M00263.AR.000699
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DATA ANALYSIS REPORT FOR FIELD EVENT 1 AT SITE 45 DRY CLEANING FACILITY SPILL AREA MCRD PARRIS ISLAND SC

4/15/2009

GEOSYNTEC CONSULTANTS

Data Analysis Report
Field Event 1: Parris Island MCRD

Former MWR Dry Cleaning Facility, Site SWMU-45
Marine Corps Recruit Depot (MCRD)
Parris Island, South Carolina

ESTCP Project ER-0705:
Assessment of the Natural Attenuation of NAPL Source Zones and Post-Treatment NAPL Source Zones

April 15, 2009

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Acronyms and Abbreviations

amsl	Above mean sea level
bgs	Below ground Surface
btoc	Below top of casing
CAH	Chlorinated aliphatic hydrocarbon
COD	Chemical oxygen demand
DCA	Dichloroethane
DCE	Dichloroethylene
DELCD	Dry electrolytic conductivity detector
Dhc	Dehalococcoides
DO	Dissolved oxygen
DOC	Dissolved organic carbon
DTW	Depth to water
EC	Electrical conductivity
ERH	Electrical resistance heating
ESTCP	Environmental Security Technology Certification Program
FID	Flame-ionization detector
ft	Feet
GC	Gas chromatography
kg	Kilogram
ND	Non-detect
NQ	Not quantified
NW	No water available for analysis
ORP	Oxidation reduction potential
PCE	Perchloroethylene
PCR	Polymerase chain reaction
Sqft	Square feet
TCA	Trichloroethane
TCE	Trichloroethylene
TOC	Top of casing
temp	Temperature
VC	Vinyl Chloride
VFA	Volatile fatty acid
VOA	Volatile organic analysis
yr	Year

1. Introduction

The field investigation of the Former MWR Dry Cleaning Facility, Site SWMU-45, Marine Corp Recruit Depot (MCRD), Parris Island, South Carolina under the Environmental Security Technology Certification Program (ESTCP) project ER-0705, *Assessment of the Natural Attenuation of NAPL Source Zones and Post-Treatment NAPL Source Zones*, was performed October 16 through October 26, 2008. Figure 1 provides a site map that identifies the specific area of interest for this field investigation.

Consistent with the objectives set forth under the ER-0705 Demonstration Plan, the field investigation at this site included the following:

- Verification of the site geological/hydro-geological conceptual model;
- Collection of data necessary to determine groundwater concentrations, dissolved phase contaminant flux, and biodegradation activity;
- Collection of data necessary to determine soil gas concentrations above the source zone and the vapor phase contaminant flux; and,
- Collection of soil and groundwater samples for assessment of biodegraders

2. Field Investigation

In accordance with the approved generic demonstration plan for this project, field investigations were performed to complete the objectives mentioned above. Tables 1 and 2 outline the types of sampling/testing performed, the locations for which are shown in Figure 2. Site activities are as follows:

2.1 Verification of the site hydro-geological conceptual model:

a. Basic Geologic Profile: Continuous soil cores were collected for geologic evaluation. Using the Geoprobe Macro Core sampler, soil cores were collected to a total depth of 18 ft bgs at the two locations shown in Figure 2. A basic geologic profile can be found in Table 3.

b. Depth-to-water: Depth-to-water (DTW) was measured in select permanent monitoring wells to determine groundwater elevation, flow direction, and hydraulic gradient. Table 4 contains DTW data for selected sampling locations. Based on data collected, the dominant groundwater flow direction is to the southeast with a gradient of 0.006. A groundwater elevation map can be found in Figure 3.

c. Hydraulic Conductivity Testing – Slug Tests: Slug tests were performed in select permanent monitoring wells to provide general information on the hydraulic characteristics of the formation. Slug tests were performed as described in the non-site-specific version of the demonstration plan and were analyzed using both the Hvorslev and Bouwer and Rice methods. Results for slug testing are shown in

Table 5. Slug testing in additional wells will be performed during future field investigations.

d. Hydraulic Conductivity Testing – Aquifer Specific-Capacity Tests: Depth-discrete, aquifer specific-capacity tests were conducted at direct push locations ASU-1 through ASU-10 (see Figure 2). Data from depth-discrete aquifer-specific capacity testing provides additional detailed information on hydraulic characteristics at the site and is also used in mass flux calculations. Aquifer specific-capacity tests involve the measurement of the flowrate achieved under a fixed drawdown, and hydraulic conductivity is estimated using the Theim equation. Aquifer specific-capacity tests are described in further detail in the non-site-specific version of the Demonstration Plan. Results for aquifer specific-capacity testing are shown in Table 6.

2.2 Collection and analysis of groundwater samples and collection of data necessary to determine groundwater concentrations, dissolved phase contaminant flux, and biodegradation activity:

a. Depth-Discrete Groundwater Sampling: Depth-discrete groundwater sampling was performed at direct push locations ASU-1 through ASU-10 shown in Figure 2. Groundwater samples were collected using a Geoprobe Screenpoint Sampler and a peristaltic pump. Groundwater samples were collected and preserved as outlined in the non-site-specific Demonstration Plan.

b. Depth Discrete Groundwater Sample Analysis: At the time of groundwater sample collection, field water quality parameters including pH, electrical conductivity (EC), temperature (T), dissolved oxygen (DO), and oxidation reduction potential (ORP) were measured. Field water quality data is shown in Table 7.

General water chemistry analyses including anions (Cl^-, NO_3^{2-}, SO_4^{2-}), cations (Fe^{2+}, Mn^{2+}) dissolved organic carbon (DOC), chemical oxygen demand (COD), and alkalinity were performed as possible on all direct push samples collected. General water chemistry analyses were performed as outlined in the non-site-specific Demonstration Plan. General water chemistry data can be found in Tables 8, 9, and 10.

Chlorinated aliphatic hydrocarbon (CAH) analyses were performed on-site by heated-headspace analysis and gas chromatography (GC) using a dry electrolytic conductivity detector (DELCD) and a flame-ionization detector (FID), the details for which are provided in the non-site-specific demonstration plan. Data for CAH analyses can be found in Table 11.

c. Permanent Monitoring Well Groundwater Sampling and Analysis: To aid in the delineation of source zone extent, groundwater samples were also collected from a select package of permanent, single completion and multi-level monitoring

wells for CAH analysis. Monitoring wells sampled are shown in Table 12. Chlorinated aliphatic hydrocarbon analyses were performed on site as described above. Analytical results for monitoring well CAH analyses are shown in Table 12.

d. Volatile Fatty Acid Analysis: To determine if oil breakdown products continue to be available to contribute to DNAPL degradation, a subset of seven samples were collected from permanent, single completion and multi-level monitoring wells directly down-gradient of the zero-valent iron (ZVI) injections performed by Geosyntec under ESTCP Project ER-0431. Sample locations included PMW1 and multilevel wells ML4-7.5, ML4-12.5, ML4-17.5, ML6-7.5, ML6-12.5, and ML6-17.5. Samples were collected in 40ml VOA bottles, preserved with benzalkonium chloride, and were shipped via Fedex overnight to Microseeps, Inc., Pittsburgh, PA for analysis. Holding time for the samples was specified at 14 days. However, although samples were submitted immediately after collection, holding times were exceeded at the lab by over two weeks due to the lab's inability to analyze the samples as a result of instrument malfunction. As such, the sampling team chose to have only three of the samples analyzed. Results for volatile fatty acid analyses can be found in Table 13.

e. Dehalococcoides Analysis: Water Samples were collected to evaluate dehalococcoides biodegrader populations. One liter (1L) samples were collected at the 10 depth-discrete, direct push locations shown in Table 1. Samples were extracted using a Mobio Water DNA Extraction Kit and amplified using nested PCR (polymerase chain reaction). However, using conventional methods for extraction and amplification of DNA, results for the current sample set are inconclusive. There appear to be PCR inhibitors in the extracted samples, as general bacterial PCR was inhibited in all samples. This has been verified by spiking extracted samples with amplifiable DNA and retesting for amplification: No samples displayed positive results. Methods are currently being tested to purify the samples and allow for dehalococcoides detection to take place. When the samples have been analyzed, there will be a supplemental report submitted.

2.3 Collection of data necessary to determine soil gas concentrations above the source zone and the vapor phase contaminant flux

a. Soil Gas Sampling and Analysis: Soil gas samples were collected from temporary soil gas sampling installations within the source zone area, the locations for which are shown in Figure 2. Using a Geoprobe slide hammer, a 1-inch drive rod, and disposable stainless steel drive tips, 6" Geoprobe soil gas sampling implants were installed at 1.5 ft below ground surface, a depth estimated to be 1 ft short of the water table. Soil gas sampling implants were installed with a sand-pack and bentonite seal to facilitate soil gas sampling and diffusion tests. Vapor samples were collected in tedlar bags using a lung sampler and were analyzed on-site at the time of collection by gas chromatography (GC) using a dry electrolytic

conductivity detector (DELCD) and a flame-ionization detector (FID). Soil sampling results can be found in Table 14.

Note that soil gas sampling location *Vapor 2* was saturated at its' installation depth of 1.5 ft below ground surface. No soil gas sampling or diffusion testing was performed at this location.

b. Soil Diffusion Testing: In situ diffusion tests were performed at all soil gas sampling locations except gas sampling location *Vapor 2*. After installation of the sampling point and collection of a soil gas sample, 1 L of a mix of up to 10% helium in soil gas was injected into the sample interval. After waiting a predetemined amount of time, 1 L of soil gas was withdrawn for helium analysis. Diffusion test data is used in conjunction with soil gas concentration data to estimate mass losses of contaminant in the vapor phase. Results for diffusion testing can be found in Table 15.

