Appendix A

Performance Assessment Methods

A.1 Summary of Statistics
A.2 Sample Collection and Extraction Methods
A.3 List of Standard Sample Collection and Analytical Methods

Appendix A.1 Summary of Statistics

This summarizes the results of our statistical analyses of TCE monitoring data for the EZVI plot. The basic approach we used is the same as for previous remediation technologies (e.g., Steam). This approach consists of three main steps: (1) perform a semivariogram analysis to assess spatial correlation, (2) perform a kriging analysis to estimate the global (i.e., overall) average TCE concentration, and (3) using a normal distribution assumption, calculate confidence bounds for the estimates and assess the statistical significance of any observed average TCE reductions. In addition, for the EZVI plot, we considered two other topics: (1) the effect on the conclusions due to one high, post-demonstration TCE concentration in soil, and (2) analysis of TCE concentrations in groundwater.

Soil Monitoring Data (Full Data Set)

Although soil monitoring data were collected for all three stratigraphic layers (i.e., lower sand unit, middle fine-grained unit, and upper sand unit [USU]), statistical analyses were only conducted with the USU data. This is because the pre-demonstration soil data for the LSU and MFGU layers indicated only relatively small amounts of TCE, and it was decided these lower two layers might not provide an adequate setting for the demonstration.

Based on the spatial coordinates provided, the EZVI plot was defined to be an area of 14.92 ft. by 9.46 ft. The USU layer is assumed to be a horizontal stratigraphic unit with a constant thickness of 20 ft., centered at a vertical midpoint of -4.79 ft. (i.e., 4.79 ft. below mean sea level). For the purposes of kriging the global average TCE concentration, these dimensions are held constant for all calculations with the pre-demonstration and post-demonstration data.

In the semivariogram and kriging analyses, only those data were used which were classified by the geologists as belonging to the USU layer as shown in Table A-1. This layer was sampled pre-demonstration by a series of 8 drill holes, and post-demonstration by a series of 11 drill holes. In both cases, the drill holes were placed to provide roughly uniform spatial coverage of the EZVI plot. The resulting pre-demonstration data set consisted of N=81 TCE measurements with a sample average of 175.9 mg/kg and a sample standard deviation of 680.7 mg/kg. The resulting post-demonstration data set consisted of N=104 TCE measurements with a sample average of 105.5 mg/kg and a sample standard deviation of 468.0 mg/kg.

Table A-2 summarizes that the estimated (kriged) pre-demonstration global average TCE concentration is 220.1 mg/kg, with a two-sided, 80% confidence interval from 82.3 to 357.9 mg/kg. The kriged post-demonstration global average TCE concentration is 92.4 mg/kg, with a two-sided, 80% confidence interval from 19.3 to 165.4 mg/kg. To test whether the average TCE reduction is significant, we calculated an 80% lower confidence bound (LCB) on the difference of the Pre-demo minus Post-demo TCE concentrations. If this LCB is greater than 0 (zero), then the average reduction is significant at the 20% significance level. The estimated average TCE concentration reduction (i.e., Pre-demo minus Post-demo) is 127.7 mg/kg (i.e., 58% of the TCE was removed), with an 80% LCB of 25.6 mg/kg, which is significant at the 20% significance level. In fact, this reduction is significant up to about the 15% level of significance.

Effect of a Single High Soil Datum

As noted above, N=104 post-demonstration TCE data were collected from the EZVI plot. The majority of these data were found to be below 10 mg/kg, with 83% of the data being below 100 mg/kg, and all but two of the data being below 1000 mg/kg. The single highest measured TCE concentration was 4,502 mg/kg and the second highest TCE concentration was 1,023 mg/kg. Because the highest TCE datum was

well above the rest of the data set, there was a question as to how strongly this single datum might affect the overall statistical results. Generally speaking, if the results of an analysis can be significantly influenced by a single data point, then it is important to confirm the accuracy of that data point, and perhaps to caution reviewers that the study conclusions might be heavily tied to this one datum.

To address this potential question, the kriging analysis of the soil monitoring data was repeated after eliminating the single highest post-demonstration datum from the data set (see Table A-3). The reduced post-demonstration data set included N=103 TCE measurements with a sample average of 62.8 mg/kg and a sample standard deviation of 172.7 mg/kg. With the reduced data set, the kriged post-demonstration global average TCE concentration is 59.2 mg/kg, with a two-sided, 80% confidence interval from 35.9 to 82.6 mg/kg. The estimated average TCE concentration reduction (i.e., Pre-demo minus Post-demo) is 160.9 mg/kg (i.e., 73% of the TCE was removed), with an 80% LCB of 69.3 mg/kg, which is significant at the 20% significance level and up to about the 7% level of significance.

Clearly, eliminating the single highest post-demonstration data point would result in several predictable changes to the statistical results (in Table A-4): (a) the kriged post-demonstration average TCE concentration would drop (i.e., from 92.4 to 59.2 mg/kg), (b) the variability in post-demonstration data would drop and result in tighter confidence bounds on the post-demonstration average (i.e., width of the confidence interval (upper confidence bound minus lower confidence bound) would decrease from 146.1 to 46.7 mg/kg), the average TCE reduction and percentage reduction would increase (i.e., increase from 127.7 to 160.9 mg/kg, and from 58% to 73%, respectively), and the statistical significance of the average TCE concentration reduction would also increase (i.e., from 15% to 7% significance level).

Groundwater Monitoring Data

In addition to the soil monitoring data, a limited number of samples were collected from the groundwater in the EZVI plot before and after the demonstration. Although they may not be direct measurements of TCE levels in the soil, they may provide indirect evidence of TCE reductions.

A total of N=20 pairs of groundwater TCE concentrations were collected from four wells in the EZVI plot, each pair consisting of a pre-demonstration and post-demonstration TCE concentration at the same depth. In addition, a 21st pair of pre-demo and post-demo TCE concentrations was collected from a fifth well in the EZVI plot. Unfortunately, these data included too few discrete spatial locations to allow for a semivariogram and kriging analysis, and the overall sample size is probably too small to allow for strong statistical conclusions to be drawn. However, recognizing these limitations, a paired t-test analysis was conducted to estimate the groundwater average TCE reductions and assess possible statistical significance.

In the paired t-test analysis (Table A-5), the difference between the pre-demonstration and post-demonstration TCE concentrations (i.e., the TCE reduction) is calculated at each discrete sampling location, and then the average difference in this data set is estimated. The corresponding statistical test (using the Student's t distribution instead of the normal distribution) evaluates whether the average difference (i.e., reduction) is significantly greater than zero (0). The results of this analysis indicate that the average TCE reduction for the 21 pairs of data was 804 umoles/L, and the statistical significance of the reduction is 0.66%. Even though the groundwater data set is small, the average TCE reductions still appear to be quite significant.

Table A-1. Summary Statistics of TCE Concentrations in Soil from Upper Sand Unit

			Concentration (mg/Kg)						
Survey	**Unit**	**N**	**Mean**	**Stdev**	**Min**	**1st Qu.**	**Median**	**3rd Qu.**	**Max**
Pre Demo	USU	81	175.85	680.69	0.18	0.36	44	187	6,067
Post Combined	USU	104	105.46	467.99	0.18	0.18	1	17.5	4,502

Table A-2. Summary of Kriged TCE Soil Data from both Pre- and Post-demonstration soil results in Upper Sand Unit

Soil density = 1,590 kg/m^3

	Depth	Area	Volume	Concentration (mg/Kg)				Mass (Kg)			
Pre-Demo	ft	ft^2	^{3}	Mean	Var	Lower	Upper	Mean	Var	Lower	Upper
	20.00	141.14	79.93	220.10	11550.00	82.32	357.88	27.97	186.56	10.46	45.48

Post-Demo	Depth	Area m	Volume	Concentration (mg/Kg)				Mass (Kg)			
	ft	ft^2	^{3}	Mean	Var	Lower	Upper	Mean	Var	Lower	Upper
	20.00	141.14	79.93	92.37	3245.87	19.33	165.40	11.74	52.43	2.46	21.02

Pre-Post	Depth	Area m	Volume	Concentration (mg/Kg)				Mass (Kg)			
	ft	ft^2	^{3}		Var	Lower	Upper	Mean	Var		Upper
		141.14	79.93	127.73	14795.87	25.56	283.67	16.23	238.99	3.25	36.05

% Reduction = (1 - Post / Pre) * 100

	Mean				
	Area m	Volume			
	ft^2	^{3}		Lower	Upper
	141.14	79.93	58	22	94

20.00	Depth	m	Mean

ft
20.00

Table A-3. Summary Statistics of TCE Concentrations in Soil from Upper Sand Unit without Highest TCE Datum

		Concentration (mg/Kg)							
Survey	**Unit**	**N**	**Mean**	**Stdev**	**Min**	**1st Qu.**	**Median**	**3rd Qu.**	**Max**
Pre-Demo	USU	81	175.85	680.69	0.18	0.36	44	187	6,067
Post Combined	USU	103	62.77	172.67	0.18	0.18	1	17	1,023

Table A-4. Summary of Kriged TCE Soil Data from both Pre- and Post-demonstration soil results in Upper Sand Unit without Highest TCE Datum

Pre-Demo

	Depth	Area	Volume	Concentration (mg/Kg)				Mass (Kg)			
	ft	ft^2	^{3}	Mean	Var	Lower	Upper	Mean	Var	Lower	Upper
USU	20.00	141.14	79.93	220.10	11550.00	82.32	357.88	27.97	186.56	10.46	45.48

PostDemo (Combined) m

	Depth	Area	Volume	Concentration (mg/Kg)				Mass (Kg)			
	ft	ft^2	^{3}	Mean	Var	Lower	Upper	Mean	Var	Lower	Upper
USU	20.00	141.14	79.93	59.22	331.57	35.88	82.57	7.53	5.36	4.56	10.49

Pre - Post m

	Depth	Area	Volume	Concentration (mg/Kg)				Mass (Kg)			
	ft	ft^2	^{3}	Mean	Var	Lower	Upper	Mean	Var	Lower	Upper
USU	20.00	141.14	79.93	160.88	11881.57	69.32	300.62		191.92	8.81	38.21

% Reduction = (1 - Post / Pre) * 100 m

	Depth	Area	Volume				
		ft^2	^{3}	Mean	Lower	Upper	
USU	20.00	141.14	79.93	73	55	88	20.45

m

ft

Table A-5. Summary Statistics of TCE Concentrations in Groundwater from Upper Sand Unit

		Concentration µmoles/L			
Pre-Demo	**N**	**Mean**	**Stderr**	**LCL**	**UCL**
All	21	1,424	446	833	2,015
Low	13	33	12	17	49
High	8	3,685	560	2,893	4,477
Post-Demo	**N**	**Mean**	**Stderr**	**LCL**	**UCL**
All	21	620	280	249	992
Low	13	14	5	7	21
High	8	1,605	604	751	2,460
Pre - Post	**N**	**Mean**	**Stderr**	**LCL**	**UCL**
All	21	804	295	413	1,195
Low	13	19	14	0	37
High	8	2,079	527	1,334	2,825

One Sample t-Test for "Pre - Post"

		T	**p-value**
All	21	2.72	1.31%
Low	13	1.36	19.86%
High	8	3.95	0.55%

Reduction					
	N	**Mean**	**Stderr**	**LCL**	**UCL**
All	21	25%	27%	-11%	60%
Low	13	1%	42%	-56%	58%
High	8	63%	12%	46%	80%

LCL	**N**	80% Lower confidence limit (for a 2 side confidence interval)
UCL		80% Upper confidence limit (for a 2 side confidence interval)

Table A-6. Summary Statistics of EZVI Demonstration for TCE Concentrations in Soil (mg/kg)

Survey	Unit	N	Concentration (mg/Kg) Mean	Stdev	Min	1st Qu.	Median	3rd Qu.	Max
Pre-demonstration	USU	81	175.8514	680.6889	0.18	0.36	44	187	6067
Pre-demonstration	MFGU	44	123.793	122.995	0.18	1	55.5	248	340
Pre-demonstration	LSU	34	3.792941	9.388218	0.18	0.18	0.18	1	33
Intermediate	USU	49	95.98082	229.4949	0.18	0.18	1	35	1023
Intermediate	MFGU	9	186.5556	108.3295	1	133	247	252	296
Intermediate	LSU	0	NA	NA	NA	NA	NA	NA	NA
Post-Demonstration	USU	55	113.8985	608.9154	0.18	0.18	1	12	4502
Post-Demonstration	MFGU	28	77.18143	89.70052	0.18	5	40	131.5	293
Post-Demonstration	LSU	30	2.204667	6.424438	0.18	0.18	0.18	0.18	27
Post Combined	USU	104	105.4565	467.9888	0.18	0.18	1	17.5	4502
Post Combined	MFGU	37	103.7859	104.4303	0.18	9	58	204	296
Post Combined	LSU	30	2.204667	6.424438	0.18	0.18	0.18	0.18	27

USU: Upper Sand Unit
MFGU: Middle Fine-Grained Unit
LSU: Lower Sand Unit

A.2 Sample Collection and Extraction Methods

This section describes the modification made to the EPA standard methods to address the lithologic heterogeneities and extreme variability of the contaminant distribution expected in the DNAPL source region at Launch Complex 34. Horizontal variability was addressed by collecting a statistically determined number of soil cores in the EZVI Plot. The vertical variability at each soil coring location was addressed with this modified sampling and extraction procedure, which involved extraction of much larger quantities of soil in each extracted sample, as well as allowed collection and extraction of samples in the field per event. This extraction allowed the extraction and analysis of the entire vertical column of soil at a given coring location.

A.2.1 Soil Sample Collection (Modified ASTM D4547-91) (1997a)

The soil samples collected before and after the demonstration were sampled using a stainless steel sleeve driven into the subsurface by a Vibra-push LD-2 rig. After the sleeve had been driven the required distance, it was brought to the surface and the soil sample was examined and characterized for lithology. One quarter of the sample was sliced from the core and placed into a pre-weighed 500-mL polyethylene container containing methanol. At locations where a field duplicate sample was collected, a second one-quarter sample was split from the core and placed into another pre-weighed 500-mL polyethylene container containing methanol. The remaining portion of the core was placed into a 55-gallon drum and disposed of as waste. The samples were labeled with the date, time, and sample identification code, and stored on ice at 4°C until they were brought inside to the on-site laboratory for the extraction procedure.

After receiving the samples from the drilling activities, personnel staffing the field laboratory performed the methanol extraction procedure as outlined in Section A.2.2 of this appendix. The amount of methanol used to perform the extraction technique was 250 mL. The extraction procedure was performed on all of the primary samples collected during drilling activities and on 5% of the field duplicate samples collected for quality assurance. Samples were stored at 4°C until extraction procedures were performed. After the extraction procedure was finished, the soil samples were dried in an oven at 105°C and the dry weight of each sample was determined. The samples were then disposed of as waste. The remaining three-quarter section of each core previously stored in a separate 500-mL polyethylene bottle were archived until the off-site laboratory had completed the analysis of the methanol extract. The samples were then disposed of in an appropriate manner.

A.2.2 Soil Extraction Procedure (Modified EPA SW846-Method 5035)

After the soil samples were collected from the drilling operations, samples were placed in pre-labeled and pre-weighed 500-mL polyethylene containers with methanol and then stored in a refrigerator at 4°C until the extraction procedure was performed. Extraction procedures were performed on all of the "A" samples from the outdoor and indoor soil sampling. Extraction procedures also were performed on 5% of the duplicate (or "B") samples to provide adequate quality assurance/quality control (QA/QC) on the extraction technique.

Extreme care was taken to minimize the disturbance of the soil sample so that loss of volatile components was minimal. Nitrile gloves were worn by field personnel whenever handling sample cores or pre-weighed sample containers. A modification of EPA SW846-Method 5035 was used to procure the cored samples in the field. Method 5035 lists different procedures for processing samples that are expected to contain low concentrations (0.5 to 200 μg/kg) or high concentrations

(>200 µg/kg) of volatile organic compounds (VOCs). Procedures for high levels of VOCs were used in the field because those procedures facilitated the processing of large-volume sample cores collected during soil sampling activities.

Two sample collection options and corresponding sample purging procedures are described in Method 5035; however, the procedure chosen for this study was based on collecting approximately 150 to 200 g of wet soil sample in a pre-weighed bottle that contains 250 mL of methanol. A modification of this method was used in the study, as described by the following procedure:

- The 150 to 200 g wet soil sample was collected and placed in a pre-weighed 500 mL polypropylene bottle filled with 250 mL of methanol. After capping, the bottle was reweighed to determine the total weight of the soil and the bottle with methanol. The bottle was marked with the location and the depth at which the sample was collected.

- After the containers were filled with methanol and the soil sample they were placed on an orbital shaker table and agitated for approximately 30 min.

- Containers were removed from the shaker table and reweighed to ensure that no methanol was lost during the agitation period. The containers were then placed upright and suspended soil matter was allowed to settle for approximately 15 min.

- The 500 mL containers were then placed in a floor-mounted centrifuge. The centrifuge speed was set at 3,000 rpm and the samples were centrifuged for 10 min.

- Methanol extract was then decanted into disposable 20-mL glass volatile organic analysis (VOA) vials using 10-mL disposable pipettes. The 20-mL glass VOA vials containing the extract then were capped, labeled, and stored in a refrigerator at 4°C until they were shipped on ice to the analytical laboratory.

- Methanol samples in VOA vials were placed in ice chests and maintained at approximately 4°C with ice. Samples were then shipped with properly completed chain-of-custody forms and custody seals to the subcontracted off-site laboratory.

- The dry weight of each of the soil samples was determined gravimetrically after decanting the remaining solvent and drying the soil in an oven at 105°C. Final concentrations of VOCs were calculated per the dry weight of soil.

Three potential concerns existed with the modified solvent extraction method. The first concern was that the United States Environmental Protection Agency (U.S. EPA) had not formally evaluated the use of methanol as a preservative for VOCs. However, methanol extraction often is used in site characterization studies including three technology demonstrations at Launch Complex 34 under U.S. EPA Superfund Innovative Technology Evaluation (SITE) program, so the uncertainty in using this approach was reasonable. The second concern was that the extraction procedure itself would introduce a significant dilution factor that could raise the method quantitation limit beyond that of a direct purge-and-trap procedure. The third concern was that excess methanol used in the extractions would likely fail the ignitability characteristic, thereby making the unused sample volume a hazardous waste. During characterization activities, the used methanol extract was disposed of as hazardous waste into a 55-gallon drum. This methanol extraction method was tested during preliminary site characterization activities at this site (see Appendix G, Table G-1) and, after a few refinements, was found to perform acceptably

in terms of matrix spike recoveries. Spiked TCE recoveries in replicate samples ranged from 72 to 86%.

The analytical portion of Method 5035 describes a closed-system purge-and-trap process for use on solid media such as soils, sediments, and solid waste. The purge-and-trap system consists of a unit that automatically adds water, surrogates, and internals standards to a vial containing the sample. DHL Analytical performed the analysis of the solvent extraction samples by Gas chromatogram/mass spectrum (GC/MS). Soil samples were analyzed for organic constituents according to the parameters summarized in Table A-7. Laboratory instruments were calibrated for VOCs listed under U.S. EPA Method 601 and 602. Samples were analyzed as soon as was practical and within the designated holding time from collection (14 days). No samples were analyzed outside of the designated 14-day holding time.

Table A-7. Soil Sampling and Analytical Parameters

Analytes	Extraction Method	Analytical Method	Sample Holding Time	Matrix
VOCs[(a)]	SW846-5035	SW846-8260	14 days	Methanol

(a) EPA 601/602 list.

A.3 List of Standard Sample Collection and Analytical Methods

Table A-8. Sample Collection Procedures

Measurements	Task/Sample Collection Method	Equipment Used
Primary Objectives		
CVOCs	Soil sampling/ Mod.[(a)] ASTM D4547-98 (1997a)	Butyrate or acetate sleeves 500-mL plastic bottle
CVOCs	Groundwater sampling/ Mod.[(a)] ASTM D4448-01 (1997b)	Peristaltic pump Teflon™ tubing
DHG[(b)]	Groundwater sampling/ Mod.[(a)] ASTM D4448-01 (1997b)	Peristaltic pump Teflon™ tubing
Secondary Objectives		
Field parameters[(c)] Inorganics–cations Inorganics–anions TOC, BOD, TDS, dissolved silica Alkalinity	Groundwater sampling/ Mod.[(a)] ASTM D4448-01 (1997b)	Peristaltic pump Teflon™ tubing
Hydraulic conductivity	Hydraulic conductivity/ ASTM D4044-96 (1997c)	Winsitu® data logger Laptop computer
Groundwater level	Water levels	Water level indicator

(a) Modifications to ASTM.
ASTM = American Society for Testing and Materials.
American Society for Testing and Materials. 1997a. *Standard Practice for Waste and Soils for Volatile Organics*. Designation: D 4547-98.
American Society for Testing and Materials. 1997b. *Standard Guide for Sampling Groundwater Monitoring Wells*. Designation: D 4448-01.
American Society for Testing and Materials. 1997c. *Standard Test Method (Field Procedure) for Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifers*. Designation: D 4044-96.

(b) DHG: methane, ethene, and ethane (see Appendix D).

(c) Field parameters include pH, ORP, temperature, DO, and conductivity. A flow-through cell will be attached to the peristaltic pump when measuring field parameters.

Table A-9. Sample Handling and Analytical Procedures

Measurements	Matrix	Amount Collected	Analytical Method	Maximum Holding Time[a]	Sample Preservation[b]	Sample Container	Sample Type
Primary Objectives							
CVOCs	Soil	250 g	Mod. EPA 8260[c]	14 days	4°C	Plastic	Grab
CVOCs	Groundwater	40-mL × 3	EPA 8260	14 days	4°C, pH < 2 HCl	Glass	Grab
DHG[d]	Groundwater	40 mL x 3	RS Kerr Method	7 days	4°C	Glass	Grab
Dehalococcoidis Ethenogenes[e]	Groundwater	2 x 1L	GeneTrac™ [e]	30 days	4°C	Plastic	Grab
Secondary Objectives							
Hydraulic conductivity	Aquifer	NA	ASTM D4044-96 (1997d)	NA	NA	NA	NA
Inorganics–cations[f]	Groundwater	100 mL	EPA 200.8	28 days	4°C	Plastic	Grab
Inorganics–anions[f]	Groundwater	50 mL	EPA 300.0	28 days	4°C	Plastic	Grab
Dissolved silica	Groundwater	250 mL	SW6010	28 days	None	Plastic	Grab
TOC	Soil	20 g	Based on SW9060	28 days	None	Plastic	Grab
TOC	Groundwater	500 mL	EPA 415.1	7 days	4°C, pH < 2 H_2SO_4	Plastic	Grab
TDS	Groundwater	500 mL	EPA 160.1	7 days	4°C	Plastic	Grab
BOD	Groundwater	1,000 mL	EPA 405.1	48 hours	4°C	Plastic	Grab
DHG[d]	Groundwater	40 mL x 3	RS Kerr Method	7 days	4°C	Glass	Grab
Alkalinity	Groundwater	200 mL	EPA 310.1	14 days	4°C	Plastic	Grab
Water levels	Aquifer	NA	Water level from the top of well casing	NA	NA	NA	NA

(a) Samples will be analyzed as soon as possible after the samples arrive in an off-site laboratory. The times listed are the maximum holding times that samples will be held before analysis and still be considered valid. All data obtained beyond the maximum holding times will be flagged.
(b) Samples will be preserved immediately upon sample collection, if required.
(c) Samples will be extracted using methanol on site. For the detailed extraction procedure see Appendix B.
(d) Dissolved hydrocarbon gases are analyzed by R.S. Kerr Method (see Appendix D).
(e) GeneTrac™ is a proprietary method (see Appendix D).
(f) Cations include Ca, Mg, total and dissolved Fe, Mn, K, and Na. Anions include Br, Cl, SO_4, PO_4, NO_3/NO_2 and Alkalinity.
HCl = Hydrochloric acid, H_2SO_4 = Sulfuric acid.
NA = Not applicable.

Appendix B

Hydrogeologic Measurements

B.1 Performance Monitoring Slug Tests
B.2 Well Completion Diagrams
B.3 Soil Coring Logsheets

B.1 Performance Monitoring Slug Tests

Slug tests were performed on well PA-23 within the EZVI plot before and after the demonstrations to assess any effects on aquifer quality caused by the remediation technologies. Pre-demonstration tests were conducted in the wells in March 2002. Post-demonstration tests were completed in December 2002. As the remediation system was applied to just the upper sand unit, slug tests were only performed in the shallow performance monitoring wells in the center of each plot. PA-23 is 24 ft deep with a 5 ft long screen. The test consisted of placing a pressure transducer and 1.5-inch-diameter by 5-ft-long solid PVC slug within the well. After the water level reached equilibrium, the slug was quickly removed. Removal of the slug created approximately 1.5 ft of change in water level within the well. Water level recovery was then monitored for at least 10 minutes using a TROLL pressure transducer/data logger. The data was then downloaded to a notebook computer. Three replicate tests were conducted in each well to ensure repeatable results.

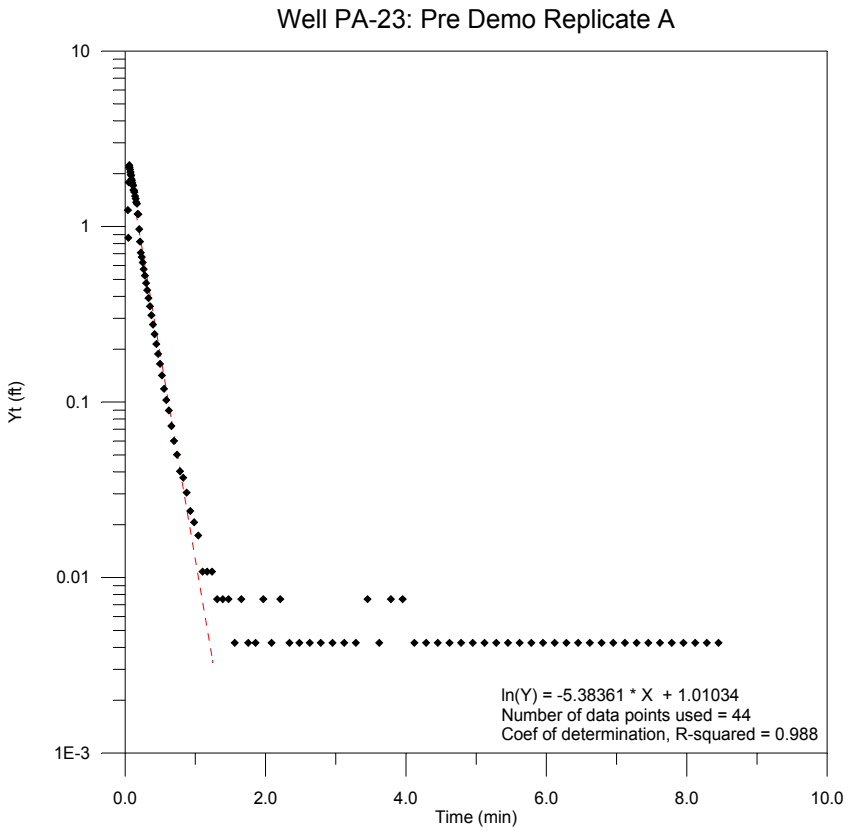
The recovery rates of the water levels were analyzed with the Bouwer (1989) and Bouwer and Rice (1976) methods for slug tests in unconfined aquifers with partially penetrating wells. Graphs were made showing the changes in water level versus time and curve fitted on a semi-logarithmic graph. The slope of the fitted line then was used in conjunction with the well parameters to provide a value of the hydraulic conductivity of the aquifer materials surrounding the well.

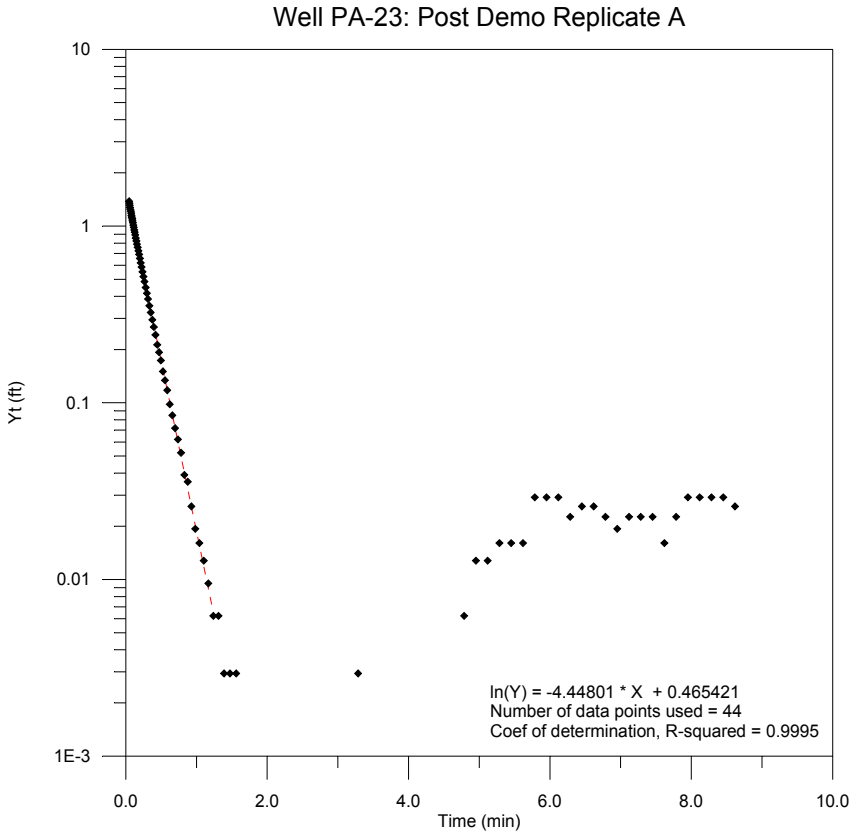
Slug test response curves are presented in this appendix. Water levels returned to equilibrium within 5 minutes for all the tests. Response curves were excellent with coefficients of determination of 0.95 or greater. Table 1 summarizes the results of the slug tests. The results show a very good agreement between the replicate tests. Comparison of the pre-demonstration and post-demonstration slug test results shows mostly negligible changes due to inherent variations in the testing methods. A change of 10 times or greater would indicate a substantial change in permeability at the site. Pre-demonstration hydraulic conductivity averaged 43 ft/day (0.015 cm/sec) in well PA-23. This value is comparable to the typical hydraulic conductivity range in the USU at LC34, which is usually higher than in the underlying hydrostratigraphic units. Post-demonstration hydraulic conductivity averaged 38.2 ft/day (0.013 cm/sec) in PA-23.

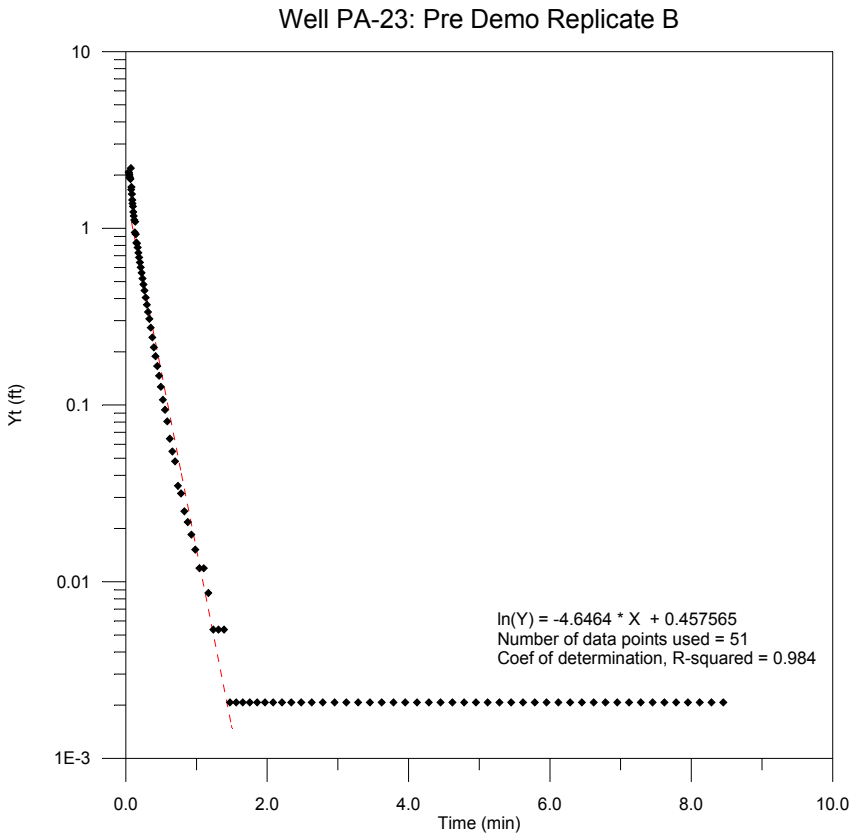
Table 1. Slug Test Results

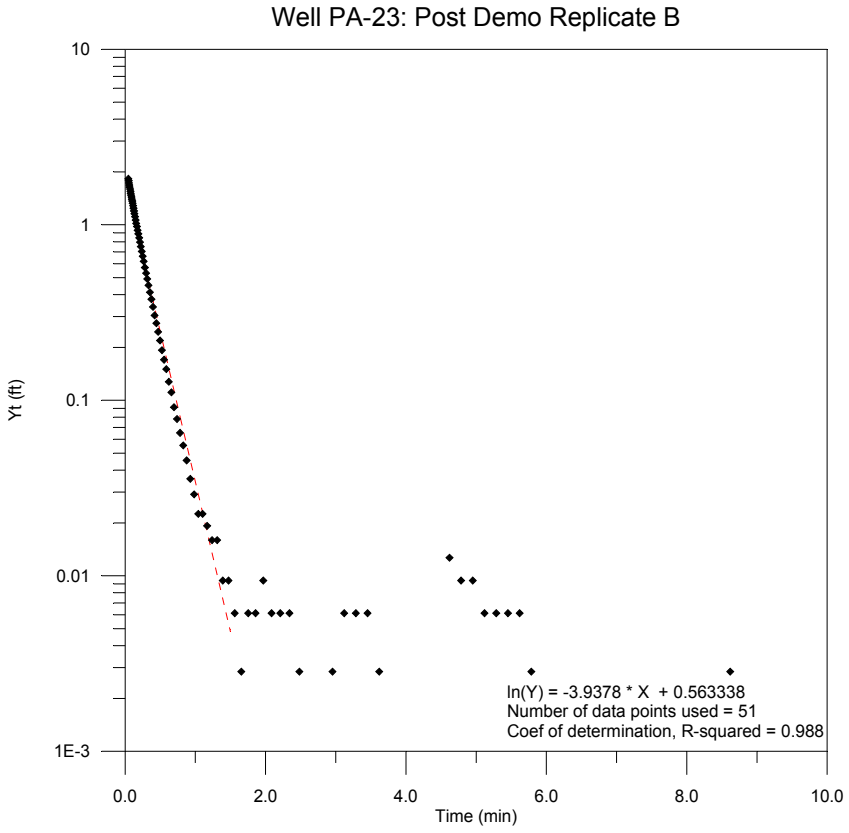
Well	Test	Hydraulic Conductivity (ft/day)	Hydraulic Conductivity (cm/s)	Response (r^2)
PA-23 (EZVI Plot)	Pre-Demonstration			
	A	47.4	0.017	Excellent (0.988)
	B	40.9	0.014	Excellent (0.984)
	C	39.6	0.014	Excellent (0.957)
	Post-Demonstration			
	A	40.5	0.014	Excellent (0.999)
	B	36.1	0.013	Excellent (0.988)
	C	37.9	0.013	Excellent (0.992)

Bouwer, H., and R.C. Rice, 1976, A slug test for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells, Water Resources Research, v.12, n.3, pp. 423-428.
Bouwer, H., 1989, The Bouwer and Rice slug test- an update, Ground Water, v. 27, n.3, pp. 304-309.

