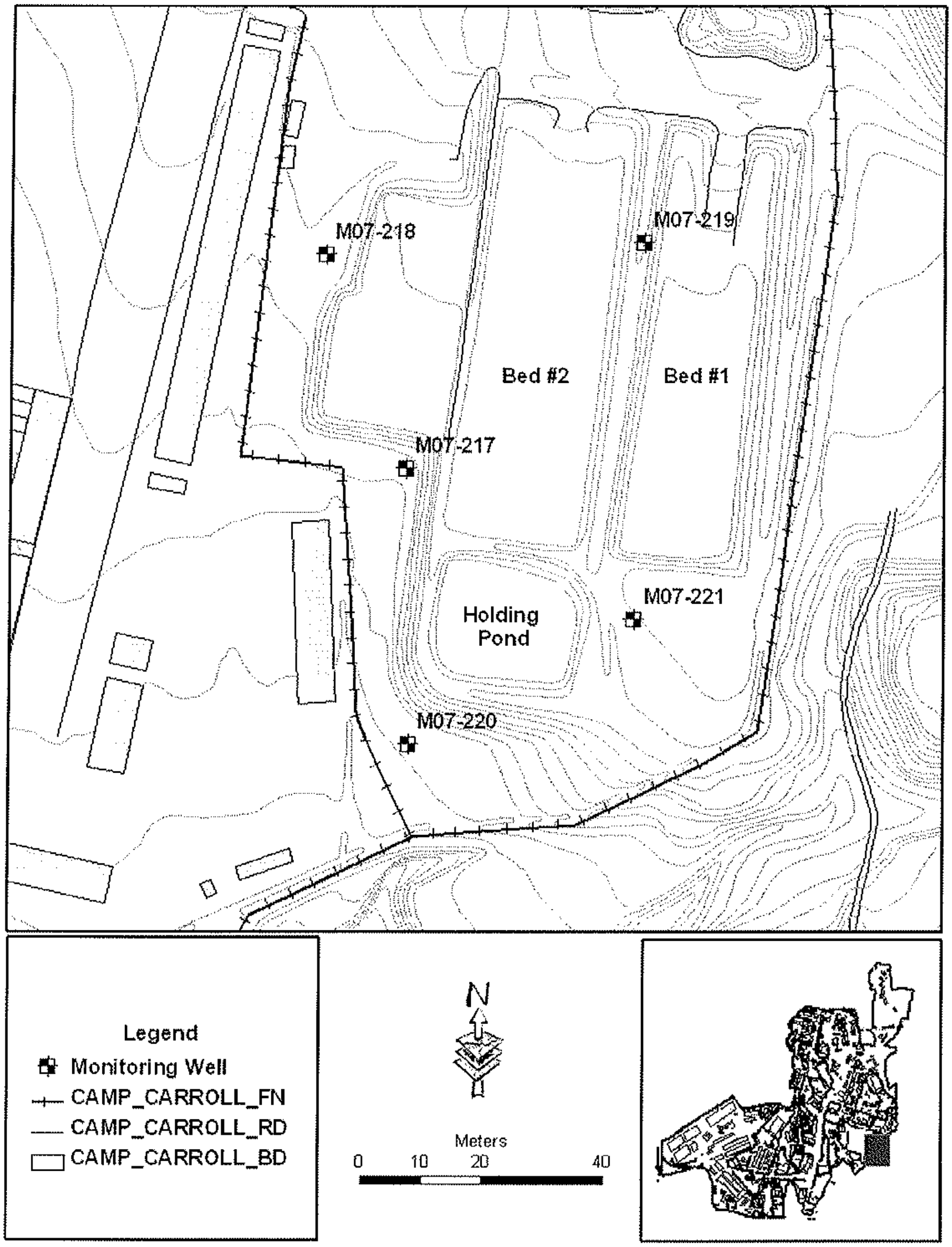
2.5.1. Sample Collection by CME75.

A split spoon sampler (5 cm diameter and 70 cm length for CEM75) was used to collect soil samples. The soil sampler was hammered through the center of the auger to the bottom of each sample interval and then retrieved back to the surface. Continuous samples were collected from surface to weathered bedrock or final collection depth for chemical analysis and description of the subsurface material such as soil type, color, moisture content, staining, odor, fill material etc. The auger was continuously advanced to the top of each soil sample collection interval.

2.5.2. Sample Collection by GeoProbe.

Subsurface soil samples were also collected with a track-mounted soil-probing machine at the places where the CME75 did not have access. The soil probing machine minimized cuttings and created a smaller diameter borehole that was easily grouted/filled after all subsurface soil samples were collected. Using the soil-probing machine, continuous soil cores were collected from the surface to the target depth. Subsurface soil sample cores were collected by advancing an open barrel sampler with a plastic sample liner (3.7 cm inner diameter) through the sample interval equivalent to the barrel length or less (normally about 0.9 m). After the barrel sampler was pushed through the desired depth interval, the sampler was extracted from the hole and the plastic liner, containing the soil sample, was removed from the barrel sampler. The discrete soil sample required for chemical analyses (e.g., VOCs, Metals and TPH) was collected from the desired depth by retrieving it from the appropriate interval of the removed plastic liner.

Figure 3. Monitoring Well Location at Land Farm of Camp Carroll.



2.5.3. Sampling Interval.

Sampling interval was determined based on the previous investigation results in 2004. Each soil sample was a composite of soil from each horizon, with exceptions of VOCs samples that were not composite soil. VOC samples were collected from 0.6-meter to 1.2-meter or from 1-meter to 2-meter interval at each borehole (0-meter to 0.6-meter interval was considered as a surface soil in this study). Sample collection intervals and analysis parameters are presented in Table 1.

Table 1. Analysis Parameters and Soil Sample Information Collected from Land Farm of Camp Carroll.

Borehole ID	Sample ID	Depth interval, meter (bgs)	VOCs[1] (8260B)	Metals (6020/7471)	OC[2] pesticides (8141A)	OP[3] pesticides (8081A)	Remarks
M07-217	S2	0.6-1.2	X				MS/MSD
	S5	1.8-3.0		X	X	X	
	S10	5.4-6.6		X	X	X	
M07-218	S2	0.6-1.2	X				
	S4	1.8-3.0		X	X	X	Duplicate of S5
	S5	1.8-3.0		X	X	X	Duplicate of S4
	S10	5.4-6.6		X	X	X	
M07-219	S2	1-2	X				
	S3	2-3		X	X	X	
	S6	5-6		X	X	X	
M07-220	S2	1-2	X				
	S3	2-3		X	X	X	
	S6	5-6		X	X	X	
M07-221	S2	1-2	X				
	S3	2-3		X	X	X	
	S4	3-4	X				
	S6	5-6		X	X	X	

1-Volatile organic compounds, 2-Organochlorine, and 3-Organophosphorous

2.6. Groundwater Monitoring Wells

2.6.1. Monitoring Well Construction.

The five boreholes were converted into groundwater monitoring wells after completion of soil sample collection. The monitoring wells were constructed to evaluate the groundwater system within overburden soil formation in the area of concern such as groundwater gradient, flow direction, and an indication of any impact to groundwater system by chemicals of concern.

Monitoring wells were installed in boreholes drilled using the CME75 and the BEC Model 6600 Modified Direct Push & Air Percussion track-mounted drill rig. A 12-cm diameter air percussion hammer was used to drill the hole as slightly larger diameter (14-cm) temporary steel casing was pushed and hammered into the subsurface to hold back the overburden. After the hammer had reached the target depth, it was removed from the hole. The monitoring well casing material was then placed inside the temporary steel casing. The steel casing was gradually removed from the hole as the annulus was filled with filter pack, bentonite, and grout. The monitoring wells were between 9.5 and 12 meters deep.

Ground-water monitoring well construction materials included 5.04-cm inside diameter (ID) threaded Schedule 40 polyvinyl chloride (PVC) solid pipe and slotted screen. Solid 5.04-cm ID schedule 40 PVC pipe with threaded ends was used from approximately 10-cm below ground surface (bgs) to a depth of approximately 3-meter above the level when ground-water encountered first during soil boring. A 0.254-mm slotted PVC well screen was threaded onto the bottom of the solid well-pipe to the base of the borehole. A PVC well point was screwed to the bottom of the well screen and a well cap was secured to the top of the well pipe. The annular space around the well from the bottom of the borehole to a minimum of 50-cm above the top of slotted section was filled with clean silica sand (0.4-1.2 mm). A 30-cm thick of seal of bentonite pellets was placed above the sand pack, and the bentonite pellets were hydrated either by water inside the borehole from cascading perched water or using a known clean water source. The remainder of the hole was filled with a Portland Type I cement grout to just below the frost line. Once the grout cured, concrete was used to fill the rest of the annulus around the well pipe. The wells were then completed with a flush-mounted and concrete pad. Appendix II presents the monitoring well construction logs.

2.6.2. Monitoring Well Development.

After installation, all wells were fully developed. The objectives of well development were to: (1) remove sediment that had settled inside the well during construction; (2) remove all water that may have been introduced during drilling and well installation; (3) remove very fine grained sediment in the filter pack and nearby formation so that groundwater samples would not be turbid and silting of the well does not occur; and (4) to improve the flow into the well from the adjacent formation, thus yielding a representative groundwater sample and an accurate water level measurement.

Well development consisted of surging by a surge block and bailing out using a stainless bailer until a noticeable reduction in sediment occurred in the discharged water. This development continued for a minimum of five well volumes of pumped water and continued until the water was visually clear or the site geologist determined that no further development is practical. Well development log is presented in Appendix III.

2.6.3. Groundwater Sampling.

Prior to sampling, wells were checked for the presence of any floating product with an electronic oil/water level indicator probe. Purging and sampling activities were conducted at least two weeks after each monitoring well had been installed and developed to allow for groundwater stabilization.

Disposable bailers were used for purging and sampling from the monitoring wells. Water samples were collected into laboratory-grade, specially cleaned sample containers, and then placed immediately into a cooler with ice for preservation. Groundwater samples were analyzed for VOCs, pesticides and metals. All samples were transported to the laboratory accompanied by chain-of-custody.

2.6.4. Water Level Measurement.

Water levels in the monitoring wells were measured with an electronic oil-water interface probe. The depth to water was conducted using a surveyed reference point located at the top of PVC well pipe.

2.7. Equipment Decontamination Procedures.

All non-dedicated sampling equipment was decontaminated prior to use and between sample collections. Decontamination consisted of first scraping away any loose soil, followed by washing in a bucket of warm detergent (e.g., Alconox) solution and a second bucket of clean water rinse. Potable water was used for the detergent wash and clean water rinse. The equipment was then allowed to air dry or was dried with clean white paper towel. When equipment was too bulky to be cleaned by hand in buckets, a power washer was used to clean the equipment between sample locations.

2.8. Survey of Site, Boreholes and Monitoring Wells.

FED personnel performed a site survey using a SOKKIA Set 2C Total Station survey instrument. The survey included the determination of ground surface elevation at each borehole location and the top of well PVC casing for each monitoring well. All elevation measurements are in meters above mean sea level, and WGS 84 UTM Zone 52N grid system is used for longitude and latitude systems. The accuracy of survey elevation for top of the casing measurements was to the nearest mm. Ground surface elevations were determined to the nearest +/- 0.001 meters.

2.9. Samples and Analytical Methods.

A total of 39 normal, 1 duplicate, 1 field blank, and MS/MSD soil samples were submitted to the STL contract laboratory in Seattle. Six ground water samples including one duplicate and one trip blank were also submitted to the laboratory for chemical analyses. STL performed the analytical work for metals, VOCs and pesticides in soil and groundwater samples. STL performed the following analyses: target metals (SW 6020 and SW7471), organochlorinated (OC)-pesticides (SW8081A), organophosphorus (OP)-pesticides (SW8041) and VOCs (SW 8260B). Table 1 summarizes the sample information. Reported chemical test results included data below the method reporting limit, but above the detection limit. These data results are qualified as estimated concentrations. Appendix IV presents the chemical test results from STL.

FED's Environmental Testing Laboratory (ETL) performed total petroleum hydrocarbon (TPH) analyses for six soil samples. Appendix V presents the chemical test result for TPH by FED's ESL. Appendix VI presents data quality discussion.

2.10. Comparison Criteria for Soil Data

In the following discussions and data analysis, reported sample chemical concentrations are compared with the U.S. Environmental Protection Agency (USEPA) Preliminary Remediation Goals (PRGs) for residential soil and tap water for Superfund Sites. Important details related with the PRGs are documented by the EPA at their web site: http://USEPA-prgs.ornl.gov/. The PRG's role in site screening is to help identify areas, contaminants, and conditions that require further attention at a particular site. Chemical concentrations above the PRGs would not automatically designate a site as "dirty" or trigger a response action; however, exceeding a PRGs suggests that further evaluation of the potential risks by site contaminants is appropriate. PRGs are also useful tools for identifying initial cleanup goals at a site. In this role, PRGs provide long-term targets to use during the analysis of different remedial alternatives.

3. FINDINGS AND DISCUSSIONS

3.1. Subsurface Soil Samples

3.1.1. Subsurface Geology.

A total of five boreholes were drilled to a depth of approximately 12 meters bgs at the land farm. Highly weathered biotite granite was encountered at about 8 meters bgs within the sampled area during this assessment. Approximately 4 to 6.5 meter thick layer of residual soil consisting of fat clay and clayey/silty sand covers the bedrock. Fill materials of clayey/silty sand and clayey sand with gravel were encountered in boreholes with thicknesses ranging from 3 to 6 meters. Depths to groundwater ranged from 2.96 to 9.6 meters in drilled boreholes with the deepest level measured in the monitoring well M07-218. Fat clays were encountered in three of five boreholes ranging in depth from 5.5 to 8 meters bgs. No fat clay was encountered in boreholes M07-217 and M07-218. A strange chemical odor was detected in return cuttings from boreholes M07-221 between 1 and 9 meters bgs. Pieces of metal, wood and vinyl were recovered from depths between 1 to 3 meters deep while drilling soil boring at M07-221 (Figure 4).

Figure 4. Materials Brought from Subsurface (1~3 m) at M07-221 During Soil Boring.

3.1.2. Volatile Organic Compounds.

VOCs were detected in soils collected from four out of five boreholes. Table 2 summarizes the test result for VOCs in soil samples. Soil samples collected from M07-220 do not contain any VOCs in the analytical list. Toluene was identified from four boreholes except M07-220. Trichloroethene (TCE), Tetrachloroethene (PCE) and naphthalene are reported in two samples from M07-219 and M07-221. Styrene was only identified in the sample from M07-219. Soil sample from M07-221 contains 15 different VOCs. The concentrations of VOCs were the highest in the vicinity of borehole M07-221. The concentrations of TCE, PCE, 1,1,2,2-Tetrachloroethane, 1,3,5-Trimethylbenzene, 1,2,4- Trimethylbenzene and 4-Isopropyltoluene reported from M07-221 exceeded their USEPA PRGs for residential soil. The concentrations of VOCs exceeding the USEPA PRGs in the soil samples of land farm are:

PCE	45,000 ug/kg at M07-221;
TCE	570,000 ug/kg at M07-221;
1,1,2,2-Tetrachloroethane	3,200 ug/kg at M07-221;
1,3,5-Trimethylbenzene	36,000 ug/kg at M07-221;
1,2,4-Trimethylbenzene	96,000 ug/kg at M07-221;
4-Isopropyltoluene	8,800 ug/kg at M07-221;

Figure 5 shows the distribution of PCE in soil. The highest concentration of PCE appeared at M07-221 located close to the water holding pond.

Table 2. Chemical Test results for VOCs in Soil Samples From Land Farm of Camp Carroll.

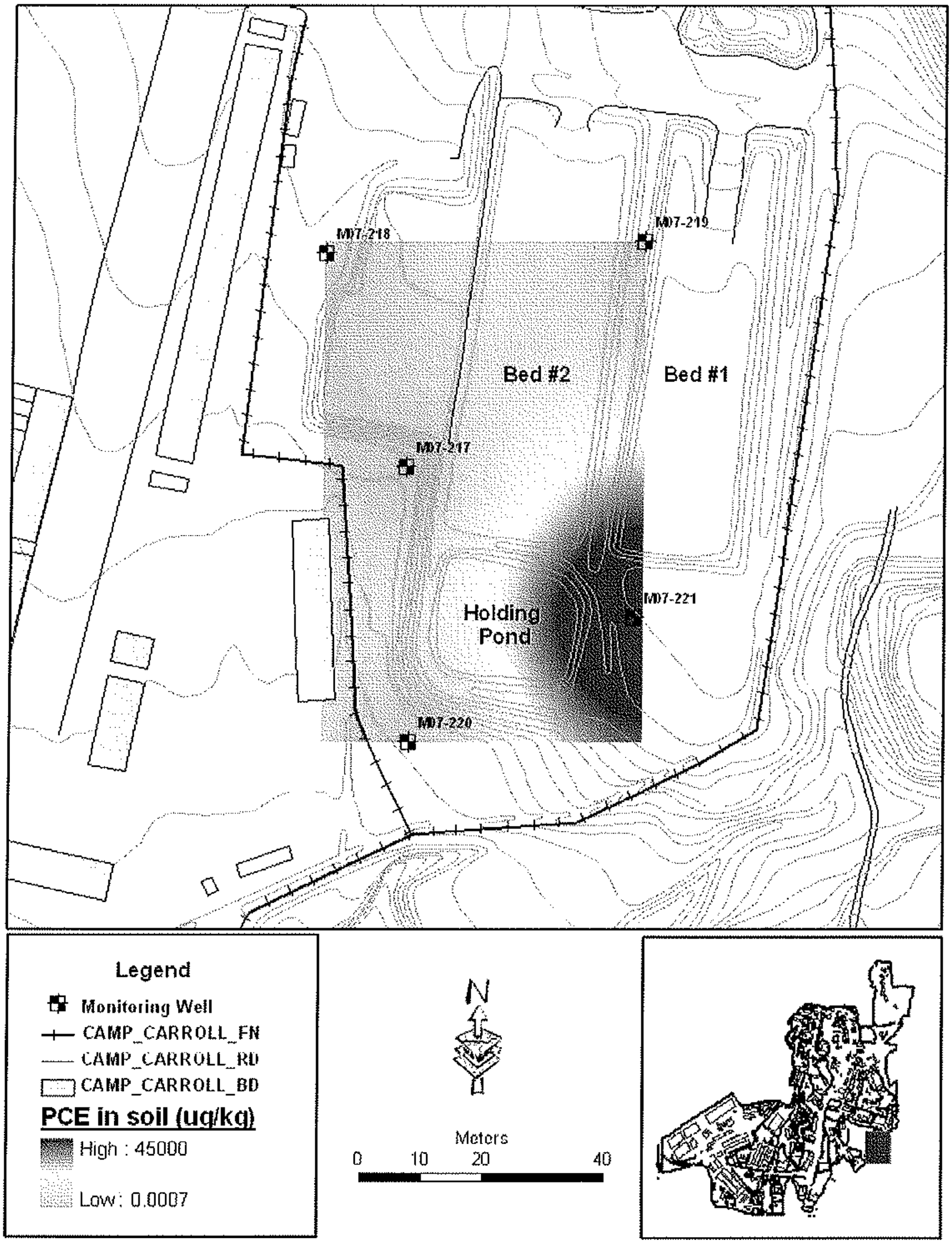
Analyte	Unit	M07-217 S2	M07-218 S2	M07-219 S2	M07-220 S2	M07-221 S2	Screen Level*	SRL**
		0.6-1.2 m	0.6-1.2 m	1-2 m	1-2 m	1-2 m		
Dichlorodifluoromethane	ug/kg	-	-	-	-	-		77
Chloromethane	ug/kg	-	-	-	-	-		77
Vinyl chloride	ug/kg	-	-	-	-	-		31
Bromomethane	ug/kg	-	-	-	-	-		390
Chloroethane	ug/kg	-	-	-	-	-		390
Trichlorofluoromethane	ug/kg	-	-	-	-	-		77
1,1-Dichloroethene	ug/kg	-	-	-	-	-		31
Carbon disulfide	ug/kg	-	-	-	-	-		77
Acetone	ug/kg	-	-	-	-	-		390
Methylene Chloride	ug/kg	-	-	-	-	-		77
trans-1,2-Dichloroethene	ug/kg	-	-	-	-	-		77
1,1-Dichloroethane	ug/kg	-	-	-	-	-		77
2,2-Dichloropropane	ug/kg	-	-	-	-	-		77
2-Butanone	ug/kg	-	-	-	-	-		390
cis-1,2-Dichloroethene	ug/kg	-	-	-	-	33,000	43,000	77
Chlorobromomethane	ug/kg	-	-	-	-	-		77
Chloroform	ug/kg	-	-	-	-	-		77
1,1,1-Trichloroethane	ug/kg	-	-	-	-	-		31
Carbon tetrachloride	ug/kg	-	-	-	-	-		31
1,1-Dichloropropene	ug/kg	-	-	-	-	-		77

Table 2. Continued (VOCs in Soil)

Analyte	Unit	M07-217 S2	M07-218 S2	M07-219 S2	M07-220 S2	M07-221 S2	Screen Level*	SRL**
		0.6-1.2 m	0.6-1.2 m	1-2 m	1-2 m	1-2 m		
Benzene	ug/kg	-	-	-	-	-		15
1,2-Dichloroethane	ug/kg	-	-	-	-	-		77
Trichloroethene	ug/kg	-	-	69	-	**570,000**	530	31
1,2-Dichloropropane	ug/kg	-	-	-	-	-		15
Dibromomethane	ug/kg	-	-	-	-	-		77
Dichlorobromomethane	ug/kg	-	-	-	-	-		77
cis-1,3-Dichloropropene	ug/kg	-	-	-	-	-		77
4-Methyl-2-pentanone	ug/kg	-	-	-	-	-		390
Toluene	ug/kg	26	26	690	-	1,900	521,000	77
trans-1,3-Dichloropropene	ug/kg	-	-	-	-	-		77
1,1,2-Trichloroethane	ug/kg	-	-	-	-	-		77
Tetrachloroethene	ug/kg	-	-	27	-	**45,000**	484	48
1,3-Dichloropropane	ug/kg	-	-	-	-	-		31
2-Hexanone	ug/kg	-	-	-	-	-		390
Chlorodibromomethane	ug/kg	-	-	-	-	-		77
Ethylene Dibromide	ug/kg	-	-	-	-	-		77
Chlorobenzene	ug/kg	-	-	-	-	-		77
Ethylbenzene	ug/kg	-	-	-	-	2,600	1,864,000	77
1,1,1,2-Tetrachloroethane	ug/kg	-	-	-	-	-		77
m-Xylene & p-Xylene	ug/kg	-	-	-	-	12,000	270,000	77
o-Xylene	ug/kg	-	-	-	-	9,000	270,000	77
Styrene	ug/kg	-	-	27	-	-	1,700,000	77
Bromoform	ug/kg	-	-	-	-	-		77
Isopropylbenzene	ug/kg	-	-	-	-	3,400	572,000	77
Bromobenzene	ug/kg	-	-	-	-	-		77
N-Propylbenzene	ug/kg	-	-	-	-	9,500	240,000	77
1,1,2,2-Tetrachloroethane	ug/kg	-	-	-	-	**3,200**	408	15
1,2,3-Trichloropropane	ug/kg	-	-	-	-	-		77
2-Chlorotoluene	ug/kg	-	-	-	-	-		77
1,3,5-Trimethylbenzene	ug/kg	-	-	-	-	**36,000**	21,200	77
4-Chlorotoluene	ug/kg	-	-	-	-	-		77
tert-Butylbenzene	ug/kg	-	-	-	-	-		77
1,2,4-Trimethylbenzene	ug/kg	-	-	-	-	96,000		77
sec-Butylbenzene	ug/kg	-	-	-	-	6,100	220,000	77
1,3-Dichlorobenzene	ug/kg	-	-	-	-	-		77
4-Isopropyltoluene	ug/kg	-	-	-	-	8,800		77
1,4-Dichlorobenzene	ug/kg	-	-	-	-	-		77
n-Butylbenzene	ug/kg	-	-	-	-	-		77
1,2-Dichlorobenzene	ug/kg	-	-	-	-	-		77
1,2-Dibromo-3-Chloropropane	ug/kg	-	-	-	-	-		77
1,2,4-Trichlorobenzene	ug/kg	-	-	-	-	-		77
1,2,3-Trichlorobenzene	ug/kg	-	-	-	-	-		77
Hexachlorobutadiene	ug/kg	-	-	-	-	-		77
Naphthalene	ug/kg	-	-	310	-	17,000	55,916	77

*-For Residential area by EPA Region 9 Preliminary Remediation Goals (PRG) for Superfund Site, 2004
** SRL- sample reporting limit, '-' indicates Non-Detected above SRL

Figure 5. Distribution of PCE in Soils of Land Farm at Camp Carroll



3.1.3. Target Metals.

Target metals were detected in all soil samples collected from the boreholes drilled at the land farm (Table 3). Mercury was detected in two soil samples from M07-217 and M07-221. Soil samples did not exceed the metal concentrations of the USEPA PRGs. The concentration ranges of the target metals are:

Arsenic	1.8~13 mg/kg;
Cadmium	0.12~0.36 mg/kg;
Chromium	3.1~12 mg/kg;
Cobalt	1.5~8.6 mg/kg;
Copper	2.4~8.0 mg/kg;
Lead	7.6~42 mg/kg;
Nickel	2.0~4.6 mg/kg;
Zinc	11~56 mg/kg;
Mercury	0.023~0.028 mg/kg;

Arsenic concentration in soil samples is presented in Figure 6. The concentration is generally higher towards the west while lead concentration appeared to be higher in the eastern side of the area of concern around M07-221 (Figure 7).

