Final Report

Critical Evaluation of State-of-the-Art In Situ Thermal Treatment Technologies for DNAPL Source Zone Treatment

ESTCP Project ER-0314

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Executive Summary

In-situ thermal soil and aquifer remediation technologies (e.g., electrical resistance heating, conductive heating, steam-based heating, etc.) have undergone rapid development and application in recent years. These technologies offer the promise of more rapid and thorough treatment of non-aqueous phase liquid (NAPL) source zones; however, their field-scale application has not been well-documented in the technical literature.

In this project, the performance of thermal technologies for DNAPL source zone remediation was assessed with particular emphasis on post-treatment groundwater quality and mass discharge (sometimes referred to as "mass flux"). This critical evaluation involved an empirical analysis of available design and operating information and performance results from pilot- and full-scale applications to see what experiences to-date have been. This was supplemented with post-treatment field sampling at selected sites to fill data gaps. This project was complementary to, and made use of knowledge gained from other ESTCP and SERDP projects that were looking at relationships between DNAPL architecture, treatment effectiveness, and groundwater mass discharge (flux).

Documents from 182 applications were collected and reviewed, which included 87 electrical resistance heating, 46 steam-based heating, 26 conductive heating, and 23 other heating technology applications conducted between 1988 and 2007. Approximately 90% of the 182 applications were implemented after 1995 and about half since 2000. More specifically, this review identified the geologic settings in which these technologies were applied, chemicals treated, design parameters, operating conditions, and performance metrics. The results of this study are summarized in a set of summary tables (spreadsheet-based tables) linking this information to five generalized geologic scenarios. The Summary Tables can be used by practitioners, regulators, and site owners to anticipate the likely performance of thermal-based DNAPL treatment technologies at their sites. The tables provide a tool where performance experience and theoretical bounds on performance expectations are linked to a small number of generalized geologic scenario site descriptors. The user can choose the generalized scenario that most closely resembles their site and can quickly assess:

a) how the technology has been applied to date in that type of setting,
b) the designs employed,
c) the operating conditions,
d) the performance monitoring that results are based on,
e) the performance observed,
f) indicators of success at other sites, and
g) reasonable bounds on expected performance.

The two summary tables are the Overall Data Summary Table and the Site-Specific Summary Table. The Overall Data Summary table provides a summary of the thermal application since 2000, while the Site-Specific Summary Table provides all the background information acquired for each site for a detailed summation of any site of interest to the user.

Additional data for these Summary Tables were gained by performing post-treatment groundwater sampling at sites where a full-scale thermal application was applied aggressively. By aggressively, we mean attaining temperatures greater that 90°C and maintaining that for at least three days. The post-treatment groundwater sampling was performed after the groundwater was allowed to cool to pre-treatment temperatures and move through the treated zone to see what residual contamination may have been left after treatment. These groundwater impacts were quantified by dissolved concentrations and mass flux (discharge) into the aquifer which were obtained through high spatial density sampling at five thermal treatment sites. The range of concentration and mass flux reductions ranged from about <10X to 1000X, and was strongly linked to how well the source zone was delineated prior to treatment.

Another product of this work is the document *State-of-the-Practice Overview of the Use of In Situ Thermal Technologies for NAPL Source Zone Cleanup*. It is intended to be a useful tool and primer for program managers considering the use of thermal technologies at their sites. It contains the results of this work, but in a more condensed format prepared for the program manager audience.

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List of Acronyms

AFP4	Air Force Plant 4
ASU	Arizona State University
bls	Below land surface
bgs	Below ground surface
BTEX	Benzene, toluene, ethylbenzene, xylene
^{o}C	Degree Celsius
CAH	Chlorinated aliphatic hydrocarbon
DELCD	Dry electrolytic conductivity detector
DNAPL	Dense non-aqueous phase liquid
DO	Dissolved oxygen
DoD	Department of Defense
DRMO	Defense Re-utilization Marketing Office
EGDY	East Gate Disposal Yard
EPA	Environmental Protection Agency
ERH	Electrical resistance heating
ESTCP	Environmental Security Technology Certification Program
FID	Flame-ionization detector
ft	Feet/foot
g / gm	Gram
HAAF	Hunter Army Airfield
HASP	Health and Safety Plan
HCl	Hydrochloric acid
in	inch
ISTD	In situ thermal desorption
L	Liter
LNAPL	Light non-aqueous phase liquid
M	Meter
MCB	Marine Corps Base
mg	Milligram
ml	Milliliter
NAPL	Non-aqueous phase liquid
NAS	Naval Air Station
NRC	National Research Council
ORP	Oxidation reduction potential
PAH	Poly-nuclear aromatic hydrocarbons
PID	Photo-ionization detector
QA	Quality assurance
QC	Quality control
RFH	Radio frequency heating
SEE	Steam enhanced extraction
SERDP	Strategic Environmental Research and Development Program
TCE	Trichloroethylene
ug	Microgram
ul	Microliter

USEPA	United States Environmental Protection Agency
VOA	Volatile organic analysis
VOC	Volatile organic compound

1.0 INTRODUCTION

1.1 BACKGROUND

Dense nonaqueous-phase liquid (DNAPL) source zone treatment is one of the most significant remediation challenges facing the Department of Defense (DoD) and the private sector. As a result, the number of in situ cleanup technologies developed and tested at DNAPL sites has increased in recent years. Approaches that employ increased temperature, chemical oxidation, surfactant flushing, and biological degradation processes have been developed and applied with varying degrees of success.

More recent critical review of the data from many of these sites has revealed that even with the most recent advancements in application of these treatment technologies, complete DNAPL source removal is unlikely. Hence, residual DNAPL after aggressive technologies have achieved their effective endpoints are expected to continue to have an impact on groundwater quality.

This project is focused on thermal-based technologies (e.g., resistive heating, conductive heating, steam-based heating) for DNAPL source treatment and a critical assessment of the potential performance of these technologies as measured by conventional and mass flux metrics. Thermal technologies are of interest because of their rapid development in recent years and because of vendor claims that they offer unique advantages over competing technologies. In particular, it is claimed that thermal technology performance is less hindered by geologic stratification and other sources of mass-transfer resistances than other flow-based technologies applied to DNAPL source zones (such as surfactant flushing, chemical oxidation, and in situ sparging).

This project is complementary to other ESTCP and SERDP projects that are looking at relationships between DNAPL architecture, treatment effectiveness, and groundwater mass discharge (flux). It is unique from the other projects in that the final report will tie together a combination of results from empirical analyses of available field data and project-specific field sampling at target sites.

It is important to note that this project is unlike other ESTCP projects in that it does not involve the field demonstration of a particular technology nor is it linked to any specific site(s). This document, therefore, is non-site-specific, and while it does focus on thermal-based DNAPL treatment technologies, it is non-technology specific.

1.2 OBJECTIVE OF THE DEMONSTRATION

In this project, the performance of thermal technologies for DNAPL source zone remediation was assessed through compilation and critical review of data available from pilot- and full-scale applications. Particular emphasis was placed on gaining a better understanding of settings in which thermal technologies have been applied, the design and operating conditions that were used, and the performance of the systems. With respect to the latter, particular emphasis was placed on post-treatment groundwater quality and source zone residual mass discharge to the aquifer (commonly referred to as “mass flux”). This critical evaluation was supplemented with post-treatment field sampling at selected sites to fill data gaps. This project was complementary to and made use of knowledge gained from other ESTCP and SERDP projects that were looking at relationships between DNAPL architecture, treatment effectiveness, and groundwater mass discharge (flux).

Included with this report are Summary Tables (spreadsheet-based tables) that can be used by practitioners, regulators, and site owners to anticipate the likely performance of thermal-based DNAPL treatment technologies at their sites. Each table is a tool where application and performance experience are linked to a small number of generalized geologic scenario site descriptors. The user can choose the generalized scenario that most closely resembles their site and can quickly assess:

a) how the technology has been applied to date in that type of setting,
b) the designs employed,
c) the operating conditions,
d) the performance monitoring that results are based on, and
e) the performance observed.

1.3 REGULATORY DRIVERS

Regulatory agencies at the federal, state, and local levels generally have groundwater quality concentration-based metrics that necessitate treatment or containment of DNAPL source zones. Thermal treatment technologies, which have undergone significant development in the past decade, present innovative options for source zone treatment.

2.0 TECHNOLOGY

This project does not involve the demonstration of a developing technology, as is common for most ESTCP projects. Rather, it seeks to supplement our understanding of existing thermal treatment technologies through the development of a practicable tool in which performance experience and theoretical bounds on performance expectations are linked to a small number of generalized scenario site descriptors. This section describes in situ thermal technology development and use.

2.1 TECHNOLOGY DESCRIPTION

The history of in situ thermal technology development and use is summarized in the United States Environmental Protection Agency (USEPA), March 2004 report, *In Situ Thermal Treatment of Chlorinated Solvents: Fundamentals and Field Applications*. In brief, most in situ thermal cleanup technologies originate from thermal heating technologies developed for enhanced oil recovery applications. In the past two decades, the understanding of in situ heating and fluid recovery gained from enhanced oil recovery applications has been applied to hazardous waste site cleanups.

The in situ thermal technologies which are most commonly used and for which data were available include steam-based heating (sometimes referred to as steam-enhanced extraction), conductive heating (sometimes referred to as in situ thermal desorption), electrical resistance heating (sometimes referred to as six- or three-phase heating), radio-frequency heating, and in-situ soil mixing with large diameter augers combined with steam and hot air injection. Each of these technologies relies on heat to enhance the removal and treatment of contaminant vapors and liquids from the subsurface. Depending on operating temperatures, heating may decrease contaminant liquid viscosity, decrease interfacial tension, increase biodegradation rates, increase solubility, and/or increase volatility. What differentiates one technology from the next is the method of heating or energy delivery, for example: steam injection, resistive heating by passing a current through the soil between electrodes, conductive heating accomplished by heat conduction away from in situ heating elements, and radio frequency heating from radio waves. Detailed descriptions of these technologies along with vendor supplied state-of-the-practice reports (with the exception of radio-frequency heating which has had limited application) are provided in Appendix B and can also be found in greater detail in Triplett Kingston (2008).

The approach used in this study to summarize data on the application and performance of in-situ heating technologies (i.e., performance experience and theoretical bounds on performance expectations linked to a small number of generalized scenario site descriptors) was similar to that employed in the NRC 2004 report *Contaminants in the Subsurface: Source Zone Assessment and Remediation*. The approach, as it pertained to this project, was to identify sites where thermal technologies had been applied and to collect and compile site characterization and in situ thermal design, operation, and treatment data from each. Although 180 in situ thermal applications were identified, acquisition of detailed application and performance data was difficult and of varying quantity and quality.

For each in situ thermal application studied, data collection focused on:

- Setting (geology, depth to groundwater, source zone boundaries, chemicals present, etc.),
- System design parameters (number of energy delivery points, area and depth of the treatment zone, etc.),
- Operating conditions (temperature achieved, duration of treatment, duration of monitoring, etc.), and,
- Performance data (emphasizing improvement in groundwater quality and reduction in mass discharge of contaminant to the aquifer).

To streamline data collection and maintain consistency of the data collected from each site, data logs were used. Data logs are shown in Appendix C.

Data reduction involved interpretation and the use of professional judgment, especially when comparing pre- and post-treatment groundwater impacts. To simplify data reduction and remain consistent with the typical quality and quantity of available data, performance data were quantified only in terms of order-of-magnitude reductions in groundwater concentrations and source zone mass discharges.

Results were compiled in tables in a manner thought to be useful to practitioners that might be interested in evaluating thermal treatment options for their sites and who would benefit from this empirical compilation of historical data.

2.2 ADVANTAGES AND LIMITATIONS OF THE TECHNOLOGY

Thermal technologies are attractive because of potentially shorter treatment times (weeks or months, rather than years for many other technologies) and lower total operations and maintenance costs. Only energy, and in some cases water and air, are added to the subsurface, rather than chemicals or bio-amendments.

In situ thermal technologies are thought to have advantages relative to other remedial options, including: (1) shorter operation times, (2) many chemicals can be treated at once, and (3) some thermal technologies, ERH and conductive heating in particular, are less sensitive to subsurface heterogeneities across a site.

The potential drawbacks of use of in situ thermal technologies include the following: (1) they are difficult to apply near occupied/active sites; (2) they require more sophisticated design and operation; (3) they may enhance the potential for contaminant to migrate to previously non-impacted areas; and (4) post-treatment soil temperatures may remain elevated for prolonged periods of time (months to years).

In addition, poor documentation and a lack of quantitative post-treatment performance data has made it difficult to confidently define practicable performance expectations for thermal technologies.

3.0 PERFORMANCE OBJECTIVES

The performance objectives for this project are captured below in Table 1.

Table 1. Performance Objectives

Performance Objective	Data Requirements	Success Criteria	Results
Quantitative Performance Objectives			
Collect data on in-situ thermal applications	Data on hydrogeologic setting, type and method of application, temperature data, and estimate of contaminant reduction	• Ability to obtain documentation • Data exists in documentation	Summary table of relevant data.
Qualitative Performance Objectives			
Assess Groundwater Quality and Mass Discharge	Groundwater concentration data and groundwater velocity	Ability to obtain accurate concentration data and velocity data	Summary tables of concentration and mass discharge data.

Developing the Preliminary Assessment Tool involved the following tasks:

- Task 1 - Data collection, review, and compilation of historical performance data: Using professional judgment, application and performance data were reduced, linked to idealized geologic conceptual models, and summarized in user-friendly performance summary tables.
- Task 2 - Supplemental post-treatment field investigations performed at sites identified in Task 1: Sites were chosen to best augment the information compiled in Task 1.

More detailed discussions of the technical approach for each task are given below.

Task 1 - Data Compilation, Interpretation, and Capture in Tables: The objective of this task was to compile and review DNAPL source zone treatment/characterization experiences at existing field sites by mining historic data from sites where a thermal treatment had been applied. Data requirements needed to support the review of thermal treatment applications and to develop and classify the sites into the idealized conceptual models included:

- subsurface and hydrogeologic characteristics (generalized geologic descriptions, groundwater flow direction, hydraulic conductivity),
- pre-treatment characterization data (chemical concentrations and distribution, source area, DNAPL mass estimates, etc.),
- technology implementation,
- DNAPL removed and measurement methods,
- DNAPL mass and/or distribution remaining after treatment,
- dissolved contaminant concentrations in and down gradient of the source zones (preferably over a period of time sufficient to evaluate rebound),
- remedial action objectives,

- post-treatment status of the source-zones/sites (e.g., monitored natural attenuation with long-term monitoring, pump-and-treat with institutional controls, closure), and
- treatment costs incurred.

Efforts during this project focused on identifying sites where thermal technologies had been applied and collecting as much of the available data listed above for those sites. It was found that thermal technologies have been applied at numerous sites but obtaining detailed site characterization and treatment/performance data for the thermal application was difficult as it was either not collected or not reported for many sites. Through considerable effort, data of varying quantity and quality was obtained for 182 thermal sites.

A preliminary review of the data revealed that database compilation would require more professional judgment and interpretation of the data than initially anticipated. Also, the construction of the database needed to be an iterative process that resulted in a final database structure reflective of the type of information contained in the reports. Because of these issues, it was critical that all key project personnel were engaged in this activity on an on-going basis.

Sample Summary Tables are shown below in Figures 1 and 2.

Task 2 - Supplemental Field Investigations at Thermal Treatment Sites: This task involved the collection of field data from sites that had undergone thermal treatment and for which sufficient time had elapsed to allow the subsurface environment to return to pre-treatment conditions. **S**upplemental data collection focused on assessing groundwater impacts as quantified by dissolved concentrations and source zone discharge (mass flux) to the aquifer following an in situ thermal treatment for NAPL removal. Site selection was based on available data and priorities for data augmentation in the summary tables, idealized conceptual models (that all results were tied to), the frequency of occurrence of site type in the broader database population of sites, and supplemental data needs identified from the database analysis.

Once the sites were selected, approvals were sought for site access, demonstration plans were prepared for each site, site investigations were performed, and field data reports were issued.

Scenario	Technology	# of Sites	# of Pilot Tests	# of Full-Scale Systems	Name(s) of Best Studied Site(s)	Peak Temperature Achieved in Target Treatment Zone			Duration of Treatment at Peak Temperature			Duration of Post-Treatment Monitoring			Estimated Post-Treatment Mass Discharge			Estimated Reduction in Mass Discharge			Criteria Used to Assess Success
						Low [C]	to	High [C]	Low [days]	to	High [days]	Low [days]	to	High [days]	Low [gm/d]	to	High [gm/d]	Low [%]	to	High [%]	see footnotes
Generalized Scenario A: relatively homogeneous and permeable unconsolidated sediments (mixtures of sands, gravels and silts, etc.)	Steam Heating																				
	Resistance Heating																				
	Other																				
Generalized Scenario B: relative homogeneous and relatively impermeable unconsolidated sediments (clays, silty clays, etc.)	Steam Heating																				
	Resistance Heating																				
	Other																				
Generalized Scenario C: largely permeable sediments with interbedded lenses of low permeable material	Steam Heating																				
	Resistance Heating																				
	Other																				
Generalized Scenario D: largely impermeable sediments with interbedded layers of higher permeable material	Steam Heating																				
	Resistance Heating																				
	Other																				
Generalized Scenario E: competent, but fractured bedrock	Steam Heating																				
	Resistance Heating																				
	Other																				
Generalized Scenario F: weathered bedrock	Steam Heating																				
	Resistance Heating																				
	Other																				
Generalized Scenario G:	Steam Heating																				
	Resistance Heating																				
	Other																				

Footnotes:
1- concentration reduction in existing monitoring well network
2 - asymptotic performance limit of treatment system
3 - mass discharge reduction
4 - mass removal criteria

Figure 1. Sample of Overall Data Summary Table

Technology	Site Name	Geology at This Site is Most Like Scenario ...	Year(s) Applied	Pilot Test?	Full-Scale System?	# of Energy Delivery Points (wells or electrodes)	Size of Target Treatment Area	Thickness of Target Treatment Interval	Depth to Top of Treatmnent Zone	Thickness of Treatment Zone Below Ground Water Table	Peak Temperature in Target Treatment Zone	Duration of Treatment at Peak Temperature	Number of Ground Water Monitoring Wells Used for Post-Treatment Monitoring	Duration of Post-Treatment Monitoring	Estimated Post-Treatment Mass Discharge			Estimated Reduction in Mass Discharge			Criteria Used to Assess Success
							[ft^2]	[ft]	[ft BGS]	[ft]	[C]	[days]		[days]	Low [gm/d]	to	High [gm/d]	Low [%]	to	High [%]	[see footnotes]
Steam Injection	Site #1																				
	Site #2																				
	Site #3																				
Electrical Resistance Heating	Site #27																				
	Site #28																				
	Site #29																				
Other Thermal Treatments	Site #62																				
	Site #63																				
	Site #64																				

Scenario Descriptors (for the target treatment zone)
A - relatively homogeneous and permeable unconsolidated sediments (sands, etc.)
B - relative homogeneous and relatively impermeable unconsolidated sediments (clays)
C - largely permeable sediments with interbedded lenses of low permeable material
D - largely impermeable sediments with interbedded layers of higher permeable material
E - Competent, but Fractured Bedrock
F - Weathered Bedrock

Footnotes - Success Criteria:
1- concentration reduction in existing monitoring well network
2 - asymptotic performance limit of treatment system
3 - mass discharge reduction
4 - mass removal criteria

Figure 2. Sample of Site-Specific Summary Table

4.0 SITE DESCRIPTION

As indicated previously, this ESTCP project does not involve the demonstration of a developing technology. Rather, it seeks to supplement our understanding of existing thermal treatment technologies. This was accomplished in two tasks: Task 1) Data Compilation, Interpretation, and Capture in Tables; and Task 2) Supplemental Field Investigations at Thermal Treatment Sites. The former involved an empirical analysis of existing data and is therefore not relevant to this section; the latter involved field data collection and is therefore the focus below.

4.1 SITE SELECTION

The following were considerations when selecting candidate sites for supplemental field investigations:

- Sufficient post-treatment time had elapsed for subsurface temperatures to return to pre-treatment conditions;
- Priorities for augmenting performance summary tables and supplemental data needs indentified from the database analysis from data collection and the empirical analysis of sites; and,
- Conceptual model types and the frequency of occurrence of each type of site in the broader database population of sites.

In addition, it was preferable that sites had the following characteristics:

- The hydrogeology of the site was reasonably well-characterized (flow direction, depth to groundwater, hydraulic properties and changes with depth are known semi-quantitatively, etc.);
- The aerial extent of the source zone was reasonably defined prior to treatment;
- The depth to groundwater was less than 20 ft;
- The total depth to impacted groundwater was less than 40 ft;
- There was access immediately down-gradient of the treatment zone for drilling and additional site investigation;
- Direct-push technology could be used for drilling/sampling purposes; and,
- Local site personnel were present to facilitate the logistics associated with the sampling events.

Brief descriptions of all the sites are provided below. For more detailed information, Appendix D provides full descriptions of each site.

4.2 SITE LOCATION AND HISTORY

Four sites were selected for supplemental data collection and investigation of post-treatment groundwater quality. These sites and a brief history for each are shown below while Figure 3 shows the location for each on a map of the continental United States:

1) Site 89, Camp LeJeune, Jacksonville, North Carolina:
   History: Site 89 at the Camp Geiger portion of Marine Corps Base (MCB) Camp LeJeune was used primarily as a storage yard for the Defense Re-utilization Marketing Office (DRMO) until June 2000.
   Treatment History: Electrical resistive heating (ERH) was selected as the technology to remove DNAPL. The system consisted of 43 deep heating electrodes installed to a depth of 26 ft below ground surface (bgs) and 48 shallow heating electrodes installed to a depth of 19 ft bgs. The system was operated from September 2003 until the beginning of May 2004. The remedial system performance was continuously monitored during operation, and an estimated 48,000 pounds of volatile organic compound (VOC) contamination were removed in recovered volatile vapors and 428 pounds of chlorinated compounds were recovered from the groundwater during the application. After the shutdown of the system, the monitoring well network was monitored for one year.

2) Building 5, Site 5-1, Naval Air Station (NAS) Alameda, Alameda, California:
   History: Building 5 housed specialty shops for aircraft component repair and maintenance from 1942 until the base was closed in April 1997. Chemical contaminants from the various industrial processes inside Building 5 are believed to have been released directly to the subsurface beneath certain operational areas.
   Treatment History: A pilot scale electrical resistive heating (ERH) application was performed in June of 2002. Based on the results of the pilot, a full-scale system was installed and operated. The system consisted of 7 electrodes installed to a depth of 19 ft bgs and 28 electrodes installed to a depth of 14 ft bgs and 1 electrode installed to 15 ft bgs. The full-scale system was operated from July 2004 until November 2004. The remedial system performance was continuously monitored during operation, and an estimated 3,000 pounds of volatile organic compound (VOC) contamination were removed in recovered volatile vapors and groundwater. After the shutdown of the system, the monitoring well network was monitored for four months.

3) Building 181, Air Force Plant 4 (AFP4), Ft. Worth, Texas
   History: Building 181 is part of a mile long structure designed for aircraft production. The primary contaminant at Building 181 is trichloroethylene (TCE). The TCE source is believed to be degreaser tanks in Building 181, which have since been removed. Several subsequent investigations found that releases of TCE had migrated through cracks in the concrete building floor resulting in contamination in the saturated and unsaturated zone.
   Treatment History: A pilot scale six-phase electrical resistance heating (ERH) application was performed completed in the winter of 2001. Based on the results of the pilot, a full-scale three-phase electrical resistance application was performed in Building 181 in 2002. The full-scale system consisted of 73 electrodes installed to a depth of 32 ft bgs, including 7 electrodes from the pilot-scale test and 2 electrodes installed during operation to enhance heat generation in target areas. The full-scale system was operated from May 2002 until December 2002. The remedial system

performance was continuously monitored during operation, and an estimated 1,417 pounds of TCE was removed via steam and vapor extraction systems. The treatment area has been monitored semi-annually since the system was shut down in 2002.

4) Former Pumphouse No. 2, Hunter Army Airfield (HAAF), Savannah, Georgia
History: Former Pumphouse No. 2 at Hunter Army Airfield (HAAF) was an aviation-gas fuel island that was used from 1953 until the early 1970s. During previous investigations, petroleum contaminates were identified in the soil and groundwater, including benzene, toluene, ethylbenzene, and xylenes (BTEX), as well as polynuclear aromatic hydrocarbon (PAH) constituents in the form of free product light non-aqueous phase liquid (LNAPL). The LNAPL source area was determined to be approximately 11,500 square feet (ft^2) by the time the ERH application was performed.
Treatment History: During the previous investigations, free product was identified. It was recommended that electrical resistance heating (ERH) be implemented to remove the free product. The system consisted of 111 electrodes installed to a depth of 16 ft below ground surface (bgs) with the conductive interval set from 8 to 16 ft bgs. A full-scale ERH system was operated from March 2002 until July 2002. After shutdown, the piezometers installed for the ERH application were left in place and are still being sampled semi-annually.

Supplemental data collection was also performed at a fifth site, Ft. Lewis East Gate Disposal Yard Area 3, Ft. Lewis, Washington. Data collection differed at the Ft. Lewis East Gate Disposal Yard since it was a real-time evaluation of a thermal treatment to evaluate the concurrent and post-treatment groundwater response. A brief summary of Ft. Lewis East Gate Disposal Yard shown below and Figure 3 shows its location:

5) Ft. Lewis East Gate Disposal Yard Area 3, Ft. Lewis, Washington
History: Ft. Lewis was initially developed as a Logistics Center in April 1942, but was transferred to ordnance jurisdiction in August 1942. It operated as an ordnance depot until 1963 when the area was turned back over to the Logistics Center to serve as the primary non-aircraft maintenance facility for Ft. Lewis. The main degreasing agent used at this facility until the mid-1970s was Trichloroethylene (TCE) when it was replaced with 1,1,1-trichloroethane (1,1,1-TCA). The waste TCE was disposed of with waste oils at several locations including the East Gate Disposal Yard (EGDY). The EGDY was used between 1946 and the mid-1970s as a waste disposal site storing barrels and vats in trenches around the yard.
Treatment History: The remedial investigations identified free product interspersed throughout the soil matrix mainly in the form of ganglia and globules. It was recommended that electrical resistance heating (ERH) be implemented to remove the free-phase product and optimize the existing groundwater pump-and-treat system. The system consisted of 93 electrodes installed to a depth of 30 ft below ground surface (bgs) with the conductive interval set from 0 to 30 ft bgs. The third full-scale ERH system at the EGDY was operated from October 2006 until January 2007. After shutdown, the monitoring wells installed for the ERH

application were left in place and are still being sampled throughout the cool-down process and then will continue to monitored quarterly.

Figure 3. Site Locations for Supplemental Investigations

4.3 SITE GEOLOGY/HYDROGEOLOGY

Table 2 below provides pertinent information regarding the site geology/hydrogeology for each supplemental data collection site. In addition, the table includes information regarding the thermal treatment applied at each.

Table 2. Site Geology, Hydrogeology, and Treatment Area Information.

Site ID	Technology	Geology at This Site is Most Like This Conceptual Scenario[1]	Number of Permanent Monitoring Wells	Type of Chemicals Treated (C-chlorinated solvents, P-petroleum hydrocarbons, W-Wood-treating, O-other)	Size of Target Treatment Area [ft^2]	Thickness of Target Treatment Interval [ft]	Depth to Water [ft]
Hunter Army Airfield Former Pumphouse #2	ERH	A	12	P, O	30,000	8	13
Air Force Plant 4 Bldg. 181	ERH	B	21	C	21,780	37	30
NAS Alameda Building 5, Site 5-1	ERH	C	15	C	14,520	20	6
Ft. Lewis EDGY Area 3	ERH	C	17	C, P	18,200	30	N/A
Camp LeJeune Site 89	ERH	C	26	C	15,873	21	5

[1]Scenario Descriptors (for the target treatment zone)
- A - relatively homogeneous and permeable unconsolidated sediments (sands, etc.)
- B - largely impermeable sediments with interbedded layers of higher permeable material
- C - largely permeable sediments with interbedded lenses of low permeable material
- D - Competent, but fractured bedrock
- E - Weathered Bedrock

ERH - Electrical resistance heating
N/A - Not Available

4.4 CONTAMINANT DISTRIBUTION

Field investigations associated with this project focused on post-treatment groundwater sampling across a transect perpendicular to groundwater flow and immediately down-gradient of the treatment zone at each site. The lateral and vertical distributions of contaminants in groundwater were determined at each site by on-site chemical analyses conducted as samples were collected. The width of each transect is given in Table 3 below.

Table 3. Sampling Transect Widths at the Supplemental Field Sites.

Site ID	Treatment Zone Width Perpendicular to GW Flow (ft)	Comments
Hunter Army Airfield Former Pumphouse #2	400	Documentation indicated quasi radial groundwater flow from the source zone, likely the result of drainage to a doglegged drainage ditch adjacent to the site.
Air Force Plant 4 Bldg 181	170	Flow direction based on groundwater contour maps and contaminant distribution from site documentation.
NAS Alameda Building 5, Site 5-1	115	Flow direction based on groundwater contour maps and site documentation.
Ft. Lewis EGDY Area 3*	110	Flow direction based on groundwater contour maps and site documentation.
Camp LeJeune Site 89	255	Flow direction based on groundwater contour maps. However, site constraints would require a transect with an approximate 30 degree angle, the apex of which was directly downgradient of source zone.

5.0 TEST DESIGN

As in Section 4.0, this section focuses on the supplemental field investigation component of this project.

5.1 CONCEPTUAL EXPERIMENTAL DESIGN

The goal of the supplemental field investigations was to collect sufficient groundwater and aquifer characterization data to assess post-treatment groundwater quality and mass discharge immediately down-gradient of source zone areas where an in situ thermal remediation had been applied. Data determined necessary for a competent evaluation of the site included the following: 1) depth-specific groundwater quality data and aquifer characterization data along a transect down-gradient of the source zone and perpendicular to the groundwater flow direction; 2) groundwater quality data and aquifer characterization data from monitoring wells in and adjacent to the source/treatment zone; 3) soil core collection to confirm geologic conceptual model; and 4) depth to water measurements for flow direction and gradient.

To accomplish the goal described above, the following field activities were undertaken:

- Groundwater sampling and aquifer characterization at depth-discrete sampling points along a transect down-gradient of the treatment zone and perpendicular to the direction of groundwater flow,
- Groundwater sampling and aquifer characterization at select monitoring wells in or adjacent to the treatment zone, and
- Analysis of water samples for general chemistry and hydrocarbon concentrations.

Aquifer characterization involved the following activities:

- Aquifer specific-capacity tests or slug tests of both depth-discrete sampling points along transects and permanent monitoring wells,
- Depth to water measurements, and
- Soil core collection.

These activities were conducted at Hunter Army Airfield, Air Force Plant 4, NAS Alameda Bldg. 5, and Camp LeJeune Site 89. The Ft. Lewis EGDY site supplemental data collection involved analysis of groundwater samples collected from permanent monitoring wells (shipped to ASU by Army Corps of Engineers personnel). Samples were collected during 16 sampling events over a 1.5 year time frame, and included pre-, concurrent-, and post-treatment sampling events.

5.2 BASELINE CHARACTERIZATION

Baseline characterization data for each supplemental characterization site were obtained from existing reports. The field studies associated with this project focused on post-treatment groundwater quality and mass flux assessment from completed thermal remediation sites, and therefore, baseline pre-treatment data had to be obtained from site reports.

5.3 TREATABILITY OR LABORATORY STUDY RESULTS

No treatability or laboratory studies were conducted as part of this project as the focus was on critical assessment of thermal technologies already being applied at the pilot- and full-scale.

5.4 DESIGN AND LAYOUT OF TECHNOLOGY COMPONENTS

No system design was conducted in this project as the focus was on critical assessment of thermal technologies being applied at the pilot- and full-scale. The designs of the thermal remediation systems implemented at sites selected for the supplemental post-treatment assessment work are summarized along with all other thermal system designs reviewed in this work in the tables presented in Chapter 6.

5.5 FIELD TESTING

Field testing for this project differed from other ESTCP projects since no demonstration was performed. Field investigations at four of five demonstration sites focused on the assessment of post-treatment groundwater quality and mass flux of contaminant from the treatment zone. Field investigations at these sites included groundwater sampling for analysis of general water quality parameters and hydrocarbon concentrations, aquifer characterization, soil core collection for verification of geology, and depth to water measurements for groundwater flow direction and gradient. Field investigations at the fifth site focused on groundwater quality response during and following an active thermal treatment.

5.6 SAMPLING AND ANALYTICAL METHODS

To accomplish the goals described above, the following field activities were undertaken:

- A sampling transect down-gradient of the treatment zone and perpendicular to the direction of groundwater flow was identified. Each transect encompassed the width of the original source zone and down-gradient dissolved plume, unless portions were inaccessible. Ideally, transects would have at least 10 sampling locations, each of which would have at least five sampling depths. Actual sampling locations and depths were dictated by site-specific factors/costs,
- At each sampling location, depth-discrete groundwater samples and aquifer characterization data were collected using direct push technology.
- Groundwater sampling and aquifer characterization was also performed at select monitoring wells in and adjacent to the treatment zone.
- Water samples were analyzed onsite for general chemistry (pH, electrical conductivity, temperature, dissolved oxygen, and oxidation reduction potential) and hydrocarbon concentrations (chlorinated solvent or petroleum hydrocarbon). Hydrocarbon concentrations were analyzed using gas chromatography and were performed on-site to

help guide selection of the sampling locations and provide a basis for any in-the-field revisions to the sampling plan.

Aquifer characterization involved the following activities:

- Aquifer specific-capacity tests: Aquifer specific capacity tests were conducted in permanent monitoring well locations of interest when slug testing was not possible and at all depth-discrete groundwater sample locations where depth to water did not exceed the capabilities of a peristaltic pump. Depth-discrete tests were conducted using a direct-push rod equipped with a groundwater sampler. Specific capacity tests involved the measurement of the steady flow rate achieved with a fixed drawdown; ideally, all tests were conducted with the same fixed drawdown (usually 0.3 – 1.0 feet), but that was variable depending on the rate of groundwater production at each interval.
- Slug testing: Slug tests were conducted in selected monitoring wells within and directly adjacent to the treatment zone. At one site where depths-to-water were too great (Air Force Plant 4), pneumatic slug testing was used at all depth-discrete groundwater sampling locations.
- Depth-to-water measurements: Depth-to-water was measured in all monitoring wells in and adjacent to the treatment zone. Using survey data from site records, measurements were converted water level elevations to determine groundwater flow direction and gradient at the time of sampling.
- Soil core collection: One to three direct-push soil cores were collected from each site. Continuous soil cores were collected along the downgradient edge of the treatment zone and extended from about 2 ft above the current groundwater elevation down to the deepest known depth of groundwater impact. Soil cores were used to confirm the site geologic conceptual model and, as needed, were subdivided in the lab into sections with visually distinct geologies for permeameter testing.

Sampling and analytical methods are summarized in Table 4.

Depth-discrete groundwater samples were collected using direct-push groundwater samplers (e.g. Geoprobe screen point sampler or groundwater profiler) and peristaltic pumps with dedicated polyethylene tubing. As possible, each sample depth was purged for at least one probe rod volume (typically about 1-L) and until a portable YSI DO meter inserted in a flow-through cell indicated stable DO and temperature readings. When purging was complete, zero-headspace groundwater samples were collected in two 40 ml volatile organic analysis (VOA) vials for analysis on site.

Groundwater sample collection from permanent monitoring wells and/or piezometers was facilitated by peristaltic pump, disposable bailers, or submersible electric pump.

Table 4. Sampling Methods.

Measurement	Description of Analyses
Field water quality measurements	Analysis of pH, electrical conductivity (EC), temperature, dissolved oxygen (DO), and oxidation reduction potential (ORP) using an Horiba U-22 with flow through cell. In certain circumstances, only dissolved oxygen was measured using a YSI 550A DO meter with flow through cell. Meters were calibrated as per manufacturer instructions at least once per day.
Hydrocarbons Chemicals of interest in groundwater (inclusive of Ft. Lewis EGDY samples)	Sample collection: Samples were collected with zero-headspace in 40 mL VOA vials and placed on ice until analyzed. Sample analysis: Heated headspace method with on-column injection. 30-ml sample warmed in 40-ml VOA vial to 35°C followed by 0.5 ml on-column injection of headspace on the GC. Separation by capillary column and analysis by PID, FID, and/or DELCD.
Specific Capacity	Specific capacity tests were conducted using an electronic water level indicator, a volumetric cylinder, a peristaltic pump, and a stop watch. After driving a direct-push rod to the desired depth, the water level was measured in the rod until stable. Then the polyethylene tubing inlet was lowered 1 ft below the stable water level and the peristaltic pump was run at a high speed that draws the water down to that level (this is apparent by slugs of air coming up in the tubing). At this point, the flow was measured by recording the time to collect 1-L of water, or under low flow conditions, how much water was collected in a ten-minute interval. Successive analyses were conducted to ensure that the yield had reached a stable value.
Slug Tests	Slug tests were conducted in conventional wells using a data-logging pressure transducer and a slug capable of displacing about 2 ft of water. The slug was either lowered into, or pulled out of the well, and the water level response was monitored until it stabilized at the pre-test level. The data was then analyzed by standard slug-test analysis methods.

At the time of sample collection, sample vials were labeled with the location ID and sampling depth. Sample collection followed procedures defined in Table 5. Since samples collected at the four field sites were analyzed within 24 hours of collection (and typically within 4 hours), samples were only preserved on ice. Since Ft. Lewis EGDY samples were shipped, they included hydrochloric acid (HCl) preserve.

Table 5. Groundwater Sample Collection Procedures.

Matrix	Analyte	Container	Preservative	Holding Time
Groundwater	Chlorinated and Petroleum Hydrocarbons	40 ml VOA	Ice*	<24 hours (on site)
		40 ml VOA	HCl, Ice (Fort Lewis EGDY site only)	<7 days (shipped to ASU)

All hydrocarbon analyses including the Ft. Lewis EGDY analyses were conducted using a heated headspace (35°C) method on dedicated SRI Model 8610C gas chromatographs equipped with FID, PID, and DELCD detectors and a DB-1 type capillary column. The instruments were calibrated each day against at least three different concentrations spanning the concentration range of interest (e.g. 10, 100, 1000 µg/L for dissolved concentrations). In addition, calibration samples were analyzed on a regular basis throughout each day to detect instrument drift. Reporting levels of 1 ug/L were established based on the calibration results.

Quality assurance (QA) samples were collected at a frequency of not less than one in ten samples. QA samples included both duplicate (split) sample collection and analysis and replicate sample analysis.

All sampling locations were recorded. For temporary sampling or transect locations, exact location was based on measurement from at least two known surveyed locations (i.e., existing wells). These measurements were then used for plotting purposes and northings/eastings could be back-calculated from known survey points. Sample locations for Ft. Lewis EGDY were surveyed.

All sampling activities were recorded in site dedicated field books. More specifically, all project, field personal maintained a continuous record of site activities their own dedicated field book.

Appendix E provides additional detail on the calibration of analytical equipment, quality assurance sampling, decontamination procedures, and sample documentation.

5.7 SAMPLING RESULTS

Specifics of the supplemental site investigation are summarized below. More detailed individual field summary reports are provided in Appendix D. Table 6 summarizes details of the sampling transects (transect length, number of sampling locations, depth intervals, etc.). Table 7 provides the number of locations where groundwater samples were collected and aquifer characterization tests were performed. Tables 8 and 9 provide an overview of pre- and post-treatment groundwater concentrations and calculated mass discharge for each site, respectively. Table 9 also provides the calculated mass discharge normalized to the width of the treatment zone perpendicular to the flow direction [mass discharge per linear distance]. The mass discharge calculations were performed using the ESTCP-sponsored Mass Flux Toolkit software provided by GSI, Inc. Mass discharge calculations for each of the constituents can be found in the field reports in Appendix D.

Table 6. Mass Discharge Sampling Transect Details for Supplemental Site Investigations.

Site ID	Number of Transect Sampling Locations	Transect Length (ft)	Vertical Sampling Interval (ft bgs)	Number of Depth-Specific GW Samples	Number of Aquifer Specific-Capacity Tests
Hunter Army Airfield Former Pumphouse #2	10	400	12 - 22	48	47
Air Force Plant 4 Bldg 181	10	170	29 - 35	13	9
NAS Alameda Site 5-1, Bldg. 5	7	115	6.5 - 21	39	39
Camp LeJeune Site 89	7	255	3 - 40	78	62
Ft. Lewis EGDY Area 3*	N/A	N/A	N/A	N/A	N/A

ft - Feet
bgs – Below ground surface
N/A – Not applicable to this site –
Note: All analysis were performed via groundwater samples from permanent monitoring wells collected by the Corp of Engineers and were sent directly to ASU for analysis. Analyses were performed pre-, during, and post-treatment to gauge how contaminant flux changed while treatment was occurring.

Table 7. Total Number and Types of Samples Collected.[1]

Site	Sampling Location	Number of GW Sample Locations	Number of Aquifer Characterization Test Locations	Analytes
Hunter Army Airfield, Former Pumphouse 2	Permanent Monitoring Wells	12	11	Petroleum Hydrocarbons
	Transect/Discrete-depth Locations	10	48	
Air Force Plant 4 Bldg. 181	Permanent Monitoring Wells	18	15	Chlorinated Solvents
	Transect/Discrete-depth Locations	11	13	
NAS Alameda Site 5-1,Bldg. 5	Permanent Monitoring Wells	11	11	Chlorinated Solvents
	Transect/Discrete-depth Locations	7	39	
Camp LeJeune Site 89	Permanent Monitoring Wells	26	23	Chlorinated Solvents
	Transect/Discrete-depth Locations	7	78	
Ft. Lewis EGDY Area 3	Permanent Monitoring Wells	17 (16 sampling events)	0* (16 sampling events)	Chlorinated Solvents

[1] Exact information on total number of samples collected can be found in Appendix D which contains the Field Reports for each site.
* Aquifer characterization data for the wells used were obtained from site reports for the Fort Lewis EGDY site.

Table 8. Range of Permanent Monitoring Well Pre- and Post-Treatment Concentration Data (ug/L)**.**

Site	Contaminant	Pre-treatment Concentration Ranges From Site Documentation (ug/L)		Post-treatment Concentration Ranges from Supplemental Field Investigations Performed Under This Study (ug/L)	
		High	Low	High	Low
Hunter Army Airfield, Former Pumphouse 2	Benzene	1,670	102	342	ND<1
	Toluene	3,630	7.6	18	ND<1
	Ethylbenzene	9,470	426	377	ND<1
	Xylenes	40,500	594	169	ND<1
	Naphthalene	N/A	N/A	43	ND<1
Air Force Plant 4, Bldg 181	Vinyl Chloride	N/A	N/A	1	ND<1
	1,1-Dichloroethene	N/A	N/A	120	ND<1
	Trans-1,2-Dichloroethene	N/A	N/A	26	ND<1
	1,1-Dichloroethane	N/A	N/A	390	ND<1
	Cis-1,2-Dichloroethene	N/A	N/A	14,000	ND<1
	1,2-Dichloroethane	N/A	N/A	670	ND<1
	1,1,1-Trichloroethane	N/A	N/A	1	ND<1
	Trichloroethylene	285,000	5,960	59,000	130
	1,1,2-Trichloroethane	N/A	N/A	ND<1	ND<1
	Tetrachloroethene	N/A	N/A	5	ND<1
NAS Alameda, Site 5-1, Bldg. 5	Vinyl Chloride	8,140	ND<0.5	29	ND<1
	1,1-Dichloroethene	15,100	ND<0.5	2	ND<1
	Trans-1,2-Dichloroethene	300	ND<0.5	2	ND<1
	1,1-Dichloroethane	48,800	15	2	ND<1
	Cis-1,2-Dichloroethene	13,700	ND<1.3	71	ND<1
	1,2-Dichloroethane	ND<250	ND<0.5	ND<1	ND<1
	1,1,1-Trichloroethane	42,000	ND<0.5	ND<1	ND<1
	Trichloroethylene	1,600	ND<0.5	76	1
	1,1,2-Trichloroethane	ND<250	ND<0.5	ND<1	ND<1
	Tetrachloroethene	54	ND<0.5	47	ND<1
Camp LeJeune, Site 89	Vinyl Chloride	1,400	ND<1	24,000	ND<1
	1,1-Dichloroethene	N/A	N/A	1,700	ND<1
	Trans-1,2-Dichloroethene	49,800	ND<2	33,000	ND<1
	Cis-1,2-Dichloroethene	224,000	ND<2	110,000	1
	Trichloroethylene	541,000	ND<2	140,000	ND<1
	1,1,2-Trichloroethane	18,600	ND<2	3,600	ND<1
	Tetrachloroethene	3,720	ND<2	1,800	ND<1
	1,1,2,2-Tertrachloroethane	2,240,000	ND<2	240,000	ND<1
Ft. Lewis EGDY Area 3	Vinyl Chloride	5,800	ND<1	170	ND<1
	1,1-Dichloroethene	N/A	N/A	24	ND<1
	Trans-1,2-Dichloroethene	480	ND<1	38	ND<1
	Cis-1,2-Dichloroethene	30,000	ND<1	2,200	ND<1
	Trichloroethylene	17,000	2	2,200	ND<1
	Tetrachloroethene	9	ND<1	1	ND<1
	1,3,5-Trimethylbenzene	88	ND<1	19	ND<1
	1,2,4-Trimethylbenzene	22	ND<1	ND<1	ND<1

Note: * NAPL was found in a well; ND<X denotes non-detection at X ug/L detection level

Table 9. Summary of Mass Discharge (Mass Flux) Calculations at Field Investigation Sites.

Site	Contaminant	Pre-treatment Discharge (kg/yr)[1]	Post-treatment Mass Discharge (kg/yr)[2]	Post-treatment Mass Discharge per Linear Foot (kg/yr/ft)
Hunter Army Airfield Former Pumphouse 2*	Total Contaminant Flux	5.2×10^{1}	1.9×10^{-1}	1.1×10^{-3}
Air Force Plant 4 Bldg 181**		6.0×10^{1}	2.1×10^{1}	1.4×10^{-1}
			4.9	3.4×10^{-2}
NAS Alameda Site 5-1, Bldg. 5*		4.9×10^{1}	1.3×10^{-1}	9.6×10^{-4}
Camp LeJeune Site 89*		6.8×10^{2}	8.2×10^{1}	5.5×10^{-1}
Ft. Lewis EGDY Area 3***		3.2×10^{1}	2.1	1.9×10^{-2}

Notes:
1 Mass discharge calculations were based on monitoring well data from the documentation.
2 Mass discharge calculations were based on discrete-depth sampling data, or a combination of discrete-depth sampling data and monitoring well data.
* Mass discharge calculations were base on discrete-depth sampling data only.
** Mass discharge calculations were performed for discrete-depth sampling data only and discrete-depth sampling data with monitoring well data.
*** Mass discharge calculations were based on monitoring well data analyzed by ASU personnel.

6.0 PERFORMANCE ASSESSMENT

The performance objectives of this demonstration included:

- Collecting application data (design, setting, operating conditions, performance) from in situ thermal applications and then compile and synthesize that information in a way that would assist others to anticipate the applicability and performance of in situ thermal technologies at their sites.

- Assess changes in groundwater quality and contaminant mass discharge from source zones treated with in situ thermal technologies.

The results from each are discussed below. Section 6.1 focuses on the former, while Section 6.2 focuses on the latter.

6.1 EMPIRICAL DATA COLLECTION AND SYNTHESIS WITH EMPHASIS ON SETTING, DESIGN, AND OPERATING CONDITIONS

The in situ thermal treatment application data collected in this study were obtained from a variety of sources including: (1) site reports, (2) published literature, (3) Environmental Protection Agency (EPA) cost and performance reports, (4) discussions with project managers, vendors, and consultants, and (5) unpublished data and observations. Sites for which data were collected encompassed in situ thermal technology applications world-wide and included electrical resistance heating (ERH), steam-based heating with and without hot water injection, conductive heating, and other methods (radio-frequency heating (RFH), hot air injection, and in situ soil large diameter auger mixing with steam and/or hot air injection).

For each technology application studied, emphasis was placed on identifying:

- the setting (geology, depth to groundwater, source zone boundaries, chemicals present, etc.),
- system design parameters (number of energy delivery points, area and depth of the treatment zone, etc.),
- operating conditions (temperature achieved, duration of treatment, duration of monitoring, etc.), and,
- performance data (emphasizing improvement in groundwater quality and reduction in mass discharge of contaminant to the aquifer).

Capture of this data involved data interpretation and the use of professional judgment, especially when comparing pre- and post-treatment groundwater impacts. To simplify data reduction and remain consistent with the typical quality and quantity of available data, performance was quantified only in terms of order-of-magnitude reductions in groundwater concentrations and source zone mass discharges.

Each technology application reviewed was assigned to one of five idealized geologic scenarios, much in the same way that the NRC (2004) used generic conceptual models to summarize knowledge about treatment technologies in general. The idealized scenarios were as follows:

- *Scenario A*: relatively homogeneous and permeable unconsolidated sediments (mixtures of sands, gravels, silts, etc.)
- *Scenario B*: largely impermeable sediments with inter-bedded layers of higher permeability sediments
- *Scenario C*: largely permeable sediments with inter-bedded lenses of low permeability sediments
- *Scenario D*: competent, but fractured bedrock (i.e. crystalline rock)
- *Scenario E*: weathered bedrock (limestone, sandstone, etc.)

A category for homogeneous and impermeable settings was not created, as this setting rarely occurs and most low permeability sites have layers, albeit thin, of higher conductivity materials (Scenario B). A generic diagram of each geologic setting can be found in Figure 4.

Finally, the results were compiled and synthesized in tables in a manner thought to be useful to practitioners interested in evaluating thermal treatment options for their sites. The structure of these tables is discussed in more detail below.

After a rigorous review of the data, compiled information was sent to each respective site contact for their review and to see if additional information could be obtained.

A total of 182 in situ thermal treatment technology applications at 163 different sites were identified in this study. Table 10 presents the number of in-situ thermal applications by technology. It also indicates how many were full-scale vs. pilot-scale applications and how many occurred since 2000. As can be seen, about half of all applications (98 of 182) were implemented at full-scale, with roughly half of those (56 of the 98) being ERH systems. Table 10 also shows that 84 of 182 applications (46%) have been implemented since 2000, over half (57%) of which were ERH systems. ERH applications outnumber all other applications since 2000 by about a factor of three, and there also seems to be a recent trend in the increasing use of conductive heating and decreasing use of steam heating.

Since the quantity and quality of information available for each application varied, a scale of 0 to 4 was used to characterize data availability for each site. Table 11 defines this scale and also summarizes the number of applications falling into each category. The following are of note:

- Sufficient data were available to identify the target chemicals of concern at 159 of 182 sites (87%).
- Sufficient data were available to identify the treatment area for 62 of 182 sites (34%) and the density of energy delivery points at 57 of 182 sites (31%); these are basic system design parameters that were compiled in this study.

- Sufficient data were available to identify the peak temperature at 49 of 182 sites (27%) and the duration of heating at 59 of 182 sites (32%); these are basic operational parameters that were compiled in this study.
- Post-treatment groundwater monitoring data were available for only 14 of 182 sites (8%); these are the basic performance data that were compiled in this study.

Thus, while there have been a large number of thermal treatment applications (at least 182), data collected for this project indicated that many have been poorly documented. This study, therefore, can provide insight to the range of settings to which thermal technologies have been applied, the designs that have been applied, and the operating conditions. However, it cannot provide much information on the actual performance of these technologies since the long-term effect on groundwater quality improvements and source zone discharge reductions appear to be poorly documented and/or not monitored at many thermal treatment sites.

Table 10. Summary of Technology Applications by Technology Type.

Technology	Number of Applications	Pilot-Scale*	Full-Scale*	Number Since Year 2000
Steam-Based Heating	46	26	19	15
Electrical Resistance Heating	87	23	56	48
Conductive Heating	26	12	14	17
Other (including Mixing/Heating)	23	14	9	4
Total	182	75	98	84

* Some sites have an unknown application size and thus are not included in the Pilot- and Full-scale count.

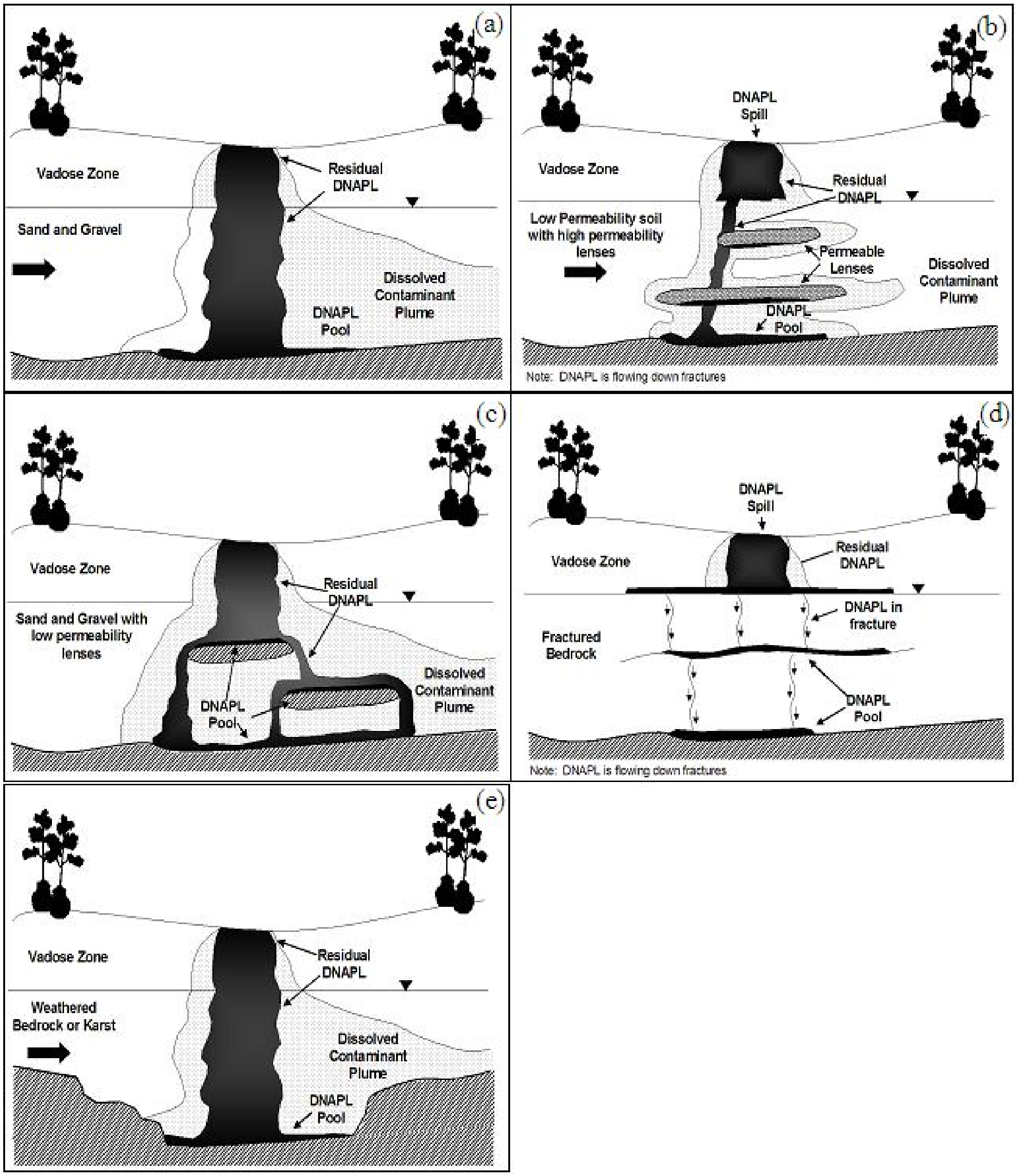


Figure 4. Generalized Geologic Scenarios. (a) Generalized scenario A - Relatively homogeneous and permeable unconsolidated sediments (mixtures of sands, gravels and silts, etc.); (b) Generalized scenario B - Largely impermeable sediments with inter-bedded lenses of higher permeability material; (c) Generalized scenario C - Largely permeable sediments with inter-bedded lenses of low permeability material; (d) Generalized scenario D - Competent, but fractured bedrock; (e) Generalized scenario E – Weathered bedrock.

Table 12 summarizes the aggregate design information for all applications reviewed. As can be seen, 117 of 121 applications for which data were available involved treating areas <4 x 10^4 ft^2 (<3716 m^2, or about one acre) and roughly two-thirds of those involved treatment zones smaller than 10^4 ft^2 (<929 m^2, or about a quarter-acre). Table 12 also indicates that the distribution was similar for all of the technologies.

Table 11. Characterization of the Data Available from the 182 Applications Reviewed.

Level of Data Quantity	Description	Number of Sites
-	Application in progress	1
0	No documentation available at the time of this study	26
1	Insufficient data to assess performance of technology, but some design information	78
2	Limited performance data; some soils and/or groundwater concentration data and some operating data (e.g., temperature information)	37
3	Good performance data record, but insufficient for estimating differences between pre- and post mass discharge from source zone	26
4	Data sufficient for full assessment of performance (groundwater concentrations and mass discharge)	14
	Total	182

Table 12. Basic Design Information Compiled for all Sites Reviewed.

Technology	Number of Sites With Target Treatment Zones With Sizes In This Range [ft^2]				Number of Sites With Density of Energy Delivery Points (electrodes or wells) In this Range [# per 100 ft^2]			
	<10^4	10^4 - 4x10^4	<4x10^4	Unknown	<0.25	0.25-0.50	>0.5	Unknown
Steam-Based Heating	16	6	4	20	20	2	4	20
Resistance Heating	36	24	0	27	10	23	27	27
Conductive Heating	19	6	0	1	1	1	23	1
Other(including Mixing/Heating)	8	2	0	13	2	0	8	13

* For the three steam auger sites, the density is one energy point per cell. This does not fit into the number calculation so it is classified as <0.5.

With respect to the area density of energy delivery points (i.e., steam injection wells, electrodes, and in situ heaters), there were clear differences between the technologies. Table 12 categorizes the number of energy delivery points per 100 ft^2(~ per 10 m^2), and indicates that most steam-based heating designs (20 of 26 with sufficient information) had densities of less than one energy delivery point per 400 ft^2 (~ one per 40 m^2, or greater than 20-ft (6-m) spacings), while most conductive heating applications involved densities greater than one energy delivery point per 200 ft^2 (~ one per 20 m^2, or less than 14 ft (4.2 m) spacings). Electrical resistance heating applications spanned the range of density categories, but were weighted more towards higher densities and electrode spacings less than 20 ft (6 m).

Table 13 summarizes the basic operating conditions for all of the applications reviewed. Of the 95 applications for which temperature data were available, 63 were operated at temperatures in the 80-110°C range in the target treatment zone. With respect to technology, most (37 of 46, or 80%) of the electrical resistance heating applications were operated within that 80-110°C range, while one-third (7 of 21) of the steam-based heating applications were operated at temperatures less than 80°C and about half of the conductive heating applications were operated at temperatures greater than 110°C.

Of note in Table 13 are the durations of application. For the applications for which data were available, 81 of 84 were operated for less than six months, and this pattern is true for all thermal technologies. It should be noted that there was little documentation as to the criteria or rationale used to determine the duration of operation; in many cases, it appeared that the duration was determined prior to start-up or may have been linked to some time-temperature criterion (i.e., operate for 2 months once a target temperature is reached). There was little indication that the duration of operation was linked to mass removal-, groundwater quality-, or soil concentration-based criteria.

Table 13. Basic Operating Conditions Summary for all Applications Reviewed.

Technology	Number of Sites With Temperatures in Target Treatment Zone in These Ranges [C]				Number of Sites With Active Heating Durations in These Ranges [y]				Number of Sites With Post-Treatment Monitoring in These Ranges [y]			
	<80	80 - 110	>110	Unknown	<0.5	0.5 - 1.0	>1.0	Unknown	<0.5	0.5 - 2.0	>2.0	Unknown
Steam-Based Heating	7	13	1	25	14	0	3	29	2	0	0	44
Resistance Heating	9	37	0	41	38	2	0	47	1	5	1	80
Conductive Heating	0	11*	12*	4	18	3	0	5	1	1	0	24
Other (including Mixing/Heating)	2	2	1	18	6	0	0	17	3	0	0	20

* One site had two different temperature values. The 80-110 C temperature was for the saturated zone and the >110 C temperature for the vadose zone.

One might argue that applications conducted in recent years are more representative of the current state-of-the practice. For that reason, the Overall Data Summary Table (Table 14) was prepared using only data from the 84 applications conducted since 2000 that were reviewed in this study. This table was formatted to flow from left to right, beginning with the five "generalized conceptual scenarios". The thought behind its structure was that practitioners interested in assessing the potential applicability of thermal technologies to their site would first choose the generalized conceptual scenario that best matches their site conditions. Then, by viewing from left to right across the table, they would be able to quickly review the experience base for each technology as applied to that generalized conceptual scenario.

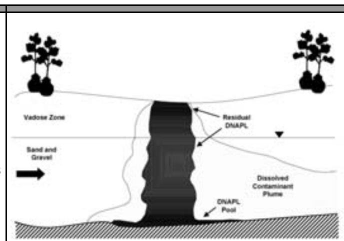
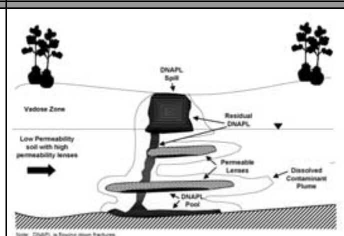
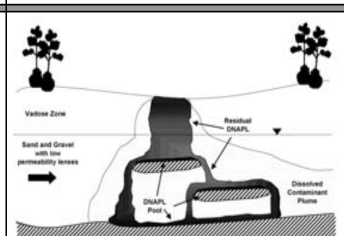
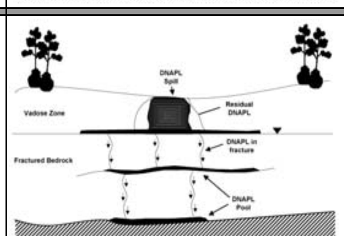
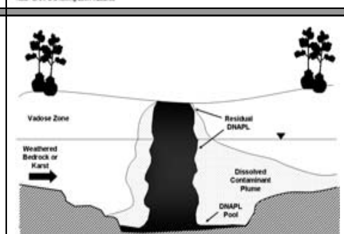
The major columns found to the right of the generalized conceptual scenarios and each thermal technology include the total number and types of applications (pilot- vs. full-scale), chemicals treated, basic design parameters, basic operating parameters, and performance measures. Columns found under each of these main headings represent categories (i.e., pilot-scale vs. full-scale under "# of sites" heading) or distributions of specific numerical values as in the case of the "Design Parameters" heading (e.g., three options for temperature in the treatment zone are presented: <80°C, 80 – 110°C, and >110°C). The numerical entry in each box of this table represents the number of sites matching that combination of conditions caused by the intersection of the row and column. For example, there are four applications of resistance heating in generalized conceptual scenario C with treatment areas $<10^4$ ft^2 (~ 1000 m^2 or one-quarter acre). Note that the number of applications totaled in each column may not total 84 due to the fact that the information might not be available for all 84 applications. In general, there is a trend towards having less information as one moves through the columns from left to right across Table 14.

Table 14 shows that majority of the thermal applications were conducted in generalized scenarios B and C. Scenario B (low permeability with high permeability lenses) accounts for 43% (36 of 84) of thermal treatments, two-thirds of which are ERH applications. Of interest was that most conductive applications occur in scenario B (10 of 17), as do ERH applications (24 of 48). Scenario C (high permeability with low permeability lenses) settings account for roughly another one-third (29%) of all applications. The majority of applications in scenario C settings are ERH, although steam-heating had most of its applications (6 of 15, or 40%) within this geologic setting.

Few applications in generalized scenarios A, D, and E were identified in this study (7, 4, and 1 of 84 total documented applications, respectively). This may reflect the low frequency of occurrence of homogeneous settings in nature (scenario A) as well as the difficulty and risks in dealing with complex fractured and bedrock settings.

Table 14 also summarizes information available on the chemicals present at 83 of 84 sites. Of those 83 sites, chlorinated solvents were treated at 63 (75%) of the sites. Petroleum hydrocarbons were the other main contaminant category treated by thermal applications and represent about 36% (30 of 84) of sites in this study. Wood-treating and other chemicals accounted for about 13% of sites (11 of 84).

Table 14. Summary of Key Information Gathered from Reviewed Applications Conducted Since 2000.

Generalized Conceptual Scenario		Technology	Total Sites		Chemical(s) Treated				Design Parameters						Operating Parameters									Performance Measures												Name(s) of Example Well-Studied Sites
			# of Sites		# of Sites Treating These Chemicals (C-chlorinated solvents, P-petroleum hydrocarbons, W-wood treating, O-other)				# of Sites With Target Treatment Zones With Sizes In This Range [ft^2]			# of Sites With Density of Energy Delivery Points (electrodes or wells) in this Range [# per 100 ft2]			# of Sites With Temperatures in Target Treatment Zone in These Ranges [C]			# of Sites With Active Heating Durations in These Ranges [y]			# of Sites With Post-Treatment Monitoring in These Ranges [y]			Sites With Final Dissolved Concentrations Generally In This Range [ug/L]			Sites With Concentration Reduction In This Range [%]			Sites With Final Mass Discharges Generally In This Range [kg/y]			Sites With Mass Discharge Reduction In This Range [%]			
			Pilot Tests	Full-Scale	C	P	W	O	$<10^4$	$10^4 - 4x10^4$	$<4x10^4$	<0.25	0.25-0.50	>0.5	<80	80 - 110	>110	<0.5	0.5 - 1.0	>1.0	<0.5	0.5 - 2.0	>2.0	<10	10 - 100	100 - 1000	10X	100X	1000X	<1	1.0 - 10	>10	10X	100X	1000X	
Generalized Scenario A: relatively homogeneous and permeable unconsolidated sediments (mixtures of sands, gravels and silts, etc.)		SEE	1	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	Guadalupe
		ERH	0	1	0	1	0	1	1	1	0	0	1	1	0	3	0	1	0	0	0	0	1	0	0	1	1	0	0	1	0	0	0	1	0	Hunter Army Airfield
		ISTD	1	4	4	3	0	1	2	1	0	0	0	3	0	2	2	1	2	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	
		Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Generalized Scenario B: largely impermeable sediments with interbedded layers of higher permeable material		SEE	1	1	2	0	0	0	1	0	0	1	0	0	0	1	0	1	0	1	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	
		ERH	6	18	16	9	1	1	14	7	0	3	8	9	3	10	0	11	7	2	1	0	0	1	1	5	2	2	3	0	0	1	1	0	0	Air Force Plant 4
		ISTD	3	7	7	1	2	2	7	3	0	0	1	9	0	7	2	1	5	2	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	Alhambra Pole Yard
		Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Generalized Scenario C: largely permeable sediments with interbedded lenses of low permeable material		SEE	3	3	3	2	1	1	2	2	1	4	0	0	2	2	0	2	0	3	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	Visalia, Lawrence Livermore National Laboratory
		ERH	2	13	14	5	0	0	4	9	0	1	4	8	1	11	0	8	4	1	0	2	0	0	0	9	7	1	1	2	4	2	6	2	0	NAS Alameda Site 5-1 ERH, Young Rainey Star, Ft. Lewis Areas 1, 2, and 3
		ISTD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Other	1	2	3	3	0	0	1	2	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	0	Cape Canaveral Air Force Station
Generalized Scenario D: competent, but fractured bedrock		SEE	2	1	3	1	0	0	2	0	0	1	0	1	1	1	0	3	0	0	1	0	0	0	0	2	2	0	0	1	0	0	1	0	0	Edwards Air Force Base, Loring Air Force Base
		ERH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		ISTD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Other	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Generalized Scenario E: weathered bedrock		SEE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		ERH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		ISTD	1	0	1	1	0	0	1	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Unknown Scenario		SEE	1	2	2	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		ERH	4	4	7	2	0	0	1	3	0	1	2	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		ISTD	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Notes:

84 sites with systems have been installed since 2000, but only 72 of these sites have known geologic settings.

Data may total more than the total number of sites because some sites treated more than one type of contaminant during an application

SEE – Steam Enhanced Extraction (Steam-based Heating)

ERH – Electrical Resistance Heating

ISTD – In Situ Thermal Desorption (Conductive Heating)

Other – Other Heating Methods (i.e. Radio-Frequency Heating or In Situ Soil Mixing combined with Heating)

Design and operating parameter information is discussed above for all sites and the data in Table 14 reflect that discussion. Of note is the absence of information for applications conducted in generalized scenarios D and E except for steam heating in scenario D.

This study collected and documented a large amount of information on thermal applications, which has been summarized above in Table 14. An additional summary table, Site-Specific Summary Table (Plate 1 – see electronic attachment *Site Specific Summary Table*) contains detailed site-specific information for all thermal applications identified in this study.

6.2 EMPIRICAL DATA COLLECTION AND SYNTHESIS WITH EMPHASIS ON PERFORMANCE (GROUNDWATER QUALITY AND MASS DISCHARGE CHANGES)

As discussed above, there was sufficient documentation to assess changes in groundwater quality and source zone mass discharge for only 14 of the 182 applications identified in this study. Two of the 14 were described as pilot treatments; however, the treatment zone appeared to completely encompass the source zone at those sites so a mass discharge analysis was performed. Table 15 presents the estimated order-of-magnitude concentration and mass discharge percent reductions for those 14 sites and reflects data from site reports and from the supplemental post-treatment assessment field work conducted during this project. In 9 of 14 sites (64%), the dissolved groundwater concentration reduction was about one order-of-magnitude (10X) or less and four sites had concentration reductions equal to or greater than two orders-of-magnitude (100X). Because mass flux or discharge calculations involve spatially variable hydraulic conductivity data, the mass discharge reduction can differ from the overall concentration reduction. For example, at sites with a 10X concentration reduction or less, the estimated mass discharge reduction varied from <10X to 1000X. Nine sites had mass discharge reductions of about 10X or less and almost one-half of the sites (6 of 14, or 43%) had at least a 100X reduction in mass discharge (please note that Site #6 is counted in both the less than or equal to 10X reduction and greater than or equal to 100X because the mass discharge values were calculated for two different vertical intervals).

Table 15. Summary of Source Zone Dissolved Groundwater Concentration and Mass Discharge Reductions Achieved at Sites with Sufficient Data to Perform this Analysis

Site No.	Heating Technology	Generalized Scenario/Site	Dissolved Groundwater Concentration Reduction	Mass Discharge Reduction				
				<10x	10x	100x	1000x	>1000x
1	ERH	Generalized Scenario A $^{(SDC)}$	10x			x		
2	ERH	Generalized Scenario B$^{+\ (SDC)}$	<10x	x	x			
3	ERH	Generalized Scenario C	10x		x			
4	ERH	Generalized Scenario C* $^{(SDC)}$	>10x to <100x		x			
5	ERH	Generalized Scenario C $^{\wedge}$	<10x	x				
6	ERH	Generalized Scenario C $^{\wedge}$	<10x	x		x		
7	ERH	Generalized Scenario C	<10x				x	
8	ERH	Generalized Scenario C $^{(SDC)}$	10x		x			
9	ERH	Generalized Scenario C $^{(SDC)}$	100x			x		
10	ERH	Generalized Scenario C	1000x		x			
11	SEE	Generalized Scenario C	100x			x		
12	SEE	Generalized Scenario C	10x	x				
13	SEE	Generalized Scenario C $^{\wedge}$	10000x				x	x
14	SEE	Generalized Scenario D*	<10x	x				

* Pilot application appeared to encompass the entire source zone based on documentation reviewed.
+ Mass discharge assessment involved two calculations using first only the post-treatment field investigation data and then the post-treatment field investigation data supplemented with data from a set of monitoring wells that were directly in line with the field investigation transect.
^ Site used two different vertical intervals to calculate mass discharge: 1) Only shallow geology and 2) shallow and deep geology.
SDC – supplemental data collection site for this project

Table 16 provides the calculated mass discharge rates for the sites summarized in Table 15. Again, the table entries reflect data gathered from reports as well as data collected during the supplemental data collection phase of this project.

Mass discharge calculations were performed using the ESTCP-sponsored Mass Flux Toolkit software by GSI, Inc. In addition to the mass flux calculation, this software allows for an uncertainty analysis of calculations and presents a statistical breakdown of the contribution each sampling location makes to the total mass discharge. An uncertainty analysis was performed for the main contaminant of concern at each field site.

Uncertainty analyses for each site indicated that most locations contributed fairly equally to the total mass discharged. However, at each site there were one or two locations where groundwater concentrations and/or hydraulic conductivity resulted in contributions of greater than +/- 25% to the total mass discharge. Appendix F presents the uncertainty analyses for each of the five field sites.

Table 16. Summary of Mass Discharge Estimates for Sites with Sufficient Data

Site No.	Heating Technology	Site	Contaminant	Pre-treatment Discharge (kg/yr)[1]	Post-treatment Discharge (kg/yr)[2]	Post-treatment Discharge per Linear Foot (kg/yr/ft)
1	ERH	Generalized Scenario A * (SDC)	Total Contaminant Mass Discharge (sum of all components)	5.2×10^{1}	1.9×10^{-1}	1.1×10^{-3}
2	ERH	Generalized Scenario B** (SDC)		6.0×10^{1}	2.1×10^{1}	1.4×10^{-1}
					4.9	3.4×10^{-2}
3	ERH	Generalized Scenario C		4.0×10^{-1}	3.1×10^{-2}	1.5×10^{-3}
4	ERH	Generalized Scenario C * (SDC)		6.8×10^{2}	8.2×10^{1}	5.5×10^{-1}
5	ERH	Generalized Scenario C ^^		1.7	6.0×10^{-1}	4.0×10^{-3}
				2.4	9.7×10^{-1}	6.5×10^{-3}
6	ERH	Generalized Scenario C^^		9.4	2.7×10^{-2}	1.4×10^{-4}
				4.9	1.6	8.7×10^{-3}
7	ERH	Generalized Scenario C^^		9.3	1.7×10^{-2}	6.3×10^{-5}
				7.4	1.6×10^{-2}	6.0×10^{-5}
8	ERH	Generalized Scenario C*** (SDC)		3.2×10^{1}	2.1	1.9×10^{-2}
9	ERH	Generalized Scenario C * (SDC)		4.9×10^{1}	1.3×10^{-1}	9.6×10^{-4}
10	ERH	Generalized Scenario C		1.2	5.4×10^{-2}	1.6×10^{-4}
11	SEE	Generalized Scenario C		4.6	7.3×10^{-2}	3.4×10^{-4}
12	SEE	Generalized Scenario C		1.3	2.8	1.0×10^{-5}
13	SEE	Generalized Scenario C ^^		1.9×10^{-2}	1.8×10^{-7}	1.2×10^{-9}
				2.9×10^{-4}	1.1×10^{-7}	7.1×10^{-10}
14	SEE	Generalized Scenario D		9.7×10^{-2}	6.1×10^{-2}	1.2×10^{-4}

Notes:
1 Mass discharge calculations were based on monitoring well data from the documentation.
2 Mass discharge calculations were based on monitoring well data from the documentation, discrete-depth sampling data, or a combination of discrete-depth sampling data and monitoring well data.
* Mass discharge calculations were base on discrete-depth sampling data only.
** Mass discharge calculations were based on monitoring well data analyzed solely by ASU personnel.
^ Mass discharge calculations were performed for discrete-depth sampling data only and discrete-depth sampling data with monitoring well data.
^^ Mass discharge calculations were performed for two different geologic settings: 1) shallow, and 2) deep and/or intermediate.
SDC – supplemental data collection site for this project

6.3 SUMMARY OF KEY OBSERVATIONS

In reviewing the information presented above in Sections 6.1 and 6.2, the following are of note:

- Documents from 182 applications were collected and reviewed, which included 87 electrical resistance heating, 46 steam-based heating, 26 conductive heating, and 23 other heating technology applications conducted between 1988 and 2007. This information indicates that a significant number of applications have occurred and this reflects the acceptance of in situ thermal technologies as viable source zone treatment options.

- Approximately half of the 182 applications have been implemented since 2000, and over half of those were ERH systems. ERH applications outnumber all other applications since 2000 by about a factor of three. There also seems to be a recent trend in the increasing use of conductive heating and decreasing use of steam-based heating.

- There seems to be a differentiation of the technologies occurring, with it being better understood that steam and ERH are primarily limited to operating temperatures at about the atmospheric boiling point of water (100 C) or lower and conductive heating is the only option for achieving significantly higher temperatures than that.

- There seems to be a convergence towards relatively closely-spaced energy delivery points in the design of ERH and conductive heating systems. Spacing for most ERH and conductive energy delivery points was less than 20 ft (6 m), while steam application well spacing was usually greater than 20 ft (6 m).

- To date, most applications have been applied to relatively small treatment zones; 117 of 121 treated areas were $<4x10^4$ ft^2 (<4000 m^2 or an acre) and two-thirds of those were $<10^4$ ft^2 (<1000 m^2 or one-quarter acre treatment areas). It is also apparent that the spatial extents of many source zones are likely ill-defined prior to treatment. This results in under-sized target treatment zones, untreated source zone areas, and minimal beneficial impact to groundwater quality and mass discharge.

- The effect of geologic setting on performance is difficult to discern in this data set because most treatment systems were installed in layered settings, characterized as either primarily fine-grained materials with higher permeability lenses (Generalized Scenario B) or primarily permeable materials with finer-grained lenses (Generalized Scenario C). Thus, our understanding of system design parameters and operating conditions is limited to those scenarios.

- Most applications (independent of specific technology) lasted less than 6 months; there was little documentation as to the criteria or rationale used to determine the duration of operation. There was little indication that the duration of operation was linked to mass removal-, groundwater quality-, or soil concentration-based criteria.

In using the Summary Tables, practitioners, regulators, and site owners can anticipate the likely performance of thermal-based source zone treatment technologies at their sites. The tables link design, operating condition, and performance experience a small number of generalized geologic scenario site descriptors. The user can choose the generalized scenario that most closely resembles their site and can quickly assess:

a) how the technology has been applied to date in that type of setting,
b) the designs employed,
c) the operating conditions,
d) the performance monitoring that results are based on,
e) the performance observed,
f) indicators of success at other sites, and
g) reasonable bounds on expected performance.

With respect to performance as measured by groundwater quality improvement and mass discharge reduction:

- Data from the five supplemental data collection sites indicated that a 100x order-of magnitude reduction was achievable if the source zone was adequately delineated and fully encompassed during treatment and if the system was operate for a sufficient period of time. Reductions of less than 100x where seen if the system was not operated for a sufficient period of time and at sites where the source zone was not fully encompassed a reduction of <10x was typical.

- For sites with a concentration reduction of 100x or more, the final groundwater concentrations could be less than 100 ug/L for individual constituents which then could correspond to a mass discharge of 1E-01 kg/yr or less. This type of treatment is desirable and can be achieved if the treatment is applied to the complete source zone and operated for a sufficiently long period of time.

- Further analysis of the data set focused on mass discharge reduction and its correlation with geology and maximum treatment temperature. Correlations between mass discharge reduction and geology were investigated, however, based on the number of sites with usable data and the fact that many had similar generic geological descriptions, it was not possible to correlate these.

- Temperature was one of the significant operational variables for thermal treatments. For each site, the maximum representative temperature or the highest temperature that was achieved throughout most of the treatment zone and held for at least one day was recorded (see Table 5.1). Analysis of the data indicated that contaminant concentration reductions ranged from <10x to 100x and the maximum representative temperatures achieved for each site ranged from 89^{o}C to 100^{o}C. Based on available data, no correlation was found, suggesting achieving a target temperature is insufficient to achieve good clean-up, and that application duration, in combination with the treatment zone temperature and treatment zone size likely control the performance.

7.0 IMPLEMENTATION ISSUES

The purpose of the study was to summarize knowledge on the performance of in-situ heating technologies. The approach, as it pertains to this project, was to identify sites where thermal technologies have been applied and collect and synthesize as much of the available data/documentation for those sites, thus allowing for knowledge on how often each individual technology was being applied. The most challenging implementation issue was a lack of sufficient documentation for most of the 182 applications identified.

8.0 REFERENCES

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9.0 APPENDICES

Appendix A

Points of Contact

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Appendix B

State-of-the-Art Technology Descriptions

Appendix C

Data Logs

Appendix D

Supplemental Site Investigation Reports
Site Specific Demo Plan and Data Analysis Reports

Appendix E

Quality Assurance Project Plan

Appendix F

Uncertainty Analysis for Mass Discharge Calculations

9.0 APPENDICES

Appendix A

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APPENDIX B

State-of-the-Art Technology Descriptions for:

- Thermal Conduction Heating
- Electrical Resistance Heating
- Steam Enhanced Extraction
- Hot Air/Steam Injection Thermal Remediation Using Large Diameter Auger (LDA) In-Situ Soil Mixing

Thermal Conduction Heating

By
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1. Overview of Technology

1.1 One paragraph description of the state of the thermal application

In-Situ Thermal Desorption (ISTD) is the simultaneous application of heat by thermal conduction heating (TCH) and vacuum to remediate organic source zones. The technology has been applied at full scale to remediate a wide variety of contaminants, ranging from low-boiling VOCs and CVOCs to high-boiling PAHs, PCBs and dioxins. It has been applied to treat both vadose and saturated zone sites, as well as fractured media (clay and rock). Virtually every project achieves much lower post-treatment concentrations than the goals. Treatment costs have been lowered dramatically by technology simplifications.

1.2 New improvements to the technology over the past 5 years

Over the past five years, ISTD has undergone a number of technology improvements. The heater wells have become simpler, less expensive and more able to resist corrosive conditions. They are amenable to installation by most available drilling methods, with installation rates in the range of 200 – 400 ft per day per rig. Control systems have become simplified. Off-gas treatment can be accomplished by a wider array of components, with the choice depending on project requirements. ISTD has been performed over a wide range of thermal well spacings and time durations, and the energy requirements for a range of subsurface conditions are well understood. As treatment costs have decreased, more CVOC DNAPL sites have been treated, where initially ISTD was mostly used for PCB soil decontamination.

2. Energy Delivery/Heating Information

2.1 Basic conceptual overview of the energy delivery/soil heating process (i.e. a conceptual drawing showing the basic components and a simple conceptual time-series of energy transfer/heating in the subsurface)

Figure 1 shows a generic sketch of a small In-Situ Thermal Desorption (ISTD) site.

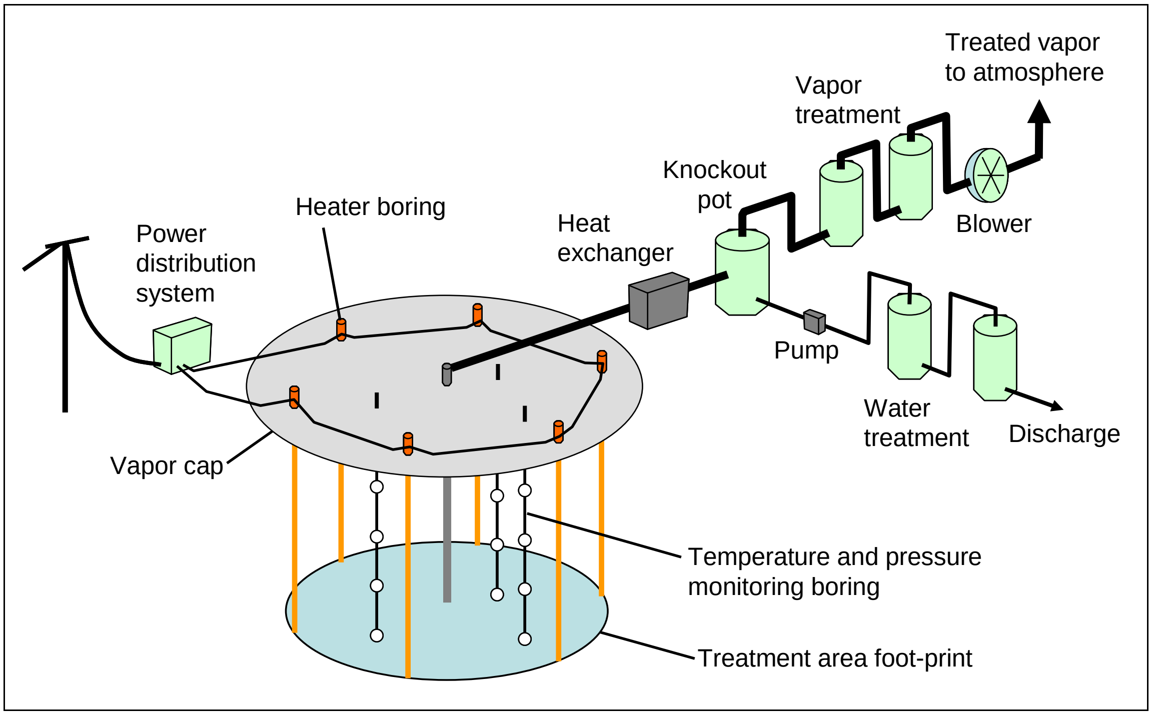

Figure 1. Conceptual Sketch of In-Situ Thermal Desorption System.

A typical site has the following components:

- Transformer to supply 480 V, 3-phase power.
- Simple electrical distribution switchgear and controllers for the heaters.
- Cables to all ISTD heater borings.
- Vertically installed heater borings, with a simple resistive heater element hanging inside a 3" diameter steel casing, either driven in or installed with grout and sandpack.
- Vapor recovery wells (horizontal or vertical, or both, depending on geology).
- Where necessary for hydraulic control, groundwater extraction wells or a physical hydraulic barrier.
- Temperature and pressure monitoring wells.
- An off-gas and water treatment system with varying components depending on contaminants and expected mass loading.

Energy transfer is by thermal conduction and fluid convection around the heaters, as the heater borings are heated to temperatures above 500^{o}C. More detail is provided in LaChance et al.[1].

[1] LaChance, J., G. Heron and R. Baker. 2006. "Verification of an Improved Approach for Implementing In-Situ Thermal Desorption for the Remediation of Chlorinated Solvents." *Remediation of Chlorinated and Recalcitrant Compounds: Proceedings of the Fifth International Conference* (May 22-25, 2006). Battelle, Columbus, OH.

A typical operational period, using treatment to the boiling point of water as an example is provided in Figure 2.

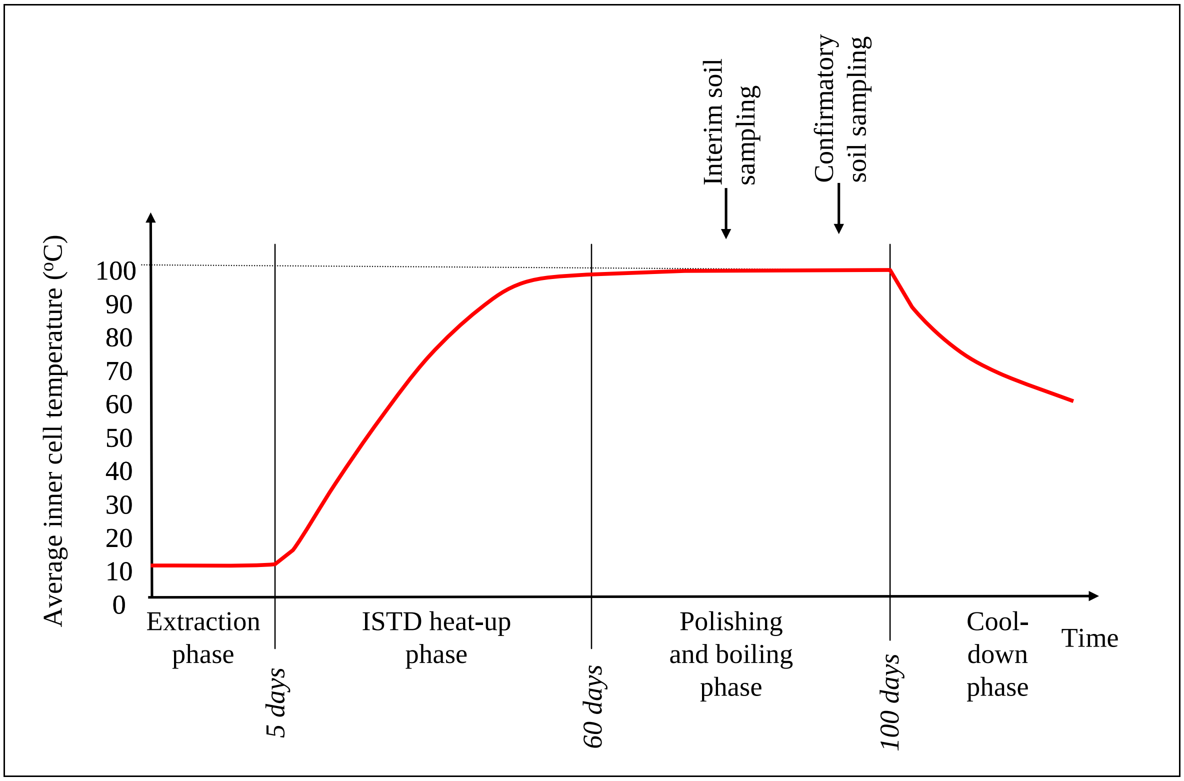

Figure 2. Typical timeline for operation of an ISTD system for VOC remediation.

The extraction phase is used to document pneumatic control and to demonstrate that the off-gas treatment system meets the regulatory demands for contaminant removal efficiency. If groundwater is extracted, this period is also used to document hydraulic control and sufficient water treatment.

During the heat-up phase, ISTD power is injected into each heater at rates of approximately 300-350 W per linear ft of heater, and the ground heats up due to the temperature gradients created and convection of heated fluids such as steam, air, and water.

The polishing phase is primarily a phase where steam is generated in-situ, and steam stripping is used to lower contaminant concentrations to below target levels. It often overlaps with heating of the bottom-most depths, and/or areas that lag behind the average heating, to the target temperature.

Interim and final confirmatory soil sampling (and groundwater sampling, where required) is used to assess the treatment efficacy. Once the data comes back from the laboratory and shows that the objectives are met, a short cool-down period follows, where steam is removed from the subsurface and the site is cooled to an acceptable final temperature. Then, the ISTD equipment and the well-field are decommissioned.

2.2 Any available information on relationship or current understanding between energy delivery and heating rates (i.e. efficiency of energy conversion to heat)

To avoid overheating of wells and heater materials, the heater element power input is limited to below 400 W/ft of heater. For instance, a 30-ft long heater will only be able to supply on the order of 10-12 kW of energy to the subsurface. This energy is conducted away from the heaters, and partially used to vaporize groundwater into steam.

The efficiency of converting electric power to heat is around 99% or better – basically all the energy is deposited in the heater elements, with minor losses in switchgear and cables. Since the heating mechanism is based on the Ohmic resistance of the heater rods, which are fully imbedded in the treatment volume, this is a direct and highly efficient way of heating.