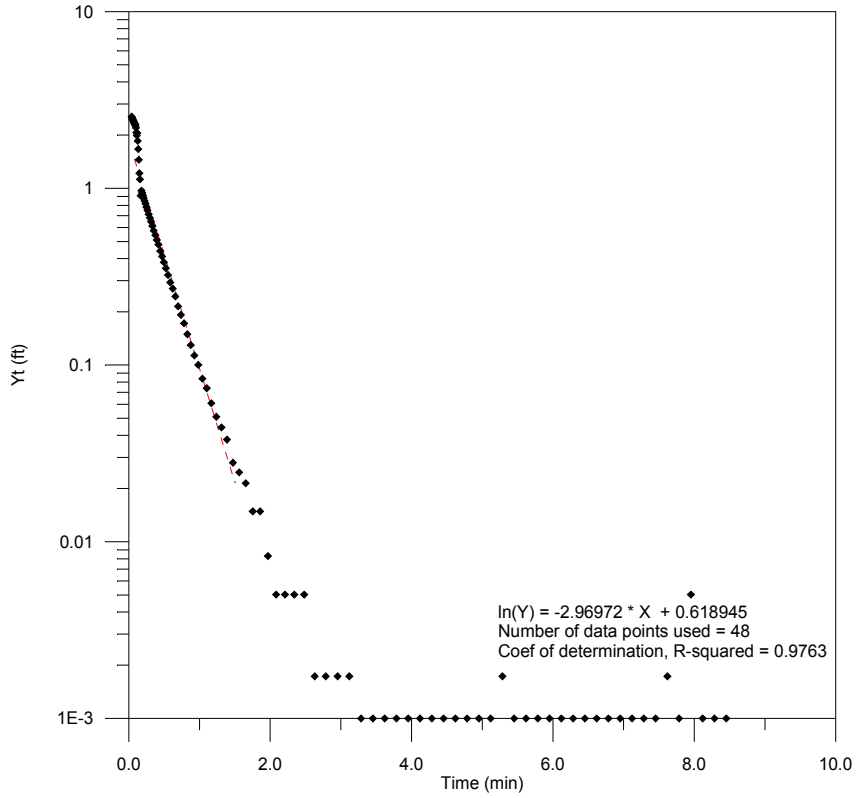

Well PA-23: Pre Demo Replicate A
Yt (ft)
10
1
0.1
0.01
1E-3
0.0
2.0
4.0
6.0
8.0
10.0
Time (min)
ln(Y) = -5.38361 * X + 1.01034
Number of data points used = 44
Coef of determination, R-squared = 0.988


Well PA-23: Post Demo Replicate A
Yt (ft)
10
1
0.1
0.01
1E-3
0.0
2.0
4.0
6.0
8.0
10.0
Time (min)
ln(Y) = -4.44801 * X + 0.465421
Number of data points used = 44
Coef of determination, R-squared = 0.9995

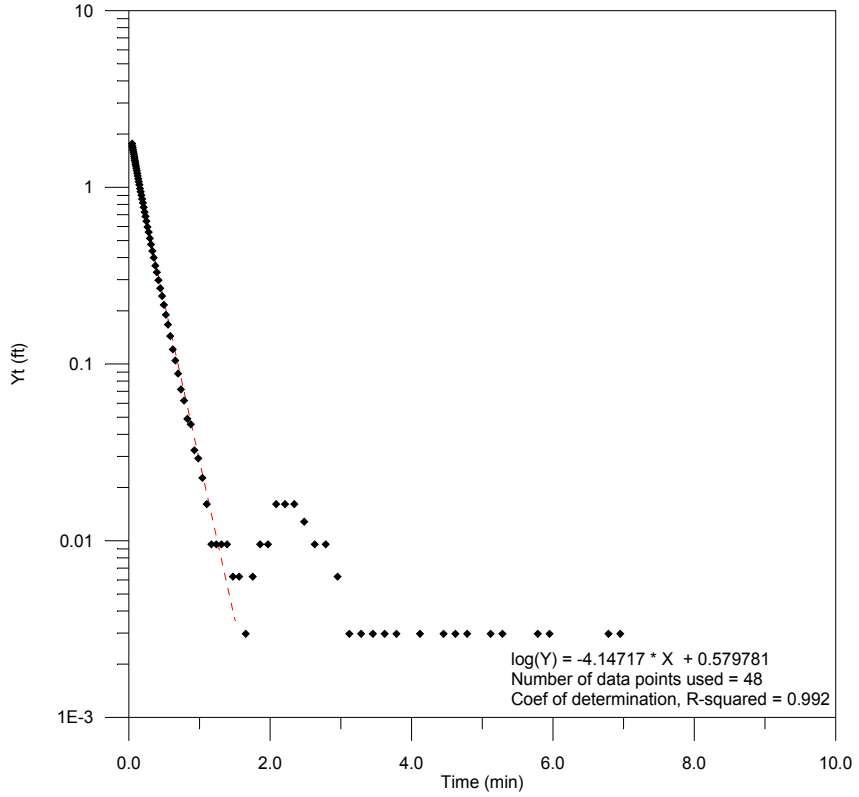

Well PA-23: Pre Demo Replicate B
Yt (ft)
10
1
0.1
0.01
1E-3
0.0
2.0
4.0
6.0
8.0
10.0
Time (min)
ln(Y) = -4.6464 * X + 0.457565
Number of data points used = 51
Coef of determination, R-squared = 0.984


Well PA-23: Post Demo Replicate B
Yt (ft)
10
1
0.1
0.01
1E-3
0.0
2.0
4.0
6.0
8.0
10.0
Time (min)
ln(Y) = -3.9378 * X + 0.563338
Number of data points used = 51
Coef of determination, R-squared = 0.988

Well PA-23: Pre Demo Replicate C



Well PA-23: Post Demo Replicate C



B.2 Well Completion Diagrams

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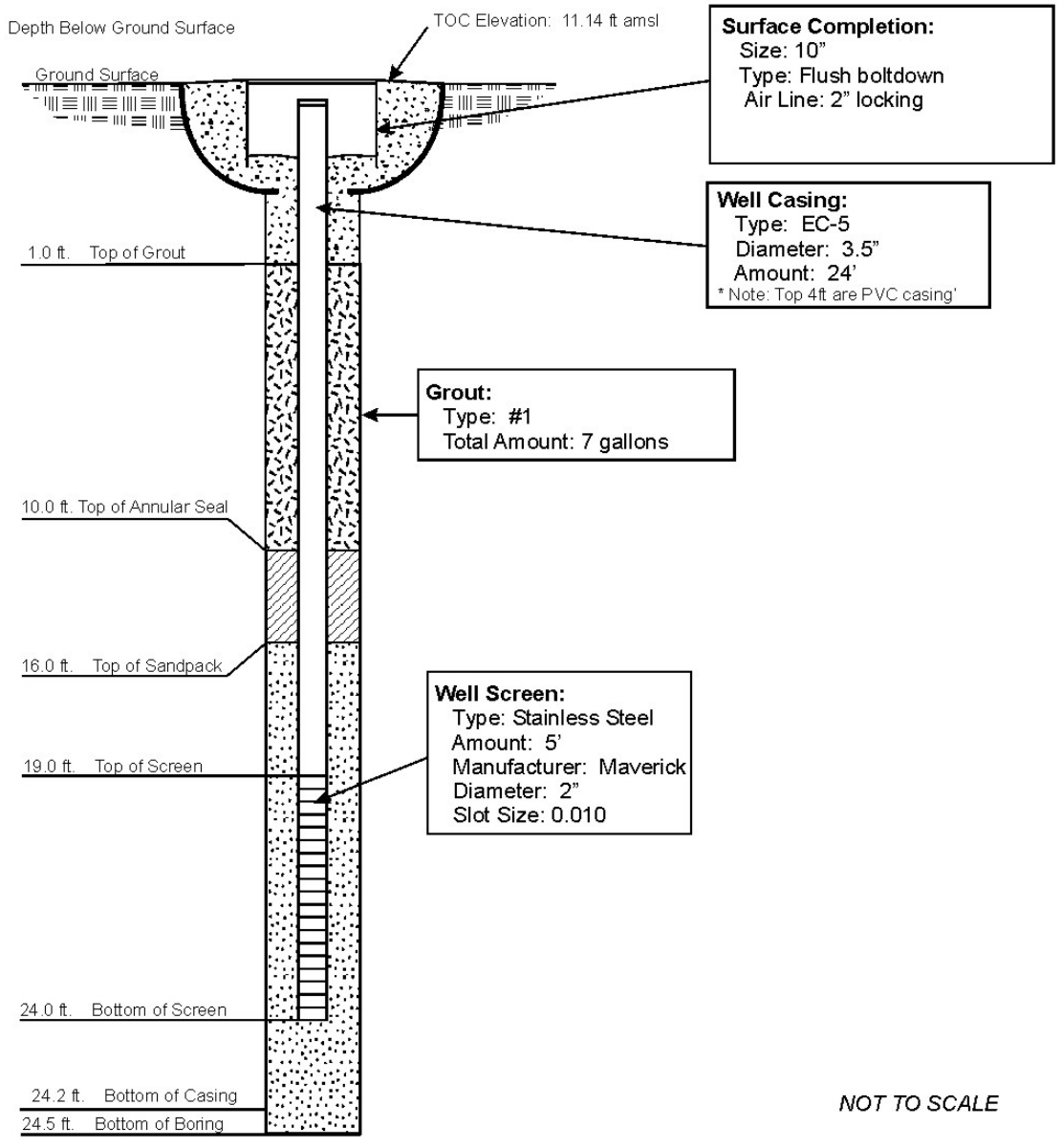
CAPE CANAVERAL
WELL COMPLETION DIAGRAM
PA-23

Project #: G482010-EPA41	Site: CCAS LC34	Well #: EZVI PA-23	Northing (NAD 83): 1521268.57
Drilling Contractor: Precision Sampling	Rig Type and Drilling Method: LD-2 Direct Push	Date: Mar 7, 2002	Easting (NAD 83): 640164.96
Reviewed by: Sam Yoon	Driller: Precision Sampling John Malo	Geologist: MG	Surface Elevation (NAVD 88): 11.14



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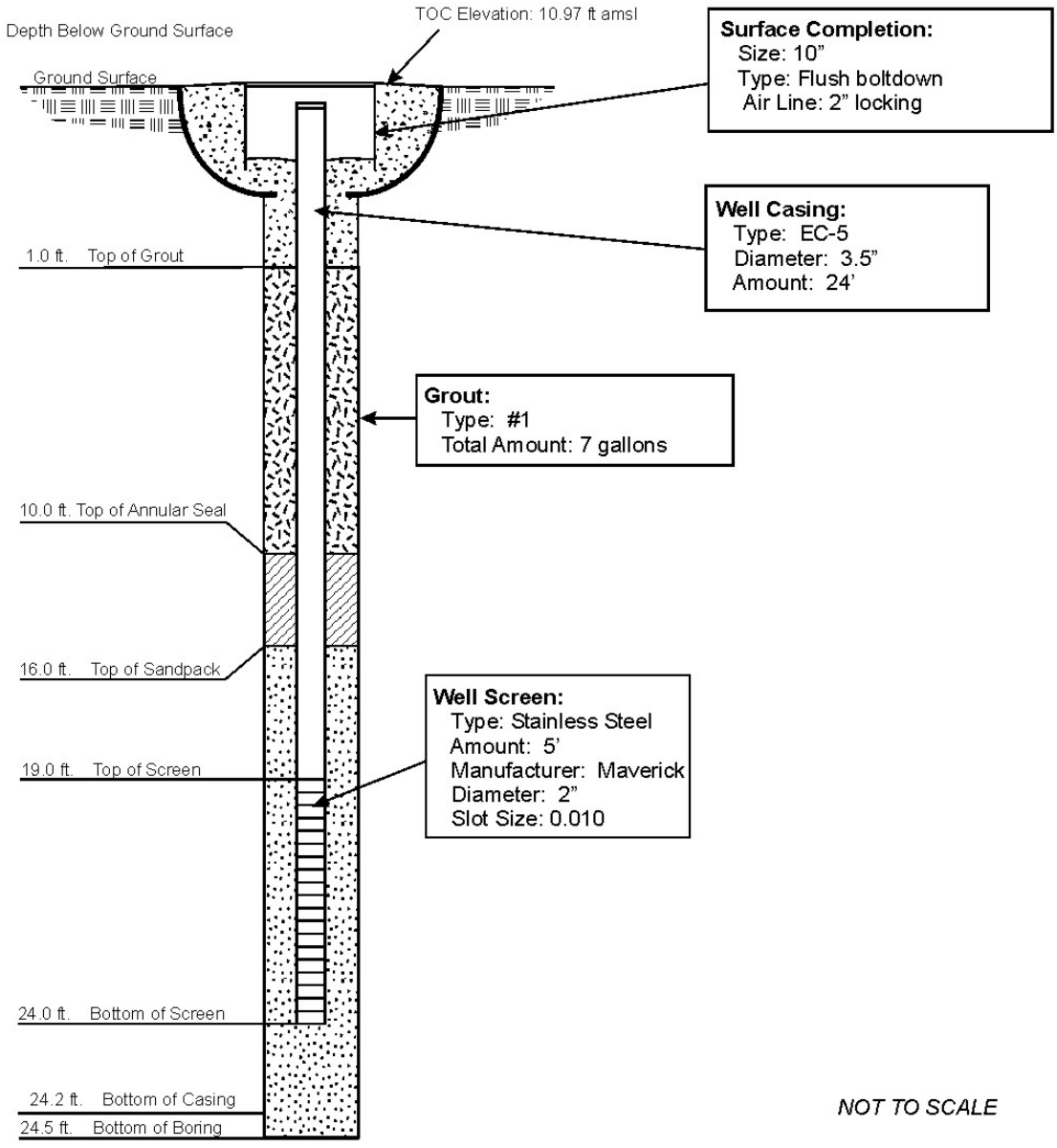
CAPE CANAVERAL
WELL COMPLETION DIAGRAM
PA-24S

Project #: G482010-EPA41	Site: CCAS LC34	Well #: EZVI PA-24S	Northing (NAD 83): 1521263.09
Drilling Contractor: Precision Sampling	Rig Type and Drilling Method: LD-2 Direct Push	Date: Mar 18, 2002	Easting (NAD 83): 640174.46
Reviewed by: Sam Yoon	Driller: Precision Sampling John Malo	Geologist: MG	Surface Elevation (NAVD 88): 10.97



WCD-PA24-S.CDR

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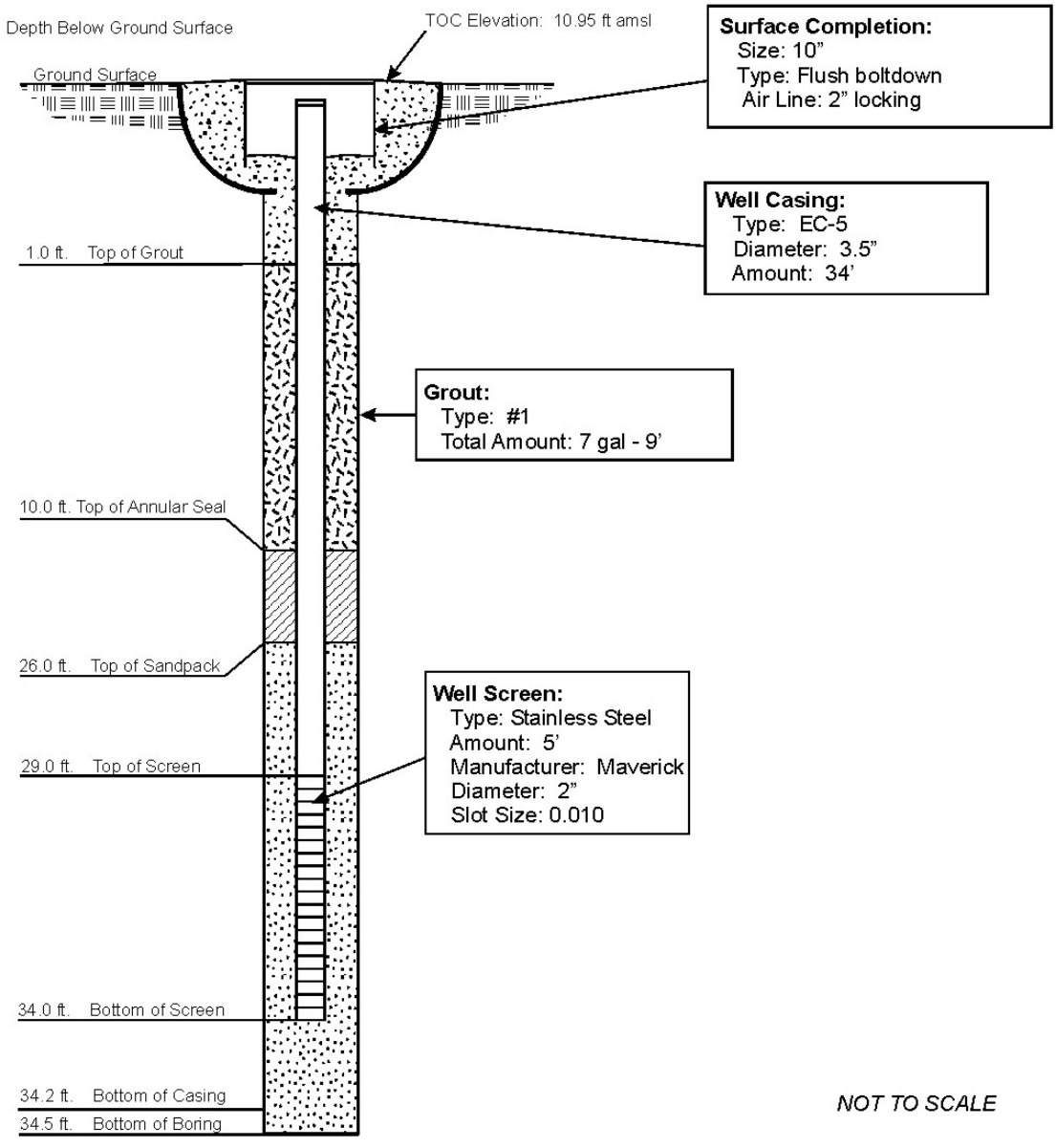
CAPE CANAVERAL
WELL COMPLETION DIAGRAM
PA-24I

Project #: G482010-EPA31	Site: CCAS LC34	Well #: EZVI PA-24I	Northing (NAD 83): 1521261.37
Drilling Contractor: Precision Sampling	Rig Type and Drilling Method: LD-2 Direct Push	Date: Mar 18, 2002	Easting (NAD 83): 640173.44
Reviewed by: Sam Yoon	Driller: Precision Sampling John Malo	Geologist: MG	Surface Elevation (NAVD 88): 10.95



WCD-PA24-LCDR

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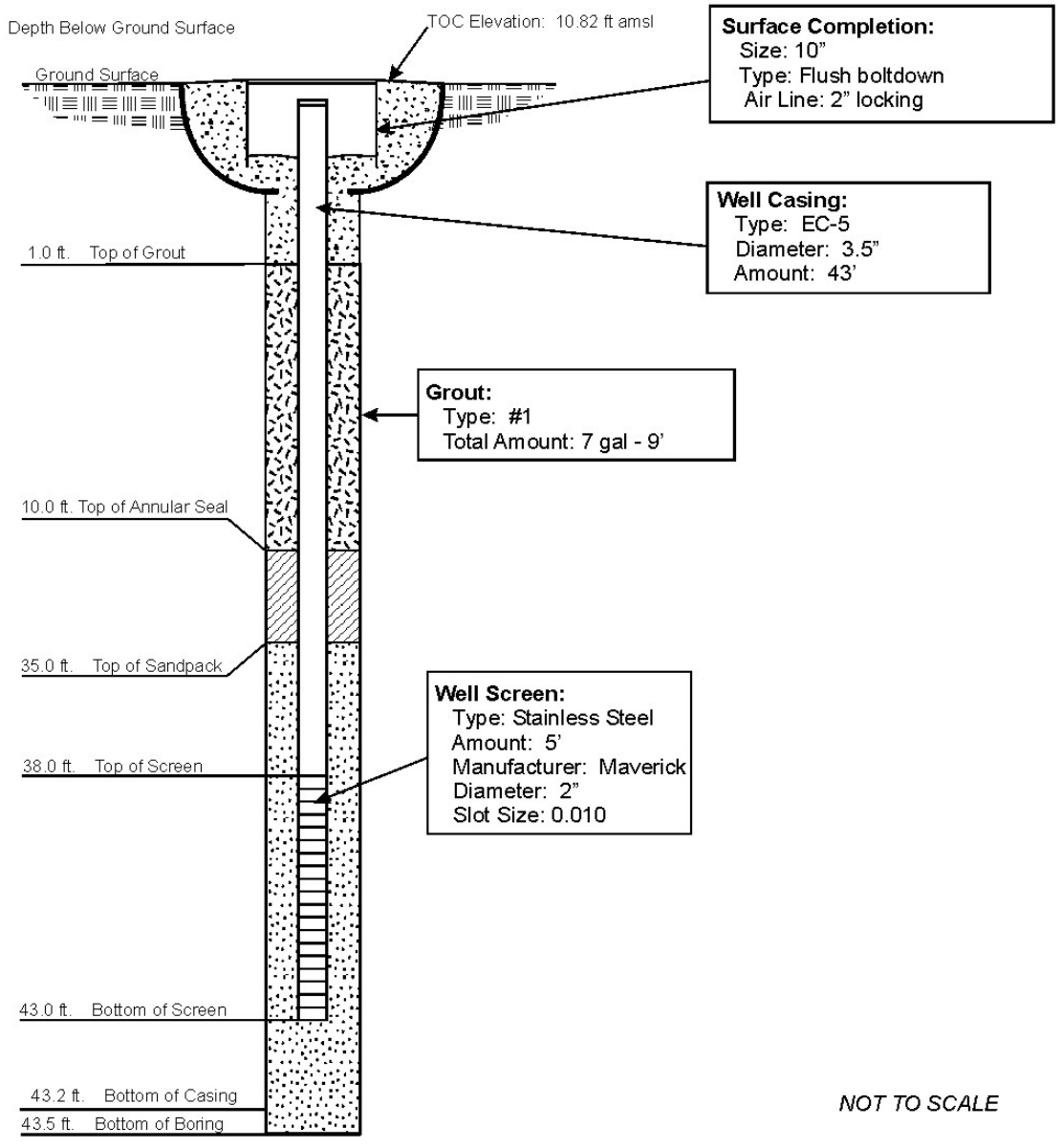
CAPE CANAVERAL
WELL COMPLETION DIAGRAM
PA-24D

Project #: G482010-EPA31	Site: CCAS LC34	Well #: EZVI PA-24D	Northing (NAD 83): 1521259.65
Drilling Contractor: Precision Sampling	Rig Type and Drilling Method: LD-2 Direct Push	Date: Mar 15, 2002	Easting (NAD 83): 640172.42
Reviewed by: Sam Yoon	Driller: Precision Sampling John Malo	Geologist: MG	Surface Elevation (NAVD 88): 10.82



WCD-PA24-D.CDR

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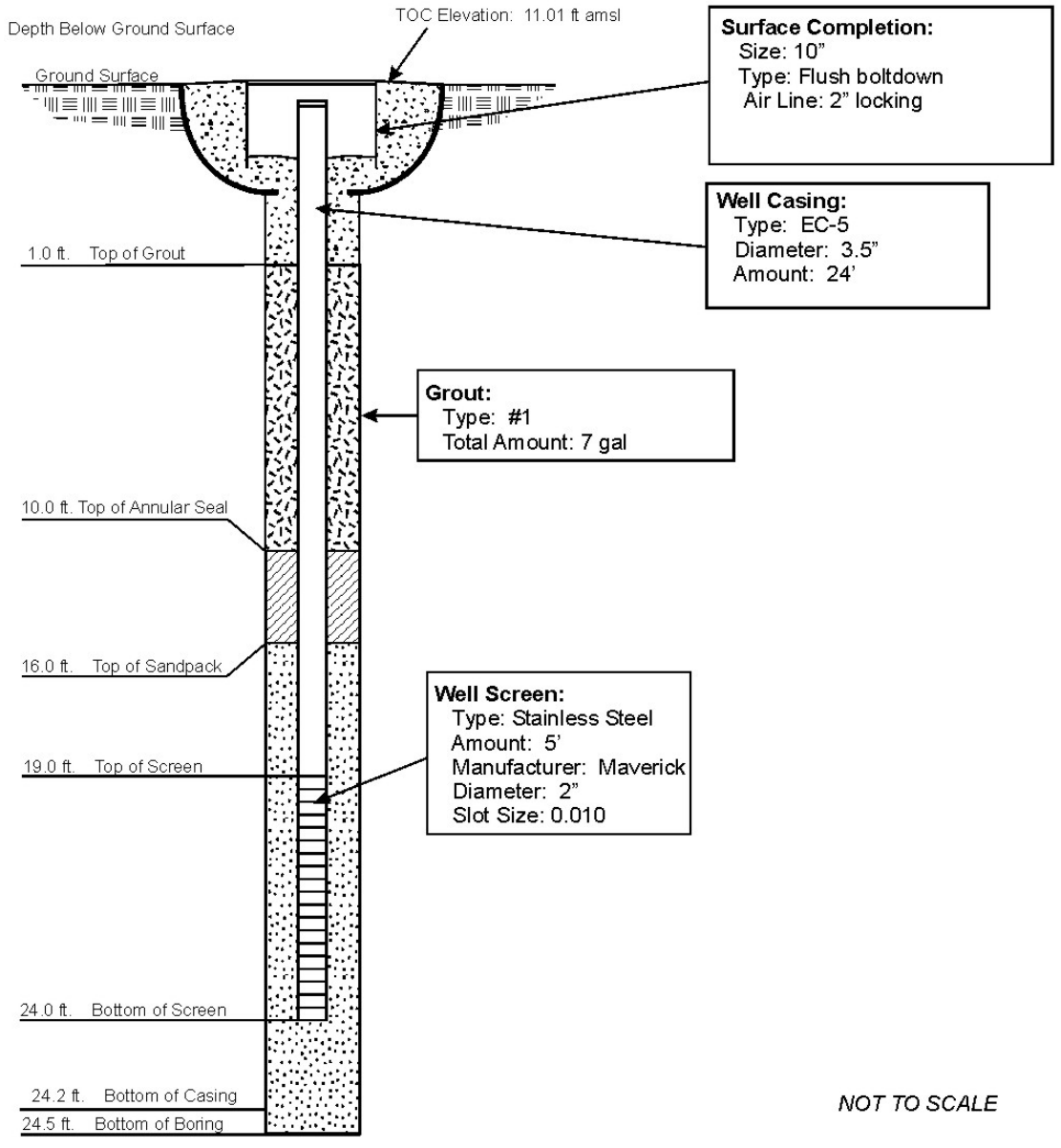
CAPE CANAVERAL
WELL COMPLETION DIAGRAM
PA-25S

Project #: G482010-EPA31	Site: CCAS LC34	Well #: EZVI PA-25S	Northing (NAD 83): 640156.69
Drilling Contractor: Precision Sampling	Rig Type and Drilling Method: LD-2 Direct Push	Date: Mar 11, 2002	Easting (NAD 83): 1521276.77
Reviewed by: Sam Yoon	Driller: Precision Sampling John Malo	Geologist: MG	Surface Elevation (NAVD 88): 11.01



WCD-PA25-S.CDR

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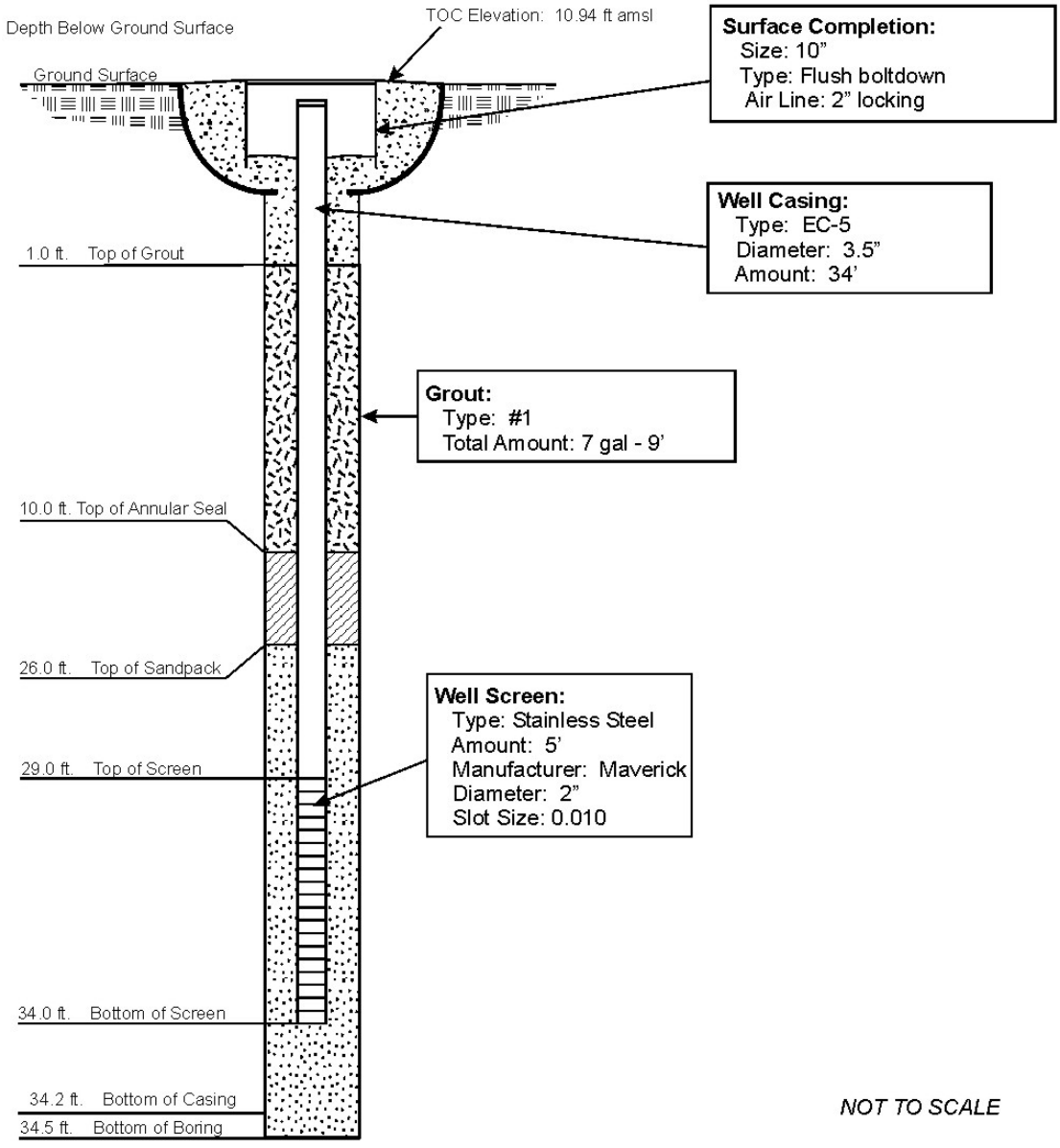
CAPE CANAVERAL
WELL COMPLETION DIAGRAM
PA-25I