Table 3. Chemical Test results for Metals in Soil from Land Farm of Camp Carroll.

Analyte	Unit	M07-217		M07-218			M07-219		M07-220		M07-221		Screen Level*	SRL**
		S5	S10	S4	S5	S10	S3	S6	S3	S6	S3	S6		
		1.8-3.0m	5.4-6.6 m	1.8-3.0m	1.8-3.0m	5.4-6.6 m	2-3 m	5-6 m	2-3 m	5-6 m	2-3 m	5-6 m		
Arsenic	mg/kg	4.2	9.5	11	13	3.9	4.5	6.2	3.3	1.8	6.2	3.3	21.6	0.21
Cadmium	mg/kg	0.22	-	0.23	0.29	0.24	0.29	-	0.12	-	0.36	-	37	0.21
Chromium	mg/kg	4.2	9.9	4.2	4.9	3.8	3.1	12	3.8	7.6	7.4	4.4	210	0.21
Cobalt	mg/kg	5.5	8.6	6.7	7.9	4.8	4.7	6.3	4.2	1.5	4.6	4.5	1380	0.21
Copper	mg/kg	4.1	8	6.5	7	6.4	4.7	4.9	3.6	2.4	7.7	6.7	3128	0.21
Lead	mg/kg	18	30	19	18	7.6	12	14	9.7	11	42	7.8	400	0.21
Nickel	mg/kg	2.5	3.9	2.9	3.4	2.3	2	4.6	2.4	3.6	3.5	2.3	1564	0.21
Zinc	mg/kg	42	31	51	56	49	44	20	34	11	50	37	23463	0.52
Mercury	mg/kg	-	0.023	-	-	-	-	-	-	-	0.028	-	23.5	0.017

*-For Residential area by EPA Region 9 Preliminary Remediation Goals (PRG) for Superfund Site, 2004
** SRL- sample reporting limit, '-' indicates Non-Detected above SRL

Figure 6. Distribution of Arsenic in Soils of Land Farm at Camp Carroll

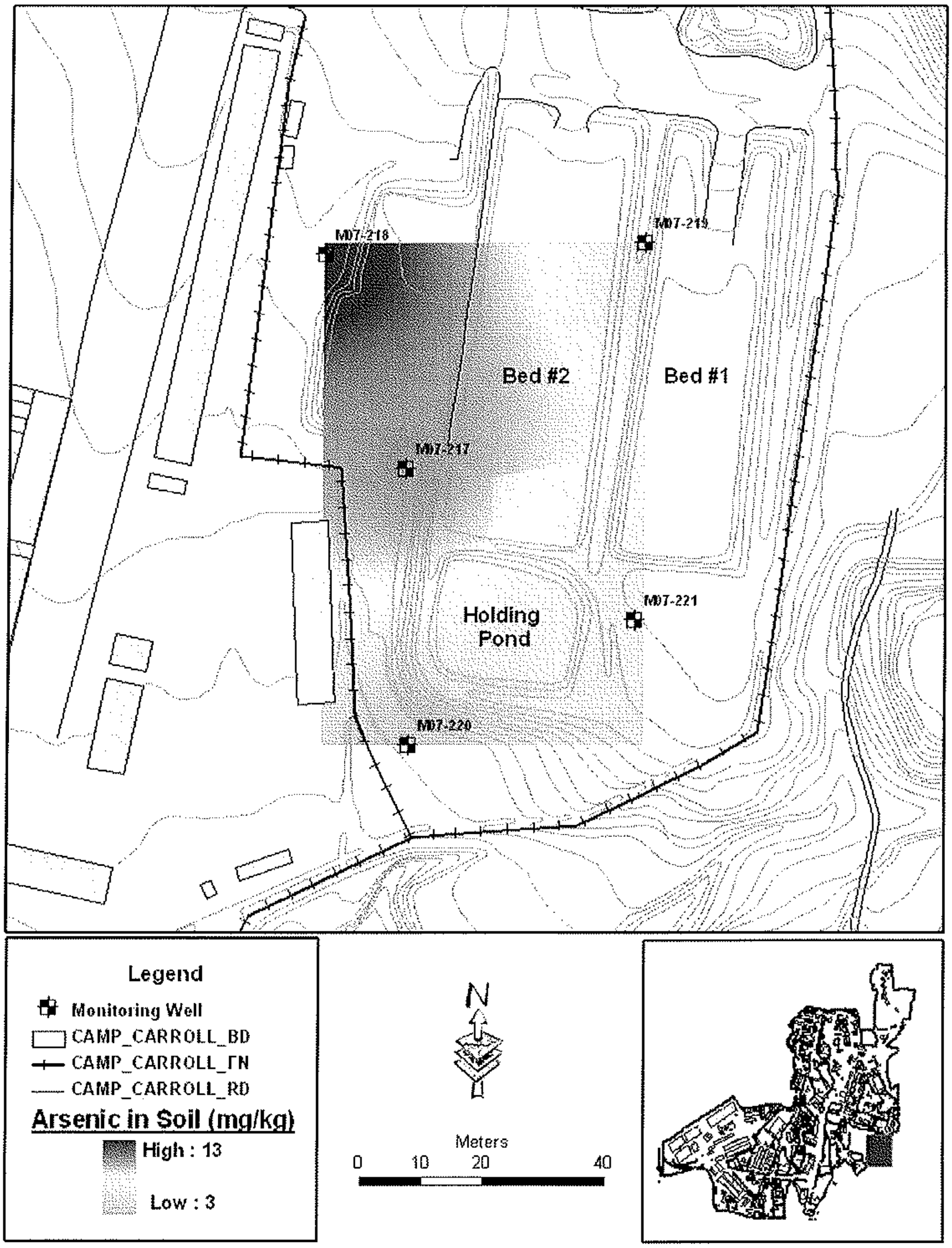
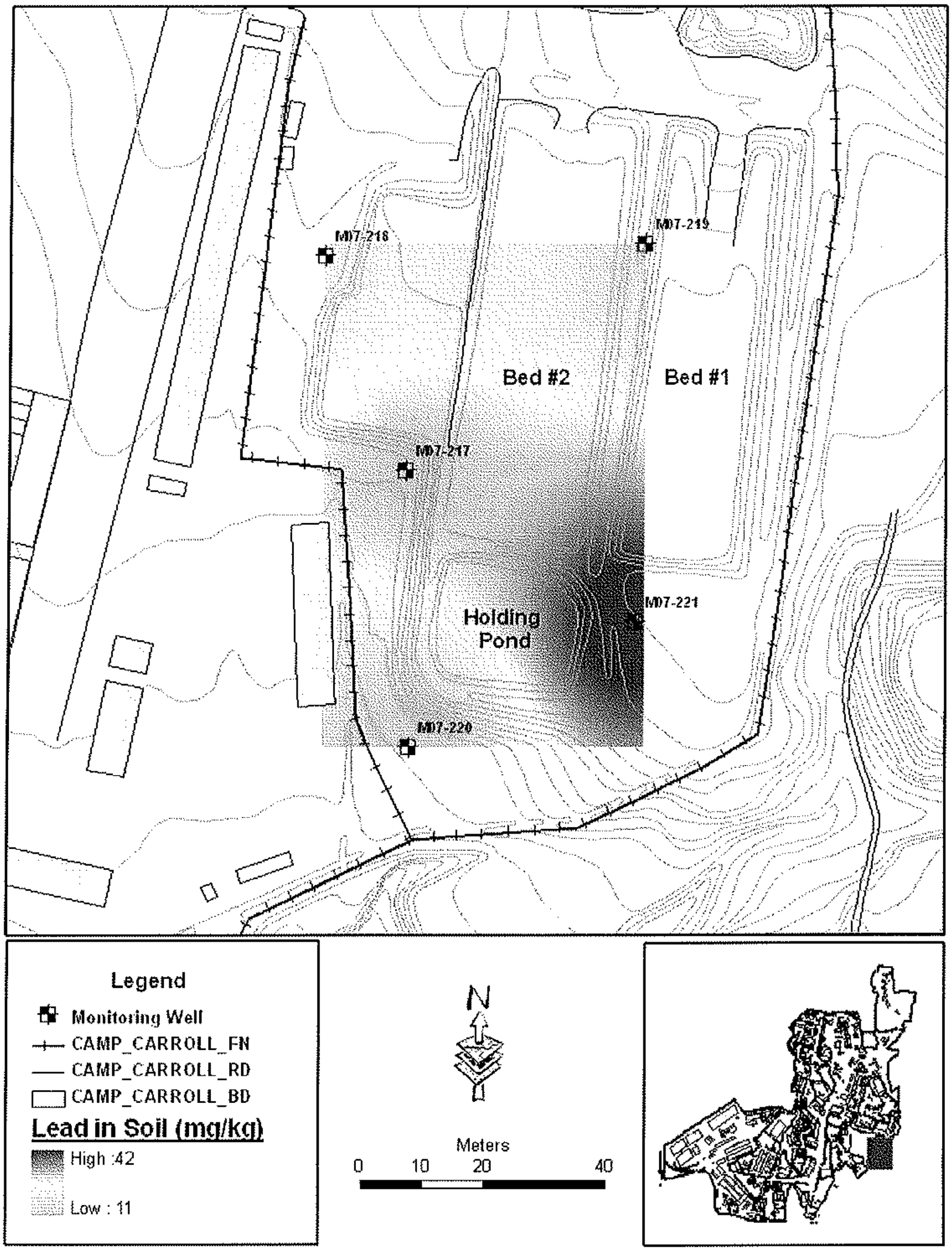


Figure 7. Distribution of Lead in Soils of Land Farm at Camp Carroll



3.1.4. OC-Pesticides

Reportable concentrations of OC-pesticides were identified in all soil samples (Table 4). The samples identified as containing pesticides were mostly collected from 2-meter to 3-meter soil horizon. The soil sample of M07-221 was identified containing 10 different pesticides. The pesticide 4, 4'-DDT was identified from four boreholes except M07-220. Six pesticides were detected at concentrations greater than their USEPA PRGs for residential soil. The concentrations exceeding the USEPA PRGs are:

Aldrin	0.42 ug/kg at M07-217;
4,4'-DDD	120 ug/kg at M07-221;
4,4'-DDE	24 ug/kg at M07-221;
4,4'-DDT	2.9~15 ug/kg at all boreholes except M07-220;
Dieldrin	2.4 ug/kg at M07-221;
Gamma-Chlordane	2.8 ug/kg at M07-221;

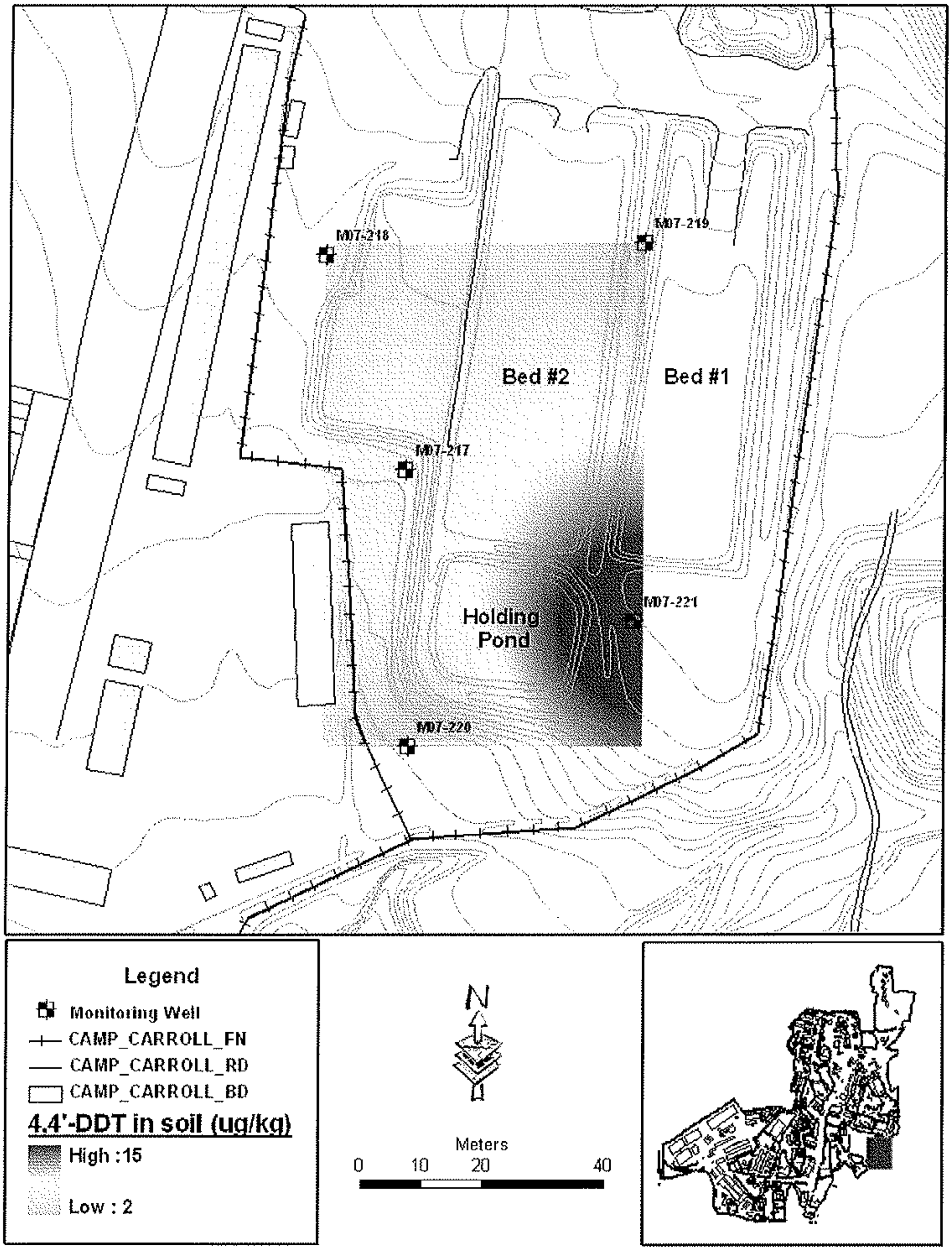
The 4,4'-DDT concentration in soil samples is presented in Figure 8. The highest concentration appeared at M07-221 close to the water holding pond.

Table 4. Chemical Test results for OC-Pesticides in Soils From Land Farm of Camp Carroll.

Analyte	Unit	M07-217		M07-218			M07-219		M07-220		M07-221		Screen Level*
		S5	S10	S4	S5	S10	S3	S6	S3	S6	S3	S6	
		1.8-3.0m	5.4-6.6 m	1.8-3.0m	1.8-3.0m	5.4-6.6 m	2-3 m	5-6 m	2-3 m	5-6 m	2-3 m	5-6 m	
Aldrin	ug/kg	-	-	-	-	-	-	-	0.42	-	-	-	0.0286
alpha-BHC	ug/kg	-	-	-	-	-	-	1.8	-	-	-	-	
beta-BHC	ug/kg	-	-	-	-	-	-	-	-	-	2.7	-	
delta-BHC	ug/kg	-	-	-	-	1.2	-	-	-	-	2.7	-	
Lindane	ug/kg	-	-	-	-	-	-	7	-	-	1.7	-	
4,4'-DDD	ug/kg	2	-	-	-	-	-	-	-	-	120	7	2.4
4,4'-DDE	ug/kg	-	-	-	-	-	-	-	-	-	24	-	1.72
4,4'-DDT	ug/kg	5.7	-	-	2.9	-	2.4	-	-	-	15	3.9	1.72
Dieldrin	ug/kg	-	-	-	-	-	-	-	-	-	2.4	-	0.03
Endosulfan I	ug/kg	-	-	-	-	-	-	-	-	-	-	-	
Endosulfan II	ug/kg	0.99	1.2	-	-	-	-	-	-	-	-	-	
Endosulfan sulfate	ug/kg	1.3	-	-	-	-	-	-	-	-	-	-	
Endrin	ug/kg	-	-	-	-	-	-	-	-	1.2	2.2	-	18.33
Endrin aldehyde	ug/kg	-	-	-	-	-	-	-	-	-	-	-	
Heptachlor	ug/kg	-	-	-	-	-	-	-	-	-	-	-	0.108
Heptachlor epoxide	ug/kg	-	-	-	-	-	-	-	-	-	-	-	0.053
Methoxychlor	ug/kg	-	-	-	-	-	-	-	-	-	-	-	
Endrin ketone	ug/kg	-	-	-	-	-	9.5	1.4	-	-	-	-	NA
Toxaphene	ug/kg	-	-	-	-	-	-	-	-	-	-	-	0.442
alpha-Chlordane	ug/kg	-	-	-	-	-	-	-	-	-	0.98	-	1.624
gamma-Chlordane	ug/kg	-	-	-	-	-	-	-	-	-	2.8	-	1.624

*-For Residential area by EPA Region 9 Preliminary Remediation Goals (PRG) for Superfund Site, 2004
** SRL- sample reporting limit, '-' indicates Non-Detected above SRL

Figure 8. Distribution of 4,4'-DDT in Soils of Land Farm at Camp Carroll



3.1.5 OP-Pesticides.

None of soil samples from the land farm detected OP-pesticides above the SRL (Table 5).

Table 5. Chemical Test results for OP-Pesticides in Soils From Land Farm of Camp Carroll.

Analyte	Unit	M07-217		M07-218			M07-219		M07-220		M07-221		SRL**
		S5	S10	S4	S5	S10	S3	S6	S3	S6	S3	S6	
		1.8-3.0m	5.4-6.6 m	1.8-3.0m	1.8-3.0m	5.4-6.6 m	2-3 m	5-6 m	2-3 m	5-6 m	2-3 m	5-6 m	
Dichlorvos	ug/kg	-	-	-	-	-	-	-	-	-	-	-	110
Mevinphos	ug/kg	-	-	-	-	-	-	-	-	-	-	-	35
Ethoprop	ug/kg	-	-	-	-	-	-	-	-	-	-	-	35
Naled	ug/kg	-	-	-	-	-	-	-	-	-	-	-	75
Sulfotepp	ug/kg	-	-	-	-	-	-	-	-	-	-	-	35
Monochrotophos	ug/kg	-	-	-	-	-	-	-	-	-	-	-	73
Phorate	ug/kg	-	-	-	-	-	-	-	-	-	-	-	35
Dimethoate	ug/kg	-	-	-	-	-	-	-	-	-	-	-	46
Demeton-O + Demeton-S	ug/kg	-	-	-	-	-	-	-	-	-	-	-	35
Diazinon	ug/kg	-	-	-	-	-	-	-	-	-	-	-	35
Disulfoton	ug/kg	-	-	-	-	-	-	-	-	-	-	-	35
Parathion methyl	ug/kg	-	-	-	-	-	-	-	-	-	-	-	43
Ronnel	ug/kg	-	-	-	-	-	-	-	-	-	-	-	35
Chlorpyrifos	ug/kg	-	-	-	-	-	-	-	-	-	-	-	73
Malathion	ug/kg	-	-	-	-	-	-	-	-	-	-	-	35
Fenthion	ug/kg	-	-	-	-	-	-	-	-	-	-	-	35
Parathion	ug/kg	-	-	-	-	-	-	-	-	-	-	-	35
Trichloronate	ug/kg	-	-	-	-	-	-	-	-	-	-	-	35
Stirophos	ug/kg	-	-	-	-	-	-	-	-	-	-	-	54
Merphos	ug/kg	-	-	-	-	-	-	-	-	-	-	-	35
Tokuthion	ug/kg	-	-	-	-	-	-	-	-	-	-	-	35
Fensulfothion	ug/kg	-	-	-	-	-	-	-	-	-	-	-	85
Bolstar	ug/kg	-	-	-	-	-	-	-	-	-	-	-	35
EPN	ug/kg	-	-	-	-	-	-	-	-	-	-	-	54
Azinphos-methyl	ug/kg	-	-	-	-	-	-	-	-	-	-	-	41
Coumaphos	ug/kg	-	-	-	-	-	-	-	-	-	-	-	35

*-For Residential area by EPA Region 9 Preliminary Remediation Goals (PRG) for Superfund Site, 2004
** SRL- sample reporting limit, '-' indicates Non-Detected above SRL

3.1.6 Total Petroleum Hydrocarbons (TPH).

A total of 6 soil samples were submitted to FED's ESL for TPH analysis (Table 6). Only one sample collected from M07-221 indicated TPH with the concentration of 10,000 mg/kg. The sample contained three different fuel types: 2,200 mg/kg of JP-4 of $C_{9\sim12}$, 1,700 mg/kg of diesel of $C_{13\sim20}$, and 6,600 mg/kg of motor oil of $C_{21\sim40}$.

Table 6. Chemical Test results for TPH in Soils From Land Farm of Camp Carroll.