Heat losses come from conduction of heat to the surface, perimeter, and bottom, where ISTD heaters typically extend between 2 and 5 ft outside the target treatment zone to ensure heating of the entire volume to the target temperature. These heat losses are inevitable and part of any heating technology where sufficient care is taken to treat the edges of the target volume.

The heating rate is typically calculated for the coolest locations within the target treatment zone, and is directly dependent on the spacing between neighboring heaters (located in a triangular pattern). Typical durations are shown in table 1.

Table 1. Typical duration of ISTD operation as a function of heater spacing.

Heater boring spacing (ft)	Operational duration for CVOC source zones (days)
10	60-80
12	90-120
15	120-180
20	300-400

Actual durations are site-specific, and depend on factors such as:

- Initial saturation (the wetter the longer it takes).
- Porosity (the higher the longer it takes).
- Water table position.
- Groundwater seepage velocity and recharge (if a hydraulic barrier is not used).
- Mineral composition (minor differences between common minerals).
- Initial contaminant mass.
- Target contaminant concentration (the lower the longer it takes).

If the project schedule is critical, the heater spacing is chosen for a given site to match the available time. This is typically done for Brownfield sites such as the Richmond site[2], where a property transfer and/or construction of new homes drive the schedule.

2.3 Limitations of the energy delivery/heating process (i.e. what temperatures can be reached?, how even is the heat/energy distribution?, do natural phenomena limit the heating?)

For compounds with boiling points below 150^{o}C, steam stripping and vaporization are effective mechanisms, and the boiling point of water is used as the target treatment temperature.

For sites where dewatering is undesirable or not practical, the presence of water will buffer the temperature to the steam temperature, which is 100^{o}C above the water table and increases with depth and pressure below the water table. At 33 ft depth below water, where the pressure is 2 atm (14.6 psig or 29.2 psia), the steam temperature is 120 ^{o}C.

For SVOCs such as PCB, coal tar, PAH and creosote, higher temperatures are used as the target treatment temperature. The target temperatures are in the range of 200^{o}C to 350 ^{o}C, depending on the physical and chemical properties of the limiting contaminant. Heating to these temperatures involves removing or boiling all of the soil moisture, which enables heating the dry soil/sediment above steam temperatures. Due to the high treatment efficiency (including accelerated kinetics of oxidation and pyrolysis[3]) at temperatures below 325 ^{o}C, sites are rarely heated beyond this temperature.

[2] LaChance et al. 2006. Ibid.

[3] Baker, R.S. and M. Kuhlman. "A Description of the Mechanisms of In-Situ Thermal Destruction (ISTD) Reactions." In: H. Al-Ekabi (Ed.), *Current Practices in Oxidation and Reduction Technologies for Soil and Groundwater*. Presented at the 2nd International Conf. on Oxidation and Reduction Technologies for Soil and Groundwater, ORTs-2, Toronto, Ontario, Canada, Nov. 17-21, 2002.

The most critical factors controlling the ability to heat a site to the target temperatures are:

- Groundwater flow, which can lead to cooling where water enters the treatment volume. Each design must address the potential for groundwater influx and cooling. In certain clay formations, permeable fractures can lead to rapid groundwater flow and cooling, as observed at a site in Ohio[4]. Other sites with groundwater zones with significant flow rates may be addressed either by limiting the flow using pumping or barriers, or by combining ISTD with the injection of steam to heat the more permeable zones[5].
- Air inflow due to the applied vacuum, leading to cooling. This is typically very minor due to the low heat capacity of atmospheric air, and the modest flow rates.
- Target zone geometry (very shallow sites and irregularly shaped sites take longer due to large surface areas and heat losses, deep sites and equidimensional sites heat faster due to low heat losses).

Each thermal design involves a careful review of the geometry, and specifically the hydrogeology and potential impacts of water flow on the heating regime. Where needed, a detailed 3D numerical simulation is used to evaluate impacts and worst-case scenarios.

2.4 Unique advantages/disadvantages of this energy delivery/heating approach for contaminant removal or destruction?

Heating depends primarily on thermal conduction – therefore the "sweep" is highly uniform. Clay layers, sand zones, and gravel zones heat up at very similar rates due to small variations in thermal conductivity (varying by a factor of only approximately three from sand to clay) and heat capacity of various minerals, sediments, soils, and rocks. This is the primary advantage of ISTD – that our heating pattern and therefore treatment duration is highly predictable. This allows the treatment performance (as determined by reduction in contaminant concentrations) to be highly predictable as well.

A unique advantage is that the ISTD heaters are simple steel rods which can be as long and deep as the site requires. The same heaters are used in the oil field for heating zones with thicknesses over 500 ft. The heaters are in 3-inch simple casings, and the borehole size does not increase as the heaters need to go deeper. Since the power used to generate

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[4] LaChance, J.C., R.S. Baker, J.P. Galligan, and J.M. Bierschenk. 2004b. "Application of 'Thermal Conductive Heating/In-Situ Thermal Desorption (ISTD)' to the Remediation of Chlorinated Volatile Organic Compounds in Saturated and Unsaturated Settings." Paper 2B-21, in: A.R. Gavaskar and A.S.C. Chen (Eds.), *Remediation of Chlorinated and Recalcitrant Compounds—2004*. Proceedings of the Fourth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2004). ISBN 1-57477-145-0, published by Battelle Press, Columbus, OH, www.battelle.org/bookstore.

[5] Baker, R.S. and G. Heron. 2004. "In-Situ Delivery of Heat by Thermal Conduction and Steam Injection for Improved DNAPL Remediation." Paper 2B-18, in: A.R. Gavaskar and A.S.C. Chen (Eds.), *Remediation of Chlorinated and Recalcitrant Compounds—2004*. Proceedings of the Fourth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2004). ISBN 1-57477-145-0, published by Battelle Press, Columbus, OH, www.battelle.org/bookstore

heat in each heater flows through the entire length of the heater, it puts out the same power density along the length of the heater, leading to relatively uniform heating over the length of the heater, despite differences in the sediment/soil/rock properties with depth. This can allow for uniform heating of deep sites with simple surface controls. One example of this, with ISTD heating to 110 ft, is the recent project in Alhambra, CA[6].

A potential disadvantage is the ability to heat a zone with groundwater flow carrying the heat away or cooling by entry of cold water. As discussed above, such cooling has to be either limited by means of a barrier (hydraulic or physical), overcome by injecting steam into the highly conductive zones, or overcome by adding more ISTD heaters to increase the power density in such zones. A good and detailed analysis of the site hydrogeology is key to managing this potential disadvantage.

For SVOCs, heating to temperatures above boiling can lead to significant in-situ destruction of contaminants. This may reduce the mass loading on the off-gas treatment system. Mechanisms and reaction processes are described by Baker and Kuhlman[7].

2.5 Is the process applied differently if the contaminants are below the water table?

In principle, no. The ISTD heaters are installed and operated in the same manner. But the hydrogeology issues and potential for groundwater flow discussed above become important. In addition, vapor extraction and control becomes dominated by steam generation and capture, as the heat creates steam. An analysis and example of this for a site where ISTD was used to treat CVOCs 15 ft below the water table is discussed by LaChance et al.[8].

As the heat travels horizontally away from the heater borings, vapors are generated by in-situ boiling of groundwater (and NAPL, if present). The generated vapors travel towards the heaters, and upward along the heater borings where increased gas phase permeability is created by the drying in the immediate vicinity of each heater. The vapors are captured and extracted by vapor collectors located in the vadose zone. This continuous removal of VOC mass, starting a few hours after the onset of heating, is a key mechanism for removal of VOCs from below the water table.

For SVOCs below the water table, water presence can prevent heating to above the boiling point. Therefore, a site-specific analysis of possible treatment efficacy with and without dewatering is performed. The cleanup standard typically drives this, as complete contaminant removal to very low soil concentrations will require dewatering and heating to above boiling, and less aggressive treatment goals such a removal of all VOC

[6] Bierschenk, J.M., R.S. Baker, R.J. Bukowski, K. Parker, R. Young, J. King, T. Landler, and D. Sheppard. 2004. "Full-Scale Phase 1a Results of ISTD Remediation at Former Alhambra, California Wood Treatment Site." Paper 4A-09, in: A.R. Gavaskar and A.S.C. Chen (Eds.), *Remediation of Chlorinated and Recalcitrant Compounds—2004*. Proceedings of the Fourth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2004). ISBN 1-57477-145-0, published by Battelle Press, Columbus, OH, www.battelle.org/bookstore.
[7] Baker and Kuhlman, Ibid.
[8] LaChance et al 2006. Ibid.

components and stabilization of the leftover NAPL phase allows treatment at the boiling point[9].

3. Process Configuration Information

3.1 Generic lay-out of the process showing spacings (heaters, electrodes, wells, etc.) of in situ components for a "typical" application

Heaters are typically located in a triangular pattern as shown on Figure 3.

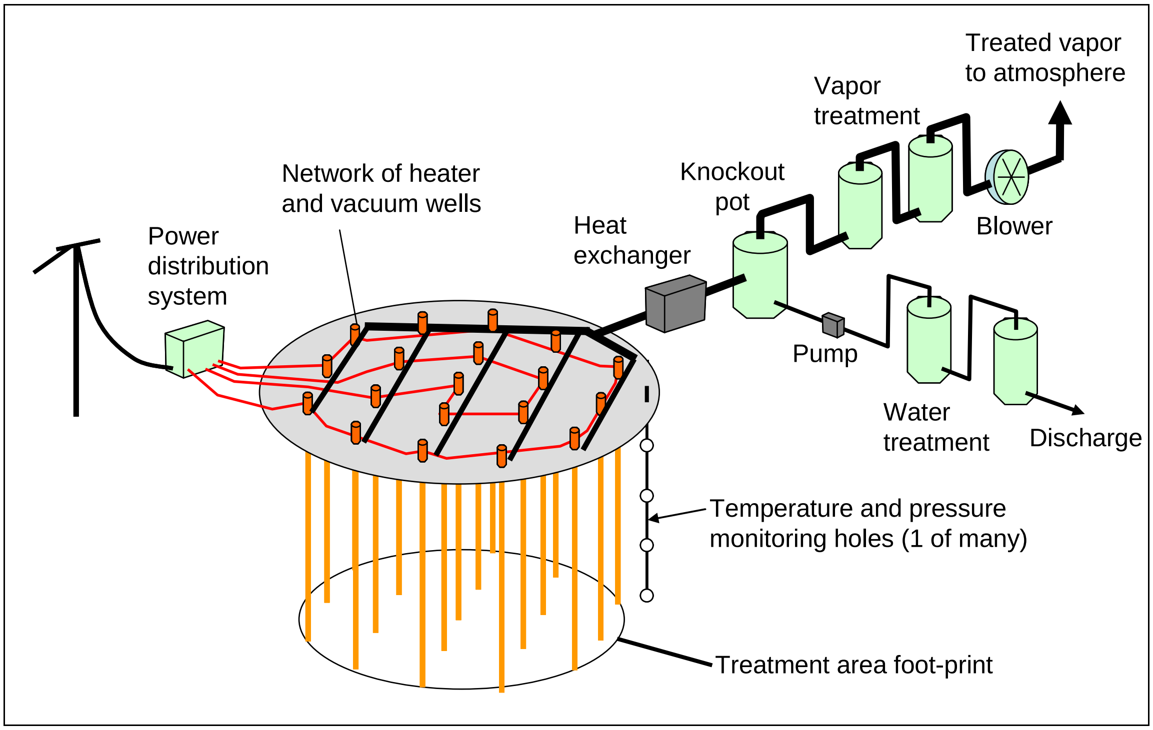


Figure 3. Generic layout of heater borings and process equipment for an ISTD project.

The spacing between heater borings is discussed in Section 1.2. For VOC sites, the heater spacing typically varies between 12 and 20 ft. For SVOC sites heated to above boiling, a typical heater spacing is between 6 and 12 ft.

Vapor and water extraction wells can either be vertical wells within the pattern (heated or unheated), or horizontal or angled wells located in optimized positions to capture the heated fluids. Figure 4 illustrates a cross-sectional view of a site where steam vapors are extracted near each heater (which is used for sites with high NAPL saturations to minimize condensation during heating), and a number of horizontal vapor extraction wells located in the vadose zone.

[9] Baker, R.S., D. Brogan and M. Lotti. 2006. "Demonstration of Tailored Levels of In-Situ Heating for Remediation of a Former MGP Site." Proceedings of the International Symposium and Exhibition on the Redevelopment of Manufactured Gas Plant Sites (MGP2006), Reading, England, April 4-6, 2006. *Journal of Land Contamination and Reclamation*, 14(2):335-339.

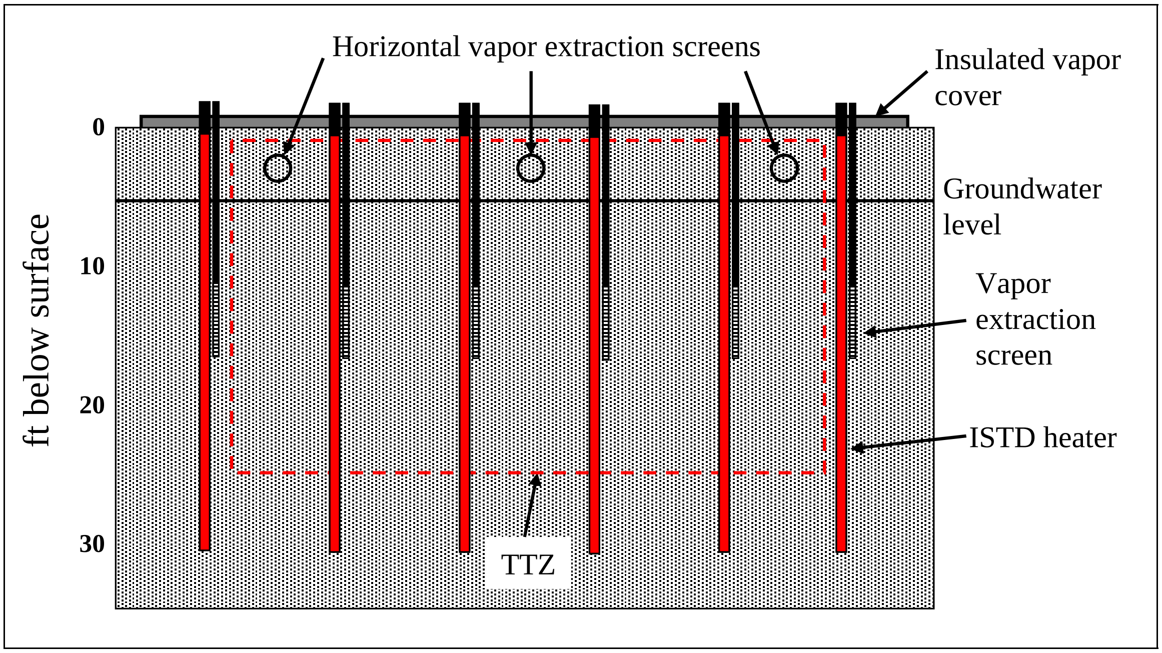


Figure 4. Conceptual cross-section of an ISTD treatment zone.

Each site is analyzed in detail, and the vapor and water recovery wells and extraction approach is determined based on site-specific conditions.

A vapor cover is typically used when treating to shallow depths. The cover serves three purposes:

1. It provides thermal insulation and prevents contaminants from condensing near the land surface, which will occur if the soil is cool.
2. It prevents rainwater infiltration, which could lead to unwanted cooling of the treatment zone.
3. It provides a vapor seal and increases the radius of influence of the vapor extraction screens.

Temperature and pressure monitoring wells are simple vertical borings used to document performance and pneumatic control during treatment. These are located inside and outside the treatment area, typically at different distances from the heaters to illustrate the heating progression.

3.2 Generic lay-out of above-ground components, showing the footprint of a "typical" application

The above-ground equipment varies from site to site depending on treatment area size, volume, nature of contamination, and local regulatory requirements for treating the effluents. A typical simple system is shown in Figure 5.

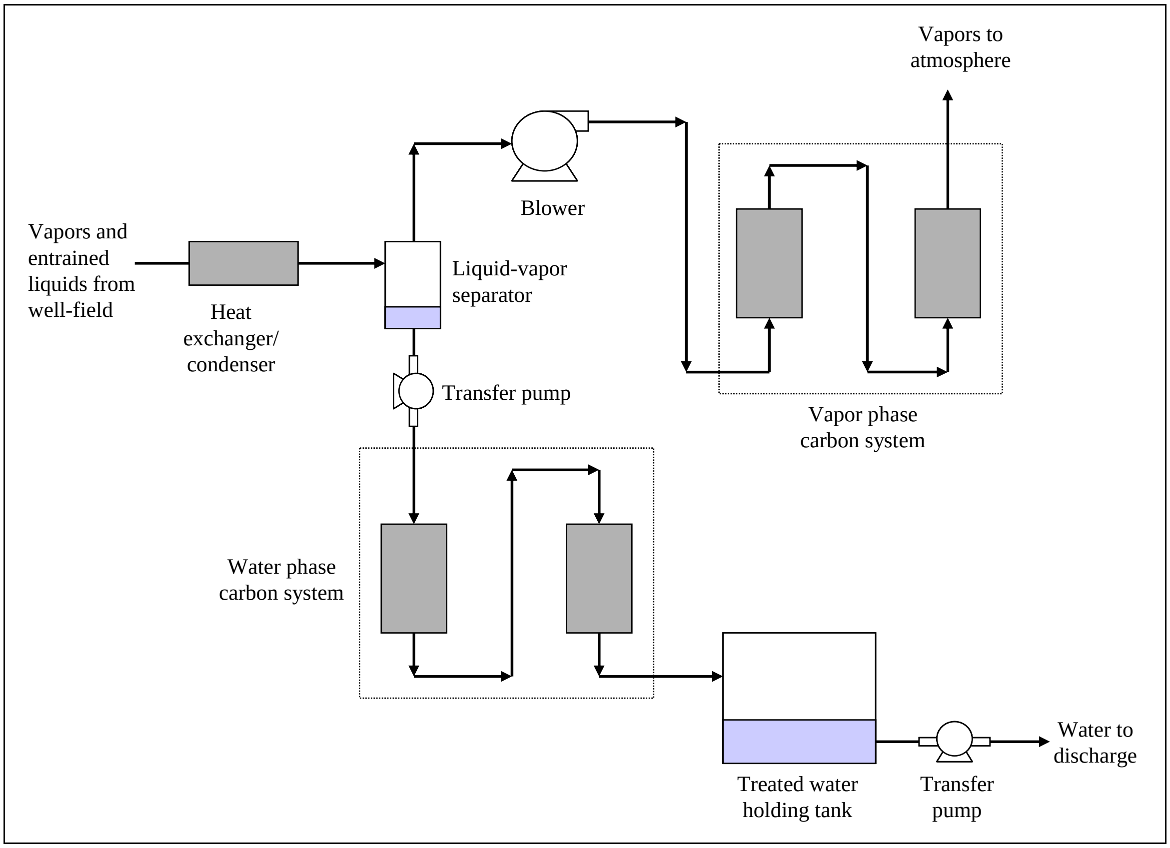


Figure 5. Example treatment system for fluids recovered during ISTD implementation.

For sites with large contaminant mass loading, the vapor treatment is often done using thermal oxidation or other methods capable of handling the high recovery rates.

The surface layout is dictated by site-specific conditions such as the location of utility connections, obstructions such as buildings, and an effort to minimize the piping runs from the well field area to the treatment process. For small sites, the treatment system is placed on a trailer or in a container, and mobilized to the site as one unit. For sites requiring large treatment components, individual process equipment units may be mobilized and connected at the site.

3.3 Special utility requirements (power, water, surface cover, security, etc.)

The required utilities are:

- Power (480 V, 3-phase).
- Water (for drilling, cleaning, office trailer, and sometimes for the process if using a cooling tower or wet acid gas scrubbing).
- Gas or diesel when fuel is used for either off-gas treatment (such as an oxidizer) or for generating power as a back-up.
- Telephone and internet for communications and process controls.

3.4 Is the process configured differently if the contaminants are below the water table?

This depends on whether dewatering is necessary, as discussed in Section 1.5. Often, treatment below the water table involves groundwater extraction and treatment.

4. Process Information

4.1 Typical durations of applications, and how does one decide to turn it off?

For VOC sites, typical durations are between 2 months and 1 year, depending on site-specific requirements and the chosen heater spacing (Section 1.2).

For SVOC sites, typical durations are between 6 months and 1 year.

Performance is typically based on soil concentrations, since soil can be readily sampled during operation, using methods identical or similar to those tested and documented by Gaberell et al.[10]. The criteria for turning off the system are typically the same as the criteria for successful remediation – the system is operated until the client has regulatory approval that the remedy is complete.

Sampling of soil eliminates a classical problem – groundwater rebound occurring after the treatment. By sampling the phase from where rebound would originate (by desorption and diffusion out of bypassed solids), the risk of post-remediation contaminant concentration increases is minimized/eliminated.

[10] Gaberell, M., A. Gavaskar, E. Drescher, J. Sminchak, L. Cumming, W-S. Yoon, and S. De Silva. 2002. Soil Core Characterization Strategy at DNAPL Sites Subjected to Strong Thermal or Chemical Remediation. Paper 1E-07, in: A.R. Gavaskar and A.S.C. Chen (Eds.), *Remediation of Chlorinated and Recalcitrant Compounds*—2002.

For some sites without specific numeric cleanup standards, other parameters are used to determine when to cease operation:

- Groundwater concentrations (although these are hard to use due to the complex chemistry at elevated temperatures and difficulty in collection of representative samples without loss of the contaminants). Groundwater samples can potentially show you more impressive remediation results due to the low solubility of most VOCs in hot water. Basing the decision to stop treatment on such samples may be risky – and rebound could occur during cool-down.
- Target treatment temperature. This would be applied to the coolest locations within the target treatment zone and used to focus the heating process towards the end of the operational period. Laboratory treatability tests can be use as guidance for selection of the target temperature and thereby provide an indication of remedial completeness when the target temperature is reached.
- Energy balance calculation showing steam stripping and generation of a certain amount of steam (typically related to the pore volume of the treatment zone). The amount of steam generation/stripping needed can be estimated based on laboratory testing, and depends on initial concentrations and the specific remediation goals.
- Diminishing recovery of contaminants while ensuring that the heating process and fluid extraction process are operated according to specifications. This can be risky, since diminishing returns can be reached without treatment of the entire targeted volume, as documented as an interim result at the Young-Rainey STAR project[11], where the discovery of a cool area led to focused heating and more complete remediation after the vapor recovery had dropped to low levels temporarily.

Site-specific performance goals are negotiated and typically made part of the contract for the ISTD project. They typically tie directly into the regulatory demands for site closure or remedy acceptance, such that the client and the ISTD contractor work towards the same objective.

4.2 Typical monitoring/diagnostics for the technology during operation (i.e. how do you know it's working?)

The monitoring is based on:

- Hydraulic control (documented using groundwater elevation monitoring).
- Pneumatic control (documented using pressure monitoring).
- Subsurface temperatures (documented using thermocouples). This includes thermocouples located in a subset of the heater borings, used for the thermostat control of the heater elements.

[11] Heron, G., Carroll, S., and Nielsen, S.G.D., 2005. Full-Scale Removal of DNAPL Constituents using steam enhanced extraction and electrical resistance heating. Ground Water Monitoring and Remediation, 25(4): 92-107.

- Contaminant removal rates and totals (estimated by sampling the effluent vapor, water, and NAPL). The totals are compared to initial mass estimates, considering the typical uncertainties of such estimates. However, the total mass recovered is never used to determine when to cease operation, due to the uncertainties in initial mass estimates.
- Vapor treatment efficacy (based on vapor samples before and after the treatment unit).
- Water/condensate treatment efficacy (based on water samples before and after the treatment unit).
- Interim sampling of soil and/or groundwater within and around the treatment zone (showing reductions in contaminant concentrations compared to original levels). These samples are typically the most important for determining when to cease operation.
- Final confirmatory sampling.

In addition, site-specific monitoring related to health and safety and community monitoring may be conducted.

4.3 Post-treatment issues (time period needed for cooling/access/etc.)

This is site-specific and depends on future site use. Typically, live steam is removed from the subsurface over a period of 1 to 2 weeks, while the site starts the cool-down. At some sites, cold water is injected to assist with cooling. When demobilization begins, the subsurface temperatures may be as high as 90°C. Removal of the surface cover enhances the cooling. Demobilization is typically complete between 1 and 2 months after completing the remediation.

5. Technology Selection

5.1 For what scenarios is the technology ideally suited?

Generally, ISTD is favored by the following conditions:

- Recalcitrant contaminants not easily addressed by Monitored Natural Attenuation (MNA), Soil Vapor Extraction (SVE), or pump and treat. The most suited contaminants would include most CVOCs, DNAPL, creosote, coal tar, and PCBs.
- Large contaminant mass and concentrations, with significant NAPL presence (so less aggressive, cheaper methods are ineffective).
- Stringent cleanup standards. ISTD treats to very low final concentrations, largely independent of the starting mass and concentration.
- Sites with a driver to clean within a relatively short time-frame (where long-term solutions suffer due to insecurity about when they can be shut off).
- Sites with target volumes above 3,000 cubic yards (the unit cost is higher for small sites).

- Sites deeper than 10 ft (our simple heaters can readily be extended deeper without much additional cost).
- SVOC sites where excavation is unpractical or expensive (so we can compete on a unit cost basis).

Most sites treated using ISTD have been CVOC DNAPL sites or SVOC sites with PCBs, coal tar, or creosote.

ISTD is potentially ideally suited for fractured rock sites. All know bedrock types have sufficient thermal conductivity to allow for effective heating using ISTD. The combination of very predictable heating and a high density of wells/borings for extraction, such that all or the majority of the fractures can be contacted and used for extraction of the generated steam, makes this a very promising option.

5.2 Under what conditions is the technology "challenged"?

The following conditions challenge the applicability of ISTD:

- Very shallow and wide-spread contamination. For such sites, heat losses may become prohibitive due to the large surface area. The on-site version of ISTD, termed In-Pile Thermal Desorption (IPTD), may apply to some of these sites.
- Contamination present under structures where vertical drilling is prohibited. Heating can readily be done using angled or horizontal borings, but the complexity and cost of the drilling and installation increases significantly compared to vertical installations.
- SVOCs below the water table with stringent cleanup standards and difficulty of dewatering. If the water prohibits drying and heating to above steam temperatures, complete treatment for SVOCs to low levels may not be possible.
- Sites with high groundwater flow rates and difficulty of controlling it during operation. As described in Section 1.2, management of the groundwater flux or additional heating of the high-flow zones may be used to overcome this challenge.

Typical concerns about geotechnical stability and damage to foundations, buildings, or underground utilities are dealt with relatively easily on a site-specific basis, and have not been a significant barrier to ISTD implementation.

Electrical Resistance Heating
By
Greg Smith (Thermal Remediation Services, Inc.)

1.0 Overview of Technology

1.1 One paragraph description of the state of the thermal application

Electrical Resistance Heating (ERH) is an aggressive in situ thermal remediation technology that was developed by the U.S. Department of Energy from the original oil production technology to enhance vapor extraction remediation technologies in low permeability soils. Soil and groundwater are heated by the passage of electrical current through saturated and unsaturated soil between electrodes, not by conductive heating from the electrodes themselves. It is the resistance to the flow of electrical current that results in increased subsurface temperatures, and ERH is typically applied to the boiling point of the contaminant and water mixture. It is estimated that more than 75 ERH applications have been performed. Capacity to perform these projects has increased over the years, with as many as 15 to 20 of these applications now being performed at any given time, mainly in North America, with some European applications. ERH has been used to treat a wide variety of contaminants including VOCs, CVOCs (especially where light non-aqueous phase liquids (LNAPL) or dense non-aqueous phase liquids (DNAPL) are present), pesticides, and is now being applied to treat PAH compounds from manufactured gas plant sites and creosote from wood treating operations.

1.2 New improvements to the technology over the past 5 years

Technological improvements over the past 5 years have been in the area of equipment and mode of application. The modifications to the mode of application have incorporated physical, chemical and biological processes that have been observed to occur during ERH. Improvements made to the equipment include simplification of power control units (PCUs), improvements in electrode design, and modification of water drip systems to maintain soil moisture around electrodes.

Improvements have been made to the efficiency of operations, both from an installation and energy focus, but also from an operational focus. More maintenance-friendly condensers are now being used to control costs and improve efficiency.
Various electrode designs have been developed over the years for a variety of applications. Most electrode designs incorporate vapor recovery in their design. Electrodes have been constructed from steel pipe, copper plate for heating distinct zones and sheet pile. Sheet pile electrodes allow for quick installation with little to no drilling wastes generated for disposal.

More robust, all-weather drip systems have been developed to maintain soil moisture in the vicinity of the electrodes. This allows for continuous all-weather operation in remote locations.

At the Ft. Lewis, Washington project, TRS was the prime contractor for what is believed to be the most-studied application of in situ thermal remediation to date. This work consisted of laboratory and field testing to evaluate the reductive dehalogenation mechanisms during ERH. At the time of this document preparation, much of this data is being evaluated and some additional studies are being conducted, however, some of the lessons learned from this project are being carried forward to incorporate reductive dehalogenation into the design of new applications.

Chemical processes that had not been considered for environmental remediation such as hydrolysis are now becoming the principal mechanism for cleanup for a variety of pesticides using ERH. Hydrolysis had not typically been considered a chemical process for groundwater remediation because at typical groundwater temperatures, the reaction is too slow. At temperatures that can easily be achieved using ERH, hydrolysis reaction rates increase by several orders of magnitude. For example, methylene chloride, which has a hydrolysis half life of 3,282 years at 15 °C, has a hydrolysis half life of 35 days at 100°C.

Physical reactions that provide enhancements to fluid recovery using ERH include a process that TRS calls steam bubble floatation. This process involves the formation of gas and vapor bubbles at the NAPL/water interface causing the NAPL to rise to the water table where it can be removed using multi-phase extraction. This process was used to recover heavy grease at Ft. Lewis, Washington and oil in Georgia.

2.0 Energy Delivery/Heating Information

2.2 Basic conceptual overview of the energy delivery/soil heating process (i.e. a conceptual drawing showing the basic components and a simple conceptual time-series of energy transfer/heating in the subsurface)

The components required to implement ERH include:

- Electrodes (steel pipe, copper plate, well points, sheet pile).
- Vapor recovery wells (which are typically co-located in the same boreholes as the electrodes).
- A steam and vapor collection system, including piping, blower, and condenser.
- A vapor treatment system.
- An ERH power control unit to condition power for application to the subsurface.
- A computer control system with modem for data acquisition and continuous remote monitoring and control of power.

The ERH electrodes conduct electrical energy into the subsurface and can be designed to allow independent control of the energy input to discrete depth intervals. Electrodes are typically constructed using either steel pipe or copper plate to treat distinct zones in the subsurface, such that multiple electrodes can be installed within the same boring. For some applications, sheet piling has been used as electrodes. Electrodes constructed using steel pipe are installed in the subsurface in a manner similar to installing groundwater monitoring wells. In the electrically conductive intervals, the surrounding borehole annulus is packed with a conductive material, such as graphite and/or steel shot, to increase the effective (conductive) diameter of the electrode. In those portions of the subsurface where electrical resistance heating is not desired, the electrode construction materials are insulated and the surrounding annulus is filled with relatively non-electrically conductive materials such as sand or cement.

The electrodes provide the opportunity to heat discrete subsurface depth intervals. In applications having layered sequences, it may be desired to treat discrete layers separately or to create thermal barriers. ERH allows this flexibility by placing electrically conductive materials at discrete intervals within the same borehole in which the electrode is constructed. Based on the current state of the technology and experience, the practical minimum thickness of the discrete zone is 8 feet because of electrical fanning and thermal conduction.

Vapor recovery (VR) is accomplished using conventional vapor extraction techniques utilizing shallow wells installed either vertically or horizontally. Once steam and volatile contaminants have been collected by the VR system, the steam is condensed and the vapor is cooled to near ambient temperatures. Conventional vapor treatment techniques are used to adsorb or destroy the vapors. However, owing to temperatures resulting from application of ERH, the materials for the construction of the wells and headers must be able to withstand temperatures in the order of 100ºC.

An ERH power control unit (PCU) is used to step-down standard line voltage for application as three or six separate electrical phases (as desired). The PCU includes isolation transformers that force ERH current to flow between the electrodes only, preventing ERH current from flowing to a distant electrical sink. Isolation transformers are so named because there is no conductive path between the isolated circuit and the rest of the electrical grid. Because there is no electrical path through the isolation transformer, electricity cannot leave the ERH field. Resistance by the subsurface environment to this flow of electrical current heats the soil and groundwater between the electrodes. Because electrically conductive intervals can be installed to different depth intervals, and the application of energy to the different parts of the electrode field can be controlled, it is possible to heat separate subsurface zones either independently or in unison.

The ERH process is automated, with an onsite computer equipped with a modem and appropriate software for remote access and monitoring. Multiple applications can be monitored and controlled remote from the remediation site or sites, connected via modem. Periodic site visits are required for inspection of the system, maintenance of mechanical equipment, monitoring, manual adjustments to the electrode configurations, and troubleshooting equipment malfunctions.

The only additive normally required for ERH is a drip source of potable water that is applied to soil immediately surrounding the operational electrodes. This water addition, normally incorporated in low permeability environments, prevents the soil adjacent to the electrodes from drying out and becoming nonconductive. Particular attention is paid to maintaining a net extraction of water from the site over the life of the project.

As the subsurface is resistively heated, contaminants are volatilized and soil moisture and groundwater are converted to steam. The production of steam during ERH operations effectively provides for the in situ steam stripping of VOC contaminants from the soil matrix. By raising subsurface temperatures above the boiling point of the mixture of targeted contaminants and groundwater, ERH significantly enhances the speed and effectiveness of physical contaminant removal. ERH provides the physical conditions that result in the chemical, physical, and biological reactions for their removal from the subsurface.

The rate of steam formation during ERH is very slow, typically requiring approximately 2 to 8 weeks to reach the boiling point, depending on site conditions. Once boiling does begin, it is a very gentle process, comparable to the rate of bubble formation in a glass of carbonated beverage.

The process of in situ steam generation converts groundwater to steam and then vapor recovery removes the steam from the subsurface. This has the same effect as groundwater pumping, with the net result being a slight drawdown of the water table and some measure of hydraulic control. Within the vadose zone, some decrease of soil moisture may occur if the site is covered (preventing rainfall percolation).

2.2.1 In Situ and Aboveground Treatment.

During heating, pore water increases in volume 1700-fold as it is converted to steam. This process results in the creation of fissures in clayey and silty soils, facilitating vapor transport. The steam forms very slowly, so that the formation of fissures is on a very small scale.

Above ground treatment typically involves treating vapors, condensate, and entrained water. Vapor treatment involves reducing the moisture content, typically through conventional “knock-out” pot arrangements and heat exchangers, followed by appropriate treatment (e.g., granular activated carbon, combustion, thermal oxidation, etc.) prior to permitted atmospheric discharge. Treatment of condensate and entrained water involves liquid phase granular activated carbon and/or air stripping through a cooling tower. The cooling tower is analogous to an air stripper, with the vapor fed to the vapor stream treatment equipment. The condensate and entrained water makes multiple passes through the cooling tower, significantly reducing concentrations of volatile constituents. The treated water is then disposed as appropriate for the site (e.g., returned to the subsurface as drip water, offsite treatment and disposal, discharge to the local POTW, NPDES-permitted discharge, etc.).

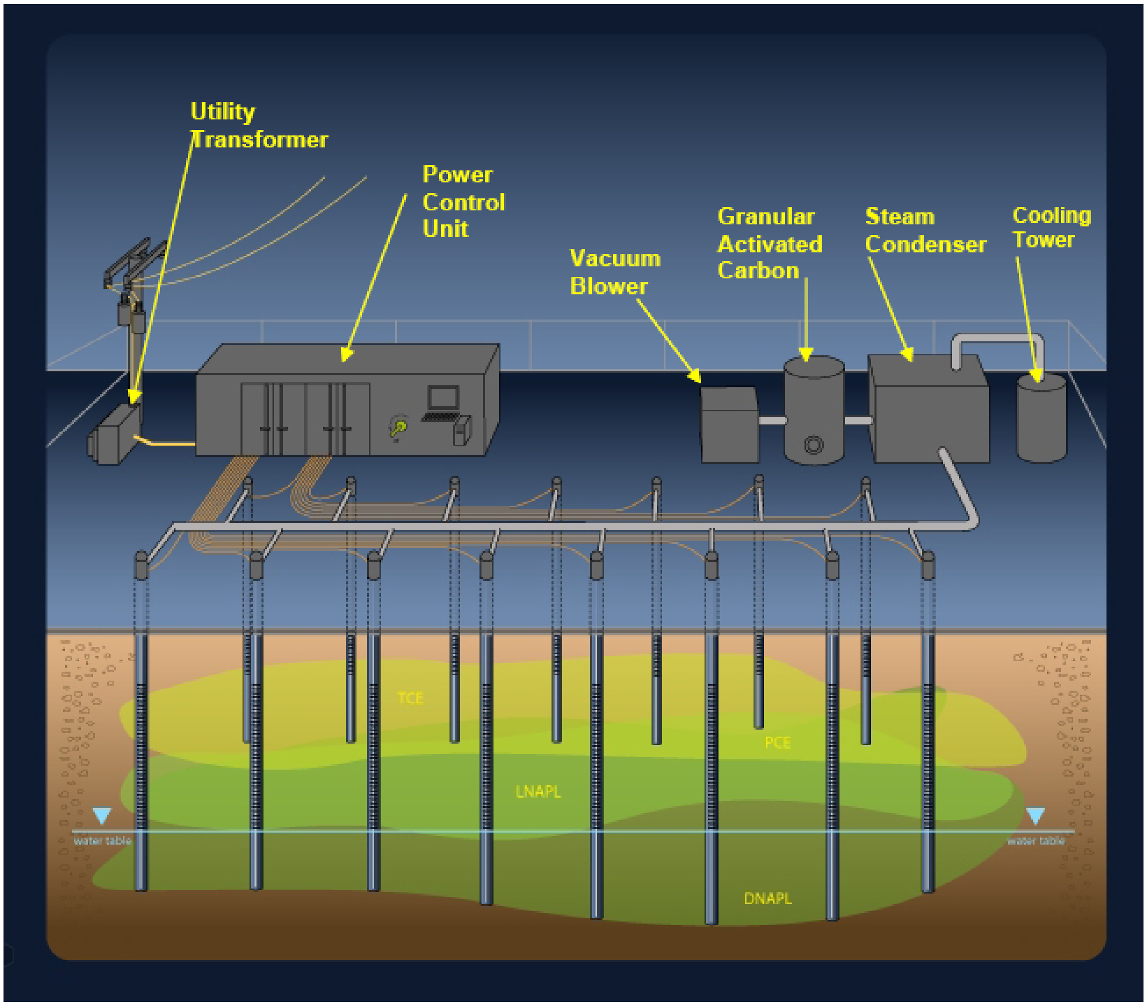


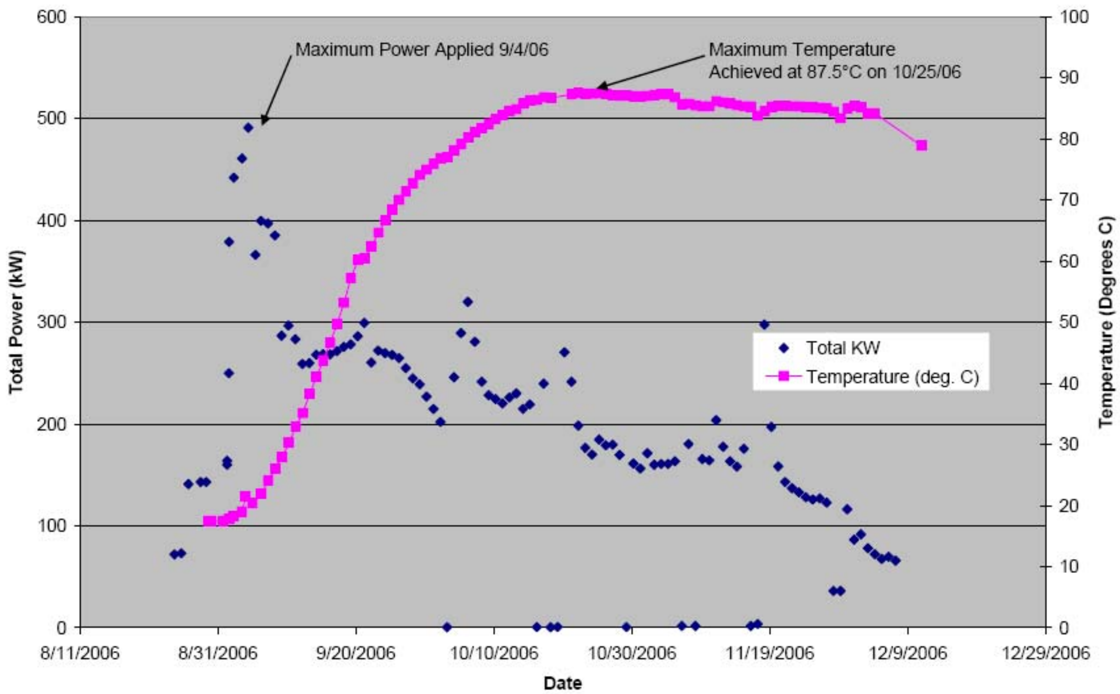
Figure 1: Conceptual Depiction of the Application of ERH

2.2 Any available information on relationship or current understanding between energy delivery and heating rates (i.e. efficiency of energy conversion to heat)

The relationship between energy input and temperature is not straightforward, for there are many factors that influence temperature, including the shape of the volume of the soil and groundwater that is being heated, heat losses (that are influenced by the geometry of the treatment volume), groundwater flow rate, applied vacuum and airflow rates, soil and groundwater electrical conductance, (which changes with temperature), depth of treatment beneath the water table, and other operational issues. Other operational issues relating to the rate of heating deal with the electrical conductivity of the site, the available electrical power, size and type of the vapor treatment system and the rate at which vapors may be discharged from the treatment system.

Figure 2 presents a graph showing the applied power and resultant average temperature for a confidential site in the Chicago, Illinois area. For this site, power was initially applied at a relatively high level, but was reduced prior to the temperature achieving its maximum of 87.5°C on October 25, 2006. It should be noted that the maximum average temperature achieved was adequate and appropriate for this application and achieved the cleanup goals within the projected timeframe.

Figure 2: Applied Power (kW) and Temperature



2.3 Limitations of the energy delivery/heating process (i.e. what temperatures can be reached?, how even is the heat/energy distribution?, do natural phenomena limit the heating?)

The maximum temperature achievable is the boiling point of water, which is governed by the atmospheric pressure (i.e., the boiling point increases with depth). Heating increases the total dissolved solids in groundwater, which in turn increases electrical conductivity. The total dissolved solids in groundwater are affected by biogeochemical reactions. For example, zones which may have high chloride from intrinsic biodegradation of chlorinated ethenes heat up rapidly. Heating becomes more even with time, as illustrated in Figure 3.

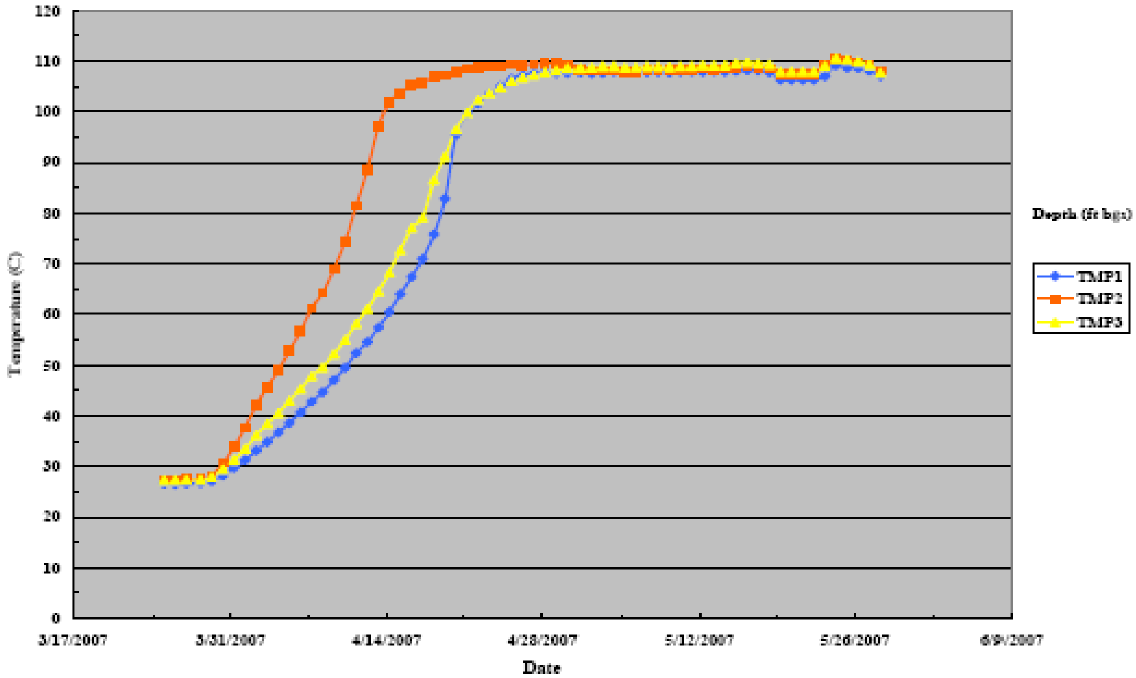


Figure 3: Temperature monitoring showing average temperature versus time at the 3 monitoring locations.

2.4 Unique advantages/disadvantages of this energy delivery/heating approach for contaminant removal or destruction?

Because ERH involves the electrical resistance of the soil matrix to create increases in temperature, there are several inherent features that create advantages for this technology. First, it seeks out the most conductive areas for treatment first. Electrical current, seeking out the path of least resistance will heat areas of high total dissolved solids (TDS) first. Areas of high TDS are the result of biogeochemical reactions associated with the biodegradation of organic compounds, which also corresponds to areas adjacent to high contaminant concentrations. TDS increases throughout ERH, such that electrical conductivity increases as well. TRS' own testing has shown that for chlorinated ethenes and ethanes, chloride represents on the order of 90% of the anions and 40% of all major ions in water during ERH. While different zones heat up quicker, the site is typically heated to a uniform temperature at depth as illustrated in Figure 3, providing for complete treatment throughout.

Second, the technology is self correcting. If some areas heat up in preference to others, the moisture content is reduced, in turn reducing the ability of the soil and groundwater to conduct electricity. The electrical current will seek other pathways until the previously heated area is re-hydrated either naturally or from the ERH drip system.

The electrodes, as noted above, are constructed of readily-available materials (steel pipe, copper plate, sheet pile, etc.) using standard drilling techniques and multiple electrodes can be constructed within the same borehole to heat selective zones. The deepest heating has been to 100 ft in Paducah, Kentucky.

2.5 Is the process applied differently if the contaminants are below the water table?

There is no real difference between applications above and below the water table. The technology requires a minimum of 3% field moisture. The main concern with applications below the water table is groundwater velocity of greater than 1 ft/day, which results in heat losses that need to be controlled. Control can be performed through conventional groundwater control methods (i.e., wells, French drains, sheet pile, slurry walls, freeze walls, etc.).

3.0 Process Configuration Information

3.1 Generic layout of the process showing spacing (heaters, electrodes, wells, temperature, etc.) of in situ components for a "typical" application

Figure 1 presents the conceptual layout for an ERH application. Electrodes are spaced 15 to 23 ft (4.6 to 7 m) apart. The spacing is dependent upon the characteristics of the contaminants to be treated, the desired rate of heating, expected heat losses, the construction of the electrodes that can be achieved, and the desired final temperature to be achieved.

Temperature monitoring points are located throughout the treatment area, and are typically located equidistant between groups of electrodes to monitor temperatures at the furthest distance from the energy application point. Each temperature monitoring point consists of a string of thermocouples, typically set at 5 ft depths.

3.2 Generic layout of above-ground components, showing the footprint of a "typical" application

The layout of the above ground treatment components is dependent upon space available and access. In general, the vapor recovery blower and the condenser are located in a manner to minimize piping from the treatment area, but maintain a safe distance from the area that is being treated. Granular activated carbon vessels and a Baker tank for temporary water storage are typically located in a manner to provide for vehicular access for water removal (if required) and change out of carbon (if required).

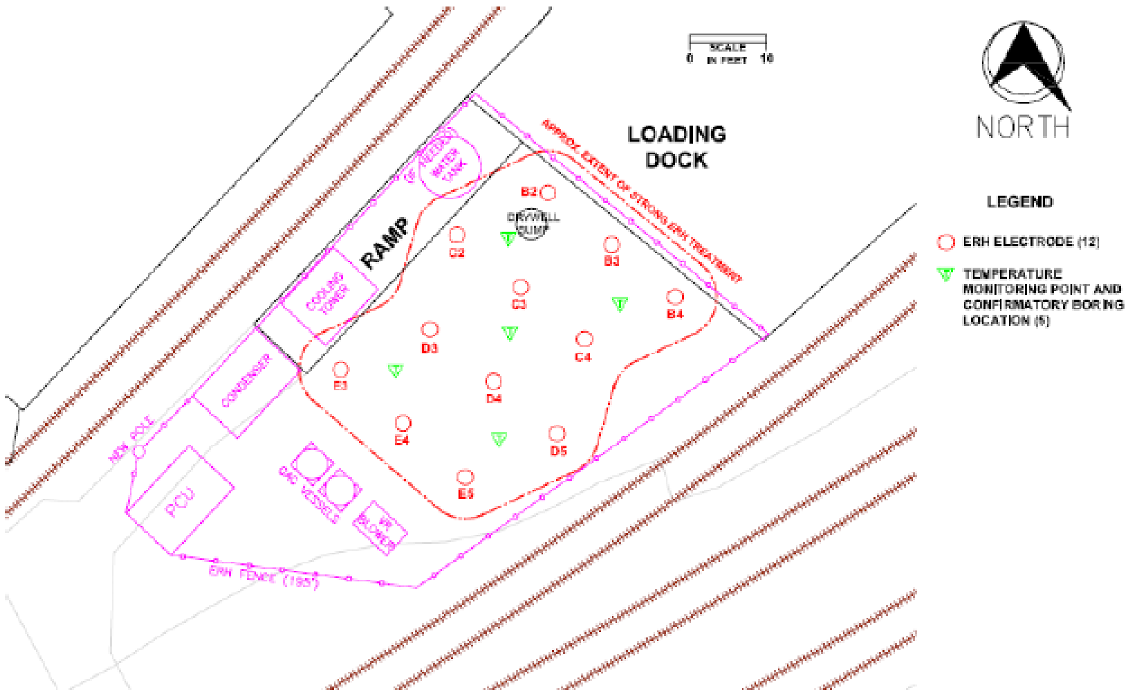


Figure 4: Typical equipment layout for ERH application

3.3 Special utility requirements (power, water, surface cover, security, etc.)

Depending on the equipment needed for a given site, 480 V three-phase or standard 13.8 KV three-phase line voltages are required to power the PCU, which then distributes power to the electrodes and ancillary equipment. A source of potable water is also required during the initial phases of application as a source of drip water and for the cooling tower at start up. Water during operations is normally supplied by the condensate produced from the heating. A data quality telephone line may be necessary for adequate remote communications. Surface covers typically consist of existing pavement or concrete if working in an industrial area. For bare ground applications, the surface may be covered with polyethylene sheeting, depending on depth of treatment depth below grade. The sheeting is used to maintain vacuum and minimize the surface infiltration from precipitation.

The level of security depends on the location where the ERH treatment is being performed. Historically, most locations have involved working in or around active and shuttered factories, where standard chain-link fencing and placarding indicating the electrical hazards has been appropriate. The next level of security that is typically used involves perimeter electronic monitoring to provide alarmed automatic shut down of the system to prevent potential electrical shock to intruders. When the perimeter system is tripped, the operator is notified and the system is restarted once the operator has confirmed that operations can safely continue. TRS has not had to impose a higher level of security, but if needed, this is envisaged as involving a perimeter electronic system with periodic to continuous manual security checks provided by a contract security company.

3.4 Is the process configured differently if the contaminants are below the water table?

As noted above under Section 2.5, there is no real difference between applications above and below the water table and as such there is no difference in the configuration.

4.0 Process Information

4.1 Typical monitoring/diagnostics for the technology during operation (i.e. how do you know it's working?)

Monitoring during ERH involves tracking temperature, power and energy application, and organic vapor concentrations. It has been observed that most of the organic vapors are produced during the heat-up portion of operations. When organic vapor concentrations decrease by approximately 80% from peak concentrations, electrical resistance heating typically is temporarily stopped and interim groundwater or soil sampling is performed. The analytical results are then evaluated to determine if and where additional treatment is required. Power application to individual electrodes may be ceased in order to focus treatment in select areas, thus reducing cost. Natural attenuation processes (most importantly intrinsic biodegradation) are also commonly assessed at this time to determine if remediation goals can be attained under post-thermal treatment conditions. Based upon the results of interim sampling, heating can be continued or post-remedial sampling can be conducted to document that the remedial action objectives for soil and groundwater have been met.

4.2 Post-treatment issues (time period needed for cooling/access/etc.)

After ERH treatment, soil and groundwater typically return to ambient temperatures within 6 to 24 months. During this cool down period, groundwater and soil sampling may be safely conducted using the proper precautions. TRS has developed protocols for sampling that have been approved by federal and state environmental protection agencies. Safe access to the site is normally restored within two days to two weeks of cessation of power application.

5.0 Technology Selection

5.1 For what scenarios is the technology ideally suited?

ERH has been most widely applied for the remediation of chlorinated ethenes and ethanes where DNAPL is present, since these groups of chemicals represent the most commonly encountered environmental contaminants, with the exception of fuels. There have been a small number of sites contaminated with fuels that have been remediated using ERH. ERH has also been used to hydrolyze a few pesticide impacted sites, and is now seeing some application for MGP site and creosote sites.

5.2 Under what conditions is the technology "challenged"?

As noted above, the technology may be challenged in instances where heat losses through high groundwater flow may represent an issue. These conditions can usually be mitigated using engineered solutions.

ERH has been used in buildings where there has been sufficient overhead clearance from which to install the electrodes. This is generally site specific, depending upon the overhead clearance and available drilling equipment with which to install the electrodes. Electrodes drilled at an angle have been successfully installed and used at a number of sites to access difficult areas.

Some PAH compounds may represent a challenge. Generally, significant reduction in concentration (>85%) has been observed for compounds with boiling points of less than 300°C. PAH compounds, with boiling temperatures of greater than 300°C tend to adhere to the soils and are not significantly reduced, but are not considered mobile in groundwater environments.

Concerns over geotechnical stability are dealt with relatively easily and have not represented a problem. ERH does not pose a threat to underground foundations and utilities.

Steam Enhanced Extraction

By
Gorm Heron (TerraTherm) and Gregory Crisp (TerraTherm)

1. Overview of Technology

1.1 One paragraph description of the state of the thermal application

Steam Enhanced Extraction (SEE) has been used successfully for treatment of large sites, and numerous pilot tests have shown great promise for applications to a variety of contaminants, including chlorinated solvents, oil, and creosote. Two large sites have been closed, achieving MCL level groundwater concentrations after effective source removal.

1.2 New improvements to the technology over the past 5 years

The technology was significantly expanded and adapted during the period of 1998-2003 with focus on optimizing steam delivery and heating completeness, use of pressure cycling to enhance removal, and applications in moderately permeable strata and fractured rock. New combinations with thermal conduction heating are promising adaptations for heterogeneous sites, and are currently being implemented.

2. Energy Delivery/Heating Information

2.1 Basic conceptual overview of the energy delivery/soil heating process (i.e. a conceptual drawing showing the basic components and a simple conceptual time-series of energy transfer/heating in the subsurface)

SEE involves installation of a network of injection and extraction wells, installation of temperature monitoring equipment, injection of steam into the wells, and extraction of hot fluids for on-site separation and treatment[12]. The injection of steam is a stable and predictable process, since the steam propagation is governed by heat transfer to the formation, which has been studied intensively for oil recovery. This predictability allows for hydraulic control of non-aqueous phase liquid (NAPL) mobility, as steam sweeps from the outside in and pushes NAPL and vaporized contaminants of concern (COCs) towards the central parts of the site for extraction.

The steam displaces subsurface fluids such as water, NAPL, and air and creates a steam zone with reduced liquid saturations. During the steam front propagation, the target zone is heated both by the steam itself, and by the warm/hot condensate migrating with it. The condensate is formed when some of the steam condenses after being cooled by the subsurface materials.

After the target zone for steam injection has been heated, a steam zone is created between the injection and extraction wells. A period of pressure cycling is induced by varying the injection pressure and rates, as well as the applied vacuum. This pressure cycling has

[12] Davis, E.L. (1998): *Steam injection for soil and aquifer remediation*. US EPA Issue paper EPA/540/S-97/505.

been demonstrated to improve removal rates for COCs dramatically, and to achieve very low concentrations in the original source zone.

Figure 1 shows a generic sketch of an SEE site.

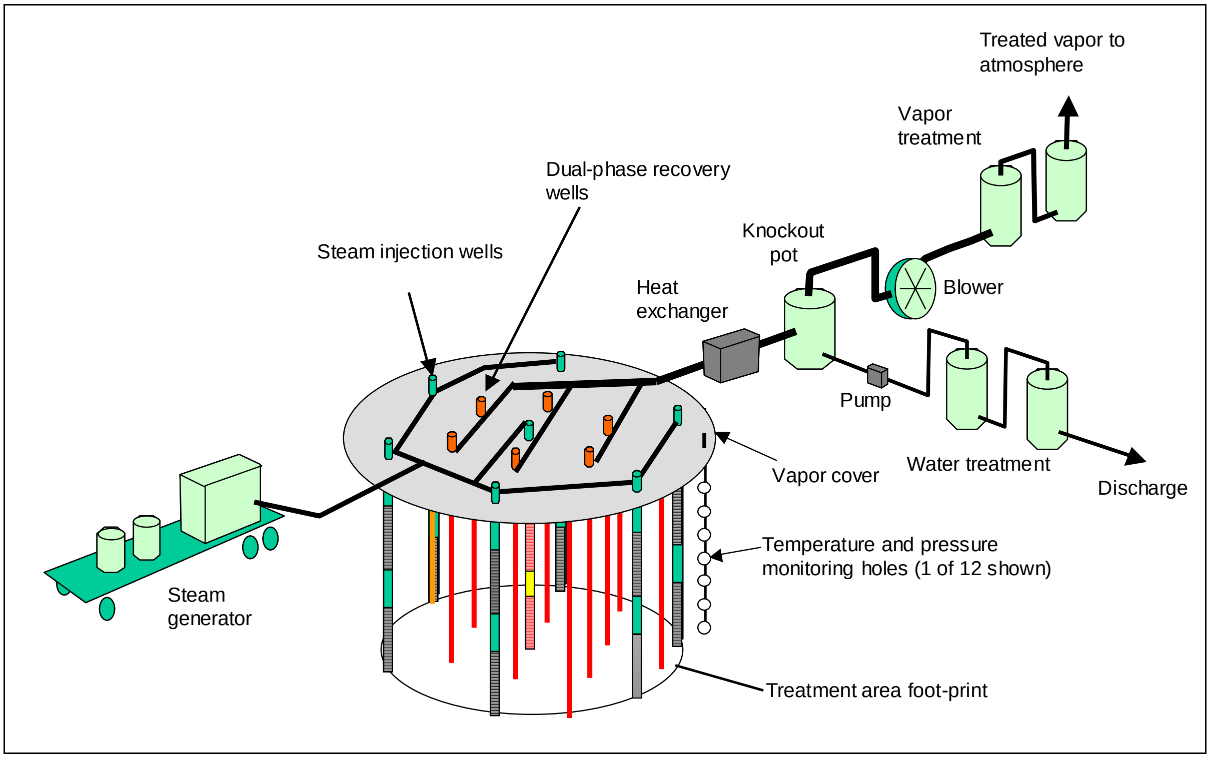


Figure 1. Conceptual Sketch of Steam Enhanced Extraction System.

A more detailed sketch of a steam generating process is shown on Figure 2. Note that the water supply is fresh water, and that the fuel can be either natural gas, propane, or diesel. Some steam generators or boilers have a pre-heating step (de-airator), where the feed water is heated using some of the produced steam.

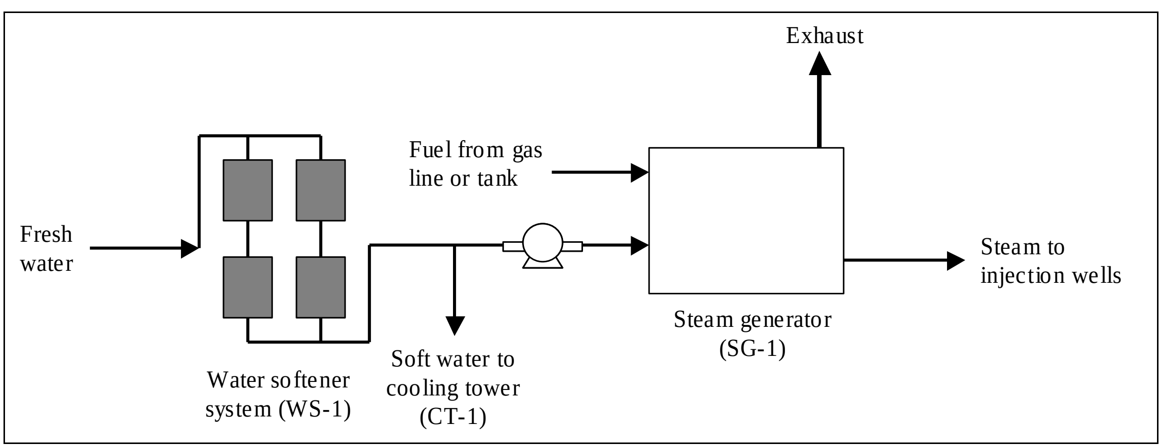


Figure 2. Steam generation system schematic.

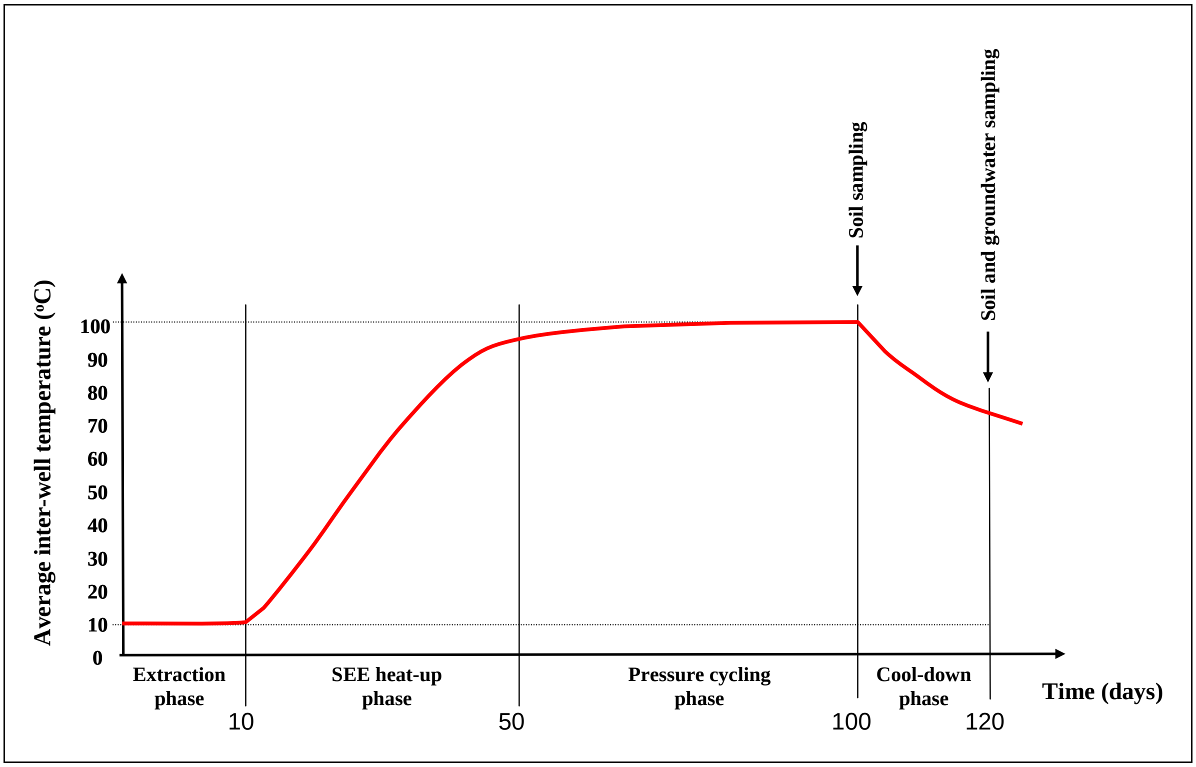
For treatment of a separate NAPL source area, the treatment zone is typically surrounded by steam injection wells installed in clean material. The extraction wells are located in high-concentration areas, each surrounded by four or six steam injection wells.

A typical site has the following components:

- Transformer to supply 480 V, 3-phase power.
- Vertically installed injection wells installed with grout and sandpack.
- Groundwater and vapor recovery wells (horizontal or vertical, or both, depending on geology).
- Temperature and pressure monitoring wells.
- A water softening and steam generation system.
- An air compressor or blower to deliver air for co-injection with steam (if used).
- An off-gas and water treatment system with varying components depending on contaminants and expected mass loading.

Air co-injection is sometimes used to minimize the risk of forming condensation banks containing NAPL, and to enhance the vapor transport to extraction wells[13].

A typical operational period, using treatment to the boiling point of water as an example is provided in Figure 3.



[13] Kaslusky and Udell 2002. A theoretical model of air and steam co-injection to prevent the downward migration of DNAPLs during Steam-Enhanced Extraction. Journal of Contaminant Hydrology, 55: 213-232.

Figure 3. Typical timeline for operation of an SEE system.

The extraction phase is used to document pneumatic control and to demonstrate that the effluent treatment system meets the regulatory demands for contaminant removal efficiency. This period is also used to document hydraulic control and sufficient water treatment.

During the heat-up phase, steam is injected into each well at a pre-determined rate (based on target zone thickness, permeability, and well spacing), and the ground heats up due to the convection of heated fluids such as steam, air, and water. The goal of this phase is to heat the target volume to steam temperature and to allow for steam break-through to the extraction wells. During this period cool groundwater is being displaced to extraction wells, and a steam zone develops until steam sweeps through to the extraction wells. This period is also called the “steam sweep”.

The pressure cycling phase is a period where steam is generated in-situ, and steam stripping is used to lower contaminant concentrations to below target levels. It often overlaps with heating of the bottom-most depths, and/or areas that lag behind the average heating, to the target temperature. Details of the pressure cycling principle was published by Udell 1996[14]. Heron et al. (2003) used pressure cycling to achieve MCL level groundwater concentrations at the Young-Rainey STAR Center Area A site[15].

Interim and final confirmatory soil sampling (and groundwater sampling, where required) is used to assess the treatment efficacy. Once the data comes back from the laboratory and shows that the objectives are met, a short cool-down period follows, where steam is removed from the subsurface and the site is cooled to an acceptable final temperature. Then, the SEE equipment and the well-field are decommissioned.

2.2 Any available information on relationship or current understanding between energy delivery and heating rates (i.e. efficiency of energy conversion to heat)

The hydrogeology controls the rate of steam injection at each site. Typically, the steam is pushed through the formation for steam breakthrough to extraction wells in less than 60 days. This is desirable to (1) limit the operations time at the site and (2) minimize the risk of steam over-ride, where the buoyancy of the steam makes it flow on top of groundwater and/or NAPL, reducing the sweep efficiency. For larger sites, the steam sweep may be staged across the site, such that the operational period is longer than that of each segment being heated with steam. This means that large sites have longer durations.

The following pressure cycle duration depends on the remediation goals. More stringent goals means longer pressure cycling. Typically, between 1 month (for small VOC sites) to a year or longer (for large creosote sites) are used.

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[14] Udell, K.S. 1996. Heat and mass transfer in clean-up of underground toxic wastes. In Annual Reviews of Heat Transfer, Vol. 7, Chang-Lin Tien, Ed.; Begell House, Inc.: New York, Wallingford, UK, pp. 333-405.
[15] Heron, G., Carroll, S., and Nielsen, S.G.D., 2005. Full-Scale Removal of DNAPL Constituents using steam enhanced extraction and electrical resistance heating. Ground Water Monitoring and Remediation, 25(4): 92-107.

Finally, the cool-down period depends on site size and objectives, but typically last between 1 week and several months.

Typical total durations are shown in table 1.

Table 1. Typical duration of SEE operation as a function of well spacing.

Steam injection well spacing (ft)	Operational duration for source zones (days)	Example site
<20	50-100	Alameda Point Site 5[16]
20-40	100-200	Young-Rainey STAR Center Area A[17]
>40	200-400+	Visalia Pole Yard (Creosote)[18]

Actual durations are site-specific, and depend on factors such as:

- Initial saturation (the wetter the longer it takes).
- Porosity (the higher the longer it takes).
- Water table position.
- Groundwater seepage velocity and recharge (if a hydraulic barrier is not used).
- Mineral composition (minor differences between common minerals).
- Initial contaminant mass.
- Target contaminant concentration (the lower the longer it takes).
- Target contaminant boiling point and volatility (higher boiling point compounds require longer operation).

If the project schedule is critical, the well spacing is chosen for a given site to match the available time.

Several tools exist for predicting/estimating the steam zone progression and time for the steam to migrate to the extraction wells. These range from simple rule-of-thumb relations to sophisticated 3-dimensional non-isothermal simulators such as T2VOC, TOUGH2, and STARS.

2.3 Limitations of the energy delivery/heating process (i.e. what temperatures can be reached?, how even is the heat/energy distribution?, do natural phenomena limit the heating?)

The largest limitation of SEE is soil permeability. Many sites are too tight to allow steam to be injected and heat the target volume sufficiently. It is typically not considered safe to inject at steam pressure above 0.5 psig per ft of overburden located over the injection

[16] Udell et al. 2000. BERC (2000). Steam Enhanced Extraction Demonstration at Site 5, Alameda Point. Field Feasibility Demonstration for the US Navy, DO-9. Berkeley Environmental Restoration Center, University of California at Berkeley.Berkeley, CA. Final report.
[17] Heron et al. 2005. Ibid.
[18] Eaker, Craig 2007. Southern California Edison, Rosemead, CA. Personal communication.

screen. Higher pressures can lead to lifting of the formation and surface escape of steam. Example sites where insufficient steam injection rates are achievable are ones dominated by thick clay zones and competent bedrock sites with minimal fracturing. Each site must be carefully evaluated to determine whether SEE technology is the right choice for delivering the energy to the target volume.

For compounds with boiling points above 200^{o}C, steam stripping and vaporization are not effective mechanisms, and technologies that can reach higher temperatures may be more applicable. SEE may only be capable of removing the mobile NAPL and reduce concentrations by steam distillation, which affects the lighter end of the NAPL (lowest molecular weight compounds in the mix).

For SVOCs such as PAH and creosote, SEE has been shown to be effective in long-term applications such as the Visalia Pole Yard[19], where SEE was followed by a period of enhanced natural attenuation. Field data from other sites also indicate that SEE can remove the bulk of the DNAPL mass in a relatively short period, if the subsurface hydrogeology allows for steam sweep of the DNAPL zones. However, such sites typically are not completely depleted in the organic contaminants, since steam stripping is less effective for the higher molecular weight contaminants such as benz(a)pyrene.

2.4 Unique advantages/disadvantages of this energy delivery/heating approach for contaminant removal or destruction?

Steam is by far the cheapest form of energy for injection. Typical boiler efficiencies in the range of 80 to 90% means that ~ 85% of the fuel value in the fuel is injected. For comparison the electricity using in ERH and TCH/ISTD applications is generated at power plants with much lower energy conversion efficiency, plus line losses for delivery. In addition, cold water is displaced by the advancing steam, such that it does not require energy for heating. The result is that the same block of earth can be heated using approximately half the fossil fuel of an electrical heating process, and costing about half. For large sites the savings may be the difference between a project being over or under the acceptable budget.

Steam injection and extraction wells are very simple and inexpensive to construct. Injection wells are 1, 2, or 4-inch diameter carbon steel pipes with a stainless steel screen, set in sandpacks and sealed using high-temperature grout. The borehole size does not increase as the wells need to go deeper.

A potential disadvantage is the inability to heat tight zones, where the steam cannot be injected at a sufficient rate. Another potential disadvantage is the steam buoyancy in deep or thick formations, where steam rise may lead to bypassing of DNAPL layers pooled at the base of an aquifer. A good and detailed analysis of the site hydrogeology is key to managing these potential disadvantages.

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[19] Eaker 2007. Ibid.

Relatively new heating combinations are designed to minimize the disadvantages of steam (by combining it with TCH) and optimizing the use of the lower-energy heating method (by enhancing electrical heating projects using steam injection).

2.5 Is the process applied differently if the contaminants are below the water table?

In principle, no. The steam wells are installed and operated in the same manner. However, for vadose zone applications, recovery of the condensate generated when steam cools in the formation is essential. This condensate can be rich in contaminants, particularly early on in the operational period. Thus, hydraulic control must be ensured.

Below the water table the steam behavior is well-described from decades of enhanced oil recovery, and SEE is an applicable technology.

Most SEE sites to date have treated both a saturated zone and a vadose zone simultaneously. This facilitates easy hydraulic control by pumping, and pneumatic control by vacuum extraction above the water table.

3. Process Configuration Information

3.1 Generic lay-out of the process showing spacings (heaters, electrodes, wells, etc.) of in situ components for a "typical" application

Steam injection and extraction wells are typically located either in a square pattern (5-spot) or in a triangular pattern (7-spot) as shown on Figure 4. However, the pattern does not have to be regular, since this is a fluid-delivery based process without electrical phasing considerations.

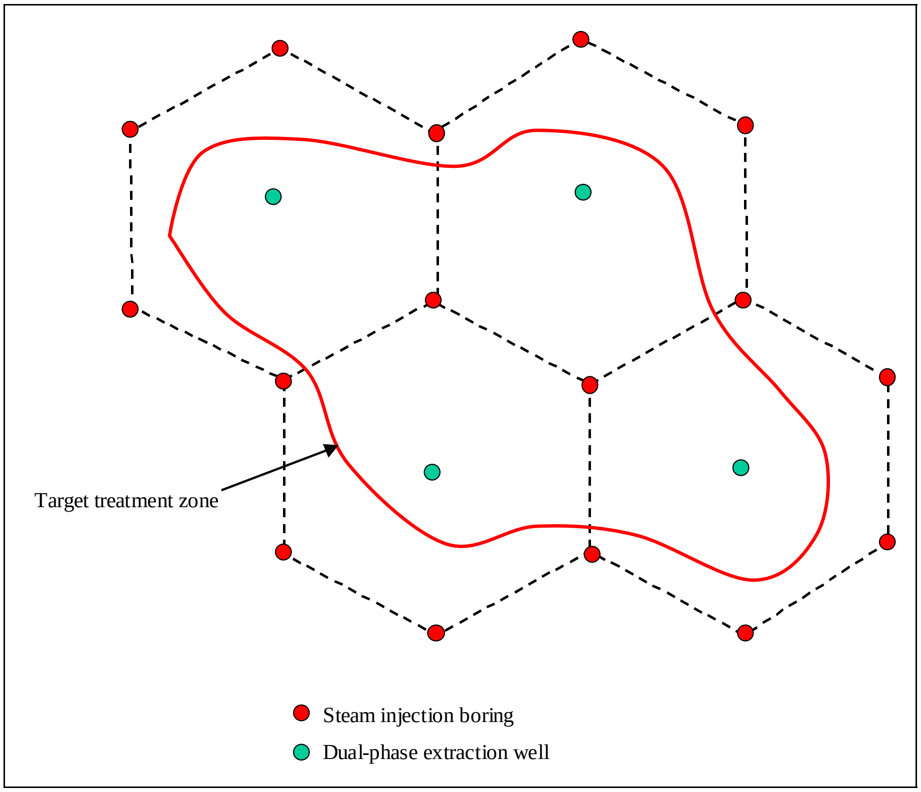


Figure 4. Generic layout of heater borings and process equipment for an SEE project.

The spacing between steam wells is discussed in Section 1.2. Well spacings have ranged from 20 ft at relatively low-permeability sites to more than 50 ft at sites with high hydraulic conductivity and significant depth.

Vapor and water extraction wells can either be vertical wells within the pattern (heated or unheated), or horizontal or angled wells located in optimized positions to capture the heated fluids. Figure 5 shows the wells in a schematic cross-section. The extraction wells are fully screened, allowing for NAPL and water recovery also when the operations lead to partial dewatering and large changes in the depth of the water table. Steam injection wells are typically screened at the base of the treatment zone, or slightly deeper to allow for steam rise into the target treatment zone.

Note that several sites have been heated using more than one steam injection well interval per location. Several projects have used three injection intervals, as for example EarthTech and SteamTech.[20]

[20] Earth Tech and SteamTech (2003): Site 61 Treatability Study Report, Steam Injection. Northwest Main Base, Operable Unit 8. Draft report submitted to US Air Force Flight Test Center, Environmental Restoration Division, Edwards AFB, California.

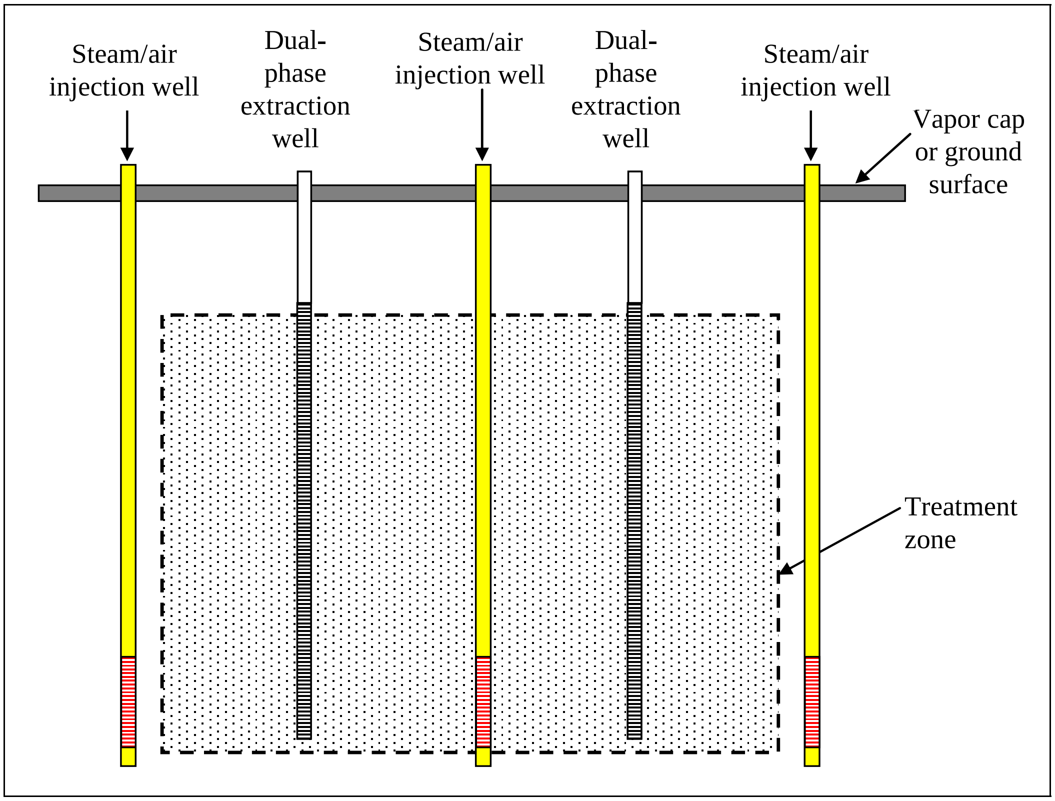


Figure 5. Generic cross-section for an SEE site with one injection interval.

Each site is analyzed in detail, and both the steam delivery and the vapor and water recovery wells and extraction approach is determined based on site-specific conditions.

A vapor cover is typically used when treating to shallow depths. The cover serves three purposes:

4. It provides thermal insulation and prevents contaminants from condensing near the land surface, which will occur if the soil is cool.
5. It prevents rainwater infiltration, which could lead to unwanted cooling of the treatment zone.
6. It provides a vapor seal and increases the radius of influence of the vapor extraction screens.

Temperature and pressure monitoring wells are simple vertical borings used to document performance and pneumatic control during treatment. These are located inside and outside the treatment area, typically at different distances from the operational wells to illustrate the progression of the SEE process in the subsurface.

3.2 Generic lay-out of above-ground components, showing the footprint of a "typical" application

The above-ground equipment varies from site to site depending on treatment area size, volume, nature of contamination, and local regulatory requirements for treating the effluents.

The steam generation system was described in Section 2.1.

A typical extraction and treatment system is shown in Figure 6. Typically, effluent fluids are condensed before vapor treatment, and that conventional vapor and water treatment technologies are acceptable. The heat exchanger/condenser reduces the temperature of the extracted vapors, to remove steam and increase the efficiency of the water and vapor treatment. The fluids then are separated into liquids and vapors in a liquid-vapor separator. The vapor treatment system is assumed to consist of a granular activated carbon (GAC) system, and a vacuum blower. Other vapor treatment options include Catalytic or Thermal Oxidation. Condensate treatment is by liquid phase GAC filtration (sometimes preceded or replaced by air stripping).

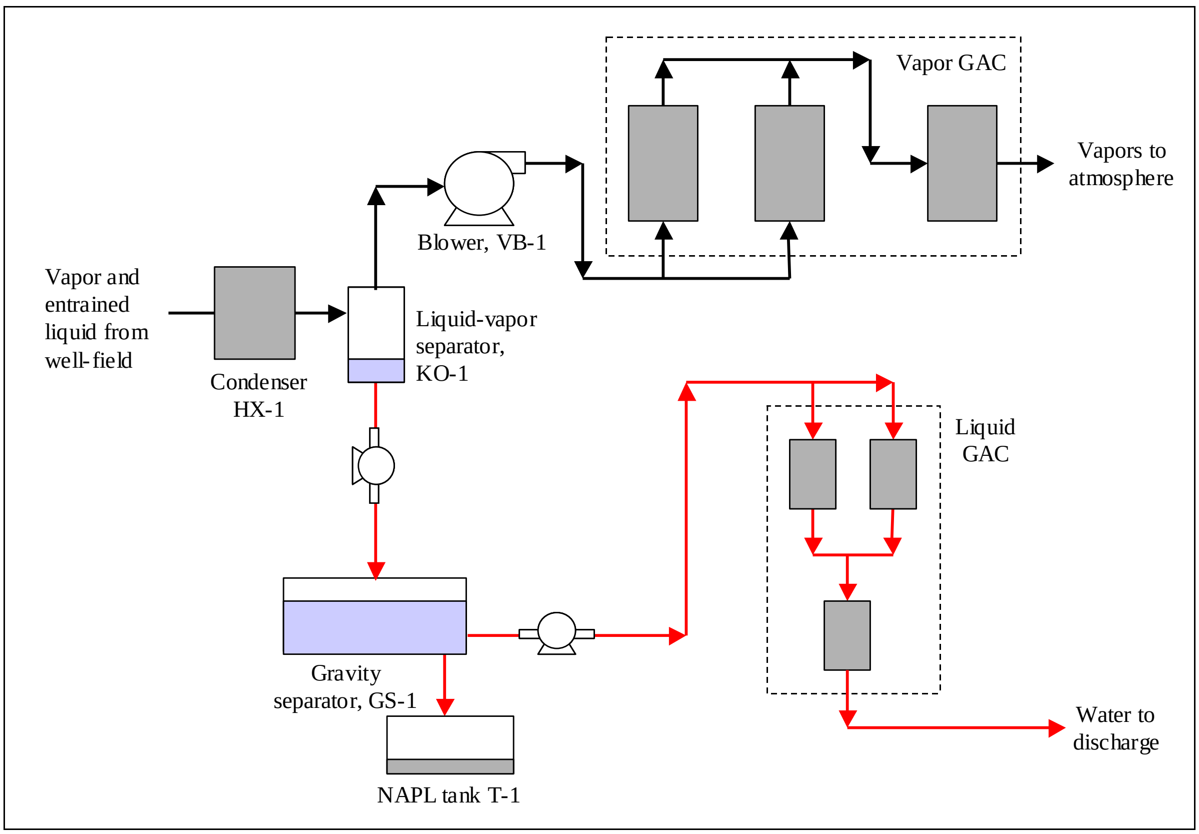


Figure 6. Effluent Treatment System.

Since the extracted fluids include water, potentially NAPL, air, and steam at varying temperatures and pressures, the treatment system is a robust combination of cooling, separation and treatment units previously proven to be effective for their functions.

For sites with large contaminant mass loading, the vapor treatment is often done using thermal oxidation or other methods capable of handling the high recovery rates.

The surface layout is dictated by site-specific conditions such as the location of utility connections, obstructions such as buildings, and an effort to minimize the piping runs from the well field area to the treatment process. For small sites, the treatment system is placed on a trailer or in a container, and mobilized to the site as one unit. For sites requiring large treatment components, individual process equipment units may be mobilized and connected at the site.

3.3 Special utility requirements (power, water, surface cover, security, etc.)

The required utilities are:

- Power (480 V, 3-phase).
- Water (for drilling, cleaning, office trailer, steam generation, and sometimes for the process if using a cooling tower or wet acid gas scrubbing).
- Gas or diesel when fuel is used for steam generation and sometimes for off-gas treatment (such as an oxidizer) or for generating power as a back-up.
- Telephone and internet for communications and process controls.

At some sites, plant steam is used, which reduces the demand for water and fuel.

3.4 Is the process configured differently if the contaminants are below the water table?

No, SEE is well suited for both vadose zone and saturated zone treatment. Condensate collection is important for vadose zone applications, since some of the injected steam condensed and must be extracted. The process equipment is very similar whether the SEE is applied above or below the water table. Vapor and liquid extraction is important in all cases.

4. Process Information

4.1 Typical durations of applications, and how does one decide to turn it off?

For VOC sites, typical durations are between 2 and 6 months, depending on site-specific requirements and the chosen well spacing.

For SVOC sites, typical durations are between 6 months and 1 year. Some sites have taken longer, when coupled with enhanced natural attenuation, or when a very large volume is treated in stages.

Performance is typically based on soil concentrations, since soil can be readily sampled during operation, using methods identical or similar to those tested and documented by Gaberell et al.[21]. The criteria for turning off the system are typically the same as the

[21] Gaberell, M., A. Gavaskar, E. Drescher, J. Sminchak, L. Cumming, W-S. Yoon, and S. De Silva. 2002. Soil Core Characterization Strategy at DNAPL Sites Subjected to Strong Thermal or Chemical

criteria for successful remediation – the system is operated until the client has regulatory approval that the remedy is complete.

Sampling of soil eliminates a classical problem – groundwater rebound occurring after the treatment. By sampling the phase from where rebound would originate (by desorption and diffusion out of bypassed solids), the risk of post-remediation contaminant concentration increases is minimized/eliminated.

For some sites without specific numeric cleanup standards, other parameters are used to determine when to cease operation:

- Groundwater concentrations (although these are hard to use due to the complex chemistry at elevated temperatures and difficulty in collection of representative samples without loss of the contaminants). Groundwater samples can potentially show you more impressive remediation results due to the low solubility of most VOCs in hot water near the boiling point. Basing the decision to stop treatment on such samples may be risky – and rebound could occur during cool-down.
- Target treatment temperature. This would be applied to the coolest locations within the target treatment zone and used to focus the heating process towards the end of the operational period.
- Energy balance calculation showing steam stripping and generation of an exchange of a certain amount of steam (typically related to the pore volume of the treatment zone). The amount of steam flushing and pressure cycling needed can be estimated based on laboratory testing, and depends on initial concentrations and the specific remediation goals.
- Diminishing recovery of contaminants while ensuring that the heating process and fluid extraction process are operated according to specifications. This can be risky, since diminishing returns can be reached without treatment of the entire targeted volume, as documented as an interim result at the Young-Rainey STAR project[22], where the discovery of a cool area led to focused heating and more complete remediation after the vapor recovery had dropped to low levels temporarily.

Site-specific performance goals are negotiated and typically made part of the contract for the SEE project. They typically tie directly into the regulatory demands for site closure or remedy acceptance, such that the client and the SEE contractor work towards the same objective.

4.2 Typical monitoring/diagnostics for the technology during operation (i.e. how do you know it's working?)

Remediation. Paper 1E-07, in: A.R. Gavaskar and A.S.C. Chen (Eds.), *Remediation of Chlorinated and Recalcitrant Compounds*—2002.

[22] Heron, G., Carroll, S., and Nielsen, S.G.D., 2005. Full-Scale Removal of DNAPL Constituents using steam enhanced extraction and electrical resistance heating. Ground Water Monitoring and Remediation, 25(4): 92-107.

The monitoring is based on:

- Hydraulic control (documented using groundwater elevation monitoring).
- Pneumatic control (documented using pressure monitoring).
- Subsurface temperatures (documented using thermocouples, fiberoptic sensors or similar temperature monitoring equipment).
- Contaminant removal rates and totals (estimated by sampling the effluent vapor, water, and NAPL). The totals are compared to initial mass estimates, considering the typical uncertainties of such estimates. However, the total mass recovered is never used to determine when to cease operation, due to the uncertainties in initial mass estimates.
- Vapor treatment efficacy (based on vapor samples before and after the treatment unit).
- Water/condensate treatment efficacy (based on water samples before and after the treatment unit).
- Energy balance calculations.
- Interim sampling of soil and/or groundwater within and around the treatment zone (showing reductions in contaminant concentrations compared to original levels). These samples are typically the most important for determining when to cease operation.
- Final confirmatory sampling.

In addition, site-specific monitoring related to health and safety and community monitoring may be conducted.

4.3 Post-treatment issues (time period needed for cooling/access/etc.)

This is site-specific and depends on future site use. Typically, live steam is removed from the subsurface over a period of 1 to 2 weeks, while the site starts the cool-down. At some sites, cold water is injected to assist with cooling. When demobilization begins, the subsurface temperatures may be as high as 90^{o}C. Removal of the surface cover enhances the cooling. Demobilization is typically complete between 1 and 2 months after completing the remediation.

5. Technology Selection

5.1 For what scenarios is the technology ideally suited?

Generally, SEE is favored by the following conditions:

- Recalcitrant contaminants not easily addressed by Monitored Natural Attenuation (MNA), Soil Vapor Extraction (SVE), or pump and treat. The most suited contaminants would include most CVOCs, DNAPL, and creosote.
- Large contaminant mass and concentrations, with significant NAPL presence, such as large fuel spills with substantial LNAPL accumulation on a water table (so less aggressive, cheaper methods are ineffective).
- Sites with a driver to clean within a relatively short time-frame (where long-term solutions suffer due to insecurity about when they can be shut off).
- Sites deeper than 10 ft (the wells can readily be extended deeper without much additional cost).
- Sites where excavation is unpractical or expensive (so SEE can compete on a unit cost basis).