To facilitate contaminant mass flux calculations (vapor or dissolved phase), concentration contour plotting, and references to the total mass of contaminant at the site, PCE equivalence was used. Use of PCE equivalence allows the total mass of contaminant to be expressed as the concentration equivalent of a single compound. For MCRD Parris Island reporting, CAH constituency was converted to PCE equivalents using an adjustment factor based on the molar equivalence of each compound. Adjustment factors are shown as a secondary table under Table 16. Details concerning the use of PCE equivalents and calculation of adjustment factors will be defined at a later date in a document to ESTCP.

Figure 5 shows a vertical chemical concentration (PCE equivalents) contour plot along transect A-A' (see Figure 2) using dissolved CAH concentration data from direct push locations ASU3 through ASU8. Transect A-A' is drawn roughly perpendicular to the dominant groundwater flow direction and data from the sampling locations are projected.

Using the CAH groundwater concentration data, depth-discrete hydraulic conductivity estimates (see Table 6), and the calculated gradient of 0.006 ft/ft, a mass flux calculation was performed using the Mass Flux Toolkit, Version 1.0. The Mass Flux Toolkit is a freeware program developed by Groundwater Services, Inc. and others under a contract funded by ESTCP. Figure 6 is a snapshot of the VOC inputs used to perform the mass flux analysis. Linear spatial and vertical interpolation of the concentration, hydraulic conductivity, hydraulic gradient, and mass flux data were used for the analysis. Figures 7 and 8 show the interpolated concentration grid and the interpolated hydraulic conductivity grid, respectively. Finally, Figure 9 shows the mass flux result for chlorinated aliphatic hydrocarbons as PCE equivalents. The mass flux of chlorinated aliphatic hydrocarbons is estimated to be 3.36 kg/yr as PCE.

Using CAH vapor concentration data, contaminant diffusion coefficient estimates, and an estimated area of impact (50 sqft per sample location), mass flux on contaminant in the vapor phase was calculated. Vapor flux estimates for each well, and adjustment factors are located in Table 16. The vapor flux was estimated to be 0.68 kg/yr as PCE.

Of interest during the purging of multi-level monitoring well ML6-9 (9 ft bgs) was that a light, non-aqueous phase liquid (LNAPL) with a petroleum hydrocarbon odor was produced. Analysis of the relative mass of product with respect to carbon range was evaluated using gas chromatography (direct injection technique). A table showing the relative mass of product within in each carbon range and a chromatogram for the NAPL direct injection are shown in Table 17. No quantification, speciation, or further analysis was performed on the product collected.

3. References

Fetter, C.W. 2000. Applied Hydrogeology. 4th ed. Upper Saddle River, New Jersey: Prentice-Hall. pp.197-200.

Mass Flux Toolkit. GSI Environmental. V1.0. Toolkit located at http://www.gsi-net.com/Software/massflx_dl/main_massflx.asp

Technology Demonstration Plan For: (ER-0431) Emulsified Zero-Valent Nano-Scale Iron Treatment of Chlorinated Solvent DNAPL Source Areas: June 15, 2006

Tables

Table 1

Depth-Discrete, Direct Push Sampling Locations and Analyses

Location	Depth (ft bgs)	Aquifer Specific Capacity Test	Field Parameters[a]	Anions	Cations	Alkalinity	COD	DOC	CAH	Dhc	Ethene /Ethane
ASU1	5	X	---	---	---	---	---	---	X	---	---
	8	X	X	X	X	X	X	X	X	---	X
	11	X	X	X	X	X	X	X	X	X	X
	14	X	X	X	X	X	X	X	X	---	---
	17	X	X	X	X	---	X	---	X	---	X
ASU2	5	X	---	---	X	---	---	X	X	---	X
	8	X	X	X	X	---	X	X	X	---	X
	11	X	X	X	X	X	X	X	X	X	X
	14	X	---	X	X	X	X	X	X	---	X
	17	X	---	X	X	X	X	X	X	---	X
ASU3	5	X	---	---	X	---	---	X	X	---	X
	8	X	X	X	X	X	X	X	X	---	X
	11	X	X	X	X	X	X	X	X	---	X
	14	X	X	X	X	X	X	X	X	---	X
	17	X	---	X	X	X	X	X	X	---	X
ASU4	5	X	---	---	---	---	---	---	X	---	---
	8	X	X	X	X	X	X	X	X	---	X
	11	X	X	X	X	X	X	X	X	---	X
	14	X	X	X	X	X	X	X	X	---	X
	17	X	---	X	X	X	X	X	X	---	X
ASU5	5	---	---	---	---	---	---	---	---	---	---
	8	X	X	X	X	X	X	X	X	---	X
	11	X	X	X	X	X	X	X	X	---	X
	14	X	X	X	X	X	X	X	X	---	X
	17	X	---	---	X	X	---	---	X	---	X
ASU6	5	X	---	X	X	X	X	X	X	---	X
	8	X	X	X	X	X	X	X	X	--	X
	11	X	X	X	X	X	X	X	X	---	X
	14	X	X	X	X	X	X	X	X	---	X
	17	X	---	X	X	X	X	X	X	---	X
ASU7	5	X	---	---	---	---	---	---	X	---	X
	8	X	X	X	X	---	X	X	X	---	X
	11	X	X	X	X	X	X	X	X	X	X
	14	X	X	X	X	X	X	X	X	---	X
	17	X	---	X	X	X	X	X	X	---	X
ASU8	5	X	---	---	---	---	---	---	X	---	X
	8	X	X	X	X	X	X	X	X	---	X
	11	X	X	X	X	X	X	X	X	---	X
	14	X	X	X	X	X	X	X	X	---	X
	17	X	X	X	X	---	X	X	X	---	X
ASU9	5	---	---	---	---	---	---	---	---	---	---
	8	X	---	X	X	X	X	X	X	X	X
	11	X	X	X	X	X	---	---	X	X	X
	14	X	X	X	X	X	X	X	X	X	X
	17	X	X	X	X	X	X	X	X	X	X
ASU10	5	X	---	---	---	---	---	---	X	---	X
	8	X	X	X	X	X	X	X	X	X	X
	11	X	X	X	X	X	X	X	X	X	X
	14	X	X	X	X	X	X	X	X	X	X
	17	X	---	X	X	X	X	X	X	---	X

a) Field Parameters include: pH, electrical conductivity, temperature, dissolve oxygen, and oxidation reduction potential
--- Not enough water for test or location not identified for testing

Table 2

Monitoring Well Sampling Locations and Tests Performed

Well	Depth (ft bgs)	DTW	CAH	Volatile Fatty Acid[1]
ML3	4		X	
	6.5		X	
	9		X	
	11.5		X	
	14		X	
	16.5		X	
	19		X	
ML4	4		X	
	6.5		X	X
	9		X	
	11.5		X	X**
	14		X	
	16.5		X	X
	19		X	
ML5	4		X	
	6.5		X	
	11.5		X	
	14		X	
	16.5		X	
	19		X	
ML6	4		X	
	6.5		X	X**
	9		X	
	11.5		X	X**
	14		X	
	16.5		X	X
	19		X	
ML7	3.5		X	
	6.5		X	
	8.5		X	
	11		X	
	13.5		X	
	16		X	
	18.5		X	

Well	Depth (interval)	DTW	CAH	Volatile Fatty Acid
MW01	SL	X		
	SU	X		
MW02	SL		X	
MW03	SU		X	
MW05	SL	X		
	SU	X		
MW06	SL	X	X	
	SU	X	X	
MW07	SL	X	X	
	SU	X	X	
MW08	SL	X		
	SU	X		
MW10	SL	X		
	SU	X		
MW13	SL	X		
	SU	X		
MW14	SL	X		
	SU	X		
MW15	SL	X		
	SU	X		
MW16	SL	X		
	SU	X		
MW21	SL	X	X	
	SU	X	X	
MW22	SL	X		
	SU	X		
MW23	SL	X		
	SU	X		
MW24		X		
PMW1			X	X

1) Samples for volatile fatty acid analysis were collected at the locations shown. Samples were immediately submitted, but exceeded the 14 day holding time at the lab due to the lab's inability analyze the samples in time as a result of instrument malfunction. As such, only the samples identified with ** were analyzed.