Project #: G482010-EPA31	Site: CCAS LC34	Well #: EZVI PA-25I	Northing (NAD 83): 1521274.69
Drilling Contractor: Precision Sampling	Rig Type and Drilling Method: LD-2 Direct Push	Date: Mar 7, 2002	Easting (NAD 83): 640155.68
Reviewed by: Sam Yoon	Driller: Precision Sampling John Malo	Geologist: MG	Surface Elevation (NAVD 88): 10.94



WCD-PA25-LCDR

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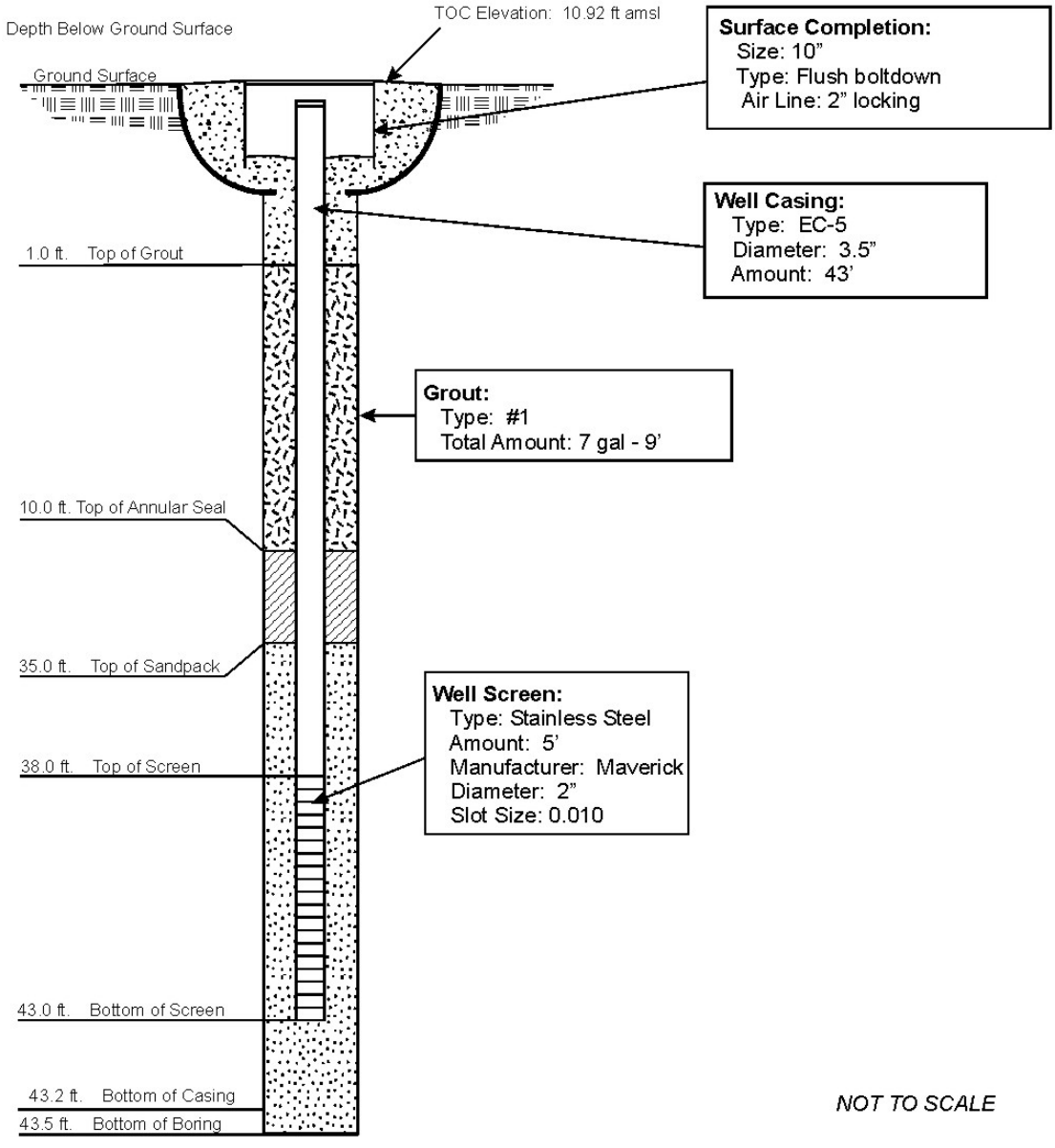
CAPE CANAVERAL
WELL COMPLETION DIAGRAM
PA-25D

Project #: G482010-EPA31	Site: CCAS LC34	Well #: EZVI PA-25D	Northing (NAD 83): 1521272.76
Drilling Contractor: Precision Sampling	Rig Type and Drilling Method: LD-2 Direct Push	Date: Mar 8, 2002	Easting (NAD 83): 640154.65
Reviewed by: Sam Yoon	Driller: Precision Sampling John Malo	Geologist: MG	Surface Elevation (NAVD 88): 10.92



WCD-PA25-D.CDR

LC34 Coring Logsheet

Boring ID EZVI-SB1

Date 1/15/02

Location EZVI Plot

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Boring Diameter	2 in	Total Depth	46 ft
Casing Outer Diameter	2 in	Sand Pack	---
Casing Inner Diameter	--- in	Sand Pack Depth	from --- to --- ft
Casing Material	---	Grout Material	Portland 15 gal.
Screen Type	---	Grout Depth	from 0 to Depth ft
Screen Slot	---	Surface Completion	Grout flush
Screen Length	--- ft	Drilling Method	Direct Push Vibra-core
Screen Depth	from --- to --- ft	Driller	Precision

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Hand auger fine-med. tan sand	0-5		SP	---	---
Fine-med. tan sand and shell fragments	6-8	EZVI-SBI-8	SP	50	0
Fine-med. tan sand and shells to fine-med. tan-gray sand	8-10	EZVI-SBI-10	SP	75	0
Fine-med. tan-gray sand	10-12	EZVI-SBI-12	SP	75	0
Fine-med. gray sand	12-14	EZVI-SBI-14	SP	75	0
Fine-med. gray sand	14-16	EZVI-SBI-16	SP	75	0
Fine-med. gray sand	16-18	EZVI-SBI-18	SP	75	2.5
Fine-med. gray sand	18-20	EZVI-SBI-20	SP	90	51
Fine-med. gray sand	20-22	EZVI-SBI-22	SP	90	8.3
Fine-med. gray sand	22-24	EZVI-SBI-24	SP	25	15
Fine-med. gray sand and silt	24-26	EZVI-SBI-26	SP	25	53
Silty fine gray sand	26-28	EZVI-SBI-28	SP-SM	75	75
Silty fine gray sand	28-30	EZVI-SBI-30	SP-SM	75	88

Logged by: J. Sminchak

Completion Date: 1/16/02

Construction Notes: 4' Macro-core acetate sleeves, rinseate = EZVI-SB1 -Rinseate, Dup = EZVI-SB1-8DUP

LC34 Coring Logsheet

Boring ID EZVI-SB1

Date 1/16/02

Location EZVI Plot

Battelle ... Putting Technology To Work

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Silty fine gray sand with some clay	30-32	EZVI-SBI-32	SP-SM	75	90
Silty fine gray sand	32-34	EZVI-SBI-34	SP-SM	75	28
Silty-clayey fine gray sand	34-36	EZVI-SBI-36	SM-SC	90	0
Silty fine gray sand to fine-med. sand and shells	36-38	EZVI-SBI-38	SM-SP	90	0
Silty fine sand to clayey fine gray sand	38-40	EZVI-SBI-40	SM-SC	90	0
Silty-clayey fine gray sand	40-42	EZVI-SBI-42	SC-SM	90	0
Silty fine gray sand with 20% shells	42-44	EZVI-SBI-44	SM-GC	90	0
Coarse shell material in silt to fine gray sand to silty clayey fine sand	44-46	EZVI-SBI-46	GC-SM-SC	90	0.6
Terminate boring at 46’ to avoid penetrating confining layer					

LC34 Coring Logsheet

Boring ID EZVI-SB2

Date 1/15/02

Location EZVI Plot

Battelle ... Putting Technology To Work

Boring Diameter	2 in	Total Depth	46 ft
Casing Outer Diameter	2 in	Sand Pack	---
Casing Inner Diameter	--- in	Sand Pack Depth	from --- to --- ft
Casing Material	---	Grout Material	Portland 15 gal.
Screen Type	---	Grout Depth	from 0 to Depth ft
Screen Slot	---	Surface Completion	Grout flush
Screen Length	--- ft	Drilling Method	Direct Push Vibra-core
Screen Depth	from --- to --- ft	Driller	Precision

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Hand auger fine-med. tan sand and shell material	0-5	---	SP	---	---
Fine tan sand	6-8	EZVI-SB2-8	SP	75	0
Fine coarse tan-orange-brown sand and shell material	8-10	EZVI-SB2-10	SP	75	0
Fine coarse tan-orange-brown sand and shell material	10-12	EZVI-SB2-12	SP	75	0
Fine coarse tan-orange-brown sand and shell material	12-14	EZVI-SB2-14	SP	75	0
Fine-med. gray sand	14-16	EZVI-SB2-16	SP	90	0.8
Fine-med. gray sand	16-18	EZVI-SB2-18	SP	90	33
Fine-med. gray sand	18-20	EZVI-SB2-20	SP	90	8.2
Fine-med. gray sand with trace silt	20-22	EZVI-SB2-22	SP	90	836
Fine gray sand	22-24	EZVI-SB2-24	SP	90	114
Fine gray sand	24-26	EZVI-SB2-26	SP	90	25
Silty fine gray sand	26-28	EZVI-SB2-28	SP-SM	90	25
Silty fine gray sand	28-30	EZVI-SB2-30	SP-SM	90	6.2

Logged by: J. Sminchak

Completion Date: 1/16/02

Construction Notes: 4' Macro-core acetate sleeves, rinseate = EZVI-SB2

-Rinseate, Dup = EZVI-SB2-24DUP

LC34 Coring Logsheet

Boring ID EZVI-SB2

Date 1/16/02

Location EZVI Plot

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Lithologic Description	Depth	Sample	USCS	Rec.	PID
Silty fine gray sand	30-32	EZVI-SB2-32	SM	90	6.2
Silty fine gray sand	32-34	EZVI-SB2-34	SM	90	1.2
Silty fine gray sand to coarse shells	34-36	EZVI-SB2-36	SM-GP	90	0.4
Coarse shells to silty-clayer fine gray sand	36-38	EZVI-SB2-38	GP-SM	90	0.8
Silty-clayey fine sand (plug at 38-38.1')	38-40	EZVI-SB2-40	SC-SM	90	0
Silty-clayey fine gray sand	40-42	EZVI-SB2-42	SM-SC	90	0
Silty soupy fine gray sand	42-44	EZVI-SB2-44	SM	90	0
Silty to fine sand to coarse shells with silt and clay	44-46	EZVI-SB2-46	SM-GC	90	0
Terminate boring at 46' to avoid penetrating confining layer					

LC34 Coring Logsheet

Boring ID EZVI-SB3

Date 1/17/02

Location EZVI Plot

Battelle ... Putting Technology To Work

Boring Diameter	2 in	Total Depth	46 ft
Casing Outer Diameter	2 in	Sand Pack	---
Casing Inner Diameter	--- in	Sand Pack Depth	from --- to --- ft
Casing Material	---	Grout Material	Portland 15 gal.
Screen Type	---	Grout Depth	from 0 to Depth ft
Screen Slot	---	Surface Completion	Grout flush
Screen Length	--- ft	Drilling Method	Direct Push Vibra-core
Screen Depth	from --- to --- ft	Driller	Precision

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Hand auger tan fine-med. sand	0-5	---	SP	---	---
Tan to orange-brown fine sand	6-8	EZVI-SB3-8	SP	75	0
Tan to orange-brown fine sand	8-10	EZVI-SB3-10	SP	75	0
Tan to orange-brown fine sand	10-12	EZVI-SB3-12	SP	75	0
Fine-med. gray sand	12-14	EZVI-SB3-14	SP	75	0
Med-coarse gray sand and shell material	14-16	EZVI-SB3-16	SP	90	0.4
Fine-med. gray sand	16-18	EZVI-SB3-18	SP	90	31
Fine-med. gray sand	18-20	EZVI-SB3-20	SP	90	271
Fine-med. gray sand	20-22	EZVI-SB3-22	SP	90	300
Fine-med. gray sand	22-24	EZVI-SB3-24	SP	75	206
Fine gray sand with trace silt	24-26	EZVI-SB3-26	SP	75	129
Silty fine gray sand	26-28	EZVI-SB3-28	SP-SM	100	18.7
Silty fine gray sand	28-30	EZVI-SB3-30	SP-SM	100	36.1

Logged by: J. Sminchak

Completion Date: 1/17/02

Construction Notes: 4' Macro-core acetate sleeves, rinseate = EZVI-SB3 -Rinseate, Dup = EZVI-SB3-40DUP

LC34 Coring Logsheet

Boring ID EZVI-SB3

Date 1/16/02

Location EZVI Plot

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Lithologic Description	Depth	Sample	USCS	Rec.	PID
Silty fine gray sand	30-32	EZVI-SB3-32	SM	100	2.2
Silty fine gray sand	32-34	EZVI-SB3-34	SM	100	6.3
Silty fine gray sand to coarse shells	34-36	EZVI-SB3-36	SM-SP	90	0.4
Silty fine gray sand, shells, trace clay	36-38	EZVI-SB3-38	SM-SP	90	0.2
Silty-clayey fine gray sand with shells	38-40	EZVI-SB3-40	SM-GC	25	0
Silty-clayey fine gray sand with shells	40-42	EZVI-SB3-42	SM-GC	50	0
Silty clayey fine sand and shells	42-44	EZVI-SB3-44	SM-GC	100	0
Silty clayey fine sand	44-46	EZVI-SB3-46	SM-SC	100	0
Terminate boring at 46’ to avoid penetrating confining layer					

LC34 Coring Logsheet

Boring ID EZVI-SB4

Date 1/17/02

Location EZVI Plot

Battelle ... Putting Technology To Work

Boring Diameter	2 in	Total Depth	46 ft
Casing Outer Diameter	2 in	Sand Pack	---
Casing Inner Diameter	--- in	Sand Pack Depth	from --- to --- ft
Casing Material	---	Grout Material	Portland 15 gal.
Screen Type	---	Grout Depth	from 0 to Depth ft
Screen Slot	---	Surface Completion	Grout flush
Screen Length	--- ft	Drilling Method	Direct Push Vibra-core
Screen Depth	from --- to --- ft	Driller	Precision

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Hand auger fine tan sand	0-5	---	SP	---	---
Tan to gray fine sand	6-8	EZVI-SB4-8	SP	90	0
Tan to orange fine-med. sand	8-10	EZVI-SB4-10	SP	90	0
Tan to orange fine-med. sand (TOC)	10-12	EZVI-SB4-12	SP	100	0
Fine-med. gray sand	12-14	EZVI-SB4-14	SP	100	0
Fine-med. gray sand	14-16	EZVI-SB4-16	SP	90	78
Fine-med. gray sand	16-18	EZVI-SB4-18	SP	90	64
Silty fine gray sand	18-20	EZVI-SB4-20	SP	90	0.4
Gray fine sand	20-22	EZVI-SB4-22	SP	90	18
Gray fine sand	22-24	EZVI-SB4-24	SP	75	21
Gray fine sand	24-26	EZVI-SB4-26	SP	75	36
Silty fine gray sand	26-28	EZVI-SB4-28	SP-SM	90	35
Silty fine gray sand	28-30	EZVI-SB4-30	SP-SM	90	9.5

Logged by: J. Sminchak

Completion Date: 1/18/02

Construction Notes: 4' Macro-core acetate sleeves, rinseate = EZVI-SB4 -Rinseate, Dup = EZVI-SB4-40DUP

LC34 Coring Logsheet

Boring ID EZVI-SB4

Date 1/17/02

Location EZVI Plot

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Lithologic Description		Depth	Sample	USCS	Rec.	PID
Silty fine gray sand	(TOC)	30-32	EZVI-SB4-32	SM-SP	90	8.0
Silty fine gray sand	(TOC)	32-34	EZVI-SB4-34	SP-SM	90	5.0
Silty fine gray sand		34-36	EZVI-SB4-36	SM	90	0.5
Coarse shells to fine gray sand		36-38	EZVI-SB4-38	GP-SP	100	0.2
Silty-clayey fine gray sand	(TOC)	38-40	EZVI-SB4-40	SM-SC	90	0.4
Coarse shells with gray fine sand	(TOC)	40-42	EZVI-SB4-42	GP	50	0
Coarse shells with minor fine gray sand		42-44	EZVI-SB4-44	GP	90	0
Silty fine gray sand to silty clayey fine gray sand		44-46	EZVI-SB4-46	SM-SC	90	0
Terminate boring at 46’ to avoid penetrating confining layer						

LC34 Coring Logsheet

Boring ID EZVI-SB5

Date 1/31/02

Location EZVI Plot

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Boring Diameter	2 in	Total Depth	42 ft
Casing Outer Diameter	2 in	Sand Pack	---
Casing Inner Diameter	--- in	Sand Pack Depth	from --- to --- ft
Casing Material	---	Grout Material	Portland
Screen Type	---	Grout Depth	from 0 to Depth ft
Screen Slot	---	Surface Completion	Flush
Screen Length	--- ft	Drilling Method	Direct Push
Screen Depth	from --- to --- ft	Driller	Precision

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Light brown, light gray, orange-brown med.-fine sand	6-8	EZVI-SB5-8	SP	50	5.9
Orange brown med.-fine sand, trace shells	8-10	EZVI-SB5-10	SP	100	15.6
Orange-brown med-fine sand	10-12	EZVI-SB5-12	SP	75	14.1
Orange-brown med sand with shells to gray med-fine sand w/shells	12-14	EZVI-SB5-14	SP	100	61.2
Gray fine sand with trace shells	14-16	EZVI-SB5-16	SP	95	384
Gray fine sand with trace shells	16-18	EZVI-SB5-18	SP	95	1876
Gray med-fine sand	18-20	EZVI-SB5-20	SP	85	> 2000
Gray med-fine sand	20-22	EZVI-SB5-22	SP	100	> 2000
Gray fine sand	22-24	EZVI-SB5-24	SP	100	> 2000
Gray fine sand	24-26	EZVI-SB5-26	SP	100	> 2000
Gray silty fine sand, trace shells	26-28	EZVI-SB5-28	SM	100	> 2000
Gray silty fine sand	28-30	EZVI-SB5-30	SM	100	> 2000
Gray silty fine sand	30-32	EZVI-SB5-32	SM	75	1800

Logged by: M. Gaberell, L. Cumming

Completion Date: 1/31/02

Construction Notes: 4' Macro-core acetate sleeves, Dup = EZVI-SB5-38DUP

LC34 Coring Logsheet

Boring ID EZVI-SB5

Date 1/31/02

Location EZVI Plot

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Lithologic Description	Depth	Sample	USCS	Rec.	PID
Gray silty fine sand to silty med sand with shells	32-34	EZVI-SB-34	SM	100	1904
Gray silty fine sand to silty med sand with shells	34-36	EZVI-SB5-36	SM	60	1652
Silty med sand with medium to coarse shells	36-38	EZVI-SB5-38	SP	100	1312
Clayey silty sand with shells	38-40	EZVI-SB5-40	SM	100	195
Clayey silty sand with shells	40-42	EZVI-SB5-42	SM	100	220
End at 42’					

LC34 Coring Logsheet

Boring ID EZVI-SB6

Date 2/1/02

Location EZVI Plot

Battelle ... Putting Technology To Work

Boring Diameter	2 in	Total Depth	46 ft
Casing Outer Diameter	2 in	Sand Pack	---
Casing Inner Diameter	--- in	Sand Pack Depth	from --- to --- ft
Casing Material	---	Grout Material	Portland
Screen Type	---	Grout Depth	from 0 to Depth ft
Screen Slot	---	Surface Completion	Grout flush
Screen Length	--- ft	Drilling Method	Direct Push Vibra-core
Screen Depth	from --- to --- ft	Driller	Precision

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Hand auger fine tan sand	0-5	---	SP	---	---
Brown to yellow to gray fine sand	6-8	EZVI-SB6-8	SP	100	21
Brown fine-med. sand	8-10	EZVI-SB6-10	SP	100	16
Gray fine-med sand	10-12	EZVI-SB6-12	SP	50	15
Fine-med gray sand	12-14	EZVI-SB6-14	SP	100	15
Fine-med gray sand	14-16	EZVI-SB6-16	SP	100	21
Fine-med gray sand	16-18	EZVI-SB6-18	SP	100	603
Fine-med gray sand	18-20	EZVI-SB6-20	SP	100	1317
Fine-med gray sand	20-22	EZVI-SB6-22	SP	100	1202
Gray fine sand, trace shells	22-24	EZVI-SB6-24	SP	80	1200
Gray fine sand, trace shells, med. sand at bottom	24-26	EZVI-SB6-26	SP	80	1600
Gray silty fine to medium sand, little shells	26-28	EZVI-SB6-28	SP-SM	100	96
Gray silty fine to medium sand, trace shells	28-30	EZVI-SB6-30	SM	100	156

Logged by: L. Cumming

Completion Date: 2/1/02

Construction Notes: 4' Macro-core acetate sleeves, rinseate = EZVI-SB6 -Rinseate, Dup = EZVI-SB6-32DUP

LC34 Coring Logsheet Boring ID EZVI-SB6

Date 2/2/02 Location EZVI Plot

Battelle ... Putting Technology To Work

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Gray silty fine to medium sand, trace shells	30-32	EZVI-SB6-32	SM	100	601
Gray silty fine to medium sand, trace shells	32-34	EZVI-SB6-34	SM	100	1600
Gray silty fine to medium sand, trace shells	34-36	EZVI-SB6-36	SM	100	45
Gray silty fine to medium sand with shells	36-38	EZVI-SB6-38	SM	100	280
Gray silty fine to medium sand and shells	38-40	EZVI-SB6-40	SM-GM	100	308
Gray silty fine to medium sand and shells to silty sand and clay	40-42	EZVI-SB6-42	GM -SM	50	168
End of core					

LC34 Coring Logsheet

Boring ID EZVI-SB7

Date 2/7/02

Location EZVI Plot

Battelle ... Putting Technology To Work

Boring Diameter	2 in	Total Depth	46 ft
Casing Outer Diameter	2 in	Sand Pack	---
Casing Inner Diameter	--- in	Sand Pack Depth	from --- to --- ft
Casing Material	---	Grout Material	Portland
Screen Type	---	Grout Depth	from 0 to Depth ft
Screen Slot	---	Surface Completion	Grout flush
Screen Length	--- ft	Drilling Method	Direct Push Vibra-core
Screen Depth	from --- to --- ft	Driller	Precision

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Hand auger fine tan sand	0-5	---	SP	---	---
Whte to lt brown fine to med sand	6-8	EZVI-SB7-8	SP	90	45
Lt brown fine sand to lt brown med sand and shell frags	8-10	EZVI-SB7-10	SP	100	12.4
White to lt brown f-m sand to lt brown med sand and shell frags	10-12	EZVI-SB7-12	SP	100	5.1
Brownish gray fine sand to lit brown sand and shells to fine-med sand	12-14	EZVI-SB7-14	SP	100	35.5
Gray fined sand to med sand and shell frags (strong odor)	14-16	EZVI-SB7-16	SP	80	230
Gray fine to med sand (strong odor)	16-18	EZVI-SB7-18	SP	100	17175
Gray fine to med sand (strong odor)	18-20	EZVI-SB7-20	SP	50	8210
Gray fine sand, trace shells, silt	20-22	EZVI-SB7-22	SP	100	2243
Gray fine sand, trace shells, silt	22-24	EZVI-SB7-24	SP-SM	90	1885
Gray fine sand, trace shells	24-26	EZVI-SB7-26	SP-SM	100	2958
Gray fine sand, trace shells	26-28	EZVI-SB7-28	SM	90	3412
Gray fine sand, trace shells	28-30	EZVI-SB7-30	SM	100	4225

Logged by: L. Cumming

Completion Date: 2/7/02

Construction Notes: 4' Macro-core acetate sleeves, rinseate = EZVI-SB7 -Rinseate, Dup = EZVI-SB7-44DUP

LC34 Coring Logsheet Boring ID EZVI-SB7

Date 2/7/02 Location EZVI Plot

Battelle ... Putting Technology To Work

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Gray silty fine sand, trace shells, more silty	30-32	EZVI-SB7-32	SM	100	1421
Gray silty fine sand, shells	32-34	EZVI-SB7-34	SM	100	691
Gray silty fine sand, some shells	34-36	EZVI-SB7-36	SM	90	66
Gray silty fine sand, some shells	36-38	EZVI-SB7-38	SM	100	70
Gray silty fine sand and shells to clayey sand	38-40	EZVI-SB7-40	SM-SC	100	395
Gray silty sand and shells to silty sand, trace shells	40-42	EZVI-SB7-42	SM	100	220
Gray silty fine sand, trace shells	40-44	EZVI-SB7-44	SM	100	12.5
Gray silty fine sand and med gravel shells	40-46	EZVI-SB7-46	SM-GM	100	28.8
End of core					

LC34 Coring Logsheet

Boring ID EZVI-WP1

Date 1/18/02

Location EZVI Plot

Battelle ... Putting Technology To Work

Boring Diameter	2 in	Total Depth	40 ft
Casing Outer Diameter	2 in	Sand Pack	---
Casing Inner Diameter	--- in	Sand Pack Depth	from --- to --- ft
Casing Material	---	Grout Material	Portland 10gal
Screen Type	---	Grout Depth	from 0 to Depth ft
Screen Slot	---	Surface Completion	Grout flush
Screen Length	--- ft	Drilling Method	Direct Push Vibra-core
Screen Depth	from --- to --- ft	Driller	Precision

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Hand auger fine tan sand	0-5	---	SP	---	---
Direct push	5-15	EZVI-SB7-8	---	---	---
Cl sample	15	EZVI-WP1-15	---	500 ml	---
Direct push	15-20	---	---	---	---
Cl sample	20	EZVI-WP1-20	---	500 ml	---
Direct push	20-30	---	---	---	---
Cl sample	30	EZVI-WP1-30	---	500 ml	---
Direct push	30-38	---	---	---	---
Cl sample silty, low flow	38	EZVI-WP1-38	---	500 ml	---
Direct push	38-40	---	---	---	---
Cl sample, silty, low flow	40	EZVI-WP1-40	---	500 ml	---

Logged by: J. Sminchak

Completion Date: 1/18/02

Construction Notes:

Waterloo Profiler, purge 0.7 L each Sample

LC34 Coring Logsheet

Boring ID EZVI-WP2

Date 1/19/02

Location EZVI Plot

Battelle ... Putting Technology To Work

Boring Diameter	2 in	Total Depth	38 ft
Casing Outer Diameter	2 in	Sand Pack	---
Casing Inner Diameter	--- in	Sand Pack Depth	from --- to --- ft
Casing Material	---	Grout Material	Portland 10gal
Screen Type	---	Grout Depth	from 0 to Depth ft
Screen Slot	---	Surface Completion	Grout flush
Screen Length	--- ft	Drilling Method	Direct Push Vibra-core
Screen Depth	from --- to --- ft	Driller	Precision

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Hand auger fine tan sand	0-5	---	SP	---	---
Direct push	5-15	---	---	---	---
Cl sample	15	EZVI-WP2-15	---	500 ml	---
Direct push	15-20	---	---	---	---
Cl sample	20	EZVI-WP2-20	---	500 ml	---
Direct push	20-30	---	---	---	---
Cl sample	30	EZVI-WP2-30	---	500 ml	---
Direct push	30-36	---	---	---	---
Cl sample silty, low flow	36	EZVI-WP2-36	---	500 ml	---
Direct push	36-38	---	---	---	---
Cl sample, silty, low flow	38	EZVI-WP2-38	---	500 ml	---

Logged by: J. Sminchak

Completion Date: 1/19/02

Construction Notes:

Waterloo Profiler, purge 0.7 L each Sample

LC34 Coring Logsheet

Boring ID EZVI-SB203

Date 10/9/02

Location EZVI Plot

Battelle . . . Putting Technology To Work

Boring Diameter	2 in	Total Depth	32 ft
Casing Outer Diameter	2 in	Sand Pack	---
Casing Inner Diameter	--- in	Sand Pack Depth	from --- to --- ft
Casing Material	---	Grout Material	Portland
Screen Type	---	Grout Depth	from 0 to Depth ft
Screen Slot	---	Surface Completion	Grout flush
Screen Length	--- ft	Drilling Method	Direct Push Vibra-core
Screen Depth	from --- to --- ft	Driller	Precision

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Hand auger fine tan sand, no sample	0-6	---	SP	---	---
Brown to medium sand; orange-brown medium sand	6-8	EZVI-SB203-8	SP	100	0.0
No recovery	8-10	---	---	0	---
Brown medium sand with trace shells; dark brown med sand; 1" EZVI band at 12' in medium sand	10-12	EZVI-SB203-12	SP	80	0.0
Fine-med orange brown sand	12-14	EZVI-SB203-14	SP	30	0.0
1" EZVI band at 14' in medium fine sand (evidence of smearing) gray medium sand with trace shells; dark gray coarse sand with shells; fine gray sand at 16'	14-16	EZVI-SB203-16	SP	100	6
Orange-brown medium-coarse sand with trace shells, gray med. sand, dark gray sand with shells @17.5', evidence of EZVI smearing at 17'	16-18	EZVI-SB203-18	SP	100	37 peak
Dark gray medium-fine sand with shells, medium gray sand, fine gray sand (no evidence of EZVI)	18-20	EZVI-SB203-20	SP	100	> 2000
Brown medium sand with shells, silty fine gray sand (no evidence of EZVI)	20-22	EZVI-SB203-22	SP	100	> 2000
Very fine gray sand (no evidence of EZVI)	22-24	EZVI-SB203-24	SP	100	> 2000
Silty gray fine sand (no evidence of EZVI)	24-26	EZVI-SB203-26	SP	10	7
Silty gray fine sand (no evidence of EZVI)	26-28	EZVI-SB203-28	SP-SM	70	3
Silty gray fine sand (no evidence of EZVI)	28-30	EZVI-SB203-30	SM	30	151

Logged by: M. Gaberell

Completion Date: 10/9/02

Construction Notes: EZVI-SB203-18-DUP, equipment rinseate at 07:30

LC34 Coring Logsheet

Boring ID EZVI-SB203

Date 10/9/02

Location EZVI Plot

Battelle ... Putting Technology To Work

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Silty gray fine sand (no evidence of EZVI)	30-32	EZVI-SB203-32	SM	80	> 2000

LC34 Coring Logsheet

Boring ID EZVI-SB204

Date 10/9/02

Location EZVI Plot

Battelle . . . Putting Technology To Work

Boring Diameter	2 in	Total Depth	32 ft
Casing Outer Diameter	2 in	Sand Pack	---
Casing Inner Diameter	--- in	Sand Pack Depth	from --- to --- ft
Casing Material	---	Grout Material	Portland
Screen Type	---	Grout Depth	from 0 to Depth ft
Screen Slot	---	Surface Completion	Grout flush
Screen Length	--- ft	Drilling Method	Direct Push Vibra-core
Screen Depth	from --- to --- ft	Driller	Precision

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Hand auger fine tan sand, no sample	0-6	---	SP	---	---
Brown medium sand; white medium sand; orange-brown medium sand with trace shells (no EZVI)	6-8	EZVI-SB203-8	SP	40	0.0
No recovery	8-10	---	---	0	---
Orange-brown medium sand with trace shells, gray, gray fine-med sand w/ trace shells (no EZVI)	10-12	EZVI-SB204-12	SP	90	0.0
Orange brown med sand w/trace shells (no EZVI)	12-14	EZVI-SB204-14	SP	20	0.0
Dark gray med sand with trace shells to fine gray sand to med sand (dark gray) (no EZVI)	14-16	EZVI-SB204-16	SP	100	0.0
Brown medium sand, gray fine sand, brown med sand with trace shells, gray fine-med sand (no EZVI)	16-18	EZVI-SB204-18	SP	100	12.6
Fine gray sand, med-coarse sand with shells @19', very fine sand (no EZVI)	18-20	EZVI-SB204-20	SP	90	146
Orange medium sand with trace shells, gray fine sand (no EZVI)	20-22	EZVI-SB204-22	SP-SM	80	17
Gray fine sand, EZVI band 4" long in med sand @~23', gray silty fine sand (no EZVI)	22-24	EZVI-SB204-24	SP-Sm	100	9
Gray fine sand (no EZVI)	24-26	EZVI-SB204-26	SM	40	56
Gray silty fine sand (no EZVI)	26-28	EZVI-SB204-28	SM	100	190
Gray silty fine sand (no EZVI)	28-30	EZVI-SB204-30	SM	40	54

Logged by: M. Gaberell

Completion Date: 10/9/02

Construction Notes: EZVI-SB204-24-DUP,

LC34 Coring Logsheet

Boring ID EZVI-SB204

Date 10/9/02

Location EZVI Plot

Battelle ... Putting Technology To Work

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Silty gray fine sand (no evidence of EZVI)	30-32	EZVI-SB204-32	SM	100	19