SEE is potentially partially suited for fractured rock sites. To date, three pilot test demonstrations have been conducted, with varying degree of success. Highly weathered and fractured rock sites with significant mass above the water table are the most promising candidate sites for SEE in rock.

5.2 Under what conditions is the technology "challenged"?

The following conditions challenge the applicability of SEE:

- Very shallow and wide-spread contamination. For such sites, heat losses may become prohibitive due to the large surface area, and the injection rates are limited by the weight of the overburden, restricting injection pressures to 5 psig or less.
- Contamination present under structures where vertical drilling is prohibited. SEE can readily be done using angled or horizontal borings, but the complexity and cost of the drilling and installation increases significantly compared to vertical installations.
- Sites dominated by low-permeability materials such as clay, fine silt, or competent bedrock with sparse fracturing. Intrinsic permeabilities below 0.1 darcy, equivalent to a hydraulic conductivity of 10^{-4} cm/sec, is considered the lower range for SEE applications. For sites with tighter zones, combinations with ERH or TCH may be applicable.
- Sites with a very stringent numerical cleanup standard for soil and groundwater and a heterogeneous geology. Generally, it is difficult to predict the exact steam migration paths and heating pattern, and thus also the final COC concentrations when using SEE than when using TCH, since the fluid-based delivery is more

sensitive to heterogeneity and permeability contrasts that TCH which relies on thermal conduction.

Typical concerns about geotechnical stability and damage to foundations, buildings, or underground utilities are dealt with relatively easily on a site-specific basis, and have not been a significant barrier to SEE implementation.

Hot Air/Steam Injection Thermal Remediation Using Large Diameter Auger (LDA) In-Situ Soil Mixing

by

Phil La Mori and Elgin Kirkland, FECC Corporation

1. Overview of Technology

1.1 One paragraph description of the state of the thermal application

Thermal treatment of contaminated soils and groundwater by in-situ soil mixing using large diameter augers (LDA) while injecting hot air and steam is an effective way to remove source zone volatile organic compounds (VOCs), semi-volatile organic compounds (SVOC) and petroleum hydrocarbons (TPHC) contamination. The technology operates one treatment cell at a time by advancing a single 6' to 10' auger to depths of over 70'.[23] During active mixing the permeability increases, permitting the soil and groundwater to be treated evenly by the injected high-pressure hot air and steam. Steam heats the contaminated soil and groundwater to a temperature of approximately 75 degrees Celsius, thermally desorbing the VOCs and volatilizing the non-adsorbed VOCs, while the air carries the volatilized off-gas contamination to the surface for capture and treatment. The process, which appears to follow pseudo first-order kinetics, is very effective in removing a large percentage of VOCs during the early treatment stages, but requires extended treatment times to further increase the percentage of removal, i.e. there is a diminishing return for thermal treatment versus cost. Typically the in-situ thermal technology removes 90 % to 97 % of the VOC and 50% to 90% of the SVOC.

1.2 New improvements to the technology over the past 5 years

The major improvement to the technology over the last 5 years has been the development of the combined thermal remediation followed by injection of zero valent iron (ZVI) powder in a water/guar slurry for remediation of chlorinated DNAPL source zones. The ZVI continues the remediation after the thermal treatment has stopped. This approach takes advantage of the strengths of both treatment technologies: for thermal treatment this is the effective removal of large amounts of contamination early on and the mixing, distribution and dissolution of the DNAPL that allows the iron to continue remediation of the chlorinated VOC long after the drilling unit has been removed. Removal efficiencies of over 99% are routinely achieved at significant cost savings when compared to thermal treatment alone.

2. Energy Delivery/Heating Information

2.1- Basic conceptual overview of the energy delivery/soil heating process (i.e. a conceptual drawing showing the basic components and a simple conceptual time-series of energy transfer/heating in the subsurface)

[23] Dual 5' to 7' diameter augers are also used.

The technology consists of three main units; 1) the track mounted crane with the drill unit and hot air, steam and reagent injection unit, 2) an off gas capture and process and treatment system, and 3) a Data Acquisition System (DAS) and a process control system. These components are configured to meet site-specific conditions and vary depending on the site conditions, characterization and cleanup requirements.

The drill platform, which contains the drilling system and air, steam and reagent dispensing systems, is attached to a track mounted crane that moves around the site on mats. The drill platform turns the drill bar, called the Kelly, that has one end attached to single bladed auger, 6' to 10' feet in diameter, that is capable of penetrating the ground surface to depths in excess of 70'. The top end of the Kelly is attached to the crane and provides the pathway for the air, steam and reagent injection. From there the treatment agents travel down a pipe inside the Kelly and are injected into the soil by ports along the trailing edges of the two bladed auger. Thermal treatment is achieved by injection of hot air and steam. Steam, which is generated by boilers with adequate total capacity, e.g. of 20,000 lb/hr at 335 F, provides the energy to volatilize VOC and SVOC. Hot air, which is channeled to the surface along an annular space created by the rotating drill Kelly, entrains the volatilized VOC and SVOC and TPHC and transfers them to the surface where the off gas is captured and treated. The ZVI slurry which is mixed in batches up to 600 gallons is injected into the soil through the same ports as the steam and air, either separately or with the steam and air. Figure 1 provides a conceptual overview of the thermal treatment operation and equipment.

The off gas capture system consists of a steel can (shroud) placed on the surface covering the drilling area. The diameter of the shroud is approximately 1.5 times the diameter of the auger to insure complete capture of the off gas. The hot off gas (100 F to 185 F) is removed from the shroud and is passed through a gas conditioning unit by a blower operating from 750 to 1200 CFM. The gas conditioning unit cools the gas to 90 F to 100 F and removes the water vapor and dirt particles before being sent to a contaminant destruction unit such as a catalytic oxidizer, flameless thermal oxidizer or thermal oxidizer. Carbon absorption beds are used as emergency backup should the oxidizer unit need to be shutdown for any reason. For small sites with lower concentration of contamination the direct use of the carbon bed is more efficient and costs less than the oxidizer.

The Data Acquisition system (DAS) and process control system are located in an operations and control trailer unit. This unit contains readouts of instrumentation to monitor and control selected key operational parameters. All the instruments also have inline display for field operational use. Also located in the unit are the flame ionization detector(s) (FID) to continuously monitor the concentration of total hydrocarbons and the gas chromatograph(s) (GC) that provides periodic data on the identification of the specific compounds in the off gas stream. The output of the FID, GC, temperature sensors, depth gage and other key instruments are stored in a computerized logging system operated at a pre-selected recording interval, e.g. 1 to 30 seconds. The measured parameters are displayed in tabular form on a monitor screen while selected key parameters are displayed as a function of time on a second monitor screen. Table 1 provides a list of the measured and displayed operational parameters. A typical display of the key operational parameters is shown in Figure 2.

Figure 1. Conceptual overview of the thermal treatment operation and equipment.

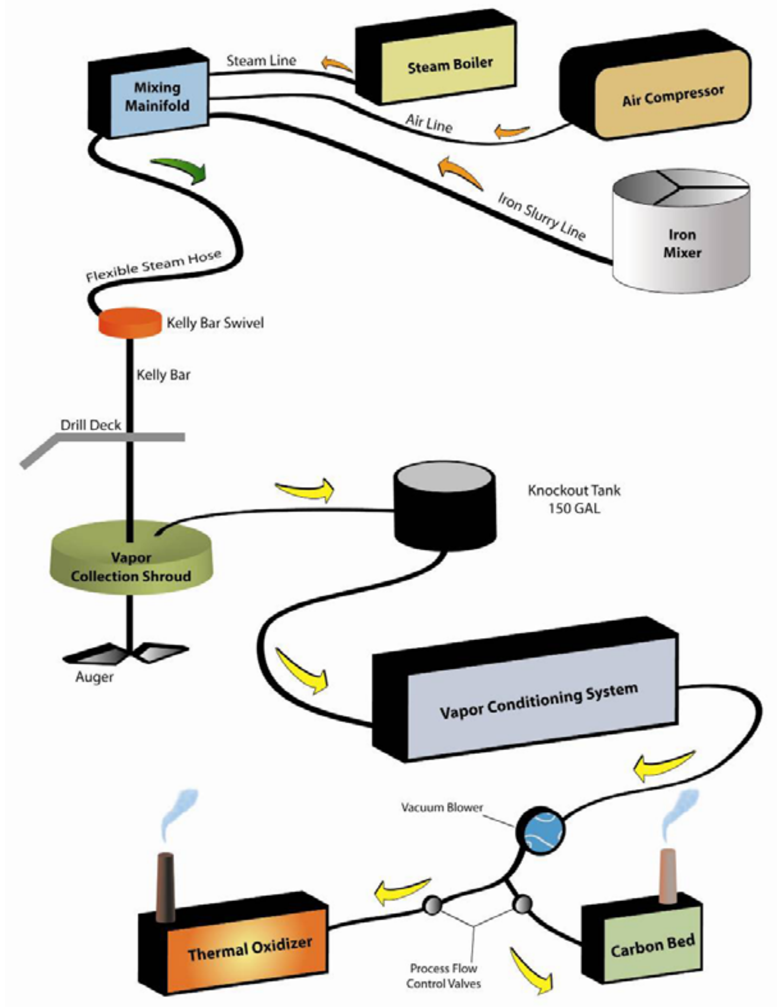
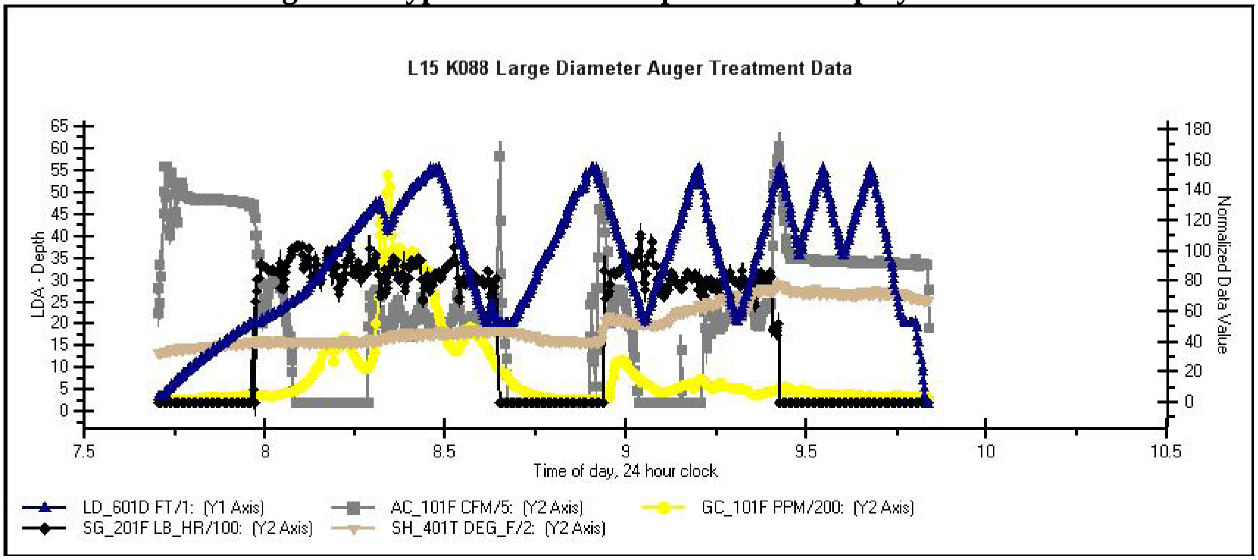


Table 1. List of Measured and Displayed Operational Parameters

Operational Location	Parameters Measured	Key Parameters Displayed for Operation & Control
Auger Drill	Depth	Depth
Steam Production	Flow rate, temperature, pressure	Flow rate
Air Compressor	Flow rate, temperature, pressure	Flow rate
Off Gas Conditioning Unit	Flow rate, temperature, pressure, off gas composition by FID and GC	Flow rate, temperature, pressure, off gas composition by FID and GC
Off Gas Shroud	Flow rate, temperature, vacuum	Flow rate, temperature, vacuum
Iron Slurry Mixer	Flow rate	Flow rate
Downhole Condition	Temperature	-

Figure 2. Typical Real Time operational Display Chart



The measured parameters are uploaded in real time to a remote location that stores, analyzes and retrieves the data. The operational data can be accessed in real time over the internet by remotely located technical staff that can then interface with the field operator and take part in the operational decisions.

2.2 -Any available information on relationship or current understanding between energy delivery and heating rates (i.e. efficiency of energy conversion to heat)

The main thermal input, i.e. energy delivery, is accomplished by steam generated from boilers as the hot air provides less than 5% of the heating. The subsurface target temperature is about 170 F (76 C). This temperature is high enough to increase the vapor pressure of most VOC enough to insure high removal rates. In many cases 170 F is greater than their boiling point or exceeds the boiling point of a mixture of the VOC and water. Heating a column of soil to this temperature usually occurs in less than 1 hour.

A typical sandy soil (located for example in Florida) has a mass of 100 lb/ft3 and contains about 30% porosity. Thus, a saturated cubic foot of this soil contains about 18.8 lb of water and 81.2 lb of sand. Since water has a heat capacity of 1 BTU/lb/°F and the sand has a heat capacity of about 0.25 BTU/lb/°F the heat capacity of the soil is about 0.391 BTU/lb/°F. Assuming that the column of soil to be heated is 30' thick and the auger is 8' in diameter, i.e. has an area of 50.27 ft2, the mass of soil to be heated is 50 ft2 x 30 ft x 100 lb/ft3 = 150,000 lb. The energy to heat the soil from an ambient 70 F to 170 F is approximately 5,850,000 BTU. This calculation indicates that it will take approximately 30 minutes to heat the soil using heat input of 12,000,000 BTU/hr.

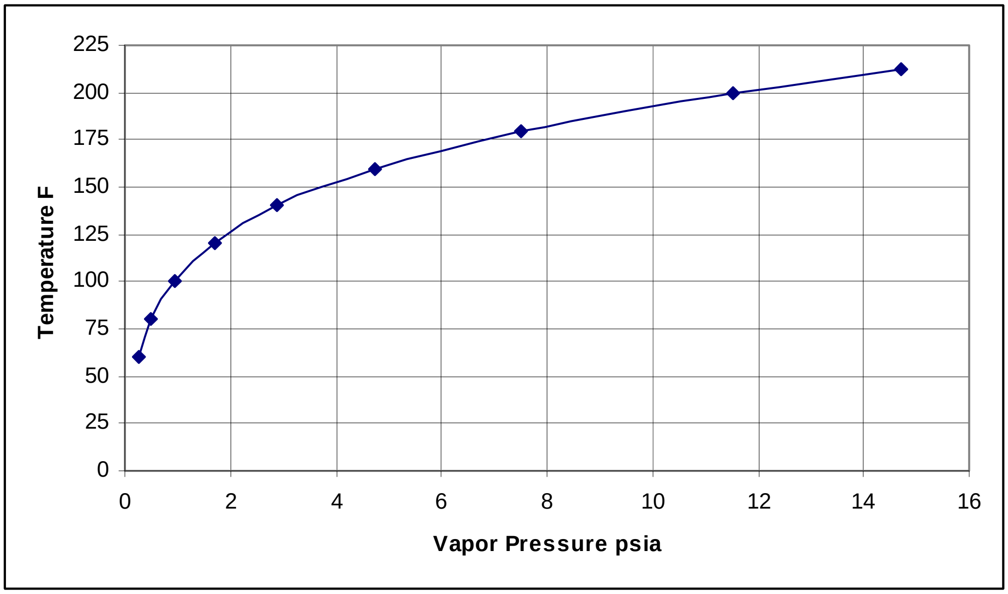
This calculation and analysis implies an initial drilling penetration rate of about 1 ft/min. This rate is often difficult to achieve during the initial penetration of the auger for the reason that during the initial penetration the ground is hard and compacted. Drilling rates of 0.5 ft/min or less are often encountered during the initial pass. When these conditions occur the heating rate is lowered to control the process.

2.3 - Limitations of the energy delivery/heating process (i.e. what temperatures can be reached, how even is the heat/energy distribution, and do natural phenomena limit the heating?)

The limitation on energy delivery caused by ground conditions and drilling rates was noted above.

There are 3 other controlling factors for the thermal input, the boiling point of water with depth, the stability of the subsurface operation to handle the steam/air flow and the cooling capacity of the off gas process treating system. The soil/groundwater can be heated to a maximum temperature of the boiling point of water at depth. In practice the operational temperature limitation is about 70 C to 80 C (158 F to 176 F) in the shroud with somewhat higher temperatures in the subsurface.[24] This surface temperature limitation is the result of the fact that the off gas reaching the surface is saturated with water vapor and this vapor must be removed from the off gas stream before it enters the thermal oxidizer and/or activated carbon beds. Above 80 C the vapor pressure increases rapidly and the heat rejection requirement of the off gas cooling unit increases quickly and the cost becomes prohibitive. Figure 3 shows the temperature/vapor pressure curve of water.

Figure 3. Temperature/vapor pressure curve of water.



Also, the subsurface stability of the operation becomes critical at higher temperatures. When the off gas temperature exceeds about 60 C in the shroud and the downhole temperature is above 70 C the annular pathway to the surface starts to collapse and open in a pulsating manner causing pressure burping and over pressuring the shroud. This can result in raising the shroud and the release of contaminated vapors into the atmosphere and work area as well as injecting steam directly into the process system. The steam is injected into the process system because the

[24] Post treatment temperature surveys show that the temperature at depth approaches the boiling point of water. Downhole temperature surveys taken during treatment also indicated that the soil temperature at depth approaches the boiling point curve.

subsurface temperature will be close to the boiling point and when the annular column reopens the first vapors to release are at the atmospheric boiling point and are saturated with steam. This problem is fairly easily controlled by diligently managing the air and steam flow.

2.4 - Unique advantages/disadvantages of this energy delivery/heating approach for contaminant removal or destruction

Some of the advantages of this technology are:
• The below ground mixing provides active remediation and assures that treatment agents contact all the contamination.
• The Data Acquisition System, including the FID and GC, for process monitoring, feed-back and control, allow operational decisions to be made real time and allow the remediation to be focused on the depths where there is contamination.
• Immediate removal and capture and/or destruction of the contamination occurs through the off gas treatment system.
• The use of the FID and GC when combined with the off gas flow permits calculation of the amount of each species removed.
• The technology provides the capability to combine the thermal treatment with other treatment processes in a single operation to achieve more complete removal and faster closure at lower cost.
• The technology operates equally well in vadose and saturated zones to 70'-100' below ground surface.

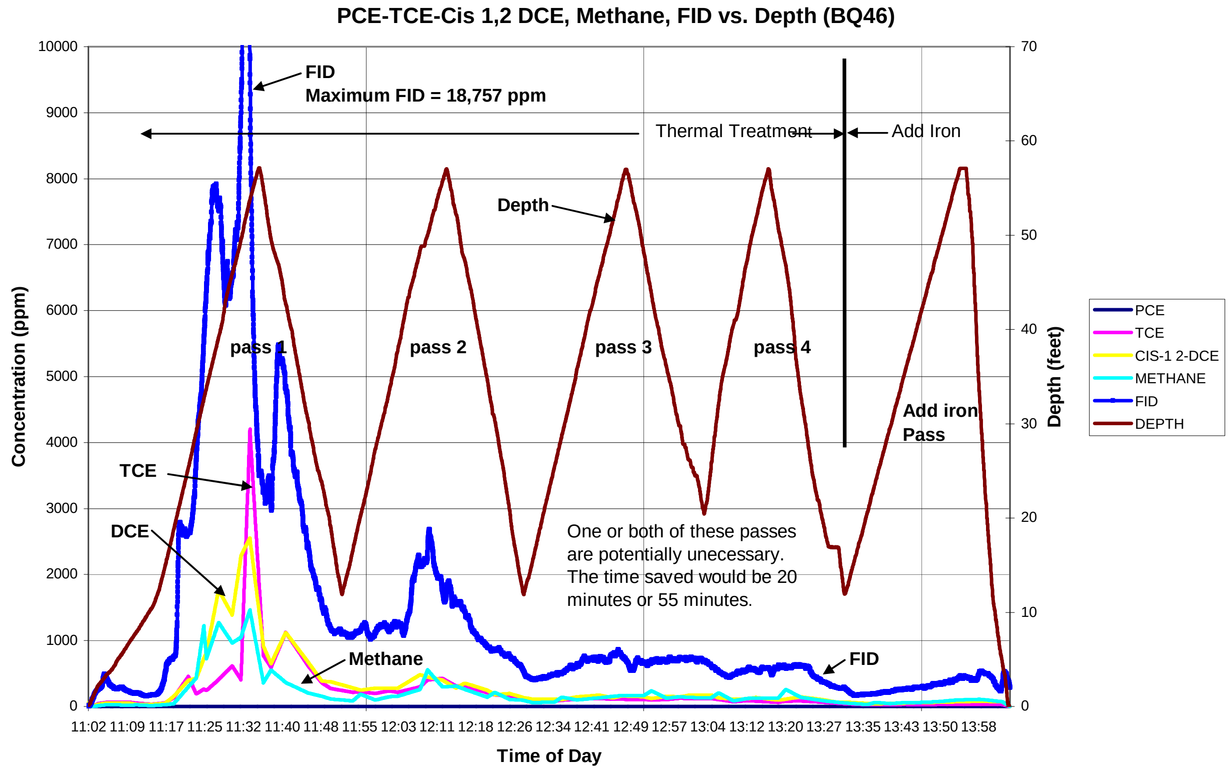
Another advantage of the technology arises from the fact that water and Cl^- VOCs are highly insoluble. The insoluble mixture forms a minimum boiling point azeotrope that is concentrated with the organic compound(s). The lower boiling point and azeotrope properties are believed to improve the thermal removal efficiency of the technology. The following table lists two azeotropes of interest.

Table 2. Data for two Important Azeotropes.

Components	Boiling Point (BP)° C.	Azeotrope BP° C.	Composition Azeotrope wt. %	Upper Layer wt. %	Lower Layer wt. %
Water	100	--	6.30	99.8	0.02
TCE	87.10	73.1	93.7	0.2	99.98
Water	100	--	17.2	99.98	0.01
PCE	121.0	88.5	82.8	.02	99.99

Other innovative aspects of the technology application include measurement and/or control of all key process parameters including downhole temperature, auger depth and real time measurement of off-gas contaminant concentration using both flame ionization detector (FID) and gas chromatograph (GC). The FID/GC allow profiling the concentration of contamination vs. depth, providing field personnel real time data to make decisions such as focusing the interval of treatment on depths showing higher contaminated levels until the removal objectives have been met. This is shown in the enclosed chart, Figure 4 where the FID increases at 17' depth with peaks at 20', 40' and 52'. This chart shows 4 thermal treatment passes from 15' to 57' plus 1 iron treatment pass (a pass is defined as full movement in both directions).

Figure 4. Typical Display of Key Operational Parameters.



One disadvantage of the technology is the long time required to achieve very high removal efficiencies with the thermal treatment. This is the result of an observed pseudo first order thermal removal rate; i.e. high removal early in the treatment but much lower removal later in the treatment. The actual contaminant removal is believed to be more complex than pseudo first order and is probably made up of air stripping, volatilization and desorption components. The air stripping and volatilization components are believed to dominate the early removal while the desorption component is much slower and dominates the later remediation. Combining the high early thermal removal with the addition of a second treatment agent has resulted in very high total contaminant removal at a reduced cost. The addition of ZVI for removal of chlorinated VOC has been very effective. The addition of an inorganic oxidizer has been proposed for petroleum hydrocarbons.

Another disadvantage of the technology is the temperature limitations of the boiling point of water and of about 80 C in the shroud. This problem was discussed above. The effect of the azeotrope formation mitigates this to some extent. Experience has shown however that the thermal remediation of semi-volatile organic compounds (SVC) is less efficient than for VOC, e.g. 60% versus over 90%.

2.5 - Is the process applied differently if the contaminants are below the water table?

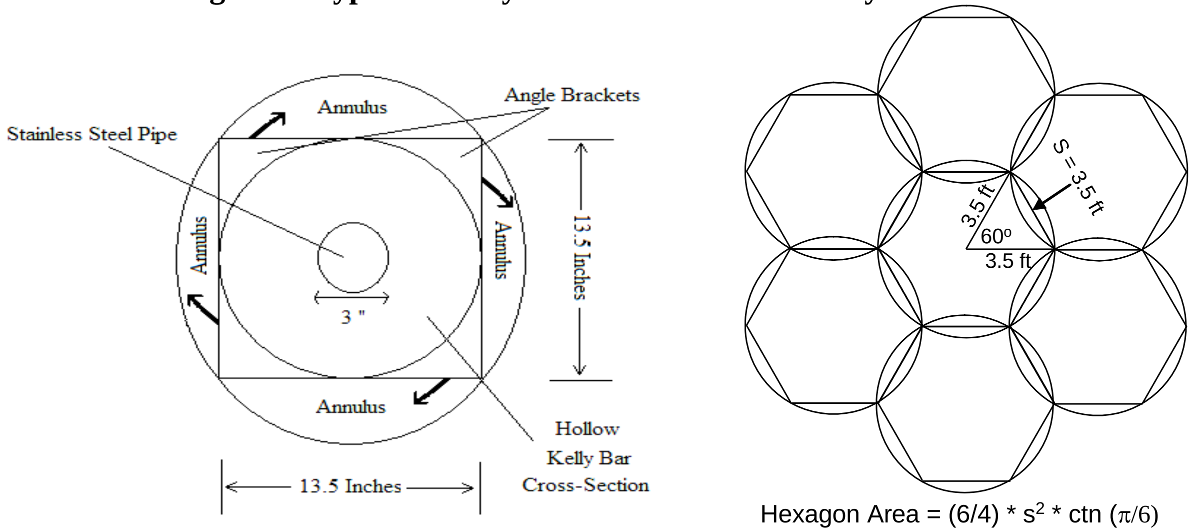
The LDA Thermal treatment technology has been applied separately in the vadose zone and saturated zone as well as in both zones in one treatment cell. There appears to be no obvious difference in the application to either zone. Calculation of the energy required to heat vadose zone soils is about ¾ of the energy to heat saturated soils. This does not present a problem because the boiler output easily supplies this difference and, as stated above, the initial drilling into the ground is often slowed so that the steam input is cut back to prevent over heating.

3. **Process Configuration Information**

Generic layout of the process showing spacing (heaters, electrodes, wells, temperature, etc.) of in situ components for a "typical" application

The technology operates as a batch process with each cell being remediated separately. Once the cell is remediated to pre-selected criteria the drill is removed from the cell and setup over the next cell. Figure 5 shows how the cells are laid out and overlapped to insure 100% areal coverage with dimensions for a 7 foot diameter auger. Figure 5 also shows the cross section of the Kelly with its welded angle brackets that create the annulus as the auger rotates. This cross section also shows the 3" diameter stainless steel injection pipe.

Figure 5. Typical cell layout surface view and Kelly cross section.



Generic layout of above-ground components, showing the footprint of a "typical" application

A typical layout of the equipment for site remediation is shown in Figure 1.

Special utility requirements (power, water, surface cover, security, etc.)

The utility requirements are nominal. A typical operation will require 500 to 1000 kilowatts of electricity, a maximum of 1500 gallons of water per hour and minimal security. An exclusion zone of about 30 meters is maintained during actual operation for personal H&S. Experience has shown that this size exclusion zone and operation with a shroud vacuum of over 1" water is adequate to control emissions and insure worker H&S. The equipment operates off of mats, but the site needs to be graded flat and have less than 3 degree slope.

Is the process configured differently if the contaminants are below the water table?

As indicated above there are no special requirements for operation below the water table.

4. Process Information

Typical durations of applications, and how does one decide to turn it off?

The decision to turn off the thermal treatment is typically based upon two factors; 1. off gas temperature in the shroud and/or downhole temperature if that measurement is available and 2. the value of the FID, or GC for a key chemical compound(s) like TCE. The temperature component is used to insure that the downhole soil temperature will provide needed thermal desorption after the treatment is complete. The actual stopping value(s) is a function of the cell contamination as determined by the first pass (i.e. a pass is defined as a descent and an ascent to the cell) maximum FID and GC readings.

The FID and/or GC component is used as an indication to turn off the thermal treatment when the reduction in values indicates that extended treatment time is needed to further increase the percentage of removal, i.e. the point where there is a diminishing return for thermal treatment versus cost. Typically this occurs when there is an 80% to 90% reduction in the maximum value observed during the initial pass into the cell. When this occurs the reduction in FID and/or GC values versus time usually becomes asymptotic.

The following table provides a typical decision tree for determining when to turn off the treatment. This table doesn't include GC criteria but these are often used. For example a GC value of less than 200 ppm TCE might be a criterion for initial FID value between 1000 and 10,000 ppm.

Table 3. Example of LDA Thermal Treatment completion Criteria.

Initial Max FID	Shroud Temperature	Final FID*	Comment
< 400 ppm	No criteria	No criteria	In and out and add ZVI
> 400 ppm but <1000 ppm	> 150 F	< 250 ppm	Should be 1 thermal treatment pass
> 1000 ppm but < 10,000 ppm	> 160 F	90% reduction or asymptotic	
> 10,000 ppm	> 170 F	> 80% reduction and asymptotic	FID values as high as 1000 ppm to 2000 ppm are acceptable.

* Measured methane is excluded

After the thermal treatment is complete, a second treatment agent, e.g. ZVI, can be injected to provide additional long term remediation for the desorbing contamination. Figure 4 illustrates how this decision process might work. After 2 complete passes it is clear that the FID as well as the GC values for TCE and DCE had been reduced to over 90% of their initial maximum and that the decrease in values was approaching asymptotic. However the shroud temperature had not yet reached the target temperature of 170 F. Two additional passes were made to heat the cell before iron was added and the treatment completed.

Although the technology is mature there is limited information available to define the exact values of FID/GC and shroud temperature and when to stop the thermal treatment. A pilot test to determine the decision tree is recommended for most projects. If the pilot test is not included in the budget it can become part of the site treatment for a modest additional cost.

Typical monitoring/diagnostics for the technology during operation (i.e. how do you know it's working?):

The key monitoring points for process operation are the depth of auger, steam flow, air flow, FID, off gas temperature and off gas flow. A GC is useful for determination of the off gas chemistry profile but is not a requirement to determine the functioning of the technology. In fact the technology has often been utilized without a GC. These measurements indicate that the process is functioning as well as providing the key control information to determine when the remediation is completed. These data are measured continuously at a selected time interval, e.g. 10 seconds, and also are displayed in tabular and graphical form to the control operator.

Post-treatment issues (time period needed for cooling/access/etc.):

When the cell treatment is completed there is often a decrease of column length in volume, e.g. ~5%, with the need to add soil to return the site to grade level. This is particularly note worthy in sandy soils. In clay soils there is often an immediate slight increase in volume followed by a slightly greater decrease in volume a day or twolater. These volume changes need to be dealt with so that the remediation operation can be completed and also to restore the surface to pretreatment elevations at the completion of the project. .

Heating the soils raises their temperature to approximately the boiling point of water as a function of depth. Because most of the sites are relatively thick, e.g. 30’ to 50’, and cover a wide area the subsurface cools slowly in the absence of cold water influx. Locations where the groundwater flow is measured in inches per day will take from one to two years to cool to their pretreatment temperatures. This presents safety and handing issues for post treatment verification groundwater and soil sampling.

5. **Technology Selection**

For what scenarios is the technology ideally suited?

This technology is ideally suited for sites where the advantages of soil mixing and rapid treatment are important. These sites come under that category:

- Sites with large concentration and mass of contamination. These sites would probably have significant NAPL presence so that other methods would be less effective or ineffective.
- Sites with uneven or variable lithology where other treatment methods would be confounded by differing permeability and contaminant concentration.
- Sites with mostly VOC or lower boiling point SVOC.
- Sites with target volumes above 3,000 cubic yards. The mobilization cost is an issue for small sites.
- Sites with stringent cleanup standards. The thermal technology when combined with ZVI will treat chlorinated VOC and when combined with an inorganic oxidizer will treat petroleum hydrocarbons, both to ppb levels.
- Sites where there is a need to achieve cleanup in a short period of time, e.g. Brownfields.
- Sites below the water table or in the groundwater.
- Sites where excavation is impractical, i.e. very expensive or difficult because of environmental concerns.
- Shallow sites where the depth is at least 5 feet.
- Sites where focused depth treatment is important.
- Sites with high groundwater flow rates.

Under what conditions is the technology "challenged"?

The technology is challenged by:

- Smaller sites, e.g. less than 2000 cubic yards, due to the high cost of mobilization.
- Sites with low concentrations are more effectively dealt with by other approaches.
- Site with infrastructure, e.g. overhead lines, buildings etc.
- Sites at great depths, e.g. over 100 feet.
- Sites with high boiling point SVOC although oxidization is a potential solution because the mixing capabilities provide excellent treatment.

APPENDIX C

Data Logs

General Site Information Facility ID#: 0010

x File Analyzed By: JT x PD ____ Date: 11/10/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ______

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ______

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: varied End of Test: varied Duration: 42 to 47 days

Type of Site: ____ Non-DOD x DoD

x Facility Name: Ft. Richardson (Arrays 1,2, and 3)

Address: ______

City, State, Zip Code: Ft. Richardson, Alaska

OU# or Site #: OU B; Poleline Rd Disposal Area (Arrays 4, 5, and 6)

x Primary point of contact: Scott Kendell

Organization: US Army Corps - Alaska District

Address: ______

City, State, Zip Code: ______

Phone #: 907-753-5661 email: scott.kendall@poa02.useace.army.mil

____ Other contacts or vendors who worked on site ____ None

Point of contact: ______

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ______

Organization: ______

Address: ______

City, State, Zip Code: ______

Phone #: ______ email: ______

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data Facility ID#: 0010

x Impacted Zone: Length (parallel to flow direction)(ft.): 225 Width (ft): 87 Thickness (ft): ______ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 2 Post-treatment: ______

Number of wells relative to treatment zone:

	In:	Upgradient:	Downgradient:	Crossgradient:
Pre-treatment	0	______	______	______
Post-treatment	0	______	______	______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 4

Number of relevant soil borings with post-treatment data: 4

Number inside treatment zone: 4 Number outside treatment zone: 4

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	None	10 mg/kg	None	1 mg/kg
	x Tetrachloroethene	____ Jet Fuel	____	None	1 mg/kg	None	0.1 mg/kg
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	x cis-1,2-dichloroethene	____ Benzene	____	None	1 mg/kg	None	None
	x trans-1,2-dichloroethene	____ Tolune	____	None	0.5 mg/kg	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	x 1,1,2-trichloroethane	____	____	None	0.1 mg/kg	None	None
	x 1,1,2,2-tetrachloroethane	____	____	None	100 mg/kg	None	1 mg/kg
	____ Vinyl Chloride	x 1,1,1,2-tetrachloroethane	____	None	0.1 mg/kg	None	None
	x chloroform	____	____	None	0.1 mg/kg	None	None
	x carbon tetrachloride	____	____	None	0.5 mg/kg	None	None
	x chlorobenzene	____	____	None	0.05 mg/kg	None	None
	____	x Benzene	____	None	0.1 mg/kg	None	None
	____	x hexachlorobutadiene	____	None	0.5 mg/kg	None	None
	____	____	____	None	None	None	None

Comments:

Information for ARRAY 1

Attachments: ______

General Site Assessment Data | Facility ID#: 0010

x Impacted Zone: Length (parallel to flow direction)(ft.): 225 Width (ft): 87 Thickness (ft): ______ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 2 Post-treatment: ______

Number of wells relative to treatment zone:

	In	Upgradient	Downgradient	Crossgradient
Pre-treatment	0			
Post-treatment	0			

x Soil Borings: Number of relevant soil borings with pre-treatment data: 2

Number of relevant soil borings with post-treatment data: 2

Number inside treatment zone: 2 Number outside treatment zone: 2

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	None	10 mg/kg	None	0.1 mg/kg
	x Tetrachloroethene	____ Jet Fuel	____	None	1 mg/kg	None	0.1 mg/kg
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	x cis-1,2-dichloroethene	____ Benzene	____	None	0.5 mg/kg	None	None
	x trans-1,2-dichloroethene	____ Tolune	____	None	0.1 mg/kg	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	x 1,1,2-trichloroethane	____	____	None	0.1 mg/kg	None	None
	x 1,1,2,2-tetrachloroethane	____	____	None	10 mg/kg	None	0.05 mg/kg
	____ Vinyl Chloride	x 1,1,1,2-tetrachloroethane	____	None	0.05 mg/kg	None	None
	x chloroform	____	____	None	0.05 mg/kg	None	None
	x carbon tetrachloride	____	____	None	0.1 mg/kg	None	None
	x chlorobenzene	____	____	None	0.05 mg/kg	None	None
	____	x Benzene	____	None	0.1 mg/kg	None	None
	____	x hexachlorobutadiene	____	None	0.1 mg/kg	None	None
	____	____	____	None	None	None	None

Comments:

Information for ARRAY 1

Attachments:

General Site Assessment Data   Facility ID#: 0010

x Impacted Zone: Length (parallel to flow direction)(ft.): 225   Width (ft): 87   Thickness (ft): ______   ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 2   Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment   In: 0   Upgradient: ______   Downgradient: ______   Crossgradient: ______

Post-treatment   In: 0   Upgradient: ______   Downgradient: ______   Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 4

Number of relevant soil borings with post-treatment data: 4

Number inside treatment zone: 1   Number outside treatment zone: 1

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	None	5 mg/kg	None	5 mg/kg
	x Tetrachloroethene	____ Jet Fuel	____	None	0.5 mg/kg	None	0.5 mg/kg
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	x cis-1,2-dichloroethene	____ Benzene	____	None	0.1 mg/kg	None	None
	x trans-1,2-dichloroethene	____ Tolune	____	None	0.1 mg/kg	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	x 1,1,2-trichloroethane	____	____	None	0.05 mg/kg	None	None
	x 1,1,2,2-tetrachloroethane	____	____	None	10 mg/kg	None	10 mg/kg
	____ Vinyl Chloride	x 1,1,1,2-tetrachloroethane	____	None	0.05 mg/kg	None	None
	x chloroform	____	____	None	0.05 mg/kg	None	None
	x carbon tetrachloride	____	____	None	0.05 mg/kg	None	None
	x chlorobenzene	____	____	None	0.05 mg/kg	None	None
	____	x Benzene	____	None	0.1 mg/kg	None	None
	____	x hexachlorobutadiene	____	None	0.1 mg/kg	None	None
	____	____	____	None	None	None	None

Comments:

Information for ARRAY 1

Attachments:

Hydrogeologic Conceptual Model | Facility ID#: 0010

x Geology:

Zone	Unconsolidated Sediments
Vadose Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	x Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone
Saturated Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	x Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	4			
	high value (ft bgs):	14			
	Unknown:				
Flow direction		NE			
Horizontal hydraulic gradient (feet/foot):					x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) — Measured using: ____ Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low	0.05			____ Unknown
high	0.5			

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 0010

x Thermal treatment: ____ Conductive ________________

x Electrical Resistance Array 1

____ 3 phase   x 6 phase   ____ AC power   ____ DC power

____ Steam ________________

____ Steam   ____ Steam + air   ____ Steam + O2

____ Other (describe) ________________

x Type of Test: ____ Pilot test   x Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

x Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only   ____ Vadose only   x Both (Saturated and Vadose zones)

x Start of Thermal Test: 7/11/1997 (ended 8/22/97   Duration: 42 d

x Hydraulic Control   x Yes   ____ No

x Treatment Cell Design:

Size of target zone (ft2):	570	____ Unknown	(27 x 27 ft)
Thickness of target zone (ft):	27	____ Unknown	
Depth to top of target zone (ft bgs):	8	____ Unknown	
Thickness of target zone below water table (ft):	25	____ Unknown	
Number of energy delivery points:	6	____ Unknown	
Number of extraction points:	1	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	20	____ Unknown
Maximum representative formation temperature (deg C):	100	____ Unknown
Time to reach maximum representative temperature (days):	10	____ Unknown
Duration of treatment at representative temperature (days):	32	x Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

Via liquid pumping:	7.6	x lb	____ kg	____ Unknown
In vapor stream:	3.86	x lb	____ kg	____ Unknown
Total:	393.6	x lb	____ kg	____ Unknown

Comments:

Attachments: Array 1 of 3

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Thermal Treatment - Design   Facility ID#: 0010

x Thermal treatment:
- ____ Conductive ____________________
- x Electrical Resistance   Array 2
  - ____ 3 phase   x 6 phase   ____ AC power   ____ DC power
- ____ Steam ____________________
  - ____ Steam   ____ Steam + air   ____ Steam + O2
- ____ Other (describe) ____________________

x Type of Test: ____ Pilot test   x Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only   ____ Vadose only   x Both (Saturated and Vadose zones)

x Start of Thermal Test: 8/24/97 (ended 10/9/97)   Duration: 47 d

x Hydraulic Control   x Yes   ____ No

x Treatment Cell Design:

Size of target zone (ft2):	570	____ Unknown	(27 x 27 ft)
Thickness of target zone (ft):	27	____ Unknown	
Depth to top of target zone (ft bgs):	8	____ Unknown	
Thickness of target zone below water table (ft):	25	____ Unknown	
Number of energy delivery points:	6	____ Unknown	
Number of extraction points:	1	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	18	____ Unknown
Maximum representative formation temperature (deg C):	100	____ Unknown
Time to reach maximum representative temperature (days):	27	____ Unknown
Duration of treatment at representative temperature (days):	20	x Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

Via liquid pumping:	2.7	x lb	____ kg	____ Unknown
In vapor stream:	217	x lb	____ kg	____ Unknown
Total:	219.7	x lb	____ kg	____ Unknown

Comments:

Array 2 of 3

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Thermal Treatment - Design   Facility ID#: 0010

x Thermal treatment: ____ Conductive ______________________

x Electrical Resistance Array e

____ 3 phase x 6 phase ____ AC power ____ DC power

____ Steam ______________________

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ______________________

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 11/6/97 (ended 12/18/97) Duration: 42 d

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	570	____ Unknown	(27 x 27 ft)
Thickness of target zone (ft):	27	____ Unknown	
Depth to top of target zone (ft bgs):	8	____ Unknown	
Thickness of target zone below water table (ft):	25	____ Unknown	
Number of energy delivery points:	6	____ Unknown	
Number of extraction points:	1	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	8	____ Unknown
Maximum representative formation temperature (deg C):	100	____ Unknown
Time to reach maximum representative temperature (days):	12	____ Unknown
Duration of treatment at representative temperature (days):	30	x Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	4.9	x lb	____ kg	____ Unknown
In vapor stream:	138	x lb	____ kg	____ Unknown
Total:	142.9	x lb	____ kg	____ Unknown

Comments:

Array 3 of 3

Attachments:

____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0010

x Performance

Remediation Goal:

x In Groundwater: Goals in mg/L: TCE-0.005; 1,1,2,2-tetrachloroethane (PCA)-0.052; PCE-0.005; cis-12-DCE - 0.007; trans-12-DCE - 0.1; benzene - 0.005; carbon tetrachloride - 0.005

x In Soil: 1,1,2-trichloroethane - 0.1 mg/kg; PCE - 4.0 mg/kg

Was the Remediation Goal Achieved:

____ In Groundwater ________________

Comment: ________________

____ In Soil ________________

Comment: ________________

General comments on the thermal application:

The application was considered only one application even though the heating of the 3 arrays was ran sequentially.

Lessons Learned

____

____ Energy

Total Energy Used: ________ ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ________ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ________ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy: ________

x Cost

Total Project Cost: 967822

____ Consultant Cost: ________

____ Thermal Vendor Cost: ________

____ Energy Cost: 30000 per month ____ m^3 ____ yd^3

____ Other Cost 1: ________

____ Other Cost 2: ________

____ Other Cost 3: ________

____ Please note other cost: ____ Other Cost 1: ________

____ Other Cost 2: ________

____ Other Cost 3: ________

General Site Information　　Facility ID#: 0020

x File Analyzed By: JT x PD ____　　Date: 9/18/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 7/31/1999　End of Test: 10/4/1999　Duration: 65 DAYS

Type of Site: ____ Non-DOD x DoD

x Facility Name: Ft. Richardson (Arrays 4, 5, and 6)

Address: ________

City, State, Zip Code: Ft. Richardson, Alaska

OU# or Site #: OU B; Poleline Rd Disposal Area (Arrays 4, 5, and 6)

x Primary point of contact: Scott Kendell

Organization: US Army Corps - Alaska District

Address: ________

City, State, Zip Code: ________

Phone #: 907-753-5661　email: scott.kendall@poa02.useace.army.mil

____ Other contacts or vendors who worked on site　____ None

Point of contact: ________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: ________

Address: ________

City, State, Zip Code: ________

Phone #: ________ email: ________

QA/QC

x Characteristics of Interest

x Good pre- and post-treatment groundwater data

____ Good temperature profile vs. time information

____ Groundwater elevations

____ Hydraulic Conductivity information

x Good pre- and post-treatment soil data

____ Flux assessment

x Geologic cross-section

General Site Assessment Data | Facility ID#: 0020

x Impacted Zone: Length (parallel to flow direction)(ft.): 225 Width (ft): 87 Thickness (ft): ______ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 4 Post-treatment: 4

Number of wells relative to treatment zone:

Pre-treatment	In: 4	Upgradient: ______	Downgradient: ______	Crossgradient: ______
Post-treatment	In: 4	Upgradient: ______	Downgradient: ______	Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 6

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: 5 Number outside treatment zone: 1

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	1 mg/L	None	0.1 mg/L	None
	x Tetrachloroethene	____ Jet Fuel	____ ______	0.01 mg/L	None	0.001 mg/L	None
	____ 1,1-dichloroethene	____ Napthalene	____ ______	None	None	None	None
	____ cis-1,2-dichloroethene	x Benzene	____ ______	0.001 mg/L	None	0.001 mg/L	None
	x trans-1,2-dichloroethene	____ Tolune	____ ______	0.1 mg/L	None	0.01 mg/L	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ______	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ______	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ______	None	None	None	None
	____ 1,1,2-trichloroethane	____ ______	____ ______	None	None	None	None
	x 1,1,2,2-tetrachloroethane	____ ______	____ ______	10 mg/L	None	0.1 mg/L	None
	____ Vinyl Chloride	____ ______	____ ______	None	None	None	None
	x carbon tet	____ ______	____ ______	0.01 mg/L	None	0.001 mg/L	None
	x cis-1,2-dichloroethene	____ ______	____ ______	0.1 mg/L	None	0.1 mg/L	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None

Comments:

Impacted zone is only the source zone.

Attachments:

Hydrogeologic Conceptual Model — Facility ID#: 0020

x Geology:

Zone		Unconsolidated Sediments
Vadose Zone:	____	Relatively homogeneous and permeable unconsolidated sediments
	____	Relatively homogeneous and impermeable unconsolidated sediments
	x	Largely permeable sediments with inter-bedded lenses of lower permeability material
	____	Largely impermeable sediments with inter-bedded layers of higher permeability material
	____	Competent, but fractured bedrock (i.e. crystalline rock)
	____	Weathered bedrock, limestone, sandstone
Saturated Zone:	____	Relatively homogeneous and permeable unconsolidated sediments
	____	Relatively homogeneous and impermeable unconsolidated sediments
	x	Largely permeable sediments with inter-bedded lenses of lower permeability material
	____	Largely impermeable sediments with inter-bedded layers of higher permeability material
	____	Competent, but fractured bedrock (i.e. crystalline rock)
	____	Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	5.5			
	high value (ft bgs):	20			
	Unknown:				
x Flow direction		NE			
x Horizontal hydraulic gradient (feet/foot):					x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) — Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	0.05			____ Unknown
high	0.5			

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments: x-section in Tech Report on pages 30-35

Thermal Treatment - Design

Facility ID#: 0020

x Thermal treatment:
- ____ Conductive
- x Electrical Resistance
  - ____ 3 phase x 6 phase ____ AC power ____ DC power
- ____ Steam
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe)

x Type of Test: ____ Pilot test ____ Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 7/31/1999 Duration: 65 days

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	5500	____ Unknown	(110 x 50 ft)
Thickness of target zone (ft):	32	____ Unknown	
Depth to top of target zone (ft bgs):	8	____ Unknown	
Thickness of target zone below water table (ft):	20	____ Unknown	
Number of energy delivery points:	21	____ Unknown	
Number of extraction points:	9	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	10	____ Unknown
Maximum representative formation temperature (deg C):	100	____ Unknown
Time to reach maximum representative temperature (days):	____	x Unknown
Duration of treatment at representative temperature (days):	____	x Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	29.6	____ lb	x kg	____ Unknown
In vapor stream:	628	____ lb	x kg	____ Unknown
Total:	658	____ lb	x kg	____ Unknown

Comments:

Attachments: 3 arrays

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0020

____ Performance

Remediation Goal:

____ In Groundwater:

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: 30000 per month ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information — Facility ID#: 0030

x File Analyzed By: JT x PD ____ — Date: 11/6/2006

Type of treatment: ____ Conductive ____ Steam ____ ERH x Other: RFH

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: 3/26/1998 End of Test: 5/13/1999 Duration: 413 d

Type of Site: ____ Non-DOD x DoD

x Facility Name: Ft. Wainwright

Address: CH2M Hill

City, State, Zip Code: Ft. Wainright, Alaska

OU# or Site #: OU 5

x Primary point of contact: Rich Horn

Organization: ____________________

Address: ____________________

City, State, Zip Code: ____________________

Phone #: 907-646-0287 email: rhorn@ch2m.com

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________________

Address: ____________________

City, State, Zip Code: ____________________

Phone #: ____________________ email: ____________________

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data   Facility ID#: 0030

____ Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______   x Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: x None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 5

Number of relevant soil borings with post-treatment data: 0

Number inside treatment zone: 5   Number outside treatment zone: 0

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	x Benzene	____	None	5 mg/kg	None	None
	____ trans-1,2-dichloroethene	x Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	x 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	x GRO	____	None	5,000 mg/kg	None	None
	____ 1,1,2,2-tetrachloroethane	x DRO	____	None	5,000 mg/kg	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

No post-treatment soils date after final phase of heating and no groundwater wells in the RFH plot

Attachments:

Hydrogeologic Conceptual Model — Facility ID#: 0030

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- x Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- x Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	14			
	high value (ft bgs):	19			
	Unknown:				
x Flow direction		NNW			
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

x K range (ft/day) — Measured using: ____ Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low	400			____ Unknown
high	600			

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 0030

x Thermal treatment:
- ____ Conductive ____
- ____ Electrical Resistance ____
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- ____ Steam ____
  - ____ Steam ____ Steam + air ____ Steam + O2
- x Other (describe) RFH

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:
- x Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 3/26/1998   Duration: 413 day

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	400	____ Unknown	(20 x 20 ft)
Thickness of target zone (ft):	10	____ Unknown	
Depth to top of target zone (ft bgs):	6	____ Unknown	
Thickness of target zone below water table (ft):	0	____ Unknown	
Number of energy delivery points:	4	____ Unknown	
Number of extraction points:	1	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	5	____ Unknown
Maximum representative formation temperature (deg C):	25	____ Unknown
Time to reach maximum representative temperature (days):	139	____ Unknown
Duration of treatment at representative temperature (days):	274	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

____ Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	____	____ lb	____ kg	____ Unknown
Total:	____	____ lb	____ kg	____ Unknown

Comments:

RF antennaes orignally set at 10 ft bgs to 20 ft bgs. Moved on May 13th to 6 to 16 ft bgs because of electrical problems thus heating only the vadose zone instead of vadose and saturated zone.

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance　　　　Facility ID#: 0030

x Performance

Remediation Goal:

x In Groundwater: DRO -1.5 mg/L: GRO -1.3 mg/L; 1,2-DCA - 0.005 mg/L; Benzene - 0.005 mg/L; Toluene - 1 mg/L; RRO - 1.11 mg/L

x In Soil: DRO - 200 mg/kg; GRO - 50 mg/kg

Was the Remediation Goal Achieved:

____ In Groundwater ____________________

Comment: ____________________

____ In Soil ____________________

Comment: ____________________

General comments on the thermal application:

Objective - 1) prevent benzene migration to Chena River and 2) reduce total dissolved hydrocarbons in river Energy numbers only for 351 days of heating and does not include high-temperature kWhr heating period 2 phases of heating: 1) 351 days to get to 15 to 40C and 2) 62 days to get to ?

Lessons Learned

____

x Energy

Total Energy Used: 55600 x kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____________________

____ Cost

Total Project Cost: ________

____ Consultant Cost: ________

____ Thermal Vendor Cost: ________

____ Energy Cost: ________ ____ m^3 ____ yd^3

____ Other Cost 1: ________

____ Other Cost 2: ________

____ Other Cost 3: ________

____ Please note other cost: ____ Other Cost 1: ____________________

____ Other Cost 2: ____________________

____ Other Cost 3: ____________________

General Site Information | Facility ID#: 0040

x File Analyzed By: JT x PD ____ Date: 11/6/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: 3/26/1998 End of Test: 8/25/1998 Duration: 155 days

Type of Site: ____ Non-DOD x DoD

x Facility Name: Ft. Wainwright

Address: CH2M Hill

City, State, Zip Code: ____________

OU# or Site #: ____________

x Primary point of contact: Rich Horn

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: 907-646-0287 email: rhorn@ch2m.com

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0040

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ x Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: 1

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: 1 Upgradient: ______ Downgradient: ______ Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 5

Number of relevant soil borings with post-treatment data: 6

Number inside treatment zone: 5 Number outside treatment zone: 6

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	x Napthalene	____	None	None	0.01 mg/L	None
	____ cis-1,2-dichloroethene	x Benzene	____	None	5 mg/kg	0.1 mg/L	0.1 mg/kg
	____ trans-1,2-dichloroethene	x Tolune	____	None	None	0.5 mg/L	None
	____ 1,1-dichloroethane	x Ethylbenzene	____	None	None	0.1 mg/L	None
	x 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	x GRO	____	None	1,000 mg/kg	0.05 mg/L	500 mg/kg
	____ 1,1,2,2-tetrachloroethane	x DRO	____	None	5,000 mg/kg	5 mg/L	1,000 mg/kg
	____ Vinyl Chloride	x total xylenes	____	None	None	0.05 mg/L	None
	____	x GRO 10-12	____	None	500 mg/kg	None	50 mg/kg
	____	x GRO 15-17	____	None	1,000 mg/kg	None	500 mg/kg
	____	x DRO 10-12	____	None	1,000 mg/kg	None	500 mg/kg
	____	x DRO 15-17	____	None	5,000 mg/kg	None	5,000 mg/kg
	____	x TAH	____	None	None	None	None
	____	x TAqH	____	None	None	None	None

Comments:

TAH - total aromatic hydrocarbons and TAqH - taol aqueous hydrocarbons for the Chena River surface water samples

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0040

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- x Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- x Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	14			
	high value (ft bgs):	19			
	Unknown:				
x Flow direction		NNW			
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

x K range (ft/day) — Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	400			____ Unknown
high	600			

Transmissivity (ft2/day): — Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design Facility ID#: 0040

x Thermal treatment: ____ Conductive

x Electrical Resistance

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe)

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:

x Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 3/26/1998 Duration: 155 days

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	700	____ Unknown	(30 x 30 ft)
Thickness of target zone (ft):	13	____ Unknown	
Depth to top of target zone (ft bgs):	10	____ Unknown	
Thickness of target zone below water table (ft):	7	____ Unknown	
Number of energy delivery points:	6	____ Unknown	
Number of extraction points:	1	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	5	____ Unknown
Maximum representative formation temperature (deg C):	90	____ Unknown
Time to reach maximum representative temperature (days):	118	____ Unknown
Duration of treatment at representative temperature (days):	35	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

____ Mass of contaminant removed:

Via liquid pumping:		____ lb	____ kg	____ Unknown
In vapor stream:		____ lb	____ kg	____ Unknown
Total:		____ lb	____ kg	____ Unknown

Comments:

Attachments: 15 ft spacing

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance   Facility ID#: 0040

x Performance

Remediation Goal:

x In Groundwater: DRO -1.5 mg/L: GRO -1.3 mg/L; 1,2-DCA - 0.005 mg/L; Benzene - 0.005 mg/L; Toluene - 1 mg/L; RRO - 1.11 mg/L

x In Soil: DRO - 200 mg/kg; GRO - 50 mg/kg

Was the Remediation Goal Achieved:

____ In Groundwater ____________________

Comment: ____________________

____ In Soil ____________________

Comment: ____________________

General comments on the thermal application:

2 separate phases of heating: 1) 98 days to heate to between 20 and 40C for 3 months and 2) 57 days to get to 80 to 100C for 1 month

Lessons Learned

____

x Energy

Total Energy Used: 205016 x kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: __________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: __________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____________________

____ Cost

Total Project Cost: __________

____ Consultant Cost: __________

____ Thermal Vendor Cost: __________

____ Energy Cost: __________ ____ m^3 ____ yd^3

____ Other Cost 1: __________

____ Other Cost 2: __________

____ Other Cost 3: __________

____ Please note other cost: ____ Other Cost 1: ____________________

____ Other Cost 2: ____________________

____ Other Cost 3: ____________________

General Site Information Facility ID#: 0043

x File Analyzed By: JT x PD ____ Date: 8/24/2007

Type of treatment: x Conductive ____ Steam ____ ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: Active x Post

Type of Test: x Pilot Test Full Scale System

Start of Test: ____________ End of Test: Aug-07 Duration: ________

Type of Site: x Non-DOD ____ DoD

x Facility Name: NASA Marshal Space Flight Center

Address: ____________

City, State, Zip Code: Huntsville, AL

OU# or Site #: ____________

x Primary point of contact: Ralph Baker

Organization: TerraTherm, Inc.

Address: 10 Stevens Road

City, State, Zip Code: Fitchburg, MA 01420

Phone #: 978-343-0300 email: rbaker@terratherm.com

x Other contacts or vendors who worked on site ____ None

Point of contact: Jason Cole

Type: X Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: CH2M HILL, Inc

Address: 2035 Lakeside Centre Way; Suite 200

City, State, Zip Code: Knoxville, TN 37922

Phone #: (865)-560-2987 email: Jason.Cole@ch2m.com

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data Facility ID#: 0043

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

____ Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0043

____ Geology:

Zone	Unconsolidated Sediments
Vadose Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone
Saturated Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown
____ K range (ft/day)	Measured using:	____ Slug Test	____ Laboratory	____ Field data	
	low				____ Unknown
	high				
Transmissivity (ft2/day):	Measured using:	____ Slug Test	____ Laboratory	____ Field data	
	low				____ Unknown
	high				

Comments:

Attachments:

Thermal Treatment - Design

Facility ID#: 0043

x Thermal treatment: x Conductive ____

____ Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

x Type of Test: x Pilot test ____ Full-scale System

____ Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ____ Duration: ____

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	858	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	22	____ Unknown	
Depth to top of target zone (ft bgs):	0	____ Unknown	
Thickness of target zone below water table (ft):	7	____ Unknown	
Number of energy delivery points:	18	____ Unknown	
Number of extraction points:	____	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	____	____ Unknown
Maximum representative formation temperature (deg C):	110	____ Unknown
Time to reach maximum representative temperature (days):	55	____ Unknown
Duration of treatment at representative temperature (days):	20	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

____ Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	____	____ lb	____ kg	____ Unknown
Total:	____	____ lb	____ kg	____ Unknown

Comments: ____

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0043

____ Performance

Remediation Goal:

____ In Groundwater:

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information Facility ID#: 0045

x File Analyzed By: JT x PD ____ Date: 10/29/2006

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: ____________ End of Test: ____________ Duration: 21 months

Type of Site: ____ Non-DOD x DoD

x Facility Name: Defense Fuel Support Point Whittier

Address: ____________

City, State, Zip Code: Whittier, AK 99693

OU# or Site #: ____________

x Primary point of contact: Wayne Barnum (DESC Headquarters contact) Jack Appolloni (DESC Alaska contact)

Organization: Defense Energy Support Center

Address: 8725 John J. Kingman Road

City, State, Zip Code: Fort Belvoir, Virginia 22060-6222

Phone #: HQ (703) 767-8314, Alaska (907) 552-4650 email: jack.appolloni@dla.mil

x Other contacts or vendors who worked on site ____ None

Point of contact: Michael Foster

Type: x Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: Michael L. Foster and Associates

Address: 13135 Old Glenn Highway, Suite 210

City, State, Zip Code: Eagle River, Alaska 99577

Phone #: 907-696-6200 email: mlf@mlfa.alaska.com

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data Facility ID#: 0045

x Impacted Zone: Length (parallel to flow direction)(ft.): 200 Width (ft): 300 Thickness (ft): 30 ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 80 Post-treatment: 57

Number of wells relative to treatment zone:

	In:	Upgradient:	Downgradient:	Crossgradient:
Pre-treatment	58	4	26	28
Post-treatment	35	4	8	23

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ________

Number of relevant soil borings with post-treatment data: ________

Number inside treatment zone: ________ Number outside treatment zone: ________

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	x JP4	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

JP4 estimated loss of 100,000 gallons

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0045

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:

____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
x Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

Saturated Zone:

____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
x Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	15			
	high value (ft bgs):	30			
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 0045

x Thermal treatment: ____ Conductive ____

____ Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

x Steam ____

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

x Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: ____ Duration: 21 months

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2): ____ ____ Unknown (150 x 150 ft)

Thickness of target zone (ft): ____ ____ Unknown

Depth to top of target zone (ft bgs): ____ ____ Unknown

Thickness of target zone below water table (ft): ____ ____ Unknown

Number of energy delivery points: ____ ____ Unknown

Number of extraction points: ____ ____ Unknown

____ Temperature Profile:

Initial formation temperature (deg C): ____ ____ Unknown

Maximum representative formation temperature (deg C): ____ ____ Unknown

Time to reach maximum representative temperature (days): ____ ____ Unknown

Duration of treatment at representative temperature (days): ____ ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	1000 gal	____ lb	____ kg	____ Unknown
In vapor stream:	15000 gal	____ lb	____ kg	____ Unknown
Total:	16000 gal	____ lb	____ kg	____ Unknown

Comments: ____

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0045

____ Performance

Remediation Goal:

____ In Groundwater: ____

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

x Cost

Total Project Cost: 3,800,000

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information — Facility ID#: 0060

x File Analyzed By: JT x PD ____ Date: 5/23/2005

Type of treatment: x Conductive ____ Steam ____ ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

x Wood Treating x Other: PAH, Dioxins/Furans, PCPs

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 2/27/2003 End of Test: 9/24/2005 Duration: 836 d

Type of Site: x Non-DOD ____ DoD

x Facility Name: Alhambra Pole Yard

Address: ____________

City, State, Zip Code: Alhambra CA 91803

OU# or Site #: AOC-2

x Primary point of contact: Tony Landler

Organization: SCE

Address: 2244 Walnut Grove Avenue

City, State, Zip Code: Rosemead CA 91770

Phone #: 626-302-8692 email: tony.landler@sce.com

x Other contacts or vendors who worked on site ____ None

Point of contact: John Bierschenk

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications X Other Contractor

Organization: TerraTherm

Address: 10 Stevens Road

City, State, Zip Code: Fitchburg, MA 01420

Phone #: 978-343-0300 email: jbierschenk@terratherm.com

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- X Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0060

x Impacted Zone: Length (parallel to flow direction)(ft.): bwlow Width (ft): ______ Thickness (ft): ______ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: x None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______
Post-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 65

Number of relevant soil borings with post-treatment data: 23

Number inside treatment zone: 65/0 Number outside treatment zone: 23/0

x Types of Contaminants

	Chlorinated Solvents:	Petroleum Hydrocarbons:	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	x Creosote	None	5,000 mg/kg	None	None
	____ Tetrachloroethene	____ Jet Fuel	x Pentachlorophenol	None	5 mg/kg	None	1 mg/kg
	____ 1,1-dichloroethene	____ Napthalene	x TPH	None	1,000 mg/kg	None	None
	____ cis-1,2-dichloroethene	____ Benzene	x benzo(a)pyrene-EQ	None	50 mg/kg	None	0.05 mg/kg
	____ trans-1,2-dichloroethene	____ Tolune	x dioxin*	None	0.01 mg/kg	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	x total PAH	None	1,000 mg/kg	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Volume treated -16,200 yd 3 from 7 to 105 ft bgs *Dioxin as 2,3,7,8-TCDD TEQ and the final concentration was actually 0.0001 mg/kg PCP was ND in post-treatment samples

Attachments:

Hydrogeologic Conceptual Model | Facility ID#: 0060

x Geology: Zone: Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 470 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	240			
	high value (ft bgs):	270			
	Unknown:				
x Flow direction		SSE			
x Horizontal hydraulic gradient (feet/foot):		0.003			____ Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 0060

x Thermal treatment:
- x Conductive — Phases 1 & 2
- ____ Electrical Resistance ____
  - ____ 3 phase   ____ 6 phase   ____ AC power   ____ DC power
- ____ Steam ____
  - ____ Steam   ____ Steam + air   ____ Steam + O2
- ____ Other (describe) ____

x Type of Test: ____ Pilot test   x Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only   x Vadose only   ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 2/27/2003   Duration: 836 days

x Hydraulic Control   X Yes   ____ No

Total Treatment Cell Design:

Size of target zone (ft2):	22500	____ Unknown	(____ x ____ ft)
Thickness of target zone (ft):	31 (average)	____ Unknown	
Depth to top of target zone (ft bgs):	0	____ Unknown	
Thickness of target zone below water table (ft):	0	____ Unknown	
Number of energy delivery points:	785	____ Unknown	
Number of extraction points:	131	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	____	____ Unknown
Maximum representative formation temperature (deg C):	____	____ Unknown
Time to reach maximum representative temperature (days):	____	____ Unknown
Duration of treatment at representative temperature (days):	____	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	____	____ lb	____ kg	____ Unknown
Total:	(1) 65575 or (2) 326771 or (3) 869670	x lb	____ kg	____ Unknown

Comments: Treatment was performed in 2 phases. Phase 1 ended in early 2004 and phase 2 was completed in September 2005 7 ft (2.1 M) spacing with depths ranging from 7 to 105 ft with an average of 31 ft bgs in a volume of 12,400 m3 (16200 yd3)
Mass Removal Calculation Methods: (1) Combustion Method (2) MicroFID® Method (3) CO2 Method

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Thermal Treatment - Design Facility ID#: 0060

x Thermal treatment: x Conductive Phase 1

____ Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

x Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only x Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 2/27/03 (ended 2/11/04) Duration: 350 days

x Hydraulic Control X Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	15278	____ Unknown (____ x ____ ft)
Thickness of target zone (ft):	33 (average)	____ Unknown
Depth to top of target zone (ft bgs):	0	____ Unknown
Thickness of target zone below water table (ft):	0	____ Unknown
Number of energy delivery points:	504	____ Unknown
Number of extraction points:	85	____ Unknown

x Temperature Profile:

Initial formation temperature (deg C):	23	____ Unknown
Maximum representative formation temperature (deg C):	315	____ Unknown
Time to reach maximum representative temperature (days):	____	____ Unknown
Duration of treatment at representative temperature (days):	____	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	____	____ lb	____ kg	____ Unknown
Total:	____	____ lb	____ kg	____ Unknown

Comments:

Phase 1 ended in early 2004 ______ 7 ft (2.1 M) spacing with depths ranging from 7 to 105 ft with an average of 33ft bgs in a volume of 8,360 m3 (11,000 yd3) ______ 419 heater-only wells and 85 heater-vacuum wells

Attachments:

Phase 1

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Thermal Treatment - Design Facility ID#: 0060

x Thermal treatment: x Conductive Phase 2

____ Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

x Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only x Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 5/27/04 (ended 9/24/05) Duration: 486 days

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	7222	____ Unknown (____ x ____ ft)
Thickness of target zone (ft):	28 (average)	____ Unknown
Depth to top of target zone (ft bgs):	0	____ Unknown
Thickness of target zone below water table (ft):	0	____ Unknown
Number of energy delivery points:	281	____ Unknown
Number of extraction points:	46	____ Unknown

x Temperature Profile:

Initial formation temperature (deg C):	29	____ Unknown
Maximum representative formation temperature (deg C):	335	____ Unknown
Time to reach maximum representative temperature (days):	____	____ Unknown
Duration of treatment at representative temperature (days):	____	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	____	____ lb	____ kg	____ Unknown
Total:	____	____ lb	____ kg	____ Unknown

Comments:

Phase 2 ended in September 2005 7 ft (2.1 M) spacing with depths ranging from 7 to 105 ft with an average of 28ft bgs in a volume of 3,952 m3 (5,200 yd3) ______ 235 heater-only wells and 46 heater-vacuum wells

Attachments:

Phase 2

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0060

x Performance

Remediation Goal:

____ In Groundwater:

x In Soil: 1. PAHs expressed as benzo(a)pyrene equivalent - 0.065 mg/kg; 2. dioxin as 2,3,7,8, TCDD TEQ - 1 ug/kg; 3. pentachlorophenol - 2.5 mg/kg

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

x In Soil

Comment:

Yes

General comments on the thermal application:

Goal was to hit interwell temperature of 635F (335C) for at least 3 days or hit 570F (300C) for 30 days No Further Action letter issued by Department of Toxic Substances Control 2/8/07.

Lessons Learned

____ Energy

Total Energy Used: 19,359,051 X kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy:

____ Cost

Total Project Cost: 17,900,000.00

____ Consultant Cost: 916,000

____ Thermal Vendor Cost: 11,263,000

____ Energy Cost: 2,265,000.00 ____ m^3 ____ yd^3

____ Other Cost 1: 687,000

____ Other Cost 2: 600,000

____ Other Cost 3: 2,169,000

X Please note other cost:

____ Other Cost 1: Laboratory and Air Quality Testing Expenses

____ Other Cost 2: SCE Labor Costs

____ Other Cost 3: ($266,000) Waste Disposal, ($415,000) Regulatory Oversight, (1,488,000) Miscellaneous Project Costs

General Site Information — Facility ID#: 0065

x File Analyzed By: JT x PD ____ — Date: 10/26/2006

Type of treatment: ____ Conductive ____ Steam ____ ERH x Other: RFH

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: ____________ End of Test: ____________ Duration: ________

Type of Site: x Non-DOD ____ DoD

x Facility Name: Texaco

Address: ____________________

City, State, Zip Code: Bakersville, CA

OU# or Site #: ____________________

x Primary point of contact: Ray Kasevich

Organization: KSN Energies

Address: 291 Main St., 3rd Floor, PO Box 612

City, State, Zip Code: Great Barrington, MA 01230

Phone #: 413-528-4651 email: rkasevich@ksnenergies.com

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: ____________________

Address: ____________________

City, State, Zip Code: ____________________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0065

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______
Post-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ________

Number of relevant soil borings with post-treatment data: ________

Number inside treatment zone: ________ Number outside treatment zone: ________

____ Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0065

____ Geology: Zone Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	________	________	________	
	high value (ft bgs):	________	________	________	
	Unknown:	________	________	________	
____ Flow direction		________	________	________	
____ Horizontal hydraulic gradient (feet/foot):		________	________	________	____ Unknown
Vertical hydraulic gradient (feet/foot):		________	________	________	____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	________	________	________	____ Unknown
high	________	________	________	

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	________	________	________	____ Unknown
high	________	________	________	

Comments: ____

Attachments: ____

Thermal Treatment - Design | Facility ID#: 0065

x Thermal treatment:

____ Conductive ________________

____ Electrical Resistance ________________

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ________________

____ Steam ____ Steam + air ____ Steam + O2

x Other (describe) RFH

____ Type of Test: ____ Pilot test ____ Full-scale System

____ Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ________________ Duration: ________________

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2):	________	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	________	____ Unknown	
Depth to top of target zone (ft bgs):	________	____ Unknown	
Thickness of target zone below water table (ft):	________	____ Unknown	
Number of energy delivery points:	________	____ Unknown	
Number of extraction points:	________	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	________	____ Unknown
Maximum representative formation temperature (deg C):	________	____ Unknown
Time to reach maximum representative temperature (days):	________	____ Unknown
Duration of treatment at representative temperature (days):	________	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	________	________
Formation temperature post-treatment monitoring event 1:	________	________
Duration of post-treatment monitoring (days):	________	________

____ Mass of contaminant removed:

Via liquid pumping:	________	____ lb	____ kg	____ Unknown
In vapor stream:	________	____ lb	____ kg	____ Unknown
Total:	________	____ lb	____ kg	____ Unknown

Comments: ________________

Attachments: ________________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0065

____ Performance

Remediation Goal:

____ In Groundwater:

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information Facility ID#: 0070

x File Analyzed By: JT x PD ____ Date: ________

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: ________ End of Test: ________ Duration: ________

Type of Site: x Non-DOD ____ DoD

x Facility Name: GATX Annex Terminal

Address: ________

City, State, Zip Code: San Pedro, CA

OU# or Site #: ________

x Primary point of contact: Paul DePercin

Organization: SITE/ US EPA

Address: ________

City, State, Zip Code: ________

Phone #: 513-569-7797 email: ________

____ Other contacts or vendors who worked on site ____ None

Point of contact: ________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: ________

Address: ________

City, State, Zip Code: ________

Phone #: ________ email: ________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data ____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information ____ Flux assessment

____ Groundwater elevations ____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0070

____ Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ______

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: ______ Number outside treatment zone: ______

____ Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	x Total VOCs	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

8925 cubic yards of contaminated soil - total Only treated 65 cubic yards

Attachments:

Hydrogeologic Conceptual Model | Facility ID#: 0070

____ Geology: | Zone | Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl   x Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	5			
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
x Horizontal hydraulic gradient (feet/foot):					x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) — Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Transmissivity (ft2/day): — Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Comments: ____________________

Attachments: ____________________

Thermal Treatment - Design Facility ID#: 0070

x Thermal treatment: ____ Conductive ______

____ Electrical Resistance ______

____ 3 phase ____ 6 phase ____ AC power ____ DC power

x Steam ______

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ______

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ______ Duration: ______

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2): ______ ____ Unknown (___ x ___ ft)

Thickness of target zone (ft): ______ ____ Unknown

Depth to top of target zone (ft bgs): ______ ____ Unknown

Thickness of target zone below water table (ft): ______ ____ Unknown

Number of energy delivery points: ______ ____ Unknown

Number of extraction points: ______ ____ Unknown

____ Temperature Profile:

Initial formation temperature (deg C): ______ ____ Unknown

Maximum representative formation temperature (deg C): ______ ____ Unknown

Time to reach maximum representative temperature (days): ______ ____ Unknown

Duration of treatment at representative temperature (days): ______ ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	______	______
Formation temperature post-treatment monitoring event 1:	______	______
Duration of post-treatment monitoring (days):	______	______

____ Mass of contaminant removed:

Via liquid pumping: ______ ____ lb ____ kg ____ Unknown

In vapor stream: ______ ____ lb ____ kg ____ Unknown

Total: ______ ____ lb ____ kg ____ Unknown

Comments: ______

Attachments: ______

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0070

____ Performance

Remediation Goal:

____ In Groundwater:

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

1. SITE demo of the Toxic treatments (USA), Inc (TTUSA) Detoxifer 2. Cost based on 8925 cubic yards of contaminated Soil

$252 to $317/cubic yards

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information   Facility ID#: 0080

x File Analyzed By: JT x PD ____   Date: 7/28/2006

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating Other:

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: 10/23/2002 End of Test: 11/20/2002 Duration: 29 days

Type of Site: ____ Non-DOD x DoD

x Facility Name: Beale AFB

Address: ____________

City, State, Zip Code: Marysville, CA

OU# or Site #: SWMU 23

x Primary point of contact: Phil Welker

Organization: URS

Address: ____________

City, State, Zip Code: ____________

Phone #: 916-679-2262 email: phil_welker@urscorp.com

x Other contacts or vendors who worked on site ____ None

Point of contact: Kent Hawley

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications x Other AFB

Organization: Beale AFB

Address: 6601 B Street

City, State, Zip Code: Beale AFB, CA 95903-1708

Phone #: (530) 634-2657 email: kent.hawley@beale.af.mil

QA/QC

x Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

x Geologic cross-section

x Hydraulic Conductivity information

General Site Assessment Data　　　　Facility ID#: 0080

x　Impacted Zone:　Length (parallel to flow direction)(ft.): 400　Width (ft): 200　Thickness (ft): 30　___ Unknown

____ Impacted zone as defined by documentation

x　Alternative method for determining size of impacted zone (See source zone definition attachments)

x　Map attachment

x　Monitor Wells:　Number of relevant monitoring wells with groundwater data:　___ None

Pre-treatment: 10　Post-treatment: 10

Number of wells relative to treatment zone:

	In:	Upgradient:	Downgradient:	Crossgradient:
Pre-treatment	______	______	______	______
Post-treatment	______	______	______	______

____ Soil Borings:　Number of relevant soil borings with pre-treatment data: 0

Number of relevant soil borings with post-treatment data: 11

Number inside treatment zone: 0　Number outside treatment zone: 11

x　Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	1 mg/L	None	0.1 mg/L	None
	x Tetrachloroethene	____ Jet Fuel	____	0.1 mg/L	None	0.01 mg/L	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	x cis-1,2-dichloroethene	____ Benzene	____	0.001 mg/L	None	0.001 mg/L	None
	x trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	x Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Have screen intervals on: BAI-01, 02, 04, 4S, 4D, 5S, and 5D. Have well coordinates of some wells pgs 5,7 and hydraulic conductivity pg 6 Pre GW concs pg 7; post GW concs pg 71

Attachments:

Map for impacted zone pg 8

Hydrogeologic Conceptual Model   Facility ID#: 0080

x Geology:

Zone		Unconsolidated Sediments
Vadose Zone:	____	Relatively homogeneous and permeable unconsolidated sediments
	____	Relatively homogeneous and impermeable unconsolidated sediments
	____	Largely permeable sediments with inter-bedded lenses of lower permeability material
	x	Largely impermeable sediments with inter-bedded layers of higher permeability material
	____	Competent, but fractured bedrock (i.e. crystalline rock)
	____	Weathered bedrock, limestone, sandstone
Saturated Zone:	____	Relatively homogeneous and permeable unconsolidated sediments
	____	Relatively homogeneous and impermeable unconsolidated sediments
	____	Largely permeable sediments with inter-bedded lenses of lower permeability material
	x	Largely impermeable sediments with inter-bedded layers of higher permeability material
	____	Competent, but fractured bedrock (i.e. crystalline rock)
	____	Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 130 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? x No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3		
Depth to water:	low value (ft bgs):	13				
	high value (ft bgs):	21				
	Unknown:					
x Flow direction		SW				
x Horizontal hydraulic gradient (feet/foot):		0.012				Unknown
Vertical hydraulic gradient (feet/foot):					x	Unknown

x K range (ft/day)   Measured using: ____ Slug Test ____ Laboratory ____ Field data

		Aquifer 1	Aquifer 2	Aquifer 3		
	low	0.75			____	Unknown
	high	14.3				

Transmissivity (ft2/day):   Measured using: ____ Slug Test ____ Laboratory ____ Field data

		Aquifer 1	Aquifer 2	Aquifer 3		
	low				x	Unknown
	high					

Comments:

Aquifer test conducted in 2003 resulted in dwatering at extraction point at low flow rates of 2.3 gpm

Attachments:

Thermal Treatment - Design   Facility ID#: 0080

x Thermal treatment:
- ____ Conductive ____________
- ____ Electrical Resistance ____________
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- x Steam DUS/HPO
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ____________

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: x Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 10/23/2002 Duration: 29 days

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	652	____ Unknown	(29 x 29 ft)
Thickness of target zone (ft):	15	____ Unknown	
Depth to top of target zone (ft bgs):	25	____ Unknown	
Thickness of target zone below water table (ft):	15	____ Unknown	
Number of energy delivery points:	1	____ Unknown	
Number of extraction points:	1	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	21	____ Unknown
Maximum representative formation temperature (deg C):	100	____ Unknown
Time to reach maximum representative temperature (days):	22	____ Unknown
Duration of treatment at representative temperature (days):	2	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	11/20/2002	100
Formation temperature post-treatment monitoring event 1:	12/2/2002	88
Duration of post-treatment monitoring (days):	Atleast 14 days	____________

____ Mass of contaminant removed:

Via liquid pumping:	____________	____ lb	____ kg	____ Unknown
In vapor stream:	____________	____ lb	____ kg	____ Unknown
Total:	____________	____ lb	____ kg	____ Unknown

Comments:

12/9/06 - 80C

Attachments: ____________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0080

x Performance

Remediation Goal:

x In Groundwater:

1. Destroy COCs, 2. heat up soil and groundwater by steam, and 3. maintain hydraulic control

____ In Soil:

Was the Remediation Goal Achieved:

x In Groundwater pp pp g

Comment: concentration levels from ~10,000 ug/L of VOCs to ~ 2,000 ug/L. Test was terminated; follow-on remedial technology applied in 2004 (ozone sparging) has reduced levels from ~2,000 ug/L to <500 ug/L; system is still operating at site.

____ In Soil

Comment:

General comments on the thermal application:

Aquifer region immediately adjacent to extraction well dried out

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy:

____ Cost

Total Project Cost:

x Consultant Cost: 930,160

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information　　　　Facility ID#: 0085

x File Analyzed By: JT x PD ____　　Date: 10/18/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: x Active ___ Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: ____________ End of Test: ____________ Duration: ________

Type of Site: ____ Non-DOD ____ DoD

x Facility Name: Pemaco Superfund Site

Address: ____________

City, State, Zip Code: Los Angelos County, CA

OU# or Site #: ____________

x Primary point of contact: Tim Garvey

Organization: TN & Associates

Address: ____________

City, State, Zip Code: Ventura, CA 93001

Phone #: 805-585-6386　　email: ____________

x Other contacts or vendors who worked on site　　____ None

Point of contact: David Flemings

Type: x Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: TRS

Address: ____________

City, State, Zip Code: ____________

Phone #: 425-396-4266　　email: dfleming@thermalrs.com

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data   Facility ID#: 0085

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______
Post-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

____ Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	50 mg/L	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____ ________	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ________	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ________	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ________	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ________	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ________	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ________	None	None	None	None
	____ 1,1,2-trichloroethane	____ ________	____ ________	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ________	____ ________	None	None	None	None
	____ Vinyl Chloride	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0085

x Geology: Zone Unconsolidated Sediments

Vadose Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

Saturated Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	60			
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 0085

x Thermal treatment:
- ____ Conductive ____________________
- x Electrical Resistance ____________________
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- ____ Steam ____________________
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ____________________

x Type of Test: ____ Pilot test x Full-scale System

____ Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: Jun-05   Duration: ____________

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2):	13200	____ Unknown (____ x ____ ft)
Thickness of target zone (ft):	20	____ Unknown
Depth to top of target zone (ft bgs):	60	____ Unknown
Thickness of target zone below water table (ft):	35	____ Unknown
Number of energy delivery points:	____________	____ Unknown
Number of extraction points:	____________	____ Unknown

____ Temperature Profile:

Initial formation temperature (deg C):	____________	____ Unknown
Maximum representative formation temperature (deg C):	____________	____ Unknown
Time to reach maximum representative temperature (days):	____________	____ Unknown
Duration of treatment at representative temperature (days):	____________	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____________	____________
Formation temperature post-treatment monitoring event 1:	____________	____________
Duration of post-treatment monitoring (days):	____________	____________

____ Mass of contaminant removed:

Via liquid pumping:	____________	____ lb	____ kg	____ Unknown
In vapor stream:	____________	____ lb	____ kg	____ Unknown
Total:	____________	____ lb	____ kg	____ Unknown

Comments: ____________________

Attachments: ____________________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0085

____ Performance

Remediation Goal:

____ In Groundwater: ____________________

____ In Soil: ____________________

Was the Remediation Goal Achieved:

____ In Groundwater ____________________

Comment: ____________________

____ In Soil ____________________

Comment: ____________________

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____________ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____________________

____ Cost

Total Project Cost: ____________

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

____ Energy Cost: ____________ ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ____________________

____ Other Cost 2: ____________________

____ Other Cost 3: ____________________

General Site Information — Facility ID#: 0090

x File Analyzed By: JT x PD ____ — Date: 5/1/2007

Type of treatment: x Conductive ____ Steam ____ ERH ____ Other: ________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ________

Treatment Status: ___ Active x Post

Type of Test: x Pilot Test ____ Full Scale System

Start of Test: Jul-04 — End of Test: Nov-05 — Duration: 480 day

Type of Site: x Non-DOD ____ DoD

x Facility Name: Carson, CA

Address: ________

City, State, Zip Code: Carson, CA

OU# or Site #: ________

x Primary point of contact: John Bierschenk

Organization: TerraTherm

Address: 10 Stevens Rd

City, State, Zip Code: Fitchburg, MA 01420

Phone #: 978-343-0300 — email: jbierschenk@terratherm.com

____ Other contacts or vendors who worked on site ____ None

Point of contact: ________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: ________

Address: ________

City, State, Zip Code: ________

Phone #: ________ email: ________

QA/QC

x Characteristics of Interest

x Good pre- and post-treatment groundwater data

x Good pre- and post-treatment soil data

x Good temperature profile vs. time information

____ Flux assessment

Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data   Facility ID#: 0090

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 6 Post-treatment: 5

Number of wells relative to treatment zone:

Pre-treatment	In: 6	Upgradient: ______	Downgradient: ______	Crossgradient: ______
Post-treatment	In: 5	Upgradient: ______	Downgradient: ______	Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 12

Number of relevant soil borings with post-treatment data: 9

Number inside treatment zone: 12/9 Number outside treatment zone: ____________

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	10 mg/L	10 mg/kg	1 mg/L	None
	____ Tetrachloroethene	____ Jet Fuel	____ ________	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ________	None	None	None	None
	x cis-1,2-dichloroethene	____ Benzene	____ ________	None	0.5 mg/kg	None	None
	x trans-1,2-dichloroethene	____ Tolune	____ ________	None	0.01 mg/kg	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ________	None	None	None	None
	x 1,2-dichloroethane	____ m/p-xylene	____ ________	5,000 mg/L	1,000 mg/kg	10 mg/L	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ________	None	None	None	None
	____ 1,1,2-trichloroethane	____ ________	____ ________	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ________	____ ________	None	None	None	None
	x Vinyl Chloride	____ ________	____ ________	10 mg/L	10 mg/kg	0.5 mg/L	None
	x Total CVOCs 20 ft	____ ________	____ ________	None	500 mg/kg	None	1 mg/kg
	x Total CVOCs 25 ft	____ ________	____ ________	None	1,000 mg/kg	None	1 mg/kg
	x Total CVOCs 30 ft	____ ________	____ ________	None	1,000 mg/kg	None	10 mg/kg
	x Total CVOCs 35 ft	____ ________	____ ________	None	5,000 mg/kg	None	100 mg/kg
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0090

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:

- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:

- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 20 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No x Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	20	25		
	high value (ft bgs):		30		
	Unknown:				
____ Flow direction					
x Horizontal hydraulic gradient (feet/foot):		0.002 to 0.004			____ Unknown
Vertical hydraulic gradient (feet/foot):		0.141			____ Unknown

x K range (ft/day) Measured using: ____ Slug Test x Laboratory ____ Field data

low	1.44			____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 0090

x Thermal treatment: x Conductive ____

____ Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

x Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only x Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: Jul-04 Duration: 480 day

x Hydraulic Control ____ Yes x No

x Treatment Cell Design:

Size of target zone (ft2):	7200	____ Unknown	(80 x 120 ft)
Thickness of target zone (ft):	20	____ Unknown	
Depth to top of target zone (ft bgs):	17	____ Unknown	
Thickness of target zone below water table (ft):	17	____ Unknown	
Number of energy delivery points:	29	____ Unknown	
Number of extraction points:	6	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	21	____ Unknown
Maximum representative formation temperature (deg C):	100	____ Unknown
Time to reach maximum representative temperature (days):	231	____ Unknown
Duration of treatment at representative temperature (days):	253	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	11/8/2005	100
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

Via liquid pumping:		____ lb	____ kg	____ Unknown
In vapor stream:		____ lb	____ kg	____ Unknown
Total:	24800 (1,2-DCA)	x lb	____ kg	____ Unknown

Comments:

22 ft spacing between thermal wells, approximately 250 to 330 watts/ft power input to each well. Treated 3,233 yd3.

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance   Facility ID#: 0090

____ Performance

Remediation Goal:

____ In Groundwater: ____________________

____ In Soil: ____________________

Was the Remediation Goal Achieved:

____ In Groundwater ____________________

Comment: ____________________

____ In Soil ____________________

Comment: ____________________

General comments on the thermal application:

Target temp 100C achieved within treatment zone.   No specific treatment goals established, Pilot Project Goals: 1) evaluate whether ISTD will remove the CVOCs from the saturated clay and 2) evaluate whether this removal would have an impact on CVOC concentrations in Unit A aqufer below thermal treatment zone.

Lessons Learned

1, 2 DCA groundwater concentrations in the Unit A aquifer, as measured by two monitor wells placed directly beneath thermal treamtent zone,   were reduced from 1,600 mg/l to 1.4 mg/l or 99.91% reduction (MW-18); and 390 mg/l to .09 mg/l or 99.98% (MW-19).

x Energy

Total Energy Used: 2085.3   x kWhr   ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ________   ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ________   ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____________________

____ Cost

Total Project Cost: ________

____ Consultant Cost: ________

Thermal Vendor Cost:

____ Energy Cost: ________   ____ m^3 ____ yd^3

____ Other Cost 1: ________

____ Other Cost 2: ________

____ Other Cost 3: ________

____ Please note other cost: ____ Other Cost 1: ____________________

____ Other Cost 2: ____________________

____ Other Cost 3: ____________________

General Site Information Facility ID#: 0095

x File Analyzed By: JT x PD ____ Date: 10/30/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: ____________ End of Test: ____________ Duration: ________

Type of Site: x Non-DOD ____ DoD

x Facility Name: Operating Dry Cleaner

Address: ____________

City, State, Zip Code: Carson, CA

OU# or Site #: ____________

x Primary point of contact: Bill Heath

Organization: CES

Address: 419 W. Entiat St

City, State, Zip Code: Kennewick, WA 99336

Phone #: 509-727-4276 email: bill@cesiweb.com

x Other contacts or vendors who worked on site ____ None

Point of contact: James Keegan

Type: x Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: TerraVac

Address: 1211 N Barsten Way

City, State, Zip Code: Anaheim, CA 92806

Phone #: 714-666-1974 email: jkeegan@terravac.com

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data Facility ID#: 0095

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	x Tetrachloroethene	____ Jet Fuel		None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene		None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene		None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune		None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane			None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	x Vinyl Chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0095

____ Geology: Zone Unconsolidated Sediments

Vadose Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
x Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

Saturated Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
x Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	15			
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design — Facility ID#: 0095

x Thermal treatment:
- ____ Conductive ____________
- x Electrical Resistance ____________
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- ____ Steam ____________
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ____________

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

____ Start of Thermal Test: ____________ Duration: ____________

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2):	____________	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	20	____ Unknown	
Depth to top of target zone (ft bgs):	8	____ Unknown	
Thickness of target zone below water table (ft):	____________	____ Unknown	
Number of energy delivery points:	13	____ Unknown	
Number of extraction points:	15	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	____________	____ Unknown
Maximum representative formation temperature (deg C):	____________	____ Unknown
Time to reach maximum representative temperature (days):	____________	____ Unknown
Duration of treatment at representative temperature (days):	____________	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____________	____________
Formation temperature post-treatment monitoring event 1:	____________	____________
Duration of post-treatment monitoring (days):	____________	____________

____ Mass of contaminant removed:

Via liquid pumping:	____________	____ lb	____ kg	____ Unknown
In vapor stream:	____________	____ lb	____ kg	____ Unknown
Total:	____________	____ lb	____ kg	____ Unknown

Comments: ____________

Attachments: ____________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0095

____ Performance

Remediation Goal:

____ In Groundwater: ____

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information　　　　Facility ID#: 0110

x File Analyzed By: JT x PD x　　　　Date: 9/18/2006

Type of treatment: ____ Conductive　x Steam　____ ERH　____ Other: ____

Type of Contaminant: ____ Chlorinated Solvents　x Petroleum Hydrocarbons　____ Pesticides

____ Wood Treating　____ Other: ____

Treatment Status: ____ Active　x Post

Type of Test: x Pilot Test　___ Full Scale System

Start of Test: 3/27/1997　End of Test: 8/14/1997　Duration: 137 days

Type of Site: ____ Non-DOD　x DoD

x Facility Name: Defense Fuel Support Point

Address: 3171 N Gaffey St.