Table 3

Geologic Description of Parris Island Soil Core ASU9

Depth (ft bgs)	**Description**
0 – 2	Very fine sand with trace silt/clay, and substantial organic matter
2 – 3	Fine sand with silt/clay, trace gravel
3 – 4	Clay with abundant fine sand
4 – 5	Fine sand with some silt/clay
5 – 6	Clayey/silty fine sand
6 – 8	Clay/silt with some fine sand
8 - 10	Clay with trace fine sand
10 – 11	Fine sand with trace silt/clay
11 – 13	Fine sand
13 – 16	Fine sand with trace silt/clay
16 - 17	Clay
17 – 18	Peat

Table 4

Depth-to Water Measurements and Calculated Groundwater Elevations for Permanent Monitoring Wells

Location	**Depth** (interval)	**Elev TOC** (ft amsl)	**DTW** (m btoc)	**DTW** (ft btoc)	**Groundwater Elevation** (m amsl)	**Groundwater Elevation** (ft amsl)
MW01	SL	7.57	0.361	1.185	1.946	6.385
	SU	7.60	0.177	0.582	2.139	7.018
MW05	SL	8.26	1.021	3.351	1.496	4.909
	SU	8.60	1.124	3.689	1.497	4.911
MW06	SL	7.57	0.591	1.939	1.716	5.631
	SU	Unknown	0.878	2.882	Unknown	Unknown
MW07	SL	Unknown	0.588	1.928	Unknown	Unknown
	SU	Unknown	0.493	1.617	Unknown	Unknown
MW08	SL	7.53	0.488	1.601	1.807	5.929
	SU	Unknown	0.483	1.584	Unknown	Unknown
MW10	SL	5.89	0.413	1.356	1.382	4.534
	SU	5.92	0.432	1.416	1.373	4.504
MW13	SL	6.41	0.669	2.196	1.284	4.214
	SU	6.27	0.668	2.192	1.243	4.078
MW14	SL	5.89	0.520	1.705	1.276	4.185
	SU	5.96	0.567	1.860	1.250	4.100
MW15	SL	8.15	1.134	3.720	1.350	4.430
	SU	8.34	1.200	3.937	1.342	4.403
MW16	SL	Unknown	1.582	5.189	Unknown	Unknown
	SU	9.25	1.596	5.236	1.223	4.014
MW21	SL	6.39	0.400	1.313	1.547	5.077
	SU	6.43	0.434	1.423	1.526	5.007
MW22	SL	6.56	0.378	1.241	1.621	5.319
	SU	6.61	0.426	1.398	1.589	5.212
MW23	SL	6.39	0.694	2.276	1.254	4.114
	SU	6.50	0.713	2.338	1.269	4.162
MW24		6.63	0.496	1.626	1.525	5.004

DTW – Depth to water
toc – Top of casing
btoc – Below top of casing
bgs – Below ground surface
amsl – Above mean sea level

Table 5

Slug Test Data

	Bouwer & Rice		Hvorslev	
Well	**ft/d**	**cm/s**	**ft/d**	**cm/s**
MW007-SU	12.13	4.28E-03	30.81	1.09E-02
MW007-SL	28.45	1.00E-02	81.26	2.87E-02
MW008-SU	9.69	3.42E-03	27.93	9.85E-03
MW008-SL	39	1.38E-02	89.36	3.15E-02
MW022-SU	1.88	6.63E-04	8.27	2.92E-03
MW022-SL	16.76	5.91E-03	42.56	1.50E-02

Table 6

Hydraulic Conductivity Estimates for Depth-Discrete Aquifer Specific-Capacity Testing

Location	Depth (ft bgs)	K (ft/d)	K (cm/sec)
ASU1	5	1.5E-01	5.3E-05
	8	2.5E-01	8.9E-05
	11	3.7E+00	1.3E-03
	14	1.2E-01	4.1E-05
	17	8.1E-01	2.9E-04
ASU2	5	1.2E-01	4.2E-05
	8	2.1E-01	7.3E-05
	11	6.3E-01	2.2E-04
	14	1.1E-01	3.7E-05
	17	7.0E-02	2.5E-05
ASU3	5	3.3E-01	1.1E-04
	8	1.2E+00	4.1E-04
	11	1.3E+00	4.5E-04
	14	5.0E-01	1.8E-04
	17	7.4E-02	2.6E-05
ASU4	5	2.5E-01	8.7E-05
	8	1.2E+00	4.1E-04
	11	2.9E-01	1.0E-04
	14	3.1E-01	1.1E-04
	17	4.3E-02	1.5E-05
ASU5	5	---	---
	8	4.8E-01	1.7E-04
	11	6.0E+00	2.1E-03
	14	2.3E-01	8.2E-05
	17	2.5E-02	8.8E-06

Location	Depth (ft bgs)	K (ft/d)	K (cm/sec)
ASU6	5	8.9E-01	3.1E-04
	8	1.4E+00	4.8E-04
	11	1.1E+01	4.0E-03
	14	2.8E-01	9.8E-05
	17	5.4E-02	1.9E-05
ASU7	5	1.1E-01	3.8E-05
	8	5.9E-01	2.1E-04
	11	1.2E+01	4.1E-03
	14	2.1E+00	7.5E-04
	17	6.5E-02	2.3E-05
ASU8	5	2.6E-02	9.1E-06
	8	5.0E-01	1.7E-04
	11	6.8E-01	2.4E-04
	14	2.2E-01	7.6E-05
	17	1.1E-01	4.0E-05
ASU9	5	---	---
	8	5.7E-01	2.0E-04
	11	4.4E+00	1.6E-03
	14	2.7E-01	9.5E-05
	17	1.3E-01	4.6E-05
ASU10	5	5.1E-02	1.8E-05
	8	5.3E-01	1.9E-04
	11	1.1E+01	3.8E-03
	14	3.3E-01	1.2E-04
	17	8.3E-02	2.9E-05

--- – No water available for analysis

Theim Method:

$$K = \frac{1}{b} \times \frac{Q}{2\pi(H)} \times ln\left(\frac{0.125}{10}\right)$$

Where Q = pumping rate (L^3/T)
H = Drawdown (ft)
K = hydraulic conductivity (L/T)
b = length of sampler or screen section (L)

Table 7

Water Quality Data for Depth-Discrete, Direct Push Groundwater Samples

Location	Depth (ft bgs)	pH	EC (µS)	T (deg C)	DO (mg/L)	ORP (mV)
ASU1	5.0	---	---	---	---	---
	8.0	5.8	318	25.5	1.2	23.2
	11.0	6.0	335	26.5	<1	-1.7
	14.0	6.5	715	25.4	---	-9.3
	17.0	6.8	1101	25.4	<1	-89.8
ASU2	5.0	---	---	---	---	---
	8.0	6.1	353	27.5	Unk	53.3
	11.0	6.2	391	27.3	1.2	-0.7
	14.0	---	---	---	---	---
	17.0	---	---	---	---	---
ASU3	5.0	---	---	---	---	---
	8.0	5.4	536	24.9	<1	31.3
	11.0	6.2	315	26.0	<1	-2.6
	14.0	6.0	1151	26.2	1.7	66.0
	17.0	---	---	---	---	---
ASU4	5.0	---	---	---	---	---
	8.0	5.4	524	25.1	<1	29.5
	11.0	6.1	426	24.8	<1	-420.0
	14.0	6.3	708	25.4	<1	-70.3
	17.0	---	---	---	---	---
ASU5	5.0	---	---	---	---	---
	8.0	6.1	700	25.5	<1	-64.5
	11.0	6.3	439	25.9	<1	-68.0
	14.0	6.2	552	25.6	<1	-10.7
	17.0	---	---	---	---	---
ASU6	5.0	---	---	---	---	---
	8.0	6.1	570	22.2	<1	-35.9
	11.0	5.8	407	22.5	<1	3.4
	14.0	6.0	481	21.2	<1	21.8
	17.0	---	---	---	---	---
ASU7	5.0	---	---	---	---	---
	8.0	6.3	559	24.2	<1	-47.6
	11.0	5.8	386	24.4	<1	-3.5
	14.0	5.9	610	23.8	<1	19.4
	17.0	---	---	---	---	---
ASU8	5.0	---	---	---	---	---
	8.0	5.5	571	22.5	<1	78.1
	11.0	5.7	553	23.5	<1	-16.9
	14.0	5.9	1830	23.2	<1	37.5
	17.0	6.0	6167	2172.0	1.2	21.0
ASU9	5.0	---	---	---	---	---
	8.0	---	---	---	---	---
	11.0	6.0	371	24.7	<1	-0.7
	14.0	6.0	740	24.5	<1	-29.3
	17.0	6.1	694	24.2	<1	15.0
ASU10	5.0	---	---	---	---	---
	8.0	6.3	1501	21.8	<1	-99.5
	11.0	5.6	447	22.4	<1	-41.2
	14.0	5.7	780	21.2	<1	23.8
	17.0	---	---	---	---	---

--- Not enough water available for analysis
<1- Dissolved oxygen values <1 mg/L are simply shown as <1

Table 8

Ion Concentration Data for Depth-Discrete, Direct Push Groundwater Samples

Location	Depth (ft bgs)	(mg/L)				
		Cl^-	NO_3^{-2}	SO_4^{-2}	Fe^{2+}	Mn^{2+}
ASU1	5	---	---	---	---	---
	8	11	<1	38	5	ND
	11	15	<1	26	4	ND
	14	112	<1	23	4	ND
	17	200	<1	<1	7	ND
ASU2	5	---	---	---	13	ND
	8	16	<1	38	3	ND
	11	25	1	20	3	ND
	14	74	<1	22	5	ND
	17	127	<1	1	7	ND
ASU3	5	---	---	---	60	ND
	8	79	<1	65	7	ND
	11	13	<1	28	5	ND
	14	131	<1	448	82	1
	17	249	1	183	32	1
ASU4	5	---	---	---	---	---
	8	39	<1	146	24	ND
	11	23	<1	51	13	ND
	14	72	<1	129	13	ND
	17	149	<1	9	2	ND
ASU5	5	---	---	---	---	---
	8	113	1	29	20	ND
	11	31	<1	14	4	ND
	14	80	<1	22	3	ND
	17	80	<1	21	3	ND

Location	Depth (ft bgs)	(mg/L)				
		Cl^-	NO_3^{-2}	SO_4^{-2}	Fe^{2+}	Mn^{2+}
ASU6	5	141	2	5	74	ND
	8	77	1	17	29	ND
	11	42	<1	23	6	ND
	14	56	2	31	4	ND
	17	133	<1	5	3	ND
ASU7	5	---	---	---	---	---
	8	29	<1	41	10	ND
	11	25	<1	33	7	ND
	14	84	1	37	5	ND
	17	609	<1	19	10	ND
ASU8	5	---	---	---	---	---
	8	61	1	90	2	ND
	11	57	<1	84	11	ND
	14	425	<1	83	2	ND
	17	2184	<1	15	14	ND
ASU9	5	---	---	---	---	---
	8	217	2	5	77	ND
	11	19	<1	36	4	ND
	14	72	<1	10	42	14
	17	119	1	<1	4	ND
ASU10	5	---	---	---	---	---
	8	305	1	1	108	ND
	11	56	<1	<1	6	ND
	14	167	<1	11	9	ND
	17	133	<1	20	4	ND