Analyte	Unit	M07-217		M07-218	M07-219	M07-220	M07-221*	SRL
		S6	S7	S6	S8	S4	S2	
		3.0-3.6 m	3.6-4.2 m	3.0-3.6 m	1-2 m	1-2 m	1-2 m	
TPH	mg/kg	ND	ND	ND	ND	ND	10,000	36

* Mixture of three different fuels such as

2000 mg/kg of JP-4 of $C_{9\sim12}$ 1,700 mg/kg of diesel of $C_{13\sim20}$: 6,300 mg/kg of motor oil of $C_{21\sim36}$.

** SRL- sample reporting limit, '-' indicates Non-Detected above SRL

3.2. Groundwater Samples

3.2.1. Groundwater Level Measurement and Flow Direction

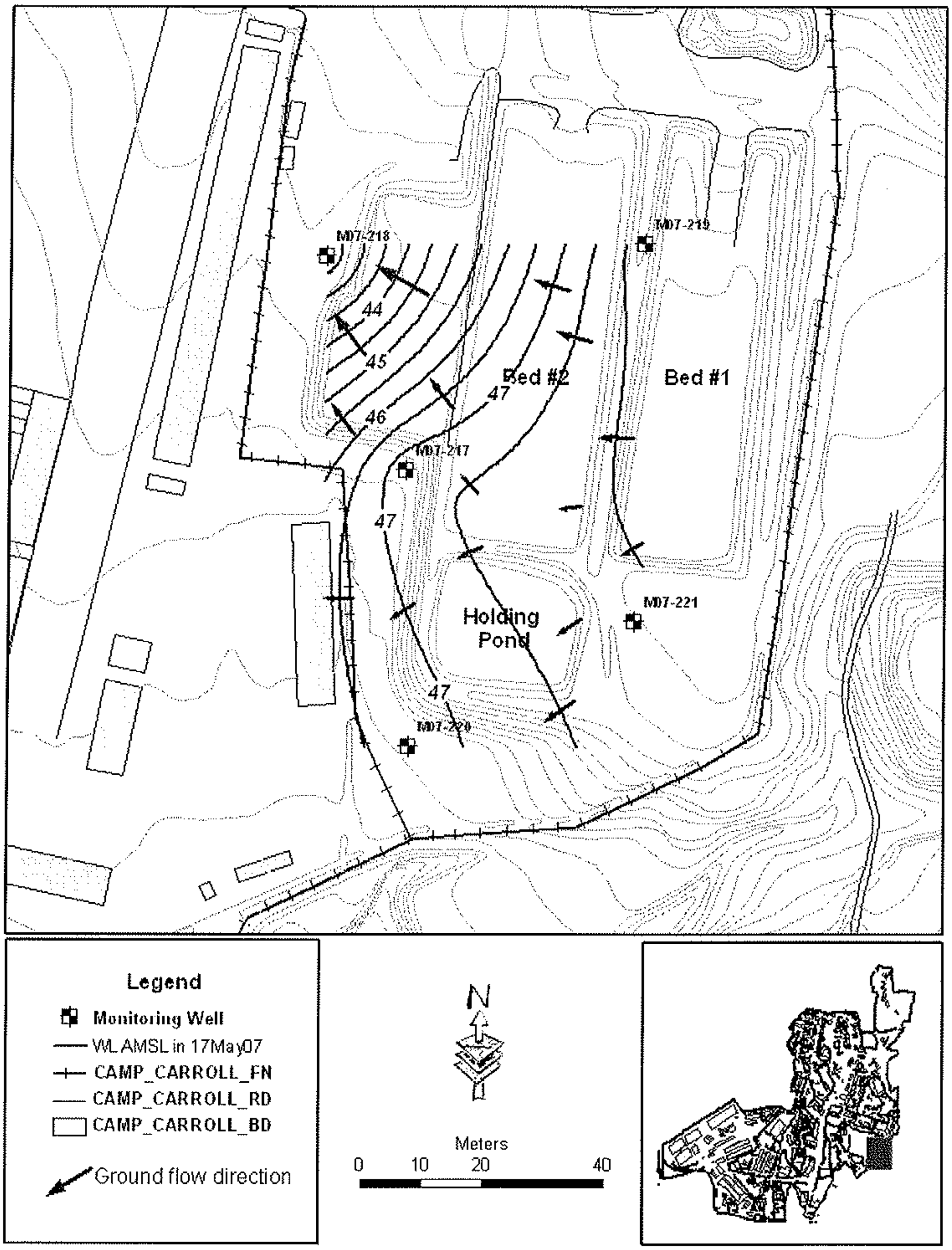
Groundwater levels were measured using an oil/water interface meter after well installation, before well development and before groundwater sampling. The result of water level measurements obtained after well installation are mentioned in the monitoring well logs in Appendix III, and the other two measurements are presented in Table 7. Figure 9 presents the contour diagram showing the groundwater gradient at the land farm area based on the measurement on 17 May 2007. Groundwater gradient at the site is apparently gentle within the treatment beds area, but gets relatively steep close to the M07-218. The groundwater flows westward, but it is divided into northwest and southwest at the western margin of the treatment bed #2. The lowest water level of 42.119 m above means sea level (msl) was found in M07-218, and the highest level of 48.275 m above msl is found in M07-219 located on the berm between the treatment beds.

Table 7. Water Level Measurement Results at Land Farm of Camp Carroll.

MW_ID	Easting	Northing	Top of Pipe (m)	WaterLevel (bgs*)		WaterLevel (msl**)	
				18-Apr-07	17-May-07	18-Apr-07	17-May-07
M07-217	447789.227	3983349.441	50.919	3.430	3.58	47.489	47.339
M07-218	447775.802	3983384.332	51.774	9.635	9.655	42.139	42.119
M07-219	447828.371	3983386.251	55.408	7.135	7.133	48.273	48.275
M07-220	447789.885	3983304.562	49.732	3.610	3.055	46.122	46.677
M07-221	447826.995	3983324.752	54.586	6.690	6.729	47.896	47.857

*- below ground surface, **- mean sea level.
Measurement before well development in 18 April 2007
Measurement before groundwater sampling in 17 May 2007

Figure 9. Groundwater Gradient Contour Diagram Based on the Measurement on 17 May at Land Farm of Camp Carroll



3.2.2. VOCs.

VOCs were detected in groundwater samples collected from all the monitoring wells installed at the land farm. Table 8 summarizes the test result for VOCs. The cis-1,2-DCE, TCE and PCE were identified from all the monitoring wells at the site of concern. Some of VOCs except those for M07-218 have concentrations that are exceeding their USEPA PRGs for residential soil.

The concentration ranges of VOCs exceeding USEPA PRGs in the groundwater samples of land farm are:

PCE	160~460 ug/L;
TCE	100~450 ug/L;
cis-1,2-DCE	86~110 ug/L;
Chloroform	0.082~16 ug/L;
1,4-Dichlorobenzene	0.51~0.54 ug/L;

Figures 10, 11 and12 show the distribution of PCE, TCE and cis-1,2-DCE concentrations in the groundwater samples of the land farm. PCE concentration in Figure 10 show that concentrations are generally higher within the treatment beds and decrease towards M07-217 and M07-218. The patterns of TCE and cis-1,2-DCE in Figures 11 and 12 are different from PCE but similar to each other as the plume seems to have originated from around M07-221 and currently the highest concentration appeared at M07-217.

Table 8. Chemical Test results for VOCs in Groundwater From Land Farm of Camp Carroll.

Analyte	Unit	M07-217	M07-218	M07-219	M07-220	M07-221	Screen Level*	SRL**
Dichlorodifluoromethane	ug/L	-	-	-	0.25	-	395	5
Chloromethane	ug/L	-	-	-	-	-		5
Vinyl chloride	ug/L	-	0.43	-	-	-	19.8	5
Bromomethane	ug/L	-	-	-	-	-		5
Chloroethane	ug/L	-	-	-	-	-		25
Trichlorofluoromethane	ug/L	-	-	-	-	-		5
1,1-Dichloroethene	ug/L	-	-	-	-	-		5
Carbon disulfide	ug/L	-	-	-	-	-		5
Acetone	ug/L	-	-	-	-	-		25
Methylene Chloride	ug/L	-	-	-	-	-		5
trans-1,2-Dichloroethene	ug/L	2.9	0.22	0.95	0.78	1.7	121.7	5
1,1-Dichloroethane	ug/L	-	-	-	-	-		5
2,2-Dichloropropane	ug/L	-	-	-	-	-		5
2-Butanone	ug/L	-	-	-	-	-		25
cis-1,2-Dichloroethene	ug/L	110	38	57	36	86	60.8	5
Chlorobromomethane	ug/L	-	-	-	-	-		5
Chloroform	ug/L	**3.3**	-	**0.82**	**4.1**	**16**	0.166	5
1,1,1-Trichloroethane	ug/L	-	-	-	-	-		5
Carbon tetrachloride	ug/L	-	-	-	-	-		5

Table 8. Continued (VOCs in Groundwater).

Analyte	Unit	M07-217	M07-218	M07-219	M07-220	M07-221	Action Level*	SRL**
1,1-Dichloropropene	ug/L	-	-	-	-	-		5
Benzene	ug/L	-	-	-	-	-		5
1,2-Dichloroethane	ug/L	-	-	-	-	-		5
Trichloroethene	ug/L	**450**	1.8	**100**	**180**	**390**	28	5
1,2-Dichloropropane	ug/L	-	-	-	-	-		5
Dibromomethane	ug/L	-	-	-	-	-		5
Dichlorobromomethane	ug/L	-	-	-	-	-		5
cis-1,3-Dichloropropene	ug/L	-	-	-	-	-		5
4-Methyl-2-pentanone	ug/L	-	-	-	-	-		25
Toluene	ug/L	-	0.09	-	-	-	723	5
trans-1,3-Dichloropropene	ug/L	-	-	-	-	-		5
1,1,2-Trichloroethane	ug/L	-	-	-	-	-		5
Tetrachloroethene	ug/L	**260**	75	**460**	160	**360**	104	5
1,3-Dichloropropane	ug/L	-	-	-	-	-		5
2-Hexanone	ug/L	-	-	-	-	-		25
Chlorodibromomethane	ug/L	-	-	-	-	-		5
Ethylene Dibromide	ug/L	-	-	-	-	-		5
Chlorobenzene	ug/L	-	-	1.5	-	-	106	5
Ethylbenzene	ug/L	-	-	-	-	-		5
1,1,1,2-Tetrachloroethane	ug/L	-	-	-	-	-		5
m-Xylene & p-Xylene	ug/L	-	-	-	-	-		10
o-Xylene	ug/L	-	-	-	-	-		5
Styrene	ug/L	-	-	-	-	-		5
Bromoform	ug/L	-	-	-	-	-		5
Isopropylbenzene	ug/L	-	-	-	-	-		5
Bromobenzene	ug/L	-	-	-	-	-		5
N-Propylbenzene	ug/L	-	-	-	-	-		5
1,1,2,2-Tetrachloroethane	ug/L	-	-	-	-	-		5
1,2,3-Trichloropropane	ug/L	-	-	-	-	-		5
2-Chlorotoluene	ug/L	-	-	-	-	-		5
1,3,5-Trimethylbenzene	ug/L	-	-	-	-	-		5
4-Chlorotoluene	ug/L	-	-	-	-	-		5
tert-Butylbenzene	ug/L	-	-	-	-	-		5
1,2,4-Trimethylbenzene	ug/L	-	-	-	-	-		5
sec-Butylbenzene	ug/L	-	-	-	-	-		5
1,3-Dichlorobenzene	ug/L	-	-	0.21	0.05	-	182.5	5
4-Isopropyltoluene	ug/L	-	-	-	-	-		5
1,4-Dichlorobenzene	ug/L	**0.51**	-	-	0.15	**0.54**	0.502	5
n-Butylbenzene	ug/L	-	-	-	-	-		5
1,2-Dichlorobenzene	ug/L	-	-	-	0.18	-	370	5
1,2-Dibromo-3-Chloropropane	ug/L	-	-	-	-	-		10
1,2,4-Trichlorobenzene	ug/L	-	-	-	0.12	0.31	7.157	5
1,2,3-Trichlorobenzene	ug/L	-	-	-	-	-		5
Hexachlorobutadiene	ug/L	-	-	-	-	-		5
Naphthalene	ug/L	-	-	-	-	0.85	6.203	5

*-For Tap Water by EPA Region 9 Preliminary Remediation Goals (PRG) for Superfund Site, 2004
** SRL- sample reporting limit, '-' indicates Non-Detected above SRL

Figure 10. Distribution of PCE in Groundwater of Land Farm at Camp Carroll

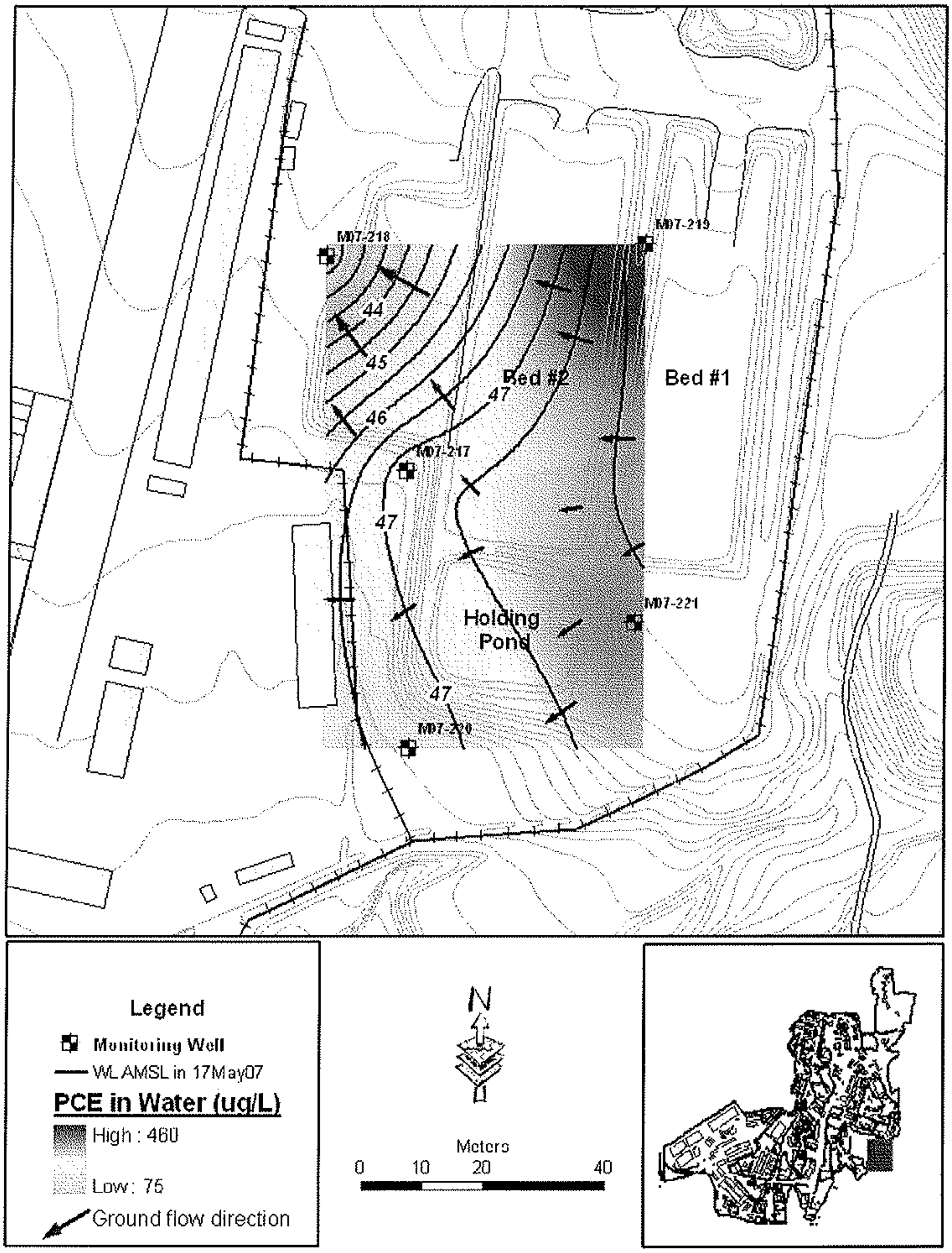


Figure 11. Distribution of TCE in Groundwater of Land Farm at Camp Carroll

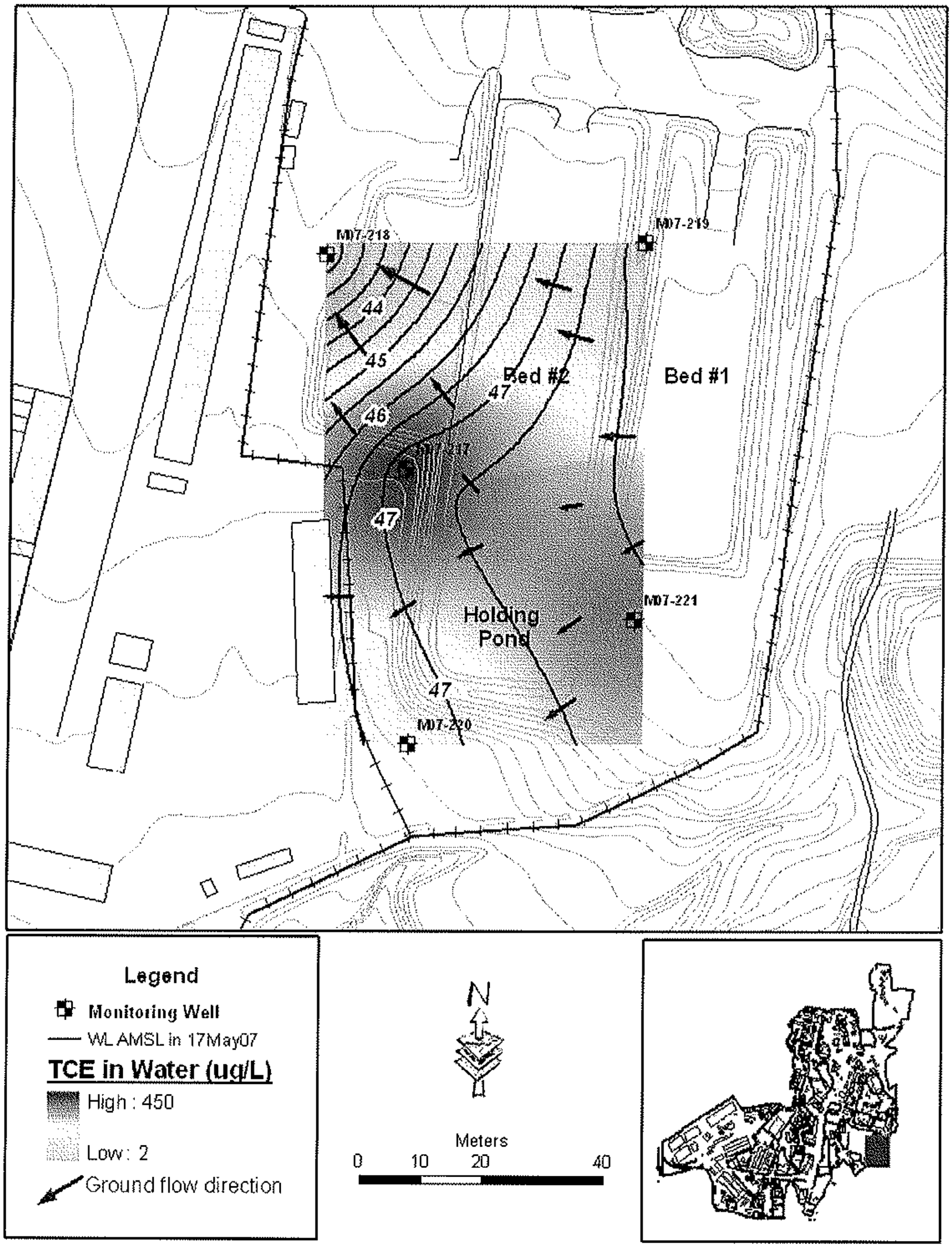
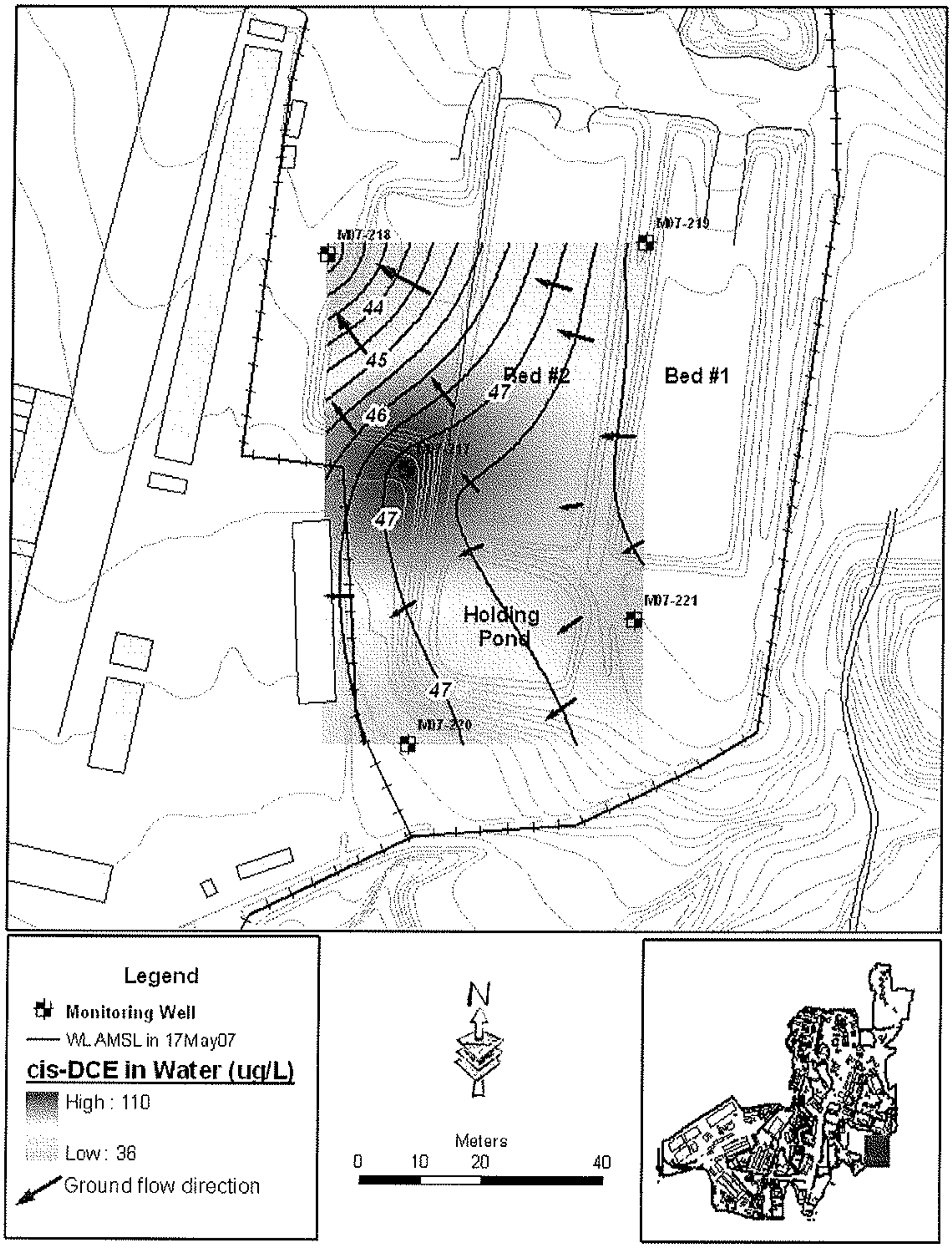


Figure 12. Distribution of cis-1,2-DCE in Groundwater of Land Farm at Camp Carroll



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3.2.3. Target Metals.