City, State, Zip Code: San Pedro, CA

OU# or Site #: ____

x Primary point of contact: Paul Rogers

Organization: ____

Address: ____

City, State, Zip Code: ____

Phone #: 703-767-8318　email: paul.rogers@dla.mil

x Other contacts or vendors who worked on site　____ None

Point of contact: Neil Irish

Type: x Vendor, Consultant　____ Vendor, Technical Applications　____ Other ____

Organization: The Source Group

Address: 1962 Freeman Ave

City, State, Zip Code: Signal Hill, CA 90755

Phone #: 562-597-1055　email: nirish@thesourcegroup.net

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data Facility ID#: 0110

x Impacted Zone: Length (parallel to flow direction)(ft.): 300 Width (ft): 200 Thickness (ft): ____ ___ Unknown

____ Impacted zone as defined by documentation

x Alternative method for determining size of impacted zone (See source zone definition attachments)

x Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 13 Post-treatment: 13

Number of wells relative to treatment zone:

	In:	Upgradient:	Downgradient:	Crossgradient:
Pre-treatment	0	6	2	5
Post-treatment	0	6	2	5

x Soil Borings: Number of relevant soil borings with pre-treatment data: 13

Number of relevant soil borings with post-treatment data: 0

Number inside treatment zone: 13 Number outside treatment zone: 0

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	x Benzene	____	0.001 mg/L	0.01 mg/kg	None	None
	____ trans-1,2-dichloroethene	x Tolune	____	0.001 mg/L	0.01 mg/kg	None	None
	____ 1,1-dichloroethane	x Ethylbenzene	____	0.001 mg/L	0.01 mg/kg	None	None
	____ 1,2-dichloroethane	x m/p-xylene	____	0.001 mg/L	0.01 mg/kg	None	None
	____ 1,1,1-trichloroethane	x o-xylene	____	0.001 mg/L	0.01 mg/kg	None	None
	____ 1,1,2-trichloroethane	x JP 4	____	1 mg/L	1,000 mg/kg	None	None
	____ 1,1,2,2-tetrachloroethane	x JP 5	____	1 mg/L	1,000 mg/kg	None	None
	____ Vinyl Chloride	x Diesel	____	1 mg/L	1,000 mg/kg	None	None
	____	x TPHd	____	1 mg/L	1,000 mg/kg	None	None
	____	x TPHg	____	0.01 mg/L	10 mg/kg	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

Figure 3 (impacted zone) - defined from cross-section map and borehole data

Hydrogeologic Conceptual Model Facility ID#: 0110

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:

- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:

- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 40 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	24			
	high value (ft bgs):	25			
	Unknown:				
x Flow direction		NE - E			
x Horizontal hydraulic gradient (feet/foot):		0.008 to 0.04			____ Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Comments:

aquifer DTW is 11 to 31 feet regionally and regional flow is to the NW, but different in treatment area

Attachments:

Thermal Treatment - Design — Facility ID#: 0110

x Thermal treatment:
- ____ Conductive ____
- ____ Electrical Resistance ____
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- x Steam ____
  - x Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ____

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 3/27/1997 Duration: 137 days

x Hydraulic Control ____ Yes x No

x Treatment Cell Design:

Size of target zone (ft2):	____	x Unknown (___ x ___ ft)
Thickness of target zone (ft):	____	x Unknown
Depth to top of target zone (ft bgs):	____	x Unknown
Thickness of target zone below water table (ft):	15	____ Unknown
Number of energy delivery points:	3	____ Unknown
Number of extraction points:	1	____ Unknown

x Temperature Profile:

Initial formation temperature (deg C):	21	____ Unknown
Maximum representative formation temperature (deg C):	90	____ Unknown
Time to reach maximum representative temperature (days):	85	____ Unknown
Duration of treatment at representative temperature (days):	40	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	____	____ lb	____ kg	____ Unknown
Total:	2200	____ lb	x kg	____ Unknown

Comments: Total mass was 800 gallons of Diesel, etc. Steam wells installed - 5 (2 not used); Recovery wells installed - 2 (1 not used) Said 20 ft radius of influence and 20 ft columnar per injection well

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0110

____ Performance

Remediation Goal:

____ In Groundwater:

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Target temp of 150F in vados zone Basis of success was from recovery data and that was only graphic showing recovery rate and cumulative recovery Boilers only ran 10/hrs/day with many at 4 hours. Total Boiler operation time of 552 hours for SI-4B and 356.5 for SI-1.

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information — Facility ID#: 0130

X File Analyzed By: JT X PD ____ — Date: 11/9/2006

Type of treatment: ____ Conductive X Steam ____ ERH ____ Other: ____________

Type of Contaminant: X Chlorinated Solvents X Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active X Post

Type of Test: X Pilot Test ___ Full Scale System

Start of Test: 5/28/2002 End of Test: 7/12/2002 Duration: 45 d

Type of Site: ____ Non-DOD X DoD

X Facility Name: Edwards AFB

Address: ____________

City, State, Zip Code: California

OU# or Site #: Site 61, OU-8

X Primary point of contact: Dr. Stephen Watts

Organization: USAF

Address: 95 ABW/CEVX 5 E. Popson Ave., Bldg. 2650a

City, State, Zip Code: Edwards AFB, CA 93524

Phone #: 661-277-1443 email: stephen.watts@edwards.af.mil

____ Other contacts or vendors who worked on site ____ None

Point of contact:

Type: X Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: SteamTech

Address:

City, State, Zip Code: Bakersfield CA -- no longer in business

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0130

X Impacted Zone: Length (parallel to flow direction)(ft.): 1025 Width (ft): 500 Thickness (ft): 60 ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

X Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 3 Post-treatment: 3

Number of wells relative to treatment zone:

Pre-treatment In: 3 Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: 3 Upgradient: ______ Downgradient: ______ Crossgradient: ______

X Soil Borings: Number of relevant soil borings with pre-treatment data: 3

Number of relevant soil borings with post-treatment data: 3

Number inside treatment zone: 3 Number outside treatment zone: 3

X Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	X Trichloroethene	____ Hexane	____ Creosote	1 mg/L	None	0.1 mg/L	None
	X Tetrachloroethene	____ Jet Fuel	____	0.005 mg/L	None	0.001 mg/L	None
	X 1,1-dichloroethene	____ Napthalene	____	0.005 mg/L	0.01 mg/kg	0.001 mg/L	None
	____ cis-1,2-dichloroethene	X Benzene	____	0.01 mg/L	0.01 mg/kg	0.001 mg/L	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	X Benzene (deep)	____	0.005 mg/L	0.01 mg/kg	0.001 mg/L	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	X TCE (deep)	____	____	1 mg/L	0.01 mg/kg	0.5 mg/L	None
	X PCE (deep)	____	____	0.01 mg/L	0.01 mg/kg	0.001 mg/L	None
	X 1-DCE (deep)	____	____	0.01 mg/L	0.01 mg/kg	0.001 mg/L	None
		____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Avg post treatment GW concentrations for PCE, Benzene, PCE (deep), 1,1-DCE (deep), and Benzene (deep) are all listed as 0.001 mg/L but were in fact all ND. First set of data is from shallow interval, the second all listed as "deep" are from deeper interval of single groundwater zone. All deep soil were ND before treatment and Benzene and 1,1 DCE were ND before treatment.

Attachments:

Hydrogeologic Conceptual Model — Facility ID#: 0130

X Geology:

Zone	Unconsolidated Sediments
Vadose Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	X Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone
Saturated Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	X Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone

X Ground surface elevation based on wells in or adjacent to treatment zone: 2335 ft amsl ____ Unknown

X Aquifer Characteristics:

Is more than 1 aquifer present? X No ____ Yes (number): ________ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	32			
	high value (ft bgs):	33			
	Unknown:				
X Flow direction		Southeast			
X Horizontal hydraulic gradient (feet/foot):		0.044 reported, likely much less			____ Unknown
Vertical hydraulic gradient (feet/foot):		none			____ Unknown

X K range (ft/day) — Measured using: X Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low	0.32			____ Unknown
high	1			

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low	31.32			____ Unknown
high	97.3			

Comments:

S=0.007 to 0.05

Attachments:

Thermal Treatment - Design Facility ID#: 0130

X Thermal treatment:
____ Conductive ____________
____ Electrical Resistance ____________
____ 3 phase ____ 6 phase ____ AC power ____ DC power
X Steam ____________
____ Steam ____ Steam + air ____ Steam + O2
____ Other (describe) ____________

X Type of Test: X Pilot test ____ Full-scale System

X Geology of Treatment Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
X Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

X Treatment Targe Zone: ____ Saturated only ____ Vadose only X Both (Saturated and Vadose zones)

X Start of Thermal Test: 5/8/2003 Duration: 45 d

X Hydraulic Control X Yes ____ No

X Treatment Cell Design:

Size of target zone (ft2):	90	____ Unknown	(x ft)
Thickness of target zone (ft):	55	____ Unknown	
Depth to top of target zone (ft bgs):	5	____ Unknown	
Thickness of target zone below water table (ft):	28	____ Unknown	
Number of energy delivery points:	1	____ Unknown	
Number of extraction points:	4	____ Unknown	

X Temperature Profile:

Initial formation temperature (deg C):	20	____ Unknown
Maximum representative formation temperature (deg C):	100	____ Unknown
Time to reach maximum representative temperature (days):	44	____ Unknown
Duration of treatment at representative temperature (days):	1	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	7/12/2002	95
Formation temperature post-treatment monitoring event 1:	8/5/2002	80
Duration of post-treatment monitoring (days):	~25	____________

X Mass of contaminant removed:

Via liquid pumping:	<1.81	____ lb	X kg	____ Unknown
In vapor stream:	1234	____ lb	X kg	____ Unknown
Total:	1342	____ lb	X kg	____ Unknown

Comments: ____________

Attachments: ____________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0130

X Performance

Remediation Goal:

X In Groundwater: 1) Quantify mass reduction of TCE and other COCs; 2) Characterize steam movement; 3) Document operation and maintenance with regards to reliability and cost.

____ In Soil:

Was the Remediation Goal Achieved:

X In Groundwater g y, g , y g

Comment: fraction of total recovery. Steam heating plus vapor phase extraction yielded most of the remaining recovery.

____ In Soil

Comment:

General comments on the thermal application:

Objective: Determine if steam is an effective technology to remove TCE and other COCs from fractured bedrock at Site 61. Steam was judged very effective. High capital cost of full scale system made USAF reluctant to scale up, although complete cleanup of plume could probably have been achieved in a short time making life-cycle cost favorable.

Lessons Learned

Initial plan and funding for 30 day pilot test was insufficient for technology evaluation.

X Energy

Total Energy Used: ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

X Total energy applied to treatment zone: 109901 kw-hr ____ kWhr/m^3 ____ kWhr/yd^3

X Other energy: 33703 ke-hr ____ kWhr/m^3 ____ kWhr/yd^3

X Please note other energy: extracted water-115x10E6 BTUs (30% of injected energy) Total energy - 375x10E6 BTUs

X Cost

Total Project Cost: 525,000

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information | Facility ID#: 0140

x File Analyzed By: JT x PD ____ | Date: 10/30/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____

Type of Contaminant: ____ Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ____ Full Scale System

Start of Test: ____ End of Test: ____ Duration: ____

Type of Site: x Non-DOD ____ DoD

x Facility Name: Former Agricultural Products

Address: ____

City, State, Zip Code: Newark, CA

OU# or Site #: ____

x Primary point of contact: Bill Heath

Organization: CES

Address: 419 W. Entiat St

City, State, Zip Code: Kennewick, WA 99336

Phone #: 509-727-4276 email: bill@cesiweb.com

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____

Organization: ____

Address: ____

City, State, Zip Code: ____

Phone #: ____ email: ____

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data | Facility ID#: 0140

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______
Post-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

____ Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____ ________	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ________	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ________	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ________	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ________	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ________	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ________	None	None	None	None
	____ 1,1,2-trichloroethane	____ ________	____ ________	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ________	____ ________	None	None	None	None
	____ Vinyl Chloride	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None

Comments: ________________________________

Attachments: ________________________________

Hydrogeologic Conceptual Model Facility ID#: 0140

____ Geology:

Zone	Unconsolidated Sediments
Vadose Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone
Saturated Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments: ____________________

Attachments: ____________________

Thermal Treatment - Design

Facility ID#: 0140

x Thermal treatment: ____ Conductive ________

x Electrical Resistance ________

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ________

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ________

x Type of Test: x Pilot test ____ Full-scale System

____ Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ________ Duration: ________

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2): ________ ____ Unknown (___ x ___ ft)

Thickness of target zone (ft): ________ ____ Unknown

Depth to top of target zone (ft bgs): ________ ____ Unknown

Thickness of target zone below water table (ft): ________ ____ Unknown

Number of energy delivery points: ________ ____ Unknown

Number of extraction points: ________ ____ Unknown

____ Temperature Profile:

Initial formation temperature (deg C): ________ ____ Unknown

Maximum representative formation temperature (deg C): ________ ____ Unknown

Time to reach maximum representative temperature (days): ________ ____ Unknown

Duration of treatment at representative temperature (days): ________ ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	________	________
Formation temperature post-treatment monitoring event 1:	________	________
Duration of post-treatment monitoring (days):	________	________

____ Mass of contaminant removed:

Via liquid pumping: ________ ____ lb ____ kg ____ Unknown

In vapor stream: ________ ____ lb ____ kg ____ Unknown

Total: ________ ____ lb ____ kg ____ Unknown

Comments: ________

Attachments: ________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0140

____ Performance

Remediation Goal:

____ In Groundwater: ________________

____ In Soil: ________________

Was the Remediation Goal Achieved:

____ In Groundwater ________________

Comment: ________________

____ In Soil ________________

Comment: ________________

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ________ ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ________ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ________ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy: ________________

____ Cost

Total Project Cost: ________

____ Consultant Cost: ________

____ Thermal Vendor Cost: ________

____ Energy Cost: ________ ____ m^3 ____ yd^3

____ Other Cost 1: ________

____ Other Cost 2: ________

____ Other Cost 3: ________

____ Please note other cost: ____ Other Cost 1: ________________

____ Other Cost 2: ________________

____ Other Cost 3: ________________

General Site Information Facility ID#: 0145

x File Analyzed By: JT x PD ____ Date: 11/15/2006

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: 6/19/2003 End of Test: 3/17/2004 Duration: 270 d

Type of Site: x Non-DOD ____ DoD

x Facility Name: Guadalupe

Address: ____________

City, State, Zip Code: Guadalupe, CA

OU# or Site #: ____________

x Primary point of contact: Paul Johnson

Organization: Arizona State University

Address: ____________

City, State, Zip Code: ____________

Phone #: 480-965-1730 email: paul.c.johnson@asu.edu

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data　　　　Facility ID#: 0145

x Impacted Zone: Length (parallel to flow direction)(ft.): 2000　Width (ft): 2000　Thickness (ft): 15　___ Unknown

___ Impacted zone as defined by documentation

___ Alternative method for determining size of impacted zone (See source zone definition attachments)

___ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data:　___ None

Pre-treatment: 4　Post-treatment: 4

Number of wells relative to treatment zone:

Pre-treatment　In: 4　Upgradient: ______　Downgradient: ______　Crossgradient: ______

Post-treatment　In: 4　Upgradient: ______　Downgradient: ______　Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 10

Number of relevant soil borings with post-treatment data: 12

Number inside treatment zone: 10　Number outside treatment zone: 12

x Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	___ Trichloroethene	___ Hexane	___ Creosote	None	None	None	None
	___ Tetrachloroethene	___ Jet Fuel	___	None	None	None	None
	___ 1,1-dichloroethene	___ Napthalene	___	None	None	None	None
	___ cis-1,2-dichloroethene	___ Benzene	___	None	None	None	None
	___ trans-1,2-dichloroethene	___ Tolune	___	None	None	None	None
	___ 1,1-dichloroethane	___ Ethylbenzene	___	None	None	None	None
	___ 1,2-dichloroethane	___ m/p-xylene	___	None	None	None	None
	___ 1,1,1-trichloroethane	___ o-xylene	___	None	None	None	None
	___ 1,1,2-trichloroethane	x TPH (leachate)	___	10 mg/L	None	5 mg/L	None
	___ 1,1,2,2-tetrachloroethane	x PAH (leachate)	___	0.05 mg/L	None	0.005 mg/L	None
	___ Vinyl Chloride	x BTEX (leachate)	___	0.01 mg/L	None	0.001 mg/L	None
	___	x TPH	___	5 mg/L	None	5 mg/L	None
	___	x PAH	___	0.01 mg/L	None	0.005 mg/L	None
	___	x BTEX	___	0.01 mg/L	None	0.001 mg/L	None
	___	x Diluent	___	None	10,000 mg/kg	None	10,000 mg/kg
	___	___	___	None	None	None	None
	___	___	___	None	None	None	None

Comments:

Diluent - Pre-treatment concentration was actually 100,000 mg/kg.

BTEX - Benzene, Toluene, Ethylbenzene, and m-, o-, p-xylenes

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0145

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- x Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- x Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 50 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	55			
	high value (ft bgs):	60			
	Unknown:				
x Flow direction		W			
x Horizontal hydraulic gradient (feet/foot):		0.003 to 0.004			____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	75			____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Porosity - 0.4 Velocity - 1 ft/day

Attachments:

Thermal Treatment - Design　　　　　Facility ID#: 0145

x Thermal treatment:
- ____ Conductive ____
- ____ Electrical Resistance ____
  - ____ 3 phase　____ 6 phase　____ AC power　____ DC power
- x Steam ____
  - ____ Steam　x Steam + air　____ Steam + O2
- ____ Other (describe) ____

x Type of Test: x Pilot test　____ Full-scale System

x Geology of Treatment Zone:
- x Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only　____ Vadose only　x Both (Saturated and Vadose zones)

x Start of Thermal Test: 6/19/2003　　Duration: 270 d

x Hydraulic Control　x Yes　____ No

x Treatment Cell Design:

Size of target zone (ft2):	4900	____ Unknown	(70 x 70 ft)
Thickness of target zone (ft):	12	____ Unknown	
Depth to top of target zone (ft bgs):	50	____ Unknown	
Thickness of target zone below water table (ft):	2	____ Unknown	
Number of energy delivery points:	4	____ Unknown	
Number of extraction points:	1	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	____	____ Unknown
Maximum representative formation temperature (deg C):	____	____ Unknown
Time to reach maximum representative temperature (days):	____	____ Unknown
Duration of treatment at representative temperature (days):	____	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	23000 gallons	____ lb	____ kg	____ Unknown
In vapor stream:	1850 gallons	____ lb	____ kg	____ Unknown
Total:	24850 gallons	____ lb	____ kg	____ Unknown

Comments:
Steam injection Began on 10/22/03 and ended on 3/17/04 so 145 days of steam injection. The other days included air injection. Steam injection pressure was cycled after steam breakthrough.
Injection well spacing - 34.5 ft

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0145

____ Performance

Remediation Goal:

____ In Groundwater:

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Objective questions: 1) What is optimum design and operating condictions? 2) What are improvements to groundwater quality? 3) What will remaining be the diluent saturation and compositions? 4) What are the projected costs? 5) What are the environmental impacts?

Objective answers: 1) Targe tempeature of a minimum of 100C 2) Minimum of equivalent 2 targe treatment zone pore volumes of steam and no simngle well injecting more than 40% of cumulative steam 3) Water mass balance is established 4) Data collection to satisfy the DQO

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information Facility ID#: 0150

X File Analyzed By: JT X PD ____ Date: 4/11/2005

Type of treatment: ____ Conductive X Steam ____ ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents X Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active X Post

Type of Test: ____ Pilot Test X Full Scale System

Start of Test: Nov-92 End of Test: Dec-93 Duration: 21 weeks

Type of Site: ____ Non-DOD X DoD

X Facility Name: Lawrence Livermore National Laboratory (LLNL)

Address: ____________

City, State, Zip Code: California

OU# or Site #: Gas Pad

X Primary point of contact: Roger Aines

Organization: LLNL

Address: ____________

City, State, Zip Code: Livermore, CA

Phone #: 923-423-7184 email: aines1@llnl.gov

Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data | Facility ID#: 0150

X Impacted Zone: Length (parallel to flow direction)(ft.): ____ Width (ft): ____ Thickness (ft): ____ X Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

X Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 14 Post-treatment: 12

Number of wells relative to treatment zone:

Pre-treatment In: ____ Upgradient: ____ Downgradient: ____ Crossgradient: ____

Post-treatment In: ____ Upgradient: ____ Downgradient: ____ Crossgradient: ____

X Soil Borings: Number of relevant soil borings with pre-treatment data: 47

Number of relevant soil borings with post-treatment data: 26

Number inside treatment zone: ____ Number outside treatment zone: ____

X Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	X Benzene	____	5 mg/L	None	0.1 mg/L	None
	____ trans-1,2-dichloroethene	X Tolune	____	1 mg/L	None	0.1 mg/L	None
	____ 1,1-dichloroethane	X Ethylbenzene	____	1 mg/L	None	0.005 mg/L	None
	X 1,2-dichloroethane	____ m/p-xylene	____	0.1 mg/L	None	0.001 mg/L	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	X Xylenes	____	5 mg/L	None	0.5 mg/L	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

1,2-DCA post treatment concentration was ND. Average post treatment concentrations based on 9/1/94 analysis. Estimated spill of 6200 gallons.

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0150

X Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- X Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- X Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

X Ground surface elevation based on wells in or adjacent to treatment zone: 640 ft amsl ____ Unknown

X Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ X Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	100			
	high value (ft bgs):	120			
	Unknown:				
X Flow direction		West			
Horizontal hydraulic gradient (feet/foot):		0.0095			____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

X K range (ft/day) — Measured using: ____ Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low	4 units with differing K			____ Unknown
high	see below			

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low				____ Unknown
high				

Comments:
1) high permeability channels - 2 to 143 ft/day (avg. 37.4). 2) relatively high permeability channels - 1.74 to 133.7 ft/day (avg. 20.6). 3) moderate permeability - 2.14 to 22.7 ft/day (avg. 15.5). 4) low permeability - <0.67 to 2.4 ft/day (avg. 1.47).

Attachments:

Thermal Treatment - Design		Facility ID#: 0150

X Thermal treatment:
- ____ Conductive ____________
- ____ Electrical Resistance ____________
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- X Steam with electrodes
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ____________

X Type of Test: ____ Pilot test X Full-scale System

X Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- X Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

X Treatment Targe Zone: ____ Saturated only ____ Vadose only X Both (Saturated and Vadose zones)

X Start of Thermal Test: Nov-92 Duration: 21 weeks

X Hydraulic Control X Yes ____ No

X Treatment Cell Design:

Size of target zone (ft2):	11304	____ Unknown	(120 x 80 ft)
Thickness of target zone (ft):	80	____ Unknown	
Depth to top of target zone (ft bgs):	60	____ Unknown	
Thickness of target zone below water table (ft):	30	____ Unknown	
Number of energy delivery points:	9	____ Unknown	
Number of extraction points:	3	____ Unknown	

X Temperature Profile:

Initial formation temperature (deg C):	23	____ Unknown
Maximum representative formation temperature (deg C):	100	____ Unknown
Time to reach maximum representative temperature (days):	21	____ Unknown
Duration of treatment at representative temperature (days):	15	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

X Mass of contaminant removed:

Via liquid pumping:	1000 gal	____ lb	____ kg	____ Unknown
In vapor stream:	6600 gal	____ lb	____ kg	____ Unknown
Total:	7600 gal	____ lb	____ kg	____ Unknown

Comments:
Energy delivery points: 6 injection/electric heating and 3 electric heating only. Temp of 100 deg C occurred during both steam passes. Timing: 11/92 to 7/93 then 11/93. 1st steam (continuous) 2/13/93 to 3/11/93. 2nd steam (cyclical) 6/2/93 to 6/30/93.

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0150

X Performance

Remediation Goal:

X In Groundwater:

MCLs: 1,2-DCA - 1 ug/L; xylene - 1750 ug/L; toluene - 100 ug/L; benzene - 1 ug/L

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater ____________________

Comment: ____________________

____ In Soil ____________________

Comment: ____________________

General comments on the thermal application:

ERH objective: raise clay layers 20 deg C so zone always above steam-temperatures in gravel zones; tests electrical safety; optimize heating method. Steam objective: Heat to steam temperature; optimize monitoring/control methods; evaluate treatment procedures and facility; quantify possible deleterious effects.

Lessons Learned

____

____ Energy

Total Energy Used: ____________ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____________

X Cost

Total Project Cost: 110 per cubic yard

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

____ Energy Cost: ____________ ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

General Site Information   Facility ID#: 0160

x File Analyzed By: JT x PD ____   Date: 9/13/2006

Type of treatment: x Conductive ____ Steam ____ ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating x Other: PCBS

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: 10/11/1997 End of Test: 11/17/1997 Duration: 37 days

Type of Site: ____ Non-DOD x DoD

x Facility Name: Mare Island Naval Shipyard

Address: Building 866, junction of Suisun Avenue and Mesa Road

City, State, Zip Code: Vallejo, CA

OU# or Site #: Site 11

x Primary point of contact: Ralph Baker

Organization: TerraTherm

Address: 10 Stevens Rd.

City, State, Zip Code: Fitchburg, MA 01420

Phone #: 978-343-0300 email: rbaker@terratherm.com

x Other contacts or vendors who worked on site ____ None

Point of contact: Richard Faris

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications x Other client

Organization: EFA West, NAVFAC (U.S. Navy)

Address: 900 Commodore Drive, Code 182

City, State, Zip Code: San Bruno, CA 94066

Phone #: 650-244-22704 email: jrfaris@efawest.navfac.navy.mil

QA/QC

x Characteristics of Interest

____ Good pre- and post-treatment groundwater data

x Good pre- and post-treatment soil data

x Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data — Facility ID#: 0160

x Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ x Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: x None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 4 composite

Number of relevant soil borings with post-treatment data: 4 composite

Number inside treatment zone: 4 composite Number outside treatment zone: ______

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	x Arclor 1254	None	100 mg/kg	None	0.01 mg/kg
	____ 1,1-dichloroethene	____ Napthalene	x Arclor 1260	None	10 mg/kg	None	0.01 mg/kg
	____ cis-1,2-dichloroethene	____ Benzene	x Total PCBs	None	100 mg/kg	None	0.01 mg/kg
	____ trans-1,2-dichloroethene	____ Tolune		None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane			None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	____ Vinyl Chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

Samples are composite samples at 0-1ft, 4-5 ft, 8-9 ft and 11-12 ft

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0160

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:

- x Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- at 4' Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:

- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- x Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 26 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	9			
	high value (ft bgs):	15			
	Unknown:				
x Flow direction		E			
x Horizontal hydraulic gradient (feet/foot):					x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low	1(10^-5) cm/sec			____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low				x Unknown
high				

Comments:

n~30%; moisture ~20%

Attachments:

Thermal Treatment - Design Facility ID#: 0160

x Thermal treatment: x Conductive ____

____ Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

x Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only x Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 10/11/1997 Duration: 37 days

x Hydraulic Control ____ Yes x No

x Treatment Cell Design:

Size of target zone (ft2):	323	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	14	____ Unknown	
Depth to top of target zone (ft bgs):	0.5	____ Unknown	
Thickness of target zone below water table (ft):	0	____ Unknown	
Number of energy delivery points:	12	____ Unknown	
Number of extraction points:	12	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	49	____ Unknown
Maximum representative formation temperature (deg C):	410	____ Unknown
Time to reach maximum representative temperature (days):	35	____ Unknown
Duration of treatment at representative temperature (days):	2	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

____ Mass of contaminant removed:

Via liquid pumping:		____ lb	____ kg	____ Unknown
In vapor stream:		____ lb	____ kg	____ Unknown
Total:		____ lb	____ kg	____ Unknown

Comments:

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0160

x Performance

Remediation Goal:

____ In Groundwater: ____

x In Soil:

PCBs > 2mg/kg by EPA regulations, but site specific at less than 1 mg/kg

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

s In Soil

Comment:

yes all samples were below 10 ug/kg

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information Facility ID#: 0180

X File Analyzed By: JT X PD ____ Date: ________

Type of treatment: ____ Conductive X Steam ____ ERH ____ Other: ________

Type of Contaminant: ____ Chlorinated Solvents X Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ________

Treatment Status: ____ Active X Post

Type of Test: X Pilot Test ___ Full Scale System

Start of Test: 5/14/1999 End of Test: 7/24/1999 Duration: 70 d

Type of Site: ____ Non-DOD X DoD

X Facility Name: NAS Alameda Point Site 5 Steam Pilot

Address: ________

City, State, Zip Code: Alameda, CA

OU# or Site #: Site 5

X Primary point of contact: Steven Peck

Organization: Navy

Address: 1455 Frazee Rd., Ste. 900

City, State, Zip Code: San Diego, CA 92108

Phone #: 619-532-0756 email: steven.peck@navy.mil

____ Other contacts or vendors who worked on site ____ None

Point of contact: ________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: ________

Address: ________

City, State, Zip Code: ________

Phone #: ________ email: ________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data - Page 1 Facility ID#: 0180

X Impacted Zone: Length (parallel to flow direction)(ft.): 375 Width (ft): 215 Thickness (ft): ____ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

X Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 42 Post-treatment: 42

Number of wells relative to treatment zone:

	In	Upgradient	Downgradient	Crossgradient
Pre-treatment	22			
Post-treatment	22			

X Soil Borings: Number of relevant soil borings with pre-treatment data: 8

Number of relevant soil borings with post-treatment data: 9

Number inside treatment zone: 8, 9 Number outside treatment zone: ____

X Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	X Trichloroethene - 7ft	50 mg/L	None	0.1 mg/L	0.01 mg/kg
	____ 1,1-dichloroethene	____ Napthalene	X Trichloroethene - 10ft	10 mg/L	None	0.05 mg/L	0.01 mg/kg
	____ cis-1,2-dichloroethene	____ Benzene	X Trichloroethene - 13ft	0.1 mg/L	None	0.05 mg/L	0.01 mg/kg
	____ trans-1,2-dichloroethene	____ Tolune	X Tetrachloroethene-7ft	0.5 mg/L	None	0.005 mg/L	0.01 mg/kg
	____ 1,1-dichloroethane	____ Ethylbenzene	X Tetrachloroethene-10ft	0.1 mg/L	None	0.001 mg/L	0.01 mg/kg
	____ 1,2-dichloroethane	____ m/p-xylene	X Tetrachloroethene-13ft	0.001 mg/L	None	0.001 mg/L	0.01 mg/kg
	____ 1,1,1-trichloroethane	____ o-xylene	X 1,1, TCA - 7ft	1 mg/L	None	0.005 mg/L	0.01 mg/kg
	____ 1,1,2-trichloroethane	____	X 1,1, TCA - 10ft	0.5 mg/L	None	0.005 mg/L	0.01 mg/kg
	____ 1,1,2,2-tetrachloroethane	____	X 1,1, TCA - 13ft	0.001 mg/L	None	0.005 mg/L	0.01 mg/kg
	____ Vinyl Chloride	____	X 1,1 DCA - 7ft	10 mg/L	None	0.01 mg/L	0.01 mg/kg
	____	____	X 1,1 DCA - 10ft	1 mg/L	None	0.005 mg/L	0.01 mg/kg
	____	____	X 1,1 DCA - 13ft	0.1 mg/L	None	0.001 mg/L	0.01 mg/kg
	____	____	X cis 1,2 DCA - 7ft	10 mg/L	None	0.05 mg/L	0.01 mg/kg
	____	____	X cis 1,2 DCA - 10ft	5 mg/L	None	0.01 mg/L	0.01 mg/kg
	____	____	X cis 1,2 DCA - 13ft	1 mg/L	None	0.1 mg/L	0.01 mg/kg
	____	____	____	None	None	None	None

Comments:

Chemicals of interest: Trichloroethene (TCE), Tetrachloroethene (PCE), 1,1,-Trichloroethane (1,1 TCA), 1,1-Dichloroethane (1,1 DCA), cis 1,2-Dichloroethane (cis 1,2 DCA), Trimethylbenzene (TMB), and Naphthalene (Naph). All average post treatment soils concentrations were 0.005 mg/Kg but were listed as 0.01 mg/Kg due spreadsheet constraints.

Attachments:

X Impacted Zone: Length (parallel to flow direction)(ft.): 375 Width (ft): 215 Thickness (ft): ____ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

X Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 42 Post-treatment: 42

Number of wells relative to treatment zone:

Pre-treatment	In: 22	Upgradient: ______	Downgradient: ______	Crossgradient: ______
Post-treatment	In: 22	Upgradient: ______	Downgradient: ______	Crossgradient: ______

X Soil Borings: Number of relevant soil borings with pre-treatment data: 8

Number of relevant soil borings with post-treatment data: 9

Number inside treatment zone: 8, 9 Number outside treatment zone: ________

____ Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	X Trimethylbenzene-7ft	0.5 mg/L	None	0.01 mg/L	0.01 mg/kg
	____ 1,1-dichloroethene	____ Napthalene	X Trimethylbenzene-10ft	0.5 mg/L	None	0.005 mg/L	0.01 mg/kg
	____ cis-1,2-dichloroethene	____ Benzene	X Trimethylbenzene-13ft	0.005 mg/L	None	0.005 mg/L	0.01 mg/kg
	____ trans-1,2-dichloroethene	____ Tolune	X Naphthalene - 7ft	0.1 mg/L	None	0.001 mg/L	0.01 mg/kg
	____ 1,1-dichloroethane	____ Ethylbenzene	X Naphthalene - 10ft	0.05 mg/L	None	0.001 mg/L	0.01 mg/kg
	____ 1,2-dichloroethane	____ m/p-xylene	X Naphthalene - 13ft	0.001 mg/L	None	0.05 mg/L	0.01 mg/kg
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Chemicals of interest: Trichloroethene (TCE), Tetrachloroethene (PCE), 1,1,-Trichloroethane (1,1 TCA), 1,1-Dichloroethane (1,1 DCA), cis 1,2-Dichloroethane (cis 1,2 DCA), Trimethylbenzene (TMB), and Naphthalene (Naph). All average post treatment soils concentrations were 0.005 mg/Kg but were listed as 0.01 mg/Kg due spreadsheet constraints.

Attachments:

Hydrogeologic Conceptual Model — Facility ID#: 0180

X Geology: — Zone / Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- X Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- X Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

X Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	5			
	high value (ft bgs):	7			
	Unknown:				
X Flow direction		Northeast			
X Horizontal hydraulic gradient (feet/foot):		0.004 to 0.006			____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

X K range (ft/day) — Measured using: ____ Slug Test ____ Laboratory ____ Field data

		Aquifer 1	Aquifer 2	Aquifer 3	
K range (ft/day)	low	0.737			____ Unknown
	high	4.819			

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

		Aquifer 1	Aquifer 2	Aquifer 3	
Transmissivity (ft2/day)	low	158.4			____ Unknown
	high				

Comments:

n=30%

Attachments:

Thermal Treatment - Design | Facility ID#: 0180

X Thermal treatment:
- ____ Conductive ____
- ____ Electrical Resistance ____
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- X Steam ____
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ____

X Type of Test: X Pilot test ____ Full-scale System

X Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- X Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

X Treatment Targe Zone: ____ Saturated only ____ Vadose only X Both (Saturated and Vadose zones)

X Start of Thermal Test: 5/14/1999 Duration: 70 d

X Hydraulic Control X Yes ____ No

X Treatment Cell Design:

Size of target zone (ft2):	2500	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	19	____ Unknown	
Depth to top of target zone (ft bgs):	0	____ Unknown	
Thickness of target zone below water table (ft):	12	____ Unknown	
Number of energy delivery points:	12	____ Unknown	
Number of extraction points:	3	____ Unknown	

X Temperature Profile:

Initial formation temperature (deg C):	20	____ Unknown
Maximum representative formation temperature (deg C):	90	____ Unknown
Time to reach maximum representative temperature (days):	25	____ Unknown
Duration of treatment at representative temperature (days):	35	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

X Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	____	____ lb	____ kg	____ Unknown
Total:	1943	____ lb	X kg	____ Unknown

Comments: ____

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0180

____ Performance

Remediation Goal: ____________________

____ In Groundwater: ____________________

____ In Soil: ____________________

Was the Remediation Goal Achieved:

____ In Groundwater ____________________

Comment: ____________________

____ In Soil ____________________

Comment: ____________________

General comments on the thermal application:

Objective: Determine if steam is a cost effective in-situ remedial technology to remove chlorinated hydrocarbon in the identified NAPL zone.

Lessons Learned

____

X Energy

Total Energy Used: ____________ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

X Total energy applied to treatment zone: 820,000 kw-hr ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____________________

____ Cost

Total Project Cost: ____________

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

____ Energy Cost: ____________ ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ____________________

____ Other Cost 2: ____________________

____ Other Cost 3: ____________________

General Site Information Facility ID#: 0190

x File Analyzed By: JT x PD ____ Date: 11/3/2006

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: 7/5/1994 End of Test: 9/23/1994 Duration: 80 days

Type of Site: ____ Non-DOD x DoD

x Facility Name: NAS Lemoore

Address: ____________

City, State, Zip Code: Lemoore, CA

OU# or Site #: Site 17

x Primary point of contact: Kent Udell

Organization: University of Utah

Address: 50 S Central Campus Dr. RM 2110 MEB

City, State, Zip Code: Salt Lake City, UT 84112

Phone #: 801-581-7934 email: udell@eng.utah.edu

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0190

x Impacted Zone: Length (parallel to flow direction)(ft.): 700 Width (ft): 366 Thickness (ft): 20 ___ Unknown

____ Impacted zone as defined by documentation

x Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 8 Post-treatment: 8

Number of wells relative to treatment zone:

	In:	Upgradient:	Downgradient:	Crossgradient:
Pre-treatment				
Post-treatment				

x Soil Borings: Number of relevant soil borings with pre-treatment data: 4

Number of relevant soil borings with post-treatment data: 4

Number inside treatment zone: ______ Number outside treatment zone: ______

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel		None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene		None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene		None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune		None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane	x JP-5		None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	____ Vinyl Chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0190

x Geology: Zone Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- x Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	16			
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

	low				____ Unknown
	high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

	low				____ Unknown
	high				

Comments:

Shallow sandy silt permeability - 4e-12 m2 deeper sandy silt permeability - 14e-12 m2

Attachments:

Thermal Treatment - Design

Facility ID#: 0190

x Thermal treatment:

____ Conductive ____

____ Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

x Steam ____

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

x Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 7/5/1994 Duration: 80 days

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	48125	____ Unknown	(275 x 175 ft)
Thickness of target zone (ft):	20	____ Unknown	
Depth to top of target zone (ft bgs):	5	____ Unknown	
Thickness of target zone below water table (ft):	9	____ Unknown	
Number of energy delivery points:	2	____ Unknown	
Number of extraction points:	8	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	25	____ Unknown
Maximum representative formation temperature (deg C):	100	____ Unknown
Time to reach maximum representative temperature (days):	10	____ Unknown
Duration of treatment at representative temperature (days):	70	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	9/23/1994	98
Formation temperature post-treatment monitoring event 1:	10/3/1994	74
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	75300 gal	____ lb	____ kg	____ Unknown
In vapor stream:	3179 gal	____ lb	____ kg	____ Unknown
Total:	78479 gal	____ lb	____ kg	____ Unknown

Comments: ____

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0190

____ Performance

Remediation Goal:

____ In Groundwater: ______

____ In Soil: ______

Was the Remediation Goal Achieved:

____ In Groundwater ______

Comment: ______

____ In Soil ______

Comment: ______

General comments on the thermal application:

______

Lessons Learned

______

____ Energy

Total Energy Used: ______ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ______ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ______ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ______

____ Cost

Total Project Cost: ______

____ Consultant Cost: ______

____ Thermal Vendor Cost: ______

____ Energy Cost: ______ ____ m^3 ____ yd^3

____ Other Cost 1: ______

____ Other Cost 2: ______

____ Other Cost 3: ______

____ Please note other cost: ____ Other Cost 1: ______

____ Other Cost 2: ______

____ Other Cost 3: ______

General Site Information Facility ID#: 0200

X File Analyzed By: JT X PD ____ Date: 11/8/2006

Type of treatment: ____ Conductive ____ Steam X ERH ____ Other: ____________

Type of Contaminant: X Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active X Post

Type of Test: X Pilot Test ___ Full Scale System

Start of Test: 6/21/2002 End of Test: 1/3/2003 Duration: 197 d

Type of Site: ____ Non-DOD X DoD

X Facility Name: NAS Alameda Point Site 5 ERH Pilot

Address: ____________

City, State, Zip Code: Alameda, CA

OU# or Site #: Site 5, Plume 5-1

X Primary point of contact: Steven Peck

Organization: Navy

Address: 1455 Frazee Rd., Ste. 900

City, State, Zip Code: San Diego, CA 92108

Phone #: 619-532-0786 email: steven.peck@navy.mil

X Other contacts or vendors who worked on site ____ None

Point of contact: John McGuire

Type: X Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: Shaw

Address: ____________

City, State, Zip Code: ____________

Phone #: 925-288-2220 email: john.mcguire@shawgrp.com

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data Facility ID#: 0200

X Impacted Zone: Length (parallel to flow direction)(ft.): 230 Width (ft): 130 Thickness (ft): 20 ___ Unknown

___ Impacted zone as defined by documentation

___ Alternative method for determining size of impacted zone (See source zone definition attachments)

___ Map attachment

X Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 15 Post-treatment: 15

Number of wells relative to treatment zone:

	In:	Upgradient:	Downgradient:	Crossgradient:
Pre-treatment	6	3	6	______
Post-treatment	6	3	6	______

___ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ____________ Number outside treatment zone: ____________

X Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	X Trichloroethene	___ Hexane	___ Creosote	1 mg/L	None	1 mg/L	None
	X Tetrachloroethene	___ Jet Fuel	___	0.05 mg/L	None	1 mg/L	None
	X 1,1-dichloroethene	___ Napthalene	___	1 mg/L	None	5 mg/L	None
	X cis-1,2-dichloroethene	___ Benzene	___	0.5 mg/L	None	10 mg/L	None
	X trans-1,2-dichloroethene	___ Tolune	___	0.05 mg/L	None	1 mg/L	None
	X 1,1-dichloroethane	___ Ethylbenzene	___	5 mg/L	None	5 mg/L	None
	X 1,2-dichloroethane	___ m/p-xylene	___	0.05 mg/L	None	1 mg/L	None
	X 1,1,1-trichloroethane	___ o-xylene	___	10 mg/L	None	50 mg/L	None
	X 1,1,2-trichloroethane	___	___	0.05 mg/L	None	10 mg/L	None
	___ 1,1,2,2-tetrachloroethane	___	___	None	None	None	None
	X Vinyl Chloride	___	___	0.1 mg/L	None	1 mg/L	None
	___	___	___	None	None	None	None
	___	___	___	None	None	None	None
	___	___	___	None	None	None	None
	___	___	___	None	None	None	None
	___	___	___	None	None	None	None
	___	___	___	None	None	None	None

Comments:

Attached sheet in file shows average concentrations for pre- and post-treatment at shallow, intermediate, and deep intervals. Only concentrations from shallow interval are shown in table. Pilot was within the source zone.

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0200

X Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- X Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- X Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

X Ground surface elevation based on wells in or adjacent to treatment zone: 10 ft amsl ____ Unknown

X Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	5			
	high value (ft bgs):	7			
	Unknown:				
X Flow direction		North to northeast			
X Horizontal hydraulic gradient (feet/foot):		0.004 to 0.006			____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

X K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

	low	0.737			____ Unknown
	high	4.819			

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

	low	158.4			____ Unknown
	high				

Comments:

S=0.007

Attachments:

Thermal Treatment - Design   Facility ID#: 0200

X Thermal treatment: ____ Conductive

X Electrical Resistance

____ 3 phase   X 6 phase   ____ AC power   ____ DC power

____ Steam

____ Steam   ____ Steam + air   ____ Steam + O2

____ Other (describe)

X Type of Test: X Pilot test   ____ Full-scale System

X Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

X Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

X Treatment Targe Zone: ____ Saturated only   ____ Vadose only   X Both (Saturated and Vadose zones)

X Start of Thermal Test: 6/21/2002   Duration: 197 d

X Hydraulic Control   X Yes   ____ No

X Treatment Cell Design:

Size of target zone (ft2): 1250   ____ Unknown   (40 x 40 ft)

Thickness of target zone (ft): 30   ____ Unknown

Depth to top of target zone (ft bgs): 0   ____ Unknown

Thickness of target zone below water table (ft): 23   ____ Unknown

Number of energy delivery points: 12   ____ Unknown

Number of extraction points: 16   ____ Unknown

X Temperature Profile:

Initial formation temperature (deg C): 25   ____ Unknown

Maximum representative formation temperature (deg C): 100   ____ Unknown

Time to reach maximum representative temperature (days): 169   ____ Unknown

Duration of treatment at representative temperature (days): 28   ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

X Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	____	____ lb	____ kg	____ Unknown
Total:	81	X lb	____ kg	____ Unknown

Comments:

Electrode spacing - 20 ft.   Vapor extraction well spacing - 15 ft.

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance | Facility ID#: 0200

X Performance

Remediation Goal:

X In Groundwater:

10,000 ug/L for contaminant.

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Determine variability of SPH at site 5 and generate design parameters for full-scale treatment. On July 25, 2002, double-wye 3-phase power configuration was rewired to a true 6-phase configuration.

Lessons Learned

Double-wye 3-phase configuration on electrodes cause power application to go awry.

X Energy

Total Energy Used: ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

X Total energy applied to treatment zone: 428874 kw hour ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information | | Facility ID#: 0215

X File Analyzed By: JT X PD ____ Date: 11/6/2006

Type of treatment: ____ Conductive ____ Steam X ERH ____ Other: ____________

Type of Contaminant: X Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active X Post

Type of Test: ____ Pilot Test X Full Scale System

Start of Test: 7/8/2004 End of Test: 11/5/2004 Duration: 120 d

Type of Site: ____ Non-DOD X DoD

X Facility Name: NAS Alameda Point Full Scale

Address: ____________

City, State, Zip Code: Alameda, CA

OU# or Site #: Site 5, Plume 5-1

X Primary point of contact: Steven Peck

Organization: Navy

Address: 1455 Frazee Rd., Ste. 900

City, State, Zip Code: San Diego, CA 92108

Phone #: 619-532-0786 email: steven.peck@mavy.mil

X Other contacts or vendors who worked on site ____ None

Point of contact: John McGuire

Type: X Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: Shaw

Address: ____________

City, State, Zip Code: ____________

Phone #: 925-288-2220 email: john.mcguire@shawgrp.com

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data - Page 1 Facility ID#: 0215

X Impacted Zone: Length (parallel to flow direction)(ft.): 230 Width (ft): 130 Thickness (ft): 20 ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

X Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 17 Post-treatment: 17

Number of wells relative to treatment zone:

	In:	Upgradient:	Downgradient:	Crossgradient:
Pre-treatment	17	______	______	______
Post-treatment	17	______	______	______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

X Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	X 111 TCA - Shallow	10 mg/L	None	0.001 mg/L	None
	____ 1,1-dichloroethene	____ Napthalene	X 112 TCA - Shallow	0.05 mg/L	None	0.001 mg/L	None
	____ cis-1,2-dichloroethene	____ Benzene	X 11 DCA - Shallow	10 mg/L	None	0.001 mg/L	None
	____ trans-1,2-dichloroethene	____ Tolune	X 11 DCE - Shallow	5 mg/L	None	0.005 mg/L	None
	____ 1,1-dichloroethane	____ Ethylbenzene	X 12 DCA - Shallow	0.05 mg/L	None	0.001 mg/L	None
	____ 1,2-dichloroethane	____ m/p-xylene	X cis-12 DCE - Shallow	1 mg/L	None	0.01 mg/L	None
	____ 1,1,1-trichloroethane	____ o-xylene	X PCE - Shallow	0.05 mg/L	None	0.01 mg/L	None
	____ 1,1,2-trichloroethane	____ ________	X trans-12 DCE - Shallow	0.1 mg/L	None	0.005 mg/L	None
	____ 1,1,2,2-tetrachloroethane	____ ________	X TCE - Shallow	1 mg/L	None	0.1 mg/L	None
	____ Vinyl Chloride	____ ________	X VC - Shallow	1 mg/L	None	0.001 mg/L	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None

Comments:

Attachments:

X Impacted Zone: Length (parallel to flow direction)(ft.): 230 Width (ft): 130 Thickness (ft): 20 ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

X Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 17 Post-treatment: 17

Number of wells relative to treatment zone:

Pre-treatment In: 17 Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: 17 Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

X Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	X 111 TCA - Intermed.	0.001 mg/L	None	0.001 mg/L	None
	____ 1,1-dichloroethene	____ Napthalene	X 112 TCA - Intermed.	0.001 mg/L	None	0.001 mg/L	None
	____ cis-1,2-dichloroethene	____ Benzene	X 11 DCA - Intermediate	0.05 mg/L	None	0.001 mg/L	None
	____ trans-1,2-dichloroethene	____ Tolune	X 11 DCE - Intermediate	0.001 mg/L	None	0.001 mg/L	None
	____ 1,1-dichloroethane	____ Ethylbenzene	X 12 DCA - Intermediate	0.001 mg/L	None	0.001 mg/L	None
	____ 1,2-dichloroethane	____ m/p-xylene	X cis-12 DCE - Intermed.	0.001 mg/L	None	0.01 mg/L	None
	____ 1,1,1-trichloroethane	____ o-xylene	X PCE - Intermediate	0.001 mg/L	None	0.001 mg/L	None
	____ 1,1,2-trichloroethane	____ ________	X trans-12 DCE - Inter.	0.001 mg/L	None	0.001 mg/L	None
	____ 1,1,2,2-tetrachloroethane	____ ________	X TCE - Inermediate	0.001 mg/L	None	0.001 mg/L	None
	____ Vinyl Chloride	____ ________	X VC - Intermediate	0.005 mg/L	None	0.001 mg/L	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model — Facility ID#: 0215

X Geology:

Zone	Unconsolidated Sediments	
Vadose Zone:	____	Relatively homogeneous and permeable unconsolidated sediments
	____	Relatively homogeneous and impermeable unconsolidated sediments
	X	Largely permeable sediments with inter-bedded lenses of lower permeability material
	____	Largely impermeable sediments with inter-bedded layers of higher permeability material
	____	Competent, but fractured bedrock (i.e. crystalline rock)
	____	Weathered bedrock, limestone, sandstone
Saturated Zone:	____	Relatively homogeneous and permeable unconsolidated sediments
	____	Relatively homogeneous and impermeable unconsolidated sediments
	X	Largely permeable sediments with inter-bedded lenses of lower permeability material
	____	Largely impermeable sediments with inter-bedded layers of higher permeability material
	____	Competent, but fractured bedrock (i.e. crystalline rock)
	____	Weathered bedrock, limestone, sandstone

X Ground surface elevation based on wells in or adjacent to treatment zone: 10 ft amsl ____ Unknown

X Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ X Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	507			
	high value (ft bgs):				
	Unknown:				
X Flow direction		N to NE			
X Horizontal hydraulic gradient (feet/foot):		0.004 to 0.006			____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

X K range (ft/day) — Measured using: ____ Slug Test ____ Laboratory ____ Field data

		Aquifer 1	Aquifer 2	Aquifer 3	
K range (ft/day)	low	0.737			____ Unknown
	high	4.819			

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

		Aquifer 1	Aquifer 2	Aquifer 3	
Transmissivity (ft2/day)	low	158.4			____ Unknown
	high				

Comments:

S=0.007

Attachments:

Thermal Treatment - Design Facility ID#: 0215

X Thermal treatment: ____ Conductive ____

X Electrical Resistance ____

____ 3 phase X 6 phase ____ AC power ____ DC power

____ Steam ____

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

X Type of Test: ____ Pilot test X Full-scale System

X Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

X Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

X Treatment Targe Zone: ____ Saturated only ____ Vadose only X Both (Saturated and Vadose zones)

X Start of Thermal Test: 7/8/2004 Duration: 120 d

X Hydraulic Control X Yes ____ No

X Treatment Cell Design:

Size of target zone (ft2):	14520	____ Unknown	(____ x ____ ft)
Thickness of target zone (ft):	20	____ Unknown	
Depth to top of target zone (ft bgs):	0	____ Unknown	
Thickness of target zone below water table (ft):	13	____ Unknown	
Number of energy delivery points:	30 electrodes *	____ Unknown	
Number of extraction points:	____	____ Unknown	

X Temperature Profile:

Initial formation temperature (deg C):	220	____ Unknown
Maximum representative formation temperature (deg C):	92	____ Unknown
Time to reach maximum representative temperature (days):	90	____ Unknown
Duration of treatment at representative temperature (days):	30	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

X Mass of contaminant removed:

Via liquid pumping:	0.18	X lb	____ kg	____ Unknown
In vapor stream:	3011.28	X lb	____ kg	____ Unknown
Total:	3011.46	X lb	____ kg	____ Unknown

Comments:

Attachments: * 30 electrodes each with 4 sheet piles.

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0215

X Performance

Remediation Goal:

X In Groundwater:

Total concentrations of the COCs below 10,000 ppb.

____ In Soil: ____

Was the Remediation Goal Achieved:

x In Groundwater

Comment:

yes

____ In Soil

Comment: ____

General comments on the thermal application:

Target temp of 92 deg C

Lessons Learned

____

X Energy

Total Energy Used: ____ ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

X Total energy applied to treatment zone: 1455923 kw-hr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information   Facility ID#: 0213

x File Analyzed By: JT x PD ____   Date: 10/26/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: x Active ___ Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: ____________ End of Test: ____________ Duration: ________

Type of Site: ____ Non-DOD x DoD

x Facility Name: NAS Alameda

Address: ____________

City, State, Zip Code: Alameda, CA

OU# or Site #: Site 5-3

x Primary point of contact: John McGuire

Organization: Shaw

Address: ____________

City, State, Zip Code: ____________

Phone #: 925-288-2220 email: john.mcguire@shawgrp.com

x Other contacts or vendors who worked on site ____ None

Point of contact: Steven Peck

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications x Other ________

Organization: Navy

Address: 1455 Frazee Road, Suite 900

City, State, Zip Code: San Diego, CA 92108

Phone #: 619-532-0786 email: steven.peck@navy.mil

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data Facility ID#: 0213

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

____ Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____ ________	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ________	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ________	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ________	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ________	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ________	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ________	None	None	None	None
	____ 1,1,2-trichloroethane	____ ________	____ ________	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ________	____ ________	None	None	None	None
	____ Vinyl Chloride	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None

Comments:

Attachments:

x Geology:

Zone	Unconsolidated Sediments
Vadose Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	x Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone
Saturated Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	x Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 0213

x Thermal treatment: ____ Conductive ________________

x Electrical Resistance ________________

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ________________

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ________________

x Type of Test: ____ Pilot test x Full-scale System

____ Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ________________ Duration: ________________

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2): ________________ ____ Unknown (___ x ___ ft)

Thickness of target zone (ft): ________________ ____ Unknown

Depth to top of target zone (ft bgs): ________________ ____ Unknown

Thickness of target zone below water table (ft): ________________ ____ Unknown

Number of energy delivery points: ________________ ____ Unknown

Number of extraction points: ________________ ____ Unknown

____ Temperature Profile:

Initial formation temperature (deg C): ________________ ____ Unknown

Maximum representative formation temperature (deg C): ________________ ____ Unknown

Time to reach maximum representative temperature (days): ________________ ____ Unknown

Duration of treatment at representative temperature (days): ________________ ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

____ Mass of contaminant removed:

Via liquid pumping: ________________ ____ lb ____ kg ____ Unknown

In vapor stream: ________________ ____ lb ____ kg ____ Unknown

Total: ________________ ____ lb ____ kg ____ Unknown

Comments: ________________

Attachments: ________________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0213

____ Performance

Remediation Goal:

____ In Groundwater:

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost:

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information | Facility ID#: 0215

x File Analyzed By: JT x PD ____ | Date: 10/26/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: x Active ___ Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: ____________ End of Test: ____________ Duration: ________

Type of Site: ____ Non-DOD x DoD

x Facility Name: NAS Alameda

Address: ____________

City, State, Zip Code: Alameda, CA

OU# or Site #: Site 4-2

x Primary point of contact: John McGuire

Organization: Shaw

Address: ____________

City, State, Zip Code: ____________

Phone #: 925-288-2220 email: john.mcguire@shawgrp.com

x Other contacts or vendors who worked on site ____ None

Point of contact: Steven Peck

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications x Other ________

Organization: Navy

Address: 1455 Frazee Road, Suite 900

City, State, Zip Code: San Diego, CA 92108

Phone #: 619-532-0786 email: steven.peck@navy.mil

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0215

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	x Tetrachloroethene	____ Jet Fuel		None	None	None	None
	x 1,1-dichloroethene	____ Napthalene		100 mg/L	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene		None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune		None	None	None	None
	x 1,1-dichloroethane	____ Ethylbenzene		None	None	None	None
	x 1,2-dichloroethane	____ m/p-xylene		None	None	None	None
	x 1,1,1-trichloroethane	____ o-xylene		100 mg/L	None	None	None
	____ 1,1,2-trichloroethane			None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	____ Vinyl Chloride			None	None	None	None
	x 1,2-DCE			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model — Facility ID#: 0215

x Geology: — Zone: Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	7			
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) — Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): — Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 0215

x Thermal treatment:
- ____ Conductive ____________
- x Electrical Resistance ____________
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- ____ Steam ____________
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ____________

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

____ Start of Thermal Test: ____________ Duration: ____________

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	34400	____ Unknown	(____ x ____ ft)
Thickness of target zone (ft):	31	____ Unknown	
Depth to top of target zone (ft bgs):	5	____ Unknown	
Thickness of target zone below water table (ft):	29	____ Unknown	
Number of energy delivery points:	92	____ Unknown	
Number of extraction points:	92	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	____________	____ Unknown
Maximum representative formation temperature (deg C):	____________	____ Unknown
Time to reach maximum representative temperature (days):	____________	____ Unknown
Duration of treatment at representative temperature (days):	____________	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____________	____________
Formation temperature post-treatment monitoring event 1:	____________	____________
Duration of post-treatment monitoring (days):	____________	____________

____ Mass of contaminant removed:

Via liquid pumping:	____________	____ lb	____ kg	____ Unknown
In vapor stream:	____________	____ lb	____ kg	____ Unknown
Total:	____________	____ lb	____ kg	____ Unknown

Comments:
Treating - 39800 yd3
All information is based on the preliminary design

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0215

x Performance

Remediation Goal:

x In Groundwater:

Screening analytes in groundwater to below 10 mg/L

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information   Facility ID#: 0230

x File Analyzed By: JT x PD x   Date: 9/13/2006

Type of treatment: x Conductive ____ Steam ____ ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating x Other: PCBs

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: Sep-98 End of Test: Mar-99 Duration: ________

Type of Site: ____ Non-DOD x DoD

x Facility Name: Naval Facility Centerville Beach in Former Transformer Bldg #2

Address: ____________________

City, State, Zip Code: Ferndale, CA

OU# or Site #: Site 6

x Primary point of contact: Ralph Baker

Organization: TerraTherm

Address: 10 Stevens Rd.

City, State, Zip Code: Fitchburg, MA 01420

Phone #: 978-343-0300 email: rbaker@terratherm.com

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: ____________________

Address: ____________________

City, State, Zip Code: ____________________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

x Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data | Facility ID#: 0230

x Impacted Zone: Length (parallel to flow direction)(ft.): 30 Width (ft): 40 Thickness (ft): 15 Unknown

x Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: x None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 2

Number of relevant soil borings with post-treatment data: 16

Number inside treatment zone: 18 Number outside treatment zone: ______

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	x PCB Aroclor 1254	None	500 mg/kg	None	0.1 mg/kg
	____ 1,1-dichloroethene	____ Napthalene		None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene		None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune		None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane			None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	____ Vinyl Chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

Impacted zone limited to 20 ft bgs

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0230

x Geology:

Zone	Unconsolidated Sediments	
Vadose Zone:	____	Relatively homogeneous and permeable unconsolidated sediments
	____	Relatively homogeneous and impermeable unconsolidated sediments
	x	Largely permeable sediments with inter-bedded lenses of lower permeability material
	____	Largely impermeable sediments with inter-bedded layers of higher permeability material
	____	Competent, but fractured bedrock (i.e. crystalline rock)
	____	Weathered bedrock, limestone, sandstone
Saturated Zone:	____	Relatively homogeneous and permeable unconsolidated sediments
	____	Relatively homogeneous and impermeable unconsolidated sediments
	x	Largely permeable sediments with inter-bedded lenses of lower permeability material
	____	Largely impermeable sediments with inter-bedded layers of higher permeability material
	____	Competent, but fractured bedrock (i.e. crystalline rock)
	____	Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl x Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	99			
	high value (ft bgs):	145			
	Unknown:				
Flow direction		west			
Horizontal hydraulic gradient (feet/foot):					x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design Facility ID#: 0230

x Thermal treatment: x Conductive
____ Electrical Resistance
____ 3 phase ____ 6 phase ____ AC power ____ DC power
____ Steam
____ Steam ____ Steam + air ____ Steam + O2
____ Other (describe)

x Type of Test: Pilot test x Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only x Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: Oct-98 Duration: 4 months

x Hydraulic Control ____ Yes x No

x Treatment Cell Design:

Size of target zone (ft2):	1200	____ Unknown	(40 x 30 ft)
Thickness of target zone (ft):	15	____ Unknown	
Depth to top of target zone (ft bgs):	3	____ Unknown	
Thickness of target zone below water table (ft):	0	____ Unknown	
Number of energy delivery points:	57	____ Unknown	
Number of extraction points:	17	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	____	x Unknown
Maximum representative formation temperature (deg C):	360	____ Unknown
Time to reach maximum representative temperature (days):	120	____ Unknown
Duration of treatment at representative temperature (days):	____	x Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	Mar-99	360
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	____	____ lb	____ kg	____ Unknown
Total:	402	x lb	____ kg	____ Unknown

Comments:
Minimal temperature data Heaters on 6 ft spacings; vacuum heater wells spacing = 10 ft

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0230

x Performance

Remediation Goal:

____ In Groundwater: ____

x In Soil: 1. Remove PCBs to at or below applicable regulator remedial goal. Remedial goal of less than 1.0 ppm or mg/kg DW and 2. Dioxins and furans: 2,3,7,8-TCDD TEQ < 1.0 ppb

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

x In Soil

Comment:

1.0 ppm or mg/kg DW was achieved in target treamtne area

General comments on the thermal application:

Site characterization $18,500; mobilization $30,000; Construction $210,124; Remediation $107,864; Site (general) $203,750; Demobilization $30,113 all at $284.15/ton

Lessons Learned

Check for unidentified storm drains

____ Energy

Total Energy Used: ____ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

x Cost

Total Project Cost: 600,351

____ Consultant Cost: ____

x Thermal Vendor Cost: 600,351

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information Facility ID#: 0235

x File Analyzed By: JT x PD ____ Date: 10/31/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: ____________ End of Test: ____________ Duration: ________

Type of Site: x Non-DOD ____ DoD

x Facility Name: Former Union Pacific Railroad

Address: ____________

City, State, Zip Code: Long Beach, CA

OU# or Site #: ____________

x Primary point of contact: Jay Dablow

Organization: ERM

Address: 3 Hutton Centre, Suite 600

City, State, Zip Code: Santa Ana, CA 92707

Phone #: 714-430-1476 email: jay.dablow@erm.com

x Other contacts or vendors who worked on site ____ None

Point of contact: Jim Levy

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: Union Pacific Railroad Company

Address: ____________

City, State, Zip Code: Rosedale, CA

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0235

____ Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ______

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: ______ Number outside treatment zone: ______

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel		None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene		None	None	None	None
	____ cis-1,2-dichloroethene	x Benzene		None	None	None	None
	____ trans-1,2-dichloroethene	x Tolune		None	None	None	None
	____ 1,1-dichloroethane	x Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	x m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	x o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane	x trimethylbenzenes		None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	____ Vinyl Chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0235

x Geology: Zone Unconsolidated Sediments

Vadose Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
x Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

Saturated Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
x Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	10			
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 0235

x Thermal treatment:
- ____ Conductive ____________
- ____ Electrical Resistance ____________
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- x Steam SVE enhanced steam in jection
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ____________

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ____________ Duration: ____________

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2):	____________	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	____________	____ Unknown	
Depth to top of target zone (ft bgs):	____________	____ Unknown	
Thickness of target zone below water table (ft):	____________	____ Unknown	
Number of energy delivery points:	____________	____ Unknown	
Number of extraction points:	____________	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	____________	____ Unknown
Maximum representative formation temperature (deg C):	____________	____ Unknown
Time to reach maximum representative temperature (days):	____________	____ Unknown
Duration of treatment at representative temperature (days):	____________	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____________	____________
Formation temperature post-treatment monitoring event 1:	____________	____________
Duration of post-treatment monitoring (days):	____________	____________

x Mass of contaminant removed:

Via liquid pumping:	____________	____ lb	____ kg	____ Unknown
In vapor stream:	____________	____ lb	____ kg	____ Unknown
Total:	60000	x lb	____ kg	____ Unknown

Comments: ____________

Attachments: ____________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0235

____ Performance

Remediation Goal:

____ In Groundwater:

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information — Facility ID#: 0238

x File Analyzed By: JT x PD ____ — Date: 10/30/2006

Type of treatment: x Conductive ____ Steam ____ ERH ____ Other: ____

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 6/13/2005 — End of Test: 7-Oct — Duration: 116 d

Type of Site: x Non-DOD ____ DoD

x Facility Name: Richmond, CA

Address: ____

City, State, Zip Code: Richmond, CA

OU# or Site #: Terminal 1 site

x Primary point of contact: Ralph Baker

Organization: TerraTherm

Address: 10 Stevens Road

City, State, Zip Code: Fitchburg, MA 01420

Phone #: 978-343-0300 — email: rbaker@terratherm.com

x Other contacts or vendors who worked on site ____ None

Point of contact: Frank Szerdy

Type: x Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____

Organization: Geomatrix Consultants, Inc

Address: 210 Webster St. 12th Fl.

City, State, Zip Code: Oakland, CA 94612

Phone #: 510-663-4100 — email: Fserdy@geomatrix.com

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data | Facility ID#: 0238

x Impacted Zone: Length (parallel to flow direction)(ft.): 65 Width (ft): 150 Thickness (ft): 20 ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: X None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 17

Number of relevant soil borings with post-treatment data: 64

Number inside treatment zone: 64 Number outside treatment zone: ________

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	None	1 mg/kg	None	0.01 mg/kg
	x Tetrachloroethene	____ Jet Fuel	____	None	50 mg/kg	None	0.01 mg/kg
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	x cis-1,2-dichloroethene	____ Benzene	____	None	10 mg/kg	None	0.05 mg/kg
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	x Vinyl Chloride	____	____	None	1 mg/kg	None	0.01 mg/kg
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0238

x Geology: Zone: Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ~15ft ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? X No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	2			
	high value (ft bgs):	4			
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low	0.0003			____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design　　Facility ID#: 0238

x Thermal treatment: x Conductive In Situ Thermal Desorption

____ Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

x Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 6/13/2005　　Duration: 116 d

x Hydraulic Control ____ Yes X No

x Treatment Cell Design:

Size of target zone (ft2):	9450	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	20	____ Unknown	
Depth to top of target zone (ft bgs):	0	____ Unknown	
Thickness of target zone below water table (ft):	18	____ Unknown	
Number of energy delivery points:	138	____ Unknown	
Number of extraction points:	12	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	17	____ Unknown
Maximum representative formation temperature (deg C):	100	____ Unknown
Time to reach maximum representative temperature (days):	110	____ Unknown
Duration of treatment at representative temperature (days):	6	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	10/8/2005	100
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

Via liquid pumping:		____ lb	____ kg	____ Unknown
In vapor stream:	6000	X lb	____ kg	____ Unknown
Total:		____ lb	____ kg	____ Unknown

Comments:

12 ft spacing of heater wells

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0238

x Performance

Remediation Goal:

____ In Groundwater: ________________________________

X In Soil:

PCE =2 mg/kg TCE = 2mg/kg DCE=17 mg/kg VC=0.23 mg/kg

Was the Remediation Goal Achieved:

____ In Groundwater ________________________________

Comment: ________________________________

X In Soil

Comment:

PCE = 0.012 mg/kg TCE = ND DCE = 0.065 mg/kg VC = 0.005 mg/kg

General comments on the thermal application:

____

Lessons Learned

____

x Energy

Total Energy Used: 2200000 ____ kWhr ____ $kWhr/m^3$ ~300 $kWhr/yd^3$

____ Total energy applied to treatment zone: ____________ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____________ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy: ________________________________

x Cost

Total Project Cost:

____ Consultant Cost: ____________

x Thermal Vendor Cost: 1,770,000

x Energy Cost: 400,000 ____ m^3 $310 yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ________________________________

____ Other Cost 2: ________________________________

____ Other Cost 3: ________________________________

General Site Information Facility ID#: 0240

x File Analyzed By: JT x PD ____ Date: 9/22/2006

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: 9/11/1999 End of Test: 4/14/2000 Duration: 113 days

Type of Site: ____ Non-DOD x DoD

x Facility Name: North Island NAS (Pilot)

Address: ____________

City, State, Zip Code: Coronado, CA

OU# or Site #: IR Site 9 Area 1

x Primary point of contact: Michael Pound

Organization: Navy

Address: ____________

City, State, Zip Code: ____________

Phone #: 619-556-9901 email: michael.pound@navy.mil

x Other contacts or vendors who worked on site ____ None

Point of contact: Richard Wong

Type: x Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: Shaw

Address: ____________

City, State, Zip Code: ____________

Phone #: 619-437-6328 x314 email: richard.wong@shawgrp.com

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0240

x Impacted Zone: Length (parallel to flow direction)(ft.): 1000 Width (ft): 500 Thickness (ft): 12 ___ Unknown

____ Impacted zone as defined by documentation

x Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 3 Post-treatment: ________

Number of wells relative to treatment zone:

	In:	Upgradient:	Downgradient:	Crossgradient:
Pre-treatment	3	______	______	______
Post-treatment	______	______	______	______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ________________

Number of relevant soil borings with post-treatment data: ________________

Number inside treatment zone: ____________ Number outside treatment zone: ____________

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	x Tetrachloroethene	____ Jet Fuel	____ ________	None	None	None	None
	x 1,1-dichloroethene	____ Napthalene	____ ________	None	None	None	None
	x cis-1,2-dichloroethene	x Benzene	____ ________	None	None	None	None
	____ trans-1,2-dichloroethene	x Tolune	____ ________	None	None	None	None
	x 1,1-dichloroethane	x Ethylbenzene	____ ________	None	None	None	None
	x 1,2-dichloroethane	x m/p-xylene	____ ________	None	None	None	None
	x 1,1,1-trichloroethane	x o-xylene	____ ________	None	None	None	None
	x 1,1,2-trichloroethane	____ ________	____ ________	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ________	____ ________	None	None	None	None
	x Vinyl Chloride	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None

Comments: ________________

Attachments: ________________

Hydrogeologic Conceptual Model — Facility ID#: 0240

x Geology:

Zone	Unconsolidated Sediments
Vadose Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	x Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone
Saturated Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	x Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 10 (aMLLW) ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	8			
	high value (ft bgs):	10			
	Unknown:				
x Flow direction		WNW			
x Horizontal hydraulic gradient (feet/foot):		0.0004 to 0.0007			____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

x K range (ft/day) — Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	0.052			____ Unknown
high	0.091			

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Comments:

aMLLW - above mean low level sea water

Attachments:

Thermal Treatment - Design Facility ID#: 0240

x Thermal treatment:
- ____ Conductive ______
- ____ Electrical Resistance ______
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- x Steam ______
  - x Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ______

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 9/11/1999 Duration: 113 days

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	7853	____ Unknown (___ x ___ ft)
Thickness of target zone (ft):	8	____ Unknown
Depth to top of target zone (ft bgs):	6	____ Unknown
Thickness of target zone below water table (ft):	4	____ Unknown
Number of energy delivery points:	6	____ Unknown
Number of extraction points:	12	____ Unknown

x Temperature Profile:

Initial formation temperature (deg C):	21	____ Unknown
Maximum representative formation temperature (deg C):	104	____ Unknown
Time to reach maximum representative temperature (days):	20	____ Unknown
Duration of treatment at representative temperature (days):	49	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	______	______
Formation temperature post-treatment monitoring event 1:	______	______
Duration of post-treatment monitoring (days):	______	______

x Mass of contaminant removed:

Via liquid pumping:	14600	x lb	____ kg	____ Unknown
In vapor stream:	14000	x lb	____ kg	____ Unknown
Total:	28600	x lb	____ kg	____ Unknown

Comments: ______

Attachments: ______

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0240

x Performance

Remediation Goal:

x In Groundwater:

See how long and if could reach 170F, the boiling point of TCE

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information | Facility ID#: 0245

x File Analyzed By: JT x PD ____ | Date: 9/22/2006

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ________

Type of Contaminant: x Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: 9/11/1999 End of Test: 4/14/2000 Duration: 113 days

Type of Site: ____ Non-DOD x DoD

x Facility Name: North Island NAS

Address: ________

City, State, Zip Code: Coronado, CA

OU# or Site #: IR Site 9 Area 1

x Primary point of contact: Michael Pound

Organization: Navy

Address: ________

City, State, Zip Code: ________

Phone #: 619-556-9901 email: michael.pound@navy.mil

x Other contacts or vendors who worked on site ____ None

Point of contact: Richard Wong

Type: x Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: Shaw

Address: ________

City, State, Zip Code: ________

Phone #: 619-437-6328 x314 email: richard.wong@shawgrp.com

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

x Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

x Hydraulic Conductivity information

General Site Assessment Data — Facility ID#: 0245

x Impacted Zone: Length (parallel to flow direction)(ft.): 1000 Width (ft): 500 Thickness (ft): 12 ___ Unknown

____ Impacted zone as defined by documentation

x Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 8 Post-treatment: 8

Number of wells relative to treatment zone:

Pre-treatment In: 8 Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 20

Number of relevant soil borings with post-treatment data: 126

Number inside treatment zone: 20/126 Number outside treatment zone: 0

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	None	5,000 mg/kg	None	5 mg/kg
	x Tetrachloroethene	____ Jet Fuel	____	None	100 mg/kg	None	5 mg/kg
	x 1,1-dichloroethene	____ Napthalene	____	None	500 mg/kg	None	0.1 mg/kg
	x cis-1,2-dichloroethene	____ Benzene	____	None	100 mg/kg	None	0.5 mg/kg
	____ trans-1,2-dichloroethene	x Tolune	____	None	500 mg/kg	None	5 mg/kg
	x 1,1-dichloroethane	____ Ethylbenzene	____	None	100 mg/kg	None	0.1 mg/kg
	x 1,2-dichloroethane	____ m/p-xylene	____	None	100 mg/kg	None	0.1 mg/kg
	x 1,1,1-trichloroethane	____ o-xylene	____	None	1,000 mg/kg	None	0.1 mg/kg
	x 1,1,2-trichloroethane	____	____	None	100 mg/kg	None	0.1 mg/kg
	____ 1,1,2,2-tetrachloroethane	x NFSO	____	None	None	None	None
	x Vinyl Chloride	____	____	None	100 mg/kg	None	0.1 mg/kg
	____	x Benzene	____	None	100 mg/kg	None	0.5 mg/kg
	____	x MTBE	____	None	100 mg/kg	None	0.1 mg/kg
	____	x Ethylbenzene	____	None	100 mg/kg	None	1 mg/kg
	____	x MeCl2	____	None	100 mg/kg	None	0.1 mg/kg
	____	x 4-methyl-2-pentanone	____	None	1,000 mg/kg	None	0.5 mg/kg
	____	x Total xylenes	____	None	100 mg/kg	None	10 mg/kg

Comments:

See attached sheets for the numbers

Attachments:

Hydrogeologic Conceptual Model | Facility ID#: 0245

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 10 (aMLLW) ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	8			
	high value (ft bgs):	10			
	Unknown:				
x Flow direction		WNW			
x Horizontal hydraulic gradient (feet/foot):		0.0004 to 0.0007			____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

x K range (ft/day) — Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	0.052			____ Unknown
high	0.091			

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Comments:

aMLLW - above mean low level sea water

Attachments:

Thermal Treatment - Design   Facility ID#: 0245

x Thermal treatment: ____ Conductive ____

____ Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

x Steam ____

x Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:

- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 10/21/2002   Duration: 32 months

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	595000	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	10	____ Unknown	
Depth to top of target zone (ft bgs):	6	____ Unknown	
Thickness of target zone below water table (ft):	6	____ Unknown	
Number of energy delivery points:	34	____ Unknown	
Number of extraction points:	70	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	21	____ Unknown
Maximum representative formation temperature (deg C):	104	____ Unknown
Time to reach maximum representative temperature (days):	20	____ Unknown
Duration of treatment at representative temperature (days):	49	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

Via liquid pumping:	278223	x lb	____ kg	____ Unknown
In vapor stream:	86600	x lb	____ kg	____ Unknown
Total:	364823	x lb	____ kg	____ Unknown

Comments:

Total volume treated of 56,000yd3

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0245

x Performance

Remediation Goal: ____________________

____ In Groundwater: ____________________

x In Soil: Reduce VOC mass in shallow subsurface soils thereby reducing exposure risks to nearby human and ecological receptors

Was the Remediation Goal Achieved:

____ In Groundwater ____________________

Comment: ____________________

x In Soil

Comment:

yes

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____________ ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____________ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____________ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy: ____________________

____ Cost

Total Project Cost: ____________

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

____ Energy Cost: ____________ ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ____________________

____ Other Cost 2: ____________________

____ Other Cost 3: ____________________

General Site Information Facility ID#: 0250

x File Analyzed By: JT x PD ____ Date: 10/18/2006

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: Sep-91 End of Test: Sep-93 Duration: 746 days

Type of Site: ____ Non-DOD ____ DoD

x Facility Name: Rainbow Disposal

Address: ____________

City, State, Zip Code: Huntington Beach, CA

OU# or Site #: ____________

x Primary point of contact: Paul de Percin

Organization: EPA SITE

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

x Other contacts or vendors who worked on site ____ None

Point of contact: Nancy Olson Martin

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: 951-782-4497 email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data   Facility ID#: 0250

x Impacted Zone: Length (parallel to flow direction)(ft.): below   Width (ft): ______   Thickness (ft): ______   ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: x None

Pre-treatment: ______   Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______
Post-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 12

Number of relevant soil borings with post-treatment data: 24

Number inside treatment zone: 12 / 18   Number outside treatment zone: 0 / 6

x Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents:	Petroleum Hydrocarbons:	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	x TPH	None	5,000 mg/kg	None	5,000 mg/kg
	____ 1,1-dichloroethene	____ Napthalene	x TRPH	None	None	None	1,000 mg/kg
	____ cis-1,2-dichloroethene	x Benzene		None	None	None	None
	____ trans-1,2-dichloroethene	x Tolune		None	None	None	None
	____ 1,1-dichloroethane	x Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	x m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	x o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane			None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	____ Vinyl Chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

70,000 to 135,000 gallons of diesel spilled

Impacted area of 2.3 acres

TPH pre concentration - 3670 mg/kg post - 3190 mg/kg   TRPH post concentration 2083 mg/kg

Attachments:

Hydrogeologic Conceptual Model | Facility ID#: 0250

x Geology: Zone | Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl   x Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No   ____ Yes (number): ____________   x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	25			
	high value (ft bgs):	40			
	Unknown:				
____ Flow direction					
x Horizontal hydraulic gradient (feet/foot):					x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 0250

x Thermal treatment:
- ____ Conductive ______
- ____ Electrical Resistance ______
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- x Steam ______
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ______

x Type of Test: ____ Pilot test   x Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only   ____ Vadose only   x Both (Saturated and Vadose zones)

x Start of Thermal Test: Sep-91   Duration: 746 days

x Hydraulic Control   x Yes   ____ No

x Treatment Cell Design:

Size of target zone (ft2):	100188	____ Unknown	(425 x 225 ft)
Thickness of target zone (ft):	25	____ Unknown	
Depth to top of target zone (ft bgs):	10	____ Unknown	
Thickness of target zone below water table (ft):	15	____ Unknown	
Number of energy delivery points:	35	____ Unknown	
Number of extraction points:	38	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	18	____ Unknown
Maximum representative formation temperature (deg C):	66	____ Unknown
Time to reach maximum representative temperature (days):	380	____ Unknown
Duration of treatment at representative temperature (days):	366	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	______	______
Formation temperature post-treatment monitoring event 1:	______	______
Duration of post-treatment monitoring (days):	______	______

x Mass of contaminant removed:

Via liquid pumping:	700 gal	____ lb	____ kg	____ Unknown
In vapor stream:	15400 gal	____ lb	____ kg	____ Unknown
Total:	16000 gal	____ lb	____ kg	____ Unknown

Comments:

Spacing - 45 ft with wells of opposite type and 60 ft for wells of same type

Attachments: ______

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance

Facility ID#: 0250

x Performance

Remediation Goal:

____ In Groundwater:

x In Soil:

See if Technology could achieve the RWQCB requirement for soil = 1000 mg/kg TPH

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

x In Soil

Comment:

No requirements were not met

General comments on the thermal application:

Cost - $46/yd3 See

Cost shee for complete details

Lessons Learned

____ Energy

Total Energy Used: _ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy:

x Cost

Total Project Cost: 4401120

____ Consultant Cost: _

____ Thermal Vendor Cost: _

x Energy Cost: 631470 ____ m^3 ____ yd^3

____ Other Cost 1: _

____ Other Cost 2: _

____ Other Cost 3: _

____ Please note other cost:

____ Other Cost 1: _

____ Other Cost 2: _

____ Other Cost 3: _

Table 3-1. SUMMARY OF RESULTS OF THE ECONOMIC ANALYSIS *

	Approx. Actual Costs.for Rainbow Disposai Total ($)	$/yd³ **	Estimated Ideal Cost for Rainbow Disposal Total ($)	$/yd³ **	Estimated Cost for a Typical site of the same size Total ($)	$/yd³ **
Time To Remediate (Days)	746		373		497	
Assumed oft-Line Factor ..	50%		100%		75%	
Site size (yd^3)	95,000					
Site Preparation Costs	$ 338,230	$ 3.56	325,960	$ 3.43	336,200	$ 3.54
Permitting and Regulatory Costs	$ 16,100	$ 0.17	11,100	$ 0.12	14,100	$ 0.15
Non-Depreciable Equipment Costs	$ 522,990	$ 5.51	$ 522,490	$ 5.50	524,070	$ 5.52
Startup and Fixed Costs	$ 758,800	$ 7.99	413,500	$ 4.35	435,700	$ 4.59
Labor Costs	$ 1,362,000	$ 14.34	775,600	$ 8.16	$ 1,033,600	$ 10.88
Consumables and Supplies Costs	$ 43,430	$ 0.46	24,320	$ 0.26	32,420	$ 0.34
Utilities Costs	$ 631,470	$ 6.65	280,190	$ 2.95	493,020	$ 5.19
Effluent Treatment and Disposal Costs	$ 71,100	$ 0.75	35,600	$ 0.37	47,400	$ 0.50
Residuals and Waste Handling and Disposal Costs	$ 67,200	$ 0.71	49,250	$ 0.52	61,400	$ 0.65
Sampling and Analytical Costs	$ 299,900	$ 3.16	195,900	$ 2.06	221,900	$ 2.34
Facility Modification, Repair, and Replacement Costs	$ 150,700	$ 1.59	57,500	$ 0.61	77,600	$ 0.82
Site Demobilization Costs	$ 139,200	$ 1.47	98,500	$ 1.04	98,500	$ 1.04
TOTAL COSTS	**$ 4,401,120**	**$ 46.33**	**$ 2,789,910**	**$ 29.37**	**$ 3,375,910**	**$ 35.54**

* This table presents a summary of the detailed costs itemized in Table 3-2.

** For each cost category, costs per cubic yard are reported to the nearest cent.

Source:

Environmental Protection Agency, In situ steam enhanced recovery process Hughes Environmental Systems, Inc., Innovative Technology Evaluation Report, EPA/540/R-94/510, National Risk Management Research Laboratory, Cincinnati, OH, July 1995b.

General Site Information Facility ID#: 0260

x File Analyzed By: JT x PD ____ Date: 10/29/2006

Type of treatment: ____ Conductive ____ Steam ____ ERH x Other: Hot air

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 1991 End of Test: 1993 Duration: < 10 months

Type of Site: x Non-DOD ____ DoD

x Facility Name: Service Station

Address: ____

City, State, Zip Code: San Francisco, CA

OU# or Site #: ____

x Primary point of contact: Robert Dahl

Organization: TerraVac

Address: ____

City, State, Zip Code: ____

Phone #: 925-363-7322 email: rdahl@terravac.com

x Other contacts or vendors who worked on site ____ None

Point of contact: TerraVac Website

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____

Organization: ____

Address: ____

City, State, Zip Code: ____

Phone #: ____ email: ____

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data Facility ID#: 0260

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______
Post-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____ ________	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ________	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ________	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ________	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ________	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ________	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ________	None	None	None	None
	____ 1,1,2-trichloroethane	x super unleaded gasoline	____ ________	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ________	____ ________	None	None	None	None
	____ Vinyl Chloride	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0260

x Geology: Zone Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

	low				____ Unknown
	high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

	low				____ Unknown
	high				

Comments:

Attachments:

Thermal Treatment - Design | Facility ID#: 0260

x Thermal treatment:
- ____ Conductive ____________________
- ____ Electrical Resistance ____________________
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- ____ Steam ____________________
  - ____ Steam ____ Steam + air ____ Steam + O2
- x Other (describe) Hot air

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 1991 Duration: 2 years

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2):	____________	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	____________	____ Unknown	
Depth to top of target zone (ft bgs):	____________	____ Unknown	
Thickness of target zone below water table (ft):	____________	____ Unknown	
Number of energy delivery points:	____________	____ Unknown	
Number of extraction points:	____________	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	____________	____ Unknown
Maximum representative formation temperature (deg C):	____________	____ Unknown
Time to reach maximum representative temperature (days):	____________	____ Unknown
Duration of treatment at representative temperature (days):	____________	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____________	____________
Formation temperature post-treatment monitoring event 1:	____________	____________
Duration of post-treatment monitoring (days):	____________	____________

x Mass of contaminant removed:

Via liquid pumping:	____________	____ lb	____ kg	____ Unknown
In vapor stream:	____________	____ lb	____ kg	____ Unknown
Total:	80000	x lb	____ kg	____ Unknown

Comments: ____________________

Attachments: ____________________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance — Facility ID#: 0260

____ Performance

Remediation Goal:

____ In Groundwater: ____

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

Hot air increased extraction rated by up to a factor of three over those without hot air injection.

Lessons Learned

____

____ Energy

Total Energy Used: ____ ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information — Facility ID#: 0270

x File Analyzed By: JT ____ PD ____ — Date: 9/26/2006

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ________

Type of Contaminant: x Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: 8/17/1988 End of Test: 9/12/1988 Duration: 15

Type of Site: x Non-DOD ____ DoD

x Facility Name: Solvent Services

Address: 1021 Berryessa Rd

City, State, Zip Code: San Jose, CA

OU# or Site #: ________

____ Primary point of contact: ________

Organization: ________

Address: ________

City, State, Zip Code: ________

Phone #: ________ email: ________

____ Other contacts or vendors who worked on site ____ None

Point of contact: ________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: ________

Address: ________

City, State, Zip Code: ________

Phone #: ________ email: ________

QA/QC

x Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

x Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data — Facility ID#: 0270

x Impacted Zone: Length (parallel to flow direction)(ft.): below — Width (ft): ______ — Thickness (ft): ______ — ___ Unknown

x Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: — x None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

	In:	Upgradient:	Downgradient:	Crossgradient:
Pre-treatment				
Post-treatment				

x Soil Borings: Number of relevant soil borings with pre-treatment data: 6

Number of relevant soil borings with post-treatment data: 2

Number inside treatment zone: 8 — Number outside treatment zone: ______

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	None	100 mg/kg	None	50 mg/kg
	x Tetrachloroethene	____ Jet Fuel	____	None	100 mg/kg	None	10 mg/kg
	x 1,1-dichloroethene	____ Napthalene	____	None	0.5 mg/kg	None	10 mg/kg
	____ cis-1,2-dichloroethene	x Benzene	____	None	0.05 mg/kg	None	None
	____ trans-1,2-dichloroethene	x Tolune	____	None	50 mg/kg	None	50 mg/kg
	____ 1,1-dichloroethane	x Ethylbenzene	____	None	100 mg/kg	None	50 mg/kg
	____ 1,2-dichloroethane	____ m/p-xylene	x 2-butanone	None	50 mg/kg	None	100 mg/kg
	x 1,1,1-trichloroethane	____ o-xylene	____	None	100 mg/kg	None	50 mg/kg
	____ 1,1,2-trichloroethane	x 1,2-dichlorobenzene	____	None	100 mg/kg	None	None
	____ 1,1,2,2-tetrachloroethane	x aceton	____	None	500 mg/kg	None	500 mg/kg
	____ Vinyl Chloride	x total xylenes	____	None	500 mg/kg	None	100 mg/kg
	x 11-dca	____	____	None	0.1 mg/kg	None	None
	x MeCl2	____	____	None	10 mg/kg	None	None
	____	x trichlorofluorethene	____	None	50 mg/kg	None	50 mg/kg
	x cis-1,2-dichloroethene	____	____	None	0.5 mg/kg	None	None
	____	x 4-methyl-2-pentanone	____	None	1 mg/kg	None	10 mg/kg
	____	x 2-hexanone	____	None	0.5 mg/kg	None	None

Comments:

41,000 yd3 contaminated at greater than 0.010 ppm — Concentrations from Table 1 for pre and Appendix C holes A1 and A2 averages

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0270

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 75 to 100 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No x Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	0			
	high value (ft bgs):				
	Unknown:				
x Flow direction		W			
x Horizontal hydraulic gradient (feet/foot):					x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown
x K range (ft/day)	Measured using:	____ Slug Test	____ Laboratory	____ Field data	
	low				x Unknown
	high				
Transmissivity (ft2/day):	Measured using:	____ Slug Test	____ Laboratory	____ Field data	
	low				x Unknown
	high				

Comments:

Transmissivity = 200 gal per day per foot; Storativity - 0.22 both for aquifer A Flow direction from Figure 3 contours

Attachments:

Thermal Treatment - Design   Facility ID#: 0270

x Thermal treatment:
- ____ Conductive ____
- ____ Electrical Resistance ____
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- x Steam ____
  - x Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ____

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: x Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 8/17/1988   Duration: 15 days

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	169	____ Unknown	(13 x 13 ft)
Thickness of target zone (ft):	18	____ Unknown	
Depth to top of target zone (ft bgs):	2	____ Unknown	
Thickness of target zone below water table (ft):	20	____ Unknown	
Number of energy delivery points:	6	____ Unknown	
Number of extraction points:	1	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	26	____ Unknown
Maximum representative formation temperature (deg C):	100	____ Unknown
Time to reach maximum representative temperature (days):	1	____ Unknown
Duration of treatment at representative temperature (days):	>1	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	186.8	____ lb	x kg	____ Unknown
In vapor stream:	548.3	____ lb	x kg	____ Unknown
Total:	762.7	____ lb	x kg	____ Unknown

Comments: ____

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0270

____ Performance

Remediation Goal:

____ In Groundwater: ____________________

____ In Soil: ____________________

Was the Remediation Goal Achieved:

____ In Groundwater ____________________

Comment: ____________________

____ In Soil ____________________

Comment: ____________________

General comments on the thermal application:

Objectives: 1) demonstrate that control of the movement of the steam zone can be maintained; 2) identify controlling parameters and phenomena which characterize the use of steam for soil contamination remediation; 3) and provice sufficeint data on the operation and performance of the process to allow for an effective design of a full-scale cleanup process.