--- – No water available for analysis
ND – Non-detect; less than detection limit of 1 mg/L
<1 – Indicates analyte was detected, but was below practical quantitation limit of 1 mg/L

Table 9

DOC/COD Concentration Data for Depth-Discrete, Direct Push Groundwater Samples

Location	Depth (ft bgs)	(mg/L) DOC	(mg/L) COD
ASU1	5	---	---
	8	23	58
	11	14	77
	14	5	32
	17	---	18
ASU2	5	18	---
	8	11	493
	11	6	3
	14	5	25
	17	5	15
ASU3	5	32	---
	8	11	39
	11	5	11
	14	4	41
	17	6	29
ASU4	5	---	---
	8	14	44
	11	6	35
	14	6	29
	17	11	42
ASU5	5	---	---
	8	31	123
	11	17	44
	14	6	23
	17	---	---

Location	Depth (ft bgs)	(mg/L) DOC	(mg/L) COD
ASU6	5	50	201
	8	43	113
	11	25	79
	14	13	71
	17	7	141
ASU7	5	---	---
	8	33	117
	11	27	75
	14	19	42
	17	6	84
ASU8	5	---	---
	8	43	121
	11	17	67
	14	21	53
	17	11	195
ASU9	5	---	---
	8	45	513
	11	---	---
	14	150	645
	17	51	241
ASU10	5	---	---
	8	110	458
	11	14	225
	14	71	263
	17	7	43

--- – No water available for analysis

Table 10

Alkalinity Data for Depth-Discrete, Direct Push Groundwater Samples

Location	Depth (ft bgs)	Alkalinity (mg/L as $CaCO_3$)
ASU1	5	---
	8	100
	11	120
	14	180
	17	---
ASU2	5	---
	8	---
	11	120
	14	160
	17	200
ASU3	5	---
	8	80
	11	120
	14	80
	17	200
ASU4	5	---
	8	40
	11	100
	14	---
	17	100
ASU5	5	---
	8	80
	11	140
	14	120
	17	---
ASU6	5	200
	8	160
	11	120
	14	120
	17	100
ASU7	5	---
	8	---
	11	140
	14	100
	17	80
ASU8	5	---
	8	100
	11	100
	14	140
	17	---
ASU9	5	---
	8	260
	11	120
	14	240
	17	160
ASU10	5	---
	8	200
	11	140
	14	120
	17	120

--- No water available for analysis

Table 11

CAH, Ethene, and Ethane Concentration Data for Depth-Discrete Groundwater Samples

Location	Depth (ft bgs)	CAH Concentration (µg/L)									
		VC	11 DCE	t - DCE	11 DCA	c-DCE	TCE	PCE	Ethene	Ethane	PCE Equivalence[1]
ASU1	5	1	ND	ND	ND	22	6	47	---	---	96
	8	ND	ND	ND	ND	3	ND	3	ND	ND	8
	11	ND	ND	ND	ND	3	1	8	ND	ND	14
	14	1	ND	ND	ND	4	1	11	---	---	21
	17	ND	ND	ND	ND	1	ND	2	ND	ND	3
ASU2	5	ND	ND	ND	ND	ND	ND	2	ND	ND	2
	8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	11	ND	ND	ND	ND	ND	ND	1	ND	ND	1
	14	ND	ND	ND	ND	ND	ND	3	6	ND	37
	17	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ASU3	5	550	24	96	ND	6300	470	190	3	ND	13000
	8	180	5	35	ND	1600	390	530	<1	ND	4300
	11	7	ND	ND	ND	24	1	7	ND	ND	67
	14	2	ND	1	ND	39	9	1	ND	ND	85
	17	7	ND	1	ND	4	1	6	ND	ND	35
ASU4	5	210	8	60	ND	2900	1100	790	---	---	7800
	8	300	7	62	ND	3200	4800	7300	ND	ND	20000
	11	190	6	42	ND	1700	1100	3500	1	ND	8400
	14	14	3	9	ND	830	180	49	ND	ND	1700
	17	7	ND	ND	ND	7	10	18	ND	ND	59
ASU5	5	---	---	---	---	---	---	---	---	---	---
	8	4700	9	180	5	4900	54	33	580	ND	25000
	11	1700	1	59	ND	860	4	13	77	ND	6600
	14	98	4	29	ND	330	2500	83	1	ND	4100
	17	13	ND	ND	ND	14	19	3	ND	ND	86
ASU6	5	3400	3	98	1	1300	3	1	180	ND	13000
	8	3400	31	450	ND	15000	3300	800	310	7	42000
	11	190	47	350	4	16000	10300	16000	15	3	58000
	14	1400	21	17	3	2800	15000	7300	7	ND	35000
	17	310	3	2	ND	610	920	660	ND	ND	3700
ASU7	5	2	ND	ND	ND	21	1	11	ND	ND	56
	8	350	30	80	ND	3200	5000	1800	2	ND	15000
	11	12	2	8	ND	280	1200	42	ND	ND	2100
	14		1	ND	ND	11	654	5	ND	ND	850
	17	1	1	ND	ND	7	93	27	ND	ND	160
ASU8	5	29	4	3	ND	180	110	110	ND	ND	650
	8	2	3	4	ND	310	1600	1200	ND	ND	3800
	11	ND	ND	ND	ND	24	99	40	ND	ND	200
	14	ND	ND	ND	ND	1	4	11	ND	ND	17
	17	ND	ND	ND	ND	1	2	7	ND	ND	11
ASU9	5	---	---	---	---	---	---	---	---	---	---
	8	18000	200	2100	ND	96000	26000	66000	1700	87	32000
	11	270	4	48	ND	1300	2100	2800	7	ND	8500
	14	340	42	48	ND	19000	1500	32000	250	320	70000
	17	4	1	1	ND	370	31	280	12	21	1200
ASU10	1	4700	24	72	ND	16000	2	5	ND	ND	41000
	5	15000	18	750	8	29000	ND	190	3000	ND	110000
	8	23000	25	19000	14	25000	ND	22	4000	66	130000
	11	48000	24	57	ND	14000	7	67	1000	440	46000
	14	4500	100	290	7	5700	2200	8600	530	250	38000
	17	180	8	3	4	310	514	2200	4	ND	4000

1) PCE equivalence based on adjustment factors in Table 16. Adjustment factors and their calculation will be detailed in a document to ESTCP at a later date.

NW - No water available for analysis

ND - Non-detect; less than detection limit of 1 ug/L

<1 - Indicates analyte was detected, but below the practical quantitation limit of 1 ug/L

--- - Not enough water available for analysis

Table 12

CAH Concentration Data for Permanent Monitoring Wells

Well	Depth (ft bgs)	CAH Concentration (µg/L)						
		VC	11 DCE	t-DCE	11 DCA	c - DCE	TCE	PCE
ML3	4	740	3	19	11	380	14	13
	6.5	15	ND	3	3	1	1	2
	9	78	ND	26	12	12	ND	ND
	11.5	65	ND	6	ND	9	4	3
	14	5	ND	ND	ND	2	ND	ND
	16.5	18	ND	ND	ND	5	ND	ND
	19	820	ND	27	ND	810	470	600
ML4	4	6500	7	140	13	9400	4	5
	6.5	725	ND	62	240	260	ND	2
	9	12000	8	460	15	9100	ND	ND
	11.5	690	3	250	7	630	ND	4
	14	1500	8	59	18	460	70	ND
	16.5	1900	ND	51	11	440	4	5
	19	73	ND	5	1	11	ND	ND
ML5	4	5200	ND	280	230	790	ND	98
	6.5	12000	ND	57	77	51	ND	ND
	11.5	5000	180	690	ND	11000	ND	ND
	14	11000	130	440	ND	8900	26	46
	16.5	4900	ND	22	5	81	1	8
	19	8100	200	270	ND	3600	1570	3700
ML6	4	9100	9	120	43	5000	5	7
	6.5	4500	ND	380	250	870	4	ND
	9	40000	ND	1100	33	5000	ND	ND
	11.5	13000	11000	220	24	2700	ND	ND
	14	13000	93	200	ND	4300	30	ND
	16.5	33000	67	60	ND	270	120	ND
	19	24000	33	95	8	9700	541	2600
ML7	3.5	930	ND	11	2	150	6	5
	6.5	11000	ND	210	130	520	27	19
	8.5	12000	28	1200	81	4800	ND	ND
	11	23000	24	110	ND	14000	1	ND
	13.5	17000	520	1200	ND	46000	ND	ND
	16	8000	ND	230	140	770	180	46
	18.5	810	ND	280	ND	89	ND	6
MW2	SL (9-14ft)	4	ND	ND	ND	ND	1	3
MW3	SU (3-7ft)	3	ND	ND	ND	ND	1	5
MW21	SL (9-14ft)	3	ND	0	ND	14	23	6
	SU (3-7ft)	83	8	49	ND	1800	1500	250
MW6	SL (9-14ft)	11	4	14	ND	590	56	5
	SU (3-7ft)	46	1	2	ND	82	22	23
MW7	SU (12ft)	340	20	170	ND	2800	7700	6400
	SL (5ft)	280	21	190	ND	5500	8300	7500
PMW1		220	ND	11	<1	120	14	9

<1 – Indicates analyte was detected, but below practical quantitation limit of 1 ug/L
ND – Non-detect; less than detection limit of 1ug/L

Table 13

Fatty Acid Analysis Results[a]

Fatty Acid	Well	ML4	ML6	
	Depth (ft bgs)	**11.5**	**6.5**	**11.5**
	PQL (mg/L)	**Concentration (mg/L)**		
N Acetic Acid	0.07	ND	330	57
N Butyric Acid	0.07	ND	28	3.1
N Hexanoic Acid	0.1	ND	2.4	ND
N i-Hexanoic Acid	0.1	ND	0.2	ND
N i-Pentanoic Acid	0.07	ND	1.3	0.26
N Lactic Acid and HIBA	0.1	0.25	13	1.4
N Pentanoic Acid	0.07	ND	25	2.2
N Propionic Acid	0.07	ND	150	8.7
N Pyruvic Acid	0.07	ND	15	1.7

PQL – Practical quantitation limit
ND – Non-detect
a – Samples were immediately submitted, but exceeded holding time at the lab due to inability of lab to analyze the samples in time as a result of instrument malfunction.