LC34 Coring Logsheet

Boring ID EZVI-SB207

Date 10/8/02

Location EZVI Plot

Battelle . . . Putting Technology To Work

Boring Diameter	2 in	Total Depth	32 ft
Casing Outer Diameter	2 in	Sand Pack	---
Casing Inner Diameter	--- in	Sand Pack Depth	from --- to --- ft
Casing Material	---	Grout Material	Portland
Screen Type	---	Grout Depth	from 0 to Depth ft
Screen Slot	---	Surface Completion	Grout flush
Screen Length	--- ft	Drilling Method	Direct Push Vibra-core
Screen Depth	from --- to --- ft	Driller	Precision

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Hand auger fine tan sand, no sample	0-6	---	SP	---	---
Med gray sand; dark brown med sand to orange-brown medium sand with trace shells	6-8	EZVI-SB207-8	SP	100	0.0
No recovery	8-10	---	---	0	---
Orange-brown medium sand, dark brown medium sand (2" thick), to gray fine sand *soil may have slid down sleeve	10-12	EZVI-SB207-12	SP	60	0.0
Brown coarse sand w/trace shells	12-14	EZVI-SB207-14	SP	50	0.0
Gray fine sand to medium gray sand, black EZVI 2" band @~15' in medium gray sand	14-16	EZVI-SB207-16	SP	100	0.0
Brown medium coarse sand with trace shells to gray fine sand (no EZVI)	16-18	EZVI-SB207-18	SP	50	0.0
Fine gray sand to med sand with trace shells, EZVI black 2" band @18' in med fine sand	18-20	EZVI-SB207-20	SP	100	0.0
Orange-brown coarse sand with trace shells (~3" thick) at 20 ft; gray medium sand to gray fine sand with trace shells; EZVI black band (2"thick) @21 ft in medium sand	20-22	EZVI-SB207-22	SP	100	191
Gray med-coarse sand with trace shells to gray sand, black EZVI band (3" thick) at 23.5 ft in med sand	22-24	EZVI-SB207-24	SP	100	22
Gray fine sand, trace silt (no EZVI)	24-26	EZVI-SB207-26	SM	40	914
Gray silty fine sand (no EZVI)	26-28	EZVI-SB207-28	SM	100	368
Gray silty fine sand (no EZVI)	28-30	EZVI-SB207-30	SM	70	282

Logged by: M. Gaberell

Completion Date: 10/8/02

Construction Notes: EZVI-SB207-24-DUP, EZVI-SB207-Rinseate at 11:58

LC34 Coring Logsheet

Boring ID EZVI-SB207

Date 10/8/02

Location EZVI Plot

Battelle ... Putting Technology To Work

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Silty gray fine sand (no evidence of EZVI)	30-32	EZVI-SB207-32	SM	100	49.5

LC34 Coring Logsheet

Boring ID EZVI-SB208

Date 10/8/02

Location EZVI Plot

Battelle ... Putting Technology To Work

Boring Diameter	2 in	Total Depth	32 ft
Casing Outer Diameter	2 in	Sand Pack	---
Casing Inner Diameter	--- in	Sand Pack Depth	from --- to --- ft
Casing Material	---	Grout Material	Portland
Screen Type	---	Grout Depth	from 0 to Depth ft
Screen Slot	---	Surface Completion	Grout flush
Screen Length	--- ft	Drilling Method	Direct Push Vibra-core
Screen Depth	from --- to --- ft	Driller	Precision

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Hand auger fine tan sand, no sample	0-6	---	SP	---	---
Med light brown sand; orange brown med sand (1" thick), tan medium sand	6-8	EZVI-SB20-8	SP	NA	0.0
Brown medium sand to brown medium sand with trace shells	8-10	---	---	0	---
Brown medium sand with trace shells to gray medium sand (1.5" black EZVI band at 12' in gray med sand)	10-12	EZVI-SB208-12	SP	NA	0.0
Brown med-fine sand with trace shells, gray fine sand, black EZVI band ½" thick at 14'	12-14	EZVI-SB208-14	SP	100	0.0
Gray fine sand, black EZVI band @15.5" in medium-fine gray sand	14-16	EZVI-SB208-16	SP	100	0.0
Tan medium sand with trace shells, gray medium sand to gray medium sand with trace shells, black EZVI band 1" thick at 17'	16-18	EZVI-SB208-18	SP	100	0.0
Fine gray sand, EZVI black 1" band @18' in med sand	18-20	---	---	0	---
No recovery	20-22	---	---	0	---
Gray med-fine sand (no EZVI)	22-24	EZVI-SB208-24	SP	40	104
No recovery	24-26	---	---	0	---
Gray silty fine sand with trace shells (no EZVI)	26-28	EZVI-SB208-28	SM	100	26 238
No recovery	28-32	---	---	0	---

Logged by: M. Gaberell

Completion Date: 10/8/02

Construction Notes: EZVI-SB208-28-DUP

LC34 Coring Logsheet

Boring ID EZVI-SB209

Date 10/8/02

Location EZVI Plot

Battelle ... Putting Technology To Work

Boring Diameter	2 in	Total Depth	32 ft
Casing Outer Diameter	2 in	Sand Pack	---
Casing Inner Diameter	--- in	Sand Pack Depth	from --- to --- ft
Casing Material	---	Grout Material	Portland
Screen Type	---	Grout Depth	from 0 to Depth ft
Screen Slot	---	Surface Completion	Grout flush
Screen Length	--- ft	Drilling Method	Direct Push Vibra-core
Screen Depth	from --- to --- ft	Driller	Precision

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Hand auger fine tan sand, no sample	0-6	---	SP	---	---
Lt to drk brown med sand, orange brown medium sand with trace shells	6-8	EZVI-SB209-8	SP	100	0.0
No recovery	8-10	---	---	0	---
Orange-brown medium-coarse sand with trace shells to gray medium-fine sand (2" black EZVI band at 12')	10-12	EZVI-SB209-12	SP	100	0.0
Brown med-fine sand with trace shells, gray med-fine sand, some evidence of EZVI	12-14	EZVI-SB209-14	SP	90	0.0
Gray fine sand, 2" black EZVI band @15.5" in med-coarse sand	14-16	EZVI-SB209-16	SP	100	0.0
Brown medium sand with trace shells, gray fine silty sand, black EZVI band at 17.5-18' in med-coarse sand'	16-18	EZVI-SB209-18	SP	100	0.0
Gray silty fine gray sand, med sand with trace shells (no EZVI)	18-20	EZVI-SB209-20	SP	100	165
Brown med sand with trace shells, gray fine silty sand, black EZVI band (1") at 21 ft in med coarse gray sand	20-22	EZVI-SB209-22	SP	100	0.0
Gray silty fine sand, EZVI black band (2") at 23" in med fine gray sand with trace shells	22-24	EZVI-SB209-24	SP-SM	100	63.5
Silty fine gray sand (no evidence of EZVI)	24-26	EZVI-SB209-26	SM	20	222
Silty fine gray sand, trace shells at 27' (no evidence of EZVI)	26-28	EZVI-SB209-28	SM	100	572
Silty fine gray sand (no evidence of EZVI)	28-30	EZVI-SB209-30	SM	40	300

Logged by: M. Gaberell

Completion Date: 10/8/02

Construction Notes: EZVI-SB209-22-DUP

LC34 Coring Logsheet

Boring ID EZVI-SB209

Date 10/8/02

Location EZVI Plot

Battelle ... Putting Technology To Work

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Silty gray fine sand, very wet at 32' (no evidence of EZVI)	30-32	X	SM	100	---

LC34 Coring Logsheet

Boring ID EZVI-SB210

Date 10/9/02

Location EZVI Plot

Battelle ... Putting Technology To Work

Boring Diameter	2 in	Total Depth	32 ft
Casing Outer Diameter	--- in	Sand Pack	---
Casing Inner Diameter	--- in	Sand Pack Depth	from --- to --- ft
Casing Material	---	Grout Material	Portland
Screen Type	---	Grout Depth	from 0 to Depth ft
Screen Slot	---	Surface Completion	Grout flush
Screen Length	--- ft	Drilling Method	Direct Push Vibra-core
Screen Depth	from --- to --- ft	Driller	Precision

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Hand auger fine tan sand, no sample	0-8	---	SP	---	---
Orange brown med sand with trace shells	8-10	X	SP	20	0.0
Orange brown med sand with trace shells, 1" EZVI band at 12' in med sand	10-12	X	SP	100	0.0
Orange-brown medium-coarse sand with trace shells (2" black EZVI band at 14')	12-14	X	SP	60	0.0
Gray med sand with trace shells, gray fine sand, gray med sand with trace shells, gray fine sand (no EZVI)	14-16	X	SP	100	348
Orange brown sand with trace shells, gray med-fine sand, gray fine sand	16-18	X	SP	100	50
Dark gray med sand with trace shells, fine gray sand, dark gray med sand with trace shells, gray fine sand, odor at 17' (no EZVI)	18-20	X	SP	100	1117
Brown medium coarse sand with trace shells, gray med sand, EZVI band 1" thick at 20.5' in medium sand, (evidence of smearing below EZVI band)	20-22	X	SP	100	65
Gray fine sand, dark gray med sand with trace shells, gray fine sand, odor (no EZVI)	22-24	X	SP-SM	100	1416
Gray silty fine sand (no EZVI)	24-26	X	SM	90	352
Gray silty fine sand (no EZVI)	26-28	X	SM	100	345

Logged by: M. Gaberell

Construction Notes: for visual ID of EZVI beyond western edge of plot

LC34 Coring Logsheet

Boring ID EZVI-SB301

Date 11/21/02

Location EZVI Post

Battelle ... Putting Technology To Work

Boring Diameter	2 in	Total Depth	46 ft
Casing Outer Diameter	2 in	Sand Pack	---
Casing Inner Diameter	--- in	Sand Pack Depth	from --- to --- ft
Casing Material	---	Grout Material	Med Bentonite Chips
Screen Type	---	Grout Depth	from 0 to Depth ft
Screen Slot	---	Surface Completion	Grout flush
Screen Length	--- ft	Drilling Method	Direct Push Vibra-core
Screen Depth	from --- to --- ft	Driller	Precision

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Hand auger fine-med. tan sand	0-5	---	SP	---	---
Lt gray-white fine-med sand to brown fine-med sand	6-8	SB301-8	SP	75	0
Gray-brown fine-med sand with shell matter	8-10	SB301-10	SP	25	0
As above to gray fine-med sand with shell matter	10-12	SB301-12	SP	100	11.8
Gray-brown fine-med sand with shell matter	12-14	SB301-14	SP	75	1.5
As above to gray fine-med sand, EZVI band at 15' (shelly layer)	14-16	SB301-16	SP	100	1.7
Orange brown fine-med sand with shell matter to gray brown fine-med sand with shell matter	16-18	SB301-18	SP	100	0.9
Gray fine-med sand to gray fine sand, EZVI band at 18.5'	18-20	SB301-20	SP	100	0.1
Gray fine-med sand, bad odor	20-22	SB301-22	SP	25	0
Gray fine-med sand, trace shells, bad odor	22-24	SB301-24	SP	100	5.6
No recovery	24-26	---	---	0	---
Silty fine gray sand	26-28	SB301-28	SM	90	69
Silty fine gray sand, trace shells	28-30	SB301-30	SM	80	7.9

Logged by: L. Cumming

Completion Date: 11/21/02

Construction Notes: 4' Macro-core acetate sleeves, rinseate = EZVI-SB301 -Rinseate, Dup = EZVI-SB301-36DUP

LC34 Coring Logsheet

Boring ID EZVI-SB301

Date 11/21/02

Location EZVI Post

Battelle ... Putting Technology To Work

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Silty fine gray sand, trace shells	30-32	SB301-32	SM	100	1.1
Silty fine gray sand	32-34	SB301-34	SM	80	3.9
Silty fine gray sand to gray silty fine-med sand with shell matter	34-36	SB301-36	SM	100	0.8
Silty fine gray sand	36-38	SB301-38	SM-SP	35	1.1
Silty fine-med gray sand and shell matter to silty fine-med sand	38-40	SB301-40	SM	100	20
Silty-clayey fine gray sand, trace shells, slightly clayey	40-42	SB301-42	SM-SP	35	0
As above	42-44	SB301-44	SM-SC	100	0
Gray silty fine-med sand and shells	44-46	SB301-46	SM-GM	100	0
End core at 46’					

LC34 Coring Logsheet

Boring ID EZVI-SB302

Date 11/18/02

Location EZVI Post

Battelle ... Putting Technology To Work

Boring Diameter	2 in	Total Depth	46 ft
Casing Outer Diameter	2 in	Sand Pack	---
Casing Inner Diameter	--- in	Sand Pack Depth	from --- to --- ft
Casing Material	---	Grout Material	Med Bentonite Chips
Screen Type	---	Grout Depth	from 0 to Depth ft
Screen Slot	---	Surface Completion	Grout flush
Screen Length	--- ft	Drilling Method	Direct Push Vibra-core
Screen Depth	from --- to --- ft	Driller	Precision

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Hand auger fine-med. tan sand	0-5	---	SP	---	---
Lt gray fine sand, some black bands to med sand to coarse sand with shell material	6-8	SB302-8	SP	100	1.3
No recovery	8-10	---	---	0	---
Brown fine-med to orange-brown sand and shell material, wet	10-12	SB302-12	SP	100	1.6
As above to gray fine-med sand with shell matter	12-14	SB302-14	SP	75	106
Gray fine-med sand with shell matter to light gray fine sand	14-16	SB302-16	SP	100	96
Orange brown fine-med sand with shell matter to very dark gray med sand, banding?	16-18	SB302-18	SP	100	30.5
Lt gray fine sand, trace shells to gray med sand to lt gray fine sand	18-20	SB302-20	SP	100	278
No recovery	20-22	---	---	0	---
Lt gray fine-med sand	22-24	SB302-24	SP	100	35
Gray fine sand to silty fine gray sand	24-26	SB302-26	SP	100	68
Silty fine gray sand	26-28	SB302-28	SP-SM	100	0
Silty fine gray sand	28-30	SB302-30	SM	100	72

Logged by: L. Cumming

Completion Date: 11/18/02

Construction Notes: 4' Macro-core acetate sleeves, rinseate = EZVI-SB302-Rinseate, Dup = EZVI-SB302-18DUP

LC34 Coring Logsheet

Boring ID EZVI-SB302

Date 11/18/02

Location EZVI Post

Battelle ... Putting Technology To Work

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Silty fine gray sand	30-32	SB302-32	SM	100	40
No recovery	32-34	---	---	0	---
Silty fine gray sand to coarse sand with shell matter	34-36	SB302-36	SM	25	1.8
Coarse shells with sand to gray silty sand with shell material	36-38	SB302-38	GM -SM	100	32
Gray silty sand with shell material	38-40	SB302-40	SM	50	0
Gray silty fine sand, soupy, clayey	40-42	SB302-42	SM-SC	100	0
Gray silty fine-med sand	42-44	SB302-44	SM	100	0
Gray silty fine-med sand	44-46	SB302-46	SM	100	0
End core at 46’					

LC34 Coring Logsheet

Boring ID EZVI-SB303

Date 11/20/02

Location EZVI Post

Battelle . . . Putting Technology To Work

Boring Diameter	2 in	Total Depth	46 ft
Casing Outer Diameter	2 in	Sand Pack	---
Casing Inner Diameter	--- in	Sand Pack Depth	from --- to --- ft
Casing Material	---	Grout Material	Med Bentonite Chips
Screen Type	---	Grout Depth	from 0 to Depth ft
Screen Slot	---	Surface Completion	Grout flush
Screen Length	--- ft	Drilling Method	Direct Push Vibra-core
Screen Depth	from --- to --- ft	Driller	Precision

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Hand auger fine-med. tan sand	0-5	---	SP	---	---
White-gray fine sand to orange-brown fine-med sand with shell material	6-8	SB303-8	SP	80	0.4
As above, more coarse, faint dark gray layer (EZVI?)	8-10	SB303-10	SP	20	0
Orange brown med sand with shell matter to light gray fine sand, black EZVI bands appear at 11-12' bgs	10-12	SB303-12	SP	100	2.8
Orange-brown med sand with shell matter to gray-orange brown med sand with shell matter, EZVI evidence	12-14	SB303-14	SP	90	35.1
Gray fine-med sand with shell matter, EZVI dark gray layers at bottom	14-16	SB303-16	SP	100	6.9
Orange brown med sand with shell matter to gray fine-med sand	16-18	SB303-18	SP	100	11.5
Gray fine-med sand, some dark gray layers	18-20	SB303-20	SP	100	> 2000
Orange-brown fine-med sand to gray fine-med sand	20-22	SB303-22	SP	100	138
Lt gray fine-med sand, more silty at bottom	22-24	SB303-24	SP-SM	100	> 2000
Gray silty fine sand	24-26	SB303-26	SM	35	4.5
Silty fine gray sand	26-28	SB303-28	SM	100	91
Silty fine gray sand, wet	28-30	SB303-30	SM	50	20.9

Logged by: L. Cumming

Completion Date: 11/20/02

Construction Notes: 4' Macro-core acetate sleeves, rinseate = EZVI-SB303-Rinseate, Dup = EZVI-SB303-20DUP

LC34 Coring Logsheet

Boring ID EZVI-SB303

Date 11/20/02

Location EZVI Post

Battelle ... Putting Technology To Work

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Silty fine gray sand, wet	30-32	SB303-32	SM	100	34
Silty fine gray sand, wet	32-34	SB303-34	SM	50	35
Silty fine gray sand, trace shells, soupy at top	34-36	SB303-36	SM-SP	100	135
Gray silty fine sand, no sample	36-38	SB303-38	SP	5	5
Gray silty fine sand to silty-clayey sand to silty fine-med sand with shell material	38-40	SB303-40	SP-SM-SC	100	0
Gray silty fine sand with shells	40-42	SB303-42	SM	30	0.5
Gray silty fine sand with more shells	42-44	SB303-44	SM	100	3.4
Gray silty fine-med sand to silty shells and fine-med sand	44-46	SB303-46	SM-GM	100	0
End core at 46’					

LC34 Coring Logsheet

Boring ID EZVI-SB304

Date 11/19/02

Location EZVI Post

Battelle . . . Putting Technology To Work

Boring Diameter	2 in	Total Depth	46 ft
Casing Outer Diameter	2 in	Sand Pack	---
Casing Inner Diameter	--- in	Sand Pack Depth	from --- to --- ft
Casing Material	---	Grout Material	Med Bentonite Chips
Screen Type	---	Grout Depth	from 0 to Depth ft
Screen Slot	---	Surface Completion	Grout flush
Screen Length	--- ft	Drilling Method	Direct Push Vibra-core
Screen Depth	from --- to --- ft	Driller	Precision

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Hand auger fine-med. tan sand	0-5	---	SP	---	---
Light gray-white fine sand to orange brown fine-medium sand	6-8	SB304-8	SP	75	14.1
Gray-brown fine-med sand	8-10	SB304-10	SP	25	0
Orange brown med sand with shell matter to gray fine-med sand	10-12	SB304-12	SP	100	0
Orange-brown fine-med sand with shell matter	12-14	SB304-14	SP	50	12.9
As above to gray fine-med sand, EZVI dark gray band at ~15.5'	14-16	SB304-16	SP	100	0
Orange brown fine-med sand with shell matter to gray fine-med sand	16-18	SB304-18	SP	100	36
Gray fine-med sand, some dark gray med sand layers, faint banding?	18-20	SB304-20	SP	100	0
Gray fine sand, bad odor	20-22	SB304-22	SP	25	0.6
Gray fine-med sand, bad odor	22-24	SB304-24	SP-SM	100	1.2
Gray fine sand, trace shell matter	24-26	SB304-26	SM	25	16
As above, more silty at bottom	26-28	SB304-28	SP-SM	100	7.3
Silty fine gray sand	28-30	SB304-30	SM	50	52

Logged by: L. Cumming

Completion Date: 11/19/02

Construction Notes: 4' Macro-core acetate sleeves, rinseate = EZVI-SB304 -Rinseate, Dup = EZVI-SB304-32DUP

LC34 Coring Logsheet

Boring ID EZVI-SB304

Date 11/19/02

Location EZVI Post

Battelle ... Putting Technology To Work

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Silty fine gray sand	30-32	SB304-32	SM	100	7.3
Silty fine gray sand	32-34	SB304-34	SM	100	52
Silty fine gray sand to gray fine-med sand	34-36	SB304-36	SM	100	2.8
Gray silty sand with shell matter to silty fine sand	36-38	SB304-38	SM	50	9.7
Gray silty fine sand to silty-clayey sand to fine to coarse sand	38-40	SB304-40	SM-SC	100	5.8
Gray silty fine sand, trace shells	40-42	SB304-42	SM	90	NR
Gray silty fine sand, trace shells	42-44	SB304-44	SM	100	NR
Gray silty fine sand with shell matter	44-46	SB304-46	SM	100	31.5
End core at 46’					

LC34 Coring Logsheet

Boring ID EZVI-SB307

Date 11/21/02

Location EZVI Post

Battelle ... Putting Technology To Work

Boring Diameter	2 in	Total Depth	46 ft
Casing Outer Diameter	2 in	Sand Pack	---
Casing Inner Diameter	--- in	Sand Pack Depth	from --- to --- ft
Casing Material	---	Grout Material	Med Bentonite Chips
Screen Type	---	Grout Depth	from 0 to Depth ft
Screen Slot	---	Surface Completion	Grout flush
Screen Length	--- ft	Drilling Method	Direct Push Vibra-core
Screen Depth	from --- to --- ft	Driller	Precision

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Hand auger fine-med. tan sand	0-5	---	SP	---	---
Light gray fine sand to orange brown fine-med sand	6-8	SB307-8	SP	75	0
No recovery	8-10	---	SP	0	---
Brown-orange fine-med sand with shells to gray fine-med sand	10-12	SB307-12	SP	100	30
Brown-gray fine-med sand to orange-brown fine-med sand with shell matter	12-14	SB307-14	SP	80	0
Gray fine-med sand with shell matter to gray fine sand, EZVI dark gray band at ~15.25'	14-16	SB307-16	SP	100	0
No recovery	16-18	---	---	0	---
Gray fine-med sand	18-20	SB307-20	SP	80	57.6
No recovery	20-22	---	---	0	---
Gray fine-med sand, EZVI band at middle (coarse layer)	22-24	SB307-24	SP-SM	100	15.8
Gray silty fine sand, trace shells	24-26	SB307-26	SM	40	429
As above	26-28	SB307-28	SM	100	232
No recovery	28-30	---	---	0	---

Logged by: L. Cumming

Completion Date: 11/21/02

Construction Notes: 4' Macro-core acetate sleeves, rinseate = EZVI-SB307-Rinseate, Dup = EZVI-SB307-26DUP

LC34 Coring Logsheet

Boring ID EZVI-SB307

Date 11/21/02

Location EZVI Post

Battelle ... Putting Technology To Work

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Silty fine gray sand, very strong TCE odor	30-32	SB307-32	SM	100	340
Silty fine gray sand, trace shells, soupy	32-34	SB307-34	SM	90	68
Silty fine gray sand, trace-little shells	34-36	SB307-36	SM	100	28
Gray silty fine sand with shell matter	36-38	SB307-38	SM-SP	75	14.1
As above to gray silty clayey sand	38-40	SB307-40	SM-SC	100	6.2
Gray silty-clayey sand to gray silty fine sand with shells	40-42	SB307-42	SC-SM	80	0
Gray silty fine sand	42-44	SB307-44	SM	100	0
Gray silty fine sand, trace large shells to silty fine sand	44-46	SB307-46	SM	100	49.3
End core at 46’					

LC34 Coring Logsheet

Boring ID EZVI-SB308

Date 11/22/02

Location EZVI Post

Battelle ... Putting Technology To Work

Boring Diameter	2 in	Total Depth	46 ft
Casing Outer Diameter	2 in	Sand Pack	---
Casing Inner Diameter	--- in	Sand Pack Depth	from --- to --- ft
Casing Material	---	Grout Material	Med Bentonite Chips
Screen Type	---	Grout Depth	from 0 to Depth ft
Screen Slot	---	Surface Completion	Grout flush
Screen Length	--- ft	Drilling Method	Direct Push Vibra-core
Screen Depth	from --- to --- ft	Driller	Precision

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Hand auger fine-med. tan sand	0-5	---	SP	---	---
Light gray to white fine sand	6-8	SB308-8	SP	30	0
As above to orange brown fine-medium sand	8-10	SB308-10	SP	100	0
Brown-orange fine-med sand with shell matter	10-12	SB308-12	SP	50	5.2
As above to gray fine-med sand	12-14	SB308-14	SP	100	5.8
No recovery	14-16	---	---	0	---
Brown-gray fine-med sand to gray fine-med sand	16-18	SB308-18	---	75	0.3
No recovery	18-20	---	---	0	---
Gray fine-med sand to gray fine sand, faint EZVI band 3” from bottom	20-22	SB308-22	---	100	100
Gray silty fine sand	22-24	SB308-24	SM	25	183
As above	24-26	SB308-26	SM	100	449
As above	26-28	None	---	<5	---
Gray silty fine sand, trace shells to gray silty fine sand, more clayey at bottom	28-30	SB308-30	SM-SC	100	182

Logged by: L. Cumming

Completion Date: 11/22/02

Construction Notes: 4’ Macro-core acetate sleeves, Dup = EZVI-SB308-42DUP

LC34 Coring Logsheet

Boring ID EZVI-SB308

Date 11/22/02

Location EZVI Post

Battelle ... Putting Technology To Work

Lithologic Description	Depth	Sample	USCS	Rec.	PID
Silty fine gray sand	30-32	---	SM	<5	18
Silty fine gray sand, more clayey at bottom interval	32-34	SB308-34	SM	100	139
Silty fine gray sand to gray silty shells and sand	34-36	SB308-36	SM-GM	<5	0
Silty sand and shells to gray fine-med sand, clayey at bottom	36-38	SB308-38	GM-SM	100	0.2
Gray clayey-silty fine-med sand to silty sand and shells	38-40	SB308-40	SM-GM	50	4.2
Silty sand and shells to clayey fine sand to clayey-silty fine-med sand	40-42	SB308-42	SM-SC	100	4.4
Gray silty fine-med sand to silty sand and shells	42-44	SB308-44	SM-GM	90	0
Gray silty fine sand and shells to silty fine-med sand	44-46	SB308-46	SM-SC	100	36
End core at 46’					

Appendix C
CVOC Measurements

Table C-1. CVOC Results of Groundwater Samples for EZVI Demonstration

	TCE (µg/L)			*cis* -1,2-DCE (µg/L)			*trans* -1,2-DCE (µg/L)			Vinyl chloride (µg/L)		
Well ID	**Pre-Demo**	**Demo 1**	**Post-Demo**	**Pre-Demo**	**Demo 1**	**Post-Demo**	**Pre-Demo**	**Demo 1**	**Post-Demo**	**Pre-Demo**	**Demo 1**	**Post-Demo**
EZVI Plot Well												
PA-23	1,180,000	92,100	8,790	16,900	17,900	169,000	<1,000	68 J	245	<1,000	53 J	21,600
PA-23-DUP	1,130,000	84,600	9,010	17,300	14,600	132,000	<1,000	33 J	314	<1,000	<100	24,700
EZVI Perimeter Wells												
PA-24S	772,000	474,000	12,100	47,400	15,800	31,700	<1,000	<50	190 J	<1,000	<50	1,580
PA-24I	258,000	110,000	86,400	149,000	161,000	181,000	482	644	1,020	140 J	1,070	779
PA-24D	469,000	497,000	656,000	61,800	83,400	99,400	260 J	360 J	610	110 J	590	160 J
PA-25S	71,300	69,600	129,000	69,200	9,320	42,800	<1,000	46 J	381	<1,000	<100	75 J
PA-25I	534,000	784,000	944,000	116,000	104,000	90,900	320J	230	270 J	<500	<100	170 J
PA-25D	2,760	36,200	53,200	60,800	101,000	117,000	278	395	544	<50	142	354
Injection & Extraction Wells												
EIW-1	144,000	NA	7,820	38,300	NA	3,280	556	NA	24 J	638	NA	322
EEW-1	1,050,000	NA	471,000	67,100	NA	80,100	550J	NA	390 J	<1,000	NA	6,980

J: Estimated value, below reporting limit.
Pre-Demo: March 2002.
Demo 1 for EZVI: August 19th to 21st, 2002.
Post-Demo: EZVI-November 2002.

Table C-2. Summary of CVOC Results in Soil from EZVI Pre-Demonstration Monitoring

Sample ID	Sample Depth (ft)		Sample Date	MeOH (g)	Wet Soil Weight (g)	Dry Soil Weight (g)	TCE		*cis* -1,2-DCE		*trans* -1,2-DCE		Vinyl Chloride	
	Top Depth	Bottom Depth					Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)
EZVI-SB-1-8	6	8	1/16/2002	194	93	89	121	0	<100	ND	<100	ND	<100	ND
EZVI-SB-1-8-DUP	6	8	1/16/2002	191	72	68	<100	ND	10J	0	<100	ND	<100	ND
EZVI-SB-1-10 (SS)	8	10	1/16/2002	193	147	125	459	1	488	1	<100	ND	<100	ND
EZVI-SB-1-12	10	12	1/16/2002	192	100	80	184	1	119	0	<100	ND	<100	ND
EZVI-SB-1-14	12	14	1/16/2002	192	149	126	1,300	3	1,920	4	34J	0	<100	ND
EZVI-SB-1-16	14	16	1/16/2002	191	88	74	1,760	6	1,600	6	34J	0	<100	ND
EZVI-SB-1-18	16	18	1/16/2002	190	124	103	34,100	87	6,200	16	60J	0	21J	0
EZVI-SB-1-20	18	20	1/16/2002	192	80	58	61,800	282	884	4	<100	ND	<100	ND
EZVI-SB-1-22	20	22	1/16/2002	192	106	93	75,400	208	1,000	3	<100	ND	<100	ND
EZVI-SB-1-24	22	24	1/16/2002	191	129	111	98,200	230	1,100	3	12J	0	<100	ND
EZVI-SB-1-26	24	26	1/16/2002	194	155	126	130,000	283	1,220	3	<100	ND	<100	ND
EZVI-SB-1-28	26	28	1/16/2002	191	135	106	103,000	263	1,590	4	<100	ND	<100	ND
EZVI-SB-1-30	28	30	1/16/2002	192	145	112	104,000	256	18,300	45	49J	0	20J	0
EZVI-SB-1-32	30	32	1/16/2002	190	190	148	3,060	6	53,000	101	140	0	<100	ND
EZVI-SB-1-34	32	34	1/16/2002	194	101	84	<100	ND	15,100	47	35J	0	<100	ND
EZVI-SB-1-36	34	36	1/16/2002	191	149	124	<100	ND	9,760	21	44J	0	<100	ND
EZVI-SB-1-38	36	38	1/16/2002	192	151	122	<100	ND	9,090	20	74J	0	<100	ND
EZVI-SB-1-40	38	40	1/16/2002	194	123	93	<100	ND	1,340	4	<100	ND	<100	ND
EZVI-SB-1-42	40	42	1/16/2002	194	126	90	<100	ND	3,110	10	44J	0	<100	ND
EZVI-SB-1-44	42	44	1/16/2002	194	146	122	140	0	3,520	8	<100	ND	<100	ND
EZVI-SB-1-46	44	46	1/16/2002	192	187	155	4,650	8	6,980	12	<100	ND	<100	ND
EZVI-SB-1-MB (SS)	Lab Blank		1/16/2002	192	NA	NA	<100	ND	<100	ND	<100	ND	<100	ND
EZVI-SB-1-RINSATE	EQ		1/16/2002	NA	NA	NA	<1.0	ND	<1.0	ND	<1.0	ND	<1.0	ND
EZVI-SB-2-8 (SS)	6	8	1/16/2002	192	101	100	<100	ND	<100	ND	<100	ND	<100	ND
EZVI-SB-2-10	8	10	1/16/2002	194	111	97	<100	ND	118	0	<100	ND	<100	ND
EZVI-SB-2-12	10	12	1/16/2002	193	113	99	<100	ND	113	0	<100	ND	<100	ND
EZVI-SB-2-14	12	14	1/16/2002	191	158	131	501	1	1,120	2	19J	0	<100	ND
EZVI-SB-2-16	14	16	1/16/2002	193	196	164	5,700	10	6,680	11	141	0	63J	0
EZVI-SB-2-18	16	18	1/16/2002	192	172	141	45,700	89	7,980	16	85J	0	38J	0
EZVI-SB-2-20	18	20	1/16/2002	191	152	130	89,800	182	4,440	9	<100	ND	<100	ND
EZVI-SB-2-22	20	22	1/16/2002	191	208	165	135,000	233	4,860	8	<100	ND	<100	ND
EZVI-SB-2-24	22	24	1/16/2002	191	97	83	67,200	207	913	3	<100	ND	<100	ND
EZVI-SB-2-24-DUP	22	24	1/16/2002	195	94	74	72,600	262	1,020	4	<100	ND	<100	ND
EZVI-SB-2-26	24	26	1/16/2002	191	90	75	75,600	259	4,440	15	<100	ND	<100	ND
EZVI-SB-2-28	26	28	1/16/2002	192	121	95	95,200	270	2,550	7	<100	ND	<100	ND
EZVI-SB-2-30	28	30	1/16/2002	194	104	85	63,000	196	10,100	31	<100	ND	<100	ND
EZVI-SB-2-32	30	32	1/16/2002	192	164	116	2,180	5	38,100	96	102	0	<100	ND
EZVI-SB-2-34	32	34	1/16/2002	191	189	157	376	1	27,500	48	79J	0	<100	ND