Lessons Learned

____

____ Energy

Total Energy Used: ____________ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____________________

____ Cost

Total Project Cost: ____________

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

____ Energy Cost: ____________ ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ____________________

____ Other Cost 2: ____________________

____ Other Cost 3: ____________________

General Site Information Facility ID#: 0275

x File Analyzed By: JT x PD ____ Date: 10/29/2006

Type of treatment: ____ Conductive ____ Steam ____ ERH x Other: Hot air

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: ____________ End of Test: ____________ Duration: ______

Type of Site: ____ Non-DOD x DoD

x Facility Name: McClellan AFB Superfund Site

Address: ____________________

City, State, Zip Code: Sacramento, CA

OU# or Site #: ____________________

x Primary point of contact: Robert Dahl

Organization: TerraVac

Address: ____________________

City, State, Zip Code: ____________________

Phone #: 925-363-7322 email: rdahl@terravac.com

x Other contacts or vendors who worked on site ____ None

Point of contact: TerraVac Website

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ______

Organization: ____________________

Address: ____________________

City, State, Zip Code: ____________________

Phone #: ______________ email: ____________________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data Facility ID#: 0275

____ Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ______

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: ______ Number outside treatment zone: ______

____ Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____ ______	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ______	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ______	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ______	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ______	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ______	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ______	None	None	None	None
	____ 1,1,2-trichloroethane	____ ______	____ ______	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ______	____ ______	None	None	None	None
	____ Vinyl Chloride	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0275

____ Geology: Zone Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design Facility ID#: 0275

____ Thermal treatment: ____ Conductive ____________

____ Electrical Resistance ____________

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____________

____ Steam ____ Steam + air ____ Steam + O2

x Other (describe) Hot Air

x Type of Test: ____ Pilot test x Full-scale System

____ Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ____________ Duration: ____________

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2): ____________ ____ Unknown (___ x ___ ft)

Thickness of target zone (ft): ____________ ____ Unknown

Depth to top of target zone (ft bgs): ____________ ____ Unknown

Thickness of target zone below water table (ft): ____________ ____ Unknown

Number of energy delivery points: 17 ____ Unknown

Number of extraction points: ____________ ____ Unknown

____ Temperature Profile:

Initial formation temperature (deg C): ____________ ____ Unknown

Maximum representative formation temperature (deg C): ____________ ____ Unknown

Time to reach maximum representative temperature (days): ____________ ____ Unknown

Duration of treatment at representative temperature (days): ____________ ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

____ Mass of contaminant removed:

Via liquid pumping: ____________ ____ lb ____ kg ____ Unknown

In vapor stream: ____________ ____ lb ____ kg ____ Unknown

Total: ____________ ____ lb ____ kg ____ Unknown

Comments: ____________

Attachments: ____________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0275

____ Performance

Remediation Goal:

____ In Groundwater: ______________________

____ In Soil: ______________________

Was the Remediation Goal Achieved:

____ In Groundwater ______________________

Comment: ______________________

____ In Soil ______________________

Comment: ______________________

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____________ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ______________________

____ Cost

Total Project Cost: ____________

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

____ Energy Cost: ____________ ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ______________________

____ Other Cost 2: ______________________

____ Other Cost 3: ______________________

General Site Information

Facility ID#: 0280

x File Analyzed By: JT x PD ____

Date: 8/28/2006

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

x Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: May-97 End of Test: Jul-00 Duration: 37 months

Type of Site: x Non-DOD ____ DoD

x Facility Name: Visalia Poleyard

Address: ____________

City, State, Zip Code: CA

OU# or Site #: ____________

x Primary point of contact: Craig Eaker

Organization: Souhern California Edison

Address: RP&A - EH&S, Quad 3A 2344 Walnut Grove Avenue

City, State, Zip Code: Rosemead, CA 91770

Phone #: 626-302-8531 email: ____________

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data   Facility ID#: 0280

x Impacted Zone: Length (parallel to flow direction)(ft.): Below   Width (ft): ____   Thickness (ft): ____   ___ Unknown

x Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: x None

Pre-treatment: ____   Post-treatment: ____

Number of wells relative to treatment zone:

Pre-treatment	In: ____	Upgradient: ____	Downgradient: ____	Crossgradient: ____
Post-treatment	In: ____	Upgradient: ____	Downgradient: ____	Crossgradient: ____

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____

Number of relevant soil borings with post-treatment data: ____

Number inside treatment zone: ____   Number outside treatment zone: ____

x Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	x Creosote	None	None	0.001 mg/L	None
	____ Tetrachloroethene	____ Jet Fuel	x PCP	None	None	0.001 mg/L	None
	____ 1,1-dichloroethene	____ Napthalene	x Benzo(a)pyrene	None	None	0.5 mg/L	None
	____ cis-1,2-dichloroethene	____ Benzene	x TPH - Diesel	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	x Dioxin	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane			None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	____ Vinyl Chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

NAPL Area - 525 ft by 150 ft; Impacted area 4.3 acres Post-treatment data from June 2006 with Dioxins = non-detect in ng/L

Attachments:

Hydrogeologic Conceptual Model | Facility ID#: 0280

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl x Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No x Yes (number): 3 ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	35	75	120	
	high value (ft bgs):			140	
	Unknown:				
____ Flow direction					
x Horizontal hydraulic gradient (feet/foot):					x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) — Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 0280

x Thermal treatment: ____ Conductive ____________

____ Electrical Resistance ____________

____ 3 phase ____ 6 phase ____ AC power ____ DC power

x Steam DUS/HPO

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____________

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 5/12/1997 Duration: 37 months

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	154,800	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	85	____ Unknown	
Depth to top of target zone (ft bgs):	20	____ Unknown	
Thickness of target zone below water table (ft):	70	____ Unknown	
Number of energy delivery points:	14	____ Unknown	
Number of extraction points:	12	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	____________	x Unknown
Maximum representative formation temperature (deg C):	130	____ Unknown
Time to reach maximum representative temperature (days):	____________	x Unknown
Duration of treatment at representative temperature (days):	____________	x Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____________	____________
Formation temperature post-treatment monitoring event 1:	____________	____________
Duration of post-treatment monitoring (days):	____________	____________

x Mass of contaminant removed:

Via liquid pumping:	199,500	x lb	____ kg	____ Unknown
In vapor stream:	239,400	x lb	____ kg	____ Unknown
Total:	1,330,000	x lb	____ kg	____ Unknown

Comments:
Phase I treated - 20 to 95 feet; Phase II treated - 20 to 125 ft Mass removed - 212,800 lb of in-situ oxidation and 678,300 lb of free product creosote

Attachments: ____________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance   Facility ID#: 0280

x Performance

Remediation Goal:

x In Groundwater:

PCP - 1 ug/L; TCDD (eqv) - 0.00003 ug/L; B(a)P - 0.2 ug/L

____ In Soil: ____

Was the Remediation Goal Achieved:

s In Groundwater

Comment:

21 wells meet the criteria for PCP and 22 wells for TCDD and B(a)P - out of 25 wells

____ In Soil

Comment: ____

General comments on the thermal application:

$57/cubic yard actually, but with lessons learned it would have been $38/cubic yard

Lessons Learned

____ Energy

Total Energy Used: ____ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

____ Cost

Total Project Cost: 21,500,000

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information Facility ID#: 0290

x File Analyzed By: JT x PD ____ Date: 10/6/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: 3/29/2002 End of Test: 1/31/2003 Duration: 309 d

Type of Site: x Non-DOD ____ DoD

x Facility Name: Lowry Landfill

Address: ____________

City, State, Zip Code: Denver, CO

OU# or Site #: South Waste Pit

x Primary point of contact: Bonnie Lavelle

Organization: EPA

Address: ____________

City, State, Zip Code: ____________

Phone #: 303-312-6579 email: ____________

x Other contacts or vendors who worked on site ____ None

Point of contact: Bill Plaehn

Type: x Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: Parsons

Address: ____________

City, State, Zip Code: ____________

Phone #: 303-764-8729 email: bill.a.plaehn@parsons.com

QA/QC

x Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

x Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0290

x Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ x Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

x Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 17 Post-treatment: 5

Number of wells relative to treatment zone:

	In	Upgradient	Downgradient	Crossgradient
Pre-treatment	7	3	1	6
Post-treatment	0	2	1	2

x Soil Borings: Number of relevant soil borings with pre-treatment data: 14

Number of relevant soil borings with post-treatment data: 14

Number inside treatment zone: 14 Number outside treatment zone: 0

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	x Methylene Chloride	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	x Acetone	None	None	None	None
	____ cis-1,2-dichloroethene	x Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	x Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	x Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	x 2-butanone	None	None	None	None
	x 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	x Xylenes (perimeter)	____	10 mg/L	None	5 mg/L	None
	____ 1,1,2,2-tetrachloroethane	x Xylenes (in treat zone)	____	10,000 mg/L	500 mg/kg	None	500 mg/kg
	____ Vinyl Chloride	____	____	None	None	None	None
	x Total VOCs (perimeter)	____	____	1,000 mg/L	None	100 mg/L	None
	x Total VOCs (in treat.zone)	____	____	10,000 mg/L	1,000 mg/kg	None	1,000 mg/kg
	____	____	x 112-trichloro-122trifluroethane	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

See attached sheets for concentration data.

Hydrogeologic Conceptual Model

Facility ID#: 0290

x Geology:

Zone		Unconsolidated Sediments
Vadose Zone:	____	Relatively homogeneous and permeable unconsolidated sediments
	____	Relatively homogeneous and impermeable unconsolidated sediments
	____	Largely permeable sediments with inter-bedded lenses of lower permeability material
	x	Largely impermeable sediments with inter-bedded layers of higher permeability material
	____	Competent, but fractured bedrock (i.e. crystalline rock)
	____	Weathered bedrock, limestone, sandstone
Saturated Zone:	____	Relatively homogeneous and permeable unconsolidated sediments
	____	Relatively homogeneous and impermeable unconsolidated sediments
	____	Largely permeable sediments with inter-bedded lenses of lower permeability material
	x	Largely impermeable sediments with inter-bedded layers of higher permeability material
	____	Competent, but fractured bedrock (i.e. crystalline rock)
	____	Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 5760 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	12			
	high value (ft bgs):	26			
	Unknown:				
x Flow direction		NW			
x Horizontal hydraulic gradient (feet/foot):		0.04 to 0.05			____ Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Comments:

Horizonation hydraulic gradient during treatment was 0.05 to 0.06 ft/ft

Attachments:

Thermal Treatment - Design Facility ID#: 0290

x Thermal treatment: ____ Conductive

x Electrical Resistance

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe)

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:

- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 3/29/2002 Duration: 309 day

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	33600	____ Unknown	(210 x 160 ft)
Thickness of target zone (ft):	16	____ Unknown	
Depth to top of target zone (ft bgs):	10	____ Unknown	
Thickness of target zone below water table (ft):	6	____ Unknown	
Number of energy delivery points:	220	____ Unknown	
Number of extraction points:	7	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	16	____ Unknown
Maximum representative formation temperature (deg C):	84	____ Unknown
Time to reach maximum representative temperature (days):	211	____ Unknown
Duration of treatment at representative temperature (days):	98	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	1/31/2003	86
Formation temperature post-treatment monitoring event 1:	4/25/2003	70
Duration of post-treatment monitoring (days):	Atleast 3 months	

x Mass of contaminant removed:

Via liquid pumping:	751	____ lb	x kg	____ Unknown
In vapor stream:	16375	____ lb	x kg	____ Unknown
Total:	17127	____ lb	x kg	____ Unknown

Comments:

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0290

____ Performance

Remediation Goal:

____ In Groundwater: ____

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

Goals: 1) Achieve 90% DRE of all chlorinated and non-chlorianted VOCs 2) Continuous and complete processing of VOC-laden off-gas during spikes in concentration s that can occur during heating

Regular electrode spacing was 18 feet, but in areas where new electrodes were installed the spacing went to 9 ft

Lessons Learned

1) They could never reach the goal of 90C in some areas because of the metal debris. 2) Metal debris in high densities causes short-circuiting isuues 3) Difficult ot heat a thin thermal barrier/hot floor just below the waste pits because of the metals above. 4) Closer electrode spacing can off-set the effect of layered highly conductive materials

x Energy

Total Energy Used: 2475898 x kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information   Facility ID#: 0295

x File Analyzed By: JT x PD ____   Date: 10/30/2006

Type of treatment: ____ Conductive ____ Steam ____ ERH x Other: RFH

Type of Contaminant: ____ Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating x Other: organochloropesticide

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: 1992   End of Test: 1992   Duration: 1 month

Type of Site: ____ Non-DOD x DoD

x Facility Name: Rocky Mountain Arsenal Basin F

Address: ____________________

City, State, Zip Code: Commerce, CO

OU# or Site #: ____________________

x Primary point of contact: Guggilam Sresty

Organization: ITT Research Institute

Address: 10 W. 35th Street

City, State, Zip Code: Chicago, IL 60616

Phone #: 312-567-4232   email: ____________________

____ Other contacts or vendors who worked on site   ____ None

Point of contact: ____________________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: ____________________

Address: ____________________

City, State, Zip Code: ____________________

Phone #: ____________________   email: ____________________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data   ____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information   ____ Flux assessment

____ Groundwater elevations   ____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0295

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

x Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	x organochloropesticide	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ________	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ________	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ________	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ________	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ________	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ________	None	None	None	None
	____ 1,1,2-trichloroethane	____ ________	____ ________	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ________	____ ________	None	None	None	None
	____ Vinyl Chloride	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0295

x Geology: Zone Unconsolidated Sediments

Vadose Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
x Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

Saturated Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
x Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 0295

x Thermal treatment: ____ Conductive ______________________

____ Electrical Resistance ______________________

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ______________________

____ Steam ____ Steam + air ____ Steam + O2

x Other (describe) RFH

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

x Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 1992   Duration: 1 month

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2): ____________ ____ Unknown (___ x ___ ft)

Thickness of target zone (ft): 16 ____ Unknown

Depth to top of target zone (ft bgs): ____________ ____ Unknown

Thickness of target zone below water table (ft): ____________ ____ Unknown

Number of energy delivery points: ____________ ____ Unknown

Number of extraction points: ____________ ____ Unknown

____ Temperature Profile:

Initial formation temperature (deg C): ____________ ____ Unknown

Maximum representative formation temperature (deg C): ____________ ____ Unknown

Time to reach maximum representative temperature (days): ____________ ____ Unknown

Duration of treatment at representative temperature (days): ____________ ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

____ Mass of contaminant removed:

Via liquid pumping: ____________ ____ lb ____ kg ____ Unknown

In vapor stream: ____________ ____ lb ____ kg ____ Unknown

Total: ____________ ____ lb ____ kg ____ Unknown

Comments:

Attachments: Treated - 50 yd3

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0295

____ Performance

Remediation Goal:

____ In Groundwater: ____

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

x In Soil

Comment:

97 to 99% destruction in soils heated to 250C or higher

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information   Facility ID#: 0300

x File Analyzed By: JT x PD ____   Date: 9/26/2006

Type of treatment: x Conductive ____ Steam ____ ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 3/3/2002 End of Test: 3/15/2002 Duration: 12 days

Type of Site: ____ Non-DOD s DoD

s Facility Name: Rocky Mountain Arsenal

Address: ____________

City, State, Zip Code: Commerce City, CO

OU# or Site #: Hex Pit

x Primary point of contact: Ralph Baker

Organization: TerraTherm

Address: 356 Broad Street

City, State, Zip Code: Fitchburg, MA 01420

Phone #: 978-343-0300 email: rbaker@terratherm.com

x Other contacts or vendors who worked on site ____ None

Point of contact: Kerry Guy

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications x Other regulator

Organization: EPA Region 8

Address: ____________

City, State, Zip Code: ____________

Phone #: 303-312-7288 email: guy.kerry@epa.gov

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data | Facility ID#: 0300

x Impacted Zone: Length (parallel to flow direction)(ft.): below Width (ft): ____ Thickness (ft): ____ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: x None

Pre-treatment: ____ Post-treatment: ____

Number of wells relative to treatment zone:

Pre-treatment In: ____ Upgradient: ____ Downgradient: ____ Crossgradient: ____

Post-treatment In: ____ Upgradient: ____ Downgradient: ____ Crossgradient: ____

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____

Number of relevant soil borings with post-treatment data: ____

Number inside treatment zone: ____ Number outside treatment zone: ____

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	x aldrin	None	100 mg/kg	None	10 mg/kg
	____ 1,1-dichloroethene	____ Napthalene	x dieldrin	None	10,000 mg/kg	None	100 mg/kg
	____ cis-1,2-dichloroethene	____ Benzene	x chlorodane	None	100 mg/kg	None	None
	____ trans-1,2-dichloroethene	____ Tolune	x endrin	None	100 mg/kg	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	x isodrin	None	100 mg/kg	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	x hexachlorocyclopentadene	None	10,000 mg/kg	None	1,000 mg/kg
	____ 1,1,1-trichloroethane	____ o-xylene	x hexachlorobenzene	None	None	None	None
	____ 1,1,2-trichloroethane	____	x hexachlorobutadiene	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	x dioxin/furan	None	100 mg/kg	None	100 mg/kg
	____ Vinyl Chloride	____	____	None	None	None	None
	x Carbon Tetrachloride	____	____	None	5 mg/kg	None	5 mg/kg
	x Chloroform	____	____	None	5 mg/kg	None	1 mg/kg
	x Tetrachloroethene	____	____	None	1 mg/kg	None	1 mg/kg
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Three stated impacted areas of 3200 yd3, 2550 yd3, and 2005 yd3

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0300

x Geology: Zone Unconsolidated Sediments

Vadose Zone:
- x Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- x Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 5280 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	10			
	high value (ft bgs):	14			
	Unknown:				
x Flow direction		NNE			
x Horizontal hydraulic gradient (feet/foot):		0.008			____ Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 0300

x Thermal treatment: x Conductive ______

____ Electrical Resistance ______

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ______

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ______

x Type of Test: s Pilot test ____ Full-scale System

____ Geology of Treatment Zone:

- x Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only x Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 3/3/2002 Duration: 12 days

s Hydraulic Control ____ Yes x No

x Treatment Cell Design:

Size of target zone (ft2):	4512	____ Unknown	(94 x 45 ft)
Thickness of target zone (ft):	12	____ Unknown	
Depth to top of target zone (ft bgs):	2	____ Unknown	
Thickness of target zone below water table (ft):	0	____ Unknown	
Number of energy delivery points:	266	____ Unknown	
Number of extraction points:	56	____ Unknown	

s Temperature Profile:

Initial formation temperature (deg C):	10	____ Unknown
Maximum representative formation temperature (deg C):	213	____ Unknown
Time to reach maximum representative temperature (days):	12	____ Unknown
Duration of treatment at representative temperature (days):	1	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	______	______
Formation temperature post-treatment monitoring event 1:	______	______
Duration of post-treatment monitoring (days):	______	______

____ Mass of contaminant removed:

Via liquid pumping:	______	____ lb	____ kg	____ Unknown
In vapor stream:	______	____ lb	____ kg	____ Unknown
Total:	______	____ lb	____ kg	____ Unknown

Comments:

Attachments: 6 ft spacing with borings completed at 12.5 ft bgs

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0300

x Performance

Remediation Goal:

____ In Groundwater:

x In Soil: 90% DRE removal for each COC (hex, aldrin, dieldrin, endrin, isodrin, and chlorodane) and reduce mean concentrations of 6 COCs below the ROD HHE criteria

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

1. Wanted also to see if ISTD could achieve RMA human health evaluation cleanup criteria for COCs; 2. Turned off after 12 days because of corrosion in pipes; 3. "Frac-outs" were seen from the horizonat well installation under the treatment zone; 4. 30 of 53 vapor tees were clogged and 40 of 56 flixible hoses had accumulation.

Lessons Learned

1. Never horizonatally drill under a finished well field; 2. Include worst case-scenario design; 3. Perform pilot if treatable waste are qualitively different than previously encountered; 4. Insulate if abnormally cold weather could occur; 5. Do not assume 90% in-situ neutralization of acids; 6. Use magnehelic gauge taps and ball valves at vapor tea to have ability to confirm flow.

____ Energy

Total Energy Used: ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy:

x Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

x Other Cost 1: 1954700

x Other Cost 2: 370000

____ Other Cost 3:

x Please note other cost:

x Other Cost 1: design and construction

x Other Cost 2: horizontal dewatering well installation

____ Other Cost 3:

General Site Information — Facility ID#: 0305

x File Analyzed By: JT x PD ____ — Date: 10/26/2006

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: ____________ End of Test: ____________ Duration: ________

Type of Site: x Non-DOD ____ DoD

x Facility Name: Plating Facility

Address: ____________

City, State, Zip Code: Danbury, CT

OU# or Site #: ____________

x Primary point of contact: Jay Dablow

Organization: ERM

Address: 3 Hutton Centre, Suite 600

City, State, Zip Code: Santa Ana, CA 92707

Phone #: 714-430-1476 email: jay.dablow@erm.com

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data | Facility ID#: 0305

____ Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ______

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: ______ Number outside treatment zone: ______

____ Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____ ______	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ______	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ______	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ______	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ______	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ______	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ______	None	None	None	None
	____ 1,1,2-trichloroethane	____ ______	____ ______	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ______	____ ______	None	None	None	None
	____ Vinyl Chloride	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None

Comments: ______

Attachments: ______

Hydrogeologic Conceptual Model Facility ID#: 0305

____ Geology: Zone: Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 0305

x Thermal treatment: ____ Conductive ____________
____ Electrical Resistance ____________
____ 3 phase ____ 6 phase ____ AC power ____ DC power
x Steam ____________
____ Steam ____ Steam + air ____ Steam + O2
____ Other (describe) ____________

x Type of Test: x Pilot test ____ Full-scale System

____ Geology of Treatment Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ____________ Duration: ____________

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2): ____________ ____ Unknown (___ x ___ ft)
Thickness of target zone (ft): ____________ ____ Unknown
Depth to top of target zone (ft bgs): ____________ ____ Unknown
Thickness of target zone below water table (ft): ____________ ____ Unknown
Number of energy delivery points: ____________ ____ Unknown
Number of extraction points: ____________ ____ Unknown

____ Temperature Profile:

Initial formation temperature (deg C): ____________ ____ Unknown
Maximum representative formation temperature (deg C): ____________ ____ Unknown
Time to reach maximum representative temperature (days): ____________ ____ Unknown
Duration of treatment at representative temperature (days): ____________ ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

____ Mass of contaminant removed:

Via liquid pumping: ____________ ____ lb ____ kg ____ Unknown
In vapor stream: ____________ ____ lb ____ kg ____ Unknown
Total: ____________ ____ lb ____ kg ____ Unknown

Comments: ____________

Attachments: ____________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0305

____ Performance

Remediation Goal:

____ In Groundwater:

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information | Facility ID#: 0310

x File Analyzed By: JT x PD ____ | Date: 10/18/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating x Other: ____________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: 2/7/1997 End of Test: 3/9/1997 Duration: 30 d

Type of Site: ____ Non-DOD x DoD

x Facility Name: Dover Air Force Base

Address: ____________

City, State, Zip Code: Dover, DE

OU# or Site #: ____________

x Primary point of contact: Tim McHale

Organization: Dover National Test Site

Address: Bldg 909 Arnold Drive Ext

City, State, Zip Code: Dover AFB, DE 19902

Phone #: 302-677-4103 email: timothy.mchale@dover.af.mil

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0310

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 6 Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: 2 Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ________

Number of relevant soil borings with post-treatment data: ________

Number inside treatment zone: ________ Number outside treatment zone: ________

____ Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

No contaminants of conern.They used two tracers that mimicked DNAPL, i.e. Perfluoromethylcyclohexane (PMCH) and perfluorotrimethycyclohexane (PTMCH).

Attachments:

Hydrogeologic Conceptual Model | Facility ID#: 0310

x Geology:

Zone	Unconsolidated Sediments
Vadose Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	x Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone
Saturated Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	x Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: Oct-35 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	25			
	high value (ft bgs):				
	Unknown:				
x Flow direction		NW			
x Horizontal hydraulic gradient (feet/foot):					x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) Measured using: ____ Slug Test x Laboratory x Field data

		Aquifer 1	Aquifer 2	Aquifer 3	
K range	low	8.5			____ Unknown
	high	27.8			

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

		Aquifer 1	Aquifer 2	Aquifer 3	
Transmissivity	low				x Unknown
	high				

Comments:

Attachments:

Thermal Treatment - Design

Facility ID#: 0310

x Thermal treatment:
____ Conductive ____________
x Electrical Resistance ____________
____ 3 phase   x 6 phase   ____ AC power   ____ DC power
____ Steam ____________
____ Steam   ____ Steam + air   ____ Steam + O2
____ Other (describe) ____________

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
x Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 2/7/1997   Duration: 30 d

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	900	____ Unknown	(30 x 30 ft)
Thickness of target zone (ft):	15	____ Unknown	
Depth to top of target zone (ft bgs):	20	____ Unknown	
Thickness of target zone below water table (ft):	10	____ Unknown	
Number of energy delivery points:	6	____ Unknown	
Number of extraction points:	1	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	14	____ Unknown
Maximum representative formation temperature (deg C):	100	____ Unknown
Time to reach maximum representative temperature (days):	17	____ Unknown
Duration of treatment at representative temperature (days):	13	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

____ Mass of contaminant removed:

Via liquid pumping:		____ lb	____ kg	____ Unknown
In vapor stream:		____ lb	____ kg	____ Unknown
Total:		____ lb	____ kg	____ Unknown

Comments:

treated - 800 yd3 by the heat extending out from the array and steam rising upward

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0310

____ Performance

Remediation Goal:

____ In Groundwater: ____

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

Goal of the project was to see if SPH would remove DNAPL from the subsurface

Lessons Learned

____

x Energy

Total Energy Used: 200000 x kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information Facility ID#: 0330

X File Analyzed By: JT X PD ____ Date: 11/9/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ________

Type of Contaminant: X Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ________

Treatment Status: ____ Active X Post

Type of Test: X Pilot Test ___ Full Scale System

Start of Test: 8/18/1999 End of Test: 7/12/2000 Duration: 203 d

Type of Site: X Non-DOD ____ DoD

X Facility Name: Cape Canaveral

Address: ________

City, State, Zip Code: Florida

OU# or Site #: LC34

X Primary point of contact: Jackie Quinn

Organization: Kennedy Space Center

Address: ________

City, State, Zip Code: ________

Phone #: 321-867-8410 email: jacqueline.w.quinn@nasa.gov

X Other contacts or vendors who worked on site ____ None

Point of contact: Stephen Antonioli

Type: X Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: MSE Technology Application

Address: PO Box 4078; 200 Technology Way

City, State, Zip Code: Butte, MT 59702

Phone #: ________ email: ________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good temperature profile vs. time information

____ Groundwater elevations

____ Hydraulic Conductivity information

____ Good pre- and post-treatment soil data

____ Flux assessment

____ Geologic cross-section

General Site Assessment Data | Facility ID#: 0330

X Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ X Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

X Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 10 Post-treatment: 10

Number of wells relative to treatment zone:

Pre-treatment In: 6 Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: 6 Upgradient: ______ Downgradient: ______ Crossgradient: ______

X Soil Borings: Number of relevant soil borings with pre-treatment data: ______

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: ______ Number outside treatment zone: ______

X Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	X Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	X TCE - Shallow	1,000 mg/L	100 mg/kg	500 mg/L	50 mg/kg
	____ 1,1-dichloroethene	____ Napthalene	X TCE - Mid	1,000 mg/L	1,000 mg/kg	100 mg/L	500 mg/kg
	____ cis-1,2-dichloroethene	____ Benzene	X TCE - Deep	1,000 mg/L	5,000 mg/kg	500 mg/L	100 mg/kg
	____ trans-1,2-dichloroethene	____ Tolune	X cis-12 DCE - Shallow	5 mg/L	1 mg/kg	10 mg/L	None
	____ 1,1-dichloroethane	____ Ethylbenzene	X cis-12 DCE - Mid	10 mg/L	10 mg/kg	50 mg/L	None
	____ 1,2-dichloroethane	____ m/p-xylene	X cis-12 DCE - Deep	10 mg/L	1 mg/kg	50 mg/L	None
	____ 1,1,1-trichloroethane	____ o-xylene	X Trans-12 DCE	None	None	None	None
	____ 1,1,2-trichloroethane	____ ______	X Trans-12 DCE	None	None	0.5 mg/L	None
	____ 1,1,2,2-tetrachloroethane	____ ______	X Trans-12 DCE	None	None	0.05 mg/L	None
	____ Vinyl Chloride	____ ______	X VC - Shallow	None	None	5 mg/L	None
	____ ______	____ ______	X VC - Mid	None	None	1 mg/L	None
	____ ______	____ ______	X VC - Deep	None	None	0.05 mg/L	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None

Comments:

Area contained an estimated 11313 kg of TCE Soil Samples from trans-12-DCE, and vinyl chloride where all ND for pre-demo soil samples and for post-treatment trans (shallow) groundwater

Attachments:

Hydrogeologic Conceptual Model   Facility ID#: 0330

x Geology:

Zone	Unconsolidated Sediments
Vadose Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	x Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone
Saturated Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	x Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 5 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No x Yes (number): 2 ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	1	46	____	
	high value (ft bgs):	5	____	____	
	Unknown:	____	____	____	
____ Flow direction		____	____	____	
x Horizontal hydraulic gradient (feet/foot):		0.000009 to 0.0007	0.000005 to 0.0008	____	____ Unknown
Vertical hydraulic gradient (feet/foot):		____	____	____	____ Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	____	____	____	____ Unknown
high	____	____	____	

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	____	____	____	____ Unknown
high	____	____	____	

Comments: Upper sand unit K= 0.14 to 13.7 ft/day average 9.7 ft/day Middle fine-grained unit K= 2.1 to 4.9 ft/day average - 3.2 ft/day Lower Sand unit K= 2.7 to 3.3 ft/day average - 1.6 ft/day

Attachments:

Thermal Treatment - Design Facility ID#: 0330

x Thermal treatment: ____ Conductive ____

x Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

x Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 8/18/1999 Duration: 203 d

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	3750	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	42	____ Unknown	
Depth to top of target zone (ft bgs):	3	____ Unknown	
Thickness of target zone below water table (ft):	41	____ Unknown	
Number of energy delivery points:	13	____ Unknown	
Number of extraction points:	12	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	26	____ Unknown
Maximum representative formation temperature (deg C):	____	____ Unknown
Time to reach maximum representative temperature (days):	____	____ Unknown
Duration of treatment at representative temperature (days):	____	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	____	____ lb	____ kg	____ Unknown
Total:	2150	x lb	____ kg	____ Unknown

Comments:

2 conductive intervals of 23 to 30 ft bgs and 38 to 45 ft bgs.

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0330

x Performance

Remediation Goal:

x In Groundwater:

FL cleanup of GW of 3 ug/L of TCE

x In Soil:

Reach FL cleanup goal for TCE in soil of 30 ug/kg

Was the Remediation Goal Achieved:

____ In Groundwater ____________________

Comment: ____________________

____ In Soil ____________________

Comment: ____________________

General comments on the thermal application:

Objective: 1) Remove 90% of TCE mass in saturated zone 2) State of FL cleanup goals 3) Clean silt and clay stringers
4) Remove DNAPL pools from depressions in clay aquitard 5) Avoid mobilization

Lessons Learned

____

x Energy

Total Energy Used: ____________ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

x Total energy applied to treatment zone: 1725000 kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____________________

x Cost

Total Project Cost: 568742

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

x Energy Cost: 72484 ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ____________________

____ Other Cost 2: ____________________

____ Other Cost 3: ____________________

General Site Information Facility ID#: 0340

X File Analyzed By: JT X PD ____ Date: 11/9/2006

Type of treatment: ____ Conductive X Steam ____ ERH ____ Other: ____________

Type of Contaminant: X Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active X Post

Type of Test: X Pilot Test ___ Full Scale System

Start of Test: 7/19/2001 End of Test: 12/28/2001 Duration: 160 d

Type of Site: X Non-DOD ____ DoD

X Facility Name: Cape Canaveral

Address: ____________

City, State, Zip Code: Florida

OU# or Site #: LC34

X Primary point of contact: Jackie Quinn

Organization: Kennedy Space Center

Address: ____________

City, State, Zip Code: ____________

Phone #: 321-867-8410 email: jacqueline.w.quinn@nasa.gov

X Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: X Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: IWR

Address: ____________

City, State, Zip Code: Santa Barbara, CA

Phone #: 805-966-7757 email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data | Facility ID#: 0340

X Impacted Zone: Length (parallel to flow direction)(ft.): ____ Width (ft): ____ Thickness (ft): ____ X Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

X Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 6 Post-treatment: 6

Number of wells relative to treatment zone:

Pre-treatment In: 6 Upgradient: ____ Downgradient: ____ Crossgradient: ____

Post-treatment In: 6 Upgradient: ____ Downgradient: ____ Crossgradient: ____

X Soil Borings: Number of relevant soil borings with pre-treatment data: 13

Number of relevant soil borings with post-treatment data: 14

Number inside treatment zone: 4 Number outside treatment zone: 4

X Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	X Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	X TCE - Shallow	500 mg/L	50 mg/kg	100 mg/L	50 mg/kg
	____ 1,1-dichloroethene	____ Napthalene	X TCE - Mid	100 mg/L	1,000 mg/kg	10 mg/L	1,000 mg/kg
	____ cis-1,2-dichloroethene	____ Benzene	X TCE - Deep	500 mg/L	1,000 mg/kg	100 mg/L	1,000 mg/kg
	____ trans-1,2-dichloroethene	____ Tolune	X cis-12 DCE - Shallow	10 mg/L	None	0.5 mg/L	None
	____ 1,1-dichloroethane	____ Ethylbenzene	X cis-12 DCE - Mid	100 mg/L	None	1 mg/L	None
	____ 1,2-dichloroethane	____ m/p-xylene	X cis-12 DCE - Deep	50 mg/L	None	0.1 mg/L	None
	____ 1,1,1-trichloroethane	____ o-xylene	X Trans-12 DCE	10 mg/L	None	0.1 mg/L	None
	____ 1,1,2-trichloroethane	____	X Trans-12 DCE	5 mg/L	None	0.05 mg/L	None
	____ 1,1,2,2-tetrachloroethane	____	X Trans-12 DCE	50 mg/L	None	0.1 mg/L	None
	____ Vinyl Chloride	____	X VC - Shallow	50 mg/L	None	0.1 mg/L	None
	____	____	X VC - Mid	10 mg/L	None	0.1 mg/L	None
	____	____	X VC - Deep	100 mg/L	None	0.1 mg/L	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Shallow treatment zone from 18 to 24 ft; Intermediate treatment zone from 25 to 28 ft; Deep from 41 to 44 ft

Soil Samples from cis-12-DCE, trans-12-DCE, and vinyl chloride where alll ND for pre-demo sample

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0340

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 5 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No x Yes (number): 2 ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	1	46		
	high value (ft bgs):	5			
	Unknown:				
____ Flow direction					
x Horizontal hydraulic gradient (feet/foot):		0.000009 to 0.0007	0.000005 to 0.0008		____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low				____ Unknown
high				

Comments: Upper sand unit K= 0.14 to 13.7 ft/day average 9.7 ft/day Middle fine-grained unit K= 2.1 to 4.9 ft/day average - 3.2 ft/day Lower Sand unit K= 2.7 to 3.3 ft/day average - 1.6 ft/day

Attachments:

Thermal Treatment - Design Facility ID#: 0340

x Thermal treatment: ____ Conductive ________

____ Electrical Resistance ________

____ 3 phase ____ 6 phase ____ AC power ____ DC power

x Steam ________

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ________

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

x Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: x Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 7/19/2001 Duration: 160 d

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	3750	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	40	____ Unknown	
Depth to top of target zone (ft bgs):	6	____ Unknown	
Thickness of target zone below water table (ft):	40	____ Unknown	
Number of energy delivery points:	4	____ Unknown	
Number of extraction points:	18	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	________	____ Unknown
Maximum representative formation temperature (deg C):	________	____ Unknown
Time to reach maximum representative temperature (days):	________	____ Unknown
Duration of treatment at representative temperature (days):	________	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	________	________
Formation temperature post-treatment monitoring event 1:	________	________
Duration of post-treatment monitoring (days):	________	________

x Mass of contaminant removed:

Via liquid pumping:	________	____ lb	____ kg	____ Unknown
In vapor stream:	________	____ lb	____ kg	____ Unknown
Total:	16400	x lb	____ kg	____ Unknown

Comments: ________

Attachments: ________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0340

____ Performance

Remediation Goal:

____ In Groundwater: ____________________

____ In Soil: ____________________

Was the Remediation Goal Achieved:

____ In Groundwater ____________________

Comment: ____________________

____ In Soil ____________________

Comment: ____________________

General comments on the thermal application:

Primary criterion for success was defined as the ability to cost effectively remove TCE DNAPL
Site Characterization cost were not included, but were estimated to be $255,000

Lessons Learned

____

____ Energy

Total Energy Used: ____________ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____________________

x Cost

Total Project Cost: 1201175

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

x Energy Cost: 13902 ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ____________________

____ Other Cost 2: ____________________

____ Other Cost 3: ____________________

General Site Information

Facility ID#: 0343

x File Analyzed By: JT x PD ____ Date: ________

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ________

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: 27-Dec End of Test: 10-Oct Duration: 250 days

Type of Site: x Non-DOD ____ DoD

x Facility Name: FDOT Greensboro Project

Address: ________

City, State, Zip Code: Greensboro, FL

OU# or Site #: ________

x Primary point of contact: Jimmy Bailey

Organization: Florida Department of Transportation

Address: PO Box 607

City, State, Zip Code: Chipley, Florida 32428-0607

Phone #: ________ email: ________

x Other contacts or vendors who worked on site ____ None

Point of contact: David Rountree

Type: x Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: WRS Infrastructure & Environment, Inc.

Address: 625 East Tennessee Street, Suite 100

City, State, Zip Code: Tallahassee, FL 32308-4939

Phone #: 850-531-9860 email: ________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0343

x Impacted Zone: Length (parallel to flow direction)(ft.): 40 Width (ft): 40 Thickness (ft): ______ x Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 12 Post-treatment: 12

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	x Diesel	5,000 mg/L	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	x Gasoline (BTEX)	5,000 mg/L	None	None	None
	____ cis-1,2-dichloroethene	x Benzene		50 mg/L	None	1 mg/L	None
	____ trans-1,2-dichloroethene	x Tolune		10 mg/L	None	0.1 mg/L	None
	____ 1,1-dichloroethane	x Ethylbenzene		1 mg/L	None	0.1 mg/L	None
	____ 1,2-dichloroethane	x m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	x o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane	x Total xylenes		5 mg/L	None	1 mg/L	None
	____ 1,1,2,2-tetrachloroethane	x MTBE		1 mg/L	None	0.1 mg/L	None
	____ Vinyl Chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

All COCs were nondetect in post treatment samples but they did not give the detection limit.

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0343

x Geology:

Zone	Unconsolidated Sediments
Vadose Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	x Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone
Saturated Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	x Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 255 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No x Yes (number): 3 ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	10			
	high value (ft bgs):				
	Unknown:				
x Flow direction		N-NE			
x Horizontal hydraulic gradient (feet/foot):		0.005752			____ Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	1.91			____ Unknown
high	5.19			

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 0343

x Thermal treatment: ____ Conductive ________________________________
x Electrical Resistance ________________________________
____ 3 phase ____ 6 phase ____ AC power ____ DC power
____ Steam ________________________________
____ Steam ____ Steam + air ____ Steam + O2
____ Other (describe) ________________________________

x Type of Test: ____ Pilot test ____ Full-scale System

x Geology of Treatment Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
x Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 2-Jan   Duration: 250 days

x Hydraulic Control ____ Yes x No

x Treatment Cell Design:

Size of target zone (ft2):	4305	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	23	____ Unknown	
Depth to top of target zone (ft bgs):	10	____ Unknown	
Thickness of target zone below water table (ft):	13	____ Unknown	
Number of energy delivery points:	9	____ Unknown	
Number of extraction points:	16	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	15	____ Unknown
Maximum representative formation temperature (deg C):	60	____ Unknown
Time to reach maximum representative temperature (days):	170	____ Unknown
Duration of treatment at representative temperature (days):	80	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

____ Mass of contaminant removed:

Via liquid pumping:		____ lb	____ kg	____ Unknown
In vapor stream:		____ lb	____ kg	____ Unknown
Total:		____ lb	____ kg	____ Unknown

Comments:

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance   Facility ID#: 0343

x Performance

Remediation Goal:

x In Groundwater:

Source Reduction

____ In Soil:

Was the Remediation Goal Achieved:

Y In Groundwater

Comment: Total VOA (BTEX compounds went from >100,000 ug/L to <200 ug/L.

Y In Soil

Comment:

General comments on the thermal application:

Very effective at removing contamination from the ground - contaminant removal rates went up by an order of magnitude. Knowledge of extent of source material is critical to proper design. Target temperature of 70 to 80C.

Lessons Learned

The remediation worked very well where it was implemented. More detailed knowledge of the contaminant distribution would have resulted in a wider application of the thermal technology. High temperatures of recovered groundwater plus high contaminant concentrations led to chemical compatibility issues not normally seen on petroleum sites.

x Energy

Total Energy Used: 291 ____ kWhr ____ $kWhr/m^3$ x $kWhr/yd^3$

____ Total energy applied to treatment zone: ____ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information Facility ID#: 0347

x File Analyzed By: JT x PD ____ Date: 10/26/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 2/21/2005 End of Test: 5/16/2005 Duration: 85 d

Type of Site: x Non-DOD ____ DoD

x Facility Name: Confidential Europe

Address: ____________

City, State, Zip Code: Europe

OU# or Site #: ____________

x Primary point of contact: James Baldock

Organization: ERM

Address: ____________

City, State, Zip Code: ____________

Phone #: 01865 384 800 email: James.baldock@erm.com

x Other contacts or vendors who worked on site ____ None

Point of contact: Ross Pollock

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: Churngold Remediation Ltd

Address: ____________

City, State, Zip Code: ____________

Phone #: 0117 916 0510 email: ross.pollock@churngold.com

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0347

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

	In:	Upgradient:	Downgradient:	Crossgradient:
Pre-treatment	______	______	______	______
Post-treatment	______	______	______	______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

x Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	x Tetrachloroethene	____ Jet Fuel		None	None	None	None
	x 1,1-dichloroethene	____ Napthalene		None	None	None	None
	x cis-1,2-dichloroethene	____ Benzene		None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune		None	None	None	None
	x 1,1-dichloroethane	____ Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane	x total xylenes		None	None	None	None
	____ 1,1,2,2-tetrachloroethane	x Ethylbenzene		None	None	None	None
	____ Vinyl Chloride			None	None	None	None
	x chloroethane			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0347

____ Geology: Zone Unconsolidated Sediments

Vadose Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

Saturated Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: __________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): __________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 0347

x Thermal treatment: ____ Conductive ____

x Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

x Type of Test: ____ Pilot test x Full-scale System

____ Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 2/21/2005 Duration: 85 d

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2): 17222 ____ Unknown (___ x ___ ft)

Thickness of target zone (ft): ____ x Unknown

Depth to top of target zone (ft bgs): ____ x Unknown

Thickness of target zone below water table (ft): ____ x Unknown

Number of energy delivery points: 25 ____ Unknown

Number of extraction points: 23 ____ Unknown

____ Temperature Profile:

Initial formation temperature (deg C): ____ ____ Unknown

Maximum representative formation temperature (deg C): ____ ____ Unknown

Time to reach maximum representative temperature (days): ____ ____ Unknown

Duration of treatment at representative temperature (days): ____ ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

Via liquid pumping: ____ ____ lb ____ kg ____ Unknown

In vapor stream: ____ ____ lb ____ kg ____ Unknown

Total: 2000 ____ lb x kg ____ Unknown

Comments:

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance | Facility ID#: 0347

____ Performance

Remediation Goal:

____ In Groundwater: ____

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information   Facility ID#: 0350

X File Analyzed By: JT X PD ____   Date: 5/12/2005

Type of treatment: ____ Conductive ____ Steam X ERH ____ Other: ____________

Type of Contaminant: X Chlorinated Solvents X Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active X Post

Type of Test: ____ Pilot Test X Full Scale System

Start of Test: 10/3/2002   End of Test: 2/17/2003   Duration: 138d

Type of Site: ____ Non-DOD ____ DoD

X Facility Name: Young Rainey Star Center

Address: ____________

City, State, Zip Code: Largo, FL

OU# or Site #: Northeast Site Area A

X Primary point of contact: Joe Daniel

Organization: SM Stoller Corporation

Address: 7887 Bryan Dairy Rd, Suite 260

City, State, Zip Code: Largo, FL 33777

Phone #: 727-549-0603   email: joe.daniel@gjo.doe.gov

X Other contacts or vendors who worked on site ____ None

Point of contact: Jack Craig

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications s Other ____________

Organization: Department of Energy

Address: 7887 Bryan Dairy Road, Suite 195

City, State, Zip Code: Largo, FL 33777

Phone #: 412-386-4754   email: jack.craig@lm.doe.gov

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data   ____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information   ____ Flux assessment

____ Groundwater elevations   ____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0350

x Impacted Zone: Length (parallel to flow direction)(ft.): 550 Width (ft): 345 Thickness (ft): 35 ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 6 Post-treatment: 24

Number of wells relative to treatment zone:

Pre-treatment In: 6 Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: 16 Upgradient: 6 Downgradient: 2 Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 36

Number of relevant soil borings with post-treatment data: 20

Number inside treatment zone: 40 Number outside treatment zone: 16

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	5 mg/L	5 mg/kg	0.001 mg/L	0.1 mg/kg
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	x cis-1,2-dichloroethene	____ Benzene	____	1 mg/L	5 mg/kg	0.005 mg/L	0.1 mg/kg
	____ trans-1,2-dichloroethene	x Tolune	____	1 mg/L	0.1 mg/kg	0.001 mg/L	0.1 mg/kg
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	x Methylene Chloride	____	____	5 mg/L	1 mg/kg	0.005 mg/L	0.1 mg/kg
	____	x FL PRO	____	None	50 mg/kg	None	10 mg/kg
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model　　　　Facility ID#: 0350

x　Geology:　　Zone: Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x　Ground surface elevation based on wells in or adjacent to treatment zone: 17 ft amsl　　x Unknown

x　Aquifer Characteristics:

Is more than 1 aquifer present?　____ No　____ Yes (number): ________　x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	1 (Average 5)			
	high value (ft bgs):	6			
	Unknown:				
x Flow direction		ESE			
x Horizontal hydraulic gradient (feet/foot):		0.002			____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

x　K range (ft/day)　　Measured using: ____ Slug Test　____ Laboratory　____ Field data

	low	0.99			____ Unknown
	high	7.1			

Transmissivity (ft2/day):　　Measured using: ____ Slug Test　____ Laboratory　____ Field data

	low				____ Unknown
	high				

Comments:

Vertical K = 1.06e-6 to 1.06e-4 cm/s
Average with Darcys - 1ft/day and n=0.3 for 20 ft/yr

Attachments:

Thermal Treatment - Design | Facility ID#: 0350

x Thermal treatment:
- ____ Conductive ______
- x Electrical Resistance ETDSP
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- X Steam ______
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ______

x Type of Test: ____ Pilot test ____ Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- X Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 10/3/2002 Duration: 138d

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	10000	____ Unknown	(100 x 100 ft)
Thickness of target zone (ft):	35	____ Unknown	
Depth to top of target zone (ft bgs):	0	____ Unknown	
Thickness of target zone below water table (ft):	30	____ Unknown	
Number of energy delivery points:	78	____ Unknown	
Number of extraction points:	28	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	28	____ Unknown
Maximum representative formation temperature (deg C):	100	____ Unknown
Time to reach maximum representative temperature (days):	68	____ Unknown
Duration of treatment at representative temperature (days):	70	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	2/19/2003	105
Formation temperature post-treatment monitoring event 1:	4/23/2003	85
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

Via liquid pumping:		____ lb	____ kg	____ Unknown
In vapor stream:		____ lb	____ kg	____ Unknown
Total:	9920 or 3880	x lb	____ kg	____ Unknown

Comments: Mass removed provides the high and low calculations Heating cycles - ERH only for hot floor 10/3/02 to 10/22/02 and steam+ERH 10/23/02 to 2/17/03 Volume treated 10000 yd3 (1816000 ft3)

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0350

x Performance

Remediation Goal:

x In Groundwater: ug/L - TCE - 11000: cis-1,2-DCE - 50000: methylene chloride - 20000: Toluene - 5500: TPH - 50000

x In Soil:

mg/kg - TCE - 20.4; cis-1,2-DCE - 70; methylene chloride -227; Toluene - 15; TPH - 2500

Was the Remediation Goal Achieved:

x In Groundwater

Comment:

yes

x In Soil

Comment:

yes

General comments on the thermal application:

Target temperature of 84C

Lessons Learned

1) Pressure cycling is effective technique for maximizing mass removal

____ Energy

Total Energy Used: 10 E9 BTU ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____________

x Cost

Total Project Cost: 3800000

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

____ Energy Cost: ____________ ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

General Site Information — Facility ID#: 0360

X File Analyzed By: JT X PD ____ — Date: 11/15/2006

Type of treatment: ____ Conductive ____ Steam X ERH ____ Other: ____________

Type of Contaminant: X Chlorinated Solvents X Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active X Post

Type of Test: ____ Pilot Test X Full Scale System

Start of Test: ____________ End of Test: 5/15/2006 Duration: ____________

Type of Site: ____ Non-DOD ____ DoD

X Facility Name: Young Rainey Star Center

Address: ____________

City, State, Zip Code: Largo, FL

OU# or Site #: Northeast Site Area B

X Primary point of contact: Paul Darr

Organization: SM Stoller Corporation

Address: 2597 B 314 Rd

City, State, Zip Code: Grand Junction, CO 81503

Phone #: 970-248-7666 email: paul.darr@gjo.doe.gov

X Other contacts or vendors who worked on site ____ None

Point of contact: Jack Craig

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications s Other ____________

Organization: Department of Energy

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data Facility ID#: 0360

___ Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

___ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: ______

Number of relevant soil borings with post-treatment data: 32

Number inside treatment zone: ______ Number outside treatment zone: ______

___ Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____ ______	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ______	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ______	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ______	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ______	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ______	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ______	None	None	None	None
	____ 1,1,2-trichloroethane	____ ______	____ ______	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ______	____ ______	None	None	None	None
	____ Vinyl Chloride	____ ______	____ ______	None	None	None	None
	____ Methylene Chloride	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model | Facility ID#: 0360

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl x Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) — Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): — Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Vertical K = 1.06e-6 to 1.06e-4 cm/s

Average with Darcys - 1ft/day and n=0.3 for 20 ft/yr

Attachments:

Thermal Treatment - Design | Facility ID#: 0360

x Thermal treatment: ____ Conductive ________________________________

x Electrical Resistance ETDSP

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ________________________________

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ________________________________

x Type of Test: ____ Pilot test ____ Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

____ Start of Thermal Test: ____________ Duration: ____________

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2): ____________ ____ Unknown (____ x ____ ft)

Thickness of target zone (ft): ____________ ____ Unknown

Depth to top of target zone (ft bgs): ____________ ____ Unknown

Thickness of target zone below water table (ft): ____________ ____ Unknown

Number of energy delivery points: ____________ ____ Unknown

Number of extraction points: ____________ ____ Unknown

____ Temperature Profile:

Initial formation temperature (deg C): ____________ ____ Unknown

Maximum representative formation temperature (deg C): ____________ ____ Unknown

Time to reach maximum representative temperature (days): ____________ ____ Unknown

Duration of treatment at representative temperature (days): ____________ ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

Via liquid pumping:	4000	x lb	____ kg	____ Unknown
In vapor stream:	14000	x lb	____ kg	____ Unknown
Total:	18000	x lb	____ kg	____ Unknown

Comments: Mass removed provides the high and low calculations ________________ Heating cycles - ERH only for hot floor 10/3/02 to 10/22/02 and steam+ERH 10/23/02 to 2/17/03 ________________ Volume treated 10000 yd3 (1816000 ft3)

Attachments: ________________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0360

____ Performance

Remediation Goal:

____ In Groundwater:

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information — Facility ID#: 0362

x File Analyzed By: JT x PD ____ — Date: 1/9/2007

Type of treatment: ____ Conductive ____ Steam ____ ERH x Other: in situ soil mixing w/steam

Type of Contaminant: x Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ____ Full Scale System

Start of Test: Jan-03 End of Test: ____ Duration: ____

Type of Site: ____ Non-DOD x DoD

x Facility Name: Cape Canaveral AF Station SLC 15 Pilot

Address: ____

City, State, Zip Code: Cape Canaveral, FL

OU# or Site #: Space Launch Complex 15, Solid Waste Management Unite (SMWU C030)

x Primary point of contact: Phil La Mori

Organization: BEM Systems

Address: 2216 South Bentley Ave. #14

City, State, Zip Code: Los Angeles, CA 90064

Phone #: 310-445-9851 email: plamori@bemsys.com

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____

Organization: ____

Address: ____

City, State, Zip Code: ____

Phone #: ____ email: ____

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0362

____ Impacted Zone: Length (parallel to flow direction)(ft.): ____ Width (ft): ____ Thickness (ft): ____ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ____________ Number outside treatment zone: ____________

____ Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	500 mg/L	500 mg/kg	None	None
	____ Tetrachloroethene	____ Jet Fuel		None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene		None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene		None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune		None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane			None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	____ Vinyl Chloride			None	None	None	None
	x Freon 113			None	None	None	None
	x Total VOCs			500 mg/L	1,000 mg/kg	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

Source was Considered to be ansywhere w/dissolved TCE above 10 parts per million (1% solubility). Estimated 582 kg TCE mass.

Attachments:

Hydrogeologic Conceptual Model | Facility ID#: 0362

x Geology:

Zone	Unconsolidated Sediments
Vadose Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	x Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone
Saturated Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	x Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 10 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No x Yes (number): 2 ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	5	100		
	high value (ft bgs):				
	Unknown:				
x Flow direction		North (usually) sometimes East			
x Horizontal hydraulic gradient (feet/foot):		10^-3 to 10^-4			____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	10				____ Unknown
high	30				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low					____ Unknown
high					

Comments:
Vertical K in clay 0.0001 ft/day
K's - sand 1 - 30 ft/day, sand 2 - 0.5 ft/day, sand 3 - 0.1 ft/day, sand 4 - 5 ft/day
K's - clay 1 - 0.001 ft/day, clay 2 - 1(10^-4) ft/day, clay 3 - 1(10^-4) ft/day, clay 4 - 0.002 ft/day

Attachments:

Thermal Treatment - Design   Facility ID#: 0362

x Thermal treatment:
- ____ Conductive ____________________
- ____ Electrical Resistance ____________________
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- ____ Steam ____________________
  - ____ Steam ____ Steam + air ____ Steam + O2
- x Other (describe) In situ mixing with steam

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: Jan-03   Duration: 6 months

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	2764	____ Unknown (____ x ____ ft)
Thickness of target zone (ft):	35	____ Unknown
Depth to top of target zone (ft bgs):	20	____ Unknown
Thickness of target zone below water table (ft):	35	____ Unknown
Number of energy delivery points:	1 per cell	____ Unknown
Number of extraction points:	1 per cell	____ Unknown

____ Temperature Profile:

Initial formation temperature (deg C):		____ Unknown
Maximum representative formation temperature (deg C):		____ Unknown
Time to reach maximum representative temperature (days):		____ Unknown
Duration of treatment at representative temperature (days):		____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

Via liquid pumping:		____ lb	____ kg	____ Unknown
In vapor stream:		____ lb	____ kg	____ Unknown
Total:		____ lb	____ kg	____ Unknown

Comments:

Pilot has 32 test cells from 20 to 55 ft

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0362

x Performance

Remediation Goal:

x In Groundwater: 80% removal

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Goal: reduce the identifiece source are mass by atleast 80% or more to meet the objective of reaching GW cleanup target levels (GCTL)

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy:

x Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information　　　　Facility ID#: 0363

x File Analyzed By: JT x PD ____　　Date: 1/9/2007

Type of treatment: ____ Conductive ____ Steam ____ ERH x Other: in situ soil mixing w/steam

Type of Contaminant: x Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: Mar-04　End of Test: Aug-04　Duration: 6 months

Type of Site: ____ Non-DOD x DoD

x Facility Name: Cape Canaveral AF Station SLC 15 Full-scale

Address: ____

City, State, Zip Code: Cape Canaveral, FL

OU# or Site #: Space Launch Complex 15, Solid Waste Management Unite (SMWU C030)

x Primary point of contact: Phil La Mori

Organization: BEM Systems

Address: 2216 South Bentley Ave. #14

City, State, Zip Code: Los Angeles, CA 90064

Phone #: 310-445-9851　email: plamori@bemsys.com

____ Other contacts or vendors who worked on site　____ None

Point of contact: ____

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____

Organization: ____

Address: ____

City, State, Zip Code: ____

Phone #: ____　email: ____

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0363

____ Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 16 Post-treatment: 16

Number of wells relative to treatment zone:

Pre-treatment In: 16 Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: 16 Upgradient: ______ Downgradient: ______ Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 16

Number of relevant soil borings with post-treatment data: 16

Number inside treatment zone: 16/16 Number outside treatment zone: ______

x Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	500 mg/L	500 mg/kg	0.01 mg/L	0.1 mg/kg
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	x Freon 113	____	____	None	None	None	None
	x Total VOCs	____	____	500 mg/L	1,000 mg/kg	0.1 mg/L	0.5 mg/kg
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Source was Considered to be ansywhere w/dissolved TCE above 10 parts per million (1% solubility). Estimated 582 kg TCE mass.

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0363

x Geology: Zone: Unconsolidated Sediments

Vadose Zone:

- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:

- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 10 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No x Yes (number): 2 ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	5	100		
	high value (ft bgs):				
	Unknown:				
x Flow direction		North (usually) sometimes East			
x Horizontal hydraulic gradient (feet/foot):		10^-3 to 10^-4			____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	10				____ Unknown
high	30				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low					____ Unknown
high					

Comments:

Vertical K in clay 0.0001 ft/day

K's - sand 1 - 30 ft/day, sand 2 - 0.5 ft/day, sand 3 - 0.1 ft/day, sand 4 - 5 ft/day

K's - clay 1 - 0.001 ft/day, clay 2 - 1(10^-4) ft/day, clay 3 - 1(10^-4) ft/day, clay 4 - 0.002 ft/day

Attachments:

Thermal Treatment - Design Facility ID#: 0363

x Thermal treatment:
____ Conductive ____
____ Electrical Resistance ____
____ 3 phase ____ 6 phase ____ AC power ____ DC power
____ Steam ____
____ Steam ____ Steam + air ____ Steam + O2
x Other (describe) In situ mixing with steam

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
x Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: Mar-04 Duration: 6 months

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	27900	____ Unknown	(155 x 180 ft)
Thickness of target zone (ft):	35	____ Unknown	
Depth to top of target zone (ft bgs):	10	____ Unknown	
Thickness of target zone below water table (ft):	35	____ Unknown	
Number of energy delivery points:	1 per cell	____ Unknown	
Number of extraction points:	1 per cell	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	____	____ Unknown
Maximum representative formation temperature (deg C):	____	____ Unknown
Time to reach maximum representative temperature (days):	____	____ Unknown
Duration of treatment at representative temperature (days):	____	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	____	____ lb	____ kg	____ Unknown
Total:	13272	x lb	____ kg	____ Unknown

Comments:

TCE only - 4234 lb. Treated 48,000 yd3 including the deluge based (10 to 45 ft bgs) and 323 cells

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0363

x Performance

Remediation Goal:

x In Groundwater: 80% removal

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Goal: reduce the identifiece source are mass by atleast 80% or more to meet the objective of reaching GW cleanup target levels (GCTL)

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy:

x Cost

Total Project Cost: 7,163,447 (includes deluge basin ($149/yd3))

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information | Facility ID#: 0364

x File Analyzed By: JT x PD ____ | Date: 1/9/2007

Type of treatment: ____ Conductive ____ Steam ____ ERH x Other: in situ soil mixing w/steam

Type of Contaminant: x Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: Oct-04 End of Test: Jan-06 Duration: 4 months

Type of Site: ____ Non-DOD x DoD

x Facility Name: Cape Canaveral AF Station Deluge Basin

Address: ____

City, State, Zip Code: Cape Canaveral, FL

OU# or Site #: Space Launch Complex 15, Solid Waste Management Unite (SMWU C030)

x Primary point of contact: Phil La Mori

Organization: BEM Systems

Address: 2216 South Bentley Ave. #14

City, State, Zip Code: Los Angeles, CA 90064

Phone #: 310-445-9851 email: plamori@bemsys.com

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____

Organization: ____

Address: ____

City, State, Zip Code: ____

Phone #: ____ email: ____

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0364

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 31 Post-treatment: 31

Number of wells relative to treatment zone:

	In:	Upgradient:	Downgradient:	Crossgradient:
Pre-treatment	13	7	9	2
Post-treatment	13	7	9	2

x Soil Borings: Number of relevant soil borings with pre-treatment data: 23

Number of relevant soil borings with post-treatment data: 23

Number inside treatment zone: 23/23 Number outside treatment zone: ________

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	500 mg/L	500 mg/kg	0.01 mg/L	0.1 mg/kg
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	x Freon 113	____	____	None	None	None	None
	x Total VOCs	____	____	500 mg/L	1,000 mg/kg	0.1 mg/L	0.5 mg/kg
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Source was Considered to be ansywhere w/dissolved TCE above 10 parts per million (1% solubility). Estimated 272 kg TCE mass.

Attachments:

x Geology:

Zone		Unconsolidated Sediments
Vadose Zone:	____	Relatively homogeneous and permeable unconsolidated sediments
	____	Relatively homogeneous and impermeable unconsolidated sediments
	x	Largely permeable sediments with inter-bedded lenses of lower permeability material
	____	Largely impermeable sediments with inter-bedded layers of higher permeability material
	____	Competent, but fractured bedrock (i.e. crystalline rock)
	____	Weathered bedrock, limestone, sandstone
Saturated Zone:	____	Relatively homogeneous and permeable unconsolidated sediments
	____	Relatively homogeneous and impermeable unconsolidated sediments
	x	Largely permeable sediments with inter-bedded lenses of lower permeability material
	____	Largely impermeable sediments with inter-bedded layers of higher permeability material
	____	Competent, but fractured bedrock (i.e. crystalline rock)
	____	Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 10 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No x Yes (number): 2 ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	5	100		
	high value (ft bgs):				
	Unknown:				
x Flow direction		North (usually) sometimes East			
x Horizontal hydraulic gradient (feet/foot):		10^-3 to 10^-4			____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	10				____ Unknown
high	30				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low					____ Unknown
high					

Comments:

Vertical K in clay 0.0001 ft/day
K's - sand 1 - 30 ft/day, sand 2 - 0.5 ft/day, sand 3 - 0.1 ft/day, sand 4 - 5 ft/day
K's - clay 1 - 0.001 ft/day, clay 2 - 1(10^-4) ft/day, clay 3 - 1(10^-4) ft/day, clay 4 - 0.002 ft/day

Attachments:

Thermal Treatment - Design　　　　Facility ID#: 0364

x　Thermal treatment:
- ____ Conductive ________________
- ____ Electrical Resistance ________________
  - ____ 3 phase　____ 6 phase　____ AC power　____ DC power
- ____ Steam ________________
  - ____ Steam　____ Steam + air　____ Steam + O2
- x Other (describe)　In situ mixing with steam

x　Type of Test:　____ Pilot test　x Full-scale System

x　Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x　Treatment Targe Zone:　____ Saturated only　____ Vadose only　x Both (Saturated and Vadose zones)

x　Start of Thermal Test:　Oct-04　　Duration:　4 months

____ Hydraulic Control　____ Yes　____ No

x　Treatment Cell Design:

Size of target zone (ft2):	17825	____ Unknown	(115 x 155 ft)
Thickness of target zone (ft):	35	____ Unknown	
Depth to top of target zone (ft bgs):	20	____ Unknown	
Thickness of target zone below water table (ft):	35	____ Unknown	
Number of energy delivery points:	1 per cell	____ Unknown	
Number of extraction points:	1 per cell	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	________	____ Unknown
Maximum representative formation temperature (deg C):	________	____ Unknown
Time to reach maximum representative temperature (days):	________	____ Unknown
Duration of treatment at representative temperature (days):	________	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	________	________
Formation temperature post-treatment monitoring event 1:	________	________
Duration of post-treatment monitoring (days):	________	________

x　Mass of contaminant removed:

Via liquid pumping:	________	____ lb	____ kg	____ Unknown
In vapor stream:	________	____ lb	____ kg	____ Unknown
Total:	13272	x lb	____ kg	____ Unknown

Comments:

Treated 48,000 yd3 including the deluge based (20 to 55 ft bgs) and 261 cells

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0364

x Performance

Remediation Goal:

x In Groundwater: 80% removal

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Goal: reduce the identifiece source are mass by atleast 80% or more to meet the objective of reaching GW cleanup target levels (GCTL)

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy:

x Cost

Total Project Cost: 7,163,447 (includes deluge basin ($149/yd3))

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information Facility ID#: 0365

x File Analyzed By: JT x PD ____ Date: 10/26/2006

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: ____________ End of Test: ____________ Duration: ____________

Type of Site: x Non-DOD ____ DoD

x Facility Name: Gulf Power / Southern Companies

Address: ____________

City, State, Zip Code: Panama City, FL

OU# or Site #: ____________

x Primary point of contact: Jay Dablow

Organization: ERM

Address: 3 Hutton Centre, Suite 600

City, State, Zip Code: Santa Ana, CA 92707

Phone #: 714-430-1476 email: jay.dablow@erm.com

x Other contacts or vendors who worked on site ____ None

Point of contact: Victor Holstrand

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications x Other ____________

Organization: FL EPA

Address: ____________

City, State, Zip Code: ____________

Phone #: 850-595-8360 x 1212 email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good temperature profile vs. time information

____ Groundwater elevations

____ Hydraulic Conductivity information

____ Good pre- and post-treatment soil data

____ Flux assessment

____ Geologic cross-section

General Site Assessment Data

Facility ID#: 0365

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

____ Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0365

x Geology: Zone Unconsolidated Sediments

Vadose Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
x Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

Saturated Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
x Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design Facility ID#: 0365

____ Thermal treatment: ____ Conductive ____________________

____ Electrical Resistance ____________________

____ 3 phase ____ 6 phase ____ AC power ____ DC power

x Steam ____________________

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____________________

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

x Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ____________ Duration: ____________

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design: 87120

Size of target zone (ft2): ____________ ____ Unknown (___ x ___ ft)

Thickness of target zone (ft): ____________ ____ Unknown

Depth to top of target zone (ft bgs): ____________ ____ Unknown

Thickness of target zone below water table (ft): ____________ ____ Unknown

Number of energy delivery points: 26 ____ Unknown

Number of extraction points: 4 ____ Unknown

____ Temperature Profile:

Initial formation temperature (deg C): ____________ ____ Unknown

Maximum representative formation temperature (deg C): ____________ ____ Unknown

Time to reach maximum representative temperature (days): ____________ ____ Unknown

Duration of treatment at representative temperature (days): ____________ ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

____ Mass of contaminant removed:

Via liquid pumping: ____________ ____ lb ____ kg ____ Unknown

In vapor stream: ____________ ____ lb ____ kg ____ Unknown

Total: ____________ ____ lb ____ kg ____ Unknown

Comments: ____________________

Attachments: ____________________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0365

____ Performance

Remediation Goal:

____ In Groundwater: ____

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information — Facility ID#: 0368

x File Analyzed By: JT x PD ____ — Date: 11/1/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: ____________ End of Test: ____________ Duration: ____________

Type of Site: x Non-DOD ____ DoD

x Facility Name: Confidential; Tampa, FL

Address: ____________

City, State, Zip Code: Tampa, FL

OU# or Site #: ____________

x Primary point of contact: Horge Rameriz

Organization: BBL

Address: ____________

City, State, Zip Code: ____________

Phone #: 813-933-0697 ext 19 email: ____________

x Other contacts or vendors who worked on site ____ None

Point of contact: Dacre Bush

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: McMillian-McGee

Address: ____________

City, State, Zip Code: ____________

Phone #: 805-295-9071 email: dacre.bush@mcmillan-mcgee.com

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0368

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

____ Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____ ________	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ________	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ________	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ________	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ________	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ________	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ________	None	None	None	None
	____ 1,1,2-trichloroethane	____ ________	____ ________	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ________	____ ________	None	None	None	None
	____ Vinyl Chloride	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0368

____ Geology:

Zone	Unconsolidated Sediments
Vadose Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone
Saturated Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: __________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): __________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design Facility ID#: 0368

x Thermal treatment: ____ Conductive ____________

x Electrical Resistance ____________

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____________

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____________

x Type of Test: ____ Pilot test x Full-scale System

____ Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ____________ Duration: ____________

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2): ____________ ____ Unknown (___ x ___ ft)

Thickness of target zone (ft): ____________ ____ Unknown

Depth to top of target zone (ft bgs): ____________ ____ Unknown

Thickness of target zone below water table (ft): ____________ ____ Unknown

Number of energy delivery points: ____________ ____ Unknown

Number of extraction points: ____________ ____ Unknown

____ Temperature Profile:

Initial formation temperature (deg C): ____________ ____ Unknown

Maximum representative formation temperature (deg C): ____________ ____ Unknown

Time to reach maximum representative temperature (days): ____________ ____ Unknown

Duration of treatment at representative temperature (days): ____________ ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____________	____________
Formation temperature post-treatment monitoring event 1:	____________	____________
Duration of post-treatment monitoring (days):	____________	____________

____ Mass of contaminant removed:

Via liquid pumping: ____________ ____ lb ____ kg ____ Unknown

In vapor stream: ____________ ____ lb ____ kg ____ Unknown

Total: ____________ ____ lb ____ kg ____ Unknown

Comments: ____________

Attachments: ____________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0368

____ Performance

Remediation Goal:

____ In Groundwater: ____

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information   Facility ID#: 0370

x File Analyzed By: JT x PD ____   Date: 10/11/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating x Other: kerosene like specialty fuel

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 5/27/1999 End of Test: 12/10/1999 Duration: 198 days

Type of Site: x Non-DOD ____ DoD

x Facility Name: Confidential Manufacturing Plant

Address: Doraville

City, State, Zip Code: GA

OU# or Site #: ____________

x Primary point of contact: Trish Reifenberger

Organization: Brown and Caldwell

Address: 990 Hammond Drive, Suite 400

City, State, Zip Code: Atlanta, GA 30328

Phone #: 770-673-3630 email: treifenberger@brncald.com

x Other contacts or vendors who worked on site ____ None

Point of contact: Greg Beyke (White paper)

Type: x Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: TRS

Address: 4137 Jensome Lane,

City, State, Zip Code: Franklin, TN

Phone #: 615-791-5772 email: gbeyke@thermalrs.com

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data | Facility ID#: 0370

x Impacted Zone: Length (parallel to flow direction)(ft.): below Width (ft): ______ Thickness (ft): 10 ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______
Post-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ______

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: ______ Number outside treatment zone: ______

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	x specialty fuel	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene		None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene		None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune		None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane			None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	____ Vinyl Chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

Impacted zone was 4,900 ft2 up to a 10 ft thick The specialty fuel has a boiling point of 228C and a viscosity of 2 mm2/s St

Attachments:

Hydrogeologic Conceptual Model — Facility ID#: 0370

x Geology:

Zone	Unconsolidated Sediments
Vadose Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	x Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone
Saturated Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	x Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 1050 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	23			
	high value (ft bgs):	27			
	Unknown:				
Flow direction		no significant flow			
Horizontal hydraulic gradient (feet/foot):		<0.01			x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) — Measured using: ____ Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low				x Unknown
high				

Transmissivity (ft2/day): — Measured using: ____ Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low				x Unknown
high				

Comments:

Average depth to water was 24 feet

Attachments:

Thermal Treatment - Design   Facility ID#: 0370

x Thermal treatment:
- ____ Conductive
- x Electrical Resistance
  - x 3 phase ____ 6 phase ____ AC power ____ DC power
- ____ Steam
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe)

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- x Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 5/27/1999   Duration: 198 days

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	4900	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	10	____ Unknown	
Depth to top of target zone (ft bgs):	20	____ Unknown	
Thickness of target zone below water table (ft):	6	____ Unknown	
Number of energy delivery points:	50	____ Unknown	
Number of extraction points:	50	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	____	x Unknown
Maximum representative formation temperature (deg C):	____	x Unknown
Time to reach maximum representative temperature (days):	____	x Unknown
Duration of treatment at representative temperature (days):	____	x Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	____	____ lb	____ kg	____ Unknown
Total:	____	____ lb	____ kg	x Unknown

Comments:

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0370

x Performance

Remediation Goal:

x In Groundwater:

To reduce LNAPL thickness to less than 1/8 inch

x In Soil:

To reduce LNAPL thickness to less than 1/8 inch

Was the Remediation Goal Achieved:

x In Groundwater

Comment:

Yes, LNAPL was reduced

x In Soil

Comment:

Yes, LNAPL was reduced

General comments on the thermal application:

Used combination wells of extraction/monitoring and ERH electrode. Goal was only to reduce LNAPL thickness

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information　　　　Facility ID#: 0373

x File Analyzed By: JT x PD ____　　　　Date: 10/30/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: x Active ____ Post

Type of Test: ____ Pilot Test ____ Full Scale System

Start of Test: 2006 End of Test: ____________ Duration: ________

Type of Site: x Non-DOD ____ DoD

x Facility Name: Cartersville, GA

Address: ____________

City, State, Zip Code: Cartersville, GA

OU# or Site #: ____________

x Primary point of contact: David Fleming

Organization: TRS

Address: 7421-A Warren SE

City, State, Zip Code: Snoqualmie, WA 98065

Phone #: 425-396-4266 email: dfleming@thermalrs.com

x Other contacts or vendors who worked on site ____ None

Point of contact: Dave Smoak

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: Mactec

Address: ____________

City, State, Zip Code: ____________

Phone #: 770-421-3400 email: desmoak@mactec.com

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data — Facility ID#: 0373

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

____ Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	x methylene chloride	____	____	1,000 mg/L	1,000 mg/kg	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0373

____ Geology:

Zone	Unconsolidated Sediments
Vadose Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone
Saturated Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	15			
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

	low				____ Unknown
	high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

	low				____ Unknown
	high				

Comments:

Attachments:

Thermal Treatment - Design Facility ID#: 0373

x Thermal treatment: ____ Conductive ____

x Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

____ Type of Test: ____ Pilot test ____ Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 2006 Duration: ____

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	12130	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	25	____ Unknown	
Depth to top of target zone (ft bgs):	5	____ Unknown	
Thickness of target zone below water table (ft):	15	____ Unknown	
Number of energy delivery points:	56	____ Unknown	
Number of extraction points:	56	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	____	____ Unknown
Maximum representative formation temperature (deg C):	____	____ Unknown
Time to reach maximum representative temperature (days):	____	____ Unknown
Duration of treatment at representative temperature (days):	____	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

____ Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	____	____ lb	____ kg	____ Unknown
Total:	____	____ lb	____ kg	____ Unknown

Comments: ____

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0373

____ Performance

Remediation Goal:

____ In Groundwater: ______

____ In Soil: ______

Was the Remediation Goal Achieved:

____ In Groundwater ______

Comment: ______

____ In Soil ______

Comment: ______

General comments on the thermal application:

______

Lessons Learned

______

____ Energy

Total Energy Used: ______ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ______ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ______ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ______

____ Cost

Total Project Cost: ______

____ Consultant Cost: ______

____ Thermal Vendor Cost: ______

____ Energy Cost: ______ ____ m^3 ____ yd^3

____ Other Cost 1: ______

____ Other Cost 2: ______

____ Other Cost 3: ______

____ Please note other cost: ____ Other Cost 1: ______

____ Other Cost 2: ______

____ Other Cost 3: ______

General Site Information | Facility ID#: 0375

x File Analyzed By: JT x PD ____ Date: 10/30/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: x Active ____ Post

Type of Test: ____ Pilot Test ____ Full Scale System

Start of Test: 2006 End of Test: ____________ Duration: ________

Type of Site: ____ Non-DOD ____ DoD

x Facility Name: Siemens Energy and Automation Facility

Address: 2037 Weems Road

City, State, Zip Code: Tucker, GA

OU# or Site #: ____________

x Primary point of contact: David Fleming

Organization: TRS

Address: 7421-A Warren SE

City, State, Zip Code: Snoqualmie, WA 98065

Phone #: 425-396-4266 email: dfleming@thermalrs.com

x Other contacts or vendors who worked on site ____ None

Point of contact: Kevin Sweeney

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: 770-751-2346 email: kevin.sweeney@siemens.com

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data | Facility ID#: 0375

____ Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ______

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: ______ Number outside treatment zone: ______

____ Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	None	1 mg/kg	None	None
	x Tetrachloroethene	____ Jet Fuel	____	None	10 mg/kg	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	x Vinyl Chloride	____	____	None	5 mg/kg	None	None
	x methylene chloride	____	____	None	100 mg/kg	None	None
	x DCE	____	____	None	5 mg/kg	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments: ______

Attachments: ______

Hydrogeologic Conceptual Model — Facility ID#: 0375

x Geology: — Zone: Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	20			
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) — Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): — Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 0375

x Thermal treatment:
- ____ Conductive ____________________
- x Electrical Resistance ____________________
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- ____ Steam ____________________
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ____________________

____ Type of Test: ____ Pilot test ____ Full-scale System

____ Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only x Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 2006   Duration: ____________________

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	16357	____ Unknown	(____ x ____ ft)
Thickness of target zone (ft):	20	____ Unknown	
Depth to top of target zone (ft bgs):	0	____ Unknown	
Thickness of target zone below water table (ft):	0	____ Unknown	
Number of energy delivery points:	65	____ Unknown	
Number of extraction points:	65	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	____________	____ Unknown
Maximum representative formation temperature (deg C):	____________	____ Unknown
Time to reach maximum representative temperature (days):	____________	____ Unknown
Duration of treatment at representative temperature (days):	____________	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____________	____________
Formation temperature post-treatment monitoring event 1:	____________	____________
Duration of post-treatment monitoring (days):	____________	____________

____ Mass of contaminant removed:

Via liquid pumping:	____________	____ lb	____ kg	____ Unknown
In vapor stream:	____________	____ lb	____ kg	____ Unknown
Total:	____________	____ lb	____ kg	____ Unknown

Comments:

17 foot electrode spacing

Attachments: ____________________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0375

x Performance

Remediation Goal:

____ In Groundwater: ____

x In Soil:

methylene Chloride - 0.08; PCE - 0.08; TCE - 0.13; DCE - 0.53; VC - 0.04 mg/kg

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____ ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information Facility ID#: 0380

x File Analyzed By: JT x PD ____ Date: 11/9/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating x Other: PAHs

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 4/5/2002 End of Test: 8/5/2002 Duration: 120 d

Type of Site: ____ Non-DOD x DoD

x Facility Name: Hunter Army Airfield, GA

Address: ____________

City, State, Zip Code: Savannah, GA

OU# or Site #: Former Pumphouse #2

x Primary point of contact: Ana Vergara

Organization: US Army Coprs of Engineerins (USACE)

Address: 100 West Oglethorpe Avenue

City, State, Zip Code: Savannah, GA 1401

Phone #: 912-652-5835 email: ana.vergara@us.army.mil

x Other contacts or vendors who worked on site ____ None

Point of contact: Patty Stoll

Type: x Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: Science Applications International Corporation

Address: 151 Lafayette Drive, PO Box 2501

City, State, Zip Code: Oak Ridge, TN 37831

Phone #: 865-481-4600 email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data | Facility ID#: 0380

x Impacted Zone: Length (parallel to flow direction)(ft.): below Width (ft): ______ Thickness (ft): ______ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 12 Post-treatment: 12

Number of wells relative to treatment zone:

Pre-treatment In: 12 Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: 12 Upgradient: ______ Downgradient: ______ Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: ______________

Number of relevant soil borings with post-treatment data: 4

Number inside treatment zone: 1 Number outside treatment zone: 3

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	x acenaphthene	None	None	0.001 mg/L	0.5 mg/kg
	____ 1,1-dichloroethene	____ Napthalene	x anthracene	None	None	0.001 mg/L	0.5 mg/kg
	____ cis-1,2-dichloroethene	x Benzene	____	0.5 mg/L	None	0.1 mg/L	0.05 mg/kg
	____ trans-1,2-dichloroethene	x Tolune	____	1 mg/L	None	0.05 mg/L	0.01 mg/kg
	____ 1,1-dichloroethane	x Ethylbenzene	____	1 mg/L	None	0.1 mg/L	0.01 mg/kg
	____ 1,2-dichloroethane	____ m/p-xylene	x 2-methynaphthalene	None	None	0.005 mg/L	None
	____ 1,1,1-trichloroethane	____ o-xylene	x benzo(a)anthracene	None	None	None	0.5 mg/kg
	____ 1,1,2-trichloroethane	x xylenes	____	5 mg/L	None	0.1 mg/L	0.01 mg/kg
	____ 1,1,2,2-tetrachloroethane	____	x benzo(a)pyrene	None	None	None	0.5 mg/kg
	____ Vinyl Chloride	____	x benzo(b)fluoranthene	None	None	None	0.5 mg/kg
	____	____	x benzo(g,h,i)perylene	None	None	None	0.1 mg/kg
	____	____	x chrysene	None	None	None	0.1 mg/kg
	____	____	x Fluoranthene	None	None	0.01 mg/L	0.1 mg/kg
	____	____	x Fluorene	None	None	0.001 mg/L	0.1 mg/kg
	____	____	x Indeno(1,2,3-cd)pyrene	None	None	None	0.1 mg/kg
	____	____	x naphthalene	None	None	0.05 mg/L	0.1 mg/kg

Comments:

Benzene impacted area of 55,000ft2 (above 5 mg/L) in January 2002. After treatment it was 12,500 ft2 in July of 2005.
Soil concentrations (mg/kg) for ethylbenzene was 0.005 and for benzene, toluene, and xylenes it was 0.001

Attachments:

General Site Assessment Data　　　　Facility ID#: 0380

x Impacted Zone: Length (parallel to flow direction)(ft.): below　Width (ft): ______　Thickness (ft): ______　___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data:　___ None

Pre-treatment: 12　Post-treatment: 12

Number of wells relative to treatment zone:

	In:	Upgradient:	Downgradient:	Crossgradient:
Pre-treatment	12	______	______	______
Post-treatment	12	______	______	______

x Soil Borings: Number of relevant soil borings with pre-treatment data: ______

Number of relevant soil borings with post-treatment data: 4

Number inside treatment zone: 1　Number outside treatment zone: 3

x Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	x phenanthrene	None	None	0.01 mg/L	1 mg/kg
	____ 1,1-dichloroethene	____ Napthalene	x pyrene	None	None	0.005 mg/L	1 mg/kg
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____ xylenes	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0380

x Geology: Zone: Unconsolidated Sediments

Vadose Zone:
- x Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- x Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl x Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No x Yes (number): 2 ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	12			
	high value (ft bgs):	16			
	Unknown:				
x Flow direction		SW			
x Horizontal hydraulic gradient (feet/foot):		0.0072 (ave)			____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low	34.3			____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low				____ Unknown
high				

Comments:

Horizontal hydraulic gradient baried from 0.0026 to 0.0091. K=0.0121 cm/sec

Attachments:

Thermal Treatment - Design Facility ID#: 0380

x Thermal treatment:
- ____ Conductive
- x Electrical Resistance
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- ____ Steam
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe)

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:
- x Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 4/5/2002 Duration: 120d

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	30000	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	8	____ Unknown	
Depth to top of target zone (ft bgs):	8	____ Unknown	
Thickness of target zone below water table (ft):	4	____ Unknown	
Number of energy delivery points:	111	____ Unknown	
Number of extraction points:	41	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	20	____ Unknown
Maximum representative formation temperature (deg C):	90	____ Unknown
Time to reach maximum representative temperature (days):	110	____ Unknown
Duration of treatment at representative temperature (days):	10	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):	24 months	

x Mass of contaminant removed:

Via liquid pumping:		____ lb	____ kg	____ Unknown
In vapor stream:		____ lb	____ kg	____ Unknown
Total:	44000	x lb	____ kg	____ Unknown

Comments:

Electrode spacing of 18 ft; vaport recorvery wells spacing of 40 ft; 23 vapor and 18 dural phase extraction wells.