Table 14

Soil Gas Concentration Data

Vapor Point	Soil Gas Concentration (µg/L)						
	VC	**11 DCE**	**t-DCE**	**11 DCA**	**c - DCE**	**TCE**	**PCE**
VP1	24	2	25	1	1200	890	10000
VP2	---	---	---	---	---	---	---
VP3	5	ND	ND	ND	6	1	4
VP4	9	ND	<1	ND	4	<1	<1
VP5	180	ND	ND	ND	35	ND	1

ND – Non-detect; less than detection limit of 1ug/L
<1 – Analyte was detected, but concentration below practical quantitation limit
--- No sample collected due to submerged screen

Table 15

Diffusion Coefficients

Location	Test	Effective Helium Diffusion Coefficient (cm^2/s)	$D_{He}^{eff} / D_{He}^{Air}$ (cm^2/s)
VP1	1	1.41E-02	2.29E-02
VP1	2	1.19E-02	1.94E-02
VP2	1	NS	NS
VP2	2	NS	NS
VP3	1	8.86E-03	1.44E-02
VP3	2	1.03E-02	1.67E-02
VP4	1	8.50E-03	1.38E-02
VP4	2	1.29E-02	2.09E-02
VP5	1	6.67E-03	1.08E-02
VP5	2	1.07E-02	1.73E-02

NS – No sample collected due to submerged sampling screen

Table 16

Vapor Flux Calculation

Vapor Point	Depth (cm)	PCE Flux Equivalence (kg/yr)	Estimated Area (ft^2)
VP1	45.72	0.67	50
VP2	NQ	NQ	NQ
VP3	45.72	0.0012	50
VP4	45.72	0.0017	50
VP5	45.72	0.025	50

NQ – not quantified due to partially submerged sampling screen

Vapor Flux Calculation

$$Flux_{Vapor} = \sum_i D_i^{air} A_i \left(\frac{D_{He}^{eff}}{D_{He}^{air}}\right)\left(\frac{\Delta C_{v,i}}{\Delta z}\right)\psi_i^j$$

Where:

D_i^{air}	–	Diffusion coefficient of compound i in air (cm^2/s)
D_{He}^{eff}	–	Measured effective helium diffusion coefficient (cm^2/s)
D_{He}^{air}	–	Diffusion coefficient of helium in air (cm^2/s)
$C_{v,i}$	–	Concentration of compound i in vapor (µg/L)
Z	–	depth of sample (cm)
ψ_i^j	–	Adjustment Factor for measured chemical i in terms of chemical j
A_i	-	Impacted Area (cm^2)

Diffusion Coefficients in Air (cm2/s)

He	VC	11 DCE	t-DCE	11 DCA	c - DCE	TCE	PCE
6.71E-1	1.06E-01	9.00E-02	7.07E-02	7.42E-02	7.36E-02	7.90E-02	7.20E-02

Adjustment Factors (ψ_i^j)

		PCE Equivalent (adjustment factor)					
		PCA	**PCE**	**TCA**	**TCE**	**DCA**	**DCE**
Measured	PCA	1.000	0.700	0.564	0.555	0.418	0.409
	PCE	1.428	1.000	0.804	0.792	0.597	0.585
	TCA	1.775	1.243	1.000	0.985	0.742	0.727
	TCE	1.802	1.262	1.015	1.000	0.753	0.738
	DCA	2.392	1.676	1.348	1.328	1.000	0.980
	DCE	2.442	1.711	1.376	1.355	1.021	1.000
	Chloroethane	3.670	2.570	2.068	2.037	1.534	1.503
	VC	3.788	2.653	2.135	2.102	1.583	1.551
	Ethane	7.873	5.515	4.436	4.369	3.291	3.224
	Ethene	8.440	5.912	4.756	4.684	3.528	3.456

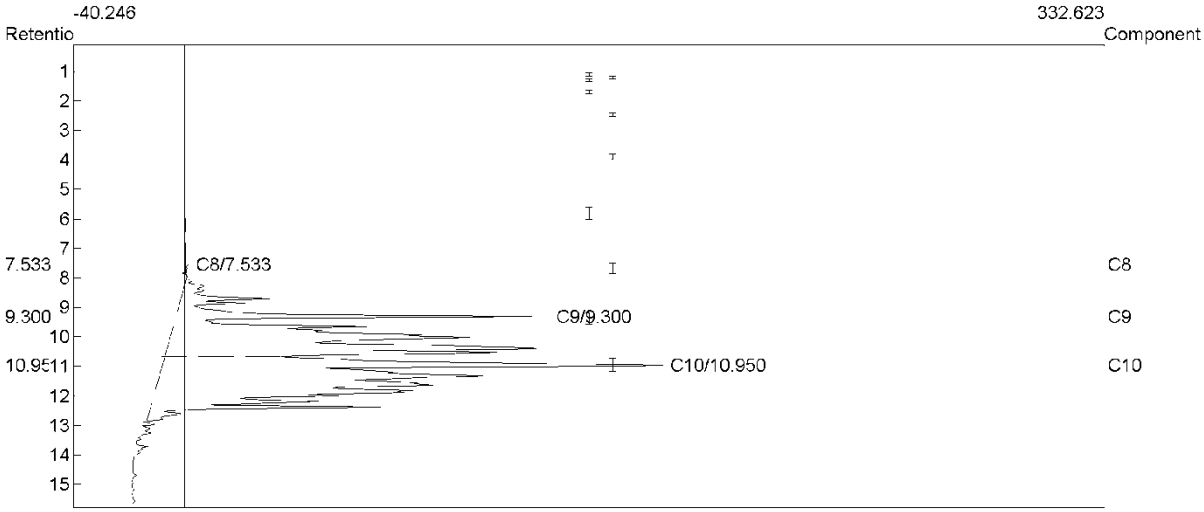
Adjustment factors calculated by ASU. Calculation will be detailed in a document to ESTCP at a later date.

Table 17

ML6 – 9ftbgs - LNAPL Carbon Range Distribution

Range	Percentage	Cumulative Percentage
C1-C8	0.00%	0.00%
C8-C9	0.05%	0.05%
C9-C10	44.86%	44.92%
C10+	55.08%	100.00%

Chromatogram for direct injection of LNAPL from ML6 – 9ftbgs



Component	Retention	Area	Height
C8	7.533	8.1540	1.010
C9	9.300	6874.5270	134.970
C10	10.950	8440.4940	180.940
		15323.1750	