Table C-2. Summary of CVOC Results in Soil from EZVI Pre-Demonstration Monitoring (Continued)

Sample ID	Sample Depth (ft)		Sample Date	MeOH (g)	Wet Soil Weight (g)	Dry Soil Weight (g)	TCE		*cis* -1,2-DCE		*trans* -1,2-DCE		Vinyl Chloride	
	Top Depth	Bottom Depth					Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)
EZVI-SB-2-36	34	36	1/16/2002	192	256	211	209	0	16,000	22	69J	0	<100	ND
EZVI-SB-2-38	36	38	1/16/2002	192	193	162	110	0	8,600	15	44J	0	<100	ND
EZVI-SB-2-40	38	40	1/16/2002	192	130	90	<100	ND	1,890	6	<100	ND	<100	ND
EZVI-SB-2-42	40	42	1/16/2002	194	192	150	<100	ND	668	1	<100	ND	<100	ND
EZVI-SB-2-44	42	44	1/16/2002	192	85	50	<100	ND	3,760	21	<100	ND	<100	ND
EZVI-SB-2-46	44	46	1/16/2002	192	211	178	<100	ND	3,180	5	<100	ND	<100	ND
EZVI-SB-2-MB (SS)	Lab Blank		1/16/2002	191	NA	NA	<100	ND	<100	ND	<100	ND	<100	ND
EZVI-SB-2-RINSATE	EQ		1/16/2002	NA	NA	NA	<1.0	ND	<1.0	ND	<1.0	ND	<1.0	ND
EZVI-SB-3-8 (SS)	6	8	1/17/2002	194	134	132	<100	ND	<100	ND	<100	ND	<100	ND
EZVI-SB-3-10	8	10	1/17/2002	191	157	140	120	0	156	0	<100	ND	<100	ND
EZVI-SB-3-12	10	12	1/17/2002	191	134	111	107	0	124	0	<100	ND	<100	ND
EZVI-SB-3-14	12	14	1/17/2002	191	171	146	544	1	1,320	2	24J	0	27J	0
EZVI-SB-3-16	14	16	1/17/2002	190	167	146	3,830	7	2,920	5	60J	0	<100	ND
EZVI-SB-3-18	16	18	1/17/2002	191	101	90	2,160,000	6,067	10,200	29	134	0	29J	0
EZVI-SB-3-20	18	20	1/17/2002	191	102	88	72,000	209	1,430	4	<100	ND	<100	ND
EZVI-SB-3-22	20	22	1/17/2002	191	109	95	72,500	195	906	2	<100	ND	<100	ND
EZVI-SB-3-24	22	24	1/17/2002	192	171	137	125,000	253	1,570	3	<100	ND	<100	ND
EZVI-SB-3-26	24	26	1/17/2002	191	144	114	114,000	272	1,180	3	<100	ND	<100	ND
EZVI-SB-3-28	26	28	1/17/2002	190	115	94	90,700	252	798	2	<100	ND	<100	ND
EZVI-SB-3-30	28	30	1/17/2002	192	114	92	118,000	340	6,040	17	12J	0	<100	ND
EZVI-SB-3-32	30	32	1/17/2002	190	127	94	72,400	211	26,400	77	62J	0	19J	0
EZVI-SB-3-34	32	34	1/17/2002	194	157	125	859	2	40,400	90	83J	0	<100	ND
EZVI-SB-3-36	34	36	1/17/2002	192	132	112	<100	ND	4,180	10	<100	ND	<100	ND
EZVI-SB-3-38	36	38	1/17/2002	192	139	118	212	0	7,220	16	17J	0	<100	ND
EZVI-SB-3-40	38	40	1/17/2002	193	142	111	241	1	347	1	<100	ND	<100	ND
EZVI-SB-3-40-DUP	38	40	1/17/2002	191	95	44	158	1	249	2	<100	ND	<100	ND
EZVI-SB-3-42	40	42	1/17/2002	192	145	116	192	0	371	1	<100	ND	<100	ND
EZVI-SB-3-44	42	44	1/17/2002	191	118	97	<100	ND	1,540	4	<100	ND	<100	ND
EZVI-SB-3-46	44	46	1/17/2002	190	152	127	15,700	33	5,150	11	<100	ND	<100	ND
EZVI-SB-3-MB (SS)	Lab Blank		1/17/2002	195	NA	NA	<100	ND	<100	ND	<100	ND	<100	ND
EZVI-SB-3-RINSATE	EQ		1/16/2002	NA	NA	NA	<1.0	ND	<1.0	ND	<1.0	ND	<1.0	ND
EZVI-SB-4-8 (SS)	6	8	1/17/2002	191	153	149	<100	ND	<100	ND	<100	ND	<100	ND
EZVI-SB-4-10	8	10	1/17/2002	193	215	188	139	0	154	0	<100	ND	<100	ND
EZVI-SB-4-12	10	12	1/17/2002	191	171	142	158	0	159	0	<100	ND	<100	ND
EZVI-SB-4-14	12	14	1/17/2002	190	148	130	2,770	6	1,890	4	39J	0	<100	ND
EZVI-SB-4-16	14	16	1/17/2002	190	129	110	2,520	6	2,840	7	52J	0	<100	ND
EZVI-SB-4-18	16	18	1/17/2002	190	119	102	17,700	45	4,570	12	67J	0	25J	0
EZVI-SB-4-20	18	20	1/17/2002	190	102	85	53,300	161	2,480	8	<100	ND	<100	ND

Table C-2. Summary of CVOC Results in Soil from EZVI Pre-Demonstration Monitoring (Continued)

Sample ID	Sample Depth (ft)		Sample Date	MeOH (g)	Wet Soil Weight (g)	Dry Soil Weight (g)	TCE		*cis* -1,2-DCE		*trans* -1,2-DCE		Vinyl Chloride	
	Top Depth	Bottom Depth					Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)
EZVI-SB-4-22	20	22	1/17/2002	190	117	91	58,500	171	1,740	5	<200	ND	<200	ND
EZVI-SB-4-24	22	24	1/17/2002	192	147	118	108,000	249	1,840	4	<200	ND	<200	ND
EZVI-SB-4-26	24	26	1/17/2002	191	175	140	146,000	289	2,020	4	<200	ND	<200	ND
EZVI-SB-4-28	26	28	1/17/2002	192	120	98	94,300	255	5,620	15	<200	ND	<200	ND
EZVI-SB-4-30	28	30	1/17/2002	191	139	108	93,500	236	17,900	45	43J	0	23J	0
EZVI-SB-4-32	30	32	1/18/2002	191	281	220	10,100	14	52,500	72	122	0	<100	ND
EZVI-SB-4-34	32	34	1/18/2002	192	152	110	23,300	60	42,200	109	100	0	<100	ND
EZVI-SB-4-36	34	36	1/18/2002	191	230	181	514	1	16,600	27	45J	0	<100	ND
EZVI-SB-4-38	36	38	1/18/2002	192	165	140	<100	ND	3,680	7	<100	ND	<100	ND
EZVI-SB-4-40	38	40	1/18/2002	191	167	107	512	1	111	0	<100	ND	<100	ND
EZVI-SB-4-40-DUP	38	40	1/18/2002	190	145	116	217	1	88J	0	<100	ND	<100	ND
EZVI-SB-4-42	40	42	1/18/2002	192	104	87	366	1	226	1	<100	ND	<100	ND
EZVI-SB-4-44	42	44	1/18/2002	191	174	144	<100	ND	2,600	5	13J	0	<100	ND
EZVI-SB-4-46	44	46	1/18/2002	192	181	151	17,500	32	5,650	10	<100	ND	<100	ND
EZVI-SB-4-MB (SS)	Lab Blank		1/17/2002	192	NA	NA	<100	ND	<100	ND	<100	ND	<100	ND
EZVI-SB-4-RINSATE	EQ		1/17/2002	NA	NA	NA	<1.0	ND	<1.0	ND	<1.0	ND	<1.0	ND
EZVI-SB-5-8 (SS)	6	8	1/31/2002	193	96	93	<100	ND	<100	ND	<100	ND	<100	ND
EZVI-SB-5-10	8	10	1/31/2002	192	119	103	105	0	78J	0	<100	ND	<100	ND
EZVI-SB-5-12	10	12	1/31/2002	192	119	104	<100	ND	128	0	<100	ND	<100	ND
EZVI-SB-5-14	12	14	1/31/2002	191	116	92	329	1	509	1	<100	ND	<100	ND
EZVI-SB-5-16	14	16	1/31/2002	192	121	114	3,510	8	2,320	5	27J	0	<100	ND
EZVI-SB-5-18	16	18	1/31/2002	191	156	136	35,200	68	7,120	14	23J	0	<100	ND
EZVI-SB-5-20	18	20	1/31/2002	192	120	105	46,800	115	3,630	9	<100	ND	<100	ND
EZVI-SB-5-22	20	22	1/31/2002	191	103	88	37,900	111	2,700	8	<100	ND	<100	ND
EZVI-SB-5-24	22	24	1/31/2002	191	122	100	67,400	178	2,700	7	<100	ND	<100	ND
EZVI-SB-5-26	24	26	1/31/2002	191	110	93	56,600	157	2,290	6	<100	ND	<100	ND
EZVI-SB-5-28	26	28	1/31/2002	191	120	102	85,000	216	2,540	6	<100	ND	<100	ND
EZVI-SB-5-30	28	30	1/31/2002	191	102	82	77,500	247	3,240	10	<100	ND	<100	ND
EZVI-SB-5-32	30	32	1/31/2002	191	104	83	44,900	142	15,300	48	31J	0	<100	ND
EZVI-SB-5-34	32	34	1/31/2002	191	96	87	15,600	45	17,500	50	36J	0	<1,00	ND
EZVI-SB-5-36	34	36	1/31/2002	189	128	107	362	1	21,800	53	53J	0	<100	ND
EZVI-SB-5-38	36	38	1/31/2002	190	100	90	4,050	11	12,800	36	28J	0	<100	ND
EZVI-SB-5-38-DUP	36	38	1/31/2002	191	92	81	245	1	11,600	36	26J	0	<100	ND
EZVI-SB-5-40	38	40	1/31/2002	192	110	77	<100	ND	10,600	38	46J	0	<100	ND
EZVI-SB-5-42	40	42	1/31/2002	192	156	126	<100	ND	8,410	18	38J	0	<100	ND
EZVI-SB-5-MB (SS)	Lab Blank		1/31/2002	191	NA	NA	<100	ND	<100	ND	<100	ND	<100	ND
EZVI-SB-5-RINSATE	EQ		1/31/2002	NA	NA	NA	<1	ND	<1	ND	<1	ND	<1	ND
EZVI-SB-6-8 (SS)	6	8	2/1/2002	191	93	94	<100	ND	<100	ND	<100	ND	<100	ND

Table C-2. Summary of CVOC Results in Soil from EZVI Pre-Demonstration Monitoring (Continued)

Sample ID	Sample Depth (ft)		Sample Date	MeOH (g)	Wet Soil Weight (g)	Dry Soil Weight (g)	TCE		*cis* -1,2-DCE		*trans* -1,2-DCE		Vinyl Chloride	
	Top Depth	Bottom Depth					Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)
EZVI-SB-6-10	8	10	2/1/2002	192	106	93	<100	ND	59J	0	<100	ND	<100	ND
EZVI-SB-6-12	10	12	2/1/2002	191	142	124	122	0	212	0	<100	ND	<100	ND
EZVI-SB-6-14	12	14	2/1/2002	192	107	96	266	1	539	1	<100	ND	<100	ND
EZVI-SB-6-16	14	16	2/1/2002	192	103	90	4,020	11	3,660	10	61J	0	<100	ND
EZVI-SB-6-18	16	18	2/1/2002	192	127	109	18,300	44	6,320	15	29J	0	<100	ND
EZVI-SB-6-20	18	20	2/1/2002	193	139	115	51,300	120	3,360	8	<100	ND	<100	ND
EZVI-SB-6-22	20	22	2/1/2002	191	141	123	58,900	124	2,200	5	<100	ND	<100	ND
EZVI-SB-6-24	22	24	2/1/2002	193	129	113	81,000	187	1,230	3	<100	ND	<100	ND
EZVI-SB-6-26	24	26	2/1/2002	193	132	110	80,500	195	1,010	2	<100	ND	<100	ND
EZVI-SB-6-28	26	28	2/1/2002	194	170	141	144,000	280	1,020	2	<100	ND	<100	ND
EZVI-SB-6-30	28	30	2/1/2002	195	98	77	93,200	324	1,940	7	<100	ND	<100	ND
EZVI-SB-6-32	30	32	2/1/2002	192	121	88	82,600	259	11,000	35	27J	0	<100	ND
EZVI-SB-6-32-DUP	30	32	2/1/2002	193	94	76	67,600	233	7,390	26	16J	0	<100	ND
EZVI-SB-6-34	32	34	2/1/2002	192	125	109	11,600	28	23,800	57	62J	0	<100	ND
EZVI-SB-6-36	34	36	2/1/2002	190	103	91	169	0	24,700	69	56J	0	<100	ND
EZVI-SB-6-38	36	38	2/1/2002	193	168	133	195	0	22,800	48	70J	0	<100	ND
EZVI-SB-6-40	38	40	2/1/2002	195	132	94	10,900	33	33,100	100	90J	0	<100	ND
EZVI-SB-6-42	40	42	2/1/2002	191	154	120	727	2	26,300 S	60	71J	0	<100	ND
EZVI-SB-6-MB (SS)	Lab Blank		2/1/2002	192	NA	NA	<100	ND	<100	ND	<100	ND	<100	ND
EZVI-SB-6-RINSATE	EQ		2/1/2002	NA	NA	NA	<1.0	ND	<1.0	ND	<1.0	ND	<1.0	ND
EZVI-SB-7-8 (SS)	6	8	2/7/2002	193	84	84	<100	ND	<100	ND	<100	ND	<100	ND
EZVI-SB-7-10	8	10	2/7/2002	190	135	135	153 SR	0	<100	ND	<100	ND	<100	ND
EZVI-SB-7-12	10	12	2/7/2002	191	102	92	137	0	55J	0	<100	ND	<100	ND
EZVI-SB-7-14	12	14	2/7/2002	192	133	114	698	2	1,010	2	<100	ND	<100	ND
EZVI-SB-7-16	14	16	2/7/2002	193	99	85	23,000	70	2,370	7	<100	ND	189	1
EZVI-SB-7-18	16	18	2/7/2002	192	139	121	541,000	1,167	11,200	24	95J	0	615	1
EZVI-SB-7-20	18	20	2/7/2002	192	139	118	92,500	207	1,740	4	<100	ND	422	1
EZVI-SB-7-22	20	22	2/7/2002	192	157	133	87,100	175	1,180	2	<100	ND	317	1
EZVI-SB-7-24	22	24	2/7/2002	193	146	127	97,600	202	1,270	3	<100	ND	390	1
EZVI-SB-7-26	24	26	2/7/2002	193	160	133	109,000	222	1,980	4	<100	ND	<100	ND
EZVI-SB-7-28	26	28	2/7/2002	191	124	97	96,600	268	4,140	11	<100	ND	<100	ND
EZVI-SB-7-30	28	30	2/7/2002	195	141	118	109,000	249	12,200	28	<100	ND	<100	ND
EZVI-SB-7-32	30	32	2/7/2002	192	133	110	305	1	17,400	42	25J	0	<100	ND
EZVI-SB-7-34	32	34	2/7/2002	192	198	152	26,900	51	56,500	107	97J	0	<100	ND
EZVI-SB-7-36	34	36	2/7/2002	192	150	128	<100	ND	12,500	26	<100	ND	<100	ND
EZVI-SB-7-38	36	38	2/7/2002	191	141	120	<100	ND	2,380	5	<100	ND	<100	ND

Table C-2. Summary of CVOC Results in Soil from EZVI Pre-Demonstration Monitoring (Continued)

Sample ID	Sample Depth (ft)		Sample Date	MeOH (g)	Wet Soil Weight (g)	Dry Soil Weight (g)	TCE		*cis* -1,2-DCE		*trans* -1,2-DCE		Vinyl Chloride	
	Top Depth	Bottom Depth					Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)
EZVI-SB-7-40	38	40	2/7/2002	192	145	111	182	0	10,600	26	37J	0	<100	ND
EZVI-SB-7-42	40	42	2/7/2002	192	154	125	<100	ND	5,720	12	<100	ND	<100	ND
EZVI-SB-7-44	42	44	2/7/2002	192	132	112	<100	ND	444	1	<100	ND	<100	ND
EZVI-SB-7-44-DUP	42	44	2/7/2002	192	133	112	161	0	430	1	<100	ND	<100	ND
EZVI-SB-7-46	44	46	2/7/2002	191	141	120	<100	ND	741	2	<100	ND	<100	ND
EZVI-SB-7-MB (SS)	Lab Blank		2/7/2002	192	NA	NA	<100	ND	<100	ND	<100	ND	<100	ND
EZVI-SB-7-RINSATE	EQ		2/7/2002	NA	NA	NA	2.88	0	<1.0	ND	<1.0	ND	<1.0	ND
EZVI-SB-8-8 (SS)	6	8	3/20/2002	193	87	88	<100	ND	<100	ND	<100	ND	<100	ND
EZVI-SB-8-10	8	10	3/20/2002	194	119	107	1,180	3	505	1	<100	ND	<100	ND
EZVI-SB-8-12	10	12	3/20/2002	193	121	87	503	2	274	1	<100	ND	<100	ND
EZVI-SB-8-14	12	14	3/20/2002	195	125	111	714	2	1,040	2	22J	0	18J	0
EZVI-SB-8-16	14	16	3/20/2002	194	103	90	7,170	21	2,210	6	46J	0	11J	0
EZVI-SB-8-18	16	18	3/20/2002	194	104	90	43,900	127	2,270	7	19J	0	<100	ND
EZVI-SB-8-20	18	20	3/20/2002	193	113	106	57,300	136	2,430	6	20J	0	<100	ND
EZVI-SB-8-22	20	22	3/20/2002	193	100	87	53,000	157	837	2	<100	ND	<100	ND
EZVI-SB-8-24	22	24	3/20/2002	192	98	93	60,600	162	802	2	<100	ND	<100	ND
EZVI-SB-8-26	24	26	3/20/2002	196	111	91	71,800	212	1,090	3	<100	ND	<100	ND
EZVI-SB-8-28	26	28	3/20/2002	195	106	88	78,800	237	1,120	3	<100	ND	<100	ND
EZVI-SB-8-30	28	30	3/20/2002	192	104	90	79,000	226	5,880	17	18J	0	<100	ND
EZVI-SB-8-32	30	32	3/20/2002	193	143	114	19,600	47	33,300	80	65J	0	<100	ND
EZVI-SB-8-34	32	34	3/20/2002	192	126	110	160	0	16,800	40	41J	0	<100	ND
EZVI-SB-8-34-DUP	32	34	3/20/2002	192	124	104	219	1	16,700	42	38J	0	<100	ND
EZVI-SB-8-36	34	36	3/20/2002	195	169	144	136	0	6,950	13	24J	0	<100	ND
EZVI-SB-8-MeOH(SS)	Lab Blank		3/20/2002	193	NA	NA	<100	ND	<100	ND	<100	ND	<100	ND
EZVI-SB-8-RINSATE	EQ		3/20/2002	NA	NA	NA	<1.0	ND	<1.0	ND	<1.0	ND	<1.0	ND

NA: Not available.
ND: Not detected.
DUP: Duplicate sample.
MB: Method blank.
SS: Surrogate spiked.
J: Result was estimated but below the reporting limit.
S: Spike Recovery outside accepted recovery limits due to the high concentration present in the sample.
R: RPD for MS/MSD outside accepted receovery limits.

Table C-3. Summary of CVOC Results in Soil from EZVI Intermediate Monitoring

Coring after the EZVI Injection	Sample Depth (ft)				Wet Soil	Dry Soil	TCE		*cis* -1,2-DCE		*trans* -1,2-DCE		Vinyl Chloride	
Sample ID	Top Depth	Bottom Depth	Sample Date	MeOH (g)	Weight (g)	Weight (g)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)
EZVI-SB-203-8 (SS)	6	8	10/9/2002	194	137	129	387	1	165	0	<100	ND	<100	ND
EZVI-SB-203-10	8	10	10/9/2002	193	No Recovery		NA	NA	NA	NA	NA	NA	NA	NA
EZVI-SB-203-12	10	12	10/9/2002	192	154	136	290	1	324	1	<100	ND	<100	ND
EZVI-SB-203-14	12	14	10/9/2002	191	122	114	324	1	198	0	<100	ND	<100	ND
EZVI-SB-203-16	14	16	10/9/2002	190	217	188	8,990	13	1,020	1	<100	ND	<100	ND
EZVI-SB-203-18	16	18	10/9/2002	191	232	201	538	1	142	0	<100	ND	<100	ND
EZVI-SB-203-18-DUP	16	18	10/9/2002	191	168	146	426	1	124	0	<100	ND	<100	ND
EZVI-SB-203-20	18	20	10/9/2002	193	158	133	505,000	1,023	16,700	34	70 J	0	<500	ND
EZVI-SB-203-22	20	22	10/9/2002	192	200	169	492,000	798	7,840	13	95 J	0	75 J	0
EZVI-SB-203-24	22	24	10/9/2002	194	126	107	200,000	495	5,800	14	33 J	0	257	1
EZVI-SB-203-26	24	26	10/9/2002	192	104	85	518	2	153	0	<100	ND	19 J	0
EZVI-SB-203-28	26	28	10/9/2002	192	123	99	433	1	191	1	<100	ND	38 J	0
EZVI-SB-203-30	28	30	10/9/2002	192	70	57	60,300	271	2,220	10	14 J	0	<100	ND
EZVI-SB-203-MeOH	Lab Blank		10/9/2002	NA	NA	NA	254	NA	54 J	NA	<100	ND	<100	ND
EZVI-SB-203-RINSATE	EQ		10/9/2002	NA	NA	NA	<1.0	ND	<1.0	ND	<1.0	ND	<1.0	ND
EZVI-SB-204-8 (SS)	6	8	10/9/2002	191	106	98	<100	ND	148	0	16 J	0	<100	ND
EZVI-SB-204-10	8	10	10/9/2002	190	No Recovery		NA	NA	NA	NA	NA	NA	NA	NA
EZVI-SB-204-12	10	12	10/9/2002	196	186	162	143	0	112	0	<100	ND	<100	ND
EZVI-SB-204-14	12	14	10/9/2002	194	81	71	148	1	58 J	0	<100	ND	<100	ND
EZVI-SB-204-16	14	16	10/9/2002	192	198	171	391	1	36 J	0	<100	ND	<100	ND
EZVI-SB-204-18	16	18	10/9/2002	193	191	163	436	1	95 J	0	<100	ND	<100	ND
EZVI-SB-204-20	18	20	10/9/2002	191	135	120	2,990	6	2,780	6	<100	ND	174	0
EZVI-SB-204-22	20	22	10/9/2002	195	174	159	1,580	3	897	1	<100	ND	17 J	0
EZVI-SB-204-24	22	24	10/9/2002	194	164	138	17,800	35	11,100	22	17 J	0	1,370	3
EZVI-SB-204-24-DUP	22	24	10/9/2002	192	144	119	5,570	13	9,260	21	13 J	0	1,490	3
EZVI-SB-204-26	24	26	10/9/2002	194	102	82	56,400	183	8,440	27	13 J	0	13 J	0
EZVI-SB-204-28	26	28	10/9/2002	192	156	128	12,800	27	2,700	6	<100	ND	38 J	0
EZVI-SB-204-30	28	30	10/9/2002	193	106	84	42,000	133	22,200	70	29 J	0	<100	ND
EZVI-SB-204-MeOH	Lab Blank		10/9/2002				200		36 J		<100	ND	<100	ND
EZVI-SB-207-8 (SS)	6	8	10/8/2002	193	157	149	535	1	161	0	<100	ND	<100	ND
EZVI-SB-207-10	8	10	10/8/2002	192	No Recovery		NA	NA	NA	NA	NA	NA	NA	NA
EZVI-SB-207-12	10	12	10/8/2002	193	148	128	246	1	90 J	0	<100	ND	<100	ND
EZVI-SB-207-14	12	14	10/8/2002	191	155	138	<100	ND	68 J	0	<100	ND	<100	ND
EZVI-SB-207-16	14	16	10/8/2002	195	224	196	<100	ND	2,030	3	<100	ND	132	0
EZVI-SB-207-18	16	18	10/8/2002	193	145	132	114	0	218	0	<100	ND	14 J	0
EZVI-SB-207-20	18	20	10/8/2002	196	230	196	37,400	54	10,600	15	22 J	0	428	1
EZVI-SB-207-22	20	22	10/8/2002	194	154	139	<100	ND	711	1	<100	ND	87 J	0
EZVI-SB-207-24	22	24	10/8/2002	197	184	161	506,000	856	13,400	23	<500	ND	1,120	2

Table C-3. Summary of CVOC Results in Soil from EZVI Intermediate Monitoring (Continued)

Coring after the EZVI Injection	Sample Depth (ft)						TCE		*cis* -1,2-DCE		*trans* -1,2-DCE		Vinyl Chloride	
Sample ID	Top Depth	Bottom Depth	Sample Date	MeOH (g)	Wet Soil Weight (g)	Dry Soil Weight (g)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)
EZVI-SB-207-24-DUP	22	24	10/8/2002	194	162	145	148,000	268	10,200	18	<500	ND	715	1
EZVI-SB-207-26	24	26	10/8/2002	193	118	101	68,400	177	1,460	4	13 J	0	14 J	0
EZVI-SB-207-28	26	28	10/8/2002	196	230	188	163,000	252	3,740	6	28 J	0	21 J	0
EZVI-SB-207-30	28	30	10/8/2002	192	114	91	84,900	248	4,570	13	41 J	0	20 J	0
EZVI-SB-207-MeOH	Lab Blank		10/8/2002				193		37 J		<100	ND	<100	ND
EZVI-SB-207-RINSATE	EQ		10/8/2002	NA	NA	NA	<1.0	ND	<1.0	ND	<1.0	ND	<1.0	ND
EZVI-SB-208-8 (SS)	6	8	10/8/2002	192	148	145	<100	ND	163	0	<100	ND	<100	ND
EZVI-SB-208-10	8	10	10/8/2002	193	98	90	<100	ND	201	1	<100	ND	<100	ND
EZVI-SB-208-12	10	12	10/8/2002	191	126	119	<100	ND	33 J	0	<100	ND	<100	ND
EZVI-SB-208-14	12	14	10/8/2002	192	130	114	<100	ND	109	0	<100	ND	<100	ND
EZVI-SB-208-16	14	16	10/8/2002	193	110	97	<100	ND	152	0	<100	ND	37 J	0
EZVI-SB-208-18	16	18	10/8/2002	191	136	97	<100	ND	295	1	<100	ND	11 J	0
EZVI-SB-208-20	18	20	10/8/2002	190	154	130	<100	ND	927	2	<100	ND	129	0
EZVI-SB-208-22	20	22	10/8/2002	192	No Recovery		NA	NA	NA	NA	NA	NA	NA	NA
EZVI-SB-208-24	22	24	10/8/2002	191	154	131	70,800	143	2,250	5	12 J	0	32 J	0
EZVI-SB-208-26	24	26	10/8/2002	192	No Recovery		NA	NA	NA	NA	NA	NA	NA	NA
EZVI-SB-208-28	26	28	10/8/2002	192	172	138	134,000	269	6,830	14	25 J	0	18 J	0
EZVI-SB-208-28-DUP	26	28	10/8/2002	190	134	109	83,900	204	5,300	13	20 J	0	12 J	0
EZVI-SB-208-30	28	30	10/8/2002	191	No Recovery		NA	NA	NA	NA	NA	NA	NA	NA
EZVI-SB-208-MeOH	Lab Blank		10/8/2002				160		33 J		<100	ND	<100	ND
EZVI-SB-209-8 (SS)	6	8	10/8/2002	191	165	155	156	0	138	0	<100	ND	<100	ND
EZVI-SB-209-10	8	10	10/8/2002	190	No Recovery		NA	NA	NA	NA	NA	NA	NA	NA
EZVI-SB-209-12	10	12	10/8/2002	190	157	139	1,120	2	184	0	<100	ND	20 J	0
EZVI-SB-209-14	12	14	10/8/2002	194	145	130	<100	ND	174	0	<100	ND	31 J	0
EZVI-SB-209-16	14	16	10/8/2002	192	209	171	<100	ND	1,300	2	<100	ND	46 J	0
EZVI-SB-209-18	16	18	10/8/2002	192	192	168	1,170	2	1,990	3	<100	ND	238	0
EZVI-SB-209-20	18	20	10/8/2002	191	171	149	22,800	40	10,100	18	14 J	0	847	1
EZVI-SB-209-22	20	22	10/8/2002	190	178	160	311	1	1,240	2	<100	ND	335	1
EZVI-SB-209-22-DUP	20	22	10/8/2002	189	151	120	166	0	828	2	<100	ND	140	0
EZVI-SB-209-24	22	24	10/8/2002	192	146	133	10,200	20	3,520	7	14 J	0	554	1
EZVI-SB-209-26	24	26	10/8/2002	192	87	71	78,800	287	1,020	4	14 J	0	10 J	0
EZVI-SB-209-28	26	28	10/8/2002	190	186	146	154,000	296	1,570	3	33 J	0	15 J	0
EZVI-SB-209-30	28	30	10/8/2002	192	101	81	76,000	247	1,480	5	10 J	0	<100	ND
EZVI-SB-209-MeOH	Lab Blank		10/8/2002				313		60 J		<100	ND	<100	ND

NA: Not available.
ND: Not detected.
DUP: Duplicate sample.

Table C-3. Summary of CVOC Results in Soil from EZVI Intermediate Monitoring (Continued)

Coring after the EZVI Injection	Sample Depth (ft)						TCE		*cis* -1,2-DCE		*trans* -1,2-DCE		Vinyl Chloride	
Sample ID	Top Depth	Bottom Depth	Sample Date	MeOH (g)	Wet Soil Weight (g)	Dry Soil Weight (g)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)

MB: Method blank.
SS: Surrogate spiked.
J: Result was estimated but below the reporting limit.
S: Spike Recovery outside accepted recovery limits due to the high concentration present in the sample.
R: RPD for MS/MSD outside accepted receovery limits.