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0380

x Performance

Remediation Goal:

x In Groundwater: Cleanup in ug/L - Benezene-469, Benzo(a)pyrene-2; benzo(b)fluoranthene-2: chrysene-2; naphthalene-428: Toluene-1316000

x In Soil: Cleanup in mg/kg - benzene-0.44; benzo(a)pyrene-6.8: benzo(b)fuoranthene-24.0: chrysene-10: ethylbenzene-389: indeno(1,2,3-cd)pyrene-0.66: Toluene-2050: total xylenes-700

Was the Remediation Goal Achieved:

x In Groundwater

Comment:

yes, except for a benzene at 733 ug/L

x In Soil

Comment:

yes

General comments on the thermal application:

Lessons Learned

x Energy

Total Energy Used: 1678000 x kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

x Cost

Total Project Cost: 1301169

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

x Energy Cost: 259000 ____ m^3 ____ yd^3

x Other Cost 1: 1042169

____ Other Cost 2: ____

____ Other Cost 3: ____

x Please note other cost: x Other Cost 1: ERH system operation and maintenance

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information Facility ID#: 0390

x File Analyzed By: JT x PD ____ Date: 9/18/2006

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: Dec-95 End of Test: 1-Sep Duration: 5.5 years

Type of Site: ____ Non-DOD ____ DoD

x Facility Name: AG Communications

Address: 400 North Wolfe Rd

City, State, Zip Code: North Lake, IL

OU# or Site #: ____________

____ Primary point of contact: ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

x Geologic cross-section

x Hydraulic Conductivity information

General Site Assessment Data   Facility ID#: 0390

x Impacted Zone: Length (parallel to flow direction)(ft.): Below   Width (ft): ____   Thickness (ft): ____   ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

x Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ____   Post-treatment: ____

Number of wells relative to treatment zone:

Pre-treatment   In: ____   Upgradient: ____   Downgradient: ____   Crossgradient: ____

Post-treatment   In: ____   Upgradient: ____   Downgradient: ____   Crossgradient: ____

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____

Number of relevant soil borings with post-treatment data: ____

Number inside treatment zone: ____   Number outside treatment zone: ____

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	10 mg/L	None	0.1 mg/L	None
	____ Tetrachloroethene	____ Jet Fuel		None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene		None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene		None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune		None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane			None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	____ Vinyl Chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

Impacted 160,000 ft2 total with VOC impacting 11,000 ft2

Attachments:

Figure 3-1

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 660 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	37			
	high value (ft bgs):	440			
	Unknown:				
x Flow direction		ESE			
x Horizontal hydraulic gradient (feet/foot):					x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	see comments			____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Comments:

See attached map (Figure 1-4)

Attachments:

Figure 1-4

Thermal Treatment - Design Facility ID#: 0390

x Thermal treatment:
- ____ Conductive
- ____ Electrical Resistance
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- x Steam
  - x Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe)

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: x Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: Dec-95 Duration: 5.5 years

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	30800	____ Unknown	(____ x ____ ft)
Thickness of target zone (ft):	____	x Unknown	
Depth to top of target zone (ft bgs):	37	____ Unknown	
Thickness of target zone below water table (ft):	____	x Unknown	
Number of energy delivery points:	57	____ Unknown	
Number of extraction points:	282	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	____	x Unknown
Maximum representative formation temperature (deg C):	____	x Unknown
Time to reach maximum representative temperature (days):	____	x Unknown
Duration of treatment at representative temperature (days):	____	x Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	____	____ lb	____ kg	____ Unknown
Total:	40,000	x lb	____ kg	____ Unknown

Comments: Injection wells - 31 at 48 feet and 26 at 39 feet Extraction Wells - 205 vapor only; 75 GW/Vapor; and 2 GW only
Hydraulic control - sheet pile

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0390

____ Performance

Remediation Goal:

____ In Groundwater: ____________________

____ In Soil: ____________________

Was the Remediation Goal Achieved:

____ In Groundwater ____________________

Comment: ____________________

____ In Soil ____________________

Comment: ____________________

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____________ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____________________

x Cost

Total Project Cost: 5,600,000 (includes pilot)

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

____ Energy Cost: ____________ ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ____________________

____ Other Cost 2: ____________________

____ Other Cost 3: ____________________

General Site Information Facility ID#: 0391

x File Analyzed By: JT x PD ____ Date: 9/18/2006

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ____ Full Scale System

Start of Test: 1993 End of Test: 1994 Duration: ____________

Type of Site: ____ Non-DOD ____ DoD

x Facility Name: AG Communications

Address: 400 North Wolfe Rd

City, State, Zip Code: North Lake, IL

OU# or Site #: ____________

____ Primary point of contact: ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good temperature profile vs. time information

____ Groundwater elevations

x Hydraulic Conductivity information

____ Good pre- and post-treatment soil data

____ Flux assessment

x Geologic cross-section

General Site Assessment Data Facility ID#: 0391

x Impacted Zone: Length (parallel to flow direction)(ft.): Below Width (ft): ______ Thickness (ft): ______ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

x Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______
Post-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ______

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: ______ Number outside treatment zone: ______

x Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	10 mg/L	None	0.1 mg/L	None
	____ Tetrachloroethene	____ Jet Fuel	____ ______	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ______	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ______	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ______	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ______	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ______	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ______	None	None	None	None
	____ 1,1,2-trichloroethane	____ ______	____ ______	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ______	____ ______	None	None	None	None
	____ Vinyl Chloride	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None

Comments:

Impacted 160,000 ft2 total with VOC impacting 11,000 ft2

Attachments:

Figure 3-1

Hydrogeologic Conceptual Model — Facility ID#: 0391

x Geology:

Zone		Unconsolidated Sediments
Vadose Zone:	____	Relatively homogeneous and permeable unconsolidated sediments
	____	Relatively homogeneous and impermeable unconsolidated sediments
	____	Largely permeable sediments with inter-bedded lenses of lower permeability material
	x	Largely impermeable sediments with inter-bedded layers of higher permeability material
	____	Competent, but fractured bedrock (i.e. crystalline rock)
	____	Weathered bedrock, limestone, sandstone
Saturated Zone:	____	Relatively homogeneous and permeable unconsolidated sediments
	____	Relatively homogeneous and impermeable unconsolidated sediments
	____	Largely permeable sediments with inter-bedded lenses of lower permeability material
	x	Largely impermeable sediments with inter-bedded layers of higher permeability material
	____	Competent, but fractured bedrock (i.e. crystalline rock)
	____	Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 660 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	37			
	high value (ft bgs):	440			
	Unknown:				
x Flow direction		ESE			
x Horizontal hydraulic gradient (feet/foot):					x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) — Measured using: ____ Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low	see comments			____ Unknown
high				

Transmissivity (ft2/day): — Measured using: ____ Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low				x Unknown
high				

Comments:

Attachments:

See attached x-section

Thermal Treatment - Design   Facility ID#: 0391

x Thermal treatment: ____ Conductive ____________________

____ Electrical Resistance ____________________

____ 3 phase ____ 6 phase ____ AC power ____ DC power

x Steam ____________________

x Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____________________

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: x Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 1993   Duration: ________

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	________	x Unknown	(___ x ___ ft)
Thickness of target zone (ft):	________	x Unknown	
Depth to top of target zone (ft bgs):	________	x Unknown	
Thickness of target zone below water table (ft):	________	x Unknown	
Number of energy delivery points:	________	x Unknown	
Number of extraction points:	________	x Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	________	x Unknown
Maximum representative formation temperature (deg C):	________	x Unknown
Time to reach maximum representative temperature (days):	________	x Unknown
Duration of treatment at representative temperature (days):	________	x Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	________	________
Formation temperature post-treatment monitoring event 1:	________	________
Duration of post-treatment monitoring (days):	________	________

x Mass of contaminant removed:

Via liquid pumping:	________	____ lb	____ kg	____ Unknown
In vapor stream:	________	____ lb	____ kg	____ Unknown
Total:	500	x lb	____ kg	____ Unknown

Comments: ____________________

Attachments: ____________________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance   Facility ID#: 0391

____ Performance

Remediation Goal:

____ In Groundwater: ____

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____ ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy: ____

x Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information Facility ID#: 0395

x File Analyzed By: JT x PD ____ Date: 10/18/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test ___ Full Scale System

Start of Test: Jul-04 End of Test: Nov-04 Duration: ______

Type of Site: ____ Non-DOD ____ DoD

x Facility Name: Iowa Department of Transportation

Address: ____________

City, State, Zip Code: Sioux City, IA

OU# or Site #: ____________

x Primary point of contact: Bill Heath

Organization: CES

Address: 419 Entiat St., Suite A

City, State, Zip Code: Kennewick, WA 99336

Phone #: 509-727-4276 email: bill@cesiweb.com

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ______

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0395

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: __________ Number outside treatment zone: __________

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel		None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene		None	None	None	None
	____ cis-1,2-dichloroethene	x Benzene		None	None	None	None
	____ trans-1,2-dichloroethene	x Tolune		None	None	None	None
	____ 1,1-dichloroethane	x Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	x m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	x o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane			None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	____ Vinyl Chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0395

x Geology: Zone Unconsolidated Sediments

Vadose Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
x Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

Saturated Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
x Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	9			
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 0395

x Thermal treatment:
- ____ Conductive ____
- x Electrical Resistance ____
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- ____ Steam ____
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ____

____ Type of Test: ____ Pilot test ____ Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: Jul-04   Duration: ____

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	3800	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	10	____ Unknown	
Depth to top of target zone (ft bgs):	4	____ Unknown	
Thickness of target zone below water table (ft):	5	____ Unknown	
Number of energy delivery points:	19	____ Unknown	
Number of extraction points:	12	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	____	____ Unknown
Maximum representative formation temperature (deg C):	____	____ Unknown
Time to reach maximum representative temperature (days):	____	____ Unknown
Duration of treatment at representative temperature (days):	____	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	____	____ lb	____ kg	____ Unknown
Total:	3700	x lb	____ kg	____ Unknown

Comments:

19 ft spacing

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance　　Facility ID#: 0395

x Performance

Remediation Goal:

____ In Groundwater: ____

x In Soil:

Benzene = 4.38 mg/kg

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

____

Lessons Learned

____

x Energy

Total Energy Used:	588812	x kWhr	____ kWhr/m^3	____ kWhr/yd^3
x Total energy applied to treatment zone:	515312 kWhr		____ kWhr/m^3	____ kWhr/yd^3
x Other energy:	73500 kWhr		____ kWhr/m^3	____ kWhr/yd^3
x Please note other energy:		process equipment		

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____　____ m^3　____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost:　____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information | Facility ID#: 0400

x File Analyzed By: JT x PD ____ Date: 10/30/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test ____ Full Scale System

Start of Test: ____________ End of Test: ____________ Duration: ________

Type of Site: x Non-DOD ____ DoD

x Facility Name: Circuit Assembling Facility

Address: ____________

City, State, Zip Code: Harwood Heights, IL

OU# or Site #: ____________

x Primary point of contact: Jeff Pope

Organization: Clayton Goup

Address: 3140 Finley Rd

City, State, Zip Code: Downers Grove, IL

Phone #: 630-795-3211 email: jpope@claytongrp.com

x Other contacts or vendors who worked on site ____ None

Point of contact: Bill Heath

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: CES

Address: 419 W. Entiat St

City, State, Zip Code: Kennewick, WA 99336

Phone #: 509-727-4276 email: bill@cesiweb.com

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0400

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: __________ Number outside treatment zone: __________

____ Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____ ________	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ________	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ________	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ________	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ________	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ________	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ________	None	None	None	None
	____ 1,1,2-trichloroethane	____ ________	____ ________	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ________	____ ________	None	None	None	None
	____ Vinyl Chloride	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0400

____ Geology: Zone Unconsolidated Sediments

Vadose Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

Saturated Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	________	________	________	
	high value (ft bgs):	________	________	________	
	Unknown:	________	________	________	
____ Flow direction		________	________	________	
____ Horizontal hydraulic gradient (feet/foot):		________	________	________	____ Unknown
Vertical hydraulic gradient (feet/foot):		________	________	________	____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	________	________	________	____ Unknown
high	________	________	________	

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	________	________	________	____ Unknown
high	________	________	________	

Comments: ____

Attachments: ____

Thermal Treatment - Design Facility ID#: 0400

x Thermal treatment: ____ Conductive ____
x Electrical Resistance ____
____ 3 phase ____ 6 phase ____ AC power ____ DC power
____ Steam ____
____ Steam ____ Steam + air ____ Steam + O2
____ Other (describe) ____

____ Type of Test: ____ Pilot test ____ Full-scale System

____ Geology of Treatment Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ____ Duration: ____

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2): ____ ____ Unknown (___ x ___ ft)
Thickness of target zone (ft): ____ ____ Unknown
Depth to top of target zone (ft bgs): ____ ____ Unknown
Thickness of target zone below water table (ft): ____ ____ Unknown
Number of energy delivery points: ____ ____ Unknown
Number of extraction points: ____ ____ Unknown

____ Temperature Profile:

Initial formation temperature (deg C): ____ ____ Unknown
Maximum representative formation temperature (deg C): ____ ____ Unknown
Time to reach maximum representative temperature (days): ____ ____ Unknown
Duration of treatment at representative temperature (days): ____ ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

____ Mass of contaminant removed:

Via liquid pumping: ____ ____ lb ____ kg ____ Unknown
In vapor stream: ____ ____ lb ____ kg ____ Unknown
Total: ____ ____ lb ____ kg ____ Unknown

Comments: ____

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0400

____ Performance

Remediation Goal:

____ In Groundwater: ____________________

____ In Soil: ____________________

Was the Remediation Goal Achieved:

____ In Groundwater ____________________

Comment: ____________________

____ In Soil ____________________

Comment: ____________________

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____________ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____________________

____ Cost

Total Project Cost: ____________

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

____ Energy Cost: ____________ ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ____________________

____ Other Cost 2: ____________________

____ Other Cost 3: ____________________

General Site Information Facility ID#: 0410

x File Analyzed By: JT x PD ____ Date: 11/1/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: ____________ End of Test: ____________ Duration: ________

Type of Site: x Non-DOD ____ DoD

x Facility Name: Electronics Manufacturing Facility

Address: ____________

City, State, Zip Code: Chicago, IL

OU# or Site #: ____________

x Primary point of contact: Bill Heath

Organization: CES

Address: 419 W Entiat St

City, State, Zip Code: Kennewick, WA 99336

Phone #: 509-727-4276 email: bill@cesiweb.com

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0410

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	x Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Impacted zone of 13000 yd3 (up to 38 ft bgs)

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0410

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- x Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- x Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	15			
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 0410

x Thermal treatment: ____ Conductive ____

x Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

x Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ____ Duration: ____

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2): ____ ____ Unknown (___ x ___ ft)

Thickness of target zone (ft): ____ ____ Unknown

Depth to top of target zone (ft bgs): ____ ____ Unknown

Thickness of target zone below water table (ft): ____ ____ Unknown

Number of energy delivery points: ____ ____ Unknown

Number of extraction points: ____ ____ Unknown

____ Temperature Profile:

Initial formation temperature (deg C): ____ ____ Unknown

Maximum representative formation temperature (deg C): ____ ____ Unknown

Time to reach maximum representative temperature (days): ____ ____ Unknown

Duration of treatment at representative temperature (days): ____ ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

____ Mass of contaminant removed:

Via liquid pumping: ____ ____ lb ____ kg ____ Unknown

In vapor stream: ____ ____ lb ____ kg ____ Unknown

Total: ____ ____ lb ____ kg ____ Unknown

Comments:

Treated - 12,500 yd3

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance   Facility ID#: 0410

____ Performance

Remediation Goal:

____ In Groundwater: ____________________

____ In Soil: ____________________

Was the Remediation Goal Achieved:

____ In Groundwater ____________________

Comment: ____________________

____ In Soil ____________________

Comment: ____________________

General comments on the thermal application:

75% PCE Reduction

Lessons Learned

____

____ Energy

Total Energy Used: ____________ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____________________

x Cost

Total Project Cost: 120/yd3

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

____ Energy Cost: ____________ ____ m^3 ____ yd^3

x Other Cost 1: 300000

____ Other Cost 2: ____________

____ Other Cost 3: ____________

x Please note other cost: x Other Cost 1: capital cost

____ Other Cost 2: ____________________

____ Other Cost 3: ____________________

General Site Information Facility ID#: 0412

x File Analyzed By: JT x PD ____ Date: 10/16/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 11/18/2002 End of Test: 3/28/2003 Duration: 120 d

Type of Site: x Non-DOD ____ DoD

x Facility Name: Operating Dry cleaner

Address: ____________

City, State, Zip Code: Chicago, IL suburb

OU# or Site #: ____________

x Primary point of contact: TRS website

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

x Other contacts or vendors who worked on site ____ None

Point of contact: Jeff Pope

Type: x Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: Clayton Group

Address: ____________

City, State, Zip Code: Chicago, IL

Phone #: 630-795-3211 email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data   Facility ID#: 0412

____ Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______
Post-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ______

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: ______ Number outside treatment zone: ______

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	x Tetrachloroethene	____ Jet Fuel	____	None	5,000 mg/kg	None	50 mg/kg
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments: ______

Attachments: ______

Hydrogeologic Conceptual Model Facility ID#: 0412

x Geology: Zone Unconsolidated Sediments

Vadose Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
x Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

Saturated Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl x Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	70			
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
x Horizontal hydraulic gradient (feet/foot):					x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

	low	2.83E-05			____ Unknown
	high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

	low				x Unknown
	high				

Comments:

Attachments:

Thermal Treatment - Design

Facility ID#: 0412

x Thermal treatment:
- ____ Conductive ____________________
- x Electrical Resistance ____________________
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- ____ Steam ____________________
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ____________________

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- x Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only x Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 11/18/2002 Duration: 120 d

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	1200	____ Unknown (___ x ___ ft)
Thickness of target zone (ft):	19	____ Unknown
Depth to top of target zone (ft bgs):	4	____ Unknown
Thickness of target zone below water table (ft):	0	____ Unknown
Number of energy delivery points:	17	____ Unknown
Number of extraction points:	13	____ Unknown

x Temperature Profile:

Initial formation temperature (deg C):	10	____ Unknown
Maximum representative formation temperature (deg C):	80	____ Unknown
Time to reach maximum representative temperature (days):	42	____ Unknown
Duration of treatment at representative temperature (days):	60	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

Via liquid pumping:	____________	____ lb	____ kg	x Unknown
In vapor stream:	____________	____ lb	____ kg	x Unknown
Total:	____________	____ lb	____ kg	x Unknown

Comments: ____________________

Attachments: ____________________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0412

x Performance

Remediation Goal:

____ In Groundwater:

x In Soil:

All PCE samples to less than 529 mg/kg

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

x In Soil

Comment:

Yes, average PCE concentration = 62 mg/kg

General comments on the thermal application:

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information   Facility ID#: 0415

x File Analyzed By: JT x PD ____   Date: 10/16/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 6/25/2003 End of Test: 7/15/2005 Duration: 751

Type of Site: ____ Non-DOD ____ DoD

x Facility Name: Lockformer Site

Address: ____________

City, State, Zip Code: Lisle, IL 60532

OU# or Site #: ____________

x Primary point of contact: Steve Faryan

Organization: EPA Region 5

Address: ____________

City, State, Zip Code: ____________

Phone #: 312-353-9351 email: faryan.steve@epa.gov

x Other contacts or vendors who worked on site ____ None

Point of contact: Stan Komperda

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications x Other ____________

Organization: IL EPA

Address: ____________

City, State, Zip Code: Springfield, IL

Phone #: 217-782-5504 email: stan.komperda@epa.state.il.us

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data | Facility ID#: 0415

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	x Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0415

x Geology: Zone Unconsolidated Sediments

Vadose Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
x Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

Saturated Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	55			
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design Facility ID#: 0415

x Thermal treatment: ____ Conductive ____________

x Electrical Resistance ____________

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____________

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____________

x Type of Test: ____ Pilot test x Full-scale System

X Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

X Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

X Treatment Targe Zone: ____ Saturated only X Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 6/25/2003 Duration: 751

x Hydraulic Control ____ Yes x No

x Treatment Cell Design:

Size of target zone (ft2):	37750	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	37	____ Unknown	
Depth to top of target zone (ft bgs):	3	____ Unknown	
Thickness of target zone below water table (ft):	0	____ Unknown	
Number of energy delivery points:	214	____ Unknown	
Number of extraction points:	214	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	13	____ Unknown
Maximum representative formation temperature (deg C):	95	____ Unknown
Time to reach maximum representative temperature (days):	____________	____ Unknown
Duration of treatment at representative temperature (days):	____________	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____________	____________
Formation temperature post-treatment monitoring event 1:	____________	____________
Duration of post-treatment monitoring (days):	____________	____________

____ Mass of contaminant removed:

Via liquid pumping:	____________	____ lb	____ kg	____ Unknown
In vapor stream:	____________	____ lb	____ kg	____ Unknown
Total:	____________	____ lb	____ kg	____ Unknown

Comments:

Treated 3 to 40 ft in Areas 1 and 2, but only treated 3 to 15 ft in the Degreaser Area.

Attachments: ____________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance   Facility ID#: 0415

____ Performance

Remediation Goal:

____ In Groundwater: ____________________

____ In Soil: ____________________

Was the Remediation Goal Achieved:

____ In Groundwater ____________________

Comment: ____________________

____ In Soil ____________________

Comment: ____________________

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____________ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

x Total energy applied to treatment zone: 9015000 kwhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____________________

____ Cost

Total Project Cost: ____________

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

____ Energy Cost: ____________ ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ____________________

____ Other Cost 2: ____________________

____ Other Cost 3: ____________________

General Site Information   Facility ID#: 0420

x File Analyzed By: JT x PD ____   Date: 9/13/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 6/4/1998   End of Test: 11/20/1998   Duration: 170 days

Type of Site: x Non-DOD ____ DoD

x Facility Name: Former Electronics Manufacturing

Address: ____________

City, State, Zip Code: Skokie, IL

OU# or Site #: ____________

s Primary point of contact: Bill Heath

Organization: CES

Address: 419 Entiat Street, Suite A

City, State, Zip Code: Kennewick, WA 99336

Phone #: 509-727-4276   email: bill@cesiweb.com

____ Other contacts or vendors who worked on site   ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________   email: ____________

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0420

x Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ x Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 7 Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ______

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: ______ Number outside treatment zone: ______

x Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	10 mg/L	None	0.1 mg/L	None
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	x cis-1,2-dichloroethene	____ Benzene	____	10 mg/L	None	1 mg/L	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	x 1,1,1-trichloroethane	____ o-xylene	____	10 mg/L	None	0.1 mg/L	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model | Facility ID#: 0420

x Geology: | Zone | Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl   x Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No   ____ Yes (number): ____________   x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	7			
	high value (ft bgs):	7			
	Unknown:				
____ Flow direction					
x Horizontal hydraulic gradient (feet/foot):					x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) — Measured using: ____ Slug Test   ____ Laboratory   ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low	0.028			____ Unknown
high	0.28			

Transmissivity (ft2/day): Measured using: ____ Slug Test   ____ Laboratory   ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low				x Unknown
high				

Comments:

K = 10 -5 to 10 -4 cm/sec

Attachments:

Thermal Treatment - Design Facility ID#: 0420

x Thermal treatment:
- ____ Conductive
- x Electrical Resistance
  - ____ 3 phase x 6 phase ____ AC power ____ DC power
- ____ Steam
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe)

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: x Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 6/4/1998 Duration: 170 days

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	23,000	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	19	____ Unknown	
Depth to top of target zone (ft bgs):	5	____ Unknown	
Thickness of target zone below water table (ft):	17	____ Unknown	
Number of energy delivery points:	107	____ Unknown	
Number of extraction points:	37	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	10	____ Unknown
Maximum representative formation temperature (deg C):	100	____ Unknown
Time to reach maximum representative temperature (days):	60	____ Unknown
Duration of treatment at representative temperature (days):	70	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

Via liquid pumping:		____ lb	____ kg	x Unknown
In vapor stream:		____ lb	____ kg	x Unknown
Total:		____ lb	____ kg	x Unknown

Comments:

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance   Facility ID#: 0420

____ Performance

Remediation Goal:

____ In Groundwater: ____________________

____ In Soil: ____________________

Was the Remediation Goal Achieved:

____ In Groundwater ____________________

Comment: ____________________

____ In Soil ____________________

Comment: ____________________

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: 1,775,000   x kWhr   ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____________   ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____________   ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____________________

x Cost

Total Project Cost: 32/yd3

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

x Energy Cost: 148000   ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost:

____ Other Cost 1: ____________________

____ Other Cost 2: ____________________

____ Other Cost 3: ____________________

General Site Information Facility ID#: 0420

x File Analyzed By: JT x PD ____ Date: 9/13/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 12/1/1998 End of Test: 4/30/1999 Duration: ____

Type of Site: x Non-DOD ____ DoD

x Facility Name: Former Electronics Manufacturing

Address: ____

City, State, Zip Code: Skokie, IL

OU# or Site #: ____

s Primary point of contact: Bill Heath

Organization: CES

Address: 419 Entiat Street, Suite A

City, State, Zip Code: Kennewick, WA 99336

Phone #: 509-727-4276 email: bill@cesiweb.com

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____

Organization: ____

Address: ____

City, State, Zip Code: ____

Phone #: email: ____

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0420

x Impacted Zone: Length (parallel to flow direction)(ft.): ____ Width (ft): ____ Thickness (ft): ____ x Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ____ Post-treatment: ____

Number of wells relative to treatment zone:

Pre-treatment In: ____ Upgradient: ____ Downgradient: ____ Crossgradient: ____

Post-treatment In: ____ Upgradient: ____ Downgradient: ____ Crossgradient: ____

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____

Number of relevant soil borings with post-treatment data: ____

Number inside treatment zone: ____ Number outside treatment zone: ____

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	1 mg/L	None	0.1 mg/L	None
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	x cis-1,2-dichloroethene	____ Benzene	____	1 mg/L	None	0.1 mg/L	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	x 1,1,1-trichloroethane	____ o-xylene	____	0.01 mg/L	None	0.001 mg/L	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0420

x Geology: Zone Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ____ ft amsl x Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	7			
	high value (ft bgs):	7			
	Unknown:				
____ Flow direction					
x Horizontal hydraulic gradient (feet/foot):					x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low	0.028			____ Unknown
high	0.28			

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low				x Unknown
high				

Comments:

K = 10 -5 to 10 -4 cm/sec

Attachments:

Thermal Treatment - Design   Facility ID#: 0420

x Thermal treatment:
- ____ Conductive
- x Electrical Resistance
  - ____ 3 phase   x 6 phase   ____ AC power   ____ DC power
- ____ Steam
  - ____ Steam   ____ Steam + air   ____ Steam + O2
- ____ Other (describe)

x Type of Test: ____ Pilot test   x Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: x Saturated only   ____ Vadose only   ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 12/1/1998   Duration: 18 weeks

x Hydraulic Control   x Yes   ____ No

x Treatment Cell Design:

Size of target zone (ft2):		x Unknown	(___ x ___ ft)
Thickness of target zone (ft):		x Unknown	
Depth to top of target zone (ft bgs):		x Unknown	
Thickness of target zone below water table (ft):		x Unknown	
Number of energy delivery points:	185	____ Unknown	
Number of extraction points:	37	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	10	____ Unknown
Maximum representative formation temperature (deg C):	100	____ Unknown
Time to reach maximum representative temperature (days):	60	____ Unknown
Duration of treatment at representative temperature (days):	70	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

Via liquid pumping:		____ lb	____ kg	x Unknown
In vapor stream:		____ lb	____ kg	x Unknown
Total:		____ lb	____ kg	x Unknown

Comments:

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0420

____ Performance

Remediation Goal:

____ In Groundwater: ____

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

x Cost

Total Project Cost: $32/cubic yard

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information — Facility ID#: 0423

x File Analyzed By: JT x PD ____ — Date: 11/1/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 5/23/2006 End of Test: 10/4/2006 Duration: 134 days

Type of Site: ____ Non-DOD x DoD

x Facility Name: Naval Station Great Lakes

Address: Decauter Ave

City, State, Zip Code: Great Lakes, IL 60088

OU# or Site #: Site 22

x Primary point of contact: Bob Davis

Organization: Tetra Tech

Address: 661 Andersen Dr., Foster Plaza 7

City, State, Zip Code: Pittsburgh, PA 15220

Phone #: 412-921-7251 email: robert.davis@ttnus.com

x Other contacts or vendors who worked on site ____ None

Point of contact: David Fleming

Type: x Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: TRS

Address: 7421-A Warren Ave SE

City, State, Zip Code: Snoqualmie, WA 98065

Phone #: 425-396-4266 email: dfleming@thermalrs.com

QA/QC

X Characteristics of Interest

____ Good pre- and post-treatment groundwater data

X Good temperature profile vs. time information

____ Groundwater elevations

____ Hydraulic Conductivity information

X Good pre- and post-treatment soil data

____ Flux assessment

X Geologic cross-section

General Site Assessment Data — Facility ID#: 0423

X Impacted Zone: Length (parallel to flow direction)(ft.): 80 Width (ft): 30 Thickness (ft): 8 to 20 ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

X Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 4 Post-treatment: 3

Number of wells relative to treatment zone:

	In	Upgradient	Downgradient	Crossgradient
Pre-treatment	4	2	2	2
Post-treatment	3	2	2	2

X Soil Borings: Number of relevant soil borings with pre-treatment data: 20

Number of relevant soil borings with post-treatment data: 10

Number inside treatment zone: 10 Number outside treatment zone: 10

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	x Tetrachloroethene	____ Jet Fuel	____	None	1,000 mg/kg	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model — Facility ID#: 0423

x Geology: — Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

X Ground surface elevation based on wells in or adjacent to treatment zone: 600 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	5			
	high value (ft bgs):	10			
	Unknown:				
X Flow direction		southerly			
x Horizontal hydraulic gradient (feet/foot):			0.1		____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

x K range (ft/day) — Measured using: x Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low	0.2			____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design

Facility ID#: 0423

x Thermal treatment: ____ Conductive

x Electrical Resistance

X 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe)

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

Largely permeable sediments with inter-bedded lenses of lower permeability material

X Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 5/23/2006 Duration: 134 days

X Hydraulic Control ____ Yes X No

x Treatment Cell Design:

Size of target zone (ft2):	2400	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	16.58	____ Unknown	
Depth to top of target zone (ft bgs):	0.5	____ Unknown	
Thickness of target zone below water table (ft):	12	____ Unknown	
Number of energy delivery points:	16	____ Unknown	
Number of extraction points:	16	____ Unknown	

X Temperature Profile:

Initial formation temperature (deg C):	15	____ Unknown
Maximum representative formation temperature (deg C):	100	____ Unknown
Time to reach maximum representative temperature (days):	30	____ Unknown
Duration of treatment at representative temperature (days):	104	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		100
Formation temperature post-treatment monitoring event 1:	____	N/A
Duration of post-treatment monitoring (days):	____	N/A

X Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	____	### lb	____ kg	____ Unknown
Total:	____	### lb	____ kg	____ Unknown

Comments:

Attachments: Volume treated - 1400 yd3

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0423

x Performance

Remediation Goal:

____ In Groundwater:

x In Soil:

PCE <20 mg/kg or 98.6% reduction

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

X In Soil

Comment:

PCE <4 mg/kg, 99% reduction

General comments on the thermal application:

Lessons Learned

Clay soils (low permeability soils) - should consider additional vapor recovery wells

x Energy

Total Energy Used: ____ x kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: 632,866 ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy: ____

X Cost

Total Project Cost: ____

X Consultant Cost: 360000

x Thermal Vendor Cost: 446000

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information Facility ID#: 0425

x File Analyzed By: JT x PD ____ Date: 10/16/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 9/22/2004 End of Test: 11/1/2004 Duration: 56 d

Type of Site: x Non-DOD ____ DoD

x Facility Name: Confidential IL

Address: ____________

City, State, Zip Code: Olney, IL

OU# or Site #: ____________

x Primary point of contact: Waye Sheu

Organization: Malcolm Pirnie

Address: ____________

City, State, Zip Code: Chicago, IL

Phone #: 847-517-8114 ext 103 email: wsheu@pirnie.com

x Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: x Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: TRS

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0425

x Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ x Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: x None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 1

Number of relevant soil borings with post-treatment data: 2

Number inside treatment zone: 1 / 2 Number outside treatment zone: 0/ 0

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	None	5,000 mg/kg	None	0.01 mg/kg
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Area 1

Attachments:

General Site Assessment Data

Facility ID#: 0425

x Impacted Zone: Length (parallel to flow direction)(ft.): ____ Width (ft): ____ Thickness (ft): ____ x Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ____ None

Pre-treatment: ____ Post-treatment: ____

Number of wells relative to treatment zone:

Pre-treatment In: ____ Upgradient: ____ Downgradient: ____ Crossgradient: ____

Post-treatment In: ____ Upgradient: ____ Downgradient: ____ Crossgradient: ____

x Soil Borings: Number of relevant soil borings with pre-treatment data: 3

Number of relevant soil borings with post-treatment data: 2

Number inside treatment zone: 3 / 2 Number outside treatment zone: 0/ 0

x Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	None	10,000 mg/kg	None	0.01 mg/kg
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Area 2

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0425

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl x Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	20			
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
x Horizontal hydraulic gradient (feet/foot):					x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Comments:
Very tight soils
10 foot spacing

Attachments:

Thermal Treatment - Design   Facility ID#: 0425

x Thermal treatment: ____ Conductive ____________________

x Electrical Resistance Area 1

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____________________

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____________________

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:

- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only x Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 9/22/2004 Duration: 56 day

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	400	____ Unknown	(20 x 20 ft)
Thickness of target zone (ft):	8	____ Unknown	
Depth to top of target zone (ft bgs):	2	____ Unknown	
Thickness of target zone below water table (ft):	0	____ Unknown	
Number of energy delivery points:	4	____ Unknown	
Number of extraction points:	1	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	20	____ Unknown
Maximum representative formation temperature (deg C):	100	____ Unknown
Time to reach maximum representative temperature (days):	28	____ Unknown
Duration of treatment at representative temperature (days):	28	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

Via liquid pumping:		____ lb	____ kg	____ Unknown
In vapor stream:		____ lb	____ kg	____ Unknown
Total:	690	x lb	____ kg	____ Unknown

Comments:
10 ft spacings
Contaminant removal is from both treatment zones

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Thermal Treatment - Design Facility ID#: 0425

x Thermal treatment: ____ Conductive ____

x Electrical Resistance Area 2

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

x Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only x Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 9/22/2004 Duration: 56 day

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	600	____ Unknown	(30 x 20 ft)
Thickness of target zone (ft):	15	____ Unknown	
Depth to top of target zone (ft bgs):	20	____ Unknown	
Thickness of target zone below water table (ft):	15	____ Unknown	
Number of energy delivery points:	8	____ Unknown	
Number of extraction points:	8	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	20	____ Unknown
Maximum representative formation temperature (deg C):	95	____ Unknown
Time to reach maximum representative temperature (days):	48	____ Unknown
Duration of treatment at representative temperature (days):	8	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	____	____ lb	____ kg	____ Unknown
Total:	690	x lb	____ kg	____ Unknown

Comments: The two electrodes from the area between zones 1 and 2 are included in this sheet because they extend down to 35 ft 10 ft spacings

Contaminant removal is from both treatment zones

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0425

x Performance

Remediation Goal:

____ In Groundwater: ____________________

x In Soil:

IL EPA Csat = 4440.78 mg/kg and a site specific goal of 75.18 mg/kg

Was the Remediation Goal Achieved:

____ In Groundwater ____________________

Comment: ____________________

x In Soil

Comment:

yes

General comments on the thermal application:

____

Lessons Learned

____

x Energy

Total Energy Used: x ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____________ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____________ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy: ____________________

x Cost

Total Project Cost: ____________

____ Consultant Cost: ____________

x Thermal Vendor Cost: 232000

____ Energy Cost: ____________ ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ____________________

____ Other Cost 2: ____________________

____ Other Cost 3: ____________________

General Site Information Facility ID#: 0440

x File Analyzed By: JT x PD ____ Date: 4/18/2005

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating x Other: methylene chloride

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 12/8/1999 End of Test: 11/10/2000 Duration: 329 days

Type of Site: x Non-DOD ____ DoD

x Facility Name: Avery Dennison Mfg. Facility

Address: 2340 Ernie Krueger Circle

City, State, Zip Code: Waukegan, IL

OU# or Site #: ____________

x Primary point of contact: Jennifer Seul

Organization: IL EPA

Address: ____________

City, State, Zip Code: ____________

Phone #: 217-785-9399 email: ____________

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data — Facility ID#: 0440

x Impacted Zone: Length (parallel to flow direction)(ft.): below — Width (ft): ____ — Thickness (ft): ____ — ___ Unknown

x Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: — ___ None

Pre-treatment: ____ Post-treatment: ____

Number of wells relative to treatment zone:

Pre-treatment In: ____ Upgradient: ____ Downgradient: ____ Crossgradient: ____

Post-treatment In: ____ Upgradient: ____ Downgradient: ____ Crossgradient: ____

x Soil Borings: Number of relevant soil borings with pre-treatment data: 154

Number of relevant soil borings with post-treatment data: 20

Number inside treatment zone: 105/20 — Number outside treatment zone: 49/0

x Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	x Methylene chloride	____	____	None	1,000 mg/kg	None	1 mg/kg
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Impacted area of 16,000 yd3

Attachments:

Hydrogeologic Conceptual Model — Facility ID#: 0440

x Geology:

Zone	Unconsolidated Sediments
Vadose Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	x Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone
Saturated Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	x Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 727 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No x Yes (number): atleast 2 ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	6 (perched)			
	high value (ft bgs):	25 (average)			
	Unknown:				
x Flow direction		NW			
x Horizontal hydraulic gradient (feet/foot):		0.00328			____ Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) — Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design Facility ID#: 0440

x Thermal treatment: ____ Conductive ____________

x Electrical Resistance ____________

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____________

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____________

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

x Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

____ Start of Thermal Test: 12/8/1999 Duration: 329 days

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	24500	____ Unknown	(____ x ____ ft)
Thickness of target zone (ft):	____________	x Unknown	
Depth to top of target zone (ft bgs):	____________	x Unknown	
Thickness of target zone below water table (ft):	____________	x Unknown	
Number of energy delivery points:	95	____ Unknown	
Number of extraction points:	39	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	13	____ Unknown
Maximum representative formation temperature (deg C):	west 90 / east 80	____ Unknown
Time to reach maximum representative temperature (days):	288	____ Unknown
Duration of treatment at representative temperature (days):	41	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____________	____________
Formation temperature post-treatment monitoring event 1:	____________	____________
Duration of post-treatment monitoring (days):	____________	____________

x Mass of contaminant removed:

Via liquid pumping:	____________	____ lb	____ kg	x Unknown
In vapor stream:	____________	____ lb	____ kg	x Unknown
Total:	____________	____ lb	____ kg	x Unknown

Comments: ____________

Attachments: ____________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0440

x Performance

Remediation Goal:

____ In Groundwater: ____________________

x In Soil: Methylene chloride: unsaturated 24 mg/kg saturated 2,000 mg/kg

Was the Remediation Goal Achieved:

____ In Groundwater ____________________

Comment: ____________________

x In Soil

Comment:

yes, but note that none of the saturated soils were over 2,000 mg/kg in pre-treatment samples

General comments on the thermal application:

Had to extend the time from 25 weeks to 47 weeks because of differences in soil heating versus modelled heating

Lessons Learned

____

____ Energy

Total Energy Used: ____________ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____________________

____ Cost

Total Project Cost: ____________

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

____ Energy Cost: ____________ ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ____________________

____ Other Cost 2: ____________________

____ Other Cost 3: ____________________

General Site Information　　　　Facility ID#: 0445

x File Analyzed By: JT x PD ____　　Date: 10/18/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 7/9/2005　End of Test: 20-Dec　Duration: 164 d

Type of Site: x Non-DOD ____ DoD

x Facility Name: Former Steel Manufacturing Facility

Address: ____

City, State, Zip Code: Fort Wayne, IN

OU# or Site #: ____

x Primary point of contact: Jon Hacker

Organization: Ft. Wayne Steel Corp

Address: ____

City, State, Zip Code: ____

Phone #: 260-434-2850　email: jhacker@valbruna.us

x Other contacts or vendors who worked on site ____ None

Point of contact: Jeff Pope

Type: x Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____

Organization: Clayton Group

Address: 3140 Finley Rd

City, State, Zip Code: Downers Grove, IL 60515

Phone #: 630-795-3211　email: jpope@claytongrp.com

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0445

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	100 mg/L	5,000 mg/kg	50 mg/L	100 mg/kg
	____ Tetrachloroethene	____ Jet Fuel		None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene		None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene		None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune		None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane			None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	____ Vinyl Chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

Estimated 60,000 lbs of TCE in the soil.

Attachments:

Hydrogeologic Conceptual Model　　　　Facility ID#: 0445

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl　____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No　____ Yes (number): ________　____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	10			
	high value (ft bgs):	12			
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day)　Measured using: ____ Slug Test　____ Laboratory　____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day):　Measured using: ____ Slug Test　____ Laboratory　____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design Facility ID#: 0445

x Thermal treatment: ____ Conductive ____

x Electrical Resistance Areas A, B, and C

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

x Type of Test: ____ Pilot test x Full-scale System

____ Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

x Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 7/9/2005 Duration: 164 d

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	12289	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	14 to 26	____ Unknown	
Depth to top of target zone (ft bgs):	8	____ Unknown	
Thickness of target zone below water table (ft):	12 to 24	____ Unknown	
Number of energy delivery points:	41	____ Unknown	
Number of extraction points:	39	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	13	____ Unknown
Maximum representative formation temperature (deg C):	90	____ Unknown
Time to reach maximum representative temperature (days):	80	____ Unknown
Duration of treatment at representative temperature (days):	____	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	____	____ lb	____ kg	____ Unknown
Total:	24348	x lb	____ kg	____ Unknown

Comments: Area A - 7718 ft2 at 8 to 28 ft Area B - 2872 ft2 at 8 to 22 ft Area C - 1699 ft2 at 8 to 34 ft

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance   Facility ID#: 0445

x Performance

Remediation Goal:

x In Groundwater:

90% mass reduction

x In Soil:

90% mass reduction

Was the Remediation Goal Achieved:

x In Groundwater

Comment:

yes - 93% reduction

x In Soil

Comment:

yes - 93% reduction

General comments on the thermal application:

Lessons Learned

x Energy

Total Energy Used: 1663351   x kWhr   ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____   ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____   ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

x Cost

Total Project Cost: ____

____ Consultant Cost: ____

x Thermal Vendor Cost: 435302

____ Energy Cost: ____   ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information

Facility ID#: 0450

x File Analyzed By: JT x PD ____ Date: 9/13/2006

Type of treatment: x Conductive ____ Steam ____ ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: Jul-97 End of Test: Dec-97 Duration: 60 d

Type of Site: x Non-DOD ____ DoD

x Facility Name: Former Premix/EMS Facility

Address: 400 S. Bridge St.

City, State, Zip Code: Portland, IN

OU# or Site #: ____________

x Primary point of contact: Ralph S. Baker, Ph.D.

Organization: TerraTherm, Inc.

Address: 10 Stevens Road

City, State, Zip Code: Fitchburg, MA 01420

Phone #: 978-343-0300 email: rbaker@terratherm.com

____ Other contacts or vendors who worked on site ____ None

Point of contact: George L. Stegemeier, Ph.D.

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications X Other Shell tech. contact

Organization: GLS Engineering, Inc.

Address: 5819 Queensloch Dr.

City, State, Zip Code: Houston, TX 77096

Phone #: 713-245-7785 email: gstegemeier@shell.com

QA/QC

x Characteristics of Interest

____ Good pre- and post-treatment groundwater data

x Good pre- and post-treatment soil data

x Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

x Geologic cross-section

x Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0450

x Impacted Zone: Length (parallel to flow direction)(ft.): 150 Width (ft): 50 Thickness (ft): 7500 ___ Unknown

___ Impacted zone as defined by documentation

___ Alternative method for determining size of impacted zone (See source zone definition attachments)

___ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: x None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ___ Upgradient: ___ Downgradient: ___ Crossgradient: ___

Post-treatment In: ___ Upgradient: ___ Downgradient: ___ Crossgradient: ___

x Soil Borings: Number of relevant soil borings with pre-treatment data: 5

Number of relevant soil borings with post-treatment data: 5

Number inside treatment zone: 10 Number outside treatment zone: ______

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	___ Hexane	___ Creosote	None	100 mg/kg	None	0.01 mg/kg
	x Tetrachloroethene	___ Jet Fuel	___	None	1,000 mg/kg	None	0.1 mg/kg
	___ 1,1-dichloroethene	___ Napthalene	___	None	None	None	None
	___ cis-1,2-dichloroethene	___ Benzene	___	None	None	None	None
	___ trans-1,2-dichloroethene	___ Tolune	___	None	None	None	None
	___ 1,1-dichloroethane	___ Ethylbenzene	___	None	None	None	None
	___ 1,2-dichloroethane	___ m/p-xylene	___	None	None	None	None
	___ 1,1,1-trichloroethane	___ o-xylene	___	None	None	None	None
	___ 1,1,2-trichloroethane	___	___	None	None	None	None
	___ 1,1,2,2-tetrachloroethane	___	___	None	None	None	None
	___ Vinyl Chloride	___	___	None	None	None	None
	___	___	___	None	None	None	None
	___	___	___	None	None	None	None
	___	___	___	None	None	None	None
	___	___	___	None	None	None	None
	___	___	___	None	None	None	None
	___	___	___	None	None	None	None

Comments:

Larger treatment area

Attachments:

General Site Assessment Data Facility ID#: 0450

x Impacted Zone: Length (parallel to flow direction)(ft.): 30 Width (ft): 20 Thickness (ft): 600 ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: x None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

___ Soil Borings: Number of relevant soil borings with pre-treatment data: ________

Number of relevant soil borings with post-treatment data: ________

Number inside treatment zone: ________ Number outside treatment zone: ________

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	x 1,1-dichloroethene	____ Napthalene	____	None	0.5 mg/kg	None	0.05 mg/kg
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Smaller treatment area

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0450

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- xx Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- xx Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl x Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	22			
	high value (ft bgs):	25			
	Unknown:				
____ Flow direction					
x Horizontal hydraulic gradient (feet/foot):					x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	1.42(10 -5)			____ Unknown
high	7.09 (10 -5)			

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Comments:

k = 0.005 to 0.025 millidarcy

Attachments:

Thermal Treatment - Design Facility ID#: 0450

x Thermal treatment: x Conductive Larger treatment zone

____ Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

x Type of Test: ____ Pilot test x Full-scale System

____ Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

x Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only x Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: Jul-97 Duration: 63 d

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	7500	____ Unknown	(150 x 50 ft)
Thickness of target zone (ft):	18	____ Unknown	
Depth to top of target zone (ft bgs):	0	____ Unknown	
Thickness of target zone below water table (ft):	0	____ Unknown	
Number of energy delivery points:	130	____ Unknown	
Number of extraction points:	130	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	____	x	Unknown
Maximum representative formation temperature (deg C):	>260		Unknown
Time to reach maximum representative temperature (days):	63		Unknown
Duration of treatment at representative temperature (days):	____	x	Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	Jun-98	<37
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	x	Unknown
In vapor stream:	____	____ lb	____ kg	x	Unknown
Total:	____	____ lb	____ kg	x	Unknown

Comments:

Well spacing of 7.5 ft (triangular)

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Thermal Treatment - Design — Facility ID#: 0450

x Thermal treatment:
- x Conductive — smaller Treatment area
- ____ Electrical Resistance ____
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- ____ Steam ____
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ____

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only x Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 1997 — Duration: 60 d

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	600	____ Unknown	(30 x 20 ft)
Thickness of target zone (ft):	12	____ Unknown	
Depth to top of target zone (ft bgs):	0	____ Unknown	
Thickness of target zone below water table (ft):	0	____ Unknown	
Number of energy delivery points:	18	____ Unknown	
Number of extraction points:	18	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	____	x Unknown
Maximum representative formation temperature (deg C):	>100	____ Unknown
Time to reach maximum representative temperature (days):	60	x Unknown
Duration of treatment at representative temperature (days):	____	x Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	x Unknown
In vapor stream:	____	____ lb	____ kg	x Unknown
Total:	____	____ lb	____ kg	x Unknown

Comments:

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0450

x Performance

Remediation Goal:

____ In Groundwater: ____

x In Soil:

PCE - 8 mg/kg; TCE - 25 mg/kg: 1,1-DCE - 0.080 mg/kg

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

x In Soil

Comment:

Yes all reached in larger treatment area

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information   Facility ID#: 0470

x File Analyzed By: JT x PD ____   Date: 10/18/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides
____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: 2/14/2003 End of Test: 9/6/2003 Duration: 175 d

Type of Site: x Non-DOD ____ DoD

x Facility Name: DOE Paducah Gaseous Diffusion Plant

Address: ____________

City, State, Zip Code: Paducah, KY (McCracken County)

OU# or Site #: ____________

x Primary point of contact: Bryan Clayton

Organization: Bechtel-Jacobs

Address: ____________

City, State, Zip Code: ____________

Phone #: 270-441-5412 email: btc@bechteljacobs.org

x Other contacts or vendors who worked on site ____ None

Point of contact: David Williams & David Dollins

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications x Other EPA / DOE

Organization: EPA / DOE

Address: ____________

City, State, Zip Code: ____________

Phone #: 4045628554 / 2704416819 email: ____________

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0470

x Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ x Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 4 Post-treatment: 4

Number of wells relative to treatment zone:

	In:	Upgradient:	Downgradient:	Crossgradient:
Pre-treatment	2	1	1	0
Post-treatment	2	1	1	0

x Soil Borings: Number of relevant soil borings with pre-treatment data: 11

Number of relevant soil borings with post-treatment data: 9

Number inside treatment zone: 11 / 9 Number outside treatment zone: 0 / 0

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	1,000 mg/L	100 mg/kg	5 mg/L	1 mg/kg
	____ Tetrachloroethene	____ Jet Fuel	x Technitium-99	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene		None	None	None	None
	x cis-1,2-dichloroethene	____ Benzene		None	None	None	None
	x trans-1,2-dichloroethene	____ Tolune		None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane			None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	x Vinyl Chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

Estimated 209,000 gallons of TCE was released

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0470

x Geology:

Zone	Unconsolidated Sediments
Vadose Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	x Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone
Saturated Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	x Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 370 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No x Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	36	53		
	high value (ft bgs):	39			
	Unknown:				
x Flow direction			N		
x Horizontal hydraulic gradient (feet/foot):					x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low		100		____ Unknown
high		1000		

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low				x Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design

Facility ID#: 0470

x Thermal treatment:
- ____ Conductive
- x Electrical Resistance
  - ____ 3 phase   x 6 phase   ____ AC power   ____ DC power
- ____ Steam
  - ____ Steam   ____ Steam + air   ____ Steam + O2
- ____ Other (describe)

x Type of Test: x Pilot test   ____ Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only   ____ Vadose only   x Both (Saturated and Vadose zones)

x Start of Thermal Test: 2/14/2003   Duration: 175 d

x Hydraulic Control   x Yes   ____ No

x Treatment Cell Design:

Size of target zone (ft2):	6825	____ Unknown	(105 x 65 ft)
Thickness of target zone (ft):	95	____ Unknown	
Depth to top of target zone (ft bgs):	2	____ Unknown	
Thickness of target zone below water table (ft):	67	____ Unknown	
Number of energy delivery points:	6	____ Unknown	
Number of extraction points:	6	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	20	____ Unknown
Maximum representative formation temperature (deg C):	70	____ Unknown
Time to reach maximum representative temperature (days):	112	____ Unknown
Duration of treatment at representative temperature (days):	63	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	9/5/2003	91
Formation temperature post-treatment monitoring event 1:	10/29/2003	58
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

Via liquid pumping:		____ lb	____ kg	____ Unknown
In vapor stream:		____ lb	____ kg	____ Unknown
Total:	10377	____ lb	x kg	____ Unknown

Comments:

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance   Facility ID#: 0470

x Performance

Remediation Goal:

x In Groundwater:

RGA (~50-90') groundwater to less than 1% TCE solubility (11000ppb)

x In Soil:

UCRS (0-50') to reduce TCE in soil by 75%

Was the Remediation Goal Achieved:

x In Groundwater

Comment:

Yes a 99.1% reduction

x In Soil

Comment:

Yes, a 98% reduction

General comments on the thermal application:

Objective: To demonstrate implementability of this technology in UCRS saturated and unsaturated soil and in RGA groundwater

Lessons Learned

Electrodes can fail to heat at discrete depths if the steel shot displaces the electric insulating (bentonite) materials making the electrode act as 1 continuous electrode which in turn may not have feed enough power to the bottom of the electrode to heat up the formation.

x Energy

Total Energy Used: 2283850   x kWhr   ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____________   ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____________   ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy: ____________

x Cost

Total Project Cost: 6300000

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

____ Energy Cost: ____________   ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

General Site Information Facility ID#: 0495

x File Analyzed By: JT x PD ____ Date: 10/30/2006

Type of treatment: ____ Conductive ____ Steam ____ ERH x Other: RFH

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____

Treatment Status: x Active ___ Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 1-Oct End of Test: ____ Duration: ____

Type of Site: x Non-DOD ____ DoD

x Facility Name: Confidential; Boston, MA

Address: ____

City, State, Zip Code: Boston, MA

OU# or Site #: ____

x Primary point of contact: Karen Brody or Joseph Fiacco

Organization: ERM

Address: 399 Boylston St., 6th Floor

City, State, Zip Code: Boston, MA 02166

Phone #: 617-646-7800 email: Karen.brody@erm.com

x Other contacts or vendors who worked on site ____ None

Point of contact: Ray Kasevich

Type: x Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____

Organization: KSN Energies

Address: 291 Main St., 3rd Floor, PO Box 612

City, State, Zip Code: Great Barrington, MA 01230

Phone #: 413-528-4651 email: rkasevich@ksnenergies.com

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data	Facility ID#: 0495

____ Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

	In:	Upgradient:	Downgradient:	Crossgradient:
Pre-treatment	______	______	______	______
Post-treatment	______	______	______	______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ______

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: ______ Number outside treatment zone: ______

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	x 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0495

x Geology: Zone Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- x Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- x Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

	low				____ Unknown
	high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

	low				____ Unknown
	high				

Comments: ____________________

Attachments: ____________________

Thermal Treatment - Design Facility ID#: 0495

x Thermal treatment: ____ Conductive ____________________

____ Electrical Resistance ____________________

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____________________

____ Steam ____ Steam + air ____ Steam + O2

x Other (describe) RFH

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

x Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ____________ Duration: ____________

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2): ____________ ____ Unknown (___ x ___ ft)

Thickness of target zone (ft): ____________ ____ Unknown

Depth to top of target zone (ft bgs): ____________ ____ Unknown

Thickness of target zone below water table (ft): ____________ ____ Unknown

Number of energy delivery points: ____________ ____ Unknown

Number of extraction points: ____________ ____ Unknown

____ Temperature Profile:

Initial formation temperature (deg C): ____________ ____ Unknown

Maximum representative formation temperature (deg C): ____________ ____ Unknown

Time to reach maximum representative temperature (days): ____________ ____ Unknown

Duration of treatment at representative temperature (days): ____________ ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____________	____________
Formation temperature post-treatment monitoring event 1:	____________	____________
Duration of post-treatment monitoring (days):	____________	____________

____ Mass of contaminant removed:

Via liquid pumping: ____________ ____ lb ____ kg ____ Unknown

In vapor stream: ____________ ____ lb ____ kg ____ Unknown

Total: ____________ ____ lb ____ kg ____ Unknown

Comments: ____________________

Attachments: ____________________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0495

____ Performance

Remediation Goal:

____ In Groundwater:

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information | | Facility ID#: 0500

x File Analyzed By: JT x PD ____ | Date: 7/26/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 7/31/2003 End of Test: 9/22/2003 Duration: 53 days

Type of Site: ____ Non-DOD x DoD

x Facility Name: Naval Weapons Industrial Reserve Plant

Address: ____________

City, State, Zip Code: Bedford, MA

OU# or Site #: Site 3

x Primary point of contact: Maritza Montegross

Organization: Navy NAVFAC Mid-Atlantic

Address: 9742 Maryland Ave.

City, State, Zip Code: Norfok, VA 23511

Phone #: 757-444-5872 email: maritza.montegross@navy.mil

x Other contacts or vendors who worked on site ____ None

Point of contact: Joe Francis

Type: x Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: TetraTech

Address: 133 Federal St., 6th Floor

City, State, Zip Code: Boston, MA 02110

Phone #: 617-457-8409 email: joseph.francis@tteci.com

QA/QC

x Characteristics of Interest

x Good pre- and post-treatment groundwater data ____ Good pre- and post-treatment soil data

x Good temperature profile vs. time information x Flux assessment

____ Groundwater elevations ____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data   Facility ID#: 0500

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 17   Post-treatment: 17

Number of wells relative to treatment zone:

	In:	Upgradient:	Downgradient:	Crossgradient:
Pre-treatment	7	2	4	4
Post-treatment	17	______	______	______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 9

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

w Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	10 mg/L	1 mg/kg	1 mg/L	None
	x Tetrachloroethene	____ Jet Fuel	____	1 mg/L	0.5 mg/kg	0.05 mg/L	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	x cis-1,2-dichloroethene	____ Benzene	____	1 mg/L	None	None	None
	x trans-1,2-dichloroethene	____ Tolune	____	0.01 mg/L	None	None	None
	x 1,1-dichloroethane	____ Ethylbenzene	____	1 mg/L	0.01 mg/kg	0.01 mg/L	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	x 1,1,1-trichloroethane	____ o-xylene	____	1 mg/L	0.01 mg/kg	0.01 mg/L	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	x 1,2-DCE (total)	____	____	1 mg/L	0.5 mg/kg	0.5 mg/L	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Pg 29 - Pilot report (appendix A) for pre data and pg 34 for post data   Appendix D in Appendix A - Soils data

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0500

x Geology: Zone Unconsolidated Sediments

Vadose Zone:
- x Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl x Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3
Depth to water:	low value (ft bgs):	15		
	high value (ft bgs):	30		
	Unknown:			

x Flow direction WSW

x Horizontal hydraulic gradient (feet/foot): x Unknown

Vertical hydraulic gradient (feet/foot): x Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low 0.099 ____ Unknown

high

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low x Unknown

high

Comments:
K = 3.5e-5 cm/s
No GW elevation data yet

Attachments:

Thermal Treatment - Design   Facility ID#: 0500

x Thermal treatment:
- ____ Conductive
- x Electrical Resistance
  - ____ 3 phase   x 6 phase   ____ AC power   ____ DC power
- ____ Steam
  - ____ Steam   ____ Steam + air   ____ Steam + O2
- ____ Other (describe)

x Type of Test: x Pilot test   ____ Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: x Saturated only   ____ Vadose only   ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 7/31/2006   Duration: 53 days

x Hydraulic Control   x Yes   ____ No

x Treatment Cell Design:

Size of target zone (ft2):	3200	____ Unknown	(40 x 80 ft)
Thickness of target zone (ft):	35	____ Unknown	
Depth to top of target zone (ft bgs):	20	____ Unknown	
Thickness of target zone below water table (ft):	35	____ Unknown	
Number of energy delivery points:	24	____ Unknown	
Number of extraction points:	24	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	13	____ Unknown
Maximum representative formation temperature (deg C):	95	____ Unknown
Time to reach maximum representative temperature (days):	38	____ Unknown
Duration of treatment at representative temperature (days):	15	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

Via liquid pumping:		____ lb	____ kg	____ Unknown
In vapor stream:		____ lb	____ kg	____ Unknown
Total:	89.9	x lb	____ kg	____ Unknown

Comments:
14 ft electrode spacing
Total 112,000 ft3

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance   Facility ID#: 0500

x Performance

Remediation Goal:

x In Groundwater: 1. determine the potential effectiveness, implementability, and xost of using ERH to treat entire source area; 2. 95% reduction in VOCs in pilot test area; 3. develop cost info

____ In Soil: ____

Was the Remediation Goal Achieved:

x In Groundwater

Comment:

No, cis-1,2-DCE went way up

____ In Soil

Comment: ____

General comments on the thermal application:

GW table dropped in treatment zone and contaminated GW might have flowed into treated area 85% of total energy of 726391 kWhr

Lessons Learned

Know lithology well when designing an application

x Energy

Total Energy Used: 616786 x kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information　　　　Facility ID#: 0501

x File Analyzed By: JT x PD ____ Date: 7/26/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 7/31/2003 End of Test: 9/22/2003 Duration: 53 days

Type of Site: ____ Non-DOD x DoD

x Facility Name: Naval Weapons Industrial Reserve Plant

Address: ____

City, State, Zip Code: Bedford, MA

OU# or Site #: Site 4

x Primary point of contact: Maritza Montegross

Organization: Navy NAVFAC Mid-Atlantic

Address: 9742 Maryland Ave.

City, State, Zip Code: Norfolk, VA 23511

Phone #: 757-444-5872 email: maritza.montegross@navy.mil

x Other contacts or vendors who worked on site ____ None

Point of contact: Joe Francis

Type: x Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____

Organization: TetraTech

Address: 133 federal St., 6th Floor

City, State, Zip Code: Boston, MA 02110

Phone #: 617-457-8409 email: joseph.francis@tteci.com

QA/QC

x Characteristics of Interest

x Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

x Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

x Hydraulic Conductivity information

General Site Assessment Data Facility ID#: 0501

____ Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 9 Post-treatment: 9

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 7

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: ______ Number outside treatment zone: ______

w Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	x Napthalene	____	None	10 mg/kg	None	None
	____ cis-1,2-dichloroethene	x Benzene	____	0.5 mg/L	None	0.005 mg/L	None
	____ trans-1,2-dichloroethene	x Tolune	____	1 mg/L	10 mg/kg	0.5 mg/L	None
	____ 1,1-dichloroethane	x Ethylbenzene	____	5 mg/L	100 mg/kg	0.5 mg/L	None
	____ 1,2-dichloroethane	x m/p-xylene	____	1 mg/L	50 mg/kg	0.1 mg/L	None
	____ 1,1,1-trichloroethane	x o-xylene	____	1 mg/L	10 mg/kg	0.1 mg/L	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Post-treatment GW data - pg. 32 and pre-treatment GW - pg. 19 Soil samples only have pre data and benzene was ND in all soil samples based on the detection limit Source zone was 50ft by 20ft by 18.5ft (9.5 to 28)

Attachments:

Hydrogeologic Conceptual Model | Facility ID#: 0501

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- x Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl   x Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	10.5			
	high value (ft bgs):	20.5			
	Unknown:				
x Flow direction		NNW			
x Horizontal hydraulic gradient (feet/foot):					x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) — Measured using: ____ Slug Test ____ Laboratory ____ Field data

		Aquifer 1	Aquifer 2	Aquifer 3	
K range (ft/day)	low	0.0032			____ Unknown
	high	0.0992			

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

		Aquifer 1	Aquifer 2	Aquifer 3	
Transmissivity (ft2/day)	low				x Unknown
	high				

Comments:
K = 3.5e-5 cm/s to 11.2e-7 cm/s No GW elevation data yet

Attachments:

Thermal Treatment - Design   Facility ID#: 0501

x Thermal treatment:
- ____ Conductive
- x Electrical Resistance
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- ____ Steam
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe)

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: x Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 7/31/2006 Duration: 53 days

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	1000	____ Unknown	(20 x 50 ft)
Thickness of target zone (ft):	18.5	____ Unknown	
Depth to top of target zone (ft bgs):	9.5	____ Unknown	
Thickness of target zone below water table (ft):	11	____ Unknown	
Number of energy delivery points:	8	____ Unknown	
Number of extraction points:	8	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	14	____ Unknown
Maximum representative formation temperature (deg C):	93	____ Unknown
Time to reach maximum representative temperature (days):	50	____ Unknown
Duration of treatment at representative temperature (days):	3	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	9/22/2003	92
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

Via liquid pumping:		____ lb	____ kg	____ Unknown
In vapor stream:		____ lb	____ kg	____ Unknown
Total:	69.5	x lb	____ kg	____ Unknown

Comments: 15 ft electrode spacing
6 months of post-treatment sampling
Total 19,425 ft3 or 719 yd3

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0501

x Performance

Remediation Goal:

x In Groundwater:

Achieve site cleanup objective of 50 ppb benzene in GW

____ In Soil:

Was the Remediation Goal Achieved:

x In Groundwater

Comment:

Yes, in treatment zone

____ In Soil

Comment:

General comments on the thermal application:

23% of total 726,391 kWhr

Lessons Learned

x Energy

Total Energy Used: 167070 x kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information | Facility ID#: 0505

x File Analyzed By: JT x PD ____ | Date: 10/26/2006

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating x Other: PCBs

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test ___ Full Scale System

Start of Test: 14-Jun-01 End of Test: ____________ Duration: ________

Type of Site: x Non-DOD ____ DoD

x Facility Name: Metal Recycling Facility (H. Cohen)

Address: ____

City, State, Zip Code: Boston, MA

OU# or Site #: ____

x Primary point of contact: Brian Coty

Organization: Shaw

Address: 88C Elm Street

City, State, Zip Code: Hopkinton, MA 01748-1656

Phone #: 508-435-9561 email: brian.coty@shawgrp.com

x Other contacts or vendors who worked on site ____ None

Point of contact: Jay Dablow

Type: x Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: ERM (formerly Shaw)

Address: 3 Hutton Centre, Suite 600

City, State, Zip Code: Santa Ana, CA 92707

Phone #: 714-430-1476 email: jay.dablow@erm.com

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data Facility ID#: 0505

x Impacted Zone: Length (parallel to flow direction)(ft.): 125 Width (ft): 150 Thickness (ft): 1 ___ Unknown

x Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: __________ Post-treatment: __________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ____________ Number outside treatment zone: ____________

____ Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0505

x Geology: Zone Unconsolidated Sediments

Vadose Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
x Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

Saturated Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
x Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ ____ Unknown (assume single aquifer)

	Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water: low value (ft bgs):	8			
high value (ft bgs):	10			
Unknown:				
____ Flow direction				
____ Horizontal hydraulic gradient (feet/foot):				____ Unknown
Vertical hydraulic gradient (feet/foot):				____ Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	0.011			____ Unknown
high	0.36			

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 0505

x Thermal treatment:
- ____ Conductive ____________
- ____ Electrical Resistance ____________
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- x Steam ____________
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ____________

____ Type of Test: ____ Pilot test ____ Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: Jun-01   Duration: ____________

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	____________	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	____________	____ Unknown	
Depth to top of target zone (ft bgs):	____________	____ Unknown	
Thickness of target zone below water table (ft):	5	____ Unknown	
Number of energy delivery points:	16	____ Unknown	
Number of extraction points:	6	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	10	____ Unknown
Maximum representative formation temperature (deg C):	60	____ Unknown
Time to reach maximum representative temperature (days):	____________	____ Unknown
Duration of treatment at representative temperature (days):	____________	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____________	____________
Formation temperature post-treatment monitoring event 1:	____________	____________
Duration of post-treatment monitoring (days):	____________	____________

____ Mass of contaminant removed:

Via liquid pumping:	____________	____ lb	____ kg	____ Unknown
In vapor stream:	____________	____ lb	____ kg	____ Unknown
Total:	____________	____ lb	____ kg	____ Unknown

Comments: ____________

Attachments: ____________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0505

____ Performance

Remediation Goal:

____ In Groundwater: ____

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information | Facility ID#: 0510

x File Analyzed By: JT x PD ____ Date: 10/26/2006

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: Mar-00 End of Test: Jun-01 Duration: 15 months

Type of Site: x Non-DOD ____ DoD

x Facility Name: Manufacturing Facility - Plastics

Address: ____________

City, State, Zip Code: Holyoke, MA

OU# or Site #: ____________

x Primary point of contact: ____________

Organization: ENSR

Address: 2 Technology Park Drive

City, State, Zip Code: Westford, MA 01886

Phone #: 978-589-3000 email: ____________

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data　　　　Facility ID#: 0510

____ Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______
Post-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ______

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: ______ Number outside treatment zone: ______

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	x Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	x Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	x Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	x m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	x o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	x styrene	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0510

x Geology: Zone Unconsolidated Sediments

Vadose Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
x Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

Saturated Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
x Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	________	________	________	
	high value (ft bgs):	________	________	________	
	Unknown:	________	________	________	
____ Flow direction		________	________	________	
____ Horizontal hydraulic gradient (feet/foot):		________	________	________	____ Unknown
Vertical hydraulic gradient (feet/foot):		________	________	________	____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	________	________	________	____ Unknown
high	________	________	________	

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	________	________	________	____ Unknown
high	________	________	________	

Comments: ____

Attachments: ____

Thermal Treatment - Design | Facility ID#: 0510

x Thermal treatment:
- ____ Conductive ____
- ____ Electrical Resistance ____
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- x Steam ____
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ____

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: Mar-00 Duration: 15 months

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2):	____	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	25	____ Unknown	
Depth to top of target zone (ft bgs):	____	____ Unknown	
Thickness of target zone below water table (ft):	____	____ Unknown	
Number of energy delivery points:	____	____ Unknown	
Number of extraction points:	____	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	____	____ Unknown
Maximum representative formation temperature (deg C):	____	____ Unknown
Time to reach maximum representative temperature (days):	____	____ Unknown
Duration of treatment at representative temperature (days):	____	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

____ Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	____	____ lb	____ kg	____ Unknown
Total:	____	____ lb	____ kg	____ Unknown

Comments:

22,500 yd3 treated in two ares of 1600 yd2 and 1100 yd2

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0510

____ Performance

Remediation Goal:

____ In Groundwater: ____

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

x Cost

Total Project Cost: $46/yd3

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

x Other Cost 1: 850000

x Other Cost 2: 180000/yr

____ Other Cost 3: ____

x Please note other cost: x Other Cost 1: Capital cost

x Other Cost 2: O&M

____ Other Cost 3: ____

General Site Information | Facility ID#: 0515

x File Analyzed By: JT x PD x | Date: 9/13/2006

Type of treatment: x Conductive ____ Steam ____ ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating x Other: coal tar, PCP, B(a)P

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 4-Mar End of Test: 5-Mar Duration: 360

Type of Site: x Non-DOD ____ DoD

x Facility Name: Former Manufactured gas plant

Address: ____________

City, State, Zip Code: North Adams, MA

OU# or Site #: ____________

x Primary point of contact: Ralph Baker

Organization: TerraTherm

Address: 356 Broad Street

City, State, Zip Code: Fitchburg. MA

Phone #: 978-343-0300 email: rbaker@terratherm.com

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

x Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data — Facility ID#: 0515

x Impacted Zone: Length (parallel to flow direction)(ft.): 62 Width (ft): 62 Thickness (ft): 18 ___ Unknown

x Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 1 Post-treatment: ________

Number of wells relative to treatment zone:

	In	Upgradient	Downgradient	Crossgradient
Pre-treatment	1			
Post-treatment				

x Soil Borings: Number of relevant soil borings with pre-treatment data: 8

Number of relevant soil borings with post-treatment data: 7

Number inside treatment zone: 6 pre, 7 post Number outside treatment zone: 2

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	x TPH*	None	5,000 mg/kg	None	50 mg/kg
	____ 1,1-dichloroethene	x Napthalene	____	None	500 mg/kg	None	5 mg/kg
	____ cis-1,2-dichloroethene	x Benzene	____	None	1,000 mg/kg	None	0.5 mg/kg
	____ trans-1,2-dichloroethene	x Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	x Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	x coal tar	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	x benzo(a)pyrene	None	10 mg/kg	None	0.5 mg/kg
	____ 1,1,2-trichloroethane	x xylenes (total)	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	x pentachlorophenol	None	None	None	None
	____ Vinyl Chloride	____	x phenanthrene	None	100 mg/kg	None	5 mg/kg
	____	____	x methy napthalene	None	None	None	None
	____	____	x anthracene	None	10 mg/kg	None	0.5 mg/kg
	____	____	x benzo(a)anthracene	None	10 mg/kg	None	0.5 mg/kg
	____	____	x chrysene	None	10 mg/kg	None	0.5 mg/kg
	____	____	x pyrene	None	50 mg/kg	None	1 mg/kg
	____	____	x fluoranthene	None	50 mg/kg	None	1 mg/kg

Comments:

* C11 - C22 aromatics

unadjusted

Numbers are based on the depths of 6 to 14 feet, see the attached sheet for concentrations per chemical average for 14 to 18 feet

Attachments:

Hydrogeologic Conceptual Model	Facility ID#: 0515

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- x Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ____ ft amsl x Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? x No ____ Yes (number): ____ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	3			
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
x Horizontal hydraulic gradient (feet/foot):					x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Comments:
Geology is all fill;
Local aquifer outside of the gas holder is DTW = 33 ft

Attachments:

Thermal Treatment - Design   Facility ID#: 0515

x Thermal treatment: x Conductive ____

____ Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone: x Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only x Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 4-Mar   Duration: 370 days

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	3020	____ Unknown	(62 x 62 ft)
Thickness of target zone (ft):	12	____ Unknown	
Depth to top of target zone (ft bgs):	5	____ Unknown	
Thickness of target zone below water table (ft):	12	____ Unknown	
Number of energy delivery points:	25	____ Unknown	
Number of extraction points:	8	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	16	____ Unknown
Maximum representative formation temperature (deg C):	325	____ Unknown
Time to reach maximum representative temperature (days):	291	____ Unknown
Duration of treatment at representative temperature (days):	79	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	3/17/2005	271
Formation temperature post-treatment monitoring event 1:	6/3/2005	123
Duration of post-treatment monitoring (days):	90	____

x Mass of contaminant removed:

Via liquid pumping:	16,700 gal of coal tar	____ lb	____ kg	____ Unknown
In vapor stream:	166,000 as napthalene	x lb	____ kg	____ Unknown
Total:	____	____ lb	____ kg	____ Unknown

Comments:

25 wells spaced on ~12ft centers. Operated in 3 stages: 1) dewatering, 2) thermally-enhanced free-product recovery with gentle heating, and 3) ISTD to achieve targe interwell temperatures of 617F (325C)

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0515

x Performance

Remediation Goal:

x In Groundwater: (1) eliminate DNAPL, (2) reduce VOCs and SVOCs, VPH , EPH to below UCLs via ISTD; (3) reduce VOSc, SVOCs, VPH, EPH, to below S-3 GW - 1 standards

x In Soil: Benzo(a)pyrene [B(a)P] - 4 mg/kg; Benzene - 10 mgkg; TPH* - 200 mg/Kg (* C11-C22 aromatics, unadjusted)

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

x In Soil

Comment:

was met from 6-14 feet, but not from 14-18' except for benzen which was met.

General comments on the thermal application:

____

Lessons Learned

____

x Energy

Total Energy Used: 701,000 x kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

x Thermal Vendor Cost: 850,000

x Energy Cost: 55,000 ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

x Please note other cost: x Other Cost 1: ~237/ton

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information Facility ID#: 0517

` File Analyzed By: JT x PD ____ Date: 8/20/2007

Type of treatment: x Conductive ____ Steam ____ ERH ____ Other: ____________

Type of Contaminant: X Chlorinated Solvents X Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating Other: ____________

Treatment Status: Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 8/15/2006 End of Test: 3/16/2007 Duration: 214 Days

Type of Site: X Non-DOD ____ DoD

x Facility Name: South Eastern MA

Address: ____________

City, State, Zip Code: South Eastern MA

OU# or Site #: ____________

x Primary point of contact: Ralph Baker

Organization: TerraTherm

Address: 10 Stevens Road

City, State, Zip Code: Fitchburg, MA 01420

Phone #: 978-343-0300 email: rbaker@terratherm.com

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0517

____ Impacted Zone: Length (parallel to flow direction)(ft.): 125 Width (ft): 80 Thickness (ft): 21 ___ Unknown

X Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 22 Post-treatment: 20

Number of wells relative to treatment zone:

	In	Upgradient	Downgradient	Crossgradient
Pre-treatment	1	0	13	8
Post-treatment	0	0	13	8

____ Soil Borings: Number of relevant soil borings with pre-treatment data: 1

Number of relevant soil borings with post-treatment data: 20

Number inside treatment zone: 20 Number outside treatment zone: ________

____ Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel		None	None	None	None
	____ 1,1-dichloroethene	X Napthalene		None	5,000 mg/kg	None	50 mg/kg
	____ cis-1,2-dichloroethene	____ Benzene		None	None	None	None
	____ trans-1,2-dichloroethene	X Tolune		None	500 mg/kg	None	0.5 mg/kg
	____ 1,1-dichloroethane	X Ethylbenzene		None	1 mg/kg	None	0.01 mg/kg
	____ 1,2-dichloroethane	X m/p-xylene		None	1 mg/kg	None	0.01 mg/kg
	____ 1,1,1-trichloroethane	X o-xylene		None	1 mg/kg	None	0.01 mg/kg
	____ 1,1,2-trichloroethane			None	None	None	None
	X 1,1,2,2-tetrachloroethane			None	0.1 mg/kg	None	0.01 mg/kg
	____ Vinyl Chloride			None	None	None	None
	X 1,2,3 and 1,2,4 Trichlorobenzene			None	5,000 mg/kg	None	10 mg/kg
	X 1,2 and 1,3 and 1,4 dichlorobenzene			None	500 mg/kg	None	0.5 mg/kg
	X 1,2,3 and 1,2,4 trimethylbenzene			None	1 mg/kg	None	0.01 mg/kg
	X chlorobenzene			None	100 mg/kg	None	0.01 mg/kg
				None	None	None	None
				None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model   Facility ID#: 0517

____ Geology:

Zone	Unconsolidated Sediments	
Vadose Zone:	X	Relatively homogeneous and permeable unconsolidated sediments
	____	Relatively homogeneous and impermeable unconsolidated sediments
	____	Largely permeable sediments with inter-bedded lenses of lower permeability material
	____	Largely impermeable sediments with inter-bedded layers of higher permeability material
	____	Competent, but fractured bedrock (i.e. crystalline rock)
	____	Weathered bedrock, limestone, sandstone
Saturated Zone:	X	Relatively homogeneous and permeable unconsolidated sediments
	____	Relatively homogeneous and impermeable unconsolidated sediments
	____	Largely permeable sediments with inter-bedded lenses of lower permeability material
	____	Largely impermeable sediments with inter-bedded layers of higher permeability material
	____	Competent, but fractured bedrock (i.e. crystalline rock)
	____	Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: 200 ft amsl   Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? X No   ____ Yes (number): ________   X Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	14			
	high value (ft bgs):	16			
	Unknown:				
____ Flow direction		North			
____ Horizontal hydraulic gradient (feet/foot):		0.01			____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day)   Measured using: X Slug Test   ____ Laboratory   ____ Field data

low	28				____ Unknown
high					

Transmissivity (ft2/day):   Measured using: ____ Slug Test   ____ Laboratory   ____ Field data

low					____ Unknown
high					

Comments: 0-14 ft bgs consisted of fill material and layers of tar (napthalene, toluene, TCB, DCB and MCB). 14-21 ft bgs consisted of native sands.

Attachments:

Thermal Treatment - Design Facility ID#: 0517

X Thermal treatment: X Conductive In Situ Thermal Desorption

____ Electrical Resistance ________

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ________

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ________

____ Type of Test: ____ Pilot test X Full-scale System

____ Geology of Treatment Zone:

- X Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only X Both (Saturated and Vadose zones)

____ Start of Thermal Test: 8/15/2007 Duration: 214 Days

____ Hydraulic Control X Yes No

____ Treatment Cell Design:

Size of target zone (ft2):	10,175	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	21	____ Unknown	
Depth to top of target zone (ft bgs):	0	____ Unknown	
Thickness of target zone below water table (ft):	5 to 7	____ Unknown	
Number of energy delivery points:	70	____ Unknown	
Number of extraction points:	Lateral Screens were Used for Vapor Extraction	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	15	____ Unknown
Maximum representative formation temperature (deg C):	150 (vadose), 100 (saturated)	____ Unknown
Time to reach maximum representative temperature (days):	200 Days	____ Unknown
Duration of treatment at representative temperature (days):	________	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	________	________
Formation temperature post-treatment monitoring event 1:	________	________
Duration of post-treatment monitoring (days):	________	________

____ Mass of contaminant removed:

Via liquid pumping:	?	____ lb	____ kg	____ Unknown
In vapor stream:	15,000	X lb	____ kg	____ Unknown
Total:	>>15000	X lb	____ kg	____ Unknown

Comments: Mass removed by the hydraulic containment/NAPL recovery system unknown at this time.

Attachments: ________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0517

____ Performance

Remediation Goal:

____ In Groundwater:

X In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

X In Soil

Comment: saturated zone. No evidence of vertical mobilization of tar/NAPL based on visual inspection of soil cores through treated tar zones and post treatment soil concentration data.

General comments on the thermal application:

Lessons Learned

____ Energy

Total Energy Used: 1,900,000 X kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost: 1,370,000

____ Energy Cost: 266,000 ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information   Facility ID#: 0520

X File Analyzed By: JT X PD ____   Date: 11/9/2006

Type of treatment: ____ Conductive ____ Steam X ERH ____ Other: ________

Type of Contaminant: X Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ________

Treatment Status: ____ Active X Post

Type of Test: X Pilot Test ___ Full Scale System

Start of Test: 10/11/2002   End of Test: 1/9/2003   Duration: 90 d

Type of Site: ____ Non-DOD X DoD

X Facility Name: Silresim Superfund Site

Address: ________

City, State, Zip Code: Lowell, MA

OU# or Site #: ________

X Primary point of contact: Jim DiLorenzo

Organization: EPA

Address: ________

City, State, Zip Code: ________

Phone #: 617-918-1247   email: dilorenzo.jim@epa.gov

____ Other contacts or vendors who worked on site   ____ None

Point of contact: ________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: ________

Address: ________

City, State, Zip Code: ________

Phone #: ________   email: ________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0520

X Impacted Zone: Length (parallel to flow direction)(ft.): 725 Width (ft): 225 Thickness (ft): 40 ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

X Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 7 Post-treatment: 7

Number of wells relative to treatment zone:

Pre-treatment	In: 3	Upgradient: 2	Downgradient: 2	Crossgradient: ______
Post-treatment	In: 3	Upgradient: 2	Downgradient: 2	Crossgradient: ______

X Soil Borings: Number of relevant soil borings with pre-treatment data: 10

Number of relevant soil borings with post-treatment data: 8

Number inside treatment zone: 3 Number outside treatment zone: 5

X Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	X Trichloroethene	____ Hexane	____ Creosote	500 mg/L	500 mg/kg	50 mg/L	5 mg/kg
	X Tetrachloroethene	____ Jet Fuel	____	10 mg/L	100 mg/kg	5 mg/L	0.5 mg/kg
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	X Tolune	____	10 mg/L	None	1 mg/L	None
	____ 1,1-dichloroethane	X Ethylbenzene	____	5 mg/L	100 mg/kg	1 mg/L	0.5 mg/kg
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	X 1,1,1-trichloroethane	____ o-xylene	____	100 mg/L	None	10 mg/L	None
	____ 1,1,2-trichloroethane	X Xylenes	____	5 mg/L	500 mg/kg	1 mg/L	0.1 mg/kg
	____ 1,1,2,2-tetrachloroethane	X Styrene	____	10 mg/L	None	1 mg/L	None
	____ Vinyl Chloride	X Acetone	____	10 mg/L	10 mg/kg	100 mg/L	5 mg/kg
	X Chloroform	____	____	50 mg/L	None	5 mg/L	None
	X Chlorobenzene	____	____	10 mg/L	None	1 mg/L	None
	X Total VOCs	____	____	500 mg/L	None	100 mg/L	None
	X Total chlorinated VOCs	____	____	500 mg/L	None	50 mg/L	None
	X Total aromatics	____	____	50 mg/L	None	10 mg/L	None
	X VOCs - Ketones	____	____	10 mg/L	None	100 mg/L	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0520

X Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- X Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- X Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____ ft amsl ____ Unknown

X Aquifer Characteristics:

Is more than 1 aquifer present? ____ No X Yes (number): 3 ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	5			
	high value (ft bgs):	10			
	Unknown:				
X Flow direction		Northwest			
X Horizontal hydraulic gradient (feet/foot):		0.017	0.009 / 0.021		____ Unknown
Vertical hydraulic gradient (feet/foot):		0.079 - 0.183			____ Unknown

X K range (ft/day) — Measured using: ____ Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low	1.1	0.31	0.27	____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design Facility ID#: 0520

X Thermal treatment:
____ Conductive ____________________
X Electrical Resistance ____________________
____ 3 phase X 6 phase ____ AC power ____ DC power
____ Steam ____________________
____ Steam ____ Steam + air ____ Steam + O2
____ Other (describe) ____________________

X Type of Test: X Pilot test ____ Full-scale System

X Geology of Treatment Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
X Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

X Treatment Targe Zone: ____ Saturated only ____ Vadose only X Both (Saturated and Vadose zones)

X Start of Thermal Test: 10/11/2002 Duration: 90 d

X Hydraulic Control X Yes ____ No

X Treatment Cell Design:

Size of target zone (ft2):	850	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	40	____ Unknown	
Depth to top of target zone (ft bgs):	2.5	____ Unknown	
Thickness of target zone below water table (ft):	35	____ Unknown	
Number of energy delivery points:	12	____ Unknown	
Number of extraction points:	4	____ Unknown	

X Temperature Profile:

Initial formation temperature (deg C):	10	____ Unknown
Maximum representative formation temperature (deg C):	105	____ Unknown
Time to reach maximum representative temperature (days):	~73	____ Unknown
Duration of treatment at representative temperature (days):	~17	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

X Mass of contaminant removed:

Via liquid pumping:		____ lb	____ kg	____ Unknown
In vapor stream:		____ lb	____ kg	____ Unknown
Total:	1500	X lb	____ kg	____ Unknown

Comments:

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0520

X Performance

Remediation Goal:

____ In Groundwater: ____

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

Objective: Prove efficacy of ERH at site by reducing soil and groundwater contaminant concentrations.

Lessons Learned

Tubing in 70 wells melted, so need to use a non-coated teflon tubing with a thick wall.

X Energy

Total Energy Used: 286,200 X kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

X Cost

Total Project Cost: 1,600,000

____ Consultant Cost: ____

____ Thermal Vendor Cost: 400,000

____ Energy Cost: 30,000 ____ m^3 ____ yd^3

X Other Cost 1: 180,000

X Other Cost 2: 140,000

X Other Cost 3: 800,000

X Please note other cost: X Other Cost 1: drilling, site prep and restoration and pre- and post- sampling

X Other Cost 2: lab (80,000) and GAC (60,000)

X Other Cost 3: everything else

General Site Information Facility ID#: 0528

x File Analyzed By: JT x PD ____ Date: 10/18/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test ____ Full Scale System

Start of Test: ____________ End of Test: ____________ Duration: ________

Type of Site: x Non-DOD ____ DoD

x Facility Name: Naval Station Annapolis

Address: ____________

City, State, Zip Code: Annapolis, MD

OU# or Site #: ____________

x Primary point of contact: Steven Kawachak

Organization: Shaw

Address: ____________

City, State, Zip Code: ____________

Phone #: 609-588-6349 email: sgkawachak@shawgrp.com

x Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant Vendor, Technical Applications ____ Other ________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good temperature profile vs. time information
- ____ Groundwater elevations
- ____ Hydraulic Conductivity information
- ____ Good pre- and post-treatment soil data
- ____ Flux assessment
- ____ Geologic cross-section

General Site Assessment Data Facility ID#: 0528

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ________________

Number of relevant soil borings with post-treatment data: ________________

Number inside treatment zone: __________ Number outside treatment zone: __________

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	x 1,1,2,2-tetrachloroethane	____	____	0.01 mg/L	100 mg/kg	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Estimated 60,000 lbs of TCE in the soil.

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0528

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:

____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

Saturated Zone:

____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	60			
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design Facility ID#: 0528

x Thermal treatment: ____ Conductive ______

x Electrical Resistance ______

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ______

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ______

____ Type of Test: ____ Pilot test ____ Full-scale System

____ Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

____ Start of Thermal Test: ______ Duration: ______

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	8577	____ Unknown	(116 x 94 ft)
Thickness of target zone (ft):	56	____ Unknown	
Depth to top of target zone (ft bgs):	29	____ Unknown	
Thickness of target zone below water table (ft):	25	____ Unknown	
Number of energy delivery points:	24	____ Unknown	
Number of extraction points:	______	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	______	____ Unknown
Maximum representative formation temperature (deg C):	______	____ Unknown
Time to reach maximum representative temperature (days):	______	____ Unknown
Duration of treatment at representative temperature (days):	______	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	______	______
Formation temperature post-treatment monitoring event 1:	______	______
Duration of post-treatment monitoring (days):	______	______

____ Mass of contaminant removed:

Via liquid pumping:	______	____ lb	____ kg	____ Unknown
In vapor stream:	______	____ lb	____ kg	____ Unknown
Total:	______	____ lb	____ kg	____ Unknown

Comments: ______

Attachments: ______

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0528

x Performance

Remediation Goal:

x In Groundwater: ____

x In Soil:

90% reduction in soil of 9.7 mg/kg

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____ ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information   Facility ID#: 0530

x File Analyzed By: JT x PD ____   Date: 11/4/2006

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: 9/1/2002 End of Test: 11/19/2002 Duration: 83 d

Type of Site: ____ Non-DOD x DoD

x Facility Name: Loring Air Force Base

Address: ____________

City, State, Zip Code: Limestone, ME

OU# or Site #: ____________

x Primary point of contact: Eva Davis

Organization: US EPA - Kerr Laboraties

Address: ____________

City, State, Zip Code: Ada, OK 74820

Phone #: 580-436-8548 email: davis.eva@epamail.epa.gov

x Other contacts or vendors who worked on site ____ None

Point of contact: Naji Akladiss

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ME Department of Environmental Protection

Address: ____________

City, State, Zip Code: Augusta, ME 04333

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data   Facility ID#: 0530

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 15 Post-treatment: 15

Number of wells relative to treatment zone:

Pre-treatment In: 15 Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: 15 Upgradient: ______ Downgradient: ______ Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 17

Number of relevant soil borings with post-treatment data: 8

Number inside treatment zone: 17 Number outside treatment zone: 8

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	0.001 mg/L	1 mg/kg	0.005 mg/L	0.1 mg/kg
	x Tetrachloroethene	____ Jet Fuel	____ ________	1 mg/L	10 mg/kg	0.05 mg/L	1 mg/kg
	x 1,1-dichloroethene	____ Napthalene	____ ________	None	0.05 mg/kg	0.001 mg/L	None
	x cis-1,2-dichloroethene	____ Benzene	____ ________	None	0.1 mg/kg	0.001 mg/L	0.1 mg/kg
	x trans-1,2-dichloroethene	____ Tolune	____ ________	None	0.05 mg/kg	None	0.01 mg/kg
	____ 1,1-dichloroethane	x Ethylbenzene	____ ________	0.001 mg/L	0.1 mg/kg	0.001 mg/L	None
	x 1,2-dichloroethane	____ m/p-xylene	____ ________	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ________	None	None	None	None
	____ 1,1,2-trichloroethane	x Benzene	____ ________	0.001 mg/L	0.05 mg/kg	0.001 mg/L	0.1 mg/kg
	____ 1,1,2,2-tetrachloroethane	x Toluene	____ ________	None	0.5 mg/kg	0.001 mg/L	0.1 mg/kg
	x Vinyl Chloride	____ ________	____ ________	None	0.05 mg/kg	None	None
	x carbon tetrachloride	____ ________	____ ________	0.001 mg/L	None	0.01 mg/L	None
	____ ________	x xylene	____ ________	0.005 mg/L	0.5 mg/kg	0.01 mg/L	0.1 mg/kg
	____ ________	x chlorobenzen	____ ________	None	0.05 mg/kg	0.001 mg/L	0.05 mg/kg
	____ ________	x styrene	____ ________	0.005 mg/L	None	None	None
	x methylene chloride	____ ________	____ ________	0.001 mg/L	None	None	None
	____ ________	x napthalene	____ ________	None	None	0.001 mg/L	0.1 mg/kg

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0530

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:

- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- x Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:

- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- x Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 740 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	20			
	high value (ft bgs):	30			
	Unknown:				
x Flow direction		SW			
x Horizontal hydraulic gradient (feet/foot):		0.03			____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	1.10E-05			____ Unknown
high	1.10E-03			

Comments:

Attachments:

Thermal Treatment - Design Facility ID#: 0530

x Thermal treatment: ____ Conductive ____________

____ Electrical Resistance ____________

____ 3 phase ____ 6 phase ____ AC power ____ DC power

x Steam ____________

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____________

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

x Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 9/1/2002 Duration: 83 d

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	7500	____ Unknown	(50 x 150 ft)
Thickness of target zone (ft):	100	____ Unknown	
Depth to top of target zone (ft bgs):	0	____ Unknown	
Thickness of target zone below water table (ft):	70 to 80	____ Unknown	
Number of energy delivery points:	9	____ Unknown	
Number of extraction points:	7	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	7	____ Unknown
Maximum representative formation temperature (deg C):	25	____ Unknown
Time to reach maximum representative temperature (days):	83	____ Unknown
Duration of treatment at representative temperature (days):	1	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	3.3	____ lb	x kg	____ Unknown
In vapor stream:	4.03	____ lb	x kg	____ Unknown
Total:	7.36	____ lb	x kg	____ Unknown

Comments: ____________

Attachments: ____________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0530

____ Performance

Remediation Goal:

____ In Groundwater:

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Objective - Improving the understanding of mechanisms controlling DNAPL an ddissolved phase contaminant behavior in fractured bedrock, evaluating howa remedation technology could be successfully implemented and controlled in fractured bedrock, reduce the mass of contaminants in the subsurface to reduce overall remediation timeframe, and evaluating characterization needs for fractured bedrock systems.

Demobilization costs are not included in the cost below.

Lessons Learned

x Energy

Total Energy Used: 445.03 x kWhr ____ kWhr/m^3 ____ kWhr/yd^3

x Total energy applied to treatment zone: 357.25 kWhr ____ kWhr/m^3 ____ kWhr/yd^3

x Other energy: 87.78 kWhr ____ kWhr/m^3 ____ kWhr/yd^3

x Please note other energy: extracted steam energy

x Cost

Total Project Cost: 1918850

____ Consultant Cost: ____

x Thermal Vendor Cost: 863000

____ Energy Cost: ____ ____ m^3 ____ yd^3

x Other Cost 1: 375800

x Other Cost 2: 426050

x Other Cost 3: 254000

x Please note other cost:

x Other Cost 1: Characterization

x Other Cost 2: construction and operation

x Other Cost 3: post-sampling, reporting, and miscellaneous

General Site Information | | Facility ID#: 0532

x File Analyzed By: JT x PD ____ Date: 10/30/2006

Type of treatment: ____ Conductive ____ Steam ____ ERH x Other: Hot air

Type of Contaminant: ____ Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 1/16/1996 End of Test: Mar-98 Duration: 2 years

Type of Site: x Non-DOD ____ DoD

x Facility Name: Union Chemical Company Superfund Site

Address: ____

City, State, Zip Code: South Hope, ME

OU# or Site #: ____

x Primary point of contact: Terrence Connelly

Organization: EPA

Address: 1 Congress Street, Suite 110

City, State, Zip Code: ____

Phone #: 617-918-1373 email: connelly.terry@epa.gov

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____

Organization: ____

Address: ____

City, State, Zip Code: ____

Phone #: ____ email: ____

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data ____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information ____ Flux assessment

____ Groundwater elevations ____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data Facility ID#: 0532

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 28 Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

____ Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____ ________	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ________	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ________	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ________	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ________	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ________	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ________	None	None	None	None
	____ 1,1,2-trichloroethane	____ ________	____ ________	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ________	____ ________	None	None	None	None
	____ Vinyl Chloride	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None

Comments: ________

Attachments: ________

Hydrogeologic Conceptual Model   Facility ID#: 0532

____ Geology:

Zone	Unconsolidated Sediments
Vadose Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone
Saturated Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	________	________	________	
	high value (ft bgs):	________	________	________	
	Unknown:	________	________	________	
____ Flow direction		________	________	________	
____ Horizontal hydraulic gradient (feet/foot):		________	________	________	____ Unknown
Vertical hydraulic gradient (feet/foot):		________	________	________	____ Unknown

____ K range (ft/day)   Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	________	________	________	____ Unknown
high	________	________	________	

Transmissivity (ft2/day):   Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	________	________	________	____ Unknown
high	________	________	________	

Comments: ____

Attachments: ____

Thermal Treatment - Design Facility ID#: 0532

x Thermal treatment: ____ Conductive ____

____ Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____

____ Steam ____ Steam + air ____ Steam + O2

x Other (describe) Hot air

x Type of Test: ____ Pilot test x Full-scale System

____ Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 16-Jan-96 Duration: 2 years

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2): ____ ____ Unknown (___ x ___ ft)

Thickness of target zone (ft): ____ ____ Unknown

Depth to top of target zone (ft bgs): ____ ____ Unknown

Thickness of target zone below water table (ft): ____ ____ Unknown

Number of energy delivery points: 91 ____ Unknown

Number of extraction points: 30 ____ Unknown

____ Temperature Profile:

Initial formation temperature (deg C): ____ ____ Unknown

Maximum representative formation temperature (deg C): ____ ____ Unknown

Time to reach maximum representative temperature (days): ____ ____ Unknown

Duration of treatment at representative temperature (days): ____ ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

____ Mass of contaminant removed:

Via liquid pumping: ____ ____ lb ____ kg ____ Unknown

In vapor stream: ____ ____ lb ____ kg ____ Unknown

Total: ____ ____ lb ____ kg ____ Unknown

Comments: ____

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance   Facility ID#: 0532

____ Performance

Remediation Goal:

____ In Groundwater: ____________________

____ In Soil: ____________________

Was the Remediation Goal Achieved:

____ In Groundwater ____________________

Comment: ____________________

____ In Soil ____________________

Comment: ____________________

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____________ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____________________

____ Cost

Total Project Cost: ____________

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

____ Energy Cost: ____________ ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ____________________

____ Other Cost 2: ____________________

____ Other Cost 3: ____________________

General Site Information Facility ID#: 0535

x File Analyzed By: JT x PD ____ Date: 9/18/2006

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

x Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 1995 End of Test: 2001 Duration: 59 months

Type of Site: x Non-DOD ____ DoD

x Facility Name: Bell Lumber and Pole Company

Address: ____________

City, State, Zip Code: New Brighton, MY

OU# or Site #: ____________

x Primary point of contact: Lyle Johnson

Organization: Western Research Institute

Address: 365 N. 9th St.