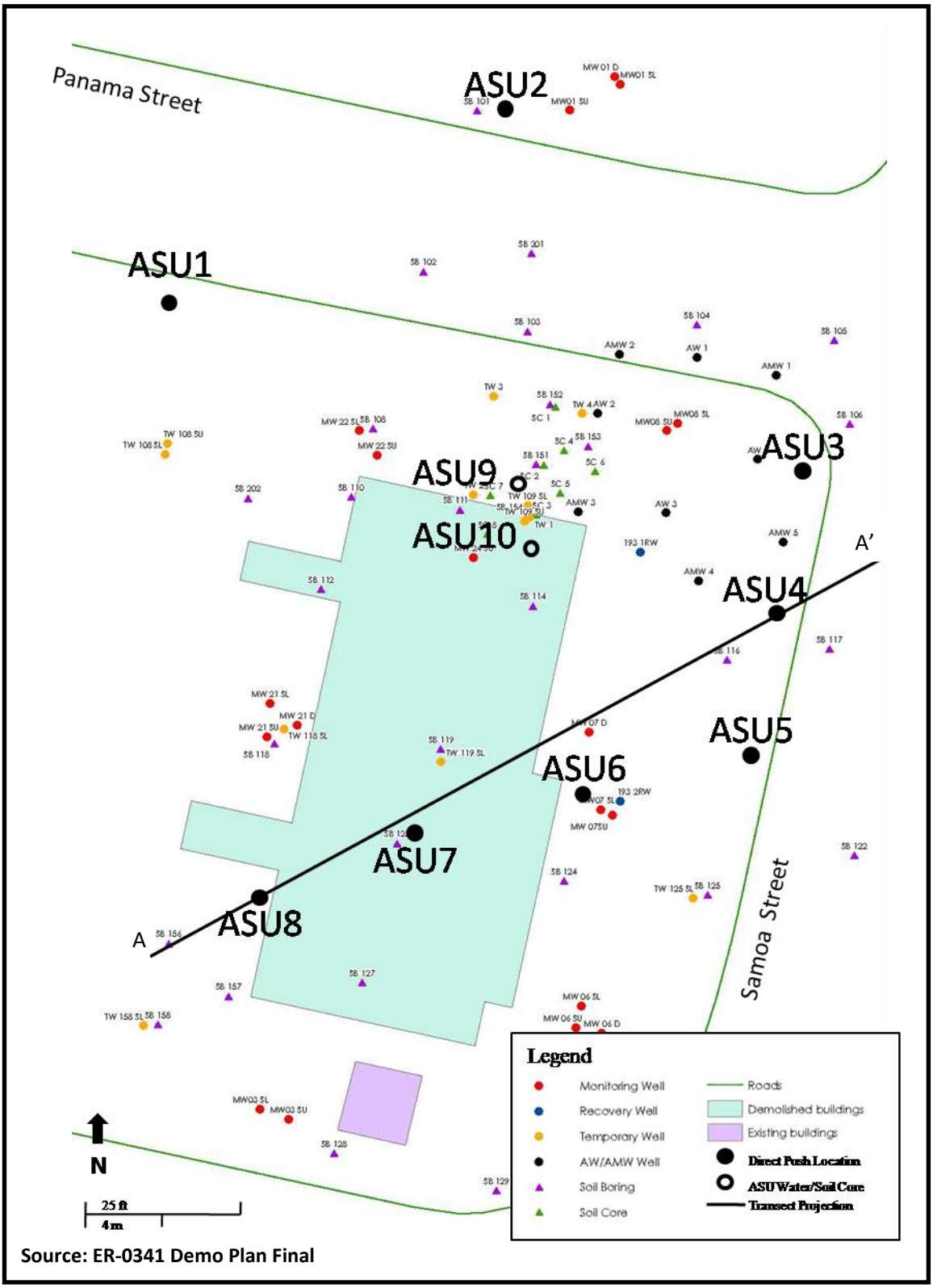
Figures

Figure 1
Site Map - MCRD Parris Island SWMU45

Source: TerraServer.Com, and StreetMap USA (Copyright © 1999-2005 ESRI Inc.)

Figure 2

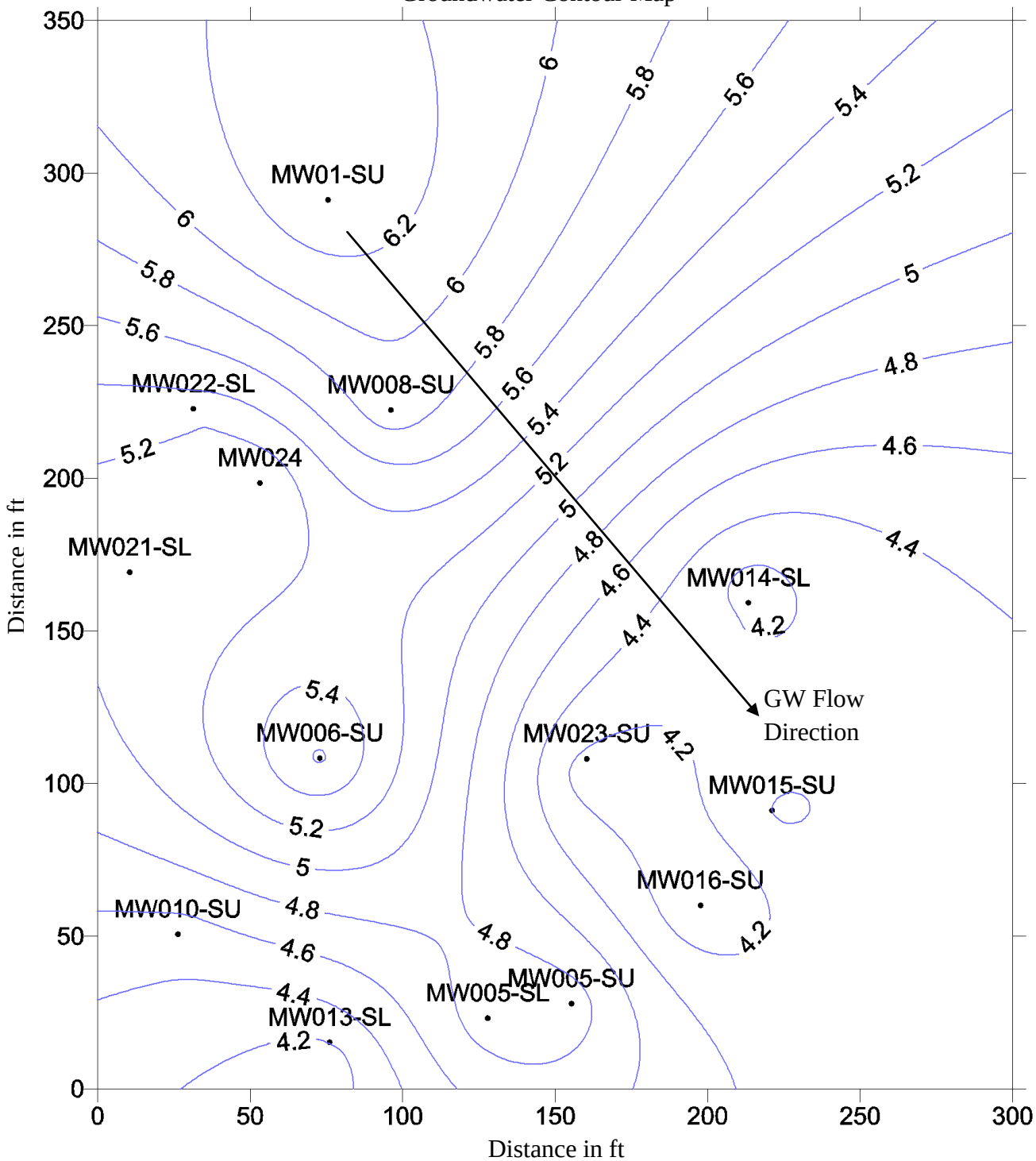
Direct Push Water/Soil Sampling Locations



Source: ER-0341 Demo Plan Final

Figure 3

Groundwater Contour Map



Note: Contour elevations are listed in ft amsl

Figure 4

Vapor Sampling Locations

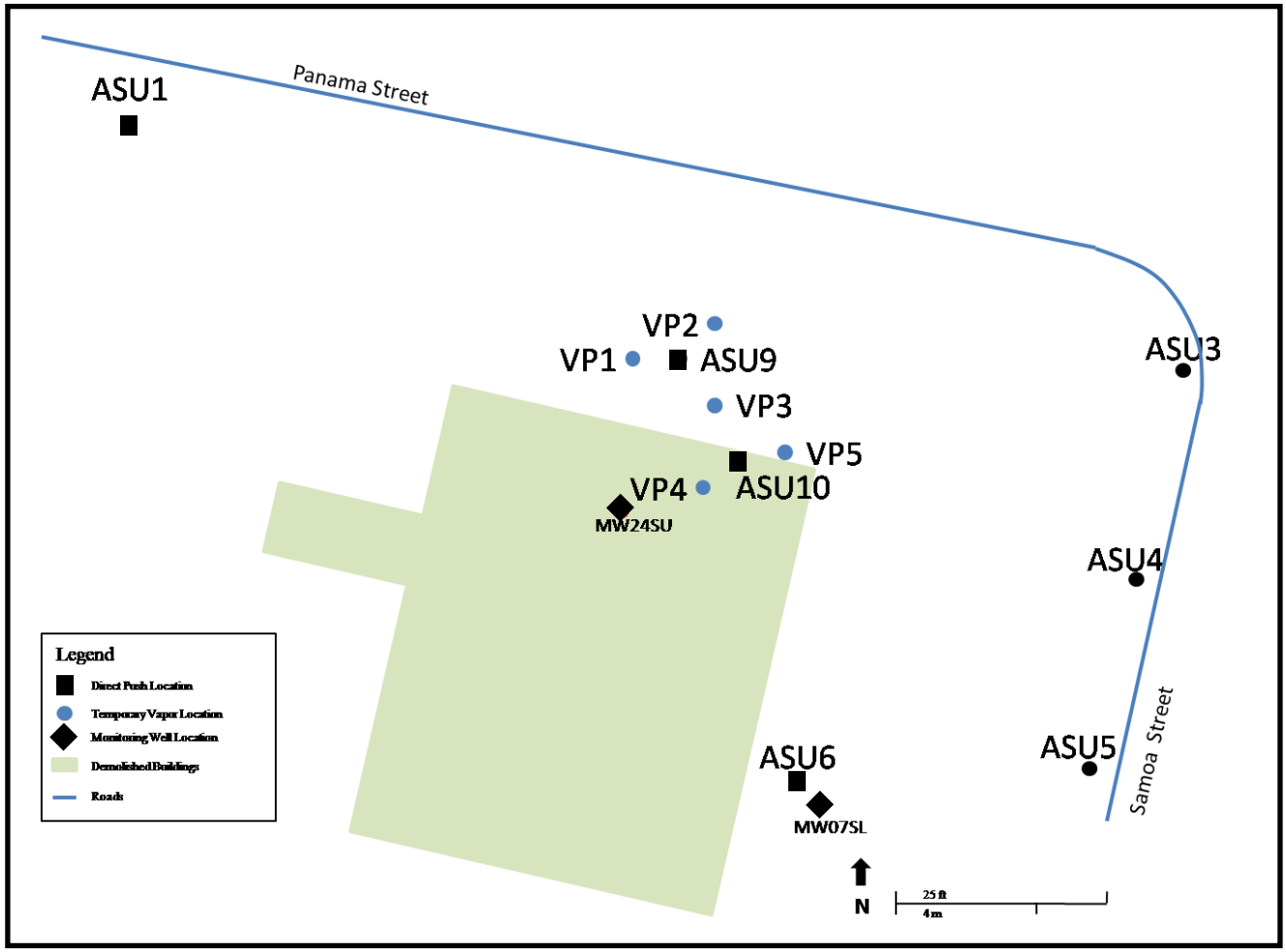
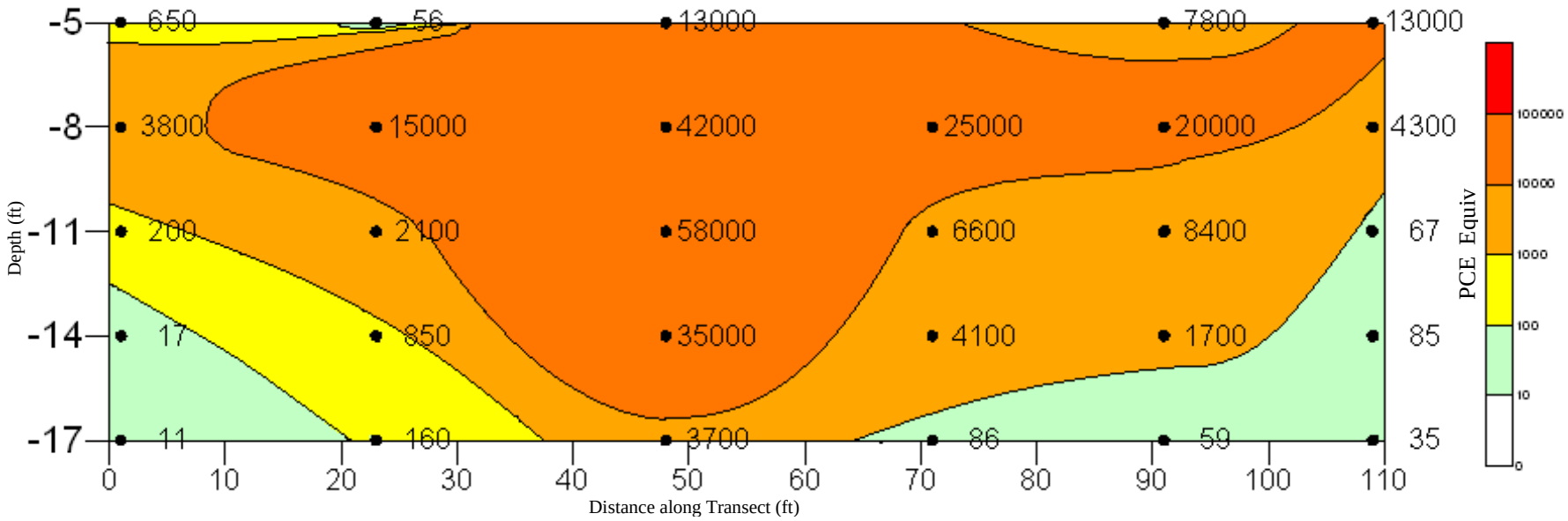