Table C-4. Summary of CVOC Results in Soil from Post-Demonstration Monitoring in EZVI Plot

Sample ID	Sample Depth (ft)		Sample Date	MeOH (g)	Wet Soil Weight (g)	Dry Soil Weight (g)	TCE		*cis* -1,2-DCE		*trans* -1,2-DCE		Vinyl Chloride	
	Top Depth	Bottom Depth					Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)
EZVI-SB-301-8 (SS)	6	8	11/21/2002	194	122	117	119	0	33J	0	<100	ND	<100	ND
EZVI-SB-301-10	8	10	11/21/2002	194	122	110	476	1	506	1	<100	ND	<100	ND
EZVI-SB-301-12	10	12	11/21/2002	195	129	111	626	1	4,580	11	<100	ND	<100	ND
EZVI-SB-301-14	12	14	11/21/2002	194	130	110	1,680	4	2,430	6	<100	ND	<100	ND
EZVI-SB-301-16	14	16	11/21/2002	194	170	152	670	1	5,560	10	<100	ND	175	0
EZVI-SB-301-18	16	18	11/21/2002	194	165	144	329	1	5,520	10	<100	ND	43J	0
EZVI-SB-301-20	18	20	11/21/2002	194	195	172	7,500	12	7,850	12	16J	0	748	1
EZVI-SB-301-22	20	22	11/21/2002	195	170	142	3,970	8	4,250	8	20J	0	2,300	4
EZVI-SB-301-24	22	24	11/21/2002	195	149	129	136	0	752	2	21J	0	4,410	9
EZVI-SB-301-26	24	26	11/21/2002	194	no recovery		NA	NA	NA	NA	NA	NA	NA	NA
EZVI-SB-301-28	26	28	11/21/2002	193	183	150	64,100	119	5,860	11	16J	0	864	2
EZVI-SB-301-30	28	30	11/21/2002	193	164	131	4,450	9	2,050	4	<100	ND	52J	0
EZVI-SB-301-32	30	32	11/21/2002	194	147	115	24,200	58	13,300	32	38J	0	11J	0
EZVI-SB-301-34	32	34	11/21/2002	194	162	128	16,400	36	21,200	46	88J	0	11J	0
EZVI-SB-301-36	34	36	11/21/2002	193	132	111	118	0	15,900	38	40J	0	<100	ND
EZVI-SB-301-36-DUP	34	36	11/21/2002	193	137	119	1,090	2	24,800	55	61J	0	<100	ND
EZVI-SB-301-38	36	38	11/21/2002	195	171	142	<100	ND	8,220	16	30J	0	<100	ND
EZVI-SB-301-40	38	40	11/21/2002	193	165	120	123	0	5,020	12	26J	0	<100	ND
EZVI-SB-301-42	40	42	11/21/2002	193	201	153	168	0	1,470	3	28J	0	<100	ND
EZVI-SB-301-44	42	44	11/21/2002	193	162	131	112	0	860	2	<100	ND	<100	ND
EZVI-SB-301-46	44	46	11/21/2002	194	317	261	574	1	7,000	8	29J	0	<100	ND
EZVI-SB-301-MB (SS)	Lab Blank		11/21/2002	194	NA	NA	130	NA	16J	NA	<100	ND	<100	ND
EZVI-SB-301-RINSATE	EQ		11/21/2002	NA	NA	NA	<1.0	ND	<1.0	ND	<1.0	ND	<1.0	ND
EZVI-SB-302-8 (SS)	6	8	11/18/002	194	151	147	192	0	65J	0	<100	ND	<100	ND
EZVI-SB-302-10	8	10	11/18/002	195	no recovery		NA	NA	NA	NA	NA	NA	NA	NA
EZVI-SB-302-12	10	12	11/18/002	195	192	168	354	1	262	0	<100	ND	<100	ND
EZVI-SB-302-14	12	14	11/18/002	195	177	158	596	1	1,400	2	<100	ND	<100	ND
EZVI-SB-302-16	14	16	11/18/002	195	154	140	5,870	11	3,210	6	<100	ND	<100	ND
EZVI-SB-302-18	16	18	11/18/002	197	135	121	2,330	5	2,890	6	<100	ND	26J	0
EZVI-SB-302-18-DUP	16	18	11/18/002	196	154	135	3,180	6	3,110	6	<100	ND	18J	0
EZVI-SB-302-20	18	20	11/18/002	195	203	175	36,100	57	5,410	8	23J	0	358	1
EZVI-SB-302-22	20	22	11/18/002	196	no recovery		NA	NA	NA	NA	NA	NA	NA	NA
EZVI-SB-302-24	22	24	11/18/002	196	209	178	11,400	18	2,940	5	23J	0	129	0
EZVI-SB-302-26	24	26	11/18/002	197	155	134	3,680	7	974	2	<100	ND	<100	ND

Table C-4. Summary of CVOC Results in Soil from Post-Demonstration Monitoring in EZVI Plot (Continued)

Sample ID	Sample Depth (ft)		Sample Date	MeOH (g)	Wet Soil Weight (g)	Dry Soil Weight (g)	TCE		*cis* -1,2-DCE		*trans* -1,2-DCE		Vinyl Chloride	
	Top Depth	Bottom Depth					Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)
EZVI-SB-302-28	26	28	11/18/002	195	188	155	4,360	8	1,160	2	10J	0	54J	0
EZVI-SB-302-30	28	30	11/18/002	195	144	115	60,000	144	13,600	33	34J	0	10J	0
EZVI-SB-302-32	30	32	11/18/002	196	230	181	17,000	28	43,500	71	95J	0	<100	ND
EZVI-SB-302-34	32	34	11/18/002	193	no recovery		NA	NA	NA	NA	NA	NA	NA	NA
EZVI-SB-302-36	34	36	11/18/002	192	189	158	124	0	21,700	38	56J	0	<100	ND
EZVI-SB-302-38	36	38	11/18/002	194	166	146	211	0	9,780	18	40J	0	<100	ND
EZVI-SB-302-40	38	40	11/18/002	194	145	117	212	0	7,660	18	36J	0	<100	ND
EZVI-SB-302-42	40	42	11/18/002	193	175	127	196	0	2,310	5	25J	0	<100	ND
EZVI-SB-302-44	42	44	11/18/002	195	188	151	222	0	2,040	4	25J	0	<100	ND
EZVI-SB-302-46	44	46	11/18/002	192	250	202	3,300	5	5,970	9	29J	0	<100	ND
EZVI-SB-302-MB (SS)	Lab Blank		11/18/002	195	NA	NA	121	NA	19J	NA	<100	ND	<100	ND
EZVI-SB-302-RINSATE	EQ		11/18/003	NA	NA	NA	<1.0	ND	<1.0	ND	<1.0	ND	<1.0	ND
EZVI-SB-303-8 (SS)	6	8	11/20/2002	196	132	126	164	0	44J	0	<100	ND	<100	ND
EZVI-SB-303-10	8	10	11/20/2002	194	131	121	194	0	83J	0	<100	ND	<100	ND
EZVI-SB-303-12	10	12	11/20/2002	196	240	209	567	1	4,580	6	<100	ND	75J	0
EZVI-SB-303-14	12	14	11/20/2002	194	101	96	364	1	5,120	13	<100	ND	16J	0
EZVI-SB-303-16	14	16	11/20/2002	195	265	227	3,290	4	6,790	9	13J	0	197	0
EZVI-SB-303-18	16	18	11/20/2002	194	171	151	784	1	8,250	15	15J	0	54J	0
EZVI-SB-303-20	18	20	11/20/2002	193	165	141	237,000	451	9,880	19	37J	0	355	1
EZVI-SB-303-20-DUP	18	20	11/20/2002	195	156	132	195,000	400	11,900	24	29J	0	483	1
EZVI-SB-303-22	20	22	11/20/2002	193	173	156	4,110	7	8,160	14	19J	0	120	0
EZVI-SB-303-24	22	24	11/20/2002	194	241	209	3,390,000	4,502	36,600	49	193	0	1,020	1
EZVI-SB-303-26	24	26	11/20/2002	193	122	101	6,410	17	1,260	3	22J	0	25J	0
EZVI-SB-303-28	26	28	11/20/2002	193	166	133	21,400	45	3,070	6	36J	0	51J	0
EZVI-SB-303-30	28	30	11/20/2002	193	132	106	115,000	293	4,160	11	20J	0	14J	0
EZVI-SB-303-32	30	32	11/20/2002	193	161	122	95,100	221	17,200	40	57J	0	17J	0
EZVI-SB-303-34	32	34	11/20/2002	194	207	163	9,880	18	48,000	85	122	0	<100	ND
EZVI-SB-303-36	34	36	11/20/2002	194	144	127	<100	ND	21,900	45	69J	0	<100	ND
EZVI-SB-303-38	36	38	11/20/2002	194	no recovery		NA	NA	NA	NA	NA	NA	NA	NA
EZVI-SB-303-40	38	40	11/20/2002	195	199	163	<100	ND	5,170	9	38J	0	<100	ND
EZVI-SB-303-42	40	42	11/20/2002	193	138	115	168	0	590	1	<100	ND	<100	ND
EZVI-SB-303-44	42	44	11/20/2002	195	189	156	290	1	627	1	13J	0	<100	ND
EZVI-SB-303-46	44	46	11/20/2002	194	206	169	242	0	3,030	5	14J	0	<100	ND
EZVI-SB-303-MB (SS)	Lab Blank		11/20/2002	194	NA	NA	<100	ND	<100	ND	<100	ND	<100	ND

Table C-4. Summary of CVOC Results in Soil from Post-Demonstration Monitoring in EZVI Plot (Continued)

Sample ID	Sample Depth (ft)		Sample Date	MeOH (g)	Wet Soil Weight (g)	Dry Soil Weight (g)	TCE		*cis* -1,2-DCE		*trans* -1,2-DCE		Vinyl Chloride	
	Top Depth	Bottom Depth					Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)
EZVI-SB-303-RINSATE	EQ		11/20/2002	NA	NA	NA	<1.0	ND	<1.0	ND	<1.0	ND	<1.0	ND
EZVI-SB-304-8 (SS)	6	8	11/19/2002	194	151	147	105	0	25J	0	<100	ND	<100	ND
EZVI-SB-304-10	8	10	11/19/2002	194	102	98	102	0	39J	0	<100	ND	<100	ND
EZVI-SB-304-12	10	12	11/19/2002	195	102	91	120	0	1,830	5	<100	ND	<100	ND
EZVI-SB-304-14	12	14	11/19/2002	195	153	134	209	0	1,740	3	<100	ND	<100	ND
EZVI-SB-304-16	14	16	11/19/2002	194	170	152	<100	ND	1,960	3	<100	ND	15J	0
EZVI-SB-304-18	16	18	11/19/2002	195	143	130	<100	ND	2,260	5	<100	ND	45J	0
EZVI-SB-304-20	18	20	11/19/2002	196	147	130	965	2	3,190	7	<100	ND	308	1
EZVI-SB-304-22	20	22	11/19/2002	196	116	98	439	1	8,540	23	<100	ND	2,300	6
EZVI-SB-304-24	22	24	11/19/2002	196	199	168	152	0	723	1	<100	ND	1,350	2
EZVI-SB-304-26	24	26	11/19/2002	194	136	116	150	0	84J	0	<100	ND	280	1
EZVI-SB-304-28	26	28	11/19/2002	194	154	122	12,200	28	1,100	3	<100	ND	25J	0
EZVI-SB-304-30	28	30	11/19/2002	195	116	94	67,400	193	13,700	39	34J	0	13J	0
EZVI-SB-304-32	30	32	11/19/2002	195	133	103	27,700	74	29,800	80	67J	0	82J	0
EZVI-SB-304-32-DUP	30	32	11/19/2002	195	147	115	25,900	63	30,500	74	72J	0	68J	0
EZVI-SB-304-34	32	34	11/19/2002	193	186	136	139	0	33,100	72	75J	0	14J	0
EZVI-SB-304-36	34	36	11/19/2002	194	179	149	<100	ND	12,800	24	36J	0	22J	0
EZVI-SB-304-38	36	38	11/19/2002	195	141	119	<100	ND	2,030	5	15J	0	<100	ND
EZVI-SB-304-40	38	40	11/19/2002	195	145	134	221	0	1,340	3	10J	0	<100	ND
EZVI-SB-304-42	40	42	11/19/2002	194	155	120	256	1	970	2	10J	0	<100	ND
EZVI-SB-304-44	42	44	11/19/2002	195	153	122	<100	ND	81J	0	<100	ND	<100	ND
EZVI-SB-304-46	44	46	11/19/2002	194	174	148	1,850	3	4,920	9	15J	0	<100	ND
EZVI-SB-304-MB (SS)	Lab Blank		11/19/2002	192	NA	NA	<100	ND	10J	NA	<100	ND	<100	ND
EZVI-SB-304-RINSATE	EQ		11/19/2002	NA	NA	NA	<1.0	ND	<1.0	ND	<1.0	ND	<1.0	ND
EZVI-SB-307-8 (SS)	6	8	11/21/2002	195	108	109	151	0	31J	0	<100	ND	<100	ND
EZVI-SB-307-10	8	10	11/21/2002	194	no recovery		NA	NA	NA	NA	NA	NA	NA	NA
EZVI-SB-307-12	10	12	11/21/2002	193	166	145	979	2	4,270	8	<100	ND	<100	ND
EZVI-SB-307-14	12	14	11/21/2002	195	174	149	760	1	4,560	8	<100	ND	17J	0
EZVI-SB-307-16	14	16	11/21/2002	192	202	184	250	0	4,210	6	<100	ND	62J	0
EZVI-SB-307-18	16	18	11/21/2002	193	no recovery		NA	NA	NA	NA	NA	NA	NA	NA
EZVI-SB-307-20	18	20	11/21/2002	193	177	152	12,700	23	3,870	7	31J	0	1,650	3
EZVI-SB-307-22	20	22	11/21/2002	194	no recovery		NA	NA	NA	NA	NA	NA	NA	NA
EZVI-SB-307-24	22	24	11/21/2002	194	236	195	13,200	19	3,900	6	31J	0	1,660	2
EZVI-SB-307-26	24	26	11/21/2002	194	164	135	55,800	113	1,430	3	15J	0	<100	ND

Table C-4. Summary of CVOC Results in Soil from Post-Demonstration Monitoring in EZVI Plot (Continued)

Sample ID	Sample Depth (ft)		Sample Date	MeOH (g)	Wet Soil Weight (g)	Dry Soil Weight (g)	TCE		*cis* -1,2-DCE		*trans* -1,2-DCE		Vinyl Chloride	
	Top Depth	Bottom Depth					Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)
EZVI-SB-307-26-DUP	24	26	11/21/2002	194	166	135	72,500	149	1,350	3	12J	0	11J	0
EZVI-SB-307-28	26	28	11/21/2002	193	134	112	73,400	175	1,340	3	15J	0	11J	0
EZVI-SB-307-30	28	30	11/21/2002	193	no recovery		NA	NA	NA	NA	NA	NA	NA	NA
EZVI-SB-307-32	30	32	11/21/2002	194	221	171	136,000	235	21,100	36	54J	0	23J	0
EZVI-SB-307-34	32	34	11/21/2002	193	219	163	51,900	96	55,200	102	118	0	16J	0
EZVI-SB-307-36	34	36	11/21/2002	194	190	155	12,700	23	50,300	91	112	0	<100	ND
EZVI-SB-307-38	36	38	11/21/2002	193	174	144	242	0	7,200	14	19J	0	<100	ND
EZVI-SB-307-40	38	40	11/21/2002	194	187	150	172	0	3,970	7	25J	0	<100	ND
EZVI-SB-307-42	40	42	11/21/2002	193	155	112	165	0	328	1	<100	ND	<100	ND
EZVI-SB-307-44	42	44	11/21/2002	193	199	156	172	0	480	1	<100	ND	<100	ND
EZVI-SB-307-46	44	46	11/21/2002	193	128	100	8,790	24	4,570	12	<100	ND	<100	ND
EZVI-SB-307-MB (SS)	Lab Blank		11/21/2002	194	NA	NA	129	NA	11J	NA	<100	ND	<100	ND
EZVI-SB-307-RINSATE	EQ		11/21/2002	NA	NA	NA	<1.0	ND	0.26J	NA	<1.0	ND	<1.0	ND
EZVI-SB-308-8 (SS)	6	8	11/22/2002	194	92	92	<100	ND	13J	0	<100	ND	<100	ND
EZVI-SB-308-10	8	10	11/22/2002	193	136	125	186	0	47J	0	<100	ND	<100	ND
EZVI-SB-308-12	10	12	11/22/2002	194	205	178	605	1	1,990	3	<100	ND	<100	ND
EZVI-SB-308-14	12	14	11/22/2002	194	157	138	131	0	999	2	<100	ND	<100	ND
EZVI-SB-308-16	14	16	11/22/2002	194	no recovery		NA	NA	NA	NA	NA	NA	NA	NA
EZVI-SB-308-18	16	18	11/22/2002	193	197	173	159	0	1,200	2	<100	ND	144	0
EZVI-SB-308-20	18	20	11/22/2002	193	no recovery		NA	NA	NA	NA	NA	NA	NA	NA
EZVI-SB-308-22	20	22	11/22/2002	194	180	152	98,300	177	24,400	44	31J	0	1,400	3
EZVI-SB-308-24	22	24	11/22/2002	193	130	109	53,500	130	2,990	7	11J	0	169	0
EZVI-SB-308-26	24	26	11/22/2002	192	161	131	60,000	125	2,210	5	<100	ND	56J	0
EZVI-SB-308-28	26	28	11/22/2002	194	no recovery		NA	NA	NA	NA	NA	NA	NA	NA
EZVI-SB-308-30	28	30	11/22/2002	193	185	146	128,000	248	5,680	11	26J	0	17J	0
EZVI-SB-308-32	30	32	11/22/2002	194	no recovery		NA	NA	NA	NA	NA	NA	NA	NA
EZVI-SB-308-34	32	34	11/22/2002	194	140	111	17,800	44	27,100	67	62J	0	<100	ND
EZVI-SB-308-36	34	36	11/22/2002	195	192	162	134	0	12,000	21	30J	0	<100	ND
EZVI-SB-308-38	36	38	11/22/2002	193	167	136	<100	ND	5,060	10	16J	0	<100	ND
EZVI-SB-308-40	38	40	11/22/2002	193	194	150	<100	ND	5,430	10	31J	0	<100	ND
EZVI-SB-308-42	40	42	11/22/2002	194	140	110	<100	ND	5,320	13	30J	0	<100	ND
EZVI-SB-308-42-DUP	40	42	11/22/2002	192	152	118	<100	ND	5,210	12	30J	0	<100	ND
EZVI-SB-308-44	42	44	11/22/2002	194	148	123	<100	ND	692	2	<100	ND	<100	ND
EZVI-SB-308-46	44	46	11/22/2002	194	215	171	16,000	27	5200	9	17J	0	<100	ND

Table C-4. Summary of CVOC Results in Soil from Post-Demonstration Monitoring in EZVI Plot (Continued)

Sample ID	Sample Depth (ft)		Sample Date	MeOH (g)	Wet Soil Weight (g)	Dry Soil Weight (g)	TCE		*cis* -1,2-DCE		*trans* -1,2-DCE		Vinyl Chloride	
	Top Depth	Bottom Depth					Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)	Results in MeOH (µg/L)	Results in Dry Soil (mg/Kg)
EZVI-SB-308-MB (SS)	Lab Blank		11/22/2002	193	NA	NA	<100	ND	<100	ND	<100	ND	<100	ND
EZVI-SB-308-RINSATE	EQ		11/22/2002	NA	NA	NA	<1.0	ND	<1.0	ND	<1.0	ND	<1.0	ND

NA: Not available.
ND: Not detected.
DUP: Duplicate sample.
MB: Method blank.
SS: Surrogate spiked.
J: Result was estimated but below the reporting limit.

C-5. Long-Term Groundwater Sampling

In December 2003 and March 2004, groundwater samples were collected from various monitoring wells associated with the EZVI demonstration and analyzed for CVOCs. The purpose of these two individual sampling events was to collect observational data on the concentrations of CVOCs in groundwater after a significant amount of time had passed since the initial injection of EZVI. The results were not intended to use in assessing the performance of the technology. Because the results were not used for performance assessment, they are not included in the main text of the report but are presented here in Appendix C-5.

In November 2002, Battelle performed the post-demonstration soil and groundwater characterization for performance assessment of the EZVI technology. In December 2003, GeoSyntec collected a round of groundwater samples from the multilevel wells along the plot edges (EML-1 through EML-4, see Figure 3-3). The results are presented in Table C-5. In addition, the pre- and post-demonstration CVOC concentrations in the multilevel wells and other nearby wells have been reprinted from Table 5-4 for reference. TCE concentrations decreased substantially in all four monitoring wells, from 23,000-76,000 μg/L during post-demonstration monitoring to <100-2,700 μg/L one year later. Decreases in cis-1,2-DCE also were observed in all four monitoring wells. With respect to vinyl chloride, concentrations increased in two monitoring wells, from 29,000 μg/L to 33,500 μg/L in EML-1 and from 500 μg/L to 1,830 μg/L in EML-3. Vinyl chloride concentrations decreased substantially in EML-2, from 20,000 μg/L to 4,950 μg/L, while concentrations remained relatively stable in EML-4 one year later. The continued decreases in TCE and *cis*-1,2-DCE concentrations one year after post-demonstration groundwater characterization suggests that the EZVI technology had a prolonged impact on the treatment area. The continued increase in VC concentrations indicates that biologically driven reductive dechlorination of the CVOCs is continuing.

In March 2004, approximately 16 months after the post-demonstration characterization, a single groundwater sampling event was conducted in several of the shallow monitoring wells in and around the test plot. The results are presented in Table C-6. In addition, the pre- and post-demonstration CVOC concentrations in the wells have been reprinted from Table 5-8 for reference. The CVOC concentrations in monitoring well PA-23 are plotted in Figure C-1. Figure C-2 contains TCE and ethene concentrations to reflect the significant difference in concentration scales between the two compounds. Although the data were collected for observational purposes, the results suggest that the EZVI treatment had a long-lasting effect on CVOCs in the subsurface. In PA-23, TCE concentrations decreased from 8,790 μg/L during post-demonstration sampling to 2 μg/L. Concentrations of the degradation byproducts *cis*-1,2 DCE, *trans*-1,2-DCE, and vinyl chloride also decreased substantially in monitoring PA-23 in the center of the test plot after post-demonstration characterization. Decreases in TCE were also seen in shallow monitoring wells PA-24S and PA-25S around the perimeter of the test plot, as well as in the injection and extraction wells EIW-1 and EEW-1. Increased concentrations of degradation daughter products *cis*-1,2-DCE, *trans*-1,2-DCE, and vinyl chloride were observed in PA-24S and PA-25S. Ethene concentrations increased substantially in PA-23 after the post-demonstration characterization event. This could suggest that the remaining EZVI in the treatment area still promotes dechlorination of TCE in and around the test area.

These groundwater samples were collected when the recirculation system in the test plot had been turned off for over one year, and natural groundwater flow patterns were likely reestablished. The results of this sampling event suggest that the CVOCs in the test plot continued to degrade by biotic and abiotic means for more than a year after injection of EZVI.

Table C-5. CVOC Groundwater Concentrations in the Multilevel Wells One Year after Post-Demonstration Characterization

	TCE (µg/L)			*cis*-1,2-DCE (µg/L)			Vinyl Chloride (µg/L)		
Well ID	Pre-Demo	Post-Demo	Long-Term	Pre-Demo	Post-Demo	Long-Term	Pre-Demo	Post-Demo	Long-Term
PA-23	1,180,000	8,790	NA	16,900	169,000	NA	<1,000	21,600	NA
EEW-1	1,050,000	471,000	NA	67,100	80,100	NA	<1,000	6,980	NA
EML-1	450,000	76,000	2,700	11,000	96,000	77,900	<500	29,000	33,500
EML-2	350,000	23,000	1,000	21,000	130,000	5,320	<500	20,000	4,950
EML-3	1,300	74,000	740	<100	41,000	2,630	<100	500	1,830
EML-4	1,600	24,000	<100	130	42,000	1,150	<20	1,500	1,460
PA-24S	772,000	12,100	NA	47,400	31,700	NA	<1,000	1,580	NA
PA-25S	71,300	129,000	NA	69,200	42,800	NA	<1,000	75J	NA

NA = not analyzed
Pre-demonstration: March 2002; Post-demonstration: November 2002; Long-Term: December 2003.

Table C-6. CVOC and Ethene Concentrations in Groundwater in Shallow Wells, March 2004

Well ID	Pre-Demo	During	Post-Demo	Long-Term	Pre-Demo	During	Post-Demo	Long-Term
	TCE (µg/L)				*cis*-1,2-DCE (µg/L)			
EZVI Plot Well								
PA-23	1,180,000	92,100	8,790	2 J	16,900	17,900	169,000	870
EZVI Perimeter Wells								
PA-24S	772,000	474,000	12,100	501	47,400	15,800	31,700	63,100
PA-25S	71,300	69,600	129,000	<5	69,200	9,320	42,800	<5
Injection and Extraction Wells								
EIW-1	144,000	NA	7,820	108	38,300	NA	3,280	8,650
EEW-1	1,050,000	NA	471,000	4.5	67,100	NA	80,100	10.6
	trans-1,2-DCE (µg/L)				Vinyl Chloride (µg/L)			
EZVI Plot Well								
PA-23	<1,000	68 J	245	71	<1,000	53 J	21,600	3,620
EZVI Perimeter Wells								
PA-24S	<1,000	<50	190 J	1,140	<1,000	<50	1,580	54,600
PA-25S	<1,000	46 J	381	83.8	<1,000	<100	75 J	8.75
Injection and Extraction Wells								
EIW-1	556	NA	24 J	148	638	NA	322	4,890
EEW-1	550 J	NA	390 J	10.5	<1,000	NA	6,980	34.9
	Ethene (µg/L)							
EZVI Plot Well								
PA-23	79.3	10	1,680	9,280				

Well IDs: S = shallow well (Upper Sand Unit)
EIW-1 = injection well; EEW-1 = extraction well.
Pre-demonstration = March 2002; during the demonstration = August 2002; post-demonstration = November 2002; Long-term = March 2004
J = Estimated value, below reporting limit.

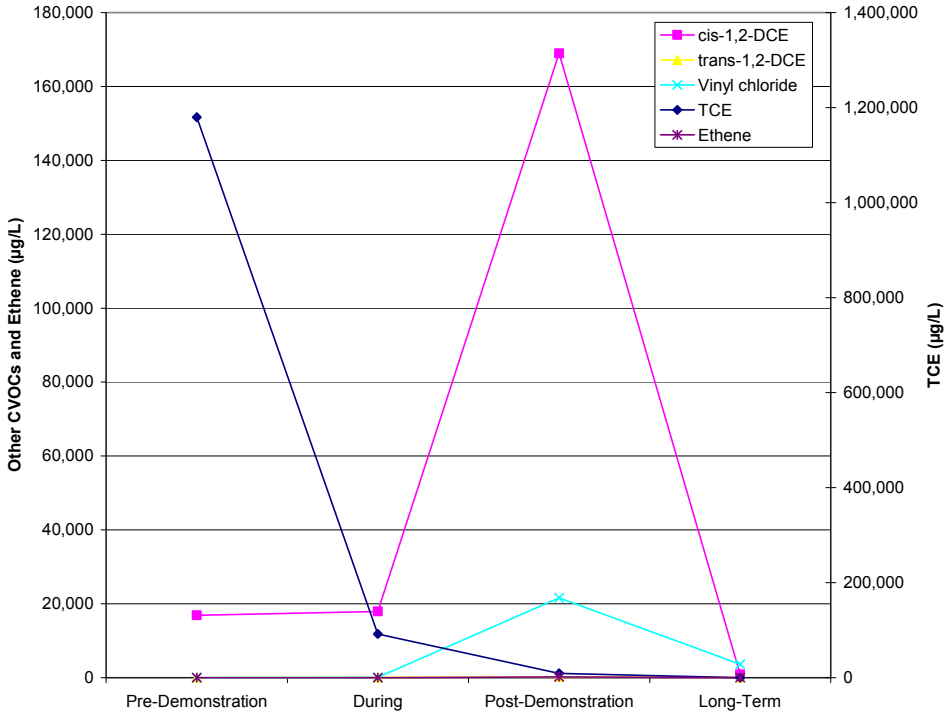

Figure C-1. CVOC Concentrations and Ethene in PA-23 After EZVI Treatment

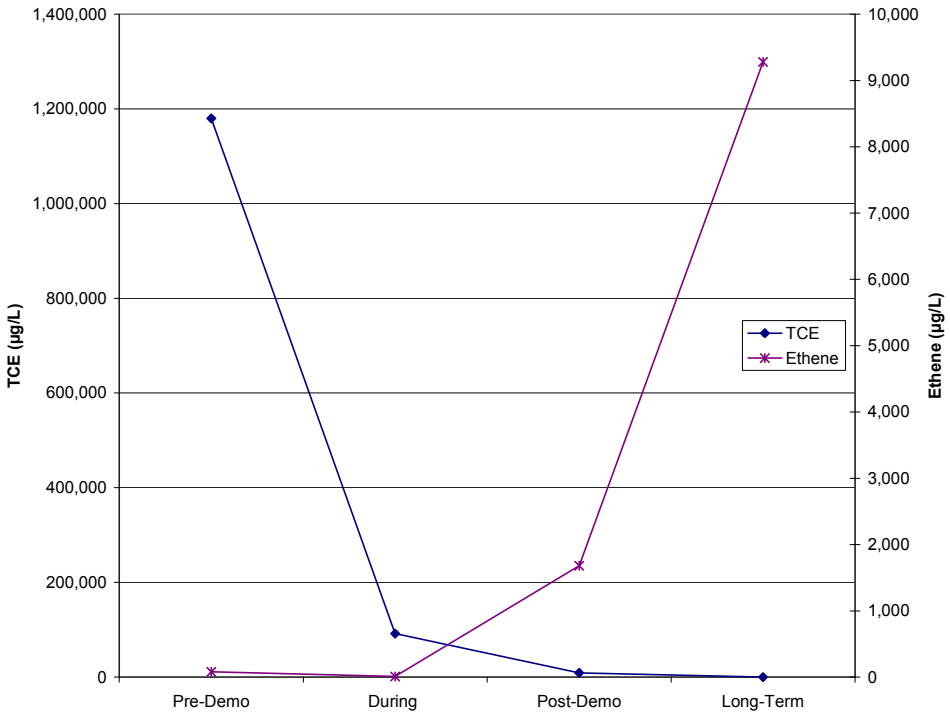

Figure C-2. TCE and Ethene Concentrations in Groundwater in PA-23 after EZVI Treatment

Appendix D

Inorganic and Other Aquifer Parameters

Table D-1. Groundwater Field Parameters

Well ID	Temperature (°C)			DO (mg/L)			pH			ORP (mV)			Conductivity (mS/cm)		
	Pre-Demo	Aug 2002	Post-Demo	Pre-Demo	Aug 2002	Post-Demo	Pre-Demo	Aug 2002	Post-Demo	Pre-Demo	Aug 2002	Post-Demo	Pre-Demo	Aug 2002	Post-Demo
EZVI Plot Well															
PA-23	26.2	29.62	27.88	0.39	0.1	0.00	6.49	7.23	6.41	31	-143	-17	0.18	1.81	0.24
EZVI Perimeter Wells															
PA-24S	25.9	29.4	27.72	1.03	0.1	0.00	6.40	7.07	6.6	42	-97	32	0.15	1.82	0.2
PA-24I	25.6	28	27.02	0.59	0.1	0.00	6.81	7.5	7.16	33	-128	55	0.22	2.73	0.28
PA-24D	25.4	27.99	26.54	0.94	0.3	0.00	6.78	7.16	6.93	15	-107	40	0.16	2.42	0.28
PA-25S	26.2	29.75	29.42	0.98	0.2	0.00	6.58	7.22	7.1	148	-125	11	0.22	1.78	0.12
PA-25I	25.7	28.93	27.53	0.90	0.2	0.00	6.83	7.56	7.12	83	-121	11	0.21	1.99	0.19
PA-25D	25.4	28.11	26.9	0.97	0.3	0.00	6.77	7.49	6.97	71	-195	3	0.33	3.1	0.3
Injection and Extraction Wells															
EIW-1	29.1	NA	26.98	0.83	NA	0.00	6.62	NA	6.6	15	NA	17	0.16	NA	0.19
EEW-1	25.4	NA	28.09	0.31	NA	0.00	6.47	NA	6.48	55	NA	106	0.16	NA	0.19

Pre-Demo: March 2002

Post-Demo: EZVI-November 2002.

Table D-2. Inorganic Results of Groundwater from the EZVI Demonstration

Well ID	Dissolved Iron (mg/L)			Total Iron (mg/L)			Manganese (mg/L)			Calcium (mg/L)			Magnesium (mg/L)			Potassium (mg/L)			Sodium (mg/L)		
	Pre-Demo	Demo 1	Post-Demo	Pre-Demo	Demo 1	Post-Demo	Pre-Demo	Demo 1	Post-Demo	Pre-Demo	Demo 1	Post-Demo	Pre-Demo	Demo 1	Post-Demo	Pre-Demo	Demo 1	Post-Demo	Pre-Demo	Demo 1	Post-Demo
EZVI Plot Well																					
PA-23	15.7	3.65	3.03	14.8	4.07	2.73	0.12	0.0498	0.121	159	111	224	19.9	34.7	51	231	122	147	36.8	72.4	67.2
PA-23-DUP	15.4	3.56	2.99	13	4.11	2.52	0.119	0.0492	0.12	157	122	240	19.2	40.9	57.7	232	133	161	34.4	80.4	66.5
EZVI Perimeter Wells																					
PA-24S	27.4	2.58	16.2	21.8	2.8	17.3	0.2	0.067	0.0701	184	160	154	26.6	40.7	41.9	116	98.9	87.1	38	64.2	65.8
PA-24I	5.54	0.751	2.56	6.05	0.811	2.62	0.148	0.0473	0.0568	935	68.3	59.1	65.3	78.2	59.4	55.6	36.2	28.6	280	323	312
PA-24D	2.36	1.74	3.12	3.07	2.04	4.2	0.0893	0.0567	0.035	104	105	87.4	53.2	61.8	59.4	50.1	53.9	46	174	218	257
PA-25S	12	2.27	2.97	13.2	2.51	3.23	0.0985	0.0318	0.0188	138	138	72	21.3	38	16.8	299	75.6	68	39.7	81.4	62.3
PA-25I	2.68	0.255	1.82	1.54	0.448	1.84	0.0461	0.0163	0.026	66.5	51.1	49.3	65.2	83	66.2	51.9	30.3	27.2	232	213	195
PA-25D	1.12	0.784	0.906	1.21	1.08	1.02	0.0391	0.0182	0.024	59.9	59.2	59.2	72.3	74.5	66.4	17.2	20.9	19.7	443	405	374
Injection and Extraction Wells																					
EIW-1	7.23	NA	6.16	7.33	NA	5.54	0.21	NA	0.653	156	NA	201	15	NA	32.7	161	NA	134	99.1	NA	65.6
EEW-1	13.4	NA	6.45	12.9	NA	6.76	0.154	NA	0.208	178	NA	160	15.9	NA	30.5	195	NA	170	37.1	NA	73.4

Well ID	Chloride (mg/L)			Phosphate (mg/L)			Bromide (mg/L)			Sulfate (mg/L)			Nitrate (NO_3-NO_2 as N)			Alkalinity (mg/L)		
	Pre-Demo	Demo 1	Post-Demo	Pre-Demo	Demo 1	Post-Demo	Pre-Demo	Demo 1	Post-Demo	Pre-Demo	Demo 1	Post-Demo	Pre-Demo	Demo 1	Post-Demo	Pre-Demo	Demo 1	Post-Demo
EZVI Plot Well																		
PA-23	200	175	294	<0.5	<3.0	<0.5	<1.0	<2.0	2.65	103.0	147	12.7	NA	<0.5	<0.5	475	384	669
PA-23-DUP	200	175	209	<0.5	<3.0	<0.5	<1.0	<2.0	2.6	103.0	147	12.9	NA	<0.5	<0.5	470	391	616
EZVI Perimeter Wells																		
PA-24S	191	183	201	<3.0	<3.0	<0.5	<2.0	<2.0	0.41 J	90.7	139	118	NA	<0.5	<0.5	392	416	461
PA-24I	463	521	581	<6.0	<3.0	<0.5	<4.0	<2.0	1.06	100.0	105	77.5	NA	<0.5	<0.5	342	364	341
PA-24D	353	487	572	<3.0	<3.0	<0.5	<2.0	<2.0	5.47	89.6	132	73.9	NA	<0.5	<0.5	320	326	316
PA-25S	244	170	128	<3.0	<3.0	<0.5	<2.0	6.2	2.61	132.0	237	112	NA	<0.5	<0.5	537	367	208
PA-25I	359	313	277	<3.0	<3.0	<0.5	<2.0	<2.0	0.36 J	136.0	112	112	NA	<0.5	<0.5	363	405	391
PA-25D	848	760	722	<3.0	<3.0	<0.5	22.9	<2.0	1.44	58.0	64.4	61.6	NA	<0.5	<0.5	222	249	267
Injection and Extraction Wells																		
EIW-1	199	NA	196	<3.0	NA	<0.5	<2.0	NA	2.66	164.0	NA	1.4 J	NA	NA	<0.5	320	NA	623
EEW-1	177	NA	195	<0.5	NA	<0.5	<1.0	NA	3.84	107.0	NA	113	NA	NA	0.842	453	NA	479

NA: Not analyzed.
S: Spike recovery outside control limits.
Pre-Demo: March 2002.
Post-Demo: EZVI-November 2002.