Target metals were detected in most samples from the monitoring wells installed at the land farm (Table 9). Mercury was detected in two water samples from M07-220 and M07-221 above the SRL. The concentrations of arsenic and lead in groundwater samples exceeded the Tap water PRGs by USEPA Region 9. The concentration ranges of the target metals exceeding the USEPA PRGs for tap water are:

Arsenic	0.41~2.5 ug/L;
Lead	0.24~5.1 ug/L;

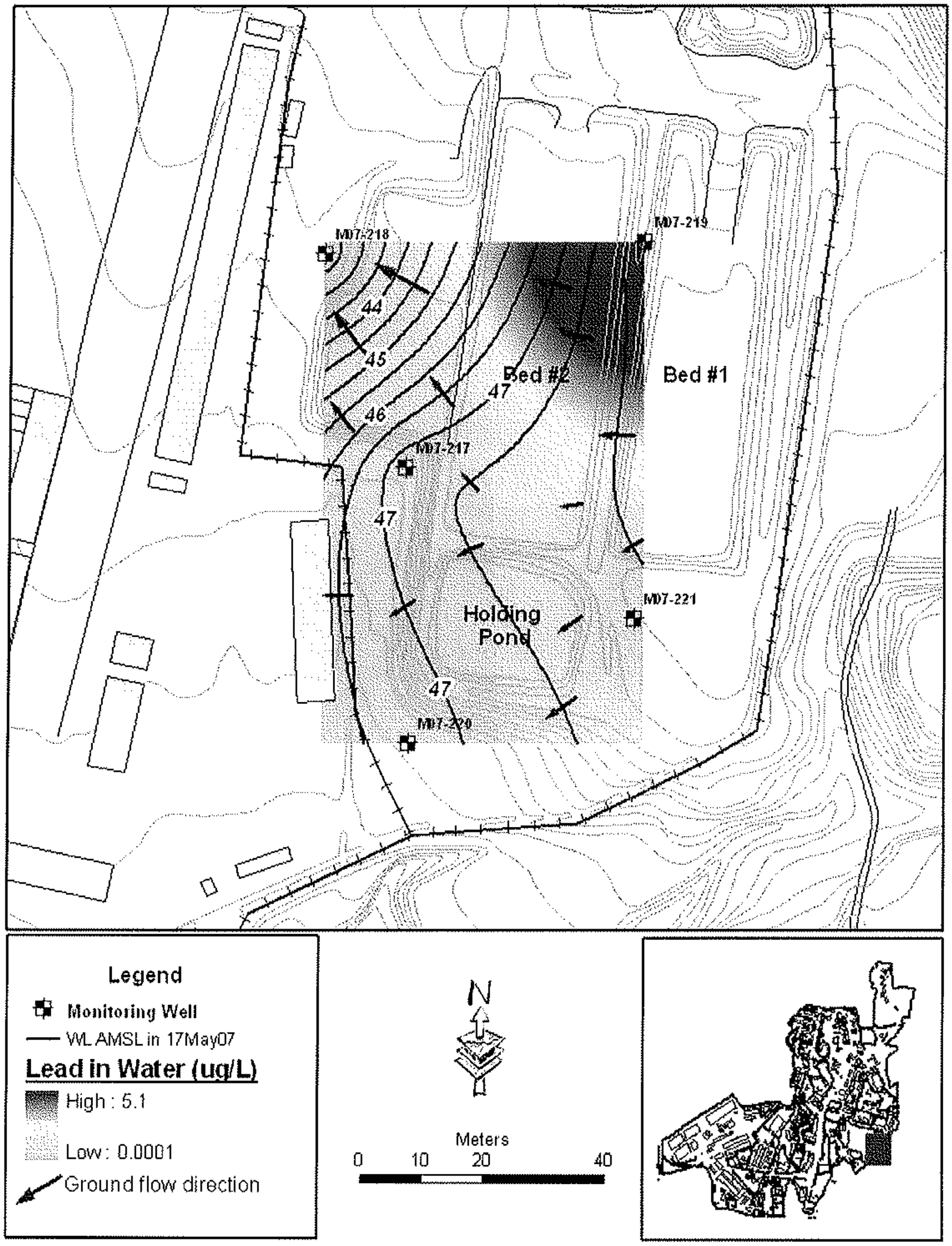
Lead concentration in water samples is presented in Figure 13. Lead in water appeared only limited area around M07-219.

Table 9. Chemical Test results for Metals in Groundwater From Land Farm of Camp Carroll.

Analyte	Unit	M07-217	M07-218	M07-219	M07-220	M07-221	Screen Level*	SRL**
Arsenic	ug/L	**0.52**	**0.41**	**2.5**	**0.43**	-	0.045	2
Cadmium	ug/L	0.12	0.35	0.12	0.15	0.076	18.25	2
Chromium	ug/L	0.38	-	0.39	0.29	0.41	109.5	2
Cobalt	ug/L	0.37	6.6	2.6	0.17	1.1	730	2
Copper	ug/L	0.23	0.098	7.3	0.3	0.21	1460	2
Lead	ug/L	**0.24**	-	**5.1**	**0.14**	**0.3**	0.004	2
Nickel	ug/L	1.5	8	2.7	0.28	0.66	730	2
Zinc	ug/L	2.6	2.2	25	6.5	4.4	10950	5
Mercury	ug/L	-	-	-	0.1	0.064	-	0.2

*-For Tap Water by EPA Region 9 Preliminary Remediation Goals (PRG) for Superfund Site, 2004

Figure 13. Distribution of Lead in Groundwater of Land Farm at Camp Carroll



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3.2.4. OC-Pesticides.

Reportable concentrations of OC-pesticides were identified in most groundwater samples (Table 10). The groundwater samples from M07-218 and M07-219 identified most items in the OC-pesticide analytical list. Six pesticides in the list were detected from all the groundwater samples submitted for analysis. Dieldrin was detected in all samples with concentrations greater than their USEPA PRGs for tap water. Five other pesticides were also detected above USEPA PRGs for tap water in one or two samples each. The concentration ranges of OC-pesticides exceeding USEPA PRGs are:

Aldrin	0.0041~0.01 ug/L at M07-218 and M07-219;
Gamma-BHC	0.055~0.68 ug/L at M07-217 and M07-219;
Dieldrin	0.0056~0.084 ug/L at all samples;
Heptachlor	0.033 ug/L at M07-219;
Heptachlor epoxide	0.019 ug/L at M07-218
Gamma-Chlordane	0.024 ug/L at M07-218;

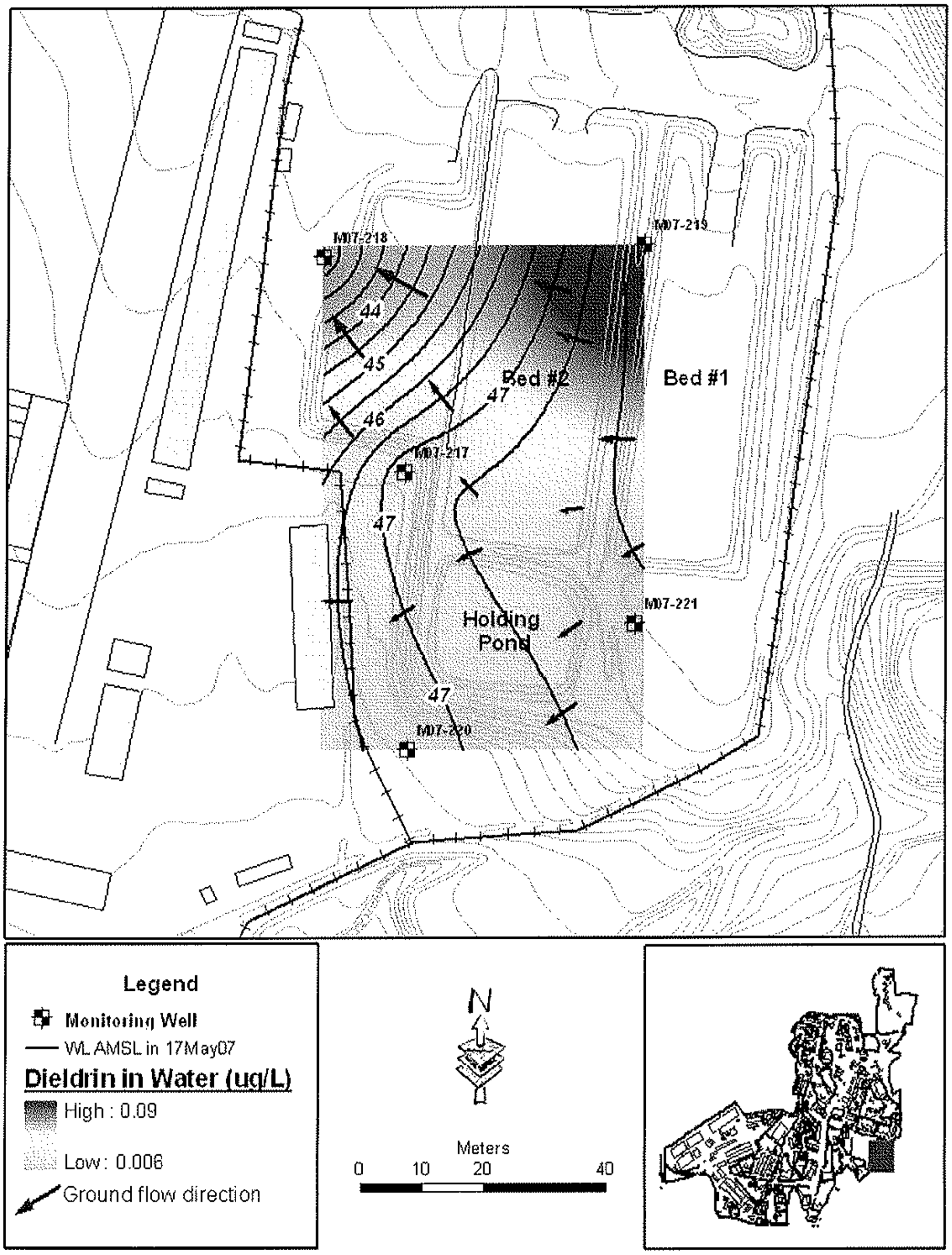
Figure 14 shows the distribution of dieldrin concentration in groundwater samples from the land farm. The distribution pattern of dieldrin in groundwater suggests that the migration occurred to west at M07-218 from east of the highest concentration of M07-219, while the other two wells (M07-220 and M07-221) at south were not affected.

Table 10. Chemical Test results for OC Pesticides in Groundwater From Land Farm of Camp Carroll

Analyte	Unit	M07-217	M07-218	M07-219	M07-220	M07-221	Screen Level*	SRL**
Aldrin	ug/L	-	0.01	0.0041	-	-	0.004	0.0095
alpha-BHC	ug/L	0.048	0.023	0.076	0.025	0.09		0.0095
beta-BHC	ug/L	0.0038	0.026	0.025	0.017	0.0054		0.019
delta-BHC	ug/L	0.027	0.024	0.16	0.024	0.066		0.0095
Lindane	ug/L	0.055	0.013	0.68	0.02	0.032	0.0517	0.0095
4,4'-DDD	ug/L	0.0037	0.23	0.0035	-	0.022	0.28	0.019
4,4'-DDE	ug/L	-	0.019	0.0033	-	-	0.198	0.019
4,4'-DDT	ug/L	-	0.035	0.011	-	0.0087	0.198	0.019
Dieldrin	ug/L	0.017	0.05	0.084	0.0082	0.0056	0.0042	0.019
Endosulfan I	ug/L	-	0.015	0.0037	-	-		0.019
Endosulfan II	ug/L	-	0.0038	0.016	-	-		0.019
Endosulfan sulfate	ug/L	0.0088	0.055	0.066	0.0071	0.0043		0.019
Endrin	ug/L	-	0.0098	-	-	-	10.95	0.019
Endrin aldehyde	ug/L	-	0.024	0.0093	-	-		0.048
Heptachlor	ug/L	0.007	0.0028	0.033	0.004	0.0097	0.0149	0.0095
Heptachlor epoxide	ug/L	-	0.019	0.0066	-	-	0.0074	0.0095
Methoxychlor	ug/L	-	0.022	0.0049	-	-	182.5	0.095
Endrin ketone	ug/L	-	0.0043	0.012	-	-		0.019
Toxaphene	ug/L	-	-	-	-	-		0.95
alpha-Chlordane	ug/L	-	0.021	0.0032	-	-		0.0095
gamma-Chlordane	ug/L	-	0.024	-	-	-		0.0095

*-For Tap Water by EPA Region 9 Preliminary Remediation Goals (PRG) for Superfund Site, 2004
** SRL- sample reporting limit, '-' indicates Non-Detected above SRL

Figure 14. Distribution of Dieldrin in Groundwater of Land Farm at Camp Carroll



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3.1.5 OP-Pesticides

None of groundwater samples from the land farm detected OP-pesticides above the SRL. Table 11 presents the test result of OP-pesticides.

Table 11. Chemical Test results for OP-Pesticides in Groundwater from Land Farm of Camp Carroll.

Analyte	Unit	M07-217	M07-218	M07-219	M07-220	M07-221	SRL*
Dichlorvos	ug/L	-	-	-	-	-	0.48
Mevinphos	ug/L	-	-	-	-	-	0.48
Ethoprop	ug/L	-	-	-	-	-	0.48
Naled	ug/L	-	-	-	-	-	0.48
Sulfotepp	ug/L	-	-	-	-	-	0.48
Monochrotophos	ug/L	-	-	-	-	-	0.48
Phorate	ug/L	-	-	-	-	-	0.48
Dimethoate	ug/L	-	-	-	-	-	0.48
Demeton-O + Demeton-S	ug/L	-	-	-	-	-	0.48
Diazinon	ug/L	-	-	-	-	-	0.57
Disulfoton	ug/L	-	-	-	-	-	0.48
Parathion methyl	ug/L	-	-	-	-	-	0.48
Ronnel	ug/L	-	-	-	-	-	0.48
Chlorpyrifos	ug/L	-	-	-	-	-	0.48
Malathion	ug/L	-	-	-	-	-	0.48
Fenthion	ug/L	-	-	-	-	-	0.48
Parathion	ug/L	-	-	-	-	-	0.48
Trichloronate	ug/L	-	-	-	-	-	0.48
Stirophos	ug/L	-	-	-	-	-	0.48
Merphos	ug/L	-	-	-	-	-	0.48
Tokuthion	ug/L	-	-	-	-	-	0.48
Fensulfothion	ug/L	-	-	-	-	-	0.48
Bolstar	ug/L	-	-	-	-	-	0.48
EPN	ug/L	-	-	-	-	-	0.57
Azinphos-methyl	ug/L	-	-	-	-	-	0.57
Coumaphos	ug/L	-	-	-	-	-	0.57

** SRL- sample reporting limit, '-' indicates Non-Detected above SRL

4. CONCEPTUAL SITE MODEL.

The site subsurface conditions are comprised of fairly permeable overburden soils of filled materials of silty sand and sand with gravel (clayey/silty sand, clayey sand and gravel fill material and some clayey sand) and weathered bedrock, which is biotite granite. The thickness of the overburden soils at the site ranged between 8 and 11 meters. Wooden chips, pieces of metal and vinyl were identified from the soil samples at M07-221. Ground water at the site of concern occurs within the overburden soils and generally flows westward within the land farm facility.

Soil contamination was identified in the subsurface soils of the land farm at Camp Carroll. Laboratory analytical results indicate that the chemicals of contamination in the subsurface soils are mainly VOCs, metals and pesticides. The depth of soil contamination is a little higher than groundwater level or close to the seasonal ground-water level, which indicates that the released chemicals could be dissolved into/ migrated along the water table beneath the site. The source of the chemicals could be from the historic dumping of such material at the bed #1. The highest contamination was identified at the southeastern part (M07-221) of the land farm which is next to the water holding pond. Some of chemicals such as TCE, PCE, OC-pesticides identified from the subsurface soil samples from the M07-221 were identified exceeding USEPA PRGs for residential soil. TPH contamination was also identified only in M07-221, with the concentration of 10,000 mg/kg.

Groundwater contamination was identified in most of the monitoring wells at the land farm. Laboratory analytical results indicate that the contaminants in the groundwater are mainly VOCs, metals and pesticides. The relatively high concentration of chemicals in the groundwater is likely to appear towards the downgradient side, which is towards the west of the land farm. This is quite different observation from the soil samples since the highest concentrations in soils were dominantly observed in the east (M07-221). For example, soil samples from M07-217 did not contain any of PCE and TCE, but in its groundwater sample even TCE is the highest among the groundwater samples. The dissolved chemicals in groundwater at M07-217 indicate the source is located at east of the site and migrate through site groundwater. Considering the occurrence patterns of VOCs in soil and groundwater samples of the land farm, a source of VOCs or other chemicals is still present in the subsurface fill material. Chemicals existing in the subsurface formation could be entered into groundwater by leaching out of soil formation during precipitation, and those gravitationally flow toward lower gradient of the site.

Information Gap

The soil and groundwater sampling work performed for this study was sufficient to assess the soil and groundwater chemical characteristics. Five groundwater monitoring wells installed during this study provide an adequate understanding of ground-water flow and quality conditions at the site of concern. In the course of this project, VOCs and pesticides contamination was identified in the subsurface soils and groundwater at the site of concern. Hydrogeologic condition indicates that the source for the chemicals is east of the land farm. However, data collected for this study is not sufficient to conclusively identify the source areas although the possible source was found to be around M07-221. Six to eight soil borings would need to be drilled east of the water holding pond to evaluate and delineate the source area for the chemicals of concern. Further studies may also be needed to fully delineate the horizontal and vertical extent of the contaminants.

5. CONCLUSIONS.

Laboratory analysis detected VOCs, metals and pesticides in site soil and groundwater. There is no direct evidence that the Land Farm bed #2 is releasing chemicals treated into the subsurface since since the chemicals identified are different from those that used to be treated. However, the source(s) of chemicals detected in soil and groundwater exists on the site such as M07-221.

Soil: None of metal concentrations exceeded EPA PRGs for residential soil. Concentrations of six VOCs, mostly solvent-related chemicals, including PCE and TCE exceeded USEPA PRGs for residential soil. Concentrations of six OC-pesticides exceeded USEPA PRGs for residential soil. Mixed TPH of JP-8, diesel and oil was identified from one soil boring with the concentration of 10,000 mg/kg. Chemical concentrations that exceeded USEPA PRGs were identified from one location (M07-221) next to the water holding pond of the site of concern. In association with findings of wood chips and pieces of metals at M07-221, there may be an unexcavated source for the chemicals.

Groundwater: Concentrations of five VOCs including PCE and TCE exceeded USEPA PRGs for tap water. Arsenic and lead in groundwater samples exceed USEPA PRGs for tab water. Concentrations of seven OC-pesticides exceeded USEPA PRGs for tap water.

Solvent-related VOCs were detected in soil and groundwater samples at levels that exceed USEPA PRG guidance. Findings during this study indicate that VOC, arsenic and pesticide contamination exists in site soil and groundwater and the levels could contribute to the contamination of the underlying ground water. Site ground-water contamination could pose a threat to human health, because ground-water supply wells are used for Camp Carroll's potable water supply. The extent of subsurface contamination has not been fully characterized at the land farm site. The findings of this assessment indicate more extensive subsurface contamination at the land farm than was originally anticipated.

6. RECOMMENDATIONS

Since Camp Carroll utilizes the supply wells for portable water supply, current findings of site ground-water contamination at Land Farm area by PCE, TCE and heavy metals could pose a threat to human health. Following recommendations are made

1) Approximately 20 soil borings are recommended on the bed #1 to evaluate and delineate the chemicals of concern.

2) Six to eight soil borings are recommended at east of the water holding pond of the Land Farm to evaluate and delineate the source area for the chemicals of concern.

3) Based on groundwater analytical results of 2003 and 2007, it is recommended that monitoring wells with detected contamination be sampled and analyzed to identify any significant groundwater changes, especially for PCE, TCE, OC pesticides and metals.

4) It is highly recommended that the removal of the source(s) of the chemical contamination be conducted immediately, once the area has been delineated, to protect the groundwater from further release or migration of contamination.

5) Groundwater investigation between the Land Farm and the six supply wells (Figure 1) at 500 m west of the Land Farm is highly recommended to identify the possible impact to the supply water by the chemicals of concern.

6) Provide this report to the appropriate medical authority to determine if the identified soil and groundwater contaminations pose a known imminent and substantial endangerment to human health (KISE).