Figure 5

Groundwater Concentration Vertical Contour Plot



Transect orientation is from ASU8 to ASU4, perpendicular to the estimated dominant flow direction, and includes ASU direct push locations 3-8

Figure 6

Mass Flux Calculation - Inputs

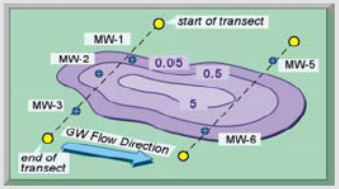
Input Data and Grid

Data Input Instructions
Enter value directly.
Value calculated by model
(Don't enter any data)

Site Location and I.D.: [redacted]
Description:

4. CHOOSE TRANSECT Transect 1

5. CHOOSE TIME PERIOD 1



6. ENTER TRANSECT DATA

6.1 Distance of Transect 1 from Source → 15 *(ft)*

6.2 ○ Darcy Velocity ◉ Hydraulic Conductivity

6.6 ◉ Sampling Interval ○ Mid Point of Sampling Interval

6.3 Hydraulic Conductivity Units: cm/sec

6.4 Uniform Hydraulic Conductivity?: No

6.5 Uniform Hydraulic Gradient?: Yes →

Hydraulic Gradient 5.78E-03 *(cm/cm)*

	Monitoring Point	Distance of Monitoring Point from Start of Transect (ft)	Sampling Interval (ft bgs) Top	Sampling Interval (ft bgs) Bottom	Plume Top (ft bgs)	Plume Bottom (ft bgs)	Hydraulic Conductivity (cm/sec)	Concentration (ug/L) *Constituent A* *PCE Equivalence*	Concentration (ug/L) *Constituent B*
1	[redacted]								
2	[redacted]	110							
3	ASU3	109	5	5.5	5	25	0.00011	1300	
4	ASU3	109	8	8.5	5	25	0.00041	4300	
5	ASU3	109	11	11.5	5	25	0.00045	67	
6	ASU3	109	14	14.5	5	25	0.00018	85	
7	ASU3	109	17	17.5	5	25	0.000026	35	
8	ASU4	90	5	5.5	5	25	0.000087	7700	
9	ASU4	90	8	8.5	5	25	0.00041	20000	
10	ASU4	90	11	11.5	5	25	0.0001	8400	
11	ASU4	90	14	14.5	5	25	0.00011	1700	
12	ASU4	90	17	17.5	5	25	0.000015	59	
13	ASU5	70	8	8.5	5	25	0.00017	2800	
14	ASU5	70	11	11.5	5	25	0.0021	6600	
15	ASU5	70	14	14.5	5	25	0.000082	4100	

7. CHOOSE GRID (OPTIONAL)

	Current Grid		Refine Grid By	Refined Grid
Number of rows	[redacted]	→	2	[redacted]
Number of columns	[redacted]		2	[redacted]

8. SELECT CONSTITUENT FOR CALCULATIONS
◉ PCE Equivalence ○ Constituent B

Next Step: Continue Data Input

Back to Transect Calculator Screen | *Import MW Data* | *Export MW Data* | *See Conc/Flux Grids*

Clear Screen | *Paste Example* | *Restore Table Formatting* | Print | ***HELP***

Figure 7

Mass Flux Calculation - Interpolated Concentration Profile

Grid Completion: Concentration

Transect 1 Time Period 1. Vertical Interpolation: Linear Horizontal Interpolation: Linear

Step 10: Interpolate Conc Horizontally | Export Conc Grid | Import Conc Grid | Next Step: Interpolate Hydraulic Conductivity Grid

Back to Data Input | Back to Conc Grid | Back to K Grid | Print | HELP

Data Input Instructions

10.80 → Enter value directly. (Values in italics represent interpolated values.)

[redacted] → Top/Bottom of plume. (Don't enter any data).

PCE Equivalence Concentrations (ug/L)

Distance from Edge of Transect (ft)

Start of Transect 0.0 | ASU8 1.0 | ASU7 22.0 | ASU6 47.0 | ASU5 70.0 | ASU4 90.0 | ASU3 109.0 | End of Transect 110.0

Depth in ft-bgs

Depth in ft-bgs	0.0	0.5	1.0	11.5	22.0	34.5	47.0	58.5	70.0	80.0	90.0	99.5	109.0	109.5	110.0
5.0	0	0.00E+00	6.50E+02	3.53E+02	5.60E+01	6.53E+03	1.30E+04	1.90E+04	2.50E+04	1.64E+04	7.80E+03	1.04E+04	1.30E+04	0.00E+00	0
6.0	0	0.00E+00	1.70E+03	3.37E+03	5.04E+03	1.39E+04	2.27E+04	2.38E+04	2.50E+04	1.84E+04	1.19E+04	1.10E+04	1.01E+04	0.00E+00	0
7.0	0	0.00E+00	2.75E+03	6.38E+03	1.00E+04	2.12E+04	3.23E+04	2.87E+04	2.50E+04	2.05E+04	1.59E+04	1.16E+04	7.20E+03	0.00E+00	0
8.0	0	0.00E+00	3.80E+03	9.40E+03	1.50E+04	2.85E+04	4.20E+04	3.35E+04	2.50E+04	2.25E+04	2.00E+04	1.22E+04	4.30E+03	0.00E+00	0
9.0	0	0.00E+00	2.60E+03	6.65E+03	1.07E+04	2.90E+04	4.73E+04	3.31E+04	1.89E+04	1.75E+04	1.61E+04	9.51E+03	2.89E+03	0.00E+00	0
10.0	0	0.00E+00	1.40E+03	3.90E+03	6.40E+03	2.95E+04	5.27E+04	3.27E+04	1.27E+04	1.25E+04	1.23E+04	6.87E+03	1.48E+03	0.00E+00	0
11.0	0	0.00E+00	2.00E+02	1.15E+03	2.10E+03	3.01E+04	5.80E+04	3.23E+04	6.60E+03	7.50E+03	8.40E+03	4.23E+03	6.70E+01	0.00E+00	0
12.0	0	0.00E+00	1.39E+02	9.11E+02	1.68E+03	2.60E+04	5.03E+04	2.81E+04	5.77E+03	5.97E+03	6.17E+03	3.12E+03	7.30E+01	0.00E+00	0
13.0	0	0.00E+00	7.80E+01	6.72E+02	1.27E+03	2.20E+04	4.27E+04	2.38E+04	4.93E+03	4.43E+03	3.93E+03	2.01E+03	7.90E+01	0.00E+00	0
14.0	0	0.00E+00	1.70E+01	4.34E+02	8.50E+02	1.79E+04	3.50E+04	1.96E+04	4.10E+03	2.90E+03	1.70E+03	8.93E+02	8.50E+01	0.00E+00	0
15.0	0	0.00E+00	1.50E+01	3.18E+02	6.20E+02	1.26E+04	2.46E+04	1.37E+04	2.76E+03	1.96E+03	1.15E+03	6.11E+02	6.83E+01	0.00E+00	0
16.0	0	0.00E+00	1.30E+01	2.02E+02	3.90E+02	7.26E+03	1.41E+04	7.78E+03	1.42E+03	1.02E+03	6.06E+02	3.29E+02	5.17E+01	0.00E+00	0
17.0	0	0.00E+00	1.10E+01	8.55E+01	1.60E+02	1.93E+03	3.70E+03	1.89E+03	8.60E+01	7.25E+01	5.90E+01	4.70E+01	3.50E+01	0.00E+00	0
18.0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0
19.0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0
20.0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0
21.0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0
22.0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0
23.0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0
24.0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0
25.0															

Figure 8

Mass Flux Calculation - Interpolated Hydraulic Conductivity Profile

Grid Completion: Hydraulic Conductivity

Transect 1 Time Period 1. Vertical Interpolation: Linear Horizontal Interpolation: Linear

Step 10: Interpolate K Horizontally | Export K Grid | Import K Grid | Next Step: View Hydraulic Gradient Grid

Back to Data Input | Back to Conc Grid | Back to K Grid | Print | HELP

Data Input Instructions

10.80 → Enter value directly. (Values in italics represent interpolated values.)