City, State, Zip Code: Laramie, WY 82072

Phone #: 307-721-2281 email: lylej@uwyo.edu

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0535

x Impacted Zone: Length (parallel to flow direction)(ft.): below Width (ft): ______ Thickness (ft): ______ ___ Unknown

x Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

	In:	Upgradient:	Downgradient:	Crossgradient:
Pre-treatment	______	______	______	______
Post-treatment	______	______	______	______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 22

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: ______ Number outside treatment zone: ______

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	x Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	x PCP	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	x Fuel Oil	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene		None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune		None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane			None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	____ Vinyl Chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

2 acres impacted

Attachments:

Hydrogeologic Conceptual Model | Facility ID#: 0535

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl   x Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No   ____ Yes (number): ____________   ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	10			
	high value (ft bgs):	20			
	Unknown:				
x Flow direction		SW			
x Horizontal hydraulic gradient (feet/foot):		0.004			____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

x K range (ft/day)   Measured using: ____ Slug Test   ____ Laboratory   ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low	3.1(10^-3) cm/s			____ Unknown
high	9.5(10^-3) cm/s			

Transmissivity (ft2/day):   Measured using: ____ Slug Test   ____ Laboratory   ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low				____ Unknown
high				

Comments:
Confining layer K=1(10^-7)cm/s
Radial velocity is 0.1 to 0.6 ft/dy

Attachments:

Thermal Treatment - Design

Facility ID#: 0535

x Thermal treatment:
____ Conductive
____ Electrical Resistance
____ 3 phase ____ 6 phase ____ AC power ____ DC power
x Steam Hot water
____ Steam ____ Steam + air ____ Steam + O2
____ Other (describe)

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
x Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: x Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 1995 Duration: 59 months

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	26136	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):		x Unknown	
Depth to top of target zone (ft bgs):		x Unknown	
Thickness of target zone below water table (ft):		x Unknown	
Number of energy delivery points:	6	____ Unknown	
Number of extraction points:	1	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):		x Unknown
Maximum representative formation temperature (deg C):	54	____ Unknown
Time to reach maximum representative temperature (days):	450	____ Unknown
Duration of treatment at representative temperature (days):		x Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

Via liquid pumping:		____ lb	____ kg	____ Unknown
In vapor stream:		____ lb	____ kg	____ Unknown
Total:	500,000	x lb	____ kg	____ Unknown

Comments: Mass removed = 83,155 gallons

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0535

____ Performance

Remediation Goal:

____ In Groundwater: ____

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

Project did not achieve design flow rates or temperature. Organic production exceeded expretations. Only treated upper 1/3 o the impacted zone

Lessons Learned

____

____ Energy

Total Energy Used: ____ ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy: ____

x Cost

Total Project Cost: 1858400

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information — Facility ID#: 0540

x File Analyzed By: JT x PD ____ — Date: 10/26/2006

Type of treatment: ____ Conductive ____ Steam ____ ERH x Other: RFH

Type of Contaminant: ____ Chlorinated Solvents X Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: 2/18/1998 End of Test: 8/21/1998 Duration: 185 days

Type of Site: x Non-DOD ____ DoD

x Facility Name: Mobil Oil

Address: ____________

City, State, Zip Code: MN

OU# or Site #: ____________

x Primary point of contact: Ray Kasevich

Organization: KSN Energies

Address: 291 Main St., 3rd Floor, PO Box 612

City, State, Zip Code: Great Barrington, MA 01230

Phone #: 413-528-4651 email: rkasevich@ksnenergies.com

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data — Facility ID#: 0540

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 11 Post-treatment: 11

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 10

Number of relevant soil borings with post-treatment data: 10

Number inside treatment zone: ________ Number outside treatment zone: ________

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	x GRO	____	100 mg/L	100 mg/kg	100 mg/L	50 mg/kg
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0540

x Geology: Zone Unconsolidated Sediments

Vadose Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
x Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

Saturated Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
x Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	30			
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	53.9			____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

K = 0.019 cm/sec

Attachments:

Thermal Treatment - Design   Facility ID#: 0540

x Thermal treatment:
- ____ Conductive ____________
- ____ Electrical Resistance ____________
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- ____ Steam ____________
  - ____ Steam ____ Steam + air ____ Steam + O2
- x Other (describe) RFH

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only x Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 2/18/1998   Duration: 185 d

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	____________	____ Unknown (___ x ___ ft)
Thickness of target zone (ft):	10	____ Unknown
Depth to top of target zone (ft bgs):	20	____ Unknown
Thickness of target zone below water table (ft):	0	____ Unknown
Number of energy delivery points:	3	____ Unknown
Number of extraction points:	10	____ Unknown

x Temperature Profile:

Initial formation temperature (deg C):	15.5	____ Unknown
Maximum representative formation temperature (deg C):	____________	____ Unknown
Time to reach maximum representative temperature (days):	____________	____ Unknown
Duration of treatment at representative temperature (days):	____________	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____________	____________
Formation temperature post-treatment monitoring event 1:	____________	____________
Duration of post-treatment monitoring (days):	____________	____________

x Mass of contaminant removed:

Via liquid pumping:	____________	____ lb	____ kg	____ Unknown
In vapor stream:	____________	____ lb	____ kg	____ Unknown
Total:	2305	____ lb	x kg	____ Unknown

Comments:

300 yd3 - treated (or 116 yd3 per RF well x 3 wells = ~348 yd3 treated)

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance   Facility ID#: 0540

x Performance

Remediation Goal:

____ In Groundwater: ______________________________

x In Soil: 1) reduce residual soil concentrations to remove on-going GW source 2) decrease remediation time frame

Was the Remediation Goal Achieved:

____ In Groundwater ______________________________

Comment: ______________________________

____ In Soil ______________________________

Comment: ______________________________

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____________ ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____________ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____________ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy: ______________________________

____ Cost

Total Project Cost: ____________

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

____ Energy Cost: ____________ ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ______________________________

____ Other Cost 2: ______________________________

____ Other Cost 3: ______________________________

General Site Information Facility ID#: 0545

x File Analyzed By: JT x PD ____ Date: 10/30/2006

Type of treatment: ____ Conductive ____ Steam ____ ERH x Other: ____________

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: ____________ End of Test: ____________ Duration: ________

Type of Site: x Non-DOD ____ DoD

x Facility Name: Ashland Refinery

Address: ____________

City, State, Zip Code: St. Paul, MN

OU# or Site #: ____________

x Primary point of contact: Ray Kasevich

Organization: KSN Energies

Address: 291 Main St., 3rd Floor, PO Box 612

City, State, Zip Code: Great Barrington, MA 01230

Phone #: 413-528-4651 email: rkasevich@ksnenergies.com

x Other contacts or vendors who worked on site ____ None

Point of contact: Daniel Berg

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: MN Pollution Control Agency

Address: ____________

City, State, Zip Code: ____________

Phone #: 651-296-0550 email: daniel.berg#pca.state.mn.us

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data Facility ID#: 0545

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

____ Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____ ________	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ________	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ________	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ________	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ________	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ________	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ________	None	None	None	None
	____ 1,1,2-trichloroethane	____ ________	____ ________	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ________	____ ________	None	None	None	None
	____ Vinyl Chloride	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0545

____ Geology: Zone Unconsolidated Sediments

Vadose Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

Saturated Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	________	________	________	
	high value (ft bgs):	________	________	________	
	Unknown:	________	________	________	
____ Flow direction		________	________	________	
____ Horizontal hydraulic gradient (feet/foot):		________	________	________	____ Unknown
Vertical hydraulic gradient (feet/foot):		________	________	________	____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	________	________	________	____ Unknown
high	________	________	________	

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	________	________	________	____ Unknown
high	________	________	________	

Comments: ____

Attachments: ____

Thermal Treatment - Design Facility ID#: 0545

x Thermal treatment:
____ Conductive ____
____ Electrical Resistance ____
____ 3 phase ____ 6 phase ____ AC power ____ DC power
____ Steam ____
____ Steam ____ Steam + air ____ Steam + O2
x Other (describe) RFH

x Type of Test: ____ Pilot test x Full-scale System

____ Geology of Treatment Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ____ Duration: ____

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:
Size of target zone (ft2): ____ ____ Unknown (___ x ___ ft)
Thickness of target zone (ft): ____ ____ Unknown
Depth to top of target zone (ft bgs): ____ ____ Unknown
Thickness of target zone below water table (ft): ____ ____ Unknown
Number of energy delivery points: ____ ____ Unknown
Number of extraction points: ____ ____ Unknown

____ Temperature Profile:
Initial formation temperature (deg C): ____ ____ Unknown
Maximum representative formation temperature (deg C): ____ ____ Unknown
Time to reach maximum representative temperature (days): ____ ____ Unknown
Duration of treatment at representative temperature (days): ____ ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

____ Mass of contaminant removed:
Via liquid pumping: ____ ____ lb ____ kg ____ Unknown
In vapor stream: ____ ____ lb ____ kg ____ Unknown
Total: ____ ____ lb ____ kg ____ Unknown

Comments: ____

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0545

____ Performance

Remediation Goal:

____ In Groundwater:

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information   Facility ID#: 0550

x File Analyzed By: JT x PD ____   Date: 10/30/2006

Type of treatment: ____ Conductive ____ Steam ____ ERH x Other: RFH

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: 3/1/1996   End of Test: 3/31/1996   Duration: 30 days

Type of Site: x Non-DOD ____ DoD

x Facility Name: Confidential Gasoline Service Station

Address: ____

City, State, Zip Code: St. Paul, MN

OU# or Site #: ____

x Primary point of contact: Ray Kasevich

Organization: KAI Technologies

Address: ____

City, State, Zip Code: ____

Phone #: ____ email: ____

____ Other contacts or vendors who worked on site   ____ None

Point of contact: ____

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____

Organization: ____

Address: ____

City, State, Zip Code: ____

Phone #: ____ email: ____

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data   ____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information   ____ Flux assessment

____ Groundwater elevations   ____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data Facility ID#: 0550

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

____ Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____ ________	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ________	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ________	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ________	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ________	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ________	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ________	None	None	None	None
	____ 1,1,2-trichloroethane	____ ________	____ ________	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ________	____ ________	None	None	None	None
	____ Vinyl Chloride	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None

Comments: ____

Attachments: ____

Hydrogeologic Conceptual Model Facility ID#: 0550

____ Geology:

Zone	Unconsolidated Sediments
Vadose Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone
Saturated Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	________	________	________	
	high value (ft bgs):	________	________	________	
	Unknown:	________	________	________	
____ Flow direction		________	________	________	
____ Horizontal hydraulic gradient (feet/foot):		________	________	________	____ Unknown
Vertical hydraulic gradient (feet/foot):		________	________	________	____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	________	________	________	____ Unknown
high	________	________	________	

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	________	________	________	____ Unknown
high	________	________	________	

Comments: ____

Attachments: ____

Thermal Treatment - Design　　　　Facility ID#: 0550

x Thermal treatment:
____ Conductive ________________
____ Electrical Resistance ________________
____ 3 phase ____ 6 phase ____ AC power ____ DC power
____ Steam ________________
____ Steam ____ Steam + air ____ Steam + O2
x Other (describe) RFH

x Type of Test: x Pilot test ____ Full-scale System

____ Geology of Treatment Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ________________ Duration: ________________

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2):	________	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	________	____ Unknown	
Depth to top of target zone (ft bgs):	________	____ Unknown	
Thickness of target zone below water table (ft):	________	____ Unknown	
Number of energy delivery points:	________	____ Unknown	
Number of extraction points:	________	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	________	____ Unknown
Maximum representative formation temperature (deg C):	________	____ Unknown
Time to reach maximum representative temperature (days):	________	____ Unknown
Duration of treatment at representative temperature (days):	________	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	________	________
Formation temperature post-treatment monitoring event 1:	________	________
Duration of post-treatment monitoring (days):	________	________

____ Mass of contaminant removed:

Via liquid pumping:	________	____ lb	____ kg	____ Unknown
In vapor stream:	________	____ lb	____ kg	____ Unknown
Total:	________	____ lb	____ kg	____ Unknown

Comments:

37 yd3 treated

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0550

____ Performance

Remediation Goal:

____ In Groundwater: ____

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information 		Facility ID#: 0560

x File Analyzed By: JT x PD ____ 		Date: 9/13/2006

Type of treatment: x Conductive ____ Steam ____ ERH ____ Other: ______________

Type of Contaminant: ____ Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating x Other: PCBs

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: Apr-97 End of Test: Jul-97 Duration: varied

Type of Site: x Non-DOD ____ DoD

x Facility Name: Missouri Electric Works

Address: Missouri State Route 61

City, State, Zip Code: Cape Girardeau, MO

OU# or Site #: CERCLIS ID Number: MOD980965982

x Primary point of contact: Pauletta France-Isetts, RPM

Organization: US EPA Region 7

Address: 726 Minnesota Ave.

City, State, Zip Code: Kansas City, KS 66101

Phone #: 913-551-7701 email: france-isetts.pauletta@epa.gov

x Other contacts or vendors who worked on site ____ None

Point of contact: Ralph Baker

Type: x Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: TerraTherm

Address: 10 Stevens Rd.

City, State, Zip Code: Fitchburg, MA 01420

Phone #: 978-343-0300 email: rbaker@terratherm.com

QA/QC

x Characteristics of Interest

____ Good pre- and post-treatment groundwater data

x Good pre- and post-treatment soil data

x Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0560

x Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ x Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: x None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 10

Number of relevant soil borings with post-treatment data: 16

Number inside treatment zone: Number outside treatment zone:

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	x Arclor 1260 @6"	None	1,000 mg/kg	None	0.01 mg/kg
	____ 1,1-dichloroethene	____ Napthalene	x Arclor 1260 @12"	None	1 mg/kg	None	0.01 mg/kg
	____ cis-1,2-dichloroethene	____ Benzene	x Arclor 1260 @18"	None	1 mg/kg	None	0.1 mg/kg
	____ trans-1,2-dichloroethene	____ Tolune	x Arclor 1260 @24"	None	1 mg/kg	None	1 mg/kg
	____ 1,1-dichloroethane	____ Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane			None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	____ Vinyl Chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

Concentration averages at different depths for thermal blanket 1 demo

Attachments:

General Site Assessment Data Facility ID#: 0560

x Impacted Zone: Length (parallel to flow direction)(ft.): ____ Width (ft): ____ Thickness (ft): ____ x Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: x None

Pre-treatment: ____ Post-treatment: ____

Number of wells relative to treatment zone:

Pre-treatment In: ____ Upgradient: ____ Downgradient: ____ Crossgradient: ____

Post-treatment In: ____ Upgradient: ____ Downgradient: ____ Crossgradient: ____

x Soil Borings: Number of relevant soil borings with pre-treatment data: 9

Number of relevant soil borings with post-treatment data: 9

Number inside treatment zone: Number outside treatment zone: ____

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	x Arclor 1260 @6"	None	100 mg/kg	None	0.01 mg/kg
	____ 1,1-dichloroethene	____ Napthalene	x Arclor 1260 @12"	None	1 mg/kg	None	0.01 mg/kg
	____ cis-1,2-dichloroethene	____ Benzene	x Arclor 1260 @18"	None	1 mg/kg	None	0.1 mg/kg
	____ trans-1,2-dichloroethene	____ Tolune	x Arclor 1260 @24"	None	1 mg/kg	None	0.1 mg/kg
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Concentration averages at different depths for thermal blanket 2 demo

Attachments:

General Site Assessment Data

Facility ID#: 0560

x Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ x Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: x None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

	In:	Upgradient:	Downgradient:	Crossgradient:
Pre-treatment	______	______	______	______
Post-treatment	______	______	______	______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 17 (111 samples)

Number of relevant soil borings with post-treatment data: 14 (101 samples)

Number inside treatment zone: 31 Number outside treatment zone: 27 pre- and 4 post- treatment samples were

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	x Arclor 1260 @2'	None	1,000 mg/kg	None	0.01 mg/kg
	____ 1,1-dichloroethene	____ Napthalene	x Arclor 1260 @4'	None	100 mg/kg	None	0.01 mg/kg
	____ cis-1,2-dichloroethene	____ Benzene	x Arclor 1260 @6'	None	100 mg/kg	None	0.01 mg/kg
	____ trans-1,2-dichloroethene	____ Tolune	x Arclor 1260 @8'	None	10 mg/kg	None	0.01 mg/kg
	____ 1,1-dichloroethane	____ Ethylbenzene	x Arclor 1260 @10'	None	1 mg/kg	None	0.01 mg/kg
	____ 1,2-dichloroethane	____ m/p-xylene	x Arclor 1260 @12'	None	5 mg/kg	None	0.01 mg/kg
	____ 1,1,1-trichloroethane	____ o-xylene	x Arclor 1260 @14'	None	1 mg/kg	None	0.1 mg/kg
	____ 1,1,2-trichloroethane	____ ______	x Arclor 1260 @16'	None	0.1 mg/kg	None	0.01 mg/kg
	____ 1,1,2,2-tetrachloroethane	____ ______	____ ______	None	None	None	None
	____ Vinyl Chloride	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None

Comments:

Concentration averages at different depths for thermal wells demo at multiple depths

Attachments:

Hydrogeologic Conceptual Model | Facility ID#: 0560

x Geology: | Zone | Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- x Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 404 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	40			
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
x Horizontal hydraulic gradient (feet/foot):					x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) — Measured using: ____ Slug Test x Laboratory ____ Field data

low	3 x 10E-3 md	horiz. air permeability	pre-treatment	x Unknown
high	50 md	horiz. air permeability	post-treatment	

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Comments:

Attachments:

Air permeability data from Vinegar et al. 1997, HazWaste World / Superfund XVIII, Washington, DC, p. 4

~~Cost and Performance Summary Report, In Situ Thermal Desorption at the M~~issouri Electric Works Superfund Site, Cape Girardeau, Missouri. U.S. ENVIRONMENTAL PROTECTION AGENCY, Office of Solid Waste and Emergency Response, Technology Innovation Office. pp. 282-288. also: France–Isetts, P. 1998. “In Situ Thermal Blankets and Wells for PCB Removal in Tight Clay Soils,” Tech Trends, EPA Region 7. (February). Available at: http://clu-in.org/products/newsltrs/TTREND/tt0298.htm

Thermal Treatment - Design   Facility ID#: 0560

x Thermal treatment: x Conductive Thermal blanket 1

____ Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

x Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only x Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: 3/13/1997 Duration: 32 days

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	160	____ Unknown	(8 x 20 ft)
Thickness of target zone (ft):	2	____ Unknown	
Depth to top of target zone (ft bgs):	0	____ Unknown	
Thickness of target zone below water table (ft):	0	____ Unknown	
Number of energy delivery points:	1	____ Unknown	
Number of extraction points:	2	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	23.8	____ Unknown
Maximum representative formation temperature (deg C):	315	____ Unknown
Time to reach maximum representative temperature (days):	30	____ Unknown
Duration of treatment at representative temperature (days):	1	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	____	____ lb	x kg	x Unknown
In vapor stream:	____	____ lb	x kg	x Unknown
Total:	____	____ lb	x kg	x Unknown

Comments:

____

Attachments:

____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Thermal Treatment - Design　　　　Facility ID#: 0560

x Thermal treatment: x Conductive Thermal blankets 2

____ Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

x Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only x Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: 7/9/1997　　Duration: 22 days

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	310	____ Unknown	(16 x 20 ft)
Thickness of target zone (ft):	2	____ Unknown	
Depth to top of target zone (ft bgs):	0	____ Unknown	
Thickness of target zone below water table (ft):	0	____ Unknown	
Number of energy delivery points:	2	____ Unknown	
Number of extraction points:	2	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	29.4	____ Unknown
Maximum representative formation temperature (deg C):	315	____ Unknown
Time to reach maximum representative temperature (days):	22	____ Unknown
Duration of treatment at representative temperature (days):	1	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

Via liquid pumping:	____ lb	x kg	____ Unknown
In vapor stream:	____ lb	x kg	____ Unknown
Total:	____ lb	x kg	____ Unknown

Comments:

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Thermal Treatment - Design   Facility ID#: 0560

x Thermal treatment: x Conductive Thermal Wells

____ Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

x Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only x Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: 4/21/1997 Duration: 42 days

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	144	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	12	____ Unknown	
Depth to top of target zone (ft bgs):	0	____ Unknown	
Thickness of target zone below water table (ft):	0	____ Unknown	
Number of energy delivery points:	12	____ Unknown	
Number of extraction points:	6	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	79	____ Unknown
Maximum representative formation temperature (deg C):	325	____ Unknown
Time to reach maximum representative temperature (days):	45	____ Unknown
Duration of treatment at representative temperature (days):	6	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	40	____ lb	x kg	____ Unknown
In vapor stream:	4(10 ^-10)	____ lb	x kg	____ Unknown
Total:	40	____ lb	x kg	____ Unknown

Comments:

Mass in thermal well application only ________ Thermal wells on a 5ft center spacing

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0560

x Performance

Remediation Goal:

____ In Groundwater: ____

x In Soil:

< 2 ppm PCB: Arclor 1260

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

x In Soil

Comment:

Yes

General comments on the thermal application:

Goals of all 3 demos: 1. Clean soils within arrays to achieve <2ppm total PCBs; 2. Show stack discharges could meet compliance stds with the state and federal for PCBs and polychlorinated dibenzodioxins/dibenzofurans (PCDDs/PCDFs); and 3. obtain a system destruction and removal efficiency (DRE) for PCBs greater than 99.9999%

Lessons Learned

____

____ Energy

Total Energy Used: ____ ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information Facility ID#: 0562

x File Analyzed By: JT x PD ____ Date: 11/3/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test ___ Full Scale System

Start of Test: ____________ End of Test: ____________ Duration: 120 d

Type of Site: x Non-DOD ____ DoD

x Facility Name: Confidential St. Louis, MO

Address: ____________

City, State, Zip Code: St. Louis, MO

OU# or Site #: ____________

x Primary point of contact: David Sarr

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: 703-709-6500 email: david.sarr@wspgroup.com

x Other contacts or vendors who worked on site ____ None

Point of contact: Dacre Bush

Type: x Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: McMillian-McGee

Address: ____________

City, State, Zip Code: ____________

Phone #: 805-295-9071 email: dacre.bush@mcmillian-mcgee.com

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data Facility ID#: 0562

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______
Post-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

____ Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____ ________	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ________	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ________	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ________	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ________	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ________	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ________	None	None	None	None
	____ 1,1,2-trichloroethane	____ ________	____ ________	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ________	____ ________	None	None	None	None
	____ Vinyl Chloride	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0562

x Geology: Zone Unconsolidated Sediments

Vadose Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
x Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

Saturated Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
x Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

	low				____ Unknown
	high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

	low				____ Unknown
	high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 0562

x Thermal treatment:
- ____ Conductive ________
- x Electrical Resistance ________
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- ____ Steam ________
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ________

____ Type of Test: ____ Pilot test ____ Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- x Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

s Start of Thermal Test: ________ Duration: 120 d

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2):	________	____ Unknown (___ x ___ ft)
Thickness of target zone (ft):	________	____ Unknown
Depth to top of target zone (ft bgs):	________	____ Unknown
Thickness of target zone below water table (ft):	________	____ Unknown
Number of energy delivery points:	________	____ Unknown
Number of extraction points:	________	____ Unknown

x Temperature Profile:

Initial formation temperature (deg C):	________	____ Unknown
Maximum representative formation temperature (deg C):	95	____ Unknown
Time to reach maximum representative temperature (days):	________	____ Unknown
Duration of treatment at representative temperature (days):	________	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	________	________
Formation temperature post-treatment monitoring event 1:	________	________
Duration of post-treatment monitoring (days):	________	________

x Mass of contaminant removed:

Via liquid pumping:	________	____ lb	____ kg	____ Unknown
In vapor stream:	________	____ lb	____ kg	____ Unknown
Total:	69000	x lb	____ kg	____ Unknown

Comments:

24 ft spacing

Attachments: ________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0562

____ Performance

Remediation Goal:

____ In Groundwater: ____

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

Goal: 99% reduction

Lessons Learned

____

x Energy

Total Energy Used: 203.58 ____ kWhr ____ $kWhr/m^3$ x $kWhr/yd^3$

____ Total energy applied to treatment zone: ____ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information Facility ID#: 0564

x File Analyzed By: JT x PD ____ Date: 10/13/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: 6/24/2005 End of Test: 10/18/2005 Duration: 117 d

Type of Site: x Non-DOD ____ DoD

x Facility Name: Operating Industrial Manufacturing Facility, Confidential Location, Missouri

Address: ____________

City, State, Zip Code: Missouri

OU# or Site #: ____________

x Primary point of contact: Larry Williams

Organization: SECOR

Address: 400 Bruns Lane

City, State, Zip Code: Springfield, IL 62702

Phone #: 217-698-7247 ext 25 email: lwilliams@SECOR.com

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data Facility ID#: 0564

x Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ x Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 1 Post-treatment: 1

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 13

Number of relevant soil borings with post-treatment data: 7

Number inside treatment zone: ______ Number outside treatment zone: ______

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	10 mg/L	500 mg/kg	0.01 mg/L	0.05 mg/kg
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model　　　　Facility ID#: 0564

x Geology:

Zone	Unconsolidated Sediments
Vadose Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	x Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone
Saturated Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	x Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl　　x Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present?　____ No　____ Yes (number): ________　x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	6			
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
x Horizontal hydraulic gradient (feet/foot):					x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day)　Measured using: ____ Slug Test　____ Laboratory　____ Field data

low				x Unknown
high				

Transmissivity (ft2/day):　Measured using: ____ Slug Test　____ Laboratory　____ Field data

low				x Unknown
high				

Comments:

The geology is a residual clay with variable limestone and chert floaters

Attachments:

Thermal Treatment - Design   Facility ID#: 0564

____ Thermal treatment: ____ Conductive ____

x Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 6/24/2006 Duration: 117 d

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	390	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	18	____ Unknown	
Depth to top of target zone (ft bgs):	4	____ Unknown	
Thickness of target zone below water table (ft):	20	____ Unknown	
Number of energy delivery points:	18	____ Unknown	
Number of extraction points:	31	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	24	____ Unknown
Maximum representative formation temperature (deg C):	100	____ Unknown
Time to reach maximum representative temperature (days):	53	____ Unknown
Duration of treatment at representative temperature (days):	64	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	x Unknown
In vapor stream:	____	____ lb	____ kg	x Unknown
Total:	____	____ lb	____ kg	x Unknown

Comments:

The extraction points were 18 electrode/vapor recovery wells and 13 additional vapor recovery wells, of which only 1 was used.

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0564

x Performance

Remediation Goal:

____ In Groundwater:

x In Soil:

At a 90% upper confidence limit, reduce TCE in soil to 0.4mg/kg. A 99% removal was needed.

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

x In Soil

Comment:

yes, had a percent removal of 99.96%

General comments on the thermal application:

Took a data set on the dissolved organic carbon (DOC) in groundwater and found a 41 times higher amount of DOC in post-treatment samples. Which is important because it further substantiates that ERH creates favorable conditions for enhanced biodegradation by increasing the DOC content in groundwater making it more bio-available.

Lessons Learned

x Energy

Total Energy Used: 607142 x kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information Facility ID#: 0565

x File Analyzed By: JT x PD ____ Date: 10/18/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ________________

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ______________________________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test ___ Full Scale System

Start of Test: 7/11/2003 End of Test: 11/30/2003 Duration: 142 d

Type of Site: x Non-DOD ____ DoD

x Facility Name: George's Conoco

Address: ______________________________

City, State, Zip Code: Ronan, MT

OU# or Site #: ______________________________

x Primary point of contact: Ken Manchester

Organization: MSE Technology Applications

Address: 200 Technology Way

City, State, Zip Code: Butte, MT

Phone #: 406-494-7397 email: ken.manchester@mse-ta.com

x Other contacts or vendors who worked on site ____ None

Point of contact: Jeffrey A. Kuhn

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other __________

Organization: Montana Dept. of Environmental Quality

Address: PO Box 20090

City, State, Zip Code: Helena, MT 59620-0901

Phone #: 406-841-5000 email: jkuhn@state.mt.us

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0565

x Impacted Zone: Length (parallel to flow direction)(ft.): below Width (ft): ____ Thickness (ft): ____ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 3 Post-treatment: ____

Number of wells relative to treatment zone:

Pre-treatment In: ____ Upgradient: ____ Downgradient: ____ Crossgradient: ____

Post-treatment In: ____ Upgradient: ____ Downgradient: ____ Crossgradient: ____

x Soil Borings: Number of relevant soil borings with pre-treatment data: 5

Number of relevant soil borings with post-treatment data: ____

Number inside treatment zone: ____ Number outside treatment zone: ____

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel		None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene		None	None	None	None
	____ cis-1,2-dichloroethene	x Benzene		10 mg/L	None	None	None
	____ trans-1,2-dichloroethene	x Tolune		None	None	None	None
	____ 1,1-dichloroethane	x Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	x m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	x o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane	x MTBE		10 mg/L	None	None	None
	____ 1,1,2,2-tetrachloroethane	x TPH		100 mg/L	None	0.001 mg/L	None
	____ Vinyl Chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

4,000 to 6,000 gallons of premium gasoline released All chemicals below detection limit in soil except for 1 xylene hit and the highest TPH Concentration at 35 ug/L

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0565

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:

- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:

- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3
Depth to water:	low value (ft bgs):	2		
	high value (ft bgs):	18		
	Unknown:			

____ Flow direction ________ ________ ________

____ Horizontal hydraulic gradient (feet/foot): ________ ________ ________ ____ Unknown

Vertical hydraulic gradient (feet/foot): ________ ________ ________ ____ Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	0.028			____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

K= 10e-6 cm/s

16 ft was depth-to-water in the treatment zone.

Attachments:

Thermal Treatment - Design — Facility ID#: 0565

x Thermal treatment:
- ____ Conductive
- x Electrical Resistance
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- ____ Steam
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe)

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 7/11/2003 Duration: 140 d

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	6450	____ Unknown	(61 x 78 ft)
Thickness of target zone (ft):	10	____ Unknown	
Depth to top of target zone (ft bgs):	15	____ Unknown	
Thickness of target zone below water table (ft):	9	____ Unknown	
Number of energy delivery points:	12	____ Unknown	
Number of extraction points:	6	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	20	____ Unknown
Maximum representative formation temperature (deg C):	____	____ Unknown
Time to reach maximum representative temperature (days):	____	____ Unknown
Duration of treatment at representative temperature (days):	____	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	____	____ lb	____ kg	____ Unknown
Total:	1574	____ lb	x kg	____ Unknown

Comments: N/S spacing of 27.6 ft and a SW/NE spacing of 24.0 ft Treated are - 2771 yd3 with effective treatment of 16 ft thick.

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0565

x Performance

Remediation Goal:

x In Groundwater:

MTBE - 30 ppb; Benzene-5 ppb; Toluene - 1000 ppb; TPH (RBSL) - 1000 ug/L

____ In Soil:

Was the Remediation Goal Achieved:

x In Groundwater

Comment:

Yes, MTBE, benzene, toluene, ethylbenzene, were non-detect and xylene was below the MCL

____ In Soil

Comment:

General comments on the thermal application:

$130/ cubic yard of effectively treated soil

Lessons Learned

x Energy

Total Energy Used: 514120 x kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy:

x Cost

Total Project Cost: 360800

____ Consultant Cost:

____ Thermal Vendor Cost:

x Energy Cost: 24404 ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information   Facility ID#: 0568

x File Analyzed By: JT x PD ____   Date: 10/15/2007

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ________

Treatment Status: ____ Active ___ Post

Type of Test: ____ Pilot Test ___ Full Scale System

Start of Test: 11/4/2006 End of Test: 1/26/2007 Duration: 82 days

Type of Site: ____ Non-DOD ____ DoD

x Facility Name: Eastern Montana

Address: ________

City, State, Zip Code: ________

OU# or Site #: ________

x Primary point of contact: Galen Davis

Organization: Kennedy Jenks Consultants

Address: ________

City, State, Zip Code: ________

Phone #: 253-874-0556 email: galendavis@kennedyjenks.com

____ Other contacts or vendors who worked on site ____ None

Point of contact: David Fleming

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: ________

Address: ________

City, State, Zip Code: ________

Phone #: ________ email: ________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data Facility ID#: 0568

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______
Post-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

____ Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	None	50 mg/kg	None	0.01 mg/kg
	____ Tetrachloroethene	____ Jet Fuel	____ ________	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ________	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ________	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ________	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ________	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ________	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ________	None	None	None	None
	____ 1,1,2-trichloroethane	____ ________	____ ________	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ________	____ ________	None	None	None	None
	____ Vinyl Chloride	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None

Comments: ____

Attachments: ____

Hydrogeologic Conceptual Model Facility ID#: 0568

____ Geology: **Zone** **Unconsolidated Sediments**

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	2			
	high value (ft bgs):	6			
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 0568

x Thermal treatment:
- ____ Conductive ____________
- x Electrical Resistance ____________
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- ____ Steam ____________
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ____________

____ Type of Test: ____ Pilot test ____ Full-scale System

____ Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 11/4/2006   Duration: 82d

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	1600	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	20	____ Unknown	
Depth to top of target zone (ft bgs):	2	____ Unknown	
Thickness of target zone below water table (ft):	20	____ Unknown	
Number of energy delivery points:	____________	____ Unknown	
Number of extraction points:	____________	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	13	____ Unknown
Maximum representative formation temperature (deg C):	77	____ Unknown
Time to reach maximum representative temperature (days):	25	____ Unknown
Duration of treatment at representative temperature (days):	57	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____________	____________
Formation temperature post-treatment monitoring event 1:	____________	____________
Duration of post-treatment monitoring (days):	____________	____________

____ Mass of contaminant removed:

Via liquid pumping:	____________	____ lb	____ kg	____ Unknown
In vapor stream:	____________	____ lb	____ kg	____ Unknown
Total:	____________	____ lb	____ kg	____ Unknown

Comments: ____________

Attachments: ____________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance   Facility ID#: 0568

____ Performance

Remediation Goal:

____ In Groundwater:

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Lessons Learned

x Energy

Total Energy Used: 251616   x kWhr   ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____   ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____   ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____   ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information   Facility ID#: 0570

X File Analyzed By: JT X PD ____   Date: 11/9/2006

Type of treatment: ____ Conductive ____ Steam X ERH ____ Other: ____________

Type of Contaminant: X Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active X Post

Type of Test: ____ Pilot Test X Full Scale System

Start of Test: 9/11/2003 End of Test: 5/11/2004 Duration: 242 d

Type of Site: ____ Non-DOD X DoD

X Facility Name: Camp LeJeune

Address: ____________

City, State, Zip Code: Jacksonville, NC

OU# or Site #: Site 89

X Primary point of contact: Ron Kenyon

Organization: Shaw

Address: ____________

City, State, Zip Code: Alpharetta, GA

Phone #: 770-663-1453 email: ronald.kenyon@shawgrp.com

X Other contacts or vendors who worked on site ____ None

Point of contact: Daniel Hood

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications x Other ____________

Organization: Navy

Address: 6506 Hampton Blvd

City, State, Zip Code: Norfolk, VA 23508-4530

Phone #: 757-322-4630 email: daniel.r.hood@navy.mil

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0570

X Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ X Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

X Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 27 Post-treatment: 27

Number of wells relative to treatment zone:

Pre-treatment	In: 10	Upgradient: 2	Downgradient: 6	Crossgradient: 9
Post-treatment	In: 10	Upgradient: 2	Downgradient: 6	Crossgradient: 9

X Soil Borings: Number of relevant soil borings with pre-treatment data: 31

Number of relevant soil borings with post-treatment data: 31

Number inside treatment zone: 20 Number outside treatment zone: ______

X Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	X Trichloroethene	____ Hexane	____ Creosote	500 mg/L	500 mg/kg	5 mg/L	10 mg/kg
	X Tetrachloroethene	____ Jet Fuel	____	10 mg/L	None	0.1 mg/L	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	X cis-1,2-dichloroethene	____ Benzene	____	100 mg/L	50 mg/kg	10 mg/L	5 mg/kg
	X trans-1,2-dichloroethene	____ Tolune	____	50 mg/L	50 mg/kg	0.1 mg/L	0.5 mg/kg
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	X	0.5 mg/L	5 mg/kg	0.01 mg/L	0.01 mg/kg
	X 1,1,2-trichloroethane	____	____	10 mg/L	50 mg/kg	0.1 mg/L	0.5 mg/kg
	X 1,1,2,2-tetrachloroethane	____	____	100 mg/L	1,000 mg/kg	0.5 mg/L	0.5 mg/kg
	X Vinyl Chloride	____	____	10 mg/L	None	0.05 mg/L	None
	X TCE - Deep	____	____	10 mg/L	50 mg/kg	0.5 mg/L	0.05 mg/kg
	X PCE - Deep	____	____	0.5 mg/L	None	0.1 mg/L	None
	X cis-12 DCE - Deep	____	____	1 mg/L	5 mg/kg	0.1 mg/L	0.05 mg/kg
	X trans-12 DCE - Deep	____	____	0.5 mg/L	5 mg/kg	0.01 mg/L	0.01 mg/kg
	X 1122 PCA - Deep	____	____	10 mg/L	5 mg/kg	0.01 mg/L	0.01 mg/kg
	X VC - Deep	____	____	0.1 mg/L	None	0.01 mg/L	None

Comments:

Shallow wells screened to 15 ft bgs. Deep wells screened to 25 ft bgs. Average post-treatment concentrations for 112 TCA - Deep, trans-12 DCE - Deep, and 1122 PCA - Deep are all 0.005 mg/L but shown as 0.01 mg/Kg due to spreadsheet constraints.

Attachments:

Hydrogeologic Conceptual Model   Facility ID#: 0570

X Geology: Zone: Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- X Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- X Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

X Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl   ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	3			
	high value (ft bgs):	5			
	Unknown:				
X Flow direction		SE			
X Horizontal hydraulic gradient (feet/foot):		0.002			____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

X K range (ft/day)   Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	8.4			____ Unknown
high	64.6			

Transmissivity (ft2/day):   Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design

Facility ID#: 0570

X Thermal treatment:
- ____ Conductive
- X Electrical Resistance
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- ____ Steam
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe)

X Type of Test: ____ Pilot test X Full-scale System

X Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- X Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

X Treatment Targe Zone: ____ Saturated only ____ Vadose only X Both (Saturated and Vadose zones)

X Start of Thermal Test: 9/11/2003 Duration: 242 d

X Hydraulic Control X Yes ____ No

X Treatment Cell Design:

Size of target zone (ft2):	15873	____ Unknown	(80 x 214 ft)
Thickness of target zone (ft):	21	____ Unknown	
Depth to top of target zone (ft bgs):	5	____ Unknown	
Thickness of target zone below water table (ft):	21	____ Unknown	
Number of energy delivery points:	91	____ Unknown	
Number of extraction points:	38	____ Unknown	

X Temperature Profile:

Initial formation temperature (deg C):	20	____ Unknown
Maximum representative formation temperature (deg C):	100	____ Unknown
Time to reach maximum representative temperature (days):	~156	____ Unknown
Duration of treatment at representative temperature (days):	~86	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):	1 yr	

X Mass of contaminant removed:

Via liquid pumping:	428	X lb	____ kg	____ Unknown
In vapor stream:	48000	X lb	____ kg	____ Unknown
Total:	48428	X lb	____ kg	____ Unknown

Comments:

Only 75% on time (~175 d).

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0570

X Performance

Remediation Goal:

X In Groundwater:

95% reduction in groundwater.

X In Soil:

95% reduction in soil.

Was the Remediation Goal Achieved:

X In Groundwater

Comment:

99% in treatment zone and 97% in perimeter zone.

X In Soil

Comment:

Yes.

General comments on the thermal application:

Objective: Evaluate effectiveness of ERH at reducing DNAPL within study area.

Lessons Learned

X Energy

Total Energy Used: 1,748,660 X kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

X Cost

Total Project Cost: 2,105,215

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

X Other Cost 1: 907,400

X Other Cost 2: 672,550

X Other Cost 3: 525,265

X Please note other cost:

X Other Cost 1: System O & M

X Other Cost 2: System installation

X Other Cost 3: Site prep, restoration, monitoring, and reporting (31,275; 324,410; 169,580)

General Site Information Facility ID#: 0573

X File Analyzed By: JT X PD ____ Date: 10/18/2006

Type of treatment: ____ Conductive ____ Steam X ERH ____ Other: ____________

Type of Contaminant: X Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active X Post

Type of Test: ____ Pilot Test ___ Full Scale System

Start of Test: 12/4/2003 End of Test: 7/8/2004 Duration: 238 d

Type of Site: X Non-DOD ____ DoD

X Facility Name: Confidential

Address: ____________

City, State, Zip Code: NC

OU# or Site #: ____________

X Primary point of contact: Brett Berra

Organization: URS Corp.

Address: ____________

City, State, Zip Code: ____________

Phone #: 919-461-1290 email: brett_berra@urscorp.com

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data   Facility ID#: 0573

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

X Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	X Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	X Tetrachloroethene	____ Jet Fuel		None	None	None	None
	X 1,1-dichloroethene	____ Napthalene		None	None	None	None
	X cis-1,2-dichloroethene	____ Benzene		None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune		None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene		None	None	None	None
	X 1,2-dichloroethane	____ m/p-xylene		None	None	None	None
	X 1,1,1-trichloroethane	____ o-xylene		None	None	None	None
	X 1,1,2-trichloroethane			None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	X Vinyl Chloride			None	None	None	None
	X Carbon tetrachloride			None	None	None	None
	X Chloroform			None	None	None	None
		X Benzene		None	None	None	None
	X Total VOCs			None	5 mg/kg	None	None
				None	None	None	None
				None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0573

X Geology: Zone Unconsolidated Sediments

Vadose Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
X Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

Saturated Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
X Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

X Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ X Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	X			
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design Facility ID#: 0573

X Thermal treatment: ____ Conductive ____________

X Electrical Resistance ____________

____ 3 phase X 6 phase ____ AC power ____ DC power

____ Steam ____________

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____________

X Type of Test: ____ Pilot test X Full-scale System

____ Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

X Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

X Treatment Targe Zone: ____ Saturated only ____ Vadose only X Both (Saturated and Vadose zones)

X Start of Thermal Test: 12/4/2003 Duration: 238 days

____ Hydraulic Control ____ Yes ____ No

X Treatment Cell Design:

Size of target zone (ft2):	12833	____ Unknown	(90 x 155 ft)
Thickness of target zone (ft):	12	____ Unknown	
Depth to top of target zone (ft bgs):	2	____ Unknown	
Thickness of target zone below water table (ft):	10	____ Unknown	
Number of energy delivery points:	62	____ Unknown	
Number of extraction points:	22	____ Unknown	

X Temperature Profile:

Initial formation temperature (deg C):	18	____ Unknown
Maximum representative formation temperature (deg C):	91	____ Unknown
Time to reach maximum representative temperature (days):	~136	____ Unknown
Duration of treatment at representative temperature (days):	~102	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

X Mass of contaminant removed:

Via liquid pumping:		____ lb	____ kg	____ Unknown
In vapor stream:	5429	X lb	____ kg	____ Unknown
Total:	5429	X lb	____ kg	____ Unknown

Comments:

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0573

X Performance

Remediation Goal:

X In Groundwater:

Remove source and eventually achieve MCLs after polishing agents were applied.

X In Soil:

Same as above

Was the Remediation Goal Achieved:

____ In Groundwater ____________________

Comment: ____________________

____ In Soil ____________________

Comment: ____________________

General comments on the thermal application:

95% reduction in total VOCs in GW. 80% reduction in total VOCs in soil.

Lessons Learned

____

____ Energy

Total Energy Used: ____________ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____________________

____ Cost

Total Project Cost: ____________

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

____ Energy Cost: ____________ ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ____________________

____ Other Cost 2: ____________________

____ Other Cost 3: ____________________

General Site Information Facility ID#: 0575

x File Analyzed By: JT x PD ____ Date: 11/1/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: ____________ End of Test: ____________ Duration: 120 d

Type of Site: x Non-DOD ____ DoD

x Facility Name: Total Petrochemicals USA, Inc. (Pilot)

Address: ____________

City, State, Zip Code: Greensboro, NC

OU# or Site #: ____________

x Primary point of contact: Monty Bennett or Rusty Field

Organization: GES

Address: ____________

City, State, Zip Code: ____________

Phone #: 804-343-0700 email: rfield@gesonline.com

x Other contacts or vendors who worked on site ____ None

Point of contact: Dacre Bush

Type: x Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: McMillan-McGee

Address: ____________

City, State, Zip Code: ____________

Phone #: 805-295-9071 email: dacre.bush@mcmillan-mcgee.com

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data   Facility ID#: 0575

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

x Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	x TBA	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0575

____ Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design Facility ID#: 0575

x Thermal treatment: ____ Conductive ______

x Electrical Resistance ______

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ______

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ______

x Type of Test: x Pilot test ____ Full-scale System

____ Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ______ Duration: ______

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2): ______ ____ Unknown (___ x ___ ft)

Thickness of target zone (ft): ______ ____ Unknown

Depth to top of target zone (ft bgs): ______ ____ Unknown

Thickness of target zone below water table (ft): ______ ____ Unknown

Number of energy delivery points: ______ ____ Unknown

Number of extraction points: ______ ____ Unknown

x Temperature Profile:

Initial formation temperature (deg C): ______ ____ Unknown

Maximum representative formation temperature (deg C): 105 ____ Unknown

Time to reach maximum representative temperature (days): ______ ____ Unknown

Duration of treatment at representative temperature (days): ______ ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

Via liquid pumping:	______	____ lb	____ kg	____ Unknown
In vapor stream:	______	____ lb	____ kg	____ Unknown
Total:	69000	x lb	____ kg	____ Unknown

Comments:

Attachments: 23 foot spacing

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0575

____ Performance

Remediation Goal:

____ In Groundwater: ____

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

____

Lessons Learned

____

x Energy

Total Energy Used: 186 ____ kWhr ____ kWhr/m^3 x kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information Facility ID#: 0576

x File Analyzed By: JT x PD ____ Date: 11/1/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: x Active ____ Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: ____________ End of Test: ____________ Duration: 120 d

Type of Site: x Non-DOD ____ DoD

x Facility Name: Total Petrochemicals USA, Inc. (Full)

Address: ____________

City, State, Zip Code: Greensboro, NC

OU# or Site #: ____________

x Primary point of contact: Monty Bennett or Rusty Field

Organization: GES

Address: ____________

City, State, Zip Code: ____________

Phone #: 804-343-0700 email: rfield@gesonline.com

x Other contacts or vendors who worked on site ____ None

Point of contact: Dacre Bush

Type: x Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: McMillan-McGee

Address: ____________

City, State, Zip Code: ____________

Phone #: 805-295-9071 email: dacre.bush@mcmillan-mcgee.com

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data — Facility ID#: 0576

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel		None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene		None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene		None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune		None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane	x TBA		None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	____ Vinyl Chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0576

____ Geology:

Zone	Unconsolidated Sediments
Vadose Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone
Saturated Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	________	________	________	
	high value (ft bgs):	________	________	________	
	Unknown:	________	________	________	
____ Flow direction		________	________	________	
____ Horizontal hydraulic gradient (feet/foot):		________	________	________	____ Unknown
Vertical hydraulic gradient (feet/foot):		________	________	________	____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	________	________	________	____ Unknown
high	________	________	________	

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	________	________	________	____ Unknown
high	________	________	________	

Comments: ____

Attachments: ____

Thermal Treatment - Design Facility ID#: 0576

x Thermal treatment: ____ Conductive ______

x Electrical Resistance ______

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ______

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ______

x Type of Test: ____ Pilot test x Full-scale System

____ Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ______ Duration: ______

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2): ______ ____ Unknown (___ x ___ ft)

Thickness of target zone (ft): ______ ____ Unknown

Depth to top of target zone (ft bgs): ______ ____ Unknown

Thickness of target zone below water table (ft): ______ ____ Unknown

Number of energy delivery points: ______ ____ Unknown

Number of extraction points: ______ ____ Unknown

x Temperature Profile:

Initial formation temperature (deg C): ______ ____ Unknown

Maximum representative formation temperature (deg C): ______ ____ Unknown

Time to reach maximum representative temperature (days): ______ ____ Unknown

Duration of treatment at representative temperature (days): ______ ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

Via liquid pumping: ______ ____ lb ____ kg ____ Unknown

In vapor stream: ______ ____ lb ____ kg ____ Unknown

Total: ______ ____ lb ____ kg ____ Unknown

Comments:

23 foot spacing

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance   Facility ID#: 0576

____ Performance

Remediation Goal:

____ In Groundwater:

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Lessons Learned

x Energy

Total Energy Used: ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost:

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information Facility ID#: 0578

x File Analyzed By: JT x PD ____ Date: ________

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ________

Type of Contaminant: ____ Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

x Wood Treating ____ Other: ________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: 10/1/2004 End of Test: 2/14/2004 Duration: 137 d

Type of Site: x Non-DOD ____ DoD

x Facility Name: Cape Fear Wood Preserving

Address: 1219 South Reilly Rd

City, State, Zip Code: Fayetteville, NC

OU# or Site #: ________

x Primary point of contact: Chad Northington

Organization: WRS Infrastructure and Environment, Inc.

Address: 221 Hobs St., Suite 108

City, State, Zip Code: Tampa, FL 33619

Phone #: 813-383-0309 email: cnorthington@wrsie.com

x Other contacts or vendors who worked on site ____ None

Point of contact: Dacre Bush

Type: x Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: McMillian-McGee

Address: ________

City, State, Zip Code: ________

Phone #: 805-295-9071 email: dacre.bush@mcmillian-mcgee.com

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0578

____ Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 8

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: ______ Number outside treatment zone: ______

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	x Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	x Total SVOC/VOC	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

The average total SVOC/VOC concentration in pre-treatment samples = 74,675 mg/kg and post-treatment average concentration of 471,542 mg/kg
Estimated DNAPL of 9159 to 26170 lbs

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0578

x Geology: Zone Unconsolidated Sediments

Vadose Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
x Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

Saturated Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
x Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl x Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3
Depth to water:	low value (ft bgs):			
	high value (ft bgs):			
	Unknown:			

____ Flow direction ____________ ____________ ____________

____ Horizontal hydraulic gradient (feet/foot): ____________ ____________ ____________ ____ Unknown

Vertical hydraulic gradient (feet/foot): ____________ ____________ ____________ ____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low ____________ ____________ ____________ ____ Unknown

high ____________ ____________ ____________

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low ____________ ____________ ____________ ____ Unknown

high ____________ ____________ ____________

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 0578

x Thermal treatment:
- ____ Conductive ____
- x Electrical Resistance ____
  - x 3 phase ____ 6 phase ____ AC power ____ DC power
- ____ Steam ____
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ____

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 10/1/2004   Duration: 137 d

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	2500	____ Unknown	(40 x 40 ft)
Thickness of target zone (ft):	16	____ Unknown	
Depth to top of target zone (ft bgs):	10	____ Unknown	
Thickness of target zone below water table (ft):	____	____ Unknown	
Number of energy delivery points:	9	____ Unknown	
Number of extraction points:	4	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	____	____ Unknown
Maximum representative formation temperature (deg C):	90	____ Unknown
Time to reach maximum representative temperature (days):	64	____ Unknown
Duration of treatment at representative temperature (days):	73	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	____	____ lb	____ kg	____ Unknown
Total:	4629.2	x lb	____ kg	____ Unknown

Comments:
Treated 2200 yd3
Spacing of 19.5 ft

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0578

x Performance

Remediation Goal:

x In Groundwater: Total PAH SPLP = <100 ug/L Naphthalene, <500 ug/L Phenol, < 2 times 2L std for all other compounds

x In Soil:

Total PAH = 800 mg/kg

Was the Remediation Goal Achieved:

x In Groundwater

Comment:

No

x In Soil

Comment:

No

General comments on the thermal application:

Lessons Learned

Problems associated with visous NAPL clogging system

x Energy

Total Energy Used: 269481.77 x kWhr ____ kWhr/m^3 ____ kWhr/yd^3

x Total energy applied to treatment zone: 310 ____ kWhr/m^3 x kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

x Cost

Total Project Cost: 500000

____ Consultant Cost: ____

x Thermal Vendor Cost: 160000

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information — Facility ID#: 0580

X File Analyzed By: JT X PD ____ — Date: 9/28/2006

Type of treatment: ____ Conductive ____ Steam X ERH ____ Other: ________

Type of Contaminant: X Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ________

Treatment Status: ____ Active X Post

Type of Test: ____ Pilot Test X Full Scale System

Start of Test: 10/3/2001 End of Test: 7/8/2002 Duration: 279 d

Type of Site: X Non-DOD ____ DoD

X Facility Name: Charleston Naval Complex

Address: ________

City, State, Zip Code: South Carolina

OU# or Site #: AOC 607 in zone F

X Primary point of contact: David Scaturo

Organization: SC Dept. of Health and Environmental Control

Address: ________

City, State, Zip Code: ________

Phone #: 803-896-4185 email: scaturdm@dhec.sc.gov

X Other contacts or vendors who worked on site ____ None

Point of contact: Dean Williamson

Type: X Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: CH2M Hill

Address: ________

City, State, Zip Code: ________

Phone #: 352-335-5877, ext 52280 email: dean.williamson@ch2m.com

QA/QC

X Characteristics of Interest

- X Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- X Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- X Geologic cross-section
- X Hydraulic Conductivity information

General Site Assessment Data Facility ID#: 0580

X Impacted Zone: Length (parallel to flow direction)(ft.): 205 Width (ft): 150 Thickness (ft): ______ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

X Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 28 Post-treatment: 43

Number of wells relative to treatment zone:

Pre-treatment In: 14 Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: 12 Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ______

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: ______ Number outside treatment zone: ______

X Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	X Trichloroethene	____ Hexane	____ Creosote	1 mg/L	None	0.1 mg/L	None
	X Tetrachloroethene	____ Jet Fuel	____	5 mg/L	None	1 mg/L	None
	X 1,1-dichloroethene	____ Napthalene	____	0.001 mg/L	None	0.01 mg/L	None
	X cis-1,2-dichloroethene	____ Benzene	____	0.5 mg/L	None	1 mg/L	None
	X trans-1,2-dichloroethene	____ Tolune	____	0.005 mg/L	None	0.01 mg/L	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	X Vinyl Chloride	____	____	0.001 mg/L	None	0.1 mg/L	None
	X 1,2-DCE total	____	____	None	None	1 mg/L	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0580

X Geology: Zone — Unconsolidated Sediments

Vadose Zone:

- ____ Relatively homogeneous and permeable unconsolidated sediments
- Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- X Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:

- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- X Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

X Ground surface elevation based on wells in or adjacent to treatment zone: ~8 ft amsl ____ Unknown

X Aquifer Characteristics:

Is more than 1 aquifer present? ____ No X Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	2	3	3	
	high value (ft bgs):	4	4	5	
	Unknown:				
X Flow direction		NE			
X Horizontal hydraulic gradient (feet/foot):		0.0107 - 0.0133		0.0133	Unknown
Vertical hydraulic gradient (feet/foot):		see attachment			Unknown

X K range (ft/day) Measured using: X Slug Test ____ Laboratory ____ Field data

low	0.194	0.45	0.0081	____ Unknown
high	1.89	1.25	0.027	

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				X Unknown
high				

Comments:

GW velocities average 0.01 ft/day. Vertical permeability in clay unit (bottom) is 0.03 ft/day

Attachments:

see attachment AOC607.doc

Thermal Treatment - Design   Facility ID#: 0580

X Thermal treatment:
- ____ Conductive ________________
- X Electrical Resistance ________________
  - X 3 phase   ____ 6 phase   ____ AC power   ____ DC power
- ____ Steam ________________
  - ____ Steam   ____ Steam + air   ____ Steam + O2
- ____ Other (describe) ________________

X Type of Test: ____ Pilot test   X Full-scale System

X Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- X Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

X Treatment Targe Zone: ____ Saturated only   ____ Vadose only   X Both (Saturated and Vadose zones)

X Start of Thermal Test: 10/3/2001   Duration: 278 d

X Hydraulic Control   X Yes   ____ No

X Treatment Cell Design:

Size of target zone (ft2):	16525	____ Unknown	(150 x 150 ft)
Thickness of target zone (ft):	12	____ Unknown	
Depth to top of target zone (ft bgs):	4	____ Unknown	
Thickness of target zone below water table (ft):	10	____ Unknown	
Number of energy delivery points:	107	____ Unknown	
Number of extraction points:	97	____ Unknown	

X Temperature Profile:

Initial formation temperature (deg C):	26	____ Unknown
Maximum representative formation temperature (deg C):	95	____ Unknown
Time to reach maximum representative temperature (days):	163	____ Unknown
Duration of treatment at representative temperature (days):	114	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:	Jan-03	35.6
Duration of post-treatment monitoring (days):		

X Mass of contaminant removed:

Via liquid pumping:		____ lb	____ kg	____ Unknown
In vapor stream:		____ lb	____ kg	____ Unknown
Total:	481.5	X lb	____ kg	____ Unknown

Comments:
6 months post treatment monitoring and then another event at 22 months before the reductive dechlorination pilot study was performed in March 2004. Used 310 3/4" ground rods, 66 to 12 ft and 244 to 10 ft; 12 8" steel piles; 6 geoprobe electrodes (2").

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance　　　　Facility ID#: 0580

X Performance

Remediation Goal:

X In Groundwater: 1) 95% reduction of total chlorinated solvents in GW concentration in treatment zone; 2) Achieve 90% reduction of the total summation of chlorinated solvents in each shallow well in the treatment zone.

____ In Soil: ____

Was the Remediation Goal Achieved:

X In Groundwater

Comment:

No

____ In Soil

Comment: ____

General comments on the thermal application:

1) Power cycled on 50 minutes and off 10 minutes to allow "re-wetting" of electrodes and to prevent area immediately around electrods from drying out; 2) Last 2 months 23 electrodes, 5 sheet piles, 70 ground rods, and 6 geoprobe electrodes were not used because they reduce to 1 power unit; 3) 14' spacing originally then went to 7 ft using ground rods.

Lessons Learned

____

____ Energy

Total Energy Used: ____ ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy: ____

X Cost

Total Project Cost: 1,274,000 total

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

X Other Cost 1: 50,000

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: X Other Cost 1: monitoring

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information — Facility ID#: 0582

x File Analyzed By: JT x PD ____ — Date: 10/26/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides
____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 2/1/2005 — End of Test: 11/1/2005 — Duration: 9 months

Type of Site: x Non-DOD ____ DoD

x Facility Name: Camlot Dry Cleaners

Address: ____________

City, State, Zip Code: Fargo, ND

OU# or Site #: ____________

x Primary point of contact: Joyce Ackerman

Organization: EPA

Address: ____________

City, State, Zip Code: ____________

Phone #: 303-312-6822 — email: ackerman.joyce@epa.gov

x Other contacts or vendors who worked on site ____ None

Point of contact: Gwen Christiansen

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: EPA

Address: ____________

City, State, Zip Code: ____________

Phone #: 303-312-6463 — email: ____________

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data	Facility ID#: 0582

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______
Post-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

____ Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	x Tetrachloroethene	____ Jet Fuel	____ ________	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ________	None	None	None	None
	x cis-1,2-dichloroethene	____ Benzene	____ ________	None	None	None	None
	x trans-1,2-dichloroethene	____ Tolune	____ ________	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ________	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ________	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ________	None	None	None	None
	____ 1,1,2-trichloroethane	____ ________	____ ________	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ________	____ ________	None	None	None	None
	x Vinyl Chloride	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0582

x Geology: Zone Unconsolidated Sediments

Vadose Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
x Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

Saturated Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
x Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3
Depth to water:	low value (ft bgs):	3		
	high value (ft bgs):	7		
	Unknown:			

____ Flow direction ________ ________ ________

____ Horizontal hydraulic gradient (feet/foot): ________ ________ ________ ____ Unknown

Vertical hydraulic gradient (feet/foot): ________ ________ ________ ____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low ________ ________ ________ ____ Unknown

high ________ ________ ________

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low ________ ________ ________ ____ Unknown

high ________ ________ ________

Comments:

Conductivity - 5000 uS/cm

Attachments:

Thermal Treatment - Design — Facility ID#: 0582

x Thermal treatment:
- ____ Conductive ____________________
- x Electrical Resistance ____________________
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- ____ Steam ____________________
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ____________________

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 2/1/2005 Duration: 9 months

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	10300	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	56	____ Unknown	
Depth to top of target zone (ft bgs):	0	____ Unknown	
Thickness of target zone below water table (ft):	____________	____ Unknown	
Number of energy delivery points:	56	____ Unknown	
Number of extraction points:	____________	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	____________	____ Unknown
Maximum representative formation temperature (deg C):	____________	____ Unknown
Time to reach maximum representative temperature (days):	____________	____ Unknown
Duration of treatment at representative temperature (days):	____________	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____________	____________
Formation temperature post-treatment monitoring event 1:	____________	____________
Duration of post-treatment monitoring (days):	____________	____________

____ Mass of contaminant removed:

Via liquid pumping:	____________	____ lb	____ kg	____ Unknown
In vapor stream:	____________	____ lb	____ kg	____ Unknown
Total:	5188	x lb	____ kg	____ Unknown

Comments:

Attachments: Treated volume of 13800 yd3

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance   Facility ID#: 0582

x Performance

Remediation Goal:

x In Groundwater:

Total VOCs of 1 mg/L

x In Soil:

PCE = 3 mg/kg

Was the Remediation Goal Achieved:

x In Groundwater

Comment:

yes

x In Soil

Comment: Yes, except in 1 location that previous characterization indicated the contamination extended beyond the boundary of designated treatment area.

General comments on the thermal application:

____

Lessons Learned

____

x Energy

Total Energy Used: ____________ ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

x Total energy applied to treatment zone: 2.8 mW-hrs ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____________ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy: ____________

____ Cost

Total Project Cost: ____________

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

____ Energy Cost: ____________ ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

General Site Information Facility ID#: 0585

x File Analyzed By: JT x PD x Date: 4/11/2005

Type of treatment: ____ Conductive ____ Steam ____ ERH x Other: Hot gas

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: 1992 End of Test: 1992 Duration: 90 hr

Type of Site: ____ Non-DOD ____ DoD

x Facility Name: Accutech demo

Address: ____

City, State, Zip Code: Somerville, NJ

OU# or Site #: ____

x Primary point of contact: EPA 540/AR-93?509 July 1993

Organization: ____

Address: ____

City, State, Zip Code: ____

Phone #: ____ email: ____

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____

Organization: ____

Address: ____

City, State, Zip Code: ____

Phone #: ____ email: ____

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good temperature profile vs. time information

____ Groundwater elevations

____ Hydraulic Conductivity information

____ Good pre- and post-treatment soil data

____ Flux assessment

____ Geologic cross-section

General Site Assessment Data | Facility ID#: 0585

____ Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ______

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: ______ Number outside treatment zone: ______

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	10 mg/L	None	None	None
	x Tetrachloroethene	____ Jet Fuel		1 mg/L	None	None	None
	____ 1,1-dichloroethene	____ Napthalene		None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene		None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune		None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane			None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	____ Vinyl Chloride			None	None	None	None
	x DCE			1 mg/L	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model — Facility ID#: 0585

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- x Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- x Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl x Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	21			
	high value (ft bgs):	25			
	Unknown:				
____ Flow direction					
x Horizontal hydraulic gradient (feet/foot):					x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) — Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 0585

x Thermal treatment:
- ____ Conductive ______
- ____ Electrical Resistance ______
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- ____ Steam ______
  - ____ Steam ____ Steam + air ____ Steam + O2
- x Other (describe) hot gas

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- x Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 1992   Duration: 90 hrs

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	______	x Unknown	(___ x ___ ft)
Thickness of target zone (ft):	______	x Unknown	
Depth to top of target zone (ft bgs):	______	x Unknown	
Thickness of target zone below water table (ft):	______	x Unknown	
Number of energy delivery points:	1	____ Unknown	
Number of extraction points:	2	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	______	x Unknown
Maximum representative formation temperature (deg C):	______	x Unknown
Time to reach maximum representative temperature (days):	______	x Unknown
Duration of treatment at representative temperature (days):	______	x Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	______	______
Formation temperature post-treatment monitoring event 1:	______	______
Duration of post-treatment monitoring (days):	______	______

x Mass of contaminant removed:

Via liquid pumping:	______	____ lb	____ kg	x Unknown
In vapor stream:	______	____ lb	____ kg	x Unknown
Total:	______	____ lb	____ kg	x Unknown

Comments: ______

Attachments: ______

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0585

____ Performance

Remediation Goal:

____ In Groundwater:

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information | Facility ID#: 0587

x File Analyzed By: JT x PD ____ Date: 9/13/2006

Type of treatment: x Conductive ____ Steam ____ ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: 2001 End of Test: ____________ Duration: 100 hrs

Type of Site: ____ Non-DOD ____ DoD

x Facility Name: Northern NJ

Address: ____________

City, State, Zip Code: NJ

OU# or Site #: ____________

x Primary point of contact: Paper by Denis M. Conley, et al

Organization: Haley & Aldrich

Address: 200 town Centre Drive, Suite 2

City, State, Zip Code: Rochester, NY 14623

Phone #: 585-359-9000 email: dconley@haleyaldrich.com

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data | Facility ID#: 0587

x Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ x Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: x None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ______

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: ______ Number outside treatment zone: ______

x Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	x Tetrachloroethene	____ Jet Fuel		None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene		None	None	None	None
	x cis-1,2-dichloroethene	____ Benzene		None	None	None	None
	x trans-1,2-dichloroethene	____ Tolune		None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane	x non-aromatic hydrocarbons		None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	____ Vinyl Chloride			None	None	None	None
	x methylene chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0587

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl x Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? x No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	3			
	high value (ft bgs):	7			
	Unknown:				
____ Flow direction					
x Horizontal hydraulic gradient (feet/foot):					x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	2.84			____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Comments:

DTW had dropped to 10 feet (from 7 ft) within 24 hours of multi-phase extraction (MPE) only wells being on
confining layer K=4.5(10^-6)cm/sec Treatment Zone (upper) K=10 -3 cm/sec

Attachments:

Thermal Treatment - Design   Facility ID#: 0587

x Thermal treatment: x Conductive ____________

____ Electrical Resistance ____________

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____________

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____________

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone: x Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only x Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 2001   Duration: ~100 hours (~4 days)

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	481	____ Unknown	(____ x ____ ft)
Thickness of target zone (ft):	____	x Unknown	
Depth to top of target zone (ft bgs):	____	x Unknown	
Thickness of target zone below water table (ft):	____	x Unknown	
Number of energy delivery points:	3	____ Unknown	
Number of extraction points:	1	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	10	____ Unknown
Maximum representative formation temperature (deg C):	88	____ Unknown
Time to reach maximum representative temperature (days):	1	____ Unknown
Duration of treatment at representative temperature (days):	~3	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	x Unknown
In vapor stream:	____	____ lb	____ kg	x Unknown
Total:	____	____ lb	____ kg	x Unknown

Comments:

Spacing of 6ft on heaters and 3.5 ft from MPE Well

Attachments: ____________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0587

x Performance

Remediation Goal:

____ In Groundwater: ____

x In Soil: 1. Determine mass removal w/ MPE and thermally enhanced MPE; 2. Determine rate of energy use necessary to achieve appreciable accelerated mass removal; 3. Determine necessary hydraulic control system; 4. Determine cost benefit.

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____ ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information   Facility ID#: 0593

x File Analyzed By: JT x PD ____   Date: 10/30/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active ____ Post

Type of Test: ____ Pilot Test ____ Full Scale System

Start of Test: ____________ End of Test: ____________ Duration: ________

Type of Site: ____ Non-DOD ____ DoD

x Facility Name: Paterson, NJ

Address: ____________

City, State, Zip Code: Paterson, NJ

OU# or Site #: ____________

x Primary point of contact: David Fleming

Organization: TRS

Address: 7421-A Warren SE

City, State, Zip Code: Snoqualmie, WA 98065

Phone #: 425-396-4266   email: dfleming@thermalrs.com

x Other contacts or vendors who worked on site   ____ None

Point of contact: Mark Bowen

Type: x Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: Anderson Mulholland

Address: ____________

City, State, Zip Code: ____________

Phone #: 914-251-0400 x307   email: mbowen@amaiconsult.com

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data Facility ID#: 0593

____ Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ______

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: ______ Number outside treatment zone: ______

____ Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	x Tetrachloroethene	____ Jet Fuel		50 mg/L	100 mg/kg	None	None
	____ 1,1-dichloroethene	____ Napthalene		None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene		None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune		None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane			None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	____ Vinyl Chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0593

____ Geology: Zone Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown
____ K range (ft/day)	Measured using:	____ Slug Test	____ Laboratory		____ Field data
	low				____ Unknown
	high				
Transmissivity (ft2/day):	Measured using:	____ Slug Test	____ Laboratory		____ Field data
	low				____ Unknown
	high				

Comments: ____________________

Attachments: ____________________

Thermal Treatment - Design　　　　Facility ID#: 0593

x Thermal treatment:

____ Conductive ____________________

x Electrical Resistance ____________________

____ 3 phase　____ 6 phase　____ AC power　____ DC power

____ Steam ____________________

____ Steam　____ Steam + air　____ Steam + O2

____ Other (describe) ____________________

____ Type of Test:　____ Pilot test　____ Full-scale System

____ Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone:　____ Saturated only　____ Vadose only　____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ____________　Duration: ____________

____ Hydraulic Control　____ Yes　____ No

____ Treatment Cell Design:

Size of target zone (ft2): ____________　____ Unknown　(___ x ___ ft)

Thickness of target zone (ft): ____________　____ Unknown

Depth to top of target zone (ft bgs): ____________　____ Unknown

Thickness of target zone below water table (ft): ____________　____ Unknown

Number of energy delivery points: ____________　____ Unknown

Number of extraction points: ____________　____ Unknown

____ Temperature Profile:

Initial formation temperature (deg C): ____________　____ Unknown

Maximum representative formation temperature (deg C): ____________　____ Unknown

Time to reach maximum representative temperature (days): ____________　____ Unknown

Duration of treatment at representative temperature (days): ____________　____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

____ Mass of contaminant removed:

Via liquid pumping: ____________　____ lb　____ kg　____ Unknown

In vapor stream: ____________　____ lb　____ kg　____ Unknown

Total: ____________　____ lb　____ kg　____ Unknown

Comments:

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0593

____ Performance

Remediation Goal:

____ In Groundwater:

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information Facility ID#: 0595

x File Analyzed By: JT x PD ____ Date: 10/30/2006

Type of treatment: ____ Conductive ____ Steam ____ ERH x Other: RFH

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: Jan-95 End of Test: Apr-95 Duration: 90 d

Type of Site: ____ Non-DOD x DoD

x Facility Name: Kirkland AFB

Address: ____________________

City, State, Zip Code: Albuquerque, NM

OU# or Site #: ____________________

x Primary point of contact: Guggilam Sresty

Organization: IIT Research Institute

Address: 10 W. 35th St

City, State, Zip Code: Chicago, IL 60616

Phone #: 312-567-4237 email: ____________________

x Other contacts or vendors who worked on site ____ None

Point of contact: James Phelan

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: Sandia National Laboratories

Address: PO Box 5800

City, State, Zip Code: Albuquerque, NM 87185-5800

Phone #: 505-845-9892 email: ____________________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0595

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

____ Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0595

____ Geology:

Zone	Unconsolidated Sediments
Vadose Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone
Saturated Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown
____ K range (ft/day)	Measured using:	____ Slug Test	____ Laboratory	____ Field data	
	low				____ Unknown
	high				
Transmissivity (ft2/day):	Measured using:	____ Slug Test	____ Laboratory	____ Field data	
	low				____ Unknown
	high				

Comments: ____________________

Attachments: ____________________

Thermal Treatment - Design Facility ID#: 0595

x Thermal treatment: ____ Conductive ____________________

____ Electrical Resistance ____________________

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____________________

____ Steam ____ Steam + air ____ Steam + O2

x Other (describe) RFH

x Type of Test: x Pilot test ____ Full-scale System

____ Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: Jan-95 Duration: 90 d

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2): ____________ ____ Unknown (___ x ___ ft)

Thickness of target zone (ft): ____________ ____ Unknown

Depth to top of target zone (ft bgs): ____________ ____ Unknown

Thickness of target zone below water table (ft): ____________ ____ Unknown

Number of energy delivery points: ____________ ____ Unknown

Number of extraction points: ____________ ____ Unknown

____ Temperature Profile:

Initial formation temperature (deg C): ____________ ____ Unknown

Maximum representative formation temperature (deg C): ____________ ____ Unknown

Time to reach maximum representative temperature (days): ____________ ____ Unknown

Duration of treatment at representative temperature (days): ____________ ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

____ Mass of contaminant removed:

Via liquid pumping: ____________ ____ lb ____ kg ____ Unknown

In vapor stream: ____________ ____ lb ____ kg ____ Unknown

Total: ____________ ____ lb ____ kg ____ Unknown

Comments: ____________________

Attachments: ____________________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0595

____ Performance

Remediation Goal:

____ In Groundwater:

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information Facility ID#: 0600

x File Analyzed By: JT x PD ____ Date: 10/19/2006

Type of treatment: ____ Conductive ____ Steam ____ ERH x Other: ____________

Type of Contaminant: ____ Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating x Other: SVOCs

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: Nov-94 End of Test: Jun-95 Duration: varied

Type of Site: ____ Non-DOD ____ DoD

x Facility Name: Sandia National Lab

Address: ____________

City, State, Zip Code: Albuquerque, NM 87185

OU# or Site #: CLW

x Primary point of contact: Sandia Report: SAND97-1251 UC-2010

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good temperature profile vs. time information

____ Groundwater elevations

____ Hydraulic Conductivity information

____ Good pre- and post-treatment soil data

____ Flux assessment

____ Geologic cross-section

General Site Assessment Data

Facility ID#: 0600

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

	In:	Upgradient:	Downgradient:	Crossgradient:
Pre-treatment	______	______	______	______
Post-treatment	______	______	______	______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 4

Number of relevant soil borings with post-treatment data: 4

Number inside treatment zone: 4 Number outside treatment zone: 0

x Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	x Total SVOCs	None	5 mg/kg	None	0.5 mg/kg
	____ 1,1-dichloroethene	____ Napthalene	____ ________	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ________	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ________	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ________	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ________	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ________	None	None	None	None
	____ 1,1,2-trichloroethane	____ ________	____ ________	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ________	____ ________	None	None	None	None
	____ Vinyl Chloride	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None

Comments:

Attachments:

x Geology: Zone: Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl x Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	485			
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
x Horizontal hydraulic gradient (feet/foot):					x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design Facility ID#: 0600

x Thermal treatment:
____ Conductive ____________
____ Electrical Resistance ____________
____ 3 phase ____ 6 phase ____ AC power ____ DC power
____ Steam ____________
____ Steam ____ Steam + air ____ Steam + O2
x Other (describe) Power Line

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
x Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only x Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: Nov-94 Duration: 33 d

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	720	____ Unknown	(16 x 45 ft)
Thickness of target zone (ft):	23	____ Unknown	
Depth to top of target zone (ft bgs):	0	____ Unknown	
Thickness of target zone below water table (ft):	0	____ Unknown	
Number of energy delivery points:	29	____ Unknown	
Number of extraction points:	6	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	18	____ Unknown
Maximum representative formation temperature (deg C):	90	____ Unknown
Time to reach maximum representative temperature (days):	24	____ Unknown
Duration of treatment at representative temperature (days):	9	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____________	85
Formation temperature post-treatment monitoring event 1:	55 days	25
Duration of post-treatment monitoring (days):	55 days	____________

x Mass of contaminant removed:

Via liquid pumping:	____________	____ lb	____ kg	____ Unknown
In vapor stream:	____________	____ lb	____ kg	____ Unknown
Total:	____________	____ lb	____ kg	x Unknown

Comments: ____________

Attachments: ____________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Thermal Treatment - Design | Facility ID#: 0600

x Thermal treatment:
____ Conductive ________
____ Electrical Resistance ________
____ 3 phase ____ 6 phase ____ AC power ____ DC power
____ Steam ________
____ Steam ____ Steam + air ____ Steam + O2
x Other (describe) RFH

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
x Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only x Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: May-95 Duration: 29 d

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	720	____ Unknown	(16 x 45 ft)
Thickness of target zone (ft):	23	____ Unknown	
Depth to top of target zone (ft bgs):	0	____ Unknown	
Thickness of target zone below water table (ft):	0	____ Unknown	
Number of energy delivery points:	29	____ Unknown	
Number of extraction points:	6	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	22	____ Unknown
Maximum representative formation temperature (deg C):	100	____ Unknown
Time to reach maximum representative temperature (days):	22	____ Unknown
Duration of treatment at representative temperature (days):	9	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		150
Formation temperature post-treatment monitoring event 1:	55 days	80
Duration of post-treatment monitoring (days):	55 days	

x Mass of contaminant removed:

Via liquid pumping:		____ lb	____ kg	____ Unknown
In vapor stream:		____ lb	____ kg	____ Unknown
Total:		____ lb	____ kg	x Unknown

Comments:

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance   Facility ID#: 0600

____ Performance

Remediation Goal:

____ In Groundwater:

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Lessons Learned

Power Line - 45,000 kWhr Radio Frequency - 30,000 kWhr Price is based on the total treated area over the course of the heatings so 6000 yd3

x Energy

Total Energy Used: 75000 x kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy:

x Cost

Total Project Cost: 151 /cubic yard

____ Consultant Cost:

____ Thermal Vendor Cost:

x Energy Cost: 14.87 ____ m^3 x yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information Facility ID#: 0610

x File Analyzed By: JT x PD ____ Date: 7/12/2007

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: Jan-91 End of Test: ____________ Duration: ________

Type of Site: x Non-DOD ____ DoD

x Facility Name: Former AT&T Skokie Works

Address: ____________

City, State, Zip Code: Skokie, IL

OU# or Site #: ____________

x Primary point of contact: Dennis Sopcich

Organization: ENSR Corporation

Address: ____________

City, State, Zip Code: ____________

Phone #: 630-836-1700 email: ____________

x Other contacts or vendors who worked on site ____ None

Point of contact: Stan Komperda

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: IL EPA

Address: 1201 N. Grand Ave. E.

City, State, Zip Code: Springfield, IL 62794-9276

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data　　　　Facility ID#: 0610

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: __________ Number outside treatment zone: __________

____ Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents:	Petroleum Hydrocarbons:	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____ ________	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ________	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ________	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ________	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ________	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ________	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ________	None	None	None	None
	____ 1,1,2-trichloroethane	____ ________	____ ________	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ________	____ ________	None	None	None	None
	____ Vinyl Chloride	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model   Facility ID#: 0610

____ Geology: Zone Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design Facility ID#: 0610

x Thermal treatment: ____ Conductive ____________

____ Electrical Resistance ____________

____ 3 phase ____ 6 phase ____ AC power ____ DC power

x Steam ____________

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____________

X Type of Test: X Pilot test ____ Full-scale System

X Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

X Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: Jan-91 Duration: ____________

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2): ____________ ____ Unknown (___ x ___ ft)

Thickness of target zone (ft): ____________ ____ Unknown

Depth to top of target zone (ft bgs): ____________ ____ Unknown

Thickness of target zone below water table (ft): ____________ ____ Unknown

Number of energy delivery points: ____________ ____ Unknown

Number of extraction points: ____________ ____ Unknown

____ Temperature Profile:

Initial formation temperature (deg C): ____________ ____ Unknown

Maximum representative formation temperature (deg C): ____________ ____ Unknown

Time to reach maximum representative temperature (days): ____________ ____ Unknown

Duration of treatment at representative temperature (days): ____________ ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

____ Mass of contaminant removed:

Via liquid pumping:	____________	____ lb	____ kg	____ Unknown
In vapor stream:	____________	____ lb	____ kg	____ Unknown
Total:	____________	____ lb	____ kg	____ Unknown

Comments:

1st Phase - initiated 1991 and expanded in 1993. The system was closed via EPA-approval

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0610

____ Performance

Remediation Goal:

____ In Groundwater: ____

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information Facility ID#: 0611

x File Analyzed By: JT x PD ____ Date: 7/12/2007

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 6/4/1998 End of Test: 4/30/1999 Duration: 8 months

Type of Site: x Non-DOD ____ DoD

x Facility Name: Former AT&T Skokie Works

Address: ____________

City, State, Zip Code: Skokie, IL

OU# or Site #: ____________

x Primary point of contact: Dennis Sopcich

Organization: ENSR Corporation

Address: ____________

City, State, Zip Code: ____________

Phone #: 630-836-1700 email: ____________

x Other contacts or vendors who worked on site ____ None

Point of contact: Stan Komperda

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: IL EPA

Address: 1201 N. Grand Ave. E.

City, State, Zip Code: Springfield, IL 62794-9276

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data Facility ID#: 0611

____ Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ______

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: ______ Number outside treatment zone: ______

____ Types of Contaminants

	Chlorinated Solvents:	Petroleum Hydrocarbons:	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	None	None	1 mg/L	None
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	x 1,1-dichloroethene	____ Napthalene	____	None	None	0.01 mg/L	None
	x cis-1,2-dichloroethene	____ Benzene	____	None	None	1 mg/L	None
	x trans-1,2-dichloroethene	____ Tolune	____	None	None	0.1 mg/L	None
	x 1,1-dichloroethane	____ Ethylbenzene	____	None	None	0.1 mg/L	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	x 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	x Vinyl Chloride	____	____	None	None	1 mg/L	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Data from the 1st ERH - system. The system was shutdown in December 1998 to January 1999 to expand the system. The whole system was also down the almost the whole month of October.

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0611

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 9 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

		Aquifer 1	Aquifer 2	Aquifer 3	
K range (ft/day)	low				____ Unknown
	high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

		Aquifer 1	Aquifer 2	Aquifer 3	
Transmissivity (ft2/day)	low				____ Unknown
	high				

Comments:

Attachments:

Thermal Treatment - Design | Facility ID#: 0611

x Thermal treatment:
- ____ Conductive ____
- x Electrical Resistance ____
  - ____ 3 phase x 6 phase ____ AC power ____ DC power
- ____ Steam ____
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ____

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 6/4/1998 Duration: 8 months

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2):	____	____ Unknown (___ x ___ ft)
Thickness of target zone (ft):	____	____ Unknown
Depth to top of target zone (ft bgs):	____	____ Unknown
Thickness of target zone below water table (ft):	____	____ Unknown
Number of energy delivery points:	____	____ Unknown
Number of extraction points:	____	____ Unknown

____ Temperature Profile:

Initial formation temperature (deg C):	____	____ Unknown
Maximum representative formation temperature (deg C):	____	____ Unknown
Time to reach maximum representative temperature (days):	____	____ Unknown
Duration of treatment at representative temperature (days):	____	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	27202	x lb	____ kg	____ Unknown
Total:	66850	x lb	____ kg	____ Unknown

Comments:

ERH by battelle begain in June of 1998 and expanded in 12/98 &1/99 and operated until April 1999

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance   Facility ID#: 0611

x Performance

Remediation Goal:

x In Groundwater: Reach risk-based target cleanup levels (RBTCLs) trans-1,2-DCE- 70,900 ug/L, cis-1,2-DCE - 35,500 ug/L, 1,1,1-TCA - 9,650 ug/L, TCE - 17,500 ug/L, 1,1-DCA - 175,000 ug/L, and Vinyl Chloride - 945 ug/L

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

Site was closed after reaching the RBTCLs via IL EPA approval.

Lessons Learned

____

____ Energy

Total Energy Used: ____ ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information Facility ID#: 0620

x File Analyzed By: JT x PD ____ Date: 4/5/2005

Type of treatment: x Conductive ____ Steam ____ ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating x Other: PCBs

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: Jan-96 End of Test: Mar-96 Duration: ~36 hours

Type of Site: ____ Non-DOD ____ DoD

x Facility Name: South Glens Falls Dragstrip

Address: Route 9

City, State, Zip Code: Moreau, Saratoga County, New York

OU# or Site #: ____________

x Primary point of contact: RT Environmental Engineering

Organization: ____________

Address: 215 W. Church Rd

City, State, Zip Code: King of Prussia, PA 19406

Phone #: ____________ email: ____________

x Other contacts or vendors who worked on site ____ None

Point of contact: Ralph Baker

Type: x Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: TerraTherm

Address: 10 Stevens Road

City, State, Zip Code: Fitchburg, MA 01420

Phone #: 978-343-0300 email: rbaker@terratherm.com

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

x Good pre- and post-treatment soil data

x Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0620

x Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ x Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: x None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 35

Number of relevant soil borings with post-treatment data: 58

Number inside treatment zone: 85 Number outside treatment zone: 8

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	x Arclor 1254	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	x Arclor 1260	None	500 mg/kg	None	0.1 mg/kg
	____ cis-1,2-dichloroethene	____ Benzene	x PCBs	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune		None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane			None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	____ Vinyl Chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model   Facility ID#: 0620

x Geology:

	Zone		Unconsolidated Sediments
	Vadose Zone:	x	Relatively homogeneous and permeable unconsolidated sediments
		____	Relatively homogeneous and impermeable unconsolidated sediments
		____	Largely permeable sediments with inter-bedded lenses of lower permeability material
		____	Largely impermeable sediments with inter-bedded layers of higher permeability material
		____	Competent, but fractured bedrock (i.e. crystalline rock)
		____	Weathered bedrock, limestone, sandstone
	Saturated Zone:	____	Relatively homogeneous and permeable unconsolidated sediments
		____	Relatively homogeneous and impermeable unconsolidated sediments
		____	Largely permeable sediments with inter-bedded lenses of lower permeability material
		____	Largely impermeable sediments with inter-bedded layers of higher permeability material
		____	Competent, but fractured bedrock (i.e. crystalline rock)
		____	Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl   x Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present?   ____ No   ____ Yes (number): ________   x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3
Depth to water:	low value (ft bgs):	22		
	high value (ft bgs):	28		
	Unknown:			

___ Flow direction

	Aquifer 1	Aquifer 2	Aquifer 3		
x Horizontal hydraulic gradient (feet/foot):				x	Unknown
Vertical hydraulic gradient (feet/foot):				x	Unknown

x K range (ft/day)   Measured using: ____ Slug Test   ____ Laboratory   ____ Field data

low				x	Unknown
high					

Transmissivity (ft2/day):   Measured using: ____ Slug Test   ____ Laboratory   ____ Field data

low				x	Unknown
high					

Comments:

Attachments: The good temperature profile data are found in the ES&T article, Iben et al. 1996, Vol. 30 No. 11, pp. 3144-3154, Fig. 3 a,b.

Thermal Treatment - Design — Facility ID#: 0620

x Thermal treatment: x Conductive — Thermal Blankets

____ Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:
- x Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only x Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: Jan-96 — Duration: 36 hours

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	4800	____ Unknown	(20 x 40 ft)
Thickness of target zone (ft):	1	____ Unknown	
Depth to top of target zone (ft bgs):	0	____ Unknown	
Thickness of target zone below water table (ft):	0	____ Unknown	
Number of energy delivery points:	6	____ Unknown	
Number of extraction points:	N/A	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	____	x Unknown
Maximum representative formation temperature (deg C):	220	____ Unknown
Time to reach maximum representative temperature (days):	1	____ Unknown
Duration of treatment at representative temperature (days):	>1	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	60.2	____ lb	x kg	____ Unknown
Total:	____	____ lb	____ kg	____ Unknown

Comments: 6 treatment cells : 1A - 35 hours (1/29/96 to 1/31/96); 1B - 26 hours (1/31/96-2/2/06); 2A - 29 hours (2/4/96 - 2/5/96); 2B - 34 hours (2/5/96 - 2/7/96); 3A - 36 hours (2/6/96 - 2/8/96); 3B - 39 hours (2/8/96 - 2/10/96) Estimated & report amounts removed total

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance   Facility ID#: 0620

x Performance

Remediation Goal:

____ In Groundwater: ____

x In Soil:

Show effectiveness of ISTD in surface soils on PCBs and show no impact on human health

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

x In Soil

Comment:

Yes, below 2ppm to 18 inches. No high emissions

General comments on the thermal application:

____

Lessons Learned

____

x Energy

Total Energy Used: ____ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

x Total energy applied to treatment zone: 5.5 GJ* ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: * from Iben et al. 1996 ES&T paper, Table 5.

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information — Facility ID#: 0625

x File Analyzed By: JT x PD ____ — Date: 11/4/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: ____________ End of Test: ____________ Duration: ________

Type of Site: x Non-DOD ____ DoD

x Facility Name: West Side Corporation Site

Address: ____________

City, State, Zip Code: Jamaica, New York

OU# or Site #: ____________

x Primary point of contact: Jon Sundquist

Organization: URS

Address: ____________

City, State, Zip Code: ____________

Phone #: 716-856-5636 email: ____________

x Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: New York Department of Environmental Conservation

Address: Remedial Bureau E, 12th Floor, 625 Broadway

City, State, Zip Code: Albany, NY 12233-7017

Phone #: 518-402-9814 email: ____________

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data | Facility ID#: 0625

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

	In:	Upgradient:	Downgradient:	Crossgradient:
Pre-treatment	______	______	______	______
Post-treatment	______	______	______	______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	x Tetrachloroethene	____ Jet Fuel	____ ________	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ________	None	None	None	None
	x cis-1,2-dichloroethene	____ Benzene	____ ________	None	None	None	None
	x trans-1,2-dichloroethene	____ Tolune	____ ________	None	None	None	None
	x 1,1-dichloroethane	____ Ethylbenzene	____ ________	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ________	None	None	None	None
	x 1,1,1-trichloroethane	____ o-xylene	____ ________	None	None	None	None
	____ 1,1,2-trichloroethane	____ ________	____ ________	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ________	____ ________	None	None	None	None
	x Vinyl Chloride	____ ________	____ ________	None	None	None	None
	____ ________	x Ethylbenzene	____ ________	None	None	None	None
	____ ________	x MTBE	____ ________	None	None	None	None
	____ ________	x Toluene	____ ________	None	None	None	None
	____ ________	x Trichlorofluoromethane	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None

Comments: ________________________

Attachments: ________________________

Hydrogeologic Conceptual Model Facility ID#: 0625

x Geology: Zone Unconsolidated Sediments

Vadose Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
x Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

Saturated Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
x Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	15			
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 0625

x Thermal treatment: ____ Conductive ____

x Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

x Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

____ Start of Thermal Test: ____ Duration: ____

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2): 1200 ____ Unknown (60 x 60 ft)

Thickness of target zone (ft): 45 ____ Unknown

Depth to top of target zone (ft bgs): 10 ____ Unknown

Thickness of target zone below water table (ft): 40 ____ Unknown

Number of energy delivery points: ____ ____ Unknown

Number of extraction points: ____ ____ Unknown

____ Temperature Profile:

Initial formation temperature (deg C): ____ ____ Unknown

Maximum representative formation temperature (deg C): ____ ____ Unknown

Time to reach maximum representative temperature (days): ____ ____ Unknown

Duration of treatment at representative temperature (days): ____ ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

____ Mass of contaminant removed:

Via liquid pumping: ____ ____ lb ____ kg ____ Unknown

In vapor stream: ____ ____ lb ____ kg ____ Unknown

Total: ____ ____ lb ____ kg ____ Unknown

Comments: ____

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0625

____ Performance

Remediation Goal:

____ In Groundwater: ______________________________

____ In Soil: ______________________________

Was the Remediation Goal Achieved:

____ In Groundwater ______________________________

Comment: ______________________________

____ In Soil ______________________________

Comment: ______________________________

General comments on the thermal application:

Objective - Reduce the mass of contaminants in source areas as much as practicable, so that when off-site GW extraction begins there is less source contamnation contributing to the plume.