APPENDIX I: BOREHOLE LOG

US Army Corps Of Engineers — EXPLORATION LOG — Far East District

HOLE NO. **M07-217**

PROJECT: **Monitoring Well Construction.**
LOCATION: **Cp Carroll** G&EE NO.: **06-075E** INSPECTOR: [redacted] b6
DATE STARTED: **03 Apr 07** FINISHED: **03 Apr 07** DRILLER: [redacted] b6
DRILLING METHOD/EQUIPMENT: **Hollow Stem Auger w/CME-75**
DRILLING AGENCY: **Far East District** HOLE DIAMETER: **18 cm** TOTAL DEPTH: **12.0 m**
OVERBURDEN THICKNESS: **10.5 m** DEPTH DRILLED: **12.0 m** WATER DEPTH: **3.41 m; AD**
COORDINATES: N: **3,983,349.4** E: **447,789.2** GROUND ELEV.: **50.99 m** DATUM: **MSL**
GROUND COVER: **Grass area** CONTAMINATION: **No**
TYPE OF HOLE: ☐ Piezometer ☒ Monitoring Well ☐ Test Pit ☐ Auger Hole ☐ other ____

ELEVATION / DEPTH (meters)	SAMPLE TYPE / NUMBER	GRAPHIC LOG	CONTAMINATED	BLOW COUNT	SPT N-VALUE	USCS / STRATA	DESCRIPTION OF MATERIALS	FIELD DATA	LAB DATA
0	S1			1 4 8	12	FILL	**SILTY SAND**: brown; moist; about 75% subangular fine to coarse Sand (max.4.8mm); about 25% Fines; no plasticity; medium dense; fill material (SM).	%Recovery = 93 PID = 9.7ppm FC = F2	
50	S2			18 16 13	29	FILL	**SILTY SAND with Gravel**: brown; moist; 10cm cobbles; about 20% subangular fine to coarse Gravel (max.7cm); about 60% subangular fine to coarse Sand (max.4.8mm); about 20% Fines; no plasticity; medium dense; fill material (SM).	%Recovery = 65 PID = 5.8ppm FC = F2	
	S3			8 10 10	20	FILL		%Recovery = 97 PID = 5.7ppm FC = F2	
2	S4			5 8 8	16		**SILTY SAND**: brown; moist; about 80% subangular fine to coarse Sand (max.4.8mm); about 20% Fines; no plasticity; medium dense to loose; fill material (SM).	%Recovery = 63 PID = 10.7ppm	
48	S5			2 5 7	12			%Recovery = 83 PID = 11.5ppm	
	S6 ▼			3 4 5	9			%Recovery = 87 PID = 16.2ppm	
4	S7			3 5 5	10			%Recovery = 87 PID = 6.9ppm	
46	S8			1 2 4	6	SC	**CLAYEY SAND**: greenish gray and brown; moist; about 65% subangular fine to coarse Sand (max.4.8mm); about 35% Fines; medium plasticity; loose; alluvial soil.	%Recovery = 97 PID = 6.2ppm	
	S9			5 3 3	6			%Recovery = 70 PID = 7.2ppm	
6 / 44	S10			2 6 9	15	SC	**CLAYEY SAND**: yellowish brown; moist; about 70% subangular fine to coarse Sand (max.4.8mm); about 30% Fines; medium plasticity; medium dense; alluvial soil.	%Recovery = 75 PID = 5.7ppm	
8 / 42	S11			13 17 16	33	SM	**SILTY SAND**: brown; moist; about 80% subangular fine to coarse Sand (max.4.8mm); about 20% Fines; no plasticity; dense to very dense; residual soil; granite texture.	%Recovery = 100 PID = 13.2ppm	
10	S12			15 33 42	75			%Recovery = 100 PID = 6.8ppm	
40 / 12	S13			50 50/12cm	50/12cm	ROCK	**GRANITE**: brown; highly weathered.	%Recovery = 100 PID = 5.3ppm	

Note:

1) Type of Samples
 G: Grab
 S: SPT
 P: Shelby Tube
 R: Rock Core
2) Groundwater Encountered After Drilling (AD)

3) PID = Parts Per Million, reading from PID (Photo Ionization Detector)

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ENVIRO-EXPLORATION LOG 06-075E, CP CARROLL.GPJ USACE SKOREA.GDT 13/7/07

US Army Corps Of Engineers

EXPLORATION LOG

HOLE NO. **M07-218**

Far East District

PROJECT: **Monitoring Well Construction.**
LOCATION: **Cp Carroll** G&EE NO.: **06-075E** INSPECTOR: [redacted] b6
DATE STARTED: **03 Apr 07** FINISHED: **04 Apr 07** DRILLER: [redacted] b6
DRILLING METHOD/EQUIPMENT: **Hollow Stem Auger w/CME-75**
DRILLING AGENCY: **Far East District** HOLE DIAMETER: **18 cm** TOTAL DEPTH: **12.3 m**
OVERBURDEN THICKNESS: **10.8 m** DEPTH DRILLED: **12.3 m** WATER DEPTH: **9.66 m; AD**
COORDINATES: N: **3,983,384.3** E: **447,775.8** GROUND ELEV.: **51.83 m** DATUM: **MSL**
GROUND COVER: **Grass area** CONTAMINATION: **No**
TYPE OF HOLE: ☐ Piezometer ☒ Monitoring Well ☐ Test Pit ☐ Auger Hole ☐ other

ELEVATION / DEPTH (meters)	SAMPLE TYPE / NUMBER	GRAPHIC LOG	CONTAMINATED	BLOW COUNT	SPT N-VALUE	USCS / STRATA	DESCRIPTION OF MATERIALS	FIELD DATA	LAB DATA
0	S1			9 8 6	14	FILL	**SILTY SAND with Gravel**: brown; moist; about 30% subangular fine to coarse Gravel (max.7cm); about 50% subangular fine to coarse Sand (max.4.8mm); about 20% Fines; no plasticity; medium dense; fill material (SM).	%Recovery = 100 PID = 3.7ppm Petro Flag = 5.3ppm FC = F2	
	S2			7 6 5	11			%Recovery = 100 PID = 4.7ppm Petro Flag = 7.4ppm	
	S3			6 5 3	8	FILL	**CLAYEY SAND**: strong brown; moist; subangular; about 70% subangular fine to coarse Sand (max.4.8mm); about 30% Fines; medium plasticity; loose; fill material (SC).	%Recovery = 100 PID = 3.9ppm Petro Flag = 6.3ppm	
50 / 2	S4			3 2 3	5			%Recovery = 93 PID = 3.5ppm Petro Flag = 5.5ppm	
	S5			2 3 2	5			%Recovery = 72 PID = 5.8ppm Petro Flag = 10.1ppm	
	S6			3 7 8	15	SM	**SILTY SAND**: yellowish brown and brown; moist; about 80% subangular fine to coarse Sand (max.4.8mm); about 20% Fines; no plasticity; medium dense to very dense; residual soil; granite texture.	%Recovery = 85 PID = 5.3ppm Petro Flag = 10.0ppm	
48 / 4	S7			6 7 8	15			%Recovery = 90 PID = 4.1ppm Petro Flag = 4.9ppm	
	S8			13 15 13	28			%Recovery = 93 PID = 4.6ppm Petro Flag = 6.5ppm	
46 / 6	S9			14 19 23	42			%Recovery = 100 PID = 4.0ppm Petro Flag = 4.5ppm	
	S10			13 19 33	52			%Recovery = 93 PID = 4.9ppm Petro Flag = 3.8ppm	
44 / 8	S11			14 29 37	66			%Recovery = 68 PID = 4.2ppm Petro Flag = 4.1ppm	
42 / 10	S12			24 50				%Recovery = 38 PID = 4.0ppm Petro Flag = 4.5ppm	
40 / 12	S13			50		ROCK	**GRANITE**: light brown; highly weathered.	%Recovery = 22 PID = 3.7ppm Petro Flag = 4.1ppm	

Note:

1) Type of Samples
   G: Grab
   S: SPT
   P: Shelby Tube
   R: Rock Core
2) Groundwater Encountered After Drilling (AD)

3) PID = Parts Per Million, reading from PID (Photo Ionization Detector)

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ENVIRO-EXPLORATION LOG 06-075E, CP CARROLL.GPJ USACE SKOREA.GDT 13/7/07

EXPLORATION LOG

US Army Corps Of Engineers

HOLE NO. **M07-219**

Far East District

PROJECT: **Monitoring Well Construction.**
LOCATION: **Cp Carroll** G&EE NO.: **06-075E** INSPECTOR: [redacted] b6
DATE STARTED: **04 Apr 07** FINISHED: **04 Apr 07** DRILLER: [redacted] b6
DRILLING METHOD/EQUIPMENT: **Geoprobe**
DRILLING AGENCY: **Far East District** HOLE DIAMETER: **5 cm** TOTAL DEPTH: **12.0 m**
OVERBURDEN THICKNESS: DEPTH DRILLED: **12.0 m** WATER DEPTH: **7.66 m; AD**
COORDINATES: N: **3,983,386.3** E: **447,828.4** GROUND ELEV.: **55.43 m** DATUM: **MSL**
GROUND COVER: **Grass area** CONTAMINATION: **No**
TYPE OF HOLE: ☐ Piezometer ☒ Monitoring Well ☐ Test Pit ☐ Auger Hole ☒ other **Direct push**

ELEVATION / DEPTH (meters)	SAMPLE TYPE / NUMBER	GRAPHIC LOG	CONTAMINATED	BLOW COUNT	SPT N-VALUE	USCS / STRATA	DESCRIPTION OF MATERIALS	FIELD DATA	LAB DATA
0	D1					FILL	**CLAYEY SAND**: strong brown; moist; about 10% fine to coarse Gravel; about 60% subangular fine to coarse Sand (max.4.8mm); about 30% Fines; medium plasticity; fill material (SC).	%Recovery = 50 PID = 6.5ppm FC = F2	
54	D2							%Recovery = 64 PID = 6.8ppm	
2	D3					FILL	**SILTY SAND**: strong brown and brown; moist; about 5% fine to coarse Gravel; about 75% subangular fine to coarse Sand (max.4.8mm); about 20% Fines; no plasticity; fill material (SM).	%Recovery = 96 PID = 2.8ppm	
52	D4							%Recovery = 100 PID = 4.9ppm	
4	D5							%Recovery = 98 PID = 6.9ppm	
50	D6							%Recovery = 100 PID = 3.7ppm	
6	D7					CH	**FAT CLAY**: brown; moist; about 20% subangular fine to medium Sand (max.2mm); about 80% Fines; high plasticity; alluvial soil.	%Recovery = 100 PID = 6.5ppm	
48	D8 ▼					SC	**CLAYEY SAND**: brown; moist; about 65% subangular fine to medium Sand (max.2mm); about 35% Fines; medium plasticity; alluvial soil.	%Recovery = 87 PID = 8ppm	
8	D9					SC	**CLAYEY SAND**: brown; moist; about 70% subangular fine to coarse Sand (max.4.8mm); about 30% Fines; medium plasticity; residual soil; granite texture.	%Recovery = 56 PID = 7.4ppm	
46	D10 ▽					SM	**SILTY SAND**: brown; moist; about 80% subangular fine to coarse Sand (max.4.8mm); about 20% Fines; no plasticity; residual soil; granite texture.	%Recovery = 74 PID = 5.6ppm	
10									
44									
12									

Note:

1) Type of Samples
   G: Grab
   S: SPT
   P: Shelby Tube
   R: Rock Core
2) Groundwater Encountered After Drilling (AD)
3) PID = Parts Per Million, reading from PID (Photo Ionization Detector)

ENVIRO-EXPLORATION LOG 06-075E, CP CARROLL.GPJ USACE SKOREA.GDT 13/7/07

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US Army Corps Of Engineers

EXPLORATION LOG

HOLE NO. **M07-220**

Far East District

PROJECT: **Monitoring Well Construction.**

LOCATION: **Cp Carroll** G&EE NO.: **06-075E** INSPECTOR: [redacted] b6

DATE STARTED: **04 Apr 07** FINISHED: **04 Apr 07** DRILLER: [redacted] b6

DRILLING METHOD/EQUIPMENT: **Geoprobe**

DRILLING AGENCY: **Far East District** HOLE DIAMETER: **5 cm** TOTAL DEPTH: **12.0 m**

OVERBURDEN THICKNESS: DEPTH DRILLED: **12.0 m** WATER DEPTH: **2.96 m; AD**

COORDINATES: N: **3,983,304.6** E: **447,789.9** GROUND ELEV.: **49.77 m** DATUM: **MSL**

GROUND COVER: **Grass area** CONTAMINATION: **No**

TYPE OF HOLE: ☐ Piezometer ☒ Monitoring Well ☐ Test Pit ☐ Auger Hole ☒ other **Direct push**

ELEVATION / DEPTH (meters)	SAMPLE TYPE / NUMBER	GRAPHIC LOG	CONTAMINATED	BLOW COUNT	SPT N-VALUE	USCS / STRATA	DESCRIPTION OF MATERIALS	FIELD DATA	LAB DATA
0	D1					FILL	**SILTY SAND**: dark brown and strong brown; moist; about 5% fine to coarse Gravel; about 75% subangular fine to coarse Sand (max.4.8mm); about 29% Fines; no plasticity; fill material (SM).	%Recovery = 78 PID = 2.5ppm FC = F2	
48 / 2	D2							%Recovery = 72 PID = 3.6ppm	
	D3 ▼					FILL	**CLAYEY SAND**: strong brown; moist; about 70% subangular fine to coarse Sand (max.4.8mm); about 30% Fines; medium plasticity; fill material (SC).	%Recovery = 100 PID = 6.9ppm	
46 / 4	D4					FILL	**SILTY SAND**: strong brown; moist; about 80% subangular fine to coarse Sand (max.4.8mm); about 20% Fines; no plasticity; fill material (SM).	%Recovery = 90 PID = 11.2ppm	
	D5							%Recovery = 94 PID = 6ppm	
44 / 6	D6					CH	**FAT CLAY with Sand**: dark greenish gray; moist; about 20% subangular fine to coarse Sand (max.4.8mm); about 80% Fines; high plasticity; alluvial soil.	%Recovery = 100 PID = 2.7ppm	
	D7					SC	**CLAYEY SAND**: greenish gray; moist; about 65% subangular fine to coarse Sand (max.4.8mm); about 35% Fines; medium plasticity; alluvial soil.	%Recovery = 80 PID = 2.7ppm	
	D8 ▽							%Recovery = 86 PID = 3.8ppm	
42 / 8						SM	**SILTY SAND**: light brown; moist; about 80% subangular fine to coarse Sand (max.4.8mm); about 20% Fines; no plasticity; residual soil; granite texture.		
40 / 10									
38 / 12									

Note:

1) Type of Samples
   - G: Grab
   - S: SPT
   - P: Shelby Tube
   - R: Rock Core
2) Groundwater Encountered After Drilling (AD)
3) PID = Parts Per Million, reading from PID (Photo Ionization Detector)

ENVIRO-EXPLORATION LOG 06-075E. CP CARROLL.GPJ USACE SKOREA.GDT 13/7/07

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EXPLORATION LOG

US Army Corps Of Engineers

HOLE NO. **M07-221**

Far East District

PROJECT: **Monitoring Well Construction.**
LOCATION: **Cp Carroll** G&EE NO.: **06-075E** INSPECTOR: [redacted] b6
DATE STARTED: **04 Apr 07** FINISHED: **04 Apr 07** DRILLER: [redacted] b6
DRILLING METHOD/EQUIPMENT: **Geoprobe**
DRILLING AGENCY: **Far East District** HOLE DIAMETER: **5 cm** TOTAL DEPTH: **12.0 m**
OVERBURDEN THICKNESS: ____ DEPTH DRILLED: **12.0 m** WATER DEPTH: **6.13 m; AD**
COORDINATES: N: **3,983,324.8** E: **447,827.0** GROUND ELEV.: **54.61 m** DATUM: **MSL**
GROUND COVER: **Grass area** CONTAMINATION: **Yes**
TYPE OF HOLE: ☐ Piezometer ☒ Monitoring Well ☐ Test Pit ☐ Auger Hole ☒ other **Direct push**

ELEVATION / DEPTH (meters)	SAMPLE TYPE / NUMBER	GRAPHIC LOG	CONTAMINATED	BLOW COUNT	SPT N-VALUE	USCS / STRATA	DESCRIPTION OF MATERIALS	FIELD DATA	LAB DATA
0 / 54	D1					FILL	**SILTY SAND**: brown; moist; about 80% subangular fine to coarse Sand (max.4.8mm); about 20% Fines; no plasticity; fill material (SM).	%Recovery = 100 PID = 572ppm FC = F2	
	D2					FILL	**SILTY SAND with Gravel**: dark grayish-green; moist; about 20% subangular fine to coarse Gravel (max.3cm); about 60% subangular fine to coarse Sand (max.4.8mm); about 20% Fines; no plasticity; fill material (SM); 1.0 to 9.0 m; w/wood, metal chips and vinyl. strange smell to 9 meters..	%Recovery = 53 PID = 1816ppm FC = F2	
2 / 52	D3					FILL	**SILTY SAND**: black; moist; about 10% fine to coarse Gravel; about 70% subangular fine to coarse Sand (max.4.8mm); about 20% Fines; no plasticity; fill material (SM).	%Recovery = 80 PID = 123ppm	
	D4						Grayish green and strong brown.	%Recovery = 79 PID = 174ppm	
4 / 50	D5						Brown.	%Recovery = 84 PID = 8.3ppm	
	D6					SC	**CLAYEY SAND**: dark grayish-green; moist; about 70% subangular fine to coarse Sand (max.4.8mm); about 30% Fines; medium plasticity; fill material (SC).	%Recovery = 100 PID = 113ppm	
6 / 48	D7	▼				SM	**SILTY SAND**: brown; moist; about 80% subangular fine to coarse Sand (max.4.8mm); about 20% Fines; no plasticity; fill material (SM).	%Recovery = 78 PID = 7.6ppm	
	D8					CL	**LEAN CLAY with Sand**: grayish green; moist; about 20% subangular fine to medium Sand (max.2mm); about 80% Fines; medium plasticity; alluvial soil.	%Recovery = 68 PID = 6.2ppm	
						SM	**SILTY SAND**: strong brown; moist; about 80% subangular fine to medium Sand (max.2mm); about 20% Fines; no plasticity; alluvial soil.		
8 / 46	D9	▽				CH	**FAT CLAY**: dark gray; moist; about 10% subangular fine to medium Sand (max.2mm); about 90% Fines; high plasticity; alluvial soil.	%Recovery = 40 PID = 2.8ppm	
10 / 44	D10					SC	**CLAYEY SAND**: gray; moist; about 70% subangular fine to coarse Sand (max.4.8mm); about 30% Fines; medium plasticity; residual soil; granite texture.	%Recovery = 75 PID = 4.8ppm	
12						SM	**SILTY SAND**: brown; moist; about 80% subangular fine to coarse Sand (max.4.8mm); about 20% Fines; no plasticity; Tertiary soil deposit; granite texture.		

Note:

1) Type of Samples
   G: Grab
   S: SPT
   P: Shelby Tube
   R: Rock Core
2) Groundwater Encountered After Drilling (AD)
3) PID = Parts Per Million, reading from PID (Photo Ionization Detector)

ENVIRO-EXPLORATION LOG 06-075E, CP CARROLL.GPJ USACE SKOREA.GDT 13/7/07

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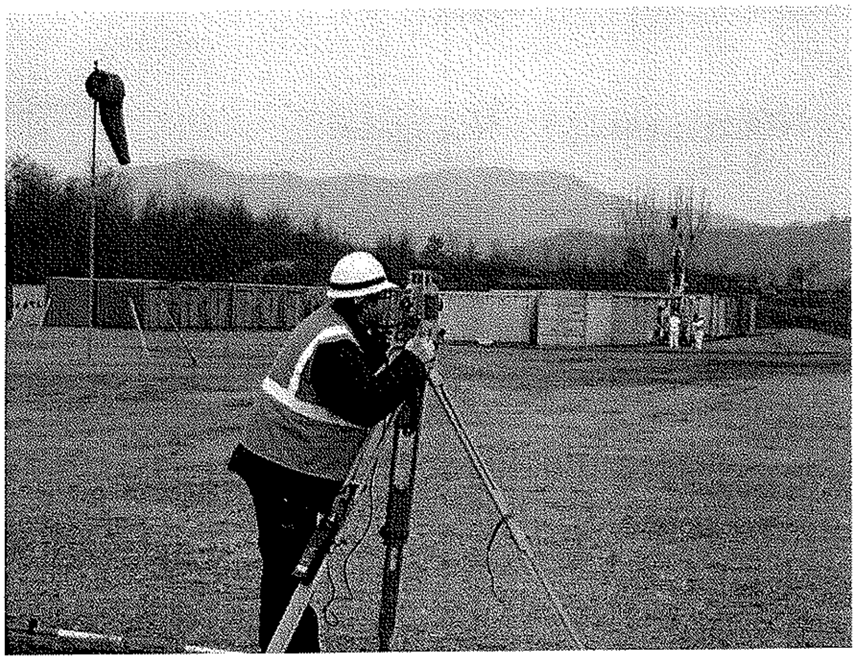
US Army Corps of Engineers
Far East District

Draft Report for

Remedial Investigation/Feasibility Study at Land Farm and Area D of Camp Carroll, Republic of Korea



March 2011

PREPARED FOR:
ENVIRONMENTAL DIVISION, DIRECTORATE OF PUBLIC WORKS, UNITED STATES ARMY GARRISON DAEGU

PREPARED BY:
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERING BRANCH, US ARMY CORPS OF ENGINEERS DISTRICT FAR EAST

1466

Executive Summary

The US Army Corps of Engineers, Far East District (FED) conducted a Remedial Investigation/Feasibility Study (RI/FS) at the Land Farm and Area D (LF-Area D) of Camp Carroll during February 2009 to March 2010. The RI at the site was conducted to better delineate the lateral extent of subsurface soil and groundwater contamination and the levels of chemicals of potential concern of the LF-Area D. The FS was also conducted to evaluate potential remedial alternatives for the site investigated.

All soil samples submitted to the analytical laboratory were analyzed for Total Petroleum Hydrocarbon (TPH), volatile organic compounds (VOCs), polyaromatic hydrocarbons (PAHs), metals, polychlorinated biphenyl (PCB), organochlorinated pesticides (OC-Pesticides) and Dioxin-Furan. Groundwater samples were collected from groundwater monitoring wells as well as the supply wells, and analyzed for VOCs and/or OC-Pesticides.

The analytical data collected during this RI was used to prepare an environmental hazard evaluation (EHE) for the site sampled, which determined whether the contamination present at the site poses a significant long-term or "chronic" threat to human health and the environment. The hazard analysis utilized an Environmental Screening Levels (ESLs) that were based upon published United States Environmental Protection Agency (US EPA) toxicity factors (Guam EPA, 2008).

A total of four chemicals from the subsurface soil exceeded the Tier 1 ESLs for future unrestricted land use: tetrachloroethlyene (PCE), toluene, dichlorodiphenyldichloroethane (DDD) and dichlorodiphenyltrichloroethane (DDT). The toluene concentration exceeded the Tier II screening level too. A total of ten groundwater samples were identified "exceeding" Tier I ESLs and nine of those exceeded the Tier II screening level for "drinking water for human toxicity". There are exposure pathways to the known receptors (potentially all installation personnel) whoever uses the groundwater within the installation. Assuming that the site is going to be under construction such as trenching and foundation excavation, the site worker could be directly exposed to the subsurface soil contamination.

It is recommended that the suspected waste buried at the site be removed to prevent further leaching chemicals to the groundwater system. And groundwater should be adequately treated prior to uptaking from the supply wells or before distributing to the buildings. After removal of buried waste and contaminated soil, a periodic monitoring of groundwater quality and subsurface is recommended to evaluate the environmental condition of the site whether change of the concentration level, natural attenuation and contaminant degradation are occurring.

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1. Introduction

This report describes the work results obtained from the Remedial Investigation (RI)/Feasibility Study (FS) conducted for the Land Farm and Area D, which are located at the central eastern portion of Camp Carroll.

This RI/FS project was conducted by US Army Corps of Engineers, Far East District (FED), with support from FED's Environmental IDIQ contractor Beautiful Environmental Construction (BEC). This report was developed in accordance with industry standards and US Environmental Protection Agency (EPA) guidelines for sampling and analysis. All field and analytical work was conducted according to the Work Plan (WP) and Site Safety and Health Plan (SSHP) developed by FED.

1.1. Project Authority.

FED was authorized by the US Army Garrison Daegu (USAG-Daegu) Directorate of Public Works (DPW), US Forces Korea (USFK) to conduct a "Remedial Investigation" on 30 April 2008 and a "Feasibility Study" on 20 April 2009 at Land Farm and Area D through MIPR 8GDBPENV06 and MIPR 9GDATENV05, respectively.

1.2. Project objectives

The overall objective of this RI/FS was to delineate the nature and extent of contamination, assess if the contamination identified at the site posed a threat to human health, and evaluate reasonable remediation alternatives to address contaminants that pose a significant threat.

The following specific objectives were addressed during this RI/FS for Land Farm and Area D.

1) Assess the presence of total petroleum hydrocarbons (TPH), polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), polychlorinated biphenyl (PCB), metals, dioxins, and organochlorinated pesticide (OC-pesticide) in subsurface soil and groundwater.
2) Assess the potential migration of VOCs from groundwater at the site to nearby operating drinking water supply wells.
3) Determine the environmental hazard posed by the contamination present by comparing site data with conservative Environmental Screening Levels (ESLs).
4) Evaluate various potential remedial approaches for any significant threats identified at the project site.