[redacted] → Top/Bottom of plume. (Don't enter any data).

Hydraulic Conductivity (cm/sec)

Distance from Edge of Transect (ft)

Start of Transect | ASU8 | ASU7 | ASU6 | ASU5 | ASU4 | ASU3 | End of Transect

Depth in ft-bgs

	0.0	0.5	1.0	11.5	22.0	34.5	47.0	58.5	70.0	80.0	90.0	99.5	109.0	109.5	110.0
5.0	0.00E+00	0.00E+00	9.10E-06	2.36E-05	3.80E-05	1.74E-04	3.10E-04	2.40E-04	1.70E-04	1.29E-04	8.70E-05	9.85E-05	1.10E-04	0.00E+00	0.00E+00
6.0	0.00E+00	0.00E+00	6.27E-05	7.90E-05	9.53E-05	2.31E-04	3.67E-04	2.68E-04	1.70E-04	1.82E-04	1.95E-04	2.02E-04	2.10E-04	0.00E+00	0.00E+00
7.0	0.00E+00	0.00E+00	1.16E-04	1.35E-04	1.53E-04	2.88E-04	4.23E-04	2.97E-04	1.70E-04	2.36E-04	3.02E-04	3.06E-04	3.10E-04	0.00E+00	0.00E+00
8.0	0.00E+00	0.00E+00	1.70E-04	1.90E-04	2.10E-04	3.45E-04	4.80E-04	3.25E-04	1.70E-04	2.90E-04	4.10E-04	4.10E-04	4.10E-04	0.00E+00	0.00E+00
9.0	0.00E+00	0.00E+00	1.93E-04	8.50E-04	1.51E-03	1.58E-03	1.65E-03	1.23E-03	8.13E-04	5.60E-04	3.07E-04	3.65E-04	4.23E-04	0.00E+00	0.00E+00
10.0	0.00E+00	0.00E+00	2.17E-04	1.51E-03	2.80E-03	2.82E-03	2.83E-03	2.14E-03	1.46E-03	8.30E-04	2.03E-04	3.20E-04	4.37E-04	0.00E+00	0.00E+00
11.0	0.00E+00	0.00E+00	2.40E-04	2.17E-03	4.10E-03	4.05E-03	4.00E-03	3.05E-03	2.10E-03	1.10E-03	1.00E-04	2.75E-04	4.50E-04	0.00E+00	0.00E+00
12.0	0.00E+00	0.00E+00	1.85E-04	1.58E-03	2.98E-03	2.84E-03	2.70E-03	2.06E-03	1.43E-03	7.65E-04	1.03E-04	2.32E-04	3.60E-04	0.00E+00	0.00E+00
13.0	0.00E+00	0.00E+00	1.31E-04	9.99E-04	1.87E-03	1.63E-03	1.40E-03	1.08E-03	7.55E-04	4.31E-04	1.07E-04	1.88E-04	2.70E-04	0.00E+00	0.00E+00
14.0	0.00E+00	0.00E+00	7.60E-05	4.13E-04	7.50E-04	4.24E-04	9.80E-05	9.00E-05	8.20E-05	9.60E-05	1.10E-04	1.45E-04	1.80E-04	0.00E+00	0.00E+00
15.0	0.00E+00	0.00E+00	6.40E-05	2.86E-04	5.08E-04	2.90E-04	7.17E-05	6.46E-05	5.76E-05	6.80E-05	7.83E-05	1.04E-04	1.29E-04	0.00E+00	0.00E+00
16.0	0.00E+00	0.00E+00	5.20E-05	1.59E-04	2.65E-04	1.55E-04	4.53E-05	3.93E-05	3.32E-05	3.99E-05	4.67E-05	6.20E-05	7.73E-05	0.00E+00	0.00E+00
17.0	0.00E+00	0.00E+00	4.00E-05	3.15E-05	2.30E-05	2.10E-05	1.90E-05	1.39E-05	8.80E-06	1.19E-05	1.50E-05	2.05E-05	2.60E-05	0.00E+00	0.00E+00
18.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
19.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
20.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
21.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
22.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
23.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
24.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
25.0															

Hydraulic Conductivity (cm/sec)

Distance from Edge of Transect (ft)

Figure 9

Mass Flux Calculation - Results

Mass Flux Result

TOTAL MASS FLUX 9.21E+00 (g/day) 3.36E+00 (kg/yr)

Next Step: Mass Flux Summary | Run/View Uncertainty Analysis (Optional) | View Final Concentration Grid | Back to Data Grid | Print | HELP

Data Representation

1. Bold values represent calculations based on given values.
2. Values in italics represent calculations based on interpolation.
3. Black shaded cells represent the top and bottom of the plume.

SELECT TRANSECT TO VIEW: Transect 1

SELECT TIME PERIOD TO VIEW: 1

PCE Equivalence Mass Flux (g/day)

Distance from Edge of Transect (ft)

Depth in ft-bgs	Start of Transect 0.0	0.5	ASU8 1.0	11.5	ASU7 22.0	34.5	ASU6 47.0	58.5	ASU5 70.0	80.0	ASU4 90.0	99.5	ASU3 109.0	109.5	End of Transect 110.0
5.0	0.00E+00	0.00E+00	1.51E-05	4.05E-05	1.14E-05	6.59E-03	2.24E-02	2.43E-02	2.12E-02	9.78E-03	3.07E-03	4.52E-03	3.32E-03	0.00E+00	0.00E+00
6.0	0.00E+00	0.00E+00	2.72E-04	1.30E-03	2.56E-03	1.86E-02	4.63E-02	3.41E-02	2.12E-02	1.56E-02	1.05E-02	9.80E-03	4.92E-03	0.00E+00	0.00E+00
7.0	0.00E+00	0.00E+00	8.17E-04	4.19E-03	8.16E-03	3.54E-02	7.62E-02	4.54E-02	2.12E-02	2.24E-02	2.18E-02	1.56E-02	5.18E-03	0.00E+00	0.00E+00
8.0	0.00E+00	0.00E+00	1.65E-03	8.70E-03	1.68E-02	5.70E-02	1.12E-01	5.81E-02	2.12E-02	3.03E-02	3.71E-02	2.20E-02	4.09E-03	0.00E+00	0.00E+00
9.0	0.00E+00	0.00E+00	1.28E-03	2.75E-02	8.60E-02	2.66E-01	4.36E-01	2.18E-01	7.66E-02	4.55E-02	2.24E-02	1.53E-02	2.84E-03	0.00E+00	0.00E+00
10.0	0.00E+00	0.00E+00	7.74E-04	2.87E-02	9.58E-02	4.82E-01	8.29E-01	3.74E-01	9.25E-02	4.82E-02	1.13E-02	9.70E-03	1.50E-03	0.00E+00	0.00E+00
11.0	0.00E+00	0.00E+00	1.23E-04	1.22E-02	4.60E-02	7.06E-01	1.29E+00	5.26E-01	6.92E-02	3.83E-02	3.80E-03	5.13E-03	7.00E-05	0.00E+00	0.00E+00
12.0	0.00E+00	0.00E+00	6.58E-05	7.04E-03	2.68E-02	4.29E-01	7.57E-01	3.09E-01	4.11E-02	2.12E-02	2.88E-03	3.19E-03	6.10E-05	0.00E+00	0.00E+00
13.0	0.00E+00	0.00E+00	2.60E-05	3.27E-03	1.26E-02	2.08E-01	3.32E-01	1.37E-01	1.86E-02	8.86E-03	1.90E-03	1.67E-03	4.95E-05	0.00E+00	0.00E+00
14.0	0.00E+00	0.00E+00	3.30E-06	8.73E-04	3.40E-03	4.41E-02	1.91E-02	9.39E-03	1.68E-03	1.29E-03	8.46E-04	5.71E-04	3.55E-05	0.00E+00	0.00E+00
15.0	0.00E+00	0.00E+00	2.45E-06	4.42E-04	1.68E-03	2.12E-02	9.81E-03	4.71E-03	7.94E-04	6.18E-04	4.09E-04	2.79E-04	2.04E-05	0.00E+00	0.00E+00
16.0	0.00E+00	0.00E+00	1.73E-06	1.56E-04	5.52E-04	6.54E-03	3.57E-03	1.63E-03	2.36E-04	1.88E-04	1.28E-04	8.99E-05	9.27E-06	0.00E+00	0.00E+00
17.0	0.00E+00	0.00E+00	1.12E-06	1.31E-05	1.96E-05	2.35E-04	3.92E-04	1.40E-04	3.78E-06	4.00E-06	4.00E-06	4.25E-06	2.11E-06	0.00E+00	0.00E+00
18.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
19.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
20.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
21.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
22.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
23.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
24.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
25.0															