Table D-3. Other Parameter Results of Groundwater from the EZVI Demonstration

Well ID	TDS (mg/L)			TOC (mg/L)		BOD (mg/L)		Dissolved Silica (mg/L)		
	Pre-Demo	August 2002	Post-Demo	Pre-Demo	Post-Demo	Pre-Demo	Post-Demo	Pre-Demo	August 2002	Post-Demo
EZVI Plot Well										
PA-23	1,090	969	1,470	150	77	3.0	30	32.1	40.6	85.7
PA-23-DUP	1,080	972	1,160	154	85	3.0	148	32.1	33.5	92.2
EZVI Perimeter Wells										
PA-24S	947	1,020	1,070	108	45	<6.0	39	32.1	46.6	65.4
PA-24I	1,290	1,390	1,460	54	19	6.0	<3.0	38.4	54.2	65.8
PA-24D	1,100	1,400	1,450	66	21	6.0	4	37.8	NA	61.2
PA-25S	1,230	1,120	663	114	21	7.0	5	31.7	NA	44.1
PA-25I	1,120	1,100	1,040	87	28	10.0	5	54.6	NA	87.1
PA-25D	1,670	1,680	1,600	18	19	<6.0	<3.0	53.5	NA	76.4
Injection and Extraction Wells										
EIW-1	993	NA	1,180	55	66	<3.0	141	20.1	NA	88.0
EEW-1	989	NA	1,200	144	76	<3.0	136	24.3	NA	49.4

Pre-Demo: March 2002.
Post-Demo: EZVI-November 2002.

Table D-4. Results of Chloride Using Waterloo Profiler®

Sample ID	Chloride mg/L	Sample ID	Chloride mg/L
EZVI Plot			
EZVI-WP1-15	64.8	EZVI-WP201-15	175
EZVI-WP1-20	170	EZVI-WP201-24	227
EZVI-WP1-30	349	EZVI-WP201-30	388
EZVI-WP1-38	783	EZVI-WP201-38	993
EZVI-WP1-40	743	EZVI-WP201-40	990
EZVI-WP2-15	88.8	EZVI-WP202-15	157
EZVI-WP2-20	188	EZVI-WP202-24	188
EZVI-WP2-30	347	EZVI-WP202-30	672
EZVI-WP2-36	763	EZVI-WP202-38	902
EZVI-WP2-38	798	EZVI-WP202-40	927

Table D-5. Results of Dissolved Gases in Groundwater from the EZVI Demonstration

Well ID	Ethane (mg/L)			Ethylene (mg/L)			Methane (mg/L)		
	Pre-Demo	August 2002	Post-Demo	Pre-Demo	August 2002	Post-Demo	Pre-Demo	August 2002	Post-Demo
EZVI Plot Well									
PA-23	0.00205	0.0022	0.0231	0.0757	0.010	1.68	0.0125	0.0432	0.547
PA-23-DUP	0.00328	0.0021	0.0214	0.0793	0.01	1.56	0.0141	0.0399	0.502
EZVI Perimeter Wells									
PA-24S	0.0376	NA	0.0047	0.274	NA	0.105	0.0218	NA	0.140
PA-24I	0.0203	NA	0.0065	0.278	NA	0.031	0.0174	NA	0.047
PA-24D	0.0388	NA	0.0089	0.475	NA	0.069	0.0127	NA	0.034
PA-25S	0.00613 R	NA	<0.002	0.207	NA	0.007	0.00734	NA	0.012
PA-25I	0.00829	NA	0.0035	0.305	NA	0.062	0.0204	NA	0.061
PA-25D	0.00909	NA	0.0048	0.051	NA	0.018	0.00524	NA	0.016
Injection and Extraction Wells									
EIW-1	<0.002	NA	<0.002	0.0234	NA	0.137	0.0145	NA	0.611
EEW-1	0.0035	NA	0.0551	0.0512	NA	0.978	0.0162	NA	0.978

R: RPD outside accepted recovery limits.
Pre-Demo: March 2002.
Post-Demo: EZVI-November 2002.

Table D-6. Results of TOC in Soil Samples Prior to the EZVI Demonstration

Sample ID	TOC Results (wt%-dry)
EZVI-SB4-12	0.10
EZVI-SB4-14	0.06
EZVI-SB4-32	0.14
EZVI-SB4-34	0.15
EZVI-SB4-40	0.32
EZVI-SB4-42	0.26

Table D-7. Mass Flux Measurements of Groundwater from the EZVI Demonstration
Provided by GeoSyntec Consultants

Extraction Transect	TCE (µmoles/L)			cis-1,2-DCE (µmoles/L)			VC (µmoles/L)			Ethene (µmoles/L)			Total Ethenes (µmoles/L)		
Depth (ft bgs)	**Pre**	**Post**	**▲**	**Pre**	**Post**	**▲**	**Pre**	**Post**	**▲**	**Pre**	**Post**	**▲**	**Pre**	**Post**	**▲**
16	49	2	**-47**	23	7	**-15**	0	320	**320**	0	128	**128**	72	458	**385**
18.5	2967	1223	**-1744**	61	1288	**1227**	0	451	**451**	0	318	**318**	3028	3280	**252**
21	6086	1278	**-4808**	330	1669	**1339**	0	622	**622**	0	402	**402**	6415	3971	**-2444**
23.5	10498	3880	**-6618**	330	1772	**1442**	0	413	**413**	0	134	**134**	10827	6198	**-4629**
26	9357	6466	**-2891**	564	2215	**1650**	0	462	**462**	0	109	**109**	9921	9252	**-669**
Sum of All Depths	28956	12849	**-16107**	1307	6950	**5643**	0	2268	**2268**	0	1091	**1091**	30263	23159	**-7105**
Injection Transect															
Depth (ft bgs)	**Pre**	**Post**	**▲**	**Pre**	**Post**	**▲**	**Pre**	**Post**	**▲**	**Pre**	**Post**	**▲**	**Pre**	**Post**	**▲**
16	18	68	**50**	4	447	**443**	0	179	**179**	0	561	**561**	22	1255	**1233**
18.5	14	18	**4**	4	19	**15**	0	2	**2**	0	90	**90**	18	129	**111**
21	22	33	**11**	1	33	**32**	0	8	**8**	0	138	**138**	23	212	**188**
23.5	47	26	**-21**	3	27	**23**	0	7	**7**	0	152	**152**	50	212	**162**
26	124	31	**-93**	17	26	**9**	0	6	**6**	0	148	**148**	141	210	**69**
Sum of All Depths	225	175	**-49**	30	551	**521**	0	202	**202**	0	1089	**1089**	255	2018	**1763**
PA-23															
	Pre	**Post**	**▲**	**Pre**	**Post**	**▲**	**Pre**	**Post**	**▲**	**Pre**	**Post**	**▲**	**Pre**	**Post**	**▲**
	723	1	**-722**	42	12	**-30**	0	45	**45**	0	145	**145**	765	202	**-563**

Table D-7. Mass Flux Measurements of Groundwater from the EZVI Demonstration (Continued)
Provided by GeoSyntec Consultants

Sample Location	TCE (µmoles/L)			cis-1,2-DCE (µmoles/L)			VC (µmoles/L)			Ethene (µmoles/L)			Total Ethenes (µmoles/L)		
	Pre	Post	Change	Pre	Post	Change	Pre	Post	Change	Pre	Post	Change	Pre	Post	Change
E-ML1-1	20	0	**-20**	0	0	**0**	0	1	**1**	0	5	**5**	20	6	**-14**
E-ML1-2	2815	1217	**-1597**	49	834	**785**	0	319	**319**	0	169	**169**	2864	2540	**-324**
E-ML1-3	3423	700	**-2723**	113	783	**670**	0	319	**319**	0	236	**236**	3536	2038	**-1498**
E-ML1-4	5173	1597	**-3575**	134	948	**814**	0	319	**319**	0	92	**92**	5307	2956	**-2351**
E-ML1-5	4564	989	**-3575**	101	1957	**1856**	0	462	**462**	0	109	**109**	4665	3518	**-1147**
E-ML2-1	30	2	**-27**	23	7	**-16**	0	319	**319**	0	124	**124**	52	452	**399**
E-ML2-2	152	6	**-146**	11	453	**442**	0	132	**132**	0	148	**148**	163	740	**576**
E-ML2-3	2662	578	**-2084**	216	886	**670**	0	303	**303**	0	166	**166**	2879	1933	**-946**
E-ML2-4	5325	2282	**-3043**	196	824	**628**	0	94	**94**	0	42	**42**	5521	3243	**-2278**
E-ML2-5	4792	5477	**685**	464	258	**-206**	0	0	**0**	0	0	**0**	5256	5735	**479**
E-ML3-1	13	67	**54**	3	443	**440**	0	175	**175**	0	494	**494**	16	1179	**1163**
E-ML3-2	9	17	**8**	3	16	**13**	0	0	**0**	0	74	**74**	12	107	**95**
E-ML3-3	10	28	**18**	0	20	**20**	0	3	**3**	0	78	**78**	10	128	**118**
E-ML3-4	21	21	**0**	2	11	**10**	0	3	**3**	0	74	**74**	22	109	**87**
E-ML3-5	33	26	**-7**	6	16	**11**	0	3	**3**	0	81	**81**	38	127	**88**
E-ML4-1	5	1	**-4**	1	4	**3**	0	4	**4**	0	67	**67**	7	76	**70**
E-ML4-2	4	1	**-3**	1	3	**2**	0	2	**2**	0	16	**16**	5	22	**16**
E-ML4-3	12	4	**-8**	1	13	**12**	0	6	**6**	0	60	**60**	14	84	**70**
E-ML4-4	27	6	**-21**	2	15	**14**	0	4	**4**	0	78	**78**	28	103	**75**
E-ML4-5	91	5	**-86**	11	9	**-2**	0	3	**3**	0	67	**67**	103	84	**-19**
PA-23	723	1	**-722**	42	12	**-30**	0	45	**45**	0	145	**145**	765	202	**-563**

Table D-8. Genetrac Analysis of Groundwater Samples from the EZVI Demonstration Provided by GeoSyntec Consultants

Well ID	Sample ID	Sample Date	Non-*Dehalococcides* Bacterial DNA	**Dehalococcides* Test, Intensity (% of Positive Control)	**Intensity Score	Test Results: *Dehalococcoides* DNA
E-ML3-2	E-ML3-2-DB	10-Jul-02	Detected	80%	+++	Detected (3 of 3 primer sets)
	E-ML3-2-RS	6-Jan-03	Not Determined	0%	-	Not Detected
PA-23	PA-23-DB	10-Jul-02	Detected	105%	++++	Detected (3 of 3 primer sets)
	PA-23-RS	6-Jan-03	Detected	151%	++++	Detected (3 of 3 primer sets)

Notes:

The above results refer only to that portion of the sample tested with the Gene-Trac™ assay. The test is based on a polymerase chain reaction (PCR) test with 3 primer sets specific to DNA sequences in the 16S rRNA gene of *Dehalococcoides* organisms. A positive (+ to ++++) result indicates that genetic material (DNA) from a member of the *Dehalococcoides* group was detected. *Dehalococcoides* organisms are the only microorganisms proven to possess the necessary enzymes for the complete dechlorination of PCE or TCE to ethene. The presence of *Dehalococcoides* genetic material has been positively correlated to complete dechlorination of chlorinated ethenes at contaminated sites.

*"Dehalococcoides Test Intensity" = quantitative assessment of electrophoresis band intensity of PCR product as a percentage of the corresponding positive control reaction. This value provides a semi-quantitative assessment of the amount of *Dehalococcoides* genetic material present in the sample. While band intensity might reflect actual concentration of the target organism, Gene-Trac™ is a semi-quantitative method and is only recommended to determine the presence or absence of *Dehalococcoides* genetic material in the sample.

**"Intensity Score", categorizes PCR product quantity based on the "intensity (% of positive control)":

++++ = Very high band intensity (greater than 100% of positive control), +++ = high band intensity (67-100%),

++ moderate band intensity (34-66%) + = low band intensity (10-33%), -/+ = inconclusive (1-9%), - = no detectable band (0%)

Appendix E

Quality Assurance/Quality Control Information

Table E-1. Results of the Extraction Procedure Performed on PA-4 Soil Samples

Extraction Procedure Conditions	Combined
Total Weight of Wet Soil (g) = 2,124.2	1,587.8 g dry soil from PA-4 boring
Concentration (mg TCE/g soil) = 3.3	529.3 g deionized water
Moisture Content of Soil (%) = 24.9	5 mL TCE

Laboratory Extraction Sample ID	TCE Concentration in MeOH (mg/L)	TCE Mass in MeOH (mg)	TCE Concentration in Spiked Soil (mg/kg)	Theoretical TCE Mass Expected in MeOH (mg)	Percentage Recovery of Spiked TCE (%)
1st Extraction procedure on same set of samples					
SEP-1-1	1800.0	547.1	3252.5	744.11	73.53
SEP-1-2	1650.0	501.8	3164.9	701.26	71.55
SEP-1-3	1950.0	592.2	3782.3	692.62	85.51
SEP-1-4	1840.0	558.1	3340.2	739.13	75.51
SEP-1-5	1860.0	564.0	3533.9	705.91	79.89
SEP-1-6 (Control)	78.3	19.4	-	25.00	77.65
				Average % Recovery =	77.20
2nd Extraction procedure on same set of samples					
SEP-2-1	568.0	172.7	861.1	887.28	19.47
SEP-2-2	315.0	95.5	500.5	843.77	11.31
SEP-2-3	170.0	51.3	268.2	846.42	6.06
SEP-2-4	329.0	99.8	498.4	885.29	11.27
SEP-2-5	312.0	94.8	476.3	880.31	10.77
SEP-2-6 (Control)	82.6	20.4	-	25.00	81.79
				Average % Recovery =	11.78
3rd Extraction procedure on same set of samples					
SEP-3-1	55.8	17.0	84.6	885.96	1.91
SEP-3-2	59.0	17.9	94.2	841.77	2.13
SEP-3-3	56.8	17.2	90.1	846.42	2.04
SEP-3-4	63.0	19.1	95.2	888.61	2.15
SEP-3-5	52.2	15.8	80.0	875.99	1.81
SEP-3-6 (Control)	84.3	20.9	-	25.00	83.55
				Average % Recovery =	2.01

Table E-2. 1,1,1-TCA Surrogate Spike Recovery Values for Soil Samples Collected During the EZVI Demonstration Characterization

EZVI Treatment Plot 1,1,1 TCA-Spiked Soil Samples QA/QC Target Level RPD < 30.0 %					**Total Number of Soil Samples Collected = 328 [Pre-(157); Post-(171)] Total Number of Spiked Samples Analyzed = 8 (Pre-) 6 (Post-)**				
Sample ID	**Sample Date**	**1,1,1-TCA Result (ug/L)**	**RPD (%)**	**Met QA/QC Criteria?**	**Sample ID**	**Sample Date**	**1,1,1-TCA Result (ug/L)**	**RPD (%)**	**Met QA/QC Criteria?**
Pre-Demonstration					***Post-Demonstration***				
EZVI-SB1-10(SS)	01/16/02	5,270	23.89	Yes	EZVI-SB302-8(SS)	11/18/02	6,560	14.55	Yes
EZVI-SB1-MB(SS)		6,700			EZVI-SB302- MB(SS)		5,670		
EZVI-SB2-8(SS)	01/16/02	5,840	19.14	Yes	EZVI-SB304-8(SS)	11/19/02	4,230	27.52	Yes
EZVI-SB2- MB(SS)		4,820			EZVI-SB304- MB(SS)		5,580		
EZVI-SB3-8(SS)	01/17/02	6,100	2.43	Yes	EZVI-SB303-8(SS)	11/20/02	5,790	32.05	No
EZVI-SB3- MB(SS)		6,250			EZVI-SB303- MB(SS)		8,000		
EZVI-SB4-8(SS)	01/18/02	5,190	19.48	Yes	EZVI-SB301-8(SS)	11/21/02	5,140	4.17	Yes
EZVI-SB4- MB(SS)		6,310			EZVI-SB301- MB(SS)		4,930		
EZVI-SB5-8(SS)	01/31/02	4,750	8.66	No	EZVI-SB307-8(SS)	11/21/02	5,300	14.52	Yes
EZVI-SB5- MB(SS)		5,180			EZVI-SB307- MB(SS)		6,130		
EZVI-SB6-8 (SS)	02/01/02	6,190	0.96	Yes	EZVI-SB308-8(SS)	11/22/02	5,200	5.06	Yes
EZVI-SB6- MB(SS)		6,250			EZVI-SB308- MB(SS)		5,470		
EZVI-SB7-8 (SS)	02/07/02	5,070	8.86	Yes					
EZVI-SB7- MB(SS)		4,640							
EZVI-SB8-8 (SS)	03/20/02	6,230	9.41	Yes					
EZVI-SB8-MeOH(SS)[(a)]		5,670							

(a) Sample was labeled with –MeOH rather than the traditional –MB.

Table E-3. Results and Precision of the Field Duplicate Samples Collected During the Pre- and Post-Demonstration Soil Sampling

EZVI Treatment Plot Field Duplicate Soil Samples QA/QC Target Level RPD < 30.0 %					**Total Number of Soil Samples Collected = 328 [Pre-(157); Post-(171)] Total Number of Field Duplicate Samples Analyzed = 8 (Pre-) 11 (Post-)**				
Sample ID	**Sample Date**	**TCE Result (mg/kg)**	**RPD (%)**	**Met QA/QC Criteria?**	**Sample ID**	**Sample Date**	**TCE Result (mg/kg)**	**RPD (%)**	**Met QA/QC Criteria?**
Pre-Demonstration					***Post-Demonstration***				
EZVI-SB1-8	01/16/02	Trace	0.0	Yes	EZVI-SB208-8	10/08/02	269	27.48	Yes
EZVI-SB1-8 DUP		Trace			EZVI-SB208-8 DUP		204		
EZVI-SB2-24	01/16/02	207	23.45	Yes	EZVI-SB207-24	10/08/02	856	104[(b)]	No
EZVI-SB2-24 DUP		262			EZVI-SB207-24 DUP		268		
EZVI-SB3-40	01/17/02	1	0.0	Yes	EZVI-SB209-22	10/08/02	1.0	0.0	Yes
EZVI-SB3-40 DUP		1			EZVI-SB209-22 DUP		Trace		
EZVI-SB4-40	01/18/02	1	0.0	Yes	EZVI-SB203-18	10/09/02	1.1	9.52	Yes
EZVI-SB4-40 DUP		1			EZVI-SB203-18 DUP		1.0		
EZVI-SB5-38	01/31/02	11	167[(a)]	No	EZVI-SB204-24	10/09/02	35	91.67[(a)]	No
EZVI-SB5-38 DUP		1			EZVI-SB204-24 DUP		13		
EZVI-SB6-32	02/01/02	259	2.34	Yes	EZVI-SB302-18	11/18/02	5.2	15.93	Yes
EZVI-SB6-32 DUP		233			EZVI-SB302-18 DUP		6.1		
EZVI-SB7-44	02/07/02	Trace	0.0	Yes	EZVI-SB304-32	11/19/02	74	16.06	Yes
EZVI-SB7-44 DUP		Trace			EZVI-SB304-32 DUP		63		
EZVI-SB8-34	03/20/02	Trace	0.0	Yes	EZVI-SB303-20	11/20/02	451	11.98	Yes
EZVI-SB8-34 DUP		1			EZVI-SB303-20 DUP		400		
					EZVI-SB301-36	11/21/02	Trace	200[(a)]	No
					EZVI-SB301-36 DUP		2.0		
					EZVI-SB307-26	11/21/02	113	27.48	Yes
					EZVI-SB307-26 DUP		149		
					EZVI-SB308-42	11/22/02	Trace	0.0	Yes
					EZVI-SB308-42 DUP		Trace		

(a) High RPD value due to the effect of low (or below detect) concentrations of TCE, which drastically affected the RPD calculation.
(b) High RPD value may be due to high levels of DNAPL distributed heterogeneously through the soil core sample.

Table E-4. Results of the Rinsate Blank Samples Collected During the Pre- and Post-Demonstration Soil Sampling

EZVI Rinsate Blank Soil Extraction QA/QC Samples **QA/QC Target Level TCE < 1.0 ug/L**				**Total Number of Soil Samples Collected = 328 [Pre-(157); Post-(171)]** **Total Number of Field Samples Analyzed = 15**			
Sample ID	**Sample Date**	**TCE Result (ug/L)**	**Met QA/QC Criteria?**	**Sample ID**	**Sample Date**	**TCE Result (ug/L)**	**Met QA/QC Criteria?**
Pre-Demonstration Rinsate Blank Samples				***Post-Demonstration Rinsate Blank Samples***			
EZVI-SB1-RINSATE	01/16/02	<1.0	Yes	EZVI-SB207-RINSATE	10/08/02	<1.0	Yes
EZVI-SB2-RINSATE	01/16/02	<1.0	Yes	EZVI-SB203-RINSATE	10/09/02	<1.0	Yes
EZVI-SB3-RINSATE	01/17/02	<1.0	Yes	EZVI-SB304-RINSATE	11/19/02	<1.0	Yes
EZVI-SB4-RINSATE	01/18/02	<1.0	Yes	EZVI-SB302-RINSATE	11/18/02	<1.0	Yes
EZVI-SB6-RINSATE	02/01/02	<1.0	Yes	EZVI-SB303-RINSATE	11/20/02	<1.0	Yes
EZVI-SB7-RINSATE	02/07/02	2.88	No	EZVI-SB301-RINSATE	11/21/02	<1.0	Yes
EZVI-SB8-RINSATE	03/20/02	<1.0	Yes	EZVI-SB307-RINSATE	11/21/02	<1.0	Yes
				EZVI-SB308-RINSATE	11/22/02	<1.0	Yes

Table E-5. Results of the Methanol Blank Samples Collected During the Pre- and Post-Demonstration Soil Sampling

EZVI Methanol Blank Soil Extraction QA/QC Samples **QA/QC Target Level < 100 ug/L**				**Total Number of Soil Samples Collected = 328 [Pre-(157); Post-(171)]** **Total Number of Methanol Blank Samples Analyzed = 19**			
Sample ID	**Sample Date**	**TCE Result (ug/L)**	**Met QA/QC Criteria?**	**Sample ID**	**Sample Date**	**TCE Result (ug/L)**	**Met QA/QC Criteria?**
Pre-Demonstration Methanol Blank Samples				***Post-Demonstration Methanol Blank Samples***			
EZVI-SB1-MEOH	01/16/02	<100	Yes	EZVI-SB208-MEOH	10/08/02	160	No
EZVI-SB2-MEOH	01/16/02	<100	Yes	EZVI-SB207-MEOH	10/08/02	193	No
EZVI-SB3-MEOH	01/17/02	<100	Yes	EZVI-SB209-MEOH	10/08/02	313	No
EZVI-SB4-MEOH	01/18/02	<100	Yes	EZVI-SB203-MEOH	10/09/02	254	No
EZVI-SB5-MEOH	01/31/02	<100	Yes	EZVI-SB204-MEOH	10/09/02	200	No
EZVI-SB6-MEOH	02/01/02	<100	Yes	EZVI-SB302-MEOH	11/18/02	<100	Yes
EZVI-SB7-MEOH	02/07/02	<100	Yes	EZVI-SB304-MEOH	11/19/02	<100	Yes
EZVI-SB8-MB[(a)]	03/20/02	<100	Yes	EZVI-SB303-MEOH	11/20/02	<100	Yes
				EZVI-SB301-MEOH	11/21/02	117	No
				EZVI-SB307-MEOH	11/21/02	140	No
				EZVI-SB308-MEOH	11/22/02	<100	Yes

(a) Sample was labeled with –MB rather than the traditional –MEOH.

Table E-6. Results and Precision of the Field Duplicate Samples Collected During the EZVI Demonstration Groundwater Sampling Events

EZVI Treatment Plot Groundwater QA/QC **QA/QC Target Level RPD < 30.0 %**		**Total Number of Groundwater Samples Collected = 28 [Pre- (10); During (8); Post- (10)]** **Total Number of Field Duplicate Samples Analyzed = 3**		
Sample ID	**Sample Date**	**TCE Result (ug/L)**	**RPD (%)**	**Met QA/QC Criteria?**
EZVI Pre-Demonstration Field Duplicate Samples				
PA-23	03/26/02	1,180,000	4.33	Yes
PA-23DUP	03/26/02	1,130,000		
During the EZVI Demonstration				
PA-23	08/20/02	92,100	8.49	Yes
PA-23DUP	08/20/02	84,600		
EZVI Post-Demonstration Field Duplicate Samples				
PA-23	11/25/02	8,790	2.47	Yes
PA-23DUP	11/25/02	9,010		

Table E-7. Results of the Rinsate Blank Samples Collected During the EZVI Demonstration Groundwater Sampling Events

EZVI Groundwater QA/QC Samples **QA/QC Target Level TCE < 3.0 ug/L**	**Total Number of Samples Collected = 28** **[Pre- (10); During- (8); Post- (10)]** **Total Number of Rinsate Blank Samples Analyzed = 3**		
Sampling Event	**Analysis Date**	**TCE Concentration (ug/L)**	**Met QA/QC Criteria?**
Pre-Demonstration	03/26/02	<1.0	Yes
During the Demonstration	08/20/02	1.05	Yes
Post-Demonstration	11/25/02	<1.0	Yes

Table E-8. Results of the Trip Blank Samples Analyzed During the EZVI Demonstration Soil and Groundwater Sampling

EZVI Trip Blank QA/QC Samples **QA/QC Target Level TCE < 3.0 ug/L**			**Total Number of Samples Collected = 328 (Soil) 28 (Groundwater)** **Total Number of Field Samples Analyzed = 19**				
Sample ID	**Sample Date**	**TCE Result (ug/L)**	**Met QA/QC Criteria?**	**Sample ID**	**Sample Date**	**Result (ug/L)**	**Met QA/QC Criteria?**
EZVI Demonstration Trip Blanks							
EZVI-TB-1	01/16/02	<1.0	Yes	EZVI-TB-11	10/09/02	12.4	No
EZVI-TB-2	01/21/02	<1.0	Yes	EZVI-TB-12	11/19/02	<1.0	Yes
EZVI-TB-3	02/01/02	<1.0	Yes	EZVI-TB-13	11/18/02	<1.0	Yes
EZVI-TB-4	02/04/02	<1.0	Yes	EZVI-TB-14	11/20/02	<1.0	Yes
EZVI-TB-5	02/07/02	<1.0	Yes	EZVI-TB-15	11/21/02	<1.0	Yes
EZVI-TB-6	02/08/02	<1.0	Yes	EZVI-TB-16	11/21/02	<1.0	Yes
EZVI-TB-7	03/20/02	1.09	Yes	EZVI-TB-17	11/22/02	<1.0	Yes
EZVI-TB-8	03/26/02	<1.0	Yes	EZVI-TB-18	11/25/02	<1.0	Yes
EZVI-TB-9	03/27/02	<1.0	Yes	EZVI-TB-19	11/25/02	<1.0	Yes
EZVI-TB-10	10/08/02	14.5	No				

Table E-9. Matrix Spike Sample Analysis for the EZVI Pre-Demonstration Soil Sampling Events

EZVI Demonstration Soil MS/MSD Samples **QA/QC Target Level Recovery % = 70 – 130 %** **QA/QC Target Level RPD < 30.0 %**						**Total Number of Samples Collected = 328 [Pre- (157); Post- (171)]** **Total Number of Matrix Spike Samples Analyzed = 18** **Total Number of Matrix Spike Duplicate Samples Analyzed = 18**					
Sample ID	**Sample Date**	**TCE Recovery (%)**	**Met QA/QC Criteria?**	**RPD (%)**	**Met QA/QC Criteria?**	**Sample ID**	**Sample Date**	**TCE Recovery (%)**	**Met QA/QC Criteria?**	**RPD (%)**	**Met QA/QC Criteria?**
EZVI Pre-Demonstration Matrix Spike Samples											
0201067-03A MS	01/18/02	103	Yes	0.054	Yes	0201104-04A MS	01/29/02	110	Yes	2.46	Yes
0201067-03A MSD		103	Yes			0201104-04A MSD		113	Yes		
0201067-26A MS	01/19/02	101	Yes	1.97	Yes	0201104-50A MS	01/29/03 01/30/03	109	Yes	4.77	Yes
0201067-26A MSD		103	Yes			0201104-50A MSD		103	Yes		
0201067-49A MS	01/21/02	121	Yes	0.446	Yes	0202007-04A MS	02/04/02	108	Yes	2.52	Yes
0201067-49A MSD		121	Yes			0202007-04A MSD		105	Yes		
0201067-60A MS	01/22/02	103	Yes	5.47	Yes	0202007-27A MS	02/04/02	108	Yes	0.918	Yes
0201067-60A MSD		90	Yes			0202007-27A MSD		108	Yes		
0201067-15A MS[(a)]	01/22/02	-52.4	No	0.712	Yes	0202007-21A MS	02/05/02	112	Yes	2.18	Yes
0201067-15A MSD[(a)]		-53.2	No			0202007-21A MSD		110	Yes		
0201087-04A MS	01/23/02	102	Yes	0.269	Yes	0202014-11A MS	02/06/02	108	Yes	0.799	Yes
0201087-04A MSD		102	Yes			0202014-11A MSD		109	Yes		
0201087-27A MS	01/23/02	105	Yes	0.381	Yes	0202037-10A MS	02/12/02	121	Yes	0.909	Yes
0201087-27A MSD		104	Yes			0202037-10A MSD		120	Yes		
0201087-17A MS	01/25/02	110	Yes	0.039	Yes	0202037-09A MS	02/13/02	130	Yes	21.5	Yes
0201087-17A MSD		110	Yes			0202037-09A MSD		162	No		
0201105-01A MS[(a)]	01/26/02	33.9	No	0.556	Yes	0203105-03A MS	03/24/02	101	Yes	1.34	Yes
0201105-01A MSD[(a)]		26.5	No			0203105-03A MSD		99.7	Yes		

(a) Spike recovery was outside of the control limits due to the high concentration of TCE present in the reference sample. No further corrective actions were required and no sample results were adversely affected.

Table E-10. Matrix Spike Sample Analysis for the EZVI Post-Demonstration Soil Sampling Events

EZVI Demonstration Soil MS/MSD Samples **QA/QC Target Level Recovery % = 70 – 130 %** **QA/QC Target Level RPD < 30.0 %**						**Total Number of Samples Collected = 328 [Pre- (157); Post- (171)]** **Total Number of Matrix Spike Samples Analyzed = 16** **Total Number of Matrix Spike Duplicate Samples Analyzed = 16**					
Sample ID	**Sample Date**	**TCE Recovery (%)**	**Met QA/QC Criteria?**	**RPD (%)**	**Met QA/QC Criteria?**	**Sample ID**	**Sample Date**	**TCE Recovery (%)**	**Met QA/QC Criteria?**	**RPD (%)**	**Met QA/QC Criteria?**
EZVI Post-Demonstration Matrix Spike Samples											
0210032-02A MS	10/10/02	101	Yes	5.08	Yes	0211098-18A MS[(a)]	11/26/02	136	No	2.45	Yes
0210032-02A MSD		96.2	Yes			0211098-18A MSD[(a)]		139	No		
0210032-13A MS	10/10/02	107	Yes	24.9	Yes	0211079-03A MS	11/20/02	110	Yes	5.44	Yes
0210032-13A MSD[(a)]		139	No			0211079-03A MSD		103	Yes		
0210037-28A MS	10/11/02	104	Yes	2.44	Yes	0211108-08A MS	11/26/02	93.5	Yes	4.51	Yes
0210037-28A MSD		102	Yes			0211108-08A MSD		98.3	Yes		
0210037-27A MS	10/14/02	89	Yes	2.20	Yes	0211108-24A MS	11/27/02	108	Yes	8.13	Yes
0210037-27A MSD		87.1	Yes			0211108-24A MSD		99.6	Yes		
0210037-05A MS	10/12/02	116	Yes	0.274	Yes	0211120-17A MS	12/02/02	111	Yes	7.24	Yes
0210037-05A MSD		117	Yes			0211120-17A MSD		103	Yes		
0210037-15A MS	10/15/02	99.7	Yes	6.94	Yes	0211142-10A MS[(a)]	12/05/02	-294	No	4.59	Yes
0210037-15A MSD		92.6	Yes			0211142-10A MSD[(a)]		-402	No		
0211089-03A MS	11/21/02	107	Yes	2.44	Yes	0211120-02A MS	12/05/02	110	Yes	4.04	Yes
0211089-03A MSD		110	Yes			0211120-02A MSD		106	Yes		
0211089-20A MS	11/22/02	111	Yes	0.649	Yes	0211121-18A MS	11/27/02	92.6	Yes	8.17	Yes
0211089-20A MSD		110	Yes			0211121-18A MSD		85.3	Yes		

(b) Spike recovery was outside of the control limits due to the high concentration of TCE present in the reference sample. No further corrective actions were required and no sample results were adversely affected.