1.3 Guidance Considerations

An environmental hazard evaluation was prepared for Land Farm and Area D of USAG-Daegu. Since there is no specific guidance to do hazard evaluation in terms of the application of regulations, there are a couple of considerations about regulatory guide lines to be applied. First, the Soil Environment Preservation Act (SEPA) of the Korean Environmental Standards was considered (Table 1-1). Since the SEPA warning level considers only for a possible adverse effect due to existence of contaminants, the use of criteria does not meet the actual hazard evaluation because it does not consider toxicity data of chemicals when human being or a habitat is exposed.

Next, for the environmental screening levels (ESLs) of this project, three criteria were considered: Californian, Guam EPA and Region IX. Those are similar in terms of number for screening level, with minor differences. One of reason to eliminate the Region IX's regional screening level is that the criteria do not deliver the hazard level of TPHs which is one of major chemicals dealing in this project. The Californian criteria are considered too conservative in comparison with the criteria in SEPA to apply for this project. The hazard evaluation utilizes conservative ESLs found in the Pacific Basin Edition of the document titled *Evaluation of Environmental Hazards at Sites with Contaminated Soil and Groundwater* which was last updated in October 2008 (Guam EPA, 2008). The risk assessment utilizes the soil and groundwater analytical data collected during the field work conducted from April 2009.

The ESL values were determined largely based upon published USEPA toxicity factors, water standards and recently promulgated RSLs. The Tier 1 ESLs selected for these sites are appropriate for future unrestricted land use of sites containing shallow (<3 meters) or deep (>3 meters) contaminated soils that are underlain by groundwater that is a potential source of drinking water. Sites that are contaminated greater than Tier 1 screening levels were evaluated in greater detail by considering site-specific characteristics during a Tier 2 screening analysis overseen by the project team risk evaluator.

Table 1-2 lists the Tier 1 default ESLs for the COPC for the unrestricted land use (most conservative scenario) and construction worker scenarios, where the underlying groundwater is considered a potential source of drinking water along with the existing Korean soil and groundwater standards. The construction worker ESLs are presented instead of the commercial/industrial land use ESLs. Generally, the project site is covered with asphalt or concrete, therefore the outdoor worker considered in the commercial/industrial land use scenario would have very limited contact with surface soils. In such cases, the more relevant commercial receptor who may come in direct contact with contaminated soils is the construction/trench worker. Because the exposure time for construction workers is significantly less than a full-time commercial worker or typical residential user, the construction worker ESLs are less stringent. If the project site is not mostly covered with asphalt/concrete, it is necessary to consider direct exposure to chemicals of concern by evaluating the commercial/industrial land use scenario and associated ESLs.

Table 1-1. Soil Criteria of Soil Environmental Preservation Act (SEPA, 2009).

Chemicals	Warning Concentration (mg/kg)			Countermeasure Concentration (mg/kg)		
	Area "1"	**Area "2"**	**Area "3"**	**Area "1"**	**Area "2"**	**Area "3"**
Cadmium(Cd)	4	10	60	12	30	180
Copper(Cu)	150	500	2000	450	1500	6000
Arsenic(As)	25	50	200	75	150	600
Mercury(Hg)	4	10	20	12	30	60
Lead(Pb)	200	400	700	600	1200	2100
Hexavalent chromium	5	15	40	15	45	120
Zinc(Zn)	300	600	2000	900	1800	5000
Nickel(Ni)	100	200	500	300	600	1500
Fluorine(F)	400	400	800	800	800	2000
Organophosphorus	10	10	30	-	-	-
Polychlorinated Biphenyls	1	4	12	3	12	36
Cyanide	2	2	120	5	5	300
Phenol	4	4	20	10	10	50
Benzene	1	1	3	3	3	9
Toluene	20	20	60	60	60	180
Ethylbenzene	50	50	340	150	150	1020
Xylens	15	15	45	45	45	135
Total BTEX	86	86	448	258	258	1344
Total Petroleum Hydrocarbons	500	800	2,000	2000	2400	6000
Trichloroethylene(TCE)	8	8	40	24	24	120
Perchloroethylene (PCE)	4	4	25	12	12	75
Benzopyrene(a)*	0.7	2	7	2	6	21
SEPA- Area "1", "2", and "3' after June 2009 in accordance with "the Record of Land Registration"						
Area "1" = residential, farmland, schools, rivers, parks, historical site, kid's outdoor playground.						
Area "2" = forest, salt farm, warehouse, stream, water intake area, recreational area, religion area.						
Area "3"= industrial area, parking lot, gas station area, roads, railroads, levee, military installation						
* Benzopyrene is only applicable for the areas that used to store/use toxic chemicals and/or to use a crosstie (ex. railroad, park, industrial area, stream area).						

Table 1-2. Tier 1 Environmental Screening Levels (ESLs) for Unrestricted Land Use of ROK and U.S. Regulatory Levels for Soil, Groundwater.

Analyte	[1] ROK Soil Regulatory Criteria (mg/kg)	Pacific Basin Tier 1 ESLs: Soil (mg/kg)	Pacific Basin Construction Worker ESLs: Soil (mg/kg)	[2] ROK Groundwater Regulatory Criteria (µg/L)	Pacific Basin Tier 1 Environmental Screening Levels: Groundwater (µg/L)
TPH-GRO*	2,000	100 / 600*	4500†	None	100
TPH-DRO	2,000	100 / 500*†	500†	None	100
TPH-RRO	2,000	100 / 2,300*	65000	None	100
Benzene	3	0.3	110	10	5
Toluene	60	3.4	930	700	40
Ethylbenzene	340	1.6	550	300	30
Total Xylene	45	2.3	440	500	20
Total BTEX	448	7.6	2030	1510	95
Anthracene		2.5	77000	None	0.73
Benzo(a)pyrene	None	0.15	18	None	0.014
Benzo(a)fluoranthene	None	1.5	180	None	0.092
Benzo(k)fluoranthene	None	1.5	1700	None	0.4
Benzo(a)anthracene	None	1.5	180	None	0.027
Benzo(g,h,i)perylene	None	27	10000	None	0.1
Chrysene	None	14	17000	None	0.35
Naphthalene	None	0.46	490	None	17
Phenanthrene	None	11	10000	None	4.6
Pyrene	None	56	7800	None	2

1- Values after June 2009, 2- concentrations after 2003

*Screening Level for TPH Constituent Based Upon Human Health Direct Exposure Values

†ESL is based on saturation limit, not potential health effects from direct exposure.

2. Site Description and History

2.1. Camp Carroll

Camp Carroll is a U.S. Army Installation located adjacent to the village of Waegwan in the south-central portion of Korea (Figure 2-1). Camp Carroll serves as the Headquarters, U.S. Army Material Support Center and functions as a staging ground for U.S. military operations on the Korean Peninsula. The primary mission of the base is to serve as a staging facility and a storage and maintenance depot. Urban areas bound Camp Carroll on the northwest, west and southwest. Hilly, forested areas bound the base on the north and east. Agricultural fields (mostly rice paddies) border the camp on the northeast and the south. The Naktong River flows north-south approximately 0.5 kilometers west of Camp Carroll. The Land Farm and Area D sites are located at the central eastern installation boundary Camp Carroll, next to the H805 helipad. Figure 2-2 presents the location of Land Farm and Area D at Camp Carroll.

2.2. Land Farm

The Camp Carroll Land Farm consists of three engineered units for treatment of .... Two of the units are treatment beds, referred to as Bed #1 (east bed) and Bed #2 (west bed) and the third unit is a water retention pond. The dimensions of each treatment bed, which is bounded by a berm, are approximately 70 meters by 30 meters. The dimensions of the water retention pond are approximately 30 meters by 20 meters. The total Land Farm site is approximately 9,100 square meters.

Camp Carroll environmental DPW personnel suspect that contaminated soil and material from Area #41 (which was ...) were disposed of in the area now occupied by the Land Farm. Their suspicions are based on the fact that contaminated soil and waste materials, such as one-gallon cans were uncovered during the excavation and construction of Bed #1 in 1995 (northwest corner of Bed #1). The Land Farm is also located near to Area D.

2.3. Area D

Area D is a former hazardous waste disposal area. Numerous hazardous materials were disposed in this disposal area between the years of 1977 and 1982. Personnel interviews indicated that numerous drums of hazardous materials were transported to Area D from Area 41. Area 41 was a ... The drums contained a variety of chemicals including pesticides (including DDT), herbicides, solvents, and over 100 other detected chemicals. The disposal area dimensions were approximately 150 meters (m) by 75 m in area; and 6 m to 9 m deep.

Reportedly, much of the disposal area material and surrounding soil was excavated between 1982 and 1983 and placed into 55-gallon drums. The fate of the excavated drums is unknown. Despite the removal activity, residual amounts of contaminated material may have remained. No visual evidence of hazardous waste disposal, such as soil discoloration, dead vegetation, or hummocky terrain, was observed during a 1992 site inspection performed by a Woodward-Clyde Consultants field team.

2.4. Summary of Previous Investigations

The two areas to be investigated have been previously evaluated for environmental conditions during an environmental site assessment ((ESA) and preliminary assessment/site investigations (PA/SIs) as follows:

Land Farm:

- Woodward Clyde in 1992?
- ESA by FED in December 2004
- Soil sampling to support of construction of treatment bed by COEFED in February 2008
- Excavation of buried construction wastes, drums and cans of unknown chemicals during excavation for constructing a new treatment bed by the contractor (ECO solution) in March 2008

Area D:

- Site Investigation by Samsung in July 2004

2.4.1. Land Farm

In 1992, monitoring well MW-23 was constructed by Woodward-Clyde personnel approximately 140 meters west of the Land Farm facility. No VOCs, SVOCs or organophosphorus (OP)-pesticides were detected in the groundwater sample collected from the monitoring well in 1992.

In 2004, results of soil sampling during the ESA showed site soils were contaminated with VOCs. Most of the detected VOCs were solvent-related chemicals. VOC contamination was detected as deep as 6 to 8 meters below ground surface. In addition, several pesticide, metal, and dioxin/furan compounds were also detected in site soils. Arsenic was detected in one soil sample at a concentration greater than the EPA guidance level for protection of ground water. Preliminary findings indicate that VOC and arsenic contamination exist in site soils and the levels could contribute to the contamination of the underlying ground water. Ground-water contamination could pose a threat to human health, because ground-water supply wells are used for Camp Carroll's potable water supply.

In 2007, soil and groundwater were sampled and analyzed by FED to determine … Results showed there were no chemicals released into the environment from the treatment bed in use. However, results of soil sampling showed that concentrations of VOCs were present, including PCE and TCE, that exceeded EPA Region IX PRGs for residential soil and for tap water. In addition, concentrations of organochlorinated (OC)-pesticides exceeded EPA Region IX PRGs for residential soil. Mixed TPH of JP-8, diesel and oil was identified from one soil boring with the concentration of 10,000 mg/kg. Groundwater sampling result indicates that concentrations of VOCs including PCE and TCE exceeded USEPA PRGs for tap water. Concentrations of arsenic, lead and OC-pesticide were detected in groundwater samples exceeding USEPA PRGs for tab water.

In 2008, during soil excavation in support of a new treatment bed, approximately 2,200 cubic meters of contaminated soils with various chemicals were excavated and stockpiled within the Land Farm facility. In association with the contaminated soil, tons of buried materials were uncovered such as 55gallon drums, 5 gallon cans and construction debris. Most 55 gallon drums were crushed and empty; one of them contained petroleum oil lubricant (POL)-like liquid that was not tested. The 5-gallon cans contained an odorless white-powder, but also were not tested.

Despite the removal and excavation activities, residual amounts of contaminated material likely remained. Figure 2-3 to 2-4 summarizes the previous investigation results at Land Farm.

2.4.2. Area D

In 2004, Samsung Co. conducted site investigations at Area D, and reported that the soil contained numerous contaminants including TPH-G, TPH-D, TPH-O, VOCs, SVOCs, pesticides, metals, and dioxins. Several soil contaminant concentrations exceeded EPA Region IX preliminary remedial goal (PRG) screening criteria. Groundwater samples obtained from Area D monitoring wells contained concentrations of TPH-G and TPH-D, VOCs, SVOCs, pesticides, metals, and dioxins. Figure 2-5 summarizes the previous investigation results at Area D.

2.5. Identification of Data Needs

2.5.1. Land Farm

Previous environmental investigations at the site found concentrations of VOCs, OC-pesticides, and metals that exceeded ESLs in soils from the site subsurface soil and groundwater. During excavation in support of treatment bed construction, tons of buried drums and cans were uncovered from the Landfarm bed #1. Although no chemical data are available, the removal activities of buried drums and cans containing various chemicals are to believed to have been the source for soil and groundwater contamination. Groundwater quality is a primary concern for the installation because it is the source of drinking water. The detection of several VOCs in groundwater from the supply wells. Table 2-1 summarizes the groundwater test results for TCE collected from the supply wells and some buildings following treatment by the aeration tower that was installed in early 1990. The concentration ranged from not detected (ND) to 1,229 μg/Liter. The highest concentration was found at the Well #15 located about 500 meters west of the Land Farm and Area D. Based on the distribution of TCE detected in the supply wells, the TCE contamination in supply wells is not likely to come from a single source. Figure 2-6 shows the location of supply wells with the chemical test data (the highest number) presented in Table 2-1 at Camp Carroll.

This RI/FS at the Land Farm site will focus on the groundwater quality to evaluate a threat to human health. To evaluate the groundwater quality of the supply wells in association with the groundwater quality at the Land Farm area, three groundwater monitoring wells (estimated 30 meter deep) were installed between the supply wells and the Land Farm to monitor the gradient of groundwater quality from the Land Farm to the supply wells. The contaminants of concern in this RI/FS at Land Farm are VOCs in groundwater.

2.5.2. Area D

The SI for Area D by Samsung in 2004 evaluated groundwater conditions and identified site surface soil contamination, but did not evaluate the vertical extent of contamination. This RI/FS at Area D expanded the SI and determined the vertical and the lateral extent of contaminations in the subsurface soil. In addition, groundwater monitoring wells were installed to determine the groundwater condition. This RI/FS report evaluates whether the soil and groundwater at the site poses a threat to human health. The contaminants of concern (CoC) for this RI/FS at Area D focuses on TPH, VOCs, semi-VOCs (SVOCs), OC-pesticides, metals, and dioxins in soil; and VOCs, PAHs, and OC-pesticides in groundwater.

Table 2-1 Trichloroethylene (TCE) Concentrations (ug/L) in Groundwater Sample from the Production Wells at Camp Carroll from 1991 to 1996.

Collection Point	28-May-96	23-Apr-96	27-Feb-96	23-Jan-96	4-Dec-95	7-Nov-95	19-Sep-95	8-Aug-95	11-Jul-95	9-May-95	7-Mar-95	2-Nov-94	24-Oct-94	9-Sep-91
Well #1	4.4	-	5.6	5.9	-	-	-	-	-	-	-	-	3.2	5.66
Well #2	21.4	-	13.8	-	-	-	-	-	-	-	-	-	20.4	3.39
Well #3	<0.5	-	<0.5	<0.5	-	-	-	-	-	-	-	-	<0.5	22.22
Well #6	103.1	-	63.9	72.7	-	-	-	-	-	-	-	-	36.8	-
Well #8	<0.5	-	0.5	-	-	-	-	-	-	-	-	-	<0.5	<0.2
Well #10	-	-	-	<0.5	-	-	-	-	-	-	-	-	<0.5	<0.2
12-247	250.7	-	240	368.1	-	-	-	-	-	-	-	-	204.1	116.97
13-279	-	-	-	-	-	-	-	-	-	-	-	-	252.4	125.1
14-283	8.1	-	15.2	8.8	-	-	-	-	-	-	-	-	26.1	-
15-286	1229	-	188.6	217.8	-	-	-	-	-	-	-	-	161.4	-
16-289	22.2	-	28.7	29.5	-	-	-	-	-	-	-	-	44.4	-
Well #17	-	-	-	4.4	-	-	-	-	-	-	-	-	-	-
Well #18	<0.5	-	0.6	<0.5	-	-	-	-	-	-	-	-	-	-
Aeration Tower (all mixed)	79.3	56.6	36.7	92.5	89.4	71.1	64	19	39.4	58.9	34.2	62.2	58	
S-262 Barracks	-	-	-	-	1	1.1	1.6	1.1	4	1.4	0.8	1.7	0.6	-
S-108 BEQs	1.3	0.7	1.3	0.9	0.8	0.9	1.6	1.1	3.3	1.5	1.1	1.7	-	-
S-627 Distribution Room	0.7	1.2	1.2	0.9	0.8	1.1	1.4	1	2.8	1.5	0.7	1.8	0.5	-
S-111 Snack Bar	1.3	-	1.3	1	-	-	-	-	-	-	-	-	-	-
S-117 WCC	1.2	-	1.3	-	-	-	-	-	-	-	-	-	-	-
S-101 BOQ	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Figure 2-1. Location of Camp Carroll in Republic of Korea.

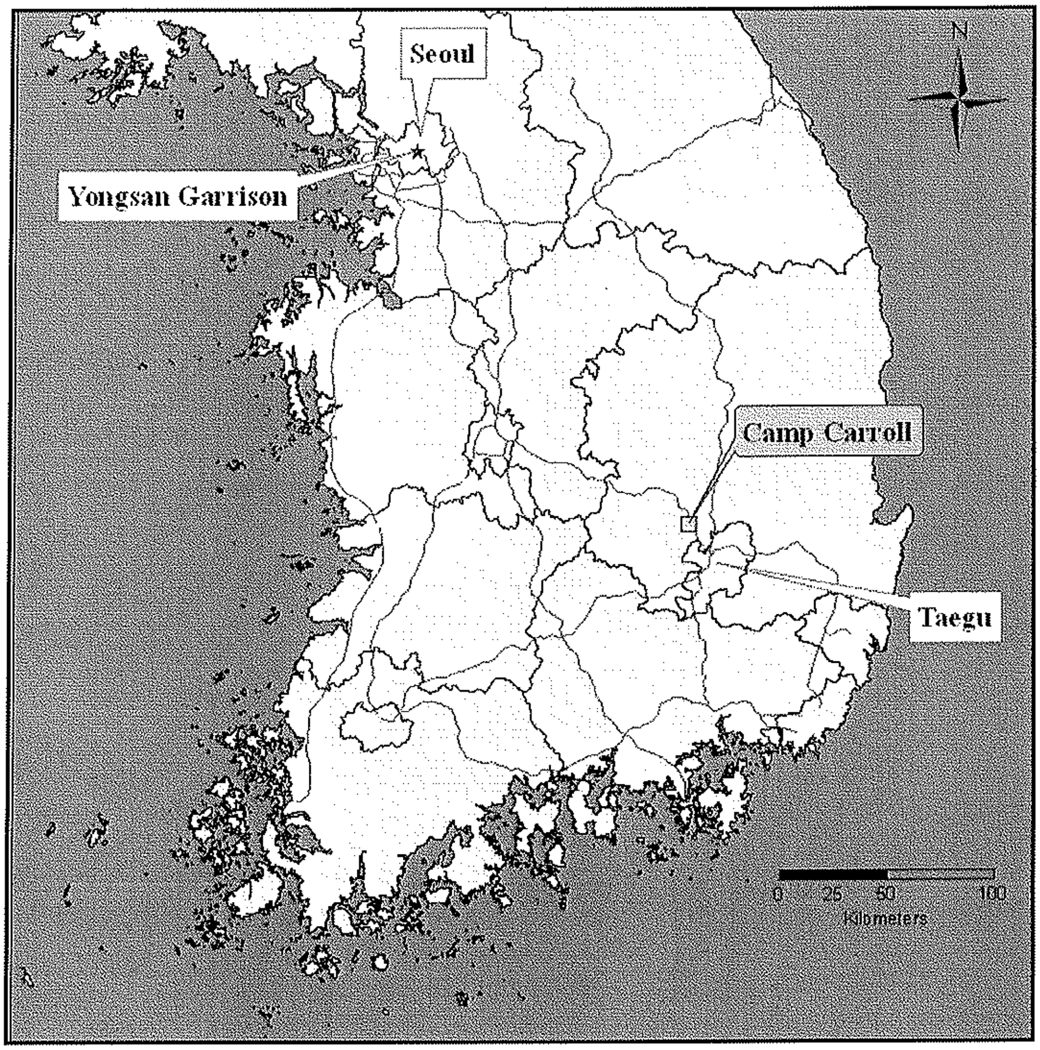


Figure 2-2. Location of Land Farm and Area D at Camp Carroll.

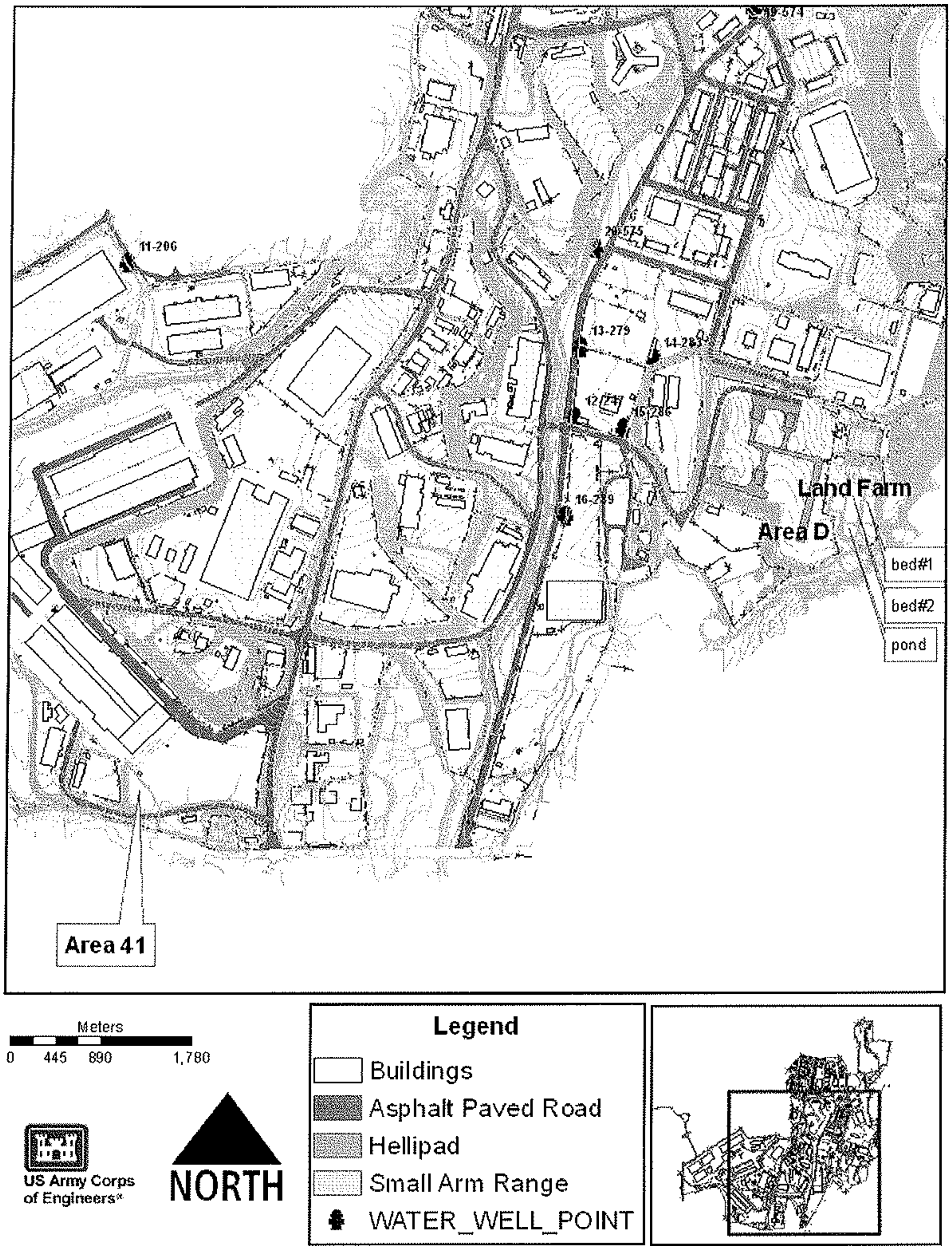


Figure 2-3. Tetrachloroethene (PCE) in the Subsurface Soil at Land Farm by FED in 2007.

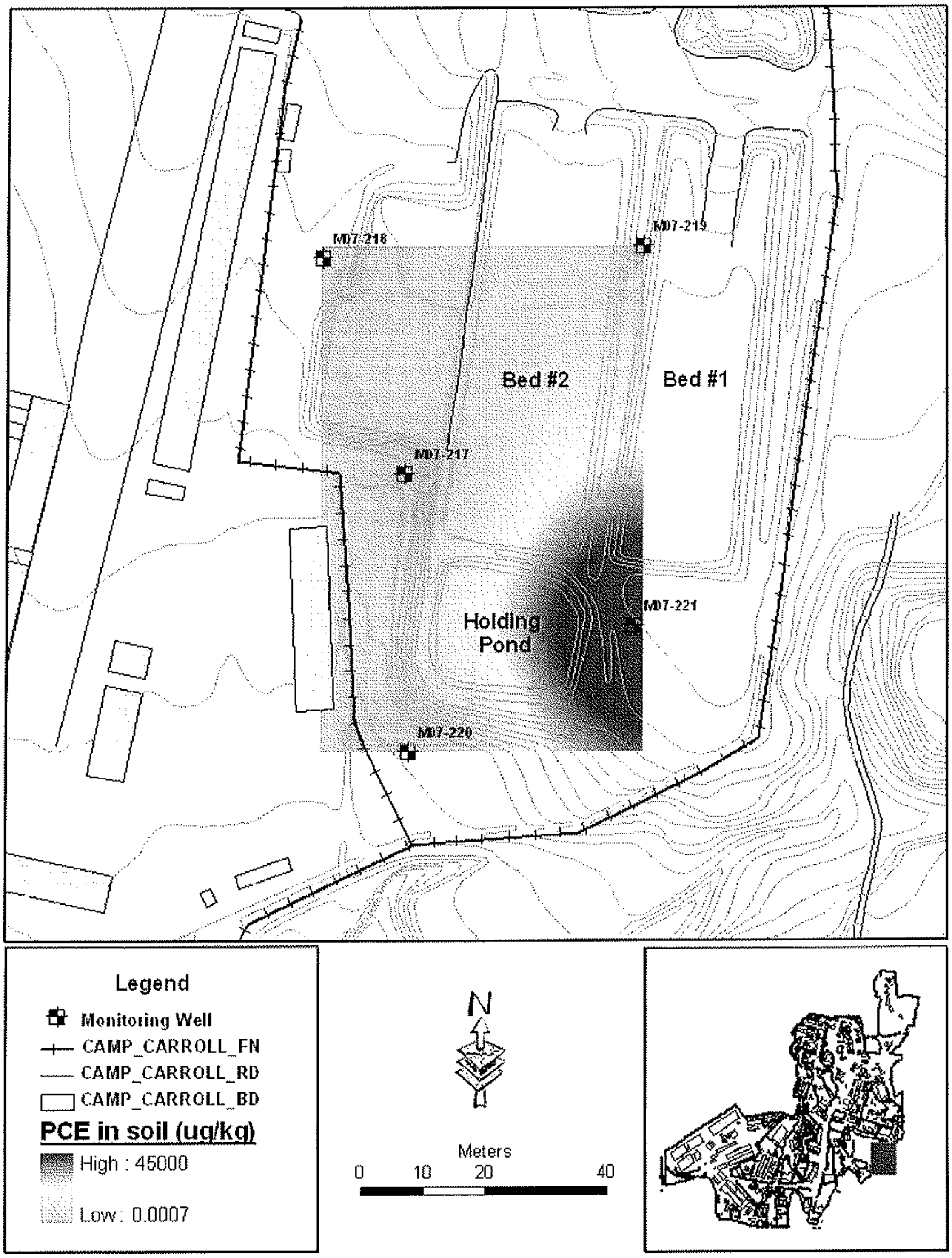
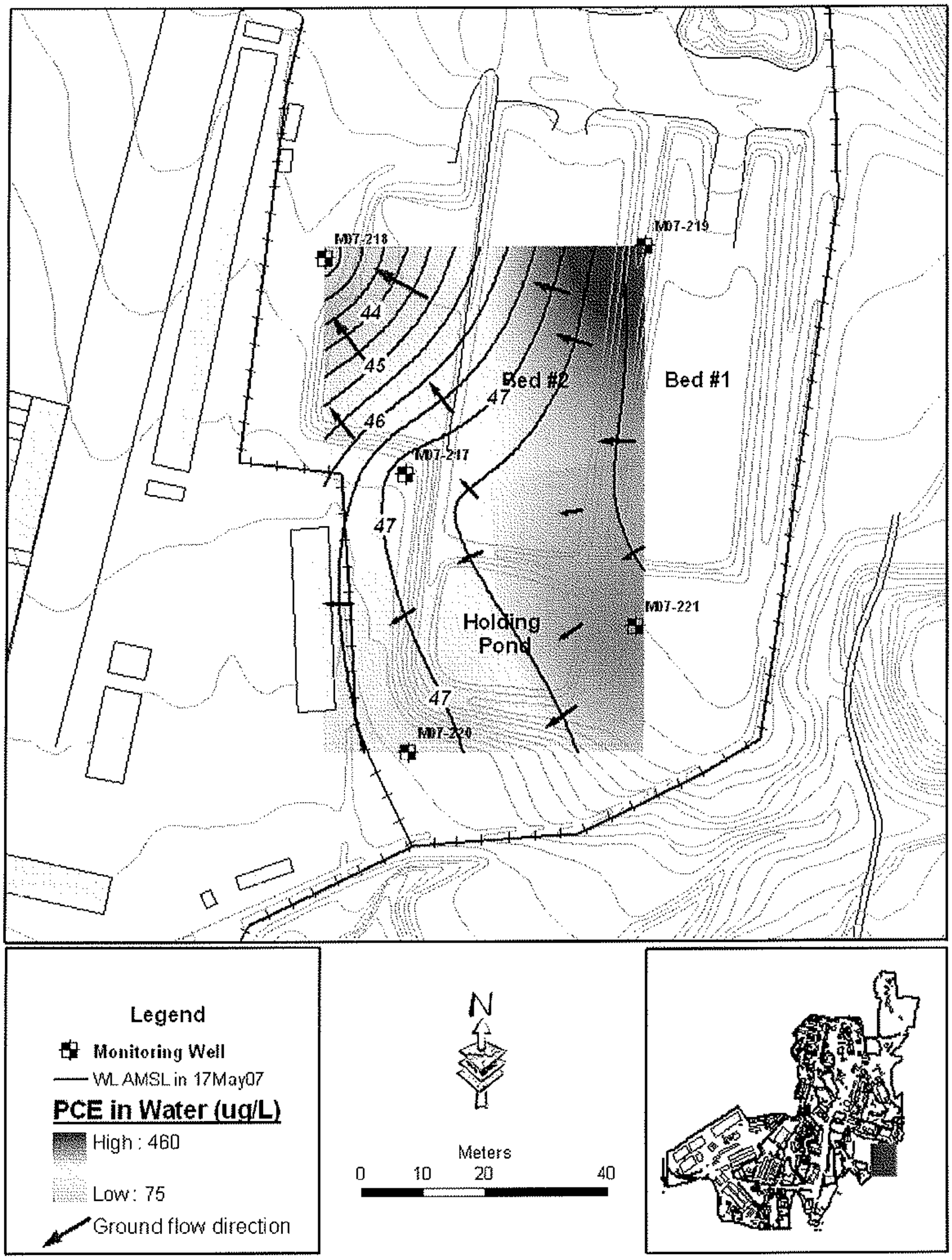


Figure 2-4 PCE in the Groundwater Sample at Land Farm by FED in 2007.



WL AMSL- water level above mean sea level

Figure 2-5 Previous Soil investigation result by Samsung in 2004 around Area D.

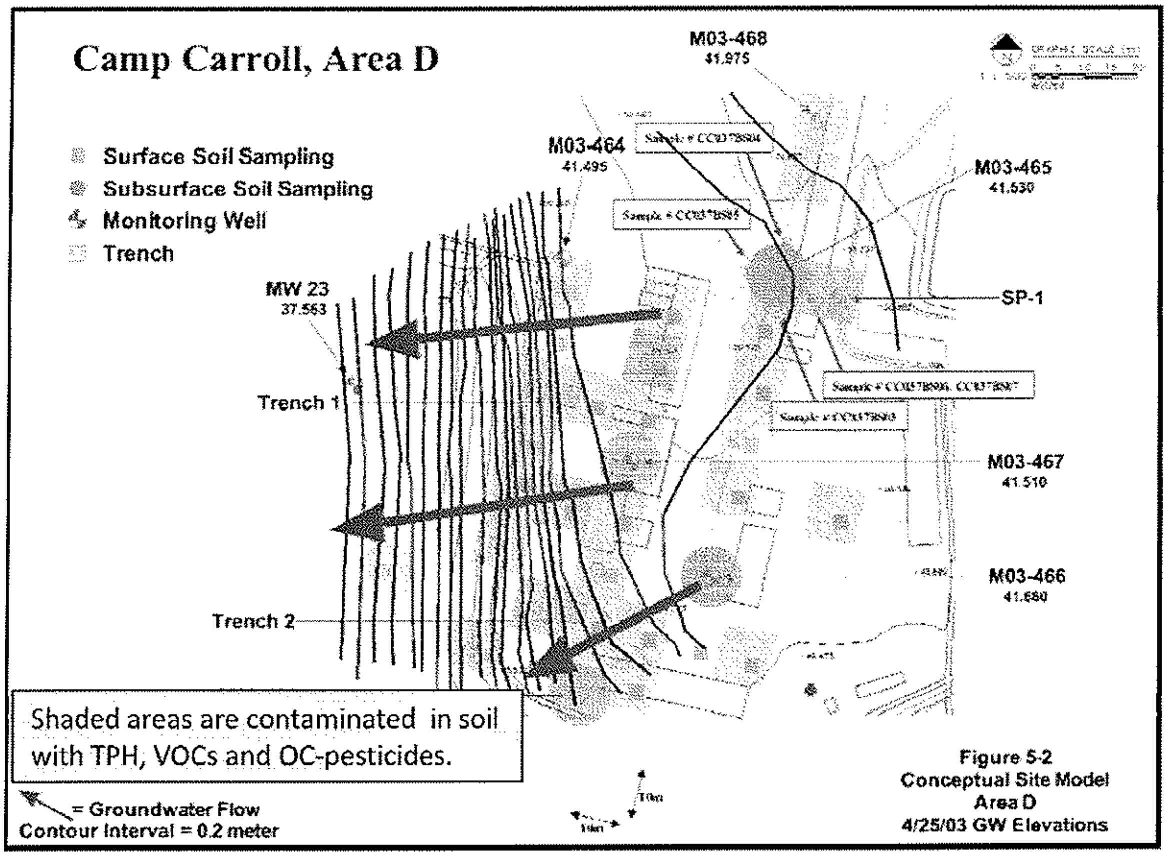


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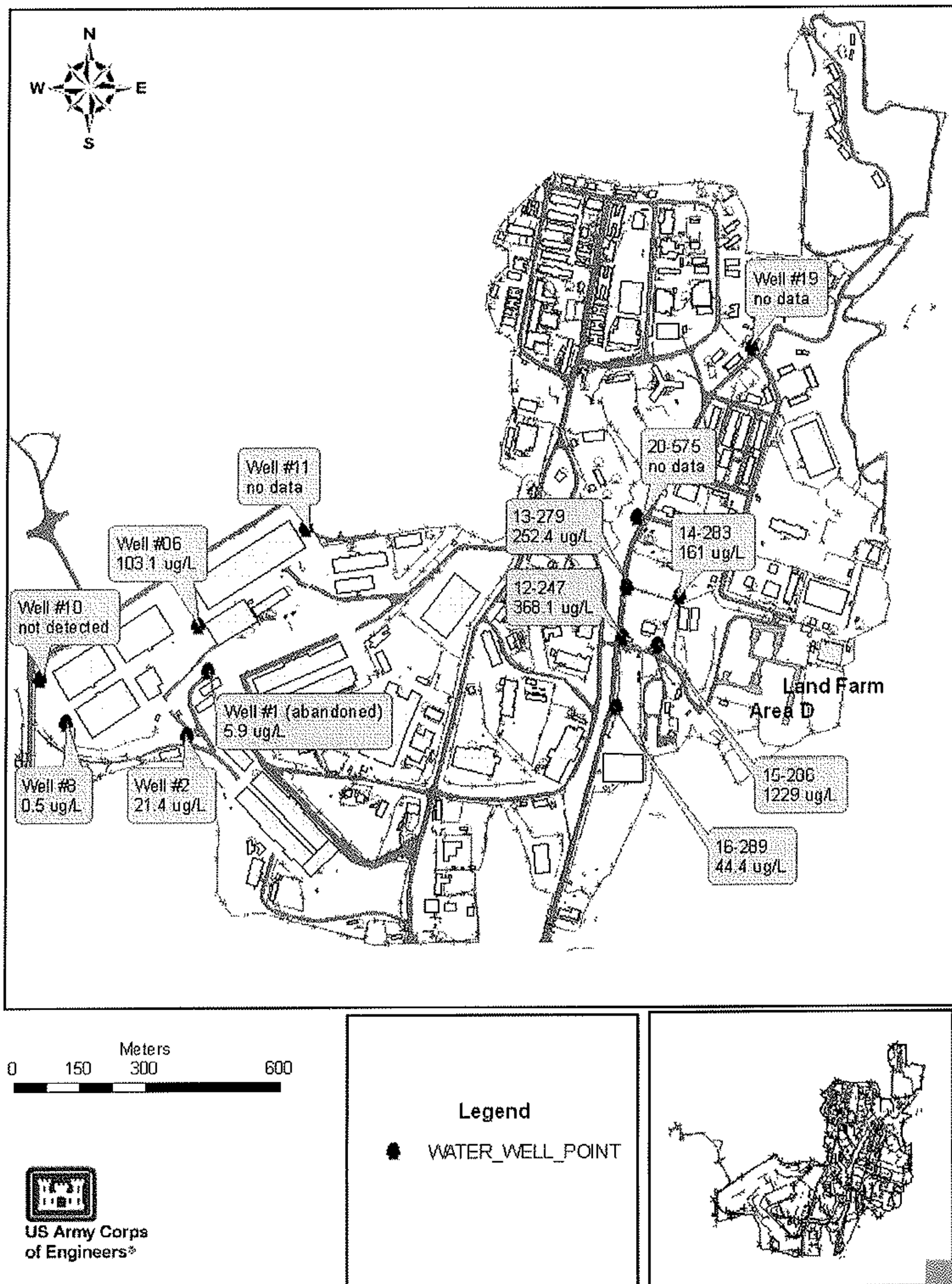
Figure 2-6 Historical TCE test result for Groundwater of the Supply Wells at Camp Carroll during 1991~1996.



3. Field Activity

3.1. Field Activities

Field procedures for this RI/FS followed the description in the project Work Plan. A total of three groundwater monitoring wells were installed as a groundwater quality assessment for Land Farm. A total of thirteen boreholes were drilled for soil sampling at Area D and two of those were converted to groundwater monitoring wells.

Since the Land Farm and Area D are located physically next to each other, for continent, hereafter the project site is referred to "**LF-Area D**". All sample collection and analyses were conducted in accordance with industry standard practice and in strict accordance with the requirements of the project specific Site Safety and Health Plan. The resultant data was used to help determine the spatial extent of contamination and whether significant subsurface contamination with the chemicals of concern at the site is present in soil and groundwater of the project site. The analytical results were used to conduct a human health risk assessment with a comparison to the Environmental Action Levels. The project chronology is summarized in Table 3-1.

3.2. Borehole drilling and soil sampling

Borehole locations were chosen prior to actual field work to provide areal coverage based on the existing available data. During performance of the field work, some proposed borehole locations were moved to avoid underground and aboveground utilities and for drill rig accessibility. The number of subsurface soil collection intervals was determined by target depth, apparent contamination, depth to shallow groundwater, and depth to bedrock. Soil samples submitted for laboratory analyses were chosen based on field observations and a Photo Ionization Detector (PID) reading to determine the level of concentrations of the chemicals of concern. Soil samples were collected from every two meters interval to the bottom of each borehole to describe soil visual properties and to submit the samples to the laboratory. Two boreholes were converted into groundwater monitoring wells (B09-193MW and B09-221MW). Those wells are to monitor groundwater quality and to measure the groundwater level.

Borehole drilling for soil samples was conducted using a direct push soil probing machine (GeoProbe). The GeoProbe minimizes cuttings and creates a smaller diameter borehole that is easily grouted/filled after all subsurface soil samples are collected. Using a GeoProbe, continuous soil cores were collected from the surface to the target depth. Subsurface soil sample cores were collected by advancing an open barrel sampler with a plastic sample liner (3.7 cm inner diameter) through the sample interval equivalent to the barrel length or less (normally about 0.9 m). After the barrel sampler was pushed through the desired depth interval, the sampler was extracted from the hole and the plastic liner, containing the soil sample, was removed from the barrel sampler. The discrete soil sample required for chemical analyses (e.g., TPH) was collected from the desired depth by retrieving it from the appropriate interval of the plastic liner. Figure 3-1 presents the soil boring location, Appendix I presents the soil bore logs.

A portion of each recovered soil sample was placed into a sealable plastic bag and the headspace was analyzed for VOCs with a PID. All soil samples were subsequently placed in zip-lock bags and kept in an ice-cooler for preservation until field screening tests were performed if required. Information on the sample container labels included project number, installation name, analysis required, sample identification number, depth, name of sample collector, and date and time of collection.

3.2.1. Headspace Analysis

Field sampling included the collection of representative headspace samples from each sampling area of concern. Soil samples were collected at periodic depths for headspace analysis to provide an indication of the vertical extent of VOC contamination within each soil core. Headspace samples were placed into individual sealable plastic bags. Then, the probe tip of a PID was inserted into the plastic bag to take a reading of the concentration of volatile contaminants present in the sample headspace.

After completion of borehole drilling, the top of borehole was plugged to keep the borehole gas inside the hole and take a measure using a PID. The PID readings were recorded by field personnel and ultimately transferred to the electronic boring log.

3.2.2. Soil Sample Identification

Each soil sample has a unique identification number that is consistent with borehole and monitoring well IDs used in previous investigation. The sample identification format provides general information about the boring type, year of investigation, and depth interval. The sample identification number used in this project follows this format: B09-XXX-S#, where

B indicates that the sample came from a soil boring
09 is the year in which the soil boring was drilled (i.e. 2009)
XXX is the sequential soil boring number
S indicates soil sample
is the sequential sample number, from top-down in the boring
MW instead of S# indicates monitoring well after soil boring.

3.3. Groundwater Monitoring Well Construction.

3.3.1. Monitoring well construction

A groundwater monitoring well installation was utilized two different rig types depending upon the well depth. In case of deep well drilling through the bed rock a FED-owned DRILTECHT40KW – Air Percussion Down-the-Hole Hammer drill rig was utilized for three monitoring wells (B09-176MW ~ 178MW). Relatively shallow monitoring wells were installed after completion of borehole drilling using a Direct Push GeoProbe. The depth of the wells and the length of the screen intervals varied depending on the site specific characteristics observed during soil boring. The well locations were chosen based on their location relative to known groundwater contamination as well as getting additional areal coverage in relation to the existing monitoring wells.

In case of FED-owned Drill Rig, a 25 centimeter (cm) diameter air percussion hammer was used to drill the hole as slightly larger diameter (20 cm) temporary steel casing is pushed and hammered into the subsurface to hold back the overburden and weathered bedrock. After the hammer has reached the target depth, it was removed from the hole. The monitoring well casing material was then placed inside the temporary steel casing.

In case of GeoProbe a 12-cm diameter air percussion hammer was used to drill the hole as slightly larger diameter (14-cm) temporary steel casing is pushed and hammered into the subsurface to hold back the overburden. After the hammer has reached the target depth, it was removed from the hole. The monitoring well casing material was then placed inside the temporary steel casing. The steel casing was gradually removed from the hole as the annulus was filled with medium grained sand filter pack, bentonite, and grout.

Ground-water monitoring well construction materials include 5.04-cm inside diameter (ID) threaded Schedule 40 polyvinyl chloride (PVC) solid pipe and slotted screen. Solid 5.04-cm ID schedule 40 PVC pipe with threaded ends was used from approximately 10-cm below ground surface (bgs) to a depth of approximately 3-meter above the level when groundwater encounters first during soil boring. A 0.254-mm slotted PVC well screen was threaded onto the bottom of the solid well-pipe to the base of the borehole. A PVC well point was screwed to the bottom of the well screen and a well cap was secured to the top of the well pipe. The annular space around the well from the bottom of the borehole to a minimum of 50 cm above the top of slotted section was filled with clean medium-grained silica sand (0.4-1.2 mm). A 30-cm thick seal of bentonite pellets was placed above the sand pack, and the bentonite pellets are hydrated either by water inside the borehole from cascading perched water or using a known clean water source. The remainder of the hole was filled with a Portland Type I cement grout to just below the frost line. Once the grout cured, concrete was used to fill the rest of the annulus around the well pipe. The wells were then completed with a flush-mount and concrete pad. Groundwater monitoring well location is presented in Figure 3-1 and the construction process was logged and placed in the Appendix II.

3.3.2. Monitoring Well Development.

After installation, all wells were fully developed. The objectives of well development were to (1) remove sediment that had settled inside the well during construction; (2) remove all water that may have been introduced during drilling and well installation; (3) remove very fine grained sediment in the filter pack and nearby formation so that groundwater samples would not be turbid and well silting does not occur; and (4) improve the flow into the well from the adjacent formation, thus yielding a representative groundwater sample and an accurate water level measurement.

Well development consisted of surging by a surge block and pumping out the tubid water using BEC's vacuum truck until a noticeable reduction in sediment occurred in the discharged water. This development continued for a minimum of five well volumes of pumped water and continued until the water was visually clear or the site geologist determined that no further development is practical.

3.3.3. Groundwater Sampling.

The groundwater sampling was conducted in accordance with the protocol described in the project work plan. Prior to sampling, wells are checked for the presence of any floating product with an electronic oil/water level indicator probe. Then, the well was purged by removing a minimum of three times the standing volume of static water present in the well.

Groundwater samples from the six supply wells were also collected and analyzed for VOCs. Sampling from the supply wells were conducted after discharging water for about 10 minutes through the sampling tab. A low pressure pump was utilized for micro purging and sampling from the monitoring wells.