Table E-11. Laboratory Control Spike Sample Analysis During the EZVI Pre-and Post Demonstration Soil Sampling Events

EZVI Demonstration Soil LCS Samples **QA/QC Target Level TCE Recovery % = 70 – 130 %**				**Total Number of Samples Collected = 328 [Pre- (157); Post- (171)]** **Total Number of Laboratory Control Spike Samples Analyzed = 41**			
Sample ID	**Sample Date**	**TCE Recovery (%)**	**Met QA/QC Criteria?**	**Sample ID**	**Sample Date**	**TCE Recovery (%)**	**Met QA/QC Criteria?**
EZVI Pre-Demonstration Laboratory Control Spike Samples							
LCS-9593	01/18/02	95.5	Yes	LCS-9649	01/25/02	110	Yes
LCS-9598	01/19/02	101	Yes	LCS-9650	01/27/02	103	Yes
LCS-9604	01/21/02	116	Yes	LCS-9662	01/28/02	90.2	Yes
LCS-9608	01/22/02	90.6	Yes	LCS-9665	01/29/02	112	Yes
LCS-9620	01/23/02	95.6	Yes	LCS-9668	01/29/02	113	Yes
LCS-9634	01/22/02	101	Yes	LCS-9706	02/04/02	107	Yes
LCS-9635	01/23/02	94.5	Yes	LCS-9711	02/04/02	106	Yes
LCS-9621	01/23/02	100	Yes	LCS-9712	02/05/02	107	Yes
LCS-9629	01/23/02	101	Yes	LCS-9726	02/05/02	107	Yes
LCS-9635	01/23/02	94.5	Yes	LCS-9772	02/11/02	121	Yes
LCS-9637	01/24/02	95.5	Yes	LCS-9788	02/13/02	123	Yes
LCS-9646	01/25/02	110	Yes	LCS-10147	03/24/02	97.6	Yes
LCS-9647	01/25/02	92	Yes				
EZVI Post-Demonstration Laboratory Control Spike Samples							
LCS-11576	10/09/02	99.5	Yes	LCS-11873	11/25/02	117	Yes
LCS-11583	10/10/02	102	Yes	LCS-11841	11/20/02	103	Yes
LCS-11595	10/11/02	103	Yes	LCS-11879	11/26/02	89	Yes
LCS-11601	10/14/02	103	Yes	LCS-11887	11/27/02	105	Yes
LCS-11593	10/11/02	102	Yes	LCS-11897	11/27/02	85.1	Yes
LCS-11600	10/14/02	108	Yes	LCS-11907	12/02/02	107	Yes
LCS-11850	11/21/02	105	Yes	LCS-11933	12/04/02	109	Yes
LCS-11857	11/22/02	103	Yes	LCS-11940	12/05/02	110	Yes

Table E-12. Method Blank Sample Analysis during the EZVI Pre- and Post-Demonstration Soil Sampling Events

EZVI Demonstration Soil QA/QC Samples **QA/QC Target Level TCE < 3.0 ug/L**				**Total Number of Samples Collected = 328 [Pre- (157); Post- (171)]** **Total Number of Method Blank Samples Analyzed = 41**			
Sample ID	**Sample Date**	**TCE Recovery (ug/L)**	**Met QA/QC Criteria?**	**Sample ID**	**Sample Date**	**TCE Recovery (ug/L)**	**Met QA/QC Criteria?**
EZVI Pre-Demonstration Method Blank Samples							
MB-9593	01/18/02	<1.0	Yes	MB-9649	01/25/02	<1.0	Yes
MB-9598	01/19/02	<1.0	Yes	MB-9650	01/27/02	<1.0	Yes
MB-9604	01/21/02	<1.0	Yes	MB-9662	01/28/02	<1.0	Yes
MB-9608	01/22/02	<1.0	Yes	MB-9665	01/29/02	<1.0	Yes
MB-9620	01/23/02	<1.0	Yes	MB-9668	01/29/02	<1.0	Yes
MB-9634	01/22/02	<1.0	Yes	MB-9706	02/04/02	<1.0	Yes
MB-9635	01/23/02	<1.0	Yes	MB-9711	02/04/02	<1.0	Yes
MB-9621[(a)]	01/23/02	<100	Unknown	MB-9712	02/05/02	<1.0	Yes
MB-9629	01/23/02	<1.0	Yes	MB-9726	02/05/02	<1.0	Yes
MB-9635	01/23/02	<1.0	Yes	MB-9772	02/11/02	<1.0	Yes
MB-9637	01/24/02	<1.0	Yes	MB-9788	02/13/02	<1.0	Yes
MB-9646	01/25/02	<1.0	Yes	MB-10147	03/24/02	<1.0	Yes
MB-9647	01/25/02	<1.0	Yes				
EZVI Post-Demonstration Method Blank Samples							
MB-11576	10/09/02	<1.0	Yes	MB-11873	11/25/02	<1.0	Yes
MB-11583	10/10/02	<1.0	Yes	MB-11841	11/20/02	<1.0	Yes
MB-11595	10/11/02	<1.0	Yes	MB-11879	11/26/02	<1.0	Yes
MB-11601	10/14/02	<1.0	Yes	MB-11887	11/27/02	<1.0	Yes
MB-11593	10/11/02	<1.0	Yes	MB-11897	11/27/02	<1.0	Yes
MB-11600	10/14/02	<1.0	Yes	MB-11907	12/02/02	<1.0	Yes
MB-11850	11/21/02	<1.0	Yes	MB-11933	12/04/02	<1.0	Yes
MB-11857	11/22/02	<1.0	Yes	MB-11940	12/05/02	<1.0	Yes

(a) Reporting limit was 100 ug/L TCE for this sample.

Table E-13. Matrix Spike Sample Analysis During the EZVI Demonstration Groundwater Sampling Events

EZVI Demonstration Groundwater QA/QC **QA/QC Target Level TCE Recovery % = 75 – 125 %** **QA/QC Target Level RPD < 20.0 %**			**Total Number of Samples Collected = 28** **[Pre- (10); During (8); Post- (10)]** **Total Number of Matrix Spike Samples Analyzed = 6** **Total Number of Matrix Spike Duplicate Samples Analyzed = 6**		
Sample ID	**Sample Date**	**TCE Recovery (%)**	**Met QA/QC Criteria?**	**RPD (%)**	**Met QA/QC Criteria?**
EZVI Pre-Demonstration Matrix Spike Samples					
0203129-04A MS	03/28/02	90.7	Yes	0.913	Yes
0203129-04A MSD		88.4	Yes		
0203133-20A MS	03/29/02	99.1	Yes	0.995	Yes
0203133-20A MSD		100	Yes		
During the EZVI Demonstration					
0208106-03A MS	08/27/02	125	Yes	7.76	Yes
0208106-03A MSD		115	Yes		
0208115-04A MS[(a)]	08/29/02	353	No	0.421	Yes
0208115-04A MSD[(a)]		347	No		
EZVI Post-Demonstration Matrix Spike Samples					
0211142-10A MS[(a)]	12/05/02	-294	No	4.59	Yes
0211142-10A MSD[(a)]		-402	No		
0211120-02A MS	12/05/02	110	Yes	4.04	Yes
0211120-02A MSD		106	Yes		

(a) Matrix spike (MS) and matrix spike duplicate (MSD) were outside of the control limits due to the high concentration of TCE present in the reference sample. No further corrective actions were required and no sample results were adversely affected.

Table E-14. Laboratory Control Spike Sample Analysis During the EZVI Demonstration Groundwater Sampling Events

EZVI Demonstration Groundwater QA/QC **QA/QC Target Level TCE Recovery % = 75 – 125 %**		**Total Number of Samples Collected = 28** **[Pre- (10); During (8); Post- (10)]** **Total Number of Matrix Spike Samples Analyzed = 6**	
Sample ID	**Sample Date**	**TCE Recovery (%)**	**Met QA/QC Criteria?**
EZVI Pre-Demonstration Laboratory Control Spike Samples			
LCS-10179	03/28/02	102	Yes
LCS-10187	03/29/02	105	Yes
During the EZVI Demonstration			
LCS-11251	08/27/02	111	Yes
LCS-11273	08/28/02	100	Yes
EZVI Post-Demonstration Laboratory Control Spike Samples			
LCS-11933	12/04/02	109	Yes
LCS-11940	12/05/02	110	Yes

Table E-15. Method Blank Sample Analysis During the EZVI Demonstration Groundwater Sampling Events

EZVI Demonstration Groundwater QA/QC **QA/QC Target Level TCE < 3.0 ug/L**		**Total Number of Samples Collected = 28** **[Pre- (10); During (8); Post- (10)]** **Total Number of Method Blank Samples Analyzed = 6**	
Sample ID	**Sample Date**	**TCE Recovery (ug/L)**	**Met QA/QC Criteria?**
EZVI Pre-Demonstration Method Blank Samples			
MB-10179	03/28/02	<1.0	Yes
MB-10187	03/29/02	<1.0	Yes
During the EZVI Demonstration			
MB-11251	08/27/02	<1.0	Yes
MB-11273	08/29/02	<1.0	Yes
EZVI Post-Demonstration Method Blank Samples			
MB-11933	12/04/02	<1.0	Yes
MB-11940	12/05/02	<1.0	Yes

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CHAIN-OF-CUSTODY

CLIENT: BATTELLE
ADDRESS: 505 KING AVE COLUMBUS, OH 43201
PHONE: 614 424 4569 FAX 614 458 4569
DATA REPORTED TO: SAM YOON
ADDITIONAL REPORT COPIES TO: EDD FORMAT

DATE: 2/7/02 PAGE 2 OF 3
PO #: 169646 DHL WORK ORDER #: 0202037
PROJECT LOCATION OR NAME: CCAS 2
CLIENT PROJECT #: G482010 COLLECTOR: ED

Authorize 5% surcharge for TRRP report? ☐ Yes ☐ No

S=SOIL W=WATER A=AIR P=PAINT SL=SLUDGE OT=OTHER

MeOH

PRESERVATION: HCl, HNO_3, H_2SO_4 ☐ NaOH ☐, ICE, UNPRESERVED

ANALYSES: BTEX ☐ MTBE ☐ | TRPH 418.1 ☐ TPH 1005 ☐ TPH 1006 ☐ | GASOLINE MOD 8015 ☐ | DIESEL - MOD 8015 ☐ | VOC 8260 ☐ | SVOC 8270 ☐ PAH 8270 ☐ | 8081 PESTICIDES ☐ 8151 HERBICIDES ☐ | 8082 PCBS ☐ | TCLP - METALS (RCRA) ☐ TCLP VOC ☐ | TCLP - PEST ☐ HERB ☐ Semi-VOC ☐ | TOTAL METALS (RCRA) ☐ OTHER LIST ☐ | LEAD - TOTAL ☐ D.W. 200.8 ☐ TCLP ☐ | RCI ☐ TOX ☐ FLASHPOINT ☐ | TDS ☐ TSS ☐ % MOISTURE ☐ | pH ☐ HEXAVALENT CHROMIUM ☐ | EXPLOSIVES ☐ PECHLORATE ☐ | CHLORIDE ☐ ANIONS ☐ ALKALINITY ☐ | VOCs (TCE, PCE, cis/trans DCE)

Field Sample I.D.	DHL Lab #	Date	Time	Matrix	Container Type	# of Containers	HCl	HNO_3	H_2SO_4 ☐ NaOH ☐	ICE	UNPRESERVED	FIELD NOTES
EZVI-SB7-24	16	2/7/02	12:00	W	20mL VOA	1					X	
EZVI-SB7-26	17			W		1					X	
EZVI-SB7-28	18			W		1					X	
EZVI-SB7-30	19			W		1					X	
EZVI-SB7-32	20			W		1					X	
EZVI-SB7-34	21			W		1					X	
EZVI-SB7-36	22			W		1					X	
EZVI-SB7-38	23			W		1					X	
EZVI-SB7-40	24			W		1					X	
EZVI-SB7-42	25			W		1					X	
EZVI-SB7-44	26			W		1					X	
EZVI-SB7-44 DUP	27			W		1					X	
EZVI-SB7-46	28			W		1					X	
EZVI-SB7-RINSATE	29		9:00	W	40mL VOA	3	X					
TRIP BLANK	30		15:00	W	20mL VOA	1					X	
TOTAL 17												

RELINQUISHED BY: (Signature) DATE/TIME 2/7/02 16:00 RECEIVED BY: (Signature) FX

RELINQUISHED BY: (Signature) FX 2-8-2 830 DATE/TIME RECEIVED BY: (Signature) Megan Stivers

RELINQUISHED BY: (Signature) DATE/TIME RECEIVED BY: (Signature)

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Appendix F

Economic Analysis Information

Appendix F

Economic Analysis Information

This appendix details the cost assessment for the application of the pump-and-treat (P&T) system for containment of a DNAPL source at Launch Complex 34, for a source zone that is the same size as the EZVI plot. Because the groundwater flow in this area is generally to the northeast, the DNAPL source could be contained by installing one or more extraction wells on the northeast side of the resistive heating plot. The life cycle cost of a pump-and-treat system can be compared to the cost of DNAPL source removal by EZVI injection, as described in Section 7 of the main report.

Experience at previous sites indicates that the most efficient long-term P&T system is one that is operated at the minimum rate necessary to contain a plume or source zone (Cherry et al., 1996). Table F-1 shows a preliminary size determination for the P&T system. The P&T system should be capable of capturing the groundwater flowing through a cross-section that is approximately 50 ft wide (width of a realistic contamination for the EZVI plot) and 30 ft deep (thickness of the EZVI target depth). Because capture with P&T systems is somewhat inefficient in that cleaner water from surrounding parts of the aquifer may also be drawn in, an additional safety factor of 100% was applied to ensure that any uncertainties in aquifer capture zone or DNAPL source characterization are accounted for. An extraction rate of 2 gallon per minute (gpm) is found to be sufficient to contain the source.

One advantage of low groundwater extraction rates is that the air effluent from stripping often does not have to be treated, as the rate of VOC discharge to the ambient air is often within regulatory limits. The longer period of operation required (at a low withdrawal rate) is more than offset by higher efficiency (lower influx of clean water from outside the plume), lower initial capital investment (smaller treatment system), and lower annual O&M requirements. Another advantage of a containment type P&T system is that, unlike source removal technologies, it does not require very extensive DNAPL zone characterization.

F.1 Capital Investment for the P&T System

The P&T system designed for this application consists of the components shown in Table F-2. Pneumatically driven pulse pumps, which are used in each well, are safer than electrical pumps in the presence of TCE vapors in the wells. This type of pump can sustain low flowrates during continuous operation. Stainless steel and Teflon™ construction ensure compatibility with the high concentrations (up to 1,100 mg/L TCE) of dissolved solvent and any free-phase DNAPL that may be expected. Extraction wells are assumed to be 30 ft deep, 2 inches in diameter, and have stainless steel screens with PVC risers.

The aboveground treatment system consists of a DNAPL separator and air stripper. Very little free-phase solvent is expected and the separator may be disconnected after the first year of operation, if desired. The air stripper used is a low-profile tray-type air stripper. As opposed to conventional packed towers, low-profile strippers have a smaller footprint, much smaller height, and can handle large air:water ratios (higher mass transfer rate of contaminants) without generating significant pressure losses. Because of their small size and easy installation, they are more often used in groundwater remediation. The capacity of the air stripper selected is much higher than 2 gpm, so that additional flow (or additional extraction wells) can be handled if required.

The high air:water ratio ensures that TCE (and other minor volatile components) are removed to the desired levels. The treated water effluent from the air stripper is discharged to the sewer. The air effluent is treated with a catalytic oxidation unit before discharge.

The piping from the wells to the air stripper is run through a 1-ft-deep covered trench. The air stripper and other associated equipment are housed on a 20-ft-x-20-ft concrete pad, covered by a basic shelter. The base will provide a power drop (through a pole transformer) and a licensed electrician will be used for the power hookups. Meters and control valves are strategically placed to control water and air flow through the system.

The existing monitoring system at the site will have to be supplemented with seven long-screen (10-foot screen) monitoring wells. The objective of these wells is to ensure that the desired containment is being achieved.

F.2 Annual Cost of the P&T System

The annual costs of P&T are shown in Table F-3 and include annual O&M. Annual O&M costs include the labor, materials, energy, and waste disposal cost of operating the system and routine maintenance (including scheduled replacement of seals, gaskets, and O-rings). Routine monitoring of the stripper influent and effluent is done through ports on the feed and effluent lines on a monthly basis. Groundwater monitoring is conducted on a quarterly basis through seven monitoring wells. All water samples are analyzed for PCE and other CVOC by-products.

F.3 Periodic Maintenance Cost

In addition to the routine maintenance described above, periodic maintenance will be required, as shown in Table F-3, to replace worn-out equipment. Based on manufacturers' recommendations for the respective equipment, replacement is done once in 5 or 10 years. In general, all equipment involving moving parts is assumed will be replaced once every 5 years, whereas other equipment is changed every 10 years.

F.4 Present Value (PV) Cost of P&T

Because a P&T system is operated for the long term, a 30-year period of operation is assumed for estimating cost. Because capital investment, annual costs, and periodic maintenance costs occur at different points in time, a life cycle analysis or present value analysis is conducted to estimate the long-term cost of P&T in today's dollars. This life cycle analysis approach is recommended for long-term remediation applications by the guidance provided in the Federal Technologies Roundtable's *Guide to Documenting and Managing Cost and Performance Information for Remediation Projects* (United States Environmental Protection Agency [U.S. EPA], 1998). The PV cost can then be compared with the cost of faster (DNAPL source reduction) remedies.

$$PV_{P\&T\ costs} = \sum \frac{\text{Annual Cost in Year t}}{(1+r)^t} \qquad \text{Equation (F-1)}$$

$$PV_{P\&T\ costs} = \text{Capital Investment} + \frac{\text{Annual cost in Year 1}}{(1+r)^1} + \ldots + \frac{\text{Annual cost in Year n}}{(1+r)^n} \qquad \text{Equation (F-2)}$$

Table F-3 shows the PV calculation for P&T based on Equation F-1. In Equation F-1, each year's cost is divided by a discount factor that reflects the rate of return that is foregone by incurring the cost. As seen in Equation F-2, at time t = 0, which is in the present, the cost incurred is the initial capital investment in equipment and labor to design, procure, and build the P&T system. Every year after that, a cost is incurred to operate and maintain the P&T system. A real rate of return (or discount rate), r, of 2.9% is used in the analysis as per recent U.S. EPA guidance on discount rates (U.S. EPA, 1999). The total PV cost of purchasing, installing, and operating a 2-gpm P&T source containment system for 30 years is estimated to be **$1,360,000** (rounded to the nearest thousand).

Long-term remediation costs are typically estimated for 30-year periods as mentioned above. Although the DNAPL source may persist for a much longer time, the contribution of costs incurred in later years to the PV cost of the P&T system is not very significant and the total 30-year cost is indicative of the total cost incurred for this application. This can be seen from the fact that in Years 28, 29, and 30, the differences in cumulative PV cost are not as significant as the difference in, say, Years 2, 3, and 4. The implication is that, due to the effect of discounting, costs that can be postponed to later years have a lower impact than costs that are incurred in the present.

As an illustration of a DNAPL source that may last much longer than the 30-year period of calculation, Figure F-1 shows a graphic representation of PV costs assuming that the same P&T system is operated for 100 years instead of 30 years. The PV cost curve flattens with each passing year. The total PV cost after 100 years (in Table F-4) is estimated at $2,126,000.

Table F-1. Pump-and-Treat (P&T) System Design Basis

Item	Value	Units	Item	Value	Units
Width of DNAPL zone, w	50	ft	Hyd. conductivity, K	40	ft/d
Depth of DNAPL zone, d	30	ft	Hyd. gradient, I	0.0007	ft/ft
Crossectional area of DNAPL zone, a	1500	sq ft	Porosity, n	0.3	
Capture zone required	140	cu ft/d	Gw velocity, v	0.093333	ft/d
Safety factor, 100%	2				
Required capture zone	280	cu ft/d	GPM =	1.5	gpm
Design pumping rate	2	gpm	Number of wells to achieve capture	1	
Pumping rate per well	2	gpm			
TCE conc. in water near DNAPL zone	100	mg/L	TCE allowed in discharge water	1	mg/L
Air stripper removal efficiency required	99.00%				
TCE in air effluent from stripper	2.4	lbs/day	TCE allowed in air effluent	6	lbs/day

Table F-2. Capital Investment for a P&T System at Launch Complex 34, Cape Canaveral

Item	# units		Unit Price	Cost	Basis
Design/Procurement					
Engineer	120	hrs	$ 85	$10,200	
Drafter	80	hrs	$ 40	$3,200	
Hydrologist	120	hrs	$ 85	$10,200	
Contingency	1	ea	$ 10,000	$10,000	10% of total capital
TOTAL				$23,600	
Pumping system					
Extraction wells	1	ea	$ 5,000	$5,000	2-inch, 30 ft deep, 30-foot SS screen; PVC; includes installation
Pulse pumps	1	ea	$ 595	$595	2.1 gpm max., 1.66"OD for 2-inch wells; handles solvent contact; pneumatic; with chec valves
Controllers	1	ea	$ 1,115	$1,115	Solar powered or 110 V; with pilot valve
Air compressor	1	ea	$ 645	$645	100 psi (125 psi max), 4.3 cfm continuous duty, oil-less; 1 hp
Miscellaneous fittings	1	ea	$ 5,000	$5,000	Estimate
Tubing	150	ft	$ 3	$509	1/2-inch OD, chemical resistant; well to surface manifold
TOTAL				$12,864	
Treatment System					
Piping	150	ft	$ 3	$509	chemical resistant
Trench	1	day	$ 320	$320	ground surface
DNAPL separarator tank	1	ea	$ 120	$120	125 gal; high grade steel with epoxy lining; conical bottom with discharge
Air stripper feed pump	1	ea	$ 460	$460	0.5 hp; up to 15 gpm
Piping	50	ft	$ 3	$170	0.5 inch, chemical resistant; feed pump to stripper
Water flow meter	1	ea	$ 160	$160	Low flow; with read out
Low-profile air stripper with control panel	1	ea	$ 9,400	$9,400	1-25 gpm, 4 tray; SS shell and trays
Pressure gauge	1	ea	$ 50	$50	SS; 0-30 psi
Blower	1	ea	$ 1,650	$1,650	5 hp
Air flow meter	1	ea	$ 175	$175	Orifice type; 0-50 cfm
Stack	10	ft	$ 2	$20	2 inch, PVC, lead out of housing
Catalytic Oxidizer	1	ea	$ 65,000	$65,000	
Carbon	2	ea	$ 1,000	$2,000	
Stripper sump pump	1	ea	$ 130	$130	To sewer
Misc. fittings, switches	1	ea	$ 5,000	$5,000	Estimate (sample ports, valves, etc.)
TOTAL				$85,163	
Site Preparation					
Conctrete pad	400	sq ft	$ 3	$1,200	20 ft x 20 ft with berm; for air stripper and associated equipment
Berm	80	ft	$ 7	$539	
Power drop	1	ea	$ 5,838	$5,838	240 V, 50 Amps; pole transformer and licensed electrician
Monitoring wells	5	wells	$ 2,149	$10,745	Verify source containment; 2-inch PVC with SS screens
Sewer connection fee	1	ea	$ 2,150	$2,150	
Sewer pipe	300	ft	$ 10	$3,102	
Housing	1	ea	$ 2,280	$2,280	20 ft x 20 ft; shelter for air stripper and associated equipment
TOTAL				$25,854	
Installation/Start Up of Treatment System					
Engineer	60	hrs	$ 85	$5,100	Labor
Technician	200	hrs	$ 40	$8,000	Labor
TOTAL				$13,100	
TOTAL CAPITAL INVESTMENT				**$160,581**	

Table F-2. Capital Investment for a P&T System at Launch Complex 34, Cape Canaveral (Continued)

O&M Cost for P&T Sytem					
Annual Operation & Maintenance					
Engineer	80	hrs	$ 85	$6,800	Oversight
Technician	500	hrs	$ 40	$20,000	Routine operation; annual cleaning of air stripper trays, routine replacement of parts; any waste disposal
Replacement materials	1	ea	$ 2,000	$2,000	Seals, o-rings, tubing, etc.
Electricity	52,560	kW-hrs	$ 0	$5,256	8 hp (~6 kW) over 1 year of operation
Fuel (catalytic oxidizer	2,200	10E6 Btu	$ 6	$13,200	
Sewer disposal fee	525,600	gal/yr	$ 0	$799	
Carbon disposal	2		$ 1,000	$2,000	
Waste disposal	1	drum	$ 80	$200	30 gal drum; DNAPL, if any; haul to incinerator
TOTAL				$50,255	
Annual Monitoring					
Air stripper influent	12	smpls	$ 120	$1,440	Verify air stripper loading; monthly
Air stripper effluent	14	smpls	$ 120	$1,680	Discharge quality confirmation; monthly; CVOC analysis; MS, MSD
Monitoring wells	20	smpls	$ 120	$2,400	5 wells; quarterly; MS, MSD
Sampling materials	1	ea	$ 500	$500	Miscellaneous
Technician	64	hrs	$ 40	$2,560	Quarterly monitoring labor (from wells) only; weekly monitoring (from sample ports) included in O&M cost
Engineer	40	hrs	$ 85	$3,400	Oversight; quarterly report
TOTAL				$5,520	
TOTAL ANNUAL COST				**$55,775**	
Periodic Maintenance, Every 5 years					
Pulse pumps	4	ea	$ 595	$2,380	As above
Air compressor	1	ea	$ 645	$645	As above
Air stripper feed pump	1	ea	$ 460	$460	As above
Blower	1	ea	$ 1,650	$1,650	As above
Catalyst replacement	1	ea	$ 5,000	$5,000	
Stripper sump pump	1	ea	$ 130	$130	As above
Miscellaneous materials	1	ea	$ 1,000	$1,000	Estimate
Technician	40	hrs	$ 40	$1,600	Labor
TOTAL				**$12,865**	
				$68,640	
Periodic Maintenance, Every 10 years					
Air stripper	1	ea	$ 9,400	$9,400	As above
Catalytic oxidizer	1	ea	$ 16,000	$16,000	Major overhaul
Water flow meters	1	ea	$ 160	$160	As above
Air flow meter	1	ea	$ 175	$175	As above
Technician	40	hrs	$ 40	$1,600	Labor
Miscellaneous materials	1	ea	$ 1,000	$1,000	Estimate
TOTAL				**$28,335**	
TOTAL PERIODIC MAINTENANCE COSTS				**$96,975**	

Table F-3. Present Value of P&T System Costs for 30 Years of Operation

	P&T		
Year	Annual Cost *	PV of Annual Cost	Cumulative PV of Annual Cost
0	**$160,581**	$160,581	$160,581
1	$55,775	$54,203	$214,784
2	$55,775	$52,676	$267,460
3	$55,775	$51,191	$318,651
4	$55,775	$49,748	$368,399
5	**$68,640**	$59,498	$427,897
6	$55,775	$46,984	$474,880
7	$55,775	$45,660	$520,540
8	$55,775	$44,373	$564,913
9	$55,775	$43,122	$608,035
10	**$96,975**	$72,863	$680,898
11	$55,775	$40,726	$721,624
12	$55,775	$39,578	$761,202
13	$55,775	$38,463	$799,664
14	$55,775	$37,379	$837,043
15	**$68,640**	$44,704	$881,747
16	$55,775	$35,302	$917,049
17	$55,775	$34,307	$951,355
18	$55,775	$33,340	$984,695
19	$55,775	$32,400	$1,017,095
20	**$96,975**	$54,746	$1,071,841
21	$55,775	$30,600	$1,102,441
22	$55,775	$29,737	$1,132,178
23	$55,775	$28,899	$1,161,077
24	$55,775	$28,085	$1,189,162
25	**$68,640**	$33,589	$1,222,751
26	$55,775	$26,524	$1,249,275
27	$55,775	$25,777	$1,275,051
28	$55,775	$25,050	$1,300,102
29	$55,775	$24,344	$1,324,446
30	**$96,975**	$41,134	$1,365,579

* Annual cost in Year zero is equal to the capital investment.
Annual cost in other years is annual O&M cost plus annual monitoring cost
Annual costs in Years 10, 20, and 30 include annual
O&M, annual monitoring, and periodic maintenance

Table F-4. Present Value of P&T System Costs for 100 Years of Operation

Year	P&T Annual Cost *	P&T PV of Annual Cost	P&T Cumulative PV of Annual Cost
0	**$160,581**	$160,581	$160,581
1	$55,775	$54,203	$214,784
2	$55,775	$52,676	$267,460
3	$55,775	$51,191	$318,651
4	$55,775	$49,748	$368,399
5	**$68,640**	$59,498	$427,897
6	$55,775	$46,984	$474,880
7	$55,775	$45,660	$520,540
8	$55,775	$44,373	$564,913
9	$55,775	$43,122	$608,035
10	**$96,975**	$72,863	$680,898
11	$55,775	$40,726	$721,624
12	$55,775	$39,578	$761,202
13	$55,775	$38,463	$799,664
14	$55,775	$37,379	$837,043
15	**$68,640**	$44,704	$881,747
16	$55,775	$35,302	$917,049
17	$55,775	$34,307	$951,355
18	$55,775	$33,340	$984,695
19	$55,775	$32,400	$1,017,095
20	**$96,975**	$54,746	$1,071,841
21	$55,775	$30,600	$1,102,441
22	$55,775	$29,737	$1,132,178
23	$55,775	$28,899	$1,161,077
24	$55,775	$28,085	$1,189,162
25	**$68,640**	$33,589	$1,222,751
26	$55,775	$26,524	$1,249,275
27	$55,775	$25,777	$1,275,051
28	$55,775	$25,050	$1,300,102
29	$55,775	$24,344	$1,324,446
30	**$96,975**	$41,134	$1,365,579
31	$55,775	$22,991	$1,388,571
32	$55,775	$22,343	$1,410,914
33	$55,775	$21,714	$1,432,628
34	$55,775	$21,102	$1,453,729
35	**$68,640**	$25,237	$1,478,966
36	$55,775	$19,929	$1,498,895
37	$55,775	$19,367	$1,518,263
38	$55,775	$18,822	$1,537,084
39	$55,775	$18,291	$1,555,375
40	**$96,975**	$30,906	$1,586,282
41	$55,775	$17,275	$1,603,556
42	$55,775	$16,788	$1,620,344
43	$55,775	$16,315	$1,636,659
44	$55,775	$15,855	$1,652,514
45	**$68,640**	$18,962	$1,671,476
46	$55,775	$14,974	$1,686,449
47	$55,775	$14,552	$1,701,001
48	$55,775	$14,142	$1,715,143
49	$55,775	$13,743	$1,728,886
50	**$68,640**	$16,436	$1,745,323
51	$55,775	$12,979	$1,758,302
52	$55,775	$12,614	$1,770,916
53	$55,775	$12,258	$1,783,174
54	$55,775	$11,913	$1,795,086
55	**$68,640**	$14,247	$1,809,334
56	$55,775	$11,251	$1,820,584
57	$55,775	$10,934	$1,831,518
58	$55,775	$10,625	$1,842,143
59	$55,775	$10,326	$1,852,469
60	**$96,975**	$17,448	$1,869,917
61	$55,775	$9,752	$1,879,669
62	$55,775	$9,477	$1,889,147
63	$55,775	$9,210	$1,898,357
64	$55,775	$8,951	$1,907,308
65	**$68,640**	$10,705	$1,918,012
66	$55,775	$8,453	$1,926,466
67	$55,775	$8,215	$1,934,681
68	$55,775	$7,984	$1,942,664
69	$55,775	$7,759	$1,950,423
70	**$96,975**	$13,109	$1,963,532
71	$55,775	$7,327	$1,970,859
72	$55,775	$7,121	$1,977,980
73	$55,775	$6,920	$1,984,901
74	$55,775	$6,725	$1,991,626
75	**$68,640**	$8,043	$1,999,669
76	$55,775	$6,351	$2,006,020
77	$55,775	$6,172	$2,012,193
78	$55,775	$5,998	$2,018,191
79	$55,775	$5,829	$2,024,021
80	**$96,975**	$9,850	$2,033,870
81	$55,775	$5,505	$2,039,376
82	$55,775	$5,350	$2,044,726
83	$55,775	$5,200	$2,049,926
84	$55,775	$5,053	$2,054,979
85	**$68,640**	$6,043	$2,061,022
86	$55,775	$4,772	$2,065,794
87	$55,775	$4,638	$2,070,432
88	$55,775	$4,507	$2,074,939
89	$55,775	$4,380	$2,079,319
90	**$96,975**	$7,401	$2,086,720
91	$55,775	$4,137	$2,090,856
92	$55,775	$4,020	$2,094,876
93	$55,775	$3,907	$2,098,783
94	$55,775	$3,797	$2,102,579
95	**$68,640**	$4,541	$2,107,120
96	$55,775	$3,586	$2,110,706
97	$55,775	$3,485	$2,114,190
98	$55,775	$3,386	$2,117,577
99	$55,775	$3,291	$2,120,867
100	**$96,975**	$5,561	$2,126,428

Figure F-1. P&T System Costs - 100 years