The groundwater parameters such as pH, temperature, specific conductance and turbidity of the removed water were monitored during the purging and sampling process. Groundwater stabilizing criteria were adopted established in American Society for Testing and Materials (ASTM) D6671-02: pH +/- 0.2, specific conductance +/- 3%, temperature +/- 0.5°C, and turbidity +/- 3%. The groundwater was sampled using a low pressure bladder pump and dedicated tubing for each well sampled. Table 3-2 presents the groundwater parameter during sampling and those during well development were also included. Groundwater temperature varies during the year, which is the highest during August to September sampling period. The pH variation shows the relatively high number during August to September, which is likely to be similar to the groundwater temperature variation. A couple of groundwater samples showed negative oxidation-reduction potential values during sampling at B03-466MW, B03-467MW, 14-283 and 15-286.

The collected water samples were placed into laboratory-grade, specially cleaned sample containers, and then placed immediately into a cooler with ice for preservation below 4°C prior to arrival to the analytical laboratory. All samples were transported to the laboratory accompanied by chain-of-custody sheets thru the priority mail service company.

3.4. Topographic survey

The FED survey section performed a location and topographic survey using a SOKKIA Set 2C Total Station survey instrument. The survey included the ground surface elevation at each borehole location, the top of well riser pipe for each monitoring well, and, if necessary the elevations of buildings, any significant utilities and fuel storage tanks. All elevation measurements were expressed in meters above mean sea level, and World Geodetic System 84 Universal Transverse Mercator (WGS 84 UTM) Zone-52 grid system was applied for longitude and latitude systems. The accuracy of survey elevation for top of the casing measurements was to the nearest 3 mm. Ground surface elevations were made to the nearest centimeter. Table 3-3 presents the borehole and monitoring well coordinates surveyed.

3.5. Investigation Derived Wastes

Waste materials, or investigation-derived wastes (IDW), that required management and disposal during the RI field work included concrete and asphalt debris, petroleum contaminated soil, used disposable sampling equipment, well development water, decontamination water and used personal protective equipment (PPE). There are no specific Korean regulations applicable to the small quantities of IDW that were generated during the course of this project. The IDW generated during the course of this investigation was placed in woven synthetic bags while development water was placed in 55-gallon drums. The bags were segregated by their contents and stored on site until transported to BEC's field facility located in Yojoo, Kyeonggi-Do at the end of each week for treatment and disposal.

There was very little concrete or asphalt debris generated during the course of the RI field work. The concrete and asphalt that was generated in order to expose the underlying soil was bagged along with the soil cuttings from the respective borehole. BEC personnel then transported the bags to their field facility for disposal.

3.5.1. Contaminated Soil

All soil cuttings retrieved during boring were bagged on-site in tight knit, woven synthetic bags. Apparent petroleum contaminated soils in the cuttings were not segregated from uncontaminated soils. All soil waste generated during this investigation was transported for treatment at BEC's off-site remediation facility located in Yojoo, Kyeonggi-Do. A non-hazardous waste manifest was used to document the transport of the contaminated soil to the treatment facility.

3.5.2. Well Development and Decontamination Water

Water from decontamination activities was pumped into a BEC vacuum truck at the end of each day and disposed of at the oil/water separator system at the Land Farm facility of Camp Carroll. Groundwater generated during well development and pump test activities was pumped into BEC's larger pump truck, and also disposed of at the same system. The well development field log is attached in Appendix III.

3.5.3. Site Restoration

Borings were backfilled with bentonite pellets and the surfaces sealed with concrete which was backfilled flush to the existing surface grade. Monitoring wells installed during the project were flush-mounted and pose no impediment to vehicular or foot traffic. All mud and soil cuttings generated in the vicinity of each soil boring and monitoring well were cleaned up by field personnel immediately following the completion of the task.

3.6. Feasibility Study Sampling

Test was performed on the aquifer matrix to determine the saturated and air permeability of the impacted aquifer material present at the site. In addition, soil samples were collected for chemical and microbial analysis that are useful for determining whether the present physical/chemical/biological condition of the aquifer is conducive for degradation of the diesel and gasoline contamination present at the sites.

3.6.1. Slug Test

The hydraulic characteristics of the aquifer underlying the site were determined by performing slug tests on the monitoring wells installed in the previous investigations and during this study. The hydraulic conductivity, K, of the aquifer was calculated using slug tests recovery measurements that were performed on all monitoring wells during 9 ~12 November 2009. After the completion of well purging work, a slug with an approximate volume of 2.5 liter was put in the wells. The drop down water level after slug into the wells was recorded using a pressure transducer data logger. Also the rise in water level after removing the slug from the wells was recorded in same way. Measurements were collected until the water level within the monitoring well returned to within approximately 3 centimeters of the original water level. The original water level in the well prior to the tests was measured with a Solinst electronic oil/water interface prove. Appendix IV presents the summary of test procedure and slug test result.

3.6.2. Aquifer Pumping Test

A pumping test was conducted to obtain information regarding the aquifer characteristics at the site. The aquifer at the site is formed within the open bedrock fractures underneath overlying soil layers. The pumping test and recovery period measurement was conducted on 24 ~ 25 February, 2010. The test was comprised of pumping a volume of groundwater from monitoring well B07-217MW at a controlled rate varying between approximately 1.2 Liter/min while monitoring the water levels within the pumping well and four observation wells (B07-874MW, B09-252MW, B09-256MW, and B01-788MW). Information was collected during the pumping test and subsequent recovery period using pressure sensitive transducers connected to data loggers. Hydraulic head, temperature, and specific conductance of the groundwater were recorded during the test. The pumping test data was interpreted using the Cooper-Jacob's method (1946) method within the computer analysis program AQTESOLV. Appendix IV presents the summary of test procedure and aquifer pumping test result.

3.6.3. Air Permeability Test.

Air Permeability is an integrated measure representing the complex relationship between the geometry of the pore system and hydraulics of the flow of air through that system. Permeability is not measured directly; rather, it is calculated by inverting an assumed model populated with measured state data (i.e. flux and pressure). For this investigation, permeability was determined by applying a pressure gradient across the project site by use of a vacuum truck.

In situ air permeability test data were performed at the site by placing a blower on a setup monitoring well, and measuring the time varying pressure responses at monitoring wells adjacent to that central well. The decision was made to perform the air permeability test by blowing out of the well by applying a vacuum rather than injection to prevent if any contaminants spread over due to air introduction into well.

A constant pressure was applied to the injection well for no longer than 25 minutes, and changes in pressure at adjacent wells were recorded at various time intervals on a roughly logarithmic basis. The measured changed in air pressure at the various monitoring wells spaced varying distance from the injection well were evaluated using analytical solutions for aquifer pumping tests that have been modified for vapor flow conditions.

3.6.4. Nutrient and Microbial Sampling

A total of 13 soil samples were collected, with one sample from each borehole. Those samples were shipped to the National Instrumentation Center of Environmental Management (NICEM) at Seoul National University. The samples were analyzed for biological and chemical properties relevant to potential future remedial measures.

Table 3-1. Project Chronology of RI/FS at LF-Area D of Camp Carroll.

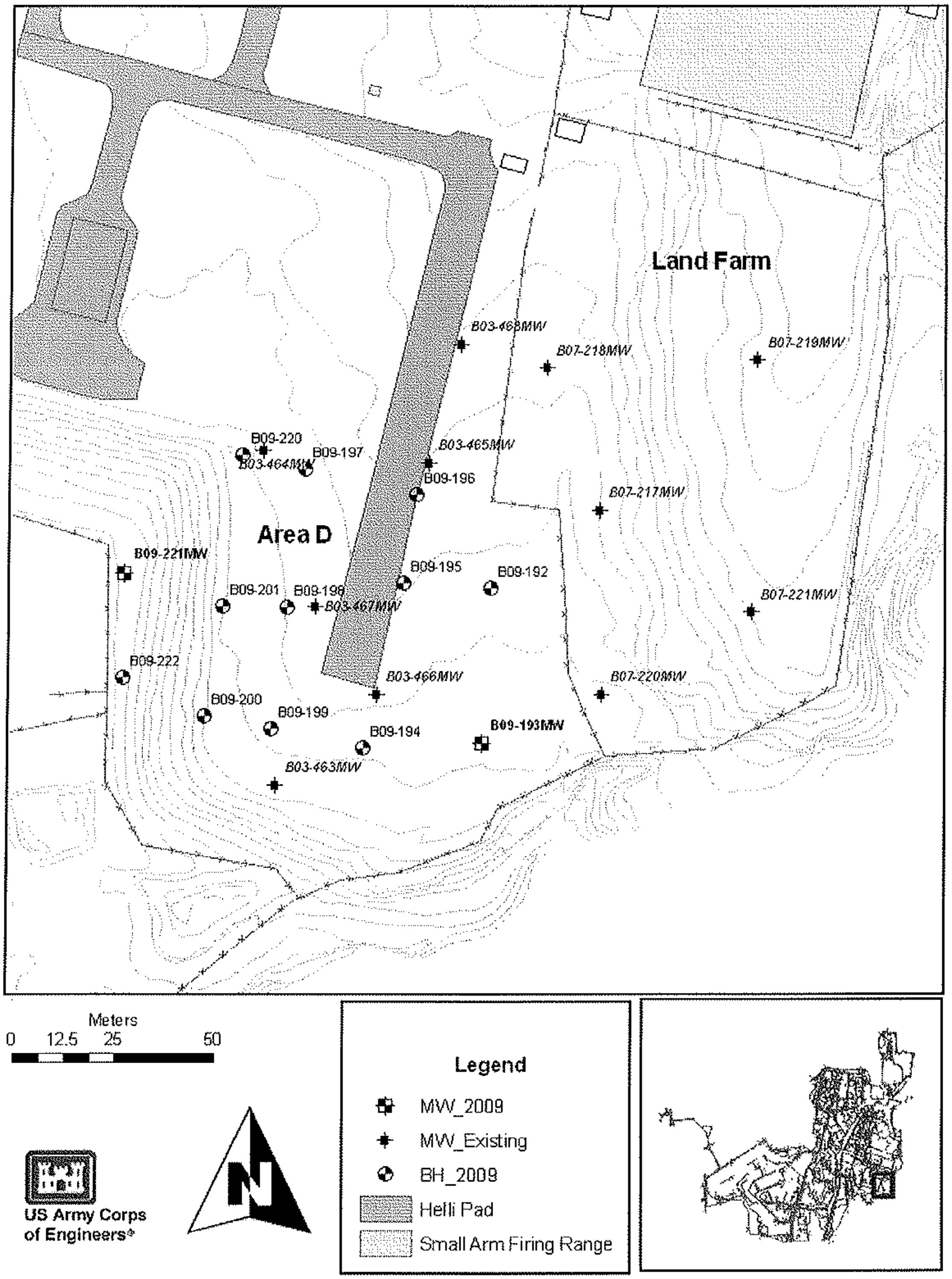
Task	Date Performed
Request a site digging permit and get approval	February 3 and 16, 2009
Borehole drilling, soil sampling and groundwater monitoring well installation	February 17~ March 13, 2009
Well development	February 23 to March 3, 2009
Groundwater Sampling	August 31 ~ September 4, 2009
Hydrologic slug test	November 9-12, 2009
Hydrologic pumping test	February 24~25, 2010
Air permeability test	March 17, 2010

Table 3-2. Topographic Survey Result for Borehole and Monitoring Well at LF-Area D of Camp Carroll.

Site Location	BH_ID	Easting	Northing	Elevation	Top of Pipe	Year Constructed
Land Farm	B09-176MW	447546.25	3983365.34	44.29	44.27	2009
	B09-177MW	447577.57	3983464.43	47.20	47.19	2009
	B09-178MW	447590.41	3983538.60	49.12	49.09	2009
	B07-217MW	447789.23	3983349.44	50.99	50.92	2007
	B07-218MW	447775.80	3983384.33	51.83	51.77	2007
	B07-219MW	447828.37	3983386.25	55.43	55.41	2007
	B07-220MW	447789.89	3983304.56	49.74	49.73	2007
	B07-221MW	447827.00	3983324.75	54.61	54.59	2007
Area D	B09-193MW	447759.92	3983292.52	49.27	49.28	2009
	B09-221MW	447671.06	3983334.28	42.98	46.22	2009
	B03-463MW	447709.20	3983282.40	48.74	48.55	2004
	B03-464MW	447705.50	3983364.10	49.92	49.79	2004
	B03-465MW	447746.40	3983361.10	50.99	50.90	2004
	B03-466MW	447734.10	3983304.60	49.72	49.58	2004
	B03-467MW	447718.70	3983326.00	79.93	49.79	2004
	B03-468MW	447754.30	3983390.10	51.55	51.41	2004
	B09-192	447761.76	3983330.29	49.800		2009
	B09-194	447730.65	3983291.25	49.40		2009
	B09-195	447740.11	3983331.66	49.56		2009
	B09-196	44743.40	3983353.04	49.54		2009
	B09-197	447715.86	3983359.47	50.11		2009
	B09-198	447711.56	3983325.59	49.55		2009
	B09-199	447707.79	3983296.07	49.21		2009
	B09-200	447691.37	3983299.22	48.61		2009
	B09-201	447695.66	3983326.08	48.99		2009
	B09-220	447700.44	3983362.88	49.79		2009
	B09-222	447670.59	3983308.41	43.31		2009

- * Elevation above the mean sea level.

Figure 3-1. Location of Boreholes and Groundwater Monitoring Wells at LF-Area D of Camp Carroll.



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4. Findings during RI/FS Investigation

4.1. Laboratory Analysis.

All laboratory analysis was performed using US EPA published methods. The laboratory that performed the analysis is accredited by the National Environmental Laboratory Accreditation Conference (NELAC) for the analytical procedures specified for this project. Soil and groundwater samples collected in this RI were submitted to the NCA-Korea Laboratory in Anyang, Korea. The contract laboratory shipped the samples for VOCs, semi VOCs (SVOCs), PAHs, dioxin, OC-pesticides, PCB and metals to the NCA laboratory in the States since the NCA-Korea lab has only certified TPH. Soil samples collected from soil borings were analyzed for diesel and residual oil range TPH by EPA 8015D, VOCs by 8260B, SVOCs by 8270D, OC-pesticide by 8081B, PCBs by 8082A, dioxins by 8290A of high resolution mass spectrometry, metals by 6020A, and mercury by 7471B.

The chemical data table presented in this report are only for those which were detected above the practical quantitation limit or at least estimated. Full data table are provided on the separate compact disk (CD). The laboratory reports are included on the same CD.

4.2. Data Quality Control/Assurance

Field and laboratory QC samples were collected and analyzed in accordance with USACE and industry standard methods and practices. The FED Environmental chemist (Dr. [redacted] performed a data review on soil and groundwater samples collected from the LF-Area D site. The data review was performed in accordance with the project work plan and Chemical Quality Assurance for Hazardous, Toxic, and Radioactive Waste (HTRW) Projects (USACE, EM 200-1-6, 1997). The accuracy, precision, representativeness, and completeness of the data were evaluated by performing analytical data quality and field quality assurance (QA) /quality control (QC) data quality review. Accuracy was evaluated using the laboratory sample receipt information, analyses requested, technical holding times, and laboratory QC data (method blank, laboratory control sample (LCS) / LCS duplicate, matrix spike (MS) / MS duplicate, and surrogate recoveries). Appendix # presents the project data quality objectives.

4.3. Subsurface Soil Investigation Result

Soil sampling strategy at LF-Area D is summarized in Table 4-1. The summaries of chemical test results for soil samples are presented. Figure 3-1 presents the locations of the soil boreholes, groundwater monitoring wells installed both this RI and the previous investigations.

4.3.1. Subsurface Geology

The subsurface geology of LF-Area D consists mostly of fill materials and residual soils. Fill materials of clayey/silty sand/clayey sand with gravel were encountered in boreholes with the thicknesses ranging from 3 to 6 m. The fill material layer is generally about 2~3 m thicker at Area D than at Land Farm. In some location the fill material at Area D appears thicker than 6 m. Residual soil consists of fat clay and silty sand underlying the fill materials.

During drilling, field crews noted a chemical odor emanating from the soil samples collected at 3 meters to 7 meters bgs in boreholes B09-196 and B09-195. The odor was a kind of mixture of various chemicals. Soil samples were stained and decolorized to grayish green at this horizon. Pieces of metal, wood, and vinyl were also recovered from the depths with soil sample.

4.3.2. Chemical Analysis Result for Soil Sample

4.3.2.1.Total petroleum hydrocarbons

A total of 26 soil samples were tested for diesel range (DRO) and residual range (RRO) TPH. The test result is presented in Table 4-2. Four samples were identified containing TPH. One soil sample contains both DRO and RRO at 55.4 mg/kg and 171 mg/kg respectively. Three other samples contain either DRO or RRO up to 30.7 mg/kg. The samples with detected TPH occur most frequently in shallow sample depths. This finding indicates that the detection of TPH is likely from a release during vehicle operations rather than a spill from a storage tank as there are no known fuel storage tanks around.

4.3.2.2.Volatile Organic Compounds

VOCs were detected in some soil samples collected from each of the borehole drilled at the Area D (Table 4-3). Toluene; 2-, 4- chlorotoluene; and tetrachloroethene were detected in site soil samples. Other VOCs are mostly below the practical quantitation limit (PQL) or the concentrations were quantitatively estimated by the chemist due to the very low concentration. Except the detection of toluene above the PQL, other VOCs normally associated with TPH such as ethylbenzene and xylenes were not reported from site soil samples above the PQL. Figures 4-1 and 4-2 present the distribution of toluene and tetrachloroethene (PCE) in site subsurface soil respectively.

Toluene was detected in 23 soil samples out of total 48. The 2-, 4- Chlorotoluene was detected in only one sample. PCE was detected in 5 soil sample out of total 48. Trichloroethene (TCE) was detected in one sample. The highest concentration of VOCs detected was found at the borehole B09-196 (Figure 4-2). The concentration ranges of VOCs in the soil samples of LF-Area D are:

2-Chlorotoluene: non-detected (ND) ~ 27,000 μg/kg at B09-196
4-Chlorotoluene: ND to 89,000 μg/kg at B09-196
Toluene: ND to 1,300,000 μg/kg
PCE: ND to 24,000 μg/kg
TCE: ND to 70 μg/kg

4.3.2.3. Semi-Volatile Organic Compounds.

No target SVOCs were detected above the PQL in soil samples collected from boreholes drilled at the Area D. Table 4-4 presents the chemical test result for SVOCs.

4.3.2.4. Target Metals.

Target metals were detected in all soil samples collected from the boreholes drilled at the Area D (Table 4-5). Selenium and Silver were not detected in soil samples above the PQL. The concentration of Mercury in soil samples was reported from two samples above the PQL. The detected concentration of metals was close to the result of the site background sample. The concentration ranges of target metals in the soil samples of LF-Area D are:

Arsenic: 4.6 mg/kg to 11 mg/kg (7.3 mg/kg of background)
Barium: 61.6 mg/kg to 105 mg/kg (98.2 mg/kg of background)
Cadmium: 0.33 mg/kg to 0.87 mg/kg (0.51 mg/kg of background)
Lead: 8.9 mg/kg to 23.7mg/kg (18.7 mg/kg of background)
Mercury: 0.044 mg/kg to 0.05 mg/kg (0.011B mg/kg of background- this result indicates that the analyte is found in a blank associated with the sample)

According to the comparison with the result of the site background sample, the site soil sample was not significantly affected by the historic activities.

4.3.2.5. Polychlorinated Biphenyls.

No PCBs were detected in soil samples collected from boreholes drilled at the LF-Area D.

4.3.2.6. Organochlorinated Pesticides.

OC-pesticides were detected in soil samples collected from each of the borehole drilled at the Area D (Table 4-6). Lindane, 4,4'-DDE, DDD and DDT were the chemicals detected above the PQL. The 4,4'- DDD and DDT were the most commonly identified in soil samples. Soil samples from B09-196 contained the highest concentration of OC-pesticide out of the detection. The concentration ranges of OC-pesticide in the soil samples of LF-Area D are:

Lindane: ND to 4,300 μg/kg
4,4'-DDE: ND to 42 μg/kg
4,4'-DDD: ND to 24,000 μg/kg
4,4'-DDT: ND to 54,000 μg/kg

4,4'-DDT was identified in soil samples collected from most of the boreholes. Maximum detected concentrations of DDT were reported from the samples collected in boreholes B09-196 and B09-201. Figure 4-3 presents the distribution of 4,4'-DDT in the site subsurface soil at LF-Area D.

4.3.2.7. Dioxins/Furans.

Soil samples were submitted for dioxin/furan analysis (Table 4-7). The International-Toxic Equivalent Factors (I-TEF) for dioxins and furans were used to calculate the International-Toxic Equivalent (I-TEQ) for each soil sample according to the Toxics Release Inventory (TRI) Program updated April 23, 2009 (http://www.epa.gov/TRI/lawsandregs/teq/teqmodprule.html).

The I-TEQ is expressed with respect to the toxicity of 2,3,7,8-TCDD and 1,2,3,7,8-PeCDD. Although 2,3,7,8-TCDD was not detected any of the soil samples, I-TEQs were calculated for all soil samples based the I-TEFs, the measured concentrations of dioxins and furans detected above the reporting limit and half the detection limit for compounds not detected. The I-TEQ calculated for each of the soil samples collected at the site ranges from 0.0236826 to 1.9045.

4.3.3. Groundwater Contamination

4.3.3.1.Groundwater Level Measurement Result

Five groundwater monitoring wells were newly installed in the vicinity of LF-Area D. The five wells in association with the six supply wells and the eleven monitoring wells installed during the previous investigations were used to assess the site hydrogeologic conditions and the groundwater quality. Figure 4-4 presents the supply and groundwater monitoring well locations utilized during this project. Table 4-8 summarizes the measurement results of water level in both below ground surface (bgs) and above mean sea level (amsl). Water levels were measured a total of three times in each well with an oil/water interface probe. Floating product was not detected in any borehole.

The water levels were measured total three times before rainy season (May), after monsoon (August) and dry season (December) to determine if any groundwater level variation occurs during the year. The groundwater level variation among the measurements is quite systematic with a linear correlation as shown in Figure 4-5. Based on the result of groundwater level measurements, the groundwater flow direction was analyzed as depicted in Figures 4-6. General groundwater flow pattern is dominantly toward western and southwestern direction, which is similar to the site topographic gradient.

4.3.3.2.Groundwater Chemical Test Result

Groundwater samples were collected three times during this RI/FS projects: May, September and December 2010 to see if any variation in groundwater quality during one year. Table 4-9 presents the groundwater sampling strategy during this project.

4.3.3.2.1. Organochlorinated Pesticides

A total of sixteen groundwater samples were collected from groundwater monitoring wells installed the LF-Area D area for OC-pesticide analysis. Table 4-10 summarizes the OC-pesticide chemical test result. An OC-pesticide was detected above the reporting limit in eleven groundwater monitoring wells during the sampling events. A total of seven OC-pesticides were detected above the reporting limit as:

Alpha-BHC: 0.046 to 0.37 µg/L
Gamma-BHC: 0.054 to 4.9 µg/L
Beta-BHC: 0.072to0.73 µg/L
Delta-BHC: 0.047 to 1.1 µg/L
Dieldrin: 0.12to 0.44 µg/L
4,4'-DDD: 0.1µg/L at B07-218MW
4, 4'-DDT: 0.1 µg/L at B07-220MW

4.3.3.2.2. Volatile Organic Compounds