Lessons Learned

____

____ Energy

Total Energy Used: ____________ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ______________________________

____ Cost

Total Project Cost: ____________

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

____ Energy Cost: ____________ ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ______________________________

____ Other Cost 2: ______________________________

____ Other Cost 3: ______________________________

General Site Information | | Facility ID#: 0635

x File Analyzed By: JT x PD ____ Date: 10/26/2006

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ____________

Type of Contaminant: X Chlorinated Solvents X Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: ____________ End of Test: ____________ Duration: ________

Type of Site: x Non-DOD ____ DoD

x Facility Name: Former Chemcial Manufacturing Facility

Address: ____________

City, State, Zip Code: Brooklynn, NY

OU# or Site #: ____________

x Primary point of contact: Todd M. Musterait

Organization: Environmental Strategies Consulting LLC

Address: 70 Graystone Lane

City, State, Zip Code: Orchard Park, NY 14127

Phone #: 716-662-5128 email: tmusterait@esc-ny.com

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data | Facility ID#: 0635

x Impacted Zone: Length (parallel to flow direction)(ft.): below Width (ft): ______ Thickness (ft): ______ ___ Unknown

x Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ______

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: ______ Number outside treatment zone: ______

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	x Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	x Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	x Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	x Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	x phenol	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	x xylenes	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	x acetone	____	____	None	None	None	None
	x methylene chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

1.6 acres - impacted

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0635

x Geology: Zone Unconsolidated Sediments

Vadose Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
x Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

Saturated Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	____	____	____	
	high value (ft bgs):	____	____	____	
	Unknown:	____	____	____	
____ Flow direction		____	____	____	
____ Horizontal hydraulic gradient (feet/foot):		____	____	____	____ Unknown
Vertical hydraulic gradient (feet/foot):		____	____	____	____ Unknown
____ K range (ft/day)	Measured using:	____ Slug Test	____ Laboratory	____ Field data	
	low	____	____	____	____ Unknown
	high	____	____	____	
Transmissivity (ft2/day):	Measured using:	____ Slug Test	____ Laboratory	____ Field data	
	low	____	____	____	____ Unknown
	high	____	____	____	

Comments: ____________________

Attachments: ____________________

Thermal Treatment - Design Facility ID#: 0635

x Thermal treatment: ____ Conductive ________

____ Electrical Resistance ________

____ 3 phase ____ 6 phase ____ AC power ____ DC power

x Steam Pilot

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ________

x Type of Test: x Pilot test ____ Full-scale System

____ Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ________ Duration: ________

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2): ________ ____ Unknown (___ x ___ ft)

Thickness of target zone (ft): ________ ____ Unknown

Depth to top of target zone (ft bgs): ________ ____ Unknown

Thickness of target zone below water table (ft): ________ ____ Unknown

Number of energy delivery points: ________ ____ Unknown

Number of extraction points: ________ ____ Unknown

____ Temperature Profile:

Initial formation temperature (deg C): ________ ____ Unknown

Maximum representative formation temperature (deg C): ________ ____ Unknown

Time to reach maximum representative temperature (days): ________ ____ Unknown

Duration of treatment at representative temperature (days): ________ ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	________	________
Formation temperature post-treatment monitoring event 1:	________	________
Duration of post-treatment monitoring (days):	________	________

____ Mass of contaminant removed:

Via liquid pumping: ________ ____ lb ____ kg ____ Unknown

In vapor stream: ________ ____ lb ____ kg ____ Unknown

Total: ________ ____ lb ____ kg ____ Unknown

Comments: ________

Attachments: ________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0635

____ Performance

Remediation Goal:

____ In Groundwater:

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information — Facility ID#: 0638

x File Analyzed By: JT x PD ____ — Date: 10/26/2006

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ____________

Type of Contaminant: X Chlorinated Solvents X Petroleum Hydrocarbons ____ Pesticides
____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ___ Pilot Test x Full Scale System

Start of Test: Jul-04 End of Test: ____________ Duration: ________

Type of Site: x Non-DOD ____ DoD

x Facility Name: Former Chemcial Manufacturing Facility

Address: ____________

City, State, Zip Code: Brooklynn, NY

OU# or Site #: ____________

x Primary point of contact: Todd M. Musterait

Organization: Environmental Strategies Consulting LLC

Address: 70 Graystone Lane

City, State, Zip Code: Orchard Park, NY 14127

Phone #: 716-662-5128 email: tmusterait@esc-ny.com

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data Facility ID#: 0638

x Impacted Zone: Length (parallel to flow direction)(ft.): below Width (ft): ____ Thickness (ft): ____ ___ Unknown

x Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ____ Post-treatment: ____

Number of wells relative to treatment zone:

Pre-treatment	In: ____	Upgradient: ____	Downgradient: ____	Crossgradient: ____
Post-treatment	In: ____	Upgradient: ____	Downgradient: ____	Crossgradient: ____

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____

Number of relevant soil borings with post-treatment data: ____

Number inside treatment zone: ____ Number outside treatment zone: ____

x Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	x Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	x Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	x Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	x Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	x phenol	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	x xylenes	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	x acetone	____	____	None	None	None	None
	x methylene chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

1.6 acres - impacted

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0638

x Geology: Zone Unconsolidated Sediments

Vadose Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
x Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

Saturated Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 0638

x Thermal treatment: ____ Conductive ____________

____ Electrical Resistance ____________

____ 3 phase ____ 6 phase ____ AC power ____ DC power

x Steam Full

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____________

x Type of Test: ____ Pilot test x Full-scale System

____ Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: Jul-04 Duration: ____________

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	____________	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	____________	____ Unknown	
Depth to top of target zone (ft bgs):	____________	____ Unknown	
Thickness of target zone below water table (ft):	____________	____ Unknown	
Number of energy delivery points:	47	____ Unknown	
Number of extraction points:	44	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	____________	____ Unknown
Maximum representative formation temperature (deg C):	____________	____ Unknown
Time to reach maximum representative temperature (days):	____________	____ Unknown
Duration of treatment at representative temperature (days):	____________	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____________	____________
Formation temperature post-treatment monitoring event 1:	____________	____________
Duration of post-treatment monitoring (days):	____________	____________

____ Mass of contaminant removed:

Via liquid pumping:	____________	____ lb	____ kg	____ Unknown
In vapor stream:	____________	____ lb	____ kg	____ Unknown
Total:	____________	____ lb	____ kg	____ Unknown

Comments: ____________

Attachments: ____________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance   Facility ID#: 0638

____ Performance

Remediation Goal:

____ In Groundwater: ____________________

____ In Soil: ____________________

Was the Remediation Goal Achieved:

____ In Groundwater ____________________

Comment: ____________________

____ In Soil ____________________

Comment: ____________________

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: __________ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: __________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: __________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____________________

____ Cost

Total Project Cost: __________

____ Consultant Cost: __________

____ Thermal Vendor Cost: __________

____ Energy Cost: __________ ____ m^3 ____ yd^3

____ Other Cost 1: __________

____ Other Cost 2: __________

____ Other Cost 3: __________

____ Please note other cost: ____ Other Cost 1: ____________________

____ Other Cost 2: ____________________

____ Other Cost 3: ____________________

General Site Information Facility ID#: 0640

x File Analyzed By: JT x PD ____ Date: 5/11/2005

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 8/26/1996 End of Test: 9/25/1996 Duration: 30 d

Type of Site: ____ Non-DOD x DoD

x Facility Name: Niagara Falls International Airport Air Reserve

Address: ____________

City, State, Zip Code: Niagara Falls, NY

OU# or Site #: Site 10

x Primary point of contact: Gerald Hromowyk

Organization: Air Reserve

Address: 2405 Franklin Drive

City, State, Zip Code: Niagara Falls, NY 14304-5063

Phone #: 716-236-3126 email: gerald.hromowyk@niagarafalls.af.mil

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data — Facility ID#: 0640

___ Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ ___ Unknown

___ Impacted zone as defined by documentation

___ Alternative method for determining size of impacted zone (See source zone definition attachments)

___ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ______ Post-treatment: 13

Number of wells relative to treatment zone:

	In:	Upgradient:	Downgradient:	Crossgradient:
Pre-treatment	______	______	______	______
Post-treatment	______	______	13	______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 15

Number of relevant soil borings with post-treatment data: 15

Number inside treatment zone: 15 Number outside treatment zone: 15

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	___ Hexane	___ Creosote	None	1 mg/kg	None	1 mg/kg
	x Tetrachloroethene	___ Jet Fuel	___	None	0.01 mg/kg	None	0.05 mg/kg
	___ 1,1-dichloroethene	___ Napthalene	___	None	None	None	None
	___ cis-1,2-dichloroethene	x Benzene	___	None	0.01 mg/kg	None	0.01 mg/kg
	x trans-1,2-dichloroethene	___ Tolune	___	None	0.05 mg/kg	None	0.01 mg/kg
	___ 1,1-dichloroethane	x Ethylbenzene	___	None	0.5 mg/kg	None	0.5 mg/kg
	___ 1,2-dichloroethane	x m/p-xylene	___	None	0.5 mg/kg	None	0.1 mg/kg
	___ 1,1,1-trichloroethane	x o-xylene	___	None	0.05 mg/kg	None	0.05 mg/kg
	___ 1,1,2-trichloroethane	x Tolune	___	None	0.01 mg/kg	None	0.01 mg/kg
	___ 1,1,2,2-tetrachloroethane	x MEK (2-butanone)	___	None	0.05 mg/kg	None	0.1 mg/kg
	___ Vinyl Chloride	x acetone	___	None	0.5 mg/kg	None	0.1 mg/kg
	x chloroform	___	___	None	0.01 mg/kg	None	0.01 mg/kg
	___	x carbon disulfide	___	None	0.01 mg/kg	None	0.05 mg/kg
	___	x methylene chloride	___	None	0.1 mg/kg	None	0.5 mg/kg
	___	___	___	None	None	None	None
	___	___	___	None	None	None	None
	___	___	___	None	None	None	None

Comments:

Chloroform pre soil concentration was actually 0.001 mg/kg and chloroform and carbon disulfide post soil concentrations were 0.005 mg/kg

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0640

x Geology: Zone Unconsolidated Sediments

Vadose Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
x Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

Saturated Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
x Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	2.5			
	high value (ft bgs):				
	Unknown:				
Flow direction					
Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	0.85			____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design Facility ID#: 0640

x Thermal treatment:
- ____ Conductive
- x Electrical Resistance
  - ____ 3 phase x 6 phase ____ AC power ____ DC power
- ____ Steam
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe)

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 8/26/1996 Duration: 330 d

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	9500	____ Unknown	(110 x 110 ft)
Thickness of target zone (ft):	9	____ Unknown	
Depth to top of target zone (ft bgs):	1	____ Unknown	
Thickness of target zone below water table (ft):	7.5	____ Unknown	
Number of energy delivery points:	29	____ Unknown	
Number of extraction points:	5	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	15	____ Unknown
Maximum representative formation temperature (deg C):	82	____ Unknown
Time to reach maximum representative temperature (days):	25	____ Unknown
Duration of treatment at representative temperature (days):	5	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	9/25/1996	75
Formation temperature post-treatment monitoring event 1:	10/15/1996	40
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

Via liquid pumping:		____ lb	____ kg	____ Unknown
In vapor stream:		____ lb	____ kg	____ Unknown
Total:	64.3	____ lb	x kg	____ Unknown

Comments:

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0640

____ Performance

Remediation Goal:

____ In Groundwater: ____________________

____ In Soil: ____________________

Was the Remediation Goal Achieved:

____ In Groundwater ____________________

Comment: ____________________

____ In Soil ____________________

Comment: ____________________

General comments on the thermal application:

Objective: Reduce VOC concentrations in the saturated and unsatured soils at site 10

Lessons Learned

____

x Energy

Total Energy Used: 336000 x kWhr ____ kWhr/m^3 ____ kWhr/yd^3

x Total energy applied to treatment zone: 140000 kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____________________

____ Cost

Total Project Cost: ____________

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

____ Energy Cost: ____________ ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ____________________

____ Other Cost 2: ____________________

____ Other Cost 3: ____________________

General Site Information Facility ID#: 0645

x File Analyzed By: JT x PD ____ Date: 10/30/2006

Type of treatment: x Conductive ____ Steam ____ ERH ____ Other: ________

Type of Contaminant: X Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ________

Treatment Status: x Active ___ Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: Nov-06 End of Test: ________ Duration: 6 months

Type of Site: ____ Non-DOD ____ DoD

x Facility Name: Syracus, NY

Address: ________

City, State, Zip Code: Syracuse, NY

OU# or Site #: ________

x Primary point of contact: Gorm Heron

Organization: TerraTherm

Address: 10 Stevens Road

City, State, Zip Code: Fitchburg, MA 01420

Phone #: 978-343-0300 email: gheron@terratherm.com

____ Other contacts or vendors who worked on site ____ None

Point of contact: ________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: ________

Address: ________

City, State, Zip Code: ________

Phone #: ________ email: ________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data | Facility ID#: 0645

x Impacted Zone: Length (parallel to flow direction)(ft.): ____ Width (ft): ____ Thickness (ft): 20 ___ Unknown

____ Impacted zone as defined by documentation

Alternative method for determining size of impacted zone (See source zone definition attachments)

X Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ____ Post-treatment: ____

Number of wells relative to treatment zone:

	In:	Upgradient:	Downgradient:	Crossgradient:
Pre-treatment				
Post-treatment				

x Soil Borings: Number of relevant soil borings with pre-treatment data: more than 30

Number of relevant soil borings with post-treatment data: 30

Number inside treatment zone: 30 Number outside treatment zone: 0

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	x Tetrachloroethene	____ Jet Fuel		None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene		None	None	None	None
	x cis-1,2-dichloroethene	____ Benzene		None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune		None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane			None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	x Vinyl Chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

See IRM Work Plan and final report when it becomes available. Treating 3 source zones totalling 16,200 cubic yards, avg. depth 20 ft

Attachments:

Map showing 3 DNAPL treatment zones

Hydrogeologic Conceptual Model | Facility ID#: 0645

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 3 ft below grade ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? x No ____ Yes (number): ____ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	3			
	high value (ft bgs):	0			
	Unknown:				
x Flow direction		south			
x Horizontal hydraulic gradient (feet/foot):		0.003			____ Unknown
Vertical hydraulic gradient (feet/foot):		unknown			____ Unknown

x K range (ft/day) — Measured using: x Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low	0.1			____ Unknown
high	1			

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 0645

x Thermal treatment: x Conductive ____

____ Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

x Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: Nov-06   Duration: 6 months

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	21870	____ Unknown (____ x ____ ft)
Thickness of target zone (ft):	18-27	____ Unknown
Depth to top of target zone (ft bgs):	0	____ Unknown
Thickness of target zone below water table (ft):	17-24	____ Unknown
Number of energy delivery points:	211	____ Unknown
Number of extraction points:	17 horizontal collectors	____ Unknown

x Temperature Profile:

Initial formation temperature (deg C):	10	____ Unknown
Maximum representative formation temperature (deg C):	110	____ Unknown
Time to reach maximum representative temperature (days):	200	____ Unknown
Duration of treatment at representative temperature (days):	60	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

____ Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	____	____ lb	____ kg	____ Unknown
Total:	____	____ lb	____ kg	____ Unknown

Comments: ____

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0645

x Performance

Remediation Goal:

____ In Groundwater:

x In Soil: 5,600 µg/kg for PCE; 2,800 µg/kg for TCE; 1,200 µg/kg for trans-1,1-dichloroethene; and 800 µg/kg for vinyl chloride

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information   Facility ID#: 0660

x File Analyzed By: JT x PD ____ Date: 4/12/2005

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: Jul-98 End of Test: Aug-99 Duration: ~1 year

Type of Site: ____ Non-DOD ____ DoD

x Facility Name: DOE Portsmouth Gaseous Diffusion Facility

Address: ____________

City, State, Zip Code: Ohio

OU# or Site #: ____________

x Primary point of contact: Sandy Childer

Organization: Bechtel-jacobs

Address: ____________

City, State, Zip Code: ____________

Phone #: 740-897-2336 email: y84@bechtel.jacobs.org

x Other contacts or vendors who worked on site ____ None

Point of contact: John Sokol

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications x Other ____________

Organization: Bechtel-Jacobs

Address: ____________

City, State, Zip Code: OH

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good temperature profile vs. time information

____ Groundwater elevations

____ Hydraulic Conductivity information

____ Good pre- and post-treatment soil data

____ Flux assessment

____ Geologic cross-section

General Site Assessment Data — Facility ID#: 0660

x Impacted Zone: Length (parallel to flow direction)(ft.): 2080 Width (ft): ____ Thickness (ft): ____ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 6 Post-treatment: 6

Number of wells relative to treatment zone:

Pre-treatment In: 6 Upgradient: ____ Downgradient: ____ Crossgradient: ____

Post-treatment In: 6 Upgradient: ____ Downgradient: ____ Crossgradient: ____

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____

Number of relevant soil borings with post-treatment data: ____

Number inside treatment zone: ____ Number outside treatment zone: ____

____ Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model — Facility ID#: 0660

x Geology: — Zone: Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- x Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ____ ft amsl — x Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3		
Depth to water:	low value (ft bgs):	30				
	high value (ft bgs):	35				
	Unknown:					
x Flow direction		E				
x Horizontal hydraulic gradient (feet/foot):					x	Unknown
Vertical hydraulic gradient (feet/foot):					x	Unknown
x K range (ft/day)	Measured using:	____ Slug Test	____ Laboratory	____ Field data		
	low				x	Unknown
	high					
Transmissivity (ft2/day):	Measured using:	____ Slug Test	____ Laboratory	____ Field data		
	low				x	Unknown
	high					

Comments:

intrinsic permeability = 5 darcy (5e-3 cm/s)

Attachments:

Thermal Treatment - Design — Facility ID#: 0660

x Thermal treatment:
- ____ Conductive
- ____ Electrical Resistance
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- x Steam DUS/HPO
  - ____ Steam x Steam + air ____ Steam + O2
- ____ Other (describe)

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: Jul-98 Duration: ~1year

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	17000	____ Unknown (180 x 120 ft)
Thickness of target zone (ft):	35	____ Unknown
Depth to top of target zone (ft bgs):	____	x Unknown
Thickness of target zone below water table (ft):	20	____ Unknown
Number of energy delivery points:	19	____ Unknown
Number of extraction points:	7	____ Unknown

x Temperature Profile:

Initial formation temperature (deg C):	18	____ Unknown
Maximum representative formation temperature (deg C):	100	____ Unknown
Time to reach maximum representative temperature (days):	112	____ Unknown
Duration of treatment at representative temperature (days):	____	c Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	x Unknown
In vapor stream:	____	____ lb	____ kg	x Unknown
Total:	400	____ lb	____ kg	____ Unknown

Comments: ____

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0660

____ Performance

Remediation Goal:

____ In Groundwater: ______________________________

____ In Soil: ______________________________

Was the Remediation Goal Achieved:

____ In Groundwater ______________________________

Comment: ______________________________

____ In Soil ______________________________

Comment: ______________________________

General comments on the thermal application:

SteamTech (vendor) published a final report with DOE as Document no. DOE/OR/11-3032, but I could not obtain this document.

Lessons Learned

____

____ Energy

Total Energy Used: ____________ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ______________________________

____ Cost

Total Project Cost: >1,000,000

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

____ Energy Cost: ____________ ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ______________________________

____ Other Cost 2: ______________________________

____ Other Cost 3: ______________________________

General Site Information Facility ID#: 0670

x File Analyzed By: JT x PD ____ Date: 10/18/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ____ Full Scale System

Start of Test: 10/19/1998 End of Test: 11/20/1998 Duration: 42 d

Type of Site: x Non-DOD ____ DoD

x Facility Name: Confidential Midwest

Address: ____________

City, State, Zip Code: Ohio

OU# or Site #: ____________

x Primary point of contact: Mark Lyverse

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

x Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data | Facility ID#: 0670

____ Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ______

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: ______ Number outside treatment zone: ______

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel		None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene		None	None	None	None
	____ cis-1,2-dichloroethene	x Benzene		0.5 mg/L	5 mg/kg	0.005 mg/L	0.05 mg/kg
	____ trans-1,2-dichloroethene	____ Tolune		None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane			None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	____ Vinyl Chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

Estimated 60,000 lbs of TCE in the soil.

Attachments: ______

Hydrogeologic Conceptual Model Facility ID#: 0670

x Geology: Zone: Unconsolidated Sediments

Vadose Zone:
- x Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- x Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 474 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	-12 (above grade)			
	high value (ft bgs):	15			
	Unknown:				
x Flow direction		S to SE			
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	1			____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design Facility ID#: 0670

x Thermal treatment: ____ Conductive ______

x Electrical Resistance ______

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ______

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ______

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone: x Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 10/19/1998 Duration: 42 d

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	______	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	20.5	____ Unknown	
Depth to top of target zone (ft bgs):	3.5	____ Unknown	
Thickness of target zone below water table (ft):	19	____ Unknown	
Number of energy delivery points:	6	____ Unknown	
Number of extraction points:	1	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	23	____ Unknown
Maximum representative formation temperature (deg C):	95	____ Unknown
Time to reach maximum representative temperature (days):	15	____ Unknown
Duration of treatment at representative temperature (days):	27	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	______	______
Formation temperature post-treatment monitoring event 1:	______	______
Duration of post-treatment monitoring (days):	______	______

x Mass of contaminant removed:

Via liquid pumping:	265 gal	____ lb	____ kg	____ Unknown
In vapor stream:	3890	x lb	____ kg	____ Unknown
Total:	______	____ lb	____ kg	____ Unknown

Comments:

Total volume heated - 1800 yd3

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance

Facility ID#: 0670

x Performance

Remediation Goal:

x In Groundwater:

98% removal of benzene

x In Soil:

98% removal of benzene

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

Goal to reach boiling point of water in subsurface and maintain for 60 days

Lessons Learned

____

____ Energy

Total Energy Used: ____ ____ kWhr ____ kWhr/m³ ____ kWhr/yd³

____ Total energy applied to treatment zone: ____ ____ kWhr/m³ ____ kWhr/yd³

____ Other energy: ____ ____ kWhr/m³ ____ kWhr/yd³

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m³ ____ yd³

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information

Facility ID#: 0673

x File Analyzed By: JT x PD ____ Date: 10/30/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: Jul-06 End of Test: Nov-06 Duration: 138 days

Type of Site: x Non-DOD ____ DoD

x Facility Name: Bedford, OH

Address: ____________

City, State, Zip Code: Bedford, OH

OU# or Site #: ____________

x Primary point of contact: David Fleming

Organization: TRS

Address: 7421-A Warren SE

City, State, Zip Code: Snoqualmie, WA 98065

Phone #: 425-396-4266 email: dfleming@thermalrs.com

x Other contacts or vendors who worked on site ____ None

Point of contact: Jeff Cossel

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: Visconsi Company

Address: ____________

City, State, Zip Code: Pepper Pike, IL

Phone #: 213-464-3580 email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data | Facility ID#: 0673

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

____ Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel		None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene		None	None	None	None
	____ cis-1,2-dichloroethene	x Benzene		None	1,000 mg/kg	None	10 mg/kg
	____ trans-1,2-dichloroethene	____ Tolune		None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane			None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	____ Vinyl Chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0673

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- x Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- x Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? x No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	18			
	high value (ft bgs):	24			
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design　　　　Facility ID#: 0673

x Thermal treatment: ____ Conductive ____
x Electrical Resistance ____
____ 3 phase ____ 6 phase ____ AC power ____ DC power
____ Steam ____
____ Steam ____ Steam + air ____ Steam + O2
____ Other (describe) ____

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
x Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: Jul-06　　Duration: 138 days

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	5800	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	25	____ Unknown	
Depth to top of target zone (ft bgs):	7	____ Unknown	
Thickness of target zone below water table (ft):	16	____ Unknown	
Number of energy delivery points:	30	____ Unknown	
Number of extraction points:	30	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	15	____ Unknown
Maximum representative formation temperature (deg C):	92	____ Unknown
Time to reach maximum representative temperature (days):	84	____ Unknown
Duration of treatment at representative temperature (days):	28	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

____ Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	____	____ lb	____ kg	____ Unknown
Total:	3390	x lb	____ kg	____ Unknown

Comments: ____

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0673

x Performance

Remediation Goal:

x In Groundwater:

Remove measurable free product

x In Soil:

Reduce benzen to less than 5 mg/kg, revised to 32 mg/kg

Was the Remediation Goal Achieved:

x In Groundwater

Comment:

No measurable free product

x In Soil

Comment:

17 of 21 samples below 5 mg/kg and all below 32 mg/kg

General comments on the thermal application:

____

Lessons Learned

____

x Energy

Total Energy Used: ________ ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

x Total energy applied to treatment zone: 839281 kw-hrs ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ________ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy: ________

____ Cost

Total Project Cost: ________

____ Consultant Cost: ________

____ Thermal Vendor Cost: ________

____ Energy Cost: ________ ____ m^3 ____ yd^3

____ Other Cost 1: ________

____ Other Cost 2: ________

____ Other Cost 3: ________

____ Please note other cost: ____ Other Cost 1: ________

____ Other Cost 2: ________

____ Other Cost 3: ________

General Site Information Facility ID#: 0685

x File Analyzed By: JT x PD ____ Date: 9/13/2006

Type of treatment: x Conductive ____ Steam ____ ERH ____ Other: ____________________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ______________________________________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 5/19/2003 End of Test: varied Duration: varied

Type of Site: x Non-DOD ____ DoD

x Facility Name: Confidential Midwest

Address: ____

City, State, Zip Code: Midwest

OU# or Site #: ____

x Primary point of contact: Ralph S. Baker, Ph.D.

Organization: TerraTherm, Inc.

Address: 10 Stevens Rd.

City, State, Zip Code: Fitchburg, MA 01420

Phone #: 978-343-0300 email: rbaker@terratherm.com

____ Other contacts or vendors who worked on site ____ None

Point of contact: Michael L. Woodruff, CPG

Type: Vendor, Consultant ____ Vendor, Technical Applications x Other Oversight consultant

Organization: The Payne Firm, Inc.

Address: 11231 Cornell Park Dr.

City, State, Zip Code: Cincinnati, OH 45242

Phone #: 513-489-2255 email: mlw@paynefirm.com

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

x Good pre- and post-treatment soil data

x Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0685

x Impacted Zone: Length (parallel to flow direction)(ft.): 240 Width (ft): 60 Thickness (ft): 15 Unknown

x Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: x None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 48

Number of relevant soil borings with post-treatment data: 54

Number inside treatment zone: 102 Number outside treatment zone: ______

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	None	100 mg/kg	None	0.05 mg/kg
	x Tetrachloroethene	____ Jet Fuel	____	None	1 mg/kg	None	0.5 mg/kg
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	x 1,1,1-trichloroethane	____ o-xylene	____	None	50 mg/kg	None	0.05 mg/kg
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

This treatment area was known as Parking Lot Area 1.

Attachments:

General Site Assessment Data

Facility ID#: 0685

x Impacted Zone: Length (parallel to flow direction)(ft.): 45 Width (ft): 70 Thickness (ft): 15 Unknown

x Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: x None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 12

Number of relevant soil borings with post-treatment data: 18

Number inside treatment zone: 30 Number outside treatment zone: ______

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	None	5 mg/kg	None	0.01 mg/kg
	x Tetrachloroethene	____ Jet Fuel	____	None	0.01 mg/kg	None	0.01 mg/kg
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	x 1,1,1-trichloroethane	____ o-xylene	____	None	0.01 mg/kg	None	0.01 mg/kg
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

This treatment area is known as Parking Lot Area 2.

Attachments:

General Site Assessment Data | Facility ID#: 0685

x Impacted Zone: Length (parallel to flow direction)(ft.): 40 Width (ft): 60 Thickness (ft): 15 Unknown

x Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: x None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 19

Number of relevant soil borings with post-treatment data: 18

Number inside treatment zone: 37 Number outside treatment zone: ______

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	None	1 mg/kg	None	0.1 mg/kg
	x Tetrachloroethene	____ Jet Fuel		None	0.01 mg/kg	None	0.01 mg/kg
	____ 1,1-dichloroethene	____ Napthalene		None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene		None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune		None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene		None	None	None	None
	x 1,1,1-trichloroethane	____ o-xylene		None	5 mg/kg	None	0.01 mg/kg
	____ 1,1,2-trichloroethane			None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	____ Vinyl Chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

This treatment area is known as the Former waste water basin.

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0685

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:

- ____ Relatively homogeneous and permeable unconsolidated sediments
- x Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:

- ____ Relatively homogeneous and permeable unconsolidated sediments
- x Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ____ ft amsl x Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? x No ____ Yes (number): ____ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	30*			
	high value (ft bgs):	35			
	Unknown:				
x Flow direction		SW			
x Horizontal hydraulic gradient (feet/foot):					x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	2.83(10 -5)			____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Comments:

* Water was at 3 ft in a perched aquifer at Parking lot Area 1.

Attachments:

Thermal Treatment - Design | Facility ID#: 0685

x Thermal treatment: x Conductive Parking Lot Area 1

____ Electrical Resistance ____________________

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____________________

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____________________

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:

- ____ Relatively homogeneous and permeable unconsolidated sediments
- x Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only x Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 5/19/2003 Duration: 195 days

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	14187	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	15	____ Unknown	
Depth to top of target zone (ft bgs):	0	____ Unknown	
Thickness of target zone below water table (ft):	0	____ Unknown	
Number of energy delivery points:	138	____ Unknown	
Number of extraction points:	36	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	~13	____ Unknown
Maximum representative formation temperature (deg C):	at least 100	____ Unknown
Time to reach maximum representative temperature (days):	150	____ Unknown
Duration of treatment at representative temperature (days):		x Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

Via liquid pumping:		____ lb	____ kg	x Unknown
In vapor stream:		____ lb	____ kg	x Unknown
Total:		____ lb	____ kg	x Unknown

Comments:

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Thermal Treatment - Design Facility ID#: 0685

x Thermal treatment: x Conductive Parking Lot Area 2

____ Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:

- ____ Relatively homogeneous and permeable unconsolidated sediments
- x Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only x Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 5/19/2003 Duration: 205 days

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	3115	____ Unknown (____ x ____ ft)
Thickness of target zone (ft):	15	____ Unknown
Depth to top of target zone (ft bgs):	0	____ Unknown
Thickness of target zone below water table (ft):	0	____ Unknown
Number of energy delivery points:	36	____ Unknown
Number of extraction points:	5	____ Unknown

x Temperature Profile:

Initial formation temperature (deg C):	~13	____ Unknown
Maximum representative formation temperature (deg C):	atleast 100	____ Unknown
Time to reach maximum representative temperature (days):	70	____ Unknown
Duration of treatment at representative temperature (days):	____	x Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	x Unknown
In vapor stream:	____	____ lb	____ kg	x Unknown
Total:	____	____ lb	____ kg	x Unknown

Comments:

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Thermal Treatment - Design   Facility ID#: 0685

x Thermal treatment: x Conductive   Former Waste Water Basin

____ Electrical Resistance ____________

____ 3 phase   ____ 6 phase   ____ AC power   ____ DC power

____ Steam ____________

____ Steam   ____ Steam + air   ____ Steam + O2

____ Other (describe) ____________

x Type of Test: ____ Pilot test   x Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

x Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only   x Vadose only   ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 5/19/2003   Duration: 190 days

x Hydraulic Control   x Yes   ____ No

x Treatment Cell Design:

Size of target zone (ft2):	2409	____ Unknown	(____ x ____ ft)
Thickness of target zone (ft):	15	____ Unknown	
Depth to top of target zone (ft bgs):	0	____ Unknown	
Thickness of target zone below water table (ft):	0	____ Unknown	
Number of energy delivery points:	32	____ Unknown	
Number of extraction points:	4	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	~13	____ Unknown
Maximum representative formation temperature (deg C):	atleast 100	____ Unknown
Time to reach maximum representative temperature (days):	135	____ Unknown
Duration of treatment at representative temperature (days):	____________	x Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____________	____________
Formation temperature post-treatment monitoring event 1:	____________	____________
Duration of post-treatment monitoring (days):	____________	____________

x Mass of contaminant removed:

Via liquid pumping:	____________	____ lb	____ kg	x Unknown
In vapor stream:	____________	____ lb	____ kg	x Unknown
Total:	____________	____ lb	____ kg	x Unknown

Comments:

____

Attachments:

____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0685

x Performance

Remediation Goal:

____ In Groundwater: ____

x In Soil:

TCE - 1.056 mg/kg; PCE - 5.94 mg/kg; 1,1,1-TCA - 28.6 mg/kg

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

s In Soil

Comment:

yes

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: 3,000,000 x kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

____ Cost

Total Project Cost:

____ Consultant Cost: ____

____ Thermal Vendor Cost: 1,300,000

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information — Facility ID#: 0690

x File Analyzed By: JT x PD ____ — Date: 10/30/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ________

Type of Contaminant: ____ Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ________

Treatment Status: x Active ___ Post

Type of Test: ____ Pilot Test ___ Full Scale System

Start of Test: ________ End of Test: ________ Duration: ________

Type of Site: ____ Non-DOD ____ DoD

x Facility Name: Confidential, OK

Address: ________

City, State, Zip Code: OK

OU# or Site #: ________

x Primary point of contact: Bill Heath

Organization: CES

Address: 419 W. Entiat St

City, State, Zip Code: Kennewick, WA 99336

Phone #: 509-727-4276 email: bill@cesiweb.com

____ Other contacts or vendors who worked on site ____ None

Point of contact: ________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: ________

Address: ________

City, State, Zip Code: ________

Phone #: ________ email: ________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data Facility ID#: 0690

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

____ Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____ ________	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ________	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ________	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ________	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ________	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ________	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ________	None	None	None	None
	____ 1,1,2-trichloroethane	____ ________	____ ________	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ________	____ ________	None	None	None	None
	____ Vinyl Chloride	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None

Comments: ________

Attachments: ________

____ Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown
____ K range (ft/day)	Measured using:	____ Slug Test	____ Laboratory	____ Field data	
	low				____ Unknown
	high				
Transmissivity (ft2/day):	Measured using:	____ Slug Test	____ Laboratory	____ Field data	
	low				____ Unknown
	high				

Comments:

Attachments:

Thermal Treatment - Design Facility ID#: 0690

x Thermal treatment:
- ____ Conductive ____________
- x Electrical Resistance ____________
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- ____ Steam ____________
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ____________

____ Type of Test: ____ Pilot test ____ Full-scale System

____ Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ____________ Duration: ____________

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2):	____________	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	____________	____ Unknown	
Depth to top of target zone (ft bgs):	____________	____ Unknown	
Thickness of target zone below water table (ft):	____________	____ Unknown	
Number of energy delivery points:	____________	____ Unknown	
Number of extraction points:	____________	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	____________	____ Unknown
Maximum representative formation temperature (deg C):	____________	____ Unknown
Time to reach maximum representative temperature (days):	____________	____ Unknown
Duration of treatment at representative temperature (days):	____________	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____________	____________
Formation temperature post-treatment monitoring event 1:	____________	____________
Duration of post-treatment monitoring (days):	____________	____________

____ Mass of contaminant removed:

Via liquid pumping:	____________	____ lb	____ kg	____ Unknown
In vapor stream:	____________	____ lb	____ kg	____ Unknown
Total:	____________	____ lb	____ kg	____ Unknown

Comments: ____________

Attachments: ____________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0690

____ Performance

Remediation Goal:

____ In Groundwater:

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information | | | Facility ID#: 0700

x File Analyzed By: JT x PD x | Date: 9/13/2006

Type of treatment: x Conductive ____ Steam ____ ERH ____ Other: ________

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 5/7/1998 End of Test: Sep-98 Duration: 120 days

Type of Site: x Non-DOD ____ DoD

x Facility Name: Former Shell Bulk Fuel Terminal

Address: 245 Jackson St.

City, State, Zip Code: Eugene, OR

OU# or Site #: State of Oregon LUST #20-94-4004; ECSI#1566

x Primary point of contact: Ralph Baker

Organization: TerraTherm

Address: 10 Stevens Road

City, State, Zip Code: Fitchburg, MA 01420

Phone #: 978-343-0300 email: rbaker@terratherm.com

x Other contacts or vendors who worked on site ____ None

Point of contact: Denis Conley

Type: x Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: Haley and Aldrich

Address: 200 Town Centre Dr

City, State, Zip Code: Rochester, NY 14623

Phone #: 585-321-4245 email: dconley@haleyaldrich.com

QA/QC

x Characteristics of Interest

x Good pre- and post-treatment groundwater data

x Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

x Groundwater elevations

____ Geologic cross-section

x Hydraulic Conductivity information

General Site Assessment Data — Facility ID#: 0700

x Impacted Zone: Length (parallel to flow direction)(ft.): 125 Width (ft): 300 Thickness (ft): ____ Unknown

x Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 9 Post-treatment: 9

Number of wells relative to treatment zone:

	In	Upgradient	Downgradient	Crossgradient
Pre-treatment	8	2	3	1
Post-treatment	4	2	2	1

x Soil Borings: Number of relevant soil borings with pre-treatment data: 18

Number of relevant soil borings with post-treatment data: 16

Number inside treatment zone: 16 Number outside treatment zone: ____

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	x Diesel - TPH	10 mg/L	5,000 mg/kg	0.1 mg/L	1,000 mg/kg
	____ 1,1-dichloroethene	____ Napthalene	x Gasoline - TPH	10 mg/L	1,000 mg/kg	0.1 mg/L	None
	____ cis-1,2-dichloroethene	x Benzene	____	0.1 mg/L	0.5 mg/kg	0.001 mg/L	0.05 mg/kg
	____ trans-1,2-dichloroethene	x Tolune	____	0.1 mg/L	1 mg/kg	0.001 mg/L	0.05 mg/kg
	____ 1,1-dichloroethane	x Ethylbenzene	____	0.1 mg/L	10 mg/kg	0.001 mg/L	0.05 mg/kg
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	x xylenes (total)	____	0.1 mg/L	10 mg/kg	0.001 mg/L	0.05 mg/kg
	____ 1,1,2,2-tetrachloroethane	x MTBE	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments: ____

Attachments: ____

Hydrogeologic Conceptual Model Facility ID#: 0700

x Geology:

Zone	Unconsolidated Sediments	
Vadose Zone:	____	Relatively homogeneous and permeable unconsolidated sediments
	____	Relatively homogeneous and impermeable unconsolidated sediments
	____	Largely permeable sediments with inter-bedded lenses of lower permeability material
	x	Largely impermeable sediments with inter-bedded layers of higher permeability material
	____	Competent, but fractured bedrock (i.e. crystalline rock)
	____	Weathered bedrock, limestone, sandstone
Saturated Zone:	____	Relatively homogeneous and permeable unconsolidated sediments
	____	Relatively homogeneous and impermeable unconsolidated sediments
	____	Largely permeable sediments with inter-bedded lenses of lower permeability material
	x	Largely impermeable sediments with inter-bedded layers of higher permeability material
	____	Competent, but fractured bedrock (i.e. crystalline rock)
	____	Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 417 ft amsl x Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No x Yes (number): 2 ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3		
Depth to water:	low value (ft bgs):	2	18	____		
	high value (ft bgs):	10	19	____		
	Unknown:	____	____	____		
____ Flow direction		____	____	____		
x Horizontal hydraulic gradient (feet/foot):		____	____	____	x	Unknown
Vertical hydraulic gradient (feet/foot):		____	____	____	x	Unknown

x K range (ft/day) Measured using: ____ Slug Test x Laboratory ____ Field data

low	0.03	14	____		Unknown
high	0.003	14	____		

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	____	____	____	x	Unknown
high	____	____	____		

Comments:

permeability: 1 to 10 millidarcy ______________ Second water bearing unit - 5000 md

Attachments:

Thermal Treatment - Design   Facility ID#: 0700

x Thermal treatment: x Conductive

____ Electrical Resistance

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe)

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

x Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 5/7/1998   Duration: 120 days

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	32000	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	11.5	____ Unknown	
Depth to top of target zone (ft bgs):	0	____ Unknown	
Thickness of target zone below water table (ft):	0	____ Unknown	
Number of energy delivery points:	761	____ Unknown	
Number of extraction points:	277	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):		x Unknown
Maximum representative formation temperature (deg C):		x Unknown
Time to reach maximum representative temperature (days):		x Unknown
Duration of treatment at representative temperature (days):		x Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

Via liquid pumping:		____ lb	____ kg	____ Unknown
In vapor stream:		____ lb	____ kg	____ Unknown
Total:	1.218 x 10^5	____ lb	x kg	____ Unknown

Comments:

dewatered zone during treatment and removed a total of 61,345 tons
Spacing on 7.5 ft centers

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance | Facility ID#: 0700

x Performance

Remediation Goal:

x In Groundwater:

DEQ Tier 1 risk-based concentrations for all groundwater exposure paths

x In Soil:

DEQ Tier 1 risk-based concentrations

Was the Remediation Goal Achieved:

x In Groundwater

Comment:

yes

x In Soil

Comment:

yes

General comments on the thermal application:

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information   Facility ID#: 0720

x File Analyzed By: JT x PD ____   Date: ________

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 5/8/2000 End of Test: 11/14/2001 Duration: 17 months

Type of Site: x Non-DOD ____ DoD

x Facility Name: ICN Pharmaceutical

Address: ________

City, State, Zip Code: Portland, OR

OU# or Site #: ________

x Primary point of contact: Chuck Esler

Organization: AMEC

Address: ________

City, State, Zip Code: ________

Phone #: 503-639-3400 email: charles.esler@amec.com

x Other contacts or vendors who worked on site ____ None

Point of contact: Jennifer Sutter

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications x Other Regulator

Organization: DEQ Northwest Region

Address: 2020 SW 4th Ave., Suite 400

City, State, Zip Code: Portland, OR 97201

Phone #: 503-229-6148 email: sutter.jennifer@deq.state.or.us

QA/QC

x Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

x Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data | Facility ID#: 0720

x Impacted Zone: Length (parallel to flow direction)(ft.): below Width (ft): ____ Thickness (ft): ____ ___ Unknown

x Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 19 Post-treatment: ____

Number of wells relative to treatment zone:

Pre-treatment In: 7 Upgradient: ____ Downgradient: ____ Crossgradient: ____

Post-treatment In: ____ Upgradient: ____ Downgradient: ____ Crossgradient: ____

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____

Number of relevant soil borings with post-treatment data: ____

Number inside treatment zone: ____ Number outside treatment zone: ____

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	x cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	x trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	x Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Source zone is 120ft by 80ft down to 56 ft for a total of between 48,000 to 65,000 yd3

Attachments:

Hydrogeologic Conceptual Model | Facility ID#: 0720

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- x Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ____ ft amsl x Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	10			
	high value (ft bgs):				
	Unknown:				
x Flow direction		S			
x Horizontal hydraulic gradient (feet/foot):					x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) — Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	0.00283			____ Unknown
high	28.3			

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Comments: 15-60' - 10e-2 cm/s with 15-30' - being fine silts; at 60'+ - 5 ft/day Low K is upper vadose zone and high K is the saturated zone

Attachments:

Thermal Treatment - Design   Facility ID#: 0720

x Thermal treatment:
- ____ Conductive
- x Electrical Resistance
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- ____ Steam
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe)

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: x Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 5/8/2000   Duration: 17 months

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	20000	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	38	____ Unknown	
Depth to top of target zone (ft bgs):	20	____ Unknown	
Thickness of target zone below water table (ft):	38	____ Unknown	
Number of energy delivery points:	73	____ Unknown	
Number of extraction points:	53	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):		x Unknown
Maximum representative formation temperature (deg C):		x Unknown
Time to reach maximum representative temperature (days):		x Unknown
Duration of treatment at representative temperature (days):		x Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

Via liquid pumping:		____ lb	____ kg	x Unknown
In vapor stream:		____ lb	____ kg	x Unknown
Total:		____ lb	____ kg	x Unknown

Comments:

17.5 ft well spacing and 15 ft vapor extraction well spacing for a total volume treated of 29,600 yd3 96 gallons of DNAPL removed

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0720

____ Performance

Remediation Goal:

____ In Groundwater: ____________________

____ In Soil: ____________________

Was the Remediation Goal Achieved:

____ In Groundwater ____________________

Comment: ____________________

____ In Soil ____________________

Comment: ____________________

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____________ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____________________

____ Cost

Total Project Cost: ____________

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

____ Energy Cost: ____________ ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ____________________

____ Other Cost 2: ____________________

____ Other Cost 3: ____________________

General Site Information   Facility ID#: 0725

x File Analyzed By: JT x PD ____   Date: 10/12/2006

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating x Other: coal tar

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 11/9/1994 End of Test: 6/7/1996 Duration: 567 d

Type of Site: ____ Non-DOD ____ DoD

x Facility Name: Brodhead Creek Superfund Site

Address: ____________

City, State, Zip Code: Stroudsburg, PA

OU# or Site #: ____________

x Primary point of contact: SITE doc: EPA/540/R-00/500 March 2000

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data | Facility ID#: 0725

x Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ x Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 13

Number of relevant soil borings with post-treatment data: 13

Number inside treatment zone: 9-Sep Number outside treatment zone: 4-Apr

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	x coal tar	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	x TRPH	None	1,000 mg/kg	None	1,000 mg/kg
	____ cis-1,2-dichloroethene	____ Benzene		None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune		None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane			None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	____ Vinyl Chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

TRPH mg/kg : pre = 1830 post= 1670

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0725

x Geology: Zone: Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 376 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	3			
	high value (ft bgs):	15			
	Unknown:				
x Flow direction		E			
x Horizontal hydraulic gradient (feet/foot):		0.005			____ Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	200			____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Comments:
porosity n=0.3 K
= 100 to 150 Darcies

Attachments:

Thermal Treatment - Design Facility ID#: 0725

x Thermal treatment: ____ Conductive ______________________

____ Electrical Resistance ______________________

____ 3 phase ____ 6 phase ____ AC power ____ DC power

x Steam CROW

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ______________________

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

x Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: x Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 11/9/1994 Duration: 567 d

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	3200	____ Unknown	(40 x 80 ft)
Thickness of target zone (ft):	________	x Unknown	
Depth to top of target zone (ft bgs):	________	x Unknown	
Thickness of target zone below water table (ft):	________	x Unknown	
Number of energy delivery points:	6	____ Unknown	
Number of extraction points:	2	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	20	____ Unknown
Maximum representative formation temperature (deg C):	70	____ Unknown
Time to reach maximum representative temperature (days):	461	____ Unknown
Duration of treatment at representative temperature (days):	1	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	________	________
Formation temperature post-treatment monitoring event 1:	________	________
Duration of post-treatment monitoring (days):	________	________

x Mass of contaminant removed:

Via liquid pumping:	________	____ lb	____ kg	x Unknown
In vapor stream:	________	____ lb	____ kg	x Unknown
Total:	1504 gal	____ lb	____ kg	____ Unknown

Comments: ______________________

Attachments: ______________________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance   Facility ID#: 0725

____ Performance

Remediation Goal:

____ In Groundwater: ______

____ In Soil: ______

Was the Remediation Goal Achieved:

____ In Groundwater ______

Comment: ______

____ In Soil ______

Comment: ______

General comments on the thermal application:

Pore volumes flushed = 25.5 (at $85000/pore volume)
the Pore volume size is 455,000 gallons

Lessons Learned

______

____ Energy

Total Energy Used: ______ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ______ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ______ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ______

x Cost

Total Project Cost: 2168000

____ Consultant Cost: ______

____ Thermal Vendor Cost: ______

x Energy Cost: 60000 ____ m^3 ____ yd^3

____ Other Cost 1: ______

____ Other Cost 2: ______

____ Other Cost 3: ______

____ Please note other cost: ____ Other Cost 1: ______

____ Other Cost 2: ______

____ Other Cost 3: ______

General Site Information Facility ID#: 0730

x File Analyzed By: JT x PD ____ Date: 10/26/2006

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active ___ Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: ____________ End of Test: ____________ Duration: ______

Type of Site: ____ Non-DOD x DoD

x Facility Name: Naval Construction Battallion Center (Former NIKE)

Address: ____________

City, State, Zip Code: North Kingston, RI

OU# or Site #: ____________

x Primary point of contact: Christine willaims

Organization: Navy

Address: ____________

City, State, Zip Code: ____________

Phone #: 617-918-1384 email: ____________

x Other contacts or vendors who worked on site ____ None

Point of contact: Ian Osgerby

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications x Other ______

Organization: Navy

Address: ____________

City, State, Zip Code: ____________

Phone #: 978-318-8631 email: ____________

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0730

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: _____ Upgradient: _____ Downgradient: _____ Crossgradient: _____

Post-treatment In: _____ Upgradient: _____ Downgradient: _____ Crossgradient: _____

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

____ Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____ ________	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ________	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ________	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ________	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ________	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ________	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ________	None	None	None	None
	____ 1,1,2-trichloroethane	____ ________	____ ________	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ________	____ ________	None	None	None	None
	____ Vinyl Chloride	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None

Comments: ________________________________

Attachments: ________________________________

Hydrogeologic Conceptual Model Facility ID#: 0730

____ Geology: Zone — Unconsolidated Sediments

Vadose Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

Saturated Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	________	________	________	
	high value (ft bgs):	________	________	________	
	Unknown:	________	________	________	
____ Flow direction		________	________	________	
____ Horizontal hydraulic gradient (feet/foot):		________	________	________	____ Unknown
Vertical hydraulic gradient (feet/foot):		________	________	________	____ Unknown
____ K range (ft/day)	Measured using:	____ Slug Test	____ Laboratory	____ Field data	
	low	________	________	________	____ Unknown
	high	________	________	________	
Transmissivity (ft2/day):	Measured using:	____ Slug Test	____ Laboratory	____ Field data	
	low	________	________	________	____ Unknown
	high	________	________	________	

Comments: ____

Attachments: ____

Thermal Treatment - Design Facility ID#: 0730

x Thermal treatment: ____ Conductive ____________________

____ Electrical Resistance ____________________

____ 3 phase ____ 6 phase ____ AC power ____ DC power

x Steam ____________________

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____________________

x Type of Test: x Pilot test ____ Full-scale System

____ Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ____________ Duration: ____________

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2): ____________ ____ Unknown (___ x ___ ft)

Thickness of target zone (ft): ____________ ____ Unknown

Depth to top of target zone (ft bgs): ____________ ____ Unknown

Thickness of target zone below water table (ft): ____________ ____ Unknown

Number of energy delivery points: ____________ ____ Unknown

Number of extraction points: ____________ ____ Unknown

____ Temperature Profile:

Initial formation temperature (deg C): ____________ ____ Unknown

Maximum representative formation temperature (deg C): ____________ ____ Unknown

Time to reach maximum representative temperature (days): ____________ ____ Unknown

Duration of treatment at representative temperature (days): ____________ ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____________	____________
Formation temperature post-treatment monitoring event 1:	____________	____________
Duration of post-treatment monitoring (days):	____________	____________

____ Mass of contaminant removed:

Via liquid pumping: ____________ ____ lb ____ kg ____ Unknown

In vapor stream: ____________ ____ lb ____ kg ____ Unknown

Total: ____________ ____ lb ____ kg ____ Unknown

Comments: ____________________

Attachments: ____________________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0730

____ Performance

Remediation Goal:

____ In Groundwater: ____

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information   Facility ID#: 0740

X File Analyzed By: JT X PD ____   Date: 11/6/2006

Type of treatment: ____ Conductive ____ Steam X ERH ____ Other: ____________

Type of Contaminant: X Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active X Post

Type of Test: X Pilot Test ___ Full Scale System

Start of Test: 11/7/1993   End of Test: 12/2/1993   Duration: 25 d

Type of Site: x Non-DOD ____ DoD

X Facility Name: Savannah River Site

Address: ____________

City, State, Zip Code: Aiken, SC

OU# or Site #: Site 321 - Area M

X Primary point of contact: Mark Amidon

Organization: Savannah River Site

Address: ____________

City, State, Zip Code: ____________

Phone #: 803-952-7781   email: mark.amidon@srs.gov

X Other contacts or vendors who worked on site   ____ None

Point of contact: Jim Kupar and Brian Looney

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: Savannah River Site / Savannah River National Laboratory

Address: ____________

City, State, Zip Code: ____________

Phone #: 803-952-6525 / 803-725-3692   email: james.kupar@srs.gov / brian02.looney@srnl.doe.gov

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data | Facility ID#: 0740

X Impacted Zone: Length (parallel to flow direction)(ft.): >25000 Width (ft): >16400 Thickness (ft): ____ ___ Unknown

____ Impacted zone as defined by documentation

X Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

X Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 0 Post-treatment: ____

Number of wells relative to treatment zone:

Pre-treatment In: ____ Upgradient: ____ Downgradient: ____ Crossgradient: ____

Post-treatment In: ____ Upgradient: ____ Downgradient: ____ Crossgradient: ____

X Soil Borings: Number of relevant soil borings with pre-treatment data: 6

Number of relevant soil borings with post-treatment data: 7

Number inside treatment zone: 5 Number outside treatment zone: 7

X Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	X Trichloroethene	____ Hexane	____ Creosote	None	0.01 mg/kg	None	None
	X Tetrachloroethene	____ Jet Fuel	____	None	0.05 mg/kg	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

average post treatment soils concentrations for both constituents at 0.0001 mg/Kg. From elevations 328 to 318.

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0740

X Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- X Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- X Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

X Ground surface elevation based on wells in or adjacent to treatment zone: 355 ft amsl ____ Unknown

X Aquifer Characteristics:

Is more than 1 aquifer present? ____ No X Yes (number): 2 ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	135	160		
	high value (ft bgs):				
	Unknown:				
X Flow direction		NE			
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Downward gradient of 2 to 8 ft/yr. Radial flow outward at 15 to 100 ft/yr.

Attachments:

Thermal Treatment - Design　　　　Facility ID#: 0740

X Thermal treatment:
- ____ Conductive
- X Electrical Resistance
  - ____ 3 phase　X 6 phase　X AC power　____ DC power
- ____ Steam
  - ____ Steam　____ Steam + air　____ Steam + O2
- ____ Other (describe)

X Type of Test: X Pilot test　____ Full-scale System

X Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- X Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

X Treatment Targe Zone: ____ Saturated only　X Vadose only　____ Both (Saturated and Vadose zones)

X Start of Thermal Test: 11/7/1993　　Duration: 25 d

X Hydraulic Control　X Yes　____ No

X Treatment Cell Design:

Size of target zone (ft2):	710	____ Unknown	(30 x 30 ft)
Thickness of target zone (ft):	21	____ Unknown	
Depth to top of target zone (ft bgs):	23	____ Unknown	
Thickness of target zone below water table (ft):	0	____ Unknown	
Number of energy delivery points:	6	____ Unknown	
Number of extraction points:	4	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	20	____ Unknown
Maximum representative formation temperature (deg C):	100	____ Unknown
Time to reach maximum representative temperature (days):	8	____ Unknown
Duration of treatment at representative temperature (days):	17	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	12/3/1993	100
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

____ Mass of contaminant removed:

Via liquid pumping:		____ lb	____ kg	____ Unknown
In vapor stream:		____ lb	____ kg	____ Unknown
Total:		____ lb	____ kg	____ Unknown

Comments:

1430 yd3 of heated soil

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance | Facility ID#: 0740

x Performance

Remediation Goal:

____ In Groundwater: ____

x In Soil: Test to evaluate the enhanced removal of chlorinated VOCs from subsurface sediments using ohmic heating.

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

____

Lessons Learned

Extraction well should be screened above and below clay lense.

x Energy

Total Energy Used: 100,000 x kWhr ____ kWhr/m^3 ____ kWhr/yd^3

x Total energy applied to treatment zone: 70 ____ kWhr/m^3 x kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

x Cost

Total Project Cost: 1,277,300

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information | Facility ID#: 0742

X File Analyzed By: JT X PD ____ Date: 9/25/2007

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: __________

Type of Contaminant: X Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: __________

Treatment Status: x Active ___ Post

Type of Test: ___ Pilot Test x Full Scale System

Start of Test: 6/15/2006 End of Test: __________ Duration: ________

Type of Site: X Non-DOD ____ DoD

X Facility Name: Savannah River Site - C Reactor Area

Address: __________

City, State, Zip Code: Aiken, SC

OU# or Site #: C Reactor

X Primary point of contact: Joseph Amari

Organization: Washington Savannah River Company

Address: __________

City, State, Zip Code: __________

Phone #: __________ email: __________

x Other contacts or vendors who worked on site ____ None

Point of contact: Robert F. Blundy

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: Washington Savannah River Company

Address: __________

City, State, Zip Code: __________

Phone #: __________ email: __________

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data | Facility ID#: 0742

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

X Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

	In:	Upgradient:	Downgradient:	Crossgradient:
Pre-treatment	______	______	______	______
Post-treatment	______	______	______	______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

X Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	X Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0742

X Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- X Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- X Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No X Yes (number): 3 ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Average K=0.4 ft/min

Attachments:

Thermal Treatment - Design

Facility ID#: 0742

X Thermal treatment: ____ Conductive ______

x Electrical Resistance ______

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ______

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ______

X Type of Test: ____ Pilot test x Full-scale System

X Geology of Treatment Zone:

- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- X Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

X Start of Thermal Test: 6/15/2006 Duration: ______

____ Hydraulic Control ____ Yes ____ No

X Treatment Cell Design:

Size of target zone (ft2): ______ ____ Unknown (___ x ___ ft)

Thickness of target zone (ft): ______ ____ Unknown

Depth to top of target zone (ft bgs): ______ ____ Unknown

Thickness of target zone below water table (ft): ______ ____ Unknown

Number of energy delivery points: ______ ____ Unknown

Number of extraction points: ______ ____ Unknown

X Temperature Profile:

Initial formation temperature (deg C): 18.3 ____ Unknown

Maximum representative formation temperature (deg C): ______ ____ Unknown

Time to reach maximum representative temperature (days): ______ ____ Unknown

Duration of treatment at representative temperature (days): ______ ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	______	______
Formation temperature post-treatment monitoring event 1:	______	______
Duration of post-treatment monitoring (days):	______	______

X Mass of contaminant removed:

Via liquid pumping: ______ ____ lb ____ kg ____ Unknown

In vapor stream: ______ ____ lb ____ kg ____ Unknown

Total: ______ ____ lb ____ kg ____ Unknown

Comments: ______

Attachments: ______

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance	Facility ID#: 0742

____ Performance

Remediation Goal:

____ In Groundwater: ______________________

____ In Soil: ______________________

Was the Remediation Goal Achieved:

____ In Groundwater ______________________

Comment: ______________________

____ In Soil ______________________

Comment: ______________________

General comments on the thermal application:

____

Lessons Learned

____

X Energy

Total Energy Used: ____________ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ______________________

X Cost

Total Project Cost: ____________

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

____ Energy Cost: ____________ ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ______________________

____ Other Cost 2: ______________________

____ Other Cost 3: ______________________

General Site Information   Facility ID#: 0750

X File Analyzed By: JT X PD ____   Date: 5/4/2005

Type of treatment: ____ Conductive X Steam ____ ERH ____ Other: ____________

Type of Contaminant: X Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active X Post

Type of Test: X Pilot Test ___ Full Scale System

Start of Test: 9/10/2000   End of Test: 9/28/2001   Duration: 365 d

Type of Site: X Non-DOD ____ DoD

X Facility Name: Savannah River Site

Address: ____________

City, State, Zip Code: Aiken, SC

OU# or Site #: 321-M Solvent Storage Area

X Primary point of contact: Jim Kupar

Organization: Bechtel Savannah River, Inc.

Address: Bldg. 730-4B, Rm 3029

City, State, Zip Code: Aiken, SC 29808

Phone #: 803-952-6525   email: james.kupar@srs.gov

____ Other contacts or vendors who worked on site   ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________   email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data   Facility ID#: 0750

X Impacted Zone: Length (parallel to flow direction)(ft.): >25000   Width (ft): >16400   Thickness (ft): 160   ___ Unknown

X Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________   Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment   In: ______   Upgradient: ______   Downgradient: ______   Crossgradient: ______

Post-treatment   In: ______   Upgradient: ______   Downgradient: ______   Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________   Number outside treatment zone: ________

X Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	X Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	X Tetrachloroethene	____ Jet Fuel	____ ________	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ________	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ________	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ________	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ________	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ________	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ________	None	None	None	None
	____ 1,1,2-trichloroethane	____ ________	____ ________	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ________	____ ________	None	None	None	None
	____ Vinyl Chloride	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0750

X Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- X Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- X Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

X Aquifer Characteristics:

Is more than 1 aquifer present? ____ No X Yes (number): 3 ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	135	160		
	high value (ft bgs):	145			
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

X K range (ft/day) — Measured using: ____ Slug Test ____ Laboratory X Field data

		Aquifer 1	Aquifer 2	Aquifer 3	
K range (ft/day)	low	576			____ Unknown
	high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

		Aquifer 1	Aquifer 2	Aquifer 3	
Transmissivity (ft2/day)	low				____ Unknown
	high				

Comments:

Average K=0.4 ft/min

Attachments:

Thermal Treatment - Design   Facility ID#: 0750

X Thermal treatment:
- ____ Conductive ____________
- ____ Electrical Resistance ____________
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- X Steam ____________
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ____________

X Type of Test: X Pilot test ____ Full-scale System

X Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- X Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

X Treatment Targe Zone: ____ Saturated only ____ Vadose only X Both (Saturated and Vadose zones)

X Start of Thermal Test: 9/10/2000 Duration: 365 d

X Hydraulic Control ____ Yes ____ No

X Treatment Cell Design:

Size of target zone (ft2):	10,000	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	140	____ Unknown	
Depth to top of target zone (ft bgs):	20	____ Unknown	
Thickness of target zone below water table (ft):	15	____ Unknown	
Number of energy delivery points:	9	____ Unknown	
Number of extraction points:	4	____ Unknown	

X Temperature Profile:

Initial formation temperature (deg C):	20	____ Unknown
Maximum representative formation temperature (deg C):	100	____ Unknown
Time to reach maximum representative temperature (days):	180	____ Unknown
Duration of treatment at representative temperature (days):	185	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	10/1/2001	99
Formation temperature post-treatment monitoring event 1:	11/2/2001	90
Duration of post-treatment monitoring (days):		

X Mass of contaminant removed:

Via liquid pumping:		____ lb	____ kg	____ Unknown
In vapor stream:		____ lb	____ kg	____ Unknown
Total:	31,000	____ lb	X kg	____ Unknown

Comments:

Treated 52,000 cubic yards. Three clusters of wells with steam injection wells in each cluster with injection intervals of 50ft-70 ft bgs and 150ft-160 ft bgs

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0750

____ Performance

Remediation Goal:

____ In Groundwater: ____

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

Steam injected - 4.5x10E10) BTUs (13188198.2 kw-hr). Objectives: 1) contaminants removed from target source area; 2) target zone must be heated to applied boiling point; 3) Air to support HPO must be injected into treatment zone.

Lessons Learned

____

X Energy

Total Energy Used: ____ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

X Total energy applied to treatment zone: 13188198 kw-hr ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

X Cost

Total Project Cost: $29 / yd3

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information | | Facility ID#: 0760

x File Analyzed By: JT x PD ____ Date: 10/11/2006

Type of treatment: ____ Conductive ____ Steam ____ ERH x Other: RFH

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: 3/25/1993 End of Test: 4/26/1993 Duration: 27 d

Type of Site: ____ Non-DOD x DoD

x Facility Name: Savannah River Site

Address: ____________________

City, State, Zip Code: Aiken, SC

OU# or Site #: Site 321 M-Area Seepage Basin

x Primary point of contact: www.osti.gov/bridge doc no.: WSRC-TR-93-673

Organization: ____________________

Address: ____________________

City, State, Zip Code: ____________________

Phone #: ____________ email: ____________

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: ____________________

Address: ____________________

City, State, Zip Code: ____________________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0760

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 20 Post-treatment: 20

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 10

Number of relevant soil borings with post-treatment data: 10

Number inside treatment zone: 20 Number outside treatment zone: 0

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	x Tetrachloroethene	____ Jet Fuel		None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene		None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene		None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune		None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene		None	None	None	None
	x 1,1,1-trichloroethane	____ o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane			None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	____ Vinyl Chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model   Facility ID#: 0760

x Geology: Zone   Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- x Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 360 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
x Horizontal hydraulic gradient (feet/foot):					x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day)   Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Transmissivity (ft2/day):   Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design Facility ID#: 0760

x Thermal treatment: ____ Conductive ____

____ Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____

____ Steam ____ Steam + air ____ Steam + O2

x Other (describe) RFH

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

x Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only x Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 3/25/1993 Duration: 27 d

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2): 3000 ____ Unknown (30 x 10 ft)

Thickness of target zone (ft): 10 ____ Unknown

Depth to top of target zone (ft bgs): 35 ____ Unknown

Thickness of target zone below water table (ft): ____ ____ Unknown

Number of energy delivery points: 1 ____ Unknown

Number of extraction points: 1 ____ Unknown

x Temperature Profile:

Initial formation temperature (deg C): 20 ____ Unknown

Maximum representative formation temperature (deg C): 65 ____ Unknown

Time to reach maximum representative temperature (days): 27 ____ Unknown

Duration of treatment at representative temperature (days): 1 ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

		lb	kg	Unknown
Via liquid pumping:		____	____	x
In vapor stream:		____	____	x
Total:	171.5	____	x	____

Comments:

Attachments: Shut down for 7 days

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0760

____ Performance

Remediation Goal:

____ In Groundwater: ____

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

Of the 21,200 kWhr used, only 65% was converted to FR power in which only 85% went into the formation

Objectives: 1) Simple installation, start up, and trouble free operation 2) accelerated TCE and Pce volatilization 3) reduced cost over comparable technologies and 4) conformance of field performance with treatability studes and computer predictive modeling

Lessons Learned

____

x Energy

Total Energy Used: 21200 x kWhr ____ kWhr/m^3 ____ kWhr/yd^3

x Total energy applied to treatment zone: 11675 kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

x Cost

Total Project Cost: 853994

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

x Energy Cost: 11020 ____ m^3 ____ yd^3

x Other Cost 1: 245867

x Other Cost 2: 241390

x Other Cost 3: 366737

x Please note other cost: x Other Cost 1: Rf delivery

x Other Cost 2: field support

x Other Cost 3: off-gas treatment/well prep and monitoring/analytical

General Site Information | | Facility ID#: 0765

x File Analyzed By: JT x PD ____ Date: 8/20/2007

Type of treatment: x Conductive ____ Steam ____ ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 1/29/2007 End of Test: 6/20/2007 Duration: 142

Type of Site: x Non-DOD ____ DoD

x Facility Name: South Eastern US

Address: ____________

City, State, Zip Code: South Eastern US

OU# or Site #: ____________

x Primary point of contact: Ralph Baker

Organization: TerraTherm, Inc.

Address: 10 Stevens Road

City, State, Zip Code: Fitchburg, MA 01420

Phone #: 978-343-0300 email: rbaker@terratherm.com

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data Facility ID#: 0765

____ Impacted Zone: Length (parallel to flow direction)(ft.): 33 Width (ft): 76 Thickness (ft): 87 ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 8 Post-treatment: 7

Number of wells relative to treatment zone:

Pre-treatment In: 4 Upgradient: ______ Downgradient: 4 Crossgradient: ______

Post-treatment In: 3 Upgradient: ______ Downgradient: 4 Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: 11

Number of relevant soil borings with post-treatment data: 6

Number inside treatment zone: 6 Number outside treatment zone: ____________

____ Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	X Trichloroethene	____ Hexane	____ Creosote	1,000 mg/L	100 mg/kg	0.005 mg/L	0.01 mg/kg
	____ Tetrachloroethene	____ Jet Fuel	____ ____________	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ____________	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ____________	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ____________	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ____________	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ____________	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ____________	None	None	None	None
	____ 1,1,2-trichloroethane	____ ____________	____ ____________	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ____________	____ ____________	None	None	None	None
	____ Vinyl Chloride	____ ____________	____ ____________	None	None	None	None
	____ ____________	____ ____________	____ ____________	None	None	None	None
	____ ____________	____ ____________	____ ____________	None	None	None	None
	____ ____________	____ ____________	____ ____________	None	None	None	None
	____ ____________	____ ____________	____ ____________	None	None	None	None
	____ ____________	____ ____________	____ ____________	None	None	None	None
	____ ____________	____ ____________	____ ____________	None	None	None	None

Comments: ____

Attachments: ____

Hydrogeologic Conceptual Model   Facility ID#: 0765

____ Geology: Zone   Unconsolidated Sediments

Vadose Zone:
- X Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- X Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- X Competent, but fractured bedrock (i.e. crystalline rock)
- X Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: 897 ft amsl   ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present?   X No   ____ Yes (number): ________   ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	55			
	high value (ft bgs):	65			
	Unknown:				
____ Flow direction		SW			
____ Horizontal hydraulic gradient (feet/foot):		0.03			____ Unknown
Vertical hydraulic gradient (feet/foot):		0.04			____ Unknown

____ K range (ft/day)   Measured using: X Slug Test   ____ Laboratory   ____ Field data

low	0.028			____ Unknown
high	0.28			

Transmissivity (ft2/day):   Measured using: ____ Slug Test   ____ Laboratory   ____ Field data

low				____ Unknown
high				

Comments: A groundwater extraction system was installed within the treatment zone to ensure capture and to enhance natural upward gradients to minimize the potential for vertical mobilization of DNAPL into the bedrock during heating.

Attachments:

Thermal Treatment - Design | Facility ID#: 0765

x Thermal treatment: X Conductive In Situ Thermal Desorption

____ Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

x Type of Test: ____ Pilot test X Full-scale System

x Geology of Treatment Zone:

X Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

X Competent, but fractured bedrock (i.e. crystalline rock)

X Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only X Both (Saturated and Vadose zones)

x Start of Thermal Test: 1/29/2007 Duration: 142

x Hydraulic Control X Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	2554	____ Unknown	(33 x 76 ft)
Thickness of target zone (ft):	87	____ Unknown	
Depth to top of target zone (ft bgs):	0	____ Unknown	
Thickness of target zone below water table (ft):	35	____ Unknown	
Number of energy delivery points:	24	____ Unknown	
Number of extraction points:	10	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	20	____ Unknown
Maximum representative formation temperature (deg C):	101	____ Unknown
Time to reach maximum representative temperature (days):	75	____ Unknown
Duration of treatment at representative temperature (days):	65	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	6/18/2007	100
Formation temperature post-treatment monitoring event 1:	7/15/2007	90
Duration of post-treatment monitoring (days):	365	____

____ Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	11,550	X lb	____ kg	____ Unknown
Total:	11,550	____ lb	____ kg	____ Unknown

Comments: ____

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0765

____ Performance

Remediation Goal:

____ In Groundwater: ____

X In Soil:

95% UCL of mean TCE concentration must be <0.060 mg/kg

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

X In Soil

Comment:

95% UCL of mean TCE concentration = 0.017 mg/kg

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: 1860600 X kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: 1776600 ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: 84000 ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: misc. motors, pumps

____ Cost

Total Project Cost: Client does not wish to disclose the cost of the

____ Consultant Cost: ____

____ Thermal Vendor Cost:

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information　　　　Facility ID#: 0768

x File Analyzed By: JT x PD ____　　　　Date: 10/11/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: 6/13/1995　End of Test: 7/8/1995　Duration: 26 d

Type of Site: ____ Non-DOD x DoD

x Facility Name: Oak Ridge Reservation

Address: ________

City, State, Zip Code: Oak Ridge, TN

OU# or Site #: Site K-25

x Primary point of contact: OSTI.gov/bridge document #: DOE/OR/22160-T22 vol 1 & 2

Organization: ________

Address: ________

City, State, Zip Code: ________

Phone #: ________ email: ________

____ Other contacts or vendors who worked on site ____ None

Point of contact: ________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: ________

Address: ________

City, State, Zip Code: ________

Phone #: ________ email: ________

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data Facility ID#: 0768

x Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ x Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ______

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: ______ Number outside treatment zone: ______

x Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	None	0.01 mg/kg	None	0.01 mg/kg
	x Tetrachloroethene	____ Jet Fuel	____	None	0.01 mg/kg	None	0.01 mg/kg
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	x Tolune	____	None	0.01 mg/kg	None	0.01 mg/kg
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	x 1,1,1-trichloroethane	____ o-xylene	____	None	0.01 mg/kg	None	0.01 mg/kg
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0768

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- x Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl x Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
x Flow direction					
x Horizontal hydraulic gradient (feet/foot):					x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Comments: ________________________________

Attachments: ________________________________

Thermal Treatment - Design Facility ID#: 0768

x Thermal treatment: ____ Conductive ____________________

x Electrical Resistance ____________________

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____________________

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____________________

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:

- ____ Relatively homogeneous and permeable unconsolidated sediments
- x Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only x Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 6/13/1995 Duration: 26 d

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	400	____ Unknown	(25 x 16 ft)
Thickness of target zone (ft):	20	____ Unknown	
Depth to top of target zone (ft bgs):	0	____ Unknown	
Thickness of target zone below water table (ft):	0	____ Unknown	
Number of energy delivery points:	31	____ Unknown	
Number of extraction points:	4	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	18	____ Unknown
Maximum representative formation temperature (deg C):	75	____ Unknown
Time to reach maximum representative temperature (days):	25	____ Unknown
Duration of treatment at representative temperature (days):	1	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

Via liquid pumping:		____ lb	____ kg	____ Unknown
In vapor stream:		____ lb	____ kg	____ Unknown
Total:		____ lb	____ kg	x Unknown

Comments:

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0768

x Performance

Remediation Goal:

____ In Groundwater:

x In Soil: 1) Heat to 85 to 95 C 2) measure extracted gas flowrate 3) collect and condense extracted gas samples 4) measure energy 5) measure temperature distrubution with time and energy

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Cost was $144/ton

Lessons Learned

x Energy

Total Energy Used: 25900 x kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ________

____ Cost

Total Project Cost: ________

____ Consultant Cost: ________

____ Thermal Vendor Cost: ________

____ Energy Cost: ________ ____ m^3 ____ yd^3

____ Other Cost 1: ________

____ Other Cost 2: ________

____ Other Cost 3: ________

____ Please note other cost: ____ Other Cost 1: ________

____ Other Cost 2: ________

____ Other Cost 3: ________

General Site Information Facility ID#: 0770

x File Analyzed By: JT x PD ____ Date: 11/14/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: 8/7/2000 End of Test: 11/5/2000 Duration: 88d

Type of Site: ____ Non-DOD ____ DoD

x Facility Name: Air Force Plant 4

Address: ____________

City, State, Zip Code: Ft. Worth, TX

OU# or Site #: Building 181

x Primary point of contact: George Walters

Organization: Air Force

Address: ASC/ENVR 1801 Tenth St., Suite 2____________

City, State, Zip Code: Wright-Patterson AFB, OH 45433-7626

Phone #: 937-255-1988 email: george.walters@wpafb.af.mil

x Other contacts or vendors who worked on site ____ None

Point of contact: Craig Holloway

Type: x Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: URS

Address: 9400 Amberglen Boulevard

City, State, Zip Code: Austin, TX 78729

Phone #: 512-454-4797 email: craig_holloway@urscorp.com

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data — Facility ID#: 0770

x Impacted Zone: Length (parallel to flow direction)(ft.): 1250 Width (ft): 700 Thickness (ft): 30 ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 10 Post-treatment: 10

Number of wells relative to treatment zone:

Pre-treatment In: 8 Upgradient: ______ Downgradient: 2 Crossgradient: ______

Post-treatment In: 8 Upgradient: ______ Downgradient: 2 Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 3

Number of relevant soil borings with post-treatment data: 3

Number inside treatment zone: 3 Number outside treatment zone: 3

x Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	50 mg/L	10 mg/kg	5 mg/L	0.5 mg/kg
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model — Facility ID#: 0770

x Geology: — Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	27			
	high value (ft bgs):	30			
	Unknown:				
x Flow direction		NE			
x Horizontal hydraulic gradient (feet/foot):		0.008			____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

x K range (ft/day) — Measured using: ____ Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low	13			____ Unknown
high	132			

Transmissivity (ft2/day): — Measured using: ____ Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low	0.087			____ Unknown
high	0.88			

Comments:

Other - Terrace aluvium aquifer K=0.05 ft/day to 4.51ft/day

Horizontal hydraulic gradient - 0.004

Attachments:

Thermal Treatment - Design | Facility ID#: 0770

x Thermal treatment:
- ____ Conductive
- x Electrical Resistance
  - ____ 3 phase x 6 phase ____ AC power ____ DC power
- ____ Steam
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe)

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 8/7/2000 Duration: 88d

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	3120	____ Unknown	(45 x 45 ft)
Thickness of target zone (ft):	37	____ Unknown	
Depth to top of target zone (ft bgs):	2.5	____ Unknown	
Thickness of target zone below water table (ft):	7	____ Unknown	
Number of energy delivery points:	7	____ Unknown	
Number of extraction points:	15	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	22	____ Unknown
Maximum representative formation temperature (deg C):	110	____ Unknown
Time to reach maximum representative temperature (days):	40	____ Unknown
Duration of treatment at representative temperature (days):	20	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

Via liquid pumping:	2.45	____ lb	x kg	____ Unknown
In vapor stream:	150	____ lb	x kg	____ Unknown
Total:	150	____ lb	x kg	____ Unknown

Comments:

Attachments: Volume treated - 3930 cubic yds

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0770

x Performance

Remediation Goal:

x In Groundwater:

TCE less than 10 mg/L

x In Soil:

TCE less than 11.5 mg/kg

Was the Remediation Goal Achieved:

x In Groundwater

Comment:

Yes, except for WJETA062 at 10.7 mg/L

x In Soil

Comment:

Yes

General comments on the thermal application:

Objective: Reach the boiling point of TCE at depth

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy:

x Cost

Total Project Cost: 548306

____ Consultant Cost:

____ Thermal Vendor Cost:

x Energy Cost: 28588 ____ m^3 ____ yd^3

x Other Cost 1: 286718

x Other Cost 2: 188515

x Other Cost 3: 44485

x Please note other cost:

x Other Cost 1: capital cost

x Other Cost 2: operation and maintenance

x Other Cost 3: other technology specific cost

General Site Information   Facility ID#: 0780

x File Analyzed By: JT x PD ____   Date: 4/7/2005

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ___ Pilot Test x Full Scale System

Start of Test: 5/13/2002 End of Test: 2/19/2002 Duration: 221 d

Type of Site: ____ Non-DOD x DoD

x Facility Name: Air Force Plant 4

Address: ____________

City, State, Zip Code: Ft. Worth, TX

OU# or Site #: Building 181

x Primary point of contact: George Walters

Organization: Air Force

Address: ASC/ENVR 1801 Tenth St., suite 2_______________

City, State, Zip Code: Wright-Patterson AFB OH 45433-7626

Phone #: 937-255-1988 email: george.walters@wpafb.af.mil

x Other contacts or vendors who worked on site ____ None

Point of contact: Craig Holloway

Type: x Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: URS

Address: 9400 Amberglen Boulevard

City, State, Zip Code: Austin, TX 78729

Phone #: 512-454-4797 email: craig_holloway@urscorp.com

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0780

x Impacted Zone: Length (parallel to flow direction)(ft.): 1250 Width (ft): 700 Thickness (ft): 30 ___ Unknown

___ Impacted zone as defined by documentation

___ Alternative method for determining size of impacted zone (See source zone definition attachments)

___ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 12 Post-treatment: 12

Number of wells relative to treatment zone:

Pre-treatment In: 9 Upgradient: ______ Downgradient: 3 Crossgradient: ______

Post-treatment In: 9 Upgradient: ______ Downgradient: 3 Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 10

Number of relevant soil borings with post-treatment data: 10

Number inside treatment zone: 10 Number outside treatment zone: 10

x Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	___ Hexane	___ Creosote	10 mg/L	1 mg/kg	5 mg/L	0.1 mg/kg
	___ Tetrachloroethene	___ Jet Fuel		None	None	None	None
	___ 1,1-dichloroethene	___ Napthalene		None	None	None	None
	___ cis-1,2-dichloroethene	___ Benzene		None	None	None	None
	___ trans-1,2-dichloroethene	___ Tolune		None	None	None	None
	___ 1,1-dichloroethane	___ Ethylbenzene		None	None	None	None
	___ 1,2-dichloroethane	___ m/p-xylene		None	None	None	None
	___ 1,1,1-trichloroethane	___ o-xylene		None	None	None	None
	___ 1,1,2-trichloroethane			None	None	None	None
	___ 1,1,2,2-tetrachloroethane			None	None	None	None
	___ Vinyl Chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0780

x Geology: Zone Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 650 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No x Yes (number): 2 ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	27			
	high value (ft bgs):	30			
	Unknown:				
x Flow direction		NE			
x Horizontal hydraulic gradient (feet/foot):		0.008			____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

	low	13			____ Unknown
	high	132			

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

	low	0.087			____ Unknown
	high	0.88			

Comments:

Other - Terrace aluvium aquifer K=0.05 ft/day to 4.51ft/day

Horizontal hydraulic gradient - 0.004

Attachments:

Thermal Treatment - Design Facility ID#: 0780

x Thermal treatment: ____ Conductive

x Electrical Resistance

x 3 phase x 6 phase ____ AC power ____ DC power

____ Steam

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe)

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

x Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 5/13/2002 Duration: 221 d

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2): 21780 ____ Unknown (130 x 150 ft)

Thickness of target zone (ft): 37 ____ Unknown

Depth to top of target zone (ft bgs): 0 ____ Unknown

Thickness of target zone below water table (ft): 5 ____ Unknown

Number of energy delivery points: 73 ____ Unknown

Number of extraction points: 10 ____ Unknown

x Temperature Profile:

Initial formation temperature (deg C): 23.4 ____ Unknown

Maximum representative formation temperature (deg C): 90 ____ Unknown

Time to reach maximum representative temperature (days): 100 ____ Unknown

Duration of treatment at representative temperature (days): 121 ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

Via liquid pumping:	0.227	____ lb	x kg	____ Unknown
In vapor stream:	640.9	____ lb	x kg	____ Unknown
Total:	641.15	____ lb	x kg	____ Unknown

Comments:

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance   Facility ID#: 0780

x Performance

Remediation Goal:

x In Groundwater:

TCE less than 10 mg/L

x In Soil:

TCE less than 11.5 mg/kg

Was the Remediation Goal Achieved:

x In Groundwater

Comment:

Yes, except for WJETA062 at 10.7 mg/L

x In Soil

Comment:

Yes

General comments on the thermal application:

Target temperature - Boiling point of TCE at depth

Lessons Learned

Area near tank did not allow electrodes, and thus area is still above target goal and continues to rise in groundwater, as of 10/2006 well was at 37,000 ppb.

x Energy

Total Energy Used: 1899000   x kWhr   ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____   ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____   ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

x Cost

Total Project Cost: 2369633

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

x Energy Cost: 85455   ____ m^3 ____ yd^3

x Other Cost 1: 740294

x Other Cost 2: 1505648

x Other Cost 3: 38236

x Please note other cost:

x Other Cost 1: capital cost

x Other Cost 2: operation and maintenance for technology

x Other Cost 3: other technology specific cost

General Site Information | Facility ID#: 0800

x File Analyzed By: JT x PD ____ Date: 10/19/2006

Type of treatment: ____ Conductive ____ Steam ____ ERH x Other: RFH

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: 4/3/1993 End of Test: 6/3/1993 Duration: 61 d

Type of Site: ____ Non-DOD x DoD

x Facility Name: Kelly AFB (IITRI)

Address: ____________

City, State, Zip Code: San Antonio, TX

OU# or Site #: S-1

____ Primary point of contact: ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data — Facility ID#: 0800

x Impacted Zone: Length (parallel to flow direction)(ft.): ____ Width (ft): ____ Thickness (ft): ____ x Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ____ Post-treatment: 3

Number of wells relative to treatment zone:

Pre-treatment In: ____ Upgradient: ____ Downgradient: ____ Crossgradient: ____

Post-treatment In: 3 Upgradient: ____ Downgradient: ____ Crossgradient: ____

x Soil Borings: Number of relevant soil borings with pre-treatment data: 21

Number of relevant soil borings with post-treatment data: 21

Number inside treatment zone: 16 / 16 Number outside treatment zone: 5 / 5

x Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	x Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	x chlorobenezene	____	None	5 mg/kg	None	5 mg/kg
	____ 1,1,2,2-tetrachloroethane	x TRPH	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments: ____

Attachments: ____

Hydrogeologic Conceptual Model — Facility ID#: 0800

x Geology: — Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 690 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	24			
	high value (ft bgs):	33			
	Unknown:				
____ Flow direction					
x Horizontal hydraulic gradient (feet/foot):					x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) — Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	15.5			____ Unknown
high				

Transmissivity (ft2/day): — Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 0800

x Thermal treatment:
- ____ Conductive ______
- ____ Electrical Resistance ______
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- ____ Steam ______
  - ____ Steam ____ Steam + air ____ Steam + O2
- x Other (describe) RFH (IITRI)

x Type of Test: ____ Pilot test ____ Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only x Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 4/3/1993 Duration: 61 d

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	141	____ Unknown	(10 x 14 ft)
Thickness of target zone (ft):	23.3	____ Unknown	
Depth to top of target zone (ft bgs):	0	____ Unknown	
Thickness of target zone below water table (ft):	0	____ Unknown	
Number of energy delivery points:	4	____ Unknown	
Number of extraction points:	16	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	20	____ Unknown
Maximum representative formation temperature (deg C):	110	____ Unknown
Time to reach maximum representative temperature (days):	56	____ Unknown
Duration of treatment at representative temperature (days):	4	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

Via liquid pumping:	______	____ lb	____ kg	x Unknown
In vapor stream:	______	____ lb	____ kg	x Unknown
Total:	______	____ lb	____ kg	x Unknown

Comments: ______

Attachments: ______

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0800

____ Performance

Remediation Goal:

____ In Groundwater: ____

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

x Cost

Total Project Cost: 2536093

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information | Facility ID#: 0801

x File Analyzed By: JT x PD ____ Date: 10/19/2006

Type of treatment: ____ Conductive ____ Steam ____ ERH x Other: RFH

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ________________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: 4/26/1994 End of Test: 6/14/1994 Duration: 50 d

Type of Site: ____ Non-DOD x DoD

x Facility Name: Kelly AFB (KAI)

Address: ________________

City, State, Zip Code: San Antonio, TX

OU# or Site #: S-1

____ Primary point of contact: ________________

Organization: ________________

Address: ________________

City, State, Zip Code: ________________

Phone #: ________________ email: ________________

____ Other contacts or vendors who worked on site ____ None

Point of contact: ________________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: ________________

Address: ________________

City, State, Zip Code: ________________

Phone #: ________________ email: ________________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data Facility ID#: 0801

x Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ x Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 24

Number of relevant soil borings with post-treatment data: 24

Number inside treatment zone: 22 / 22 Number outside treatment zone: 2 / 2

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	x Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	x chlorobenezene	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	x TRPH	____	None	1 mg/kg	None	1 mg/kg
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0801

x Geology: Zone: Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 690 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	24			
	high value (ft bgs):	33			
	Unknown:				
____ Flow direction					
x Horizontal hydraulic gradient (feet/foot):					x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	15.5			____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design Facility ID#: 0801

x Thermal treatment: ____ Conductive ________________

____ Electrical Resistance ________________

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ________________

____ Steam ____ Steam + air ____ Steam + O2

x Other (describe) RFH (KAI)

x Type of Test: ____ Pilot test ____ Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

x Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only x Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 4/26/1994 Duration: 50 d

150 Hydraulic Control ____ Yes ____ No

10 Treatment Cell Design:

Size of target zone (ft2):	141	____ Unknown	(10 x 15 ft)
Thickness of target zone (ft):	23.3	____ Unknown	
Depth to top of target zone (ft bgs):	0	____ Unknown	
Thickness of target zone below water table (ft):	0	____ Unknown	
Number of energy delivery points:	4	____ Unknown	
Number of extraction points:	16	____ Unknown	

4 Temperature Profile:

Initial formation temperature (deg C):	________	____ Unknown
Maximum representative formation temperature (deg C):	________	____ Unknown
Time to reach maximum representative temperature (days):	________	____ Unknown
Duration of treatment at representative temperature (days):	________	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	________	________
Formation temperature post-treatment monitoring event 1:	________	________
Duration of post-treatment monitoring (days):	________	________

0 Mass of contaminant removed:

Via liquid pumping:	________	____ lb	____ kg	x Unknown
In vapor stream:	________	____ lb	____ kg	x Unknown
Total:	________	____ lb	____ kg	x Unknown

Comments:

2

Attachments:

8

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0801

____ Performance

Remediation Goal:

____ In Groundwater: ____

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

x Cost

Total Project Cost: 2477216

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information Facility ID#: 0810

x File Analyzed By: JT x PD ____ Date: 9/27/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents X Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: 1998 End of Test: 2003 Duration: varied

Type of Site: x Non-DOD ____ DoD

x Facility Name: Petro-Chemical System (AKA Turtle Bayou)

Address: ____________

City, State, Zip Code: Liberty, TX

OU# or Site #: ____________

x Primary point of contact: Chris Villarreal

Organization: US EPA

Address: ____________

City, State, Zip Code: ____________

Phone #: 214-665-6758 email: chris.villarrreal@epamail.epa.gov

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

x Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

x Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data — Facility ID#: 0810

x Impacted Zone: Length (parallel to flow direction)(ft.): ____ Width (ft): ____ Thickness (ft): ____ x Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: x None

Pre-treatment: ____ Post-treatment: ____

Number of wells relative to treatment zone:

Pre-treatment In: ____ Upgradient: ____ Downgradient: ____ Crossgradient: ____

Post-treatment In: ____ Upgradient: ____ Downgradient: ____ Crossgradient: ____

x Soil Borings: Number of relevant soil borings with pre-treatment data: 1, 2, 1, 1, 2

Number of relevant soil borings with post-treatment data: ____

Number inside treatment zone: 1, 2, 1, 1, 2 Number outside treatment zone: ____

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel		None	None	None	None
	x 1,1-dichloroethene	____ Napthalene		None	None	None	None
	____ cis-1,2-dichloroethene	x Benzene		None	None	None	None
	____ trans-1,2-dichloroethene	x Tolune		None	None	None	None
	x 1,1-dichloroethane	____ Ethylbenzene		None	None	None	None
	x 1,2-dichloroethane	____ m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane	x naphthalene		None	None	None	None
	____ 1,1,2,2-tetrachloroethane	x xylenes		None	None	None	None
	x Vinyl Chloride			None	None	None	None
	x 12-DCE			None	None	None	None
		x Ethylbenzene		None	None	None	None
		x TBA		None	None	None	None
		x Acetone		None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

# of borings per cell for exampl: 1, 2, 3, and 4

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0810

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No x Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	12			
	high value (ft bgs):	22			
	Unknown:				
x Flow direction		S to SW			
x Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	below			____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	below			____ Unknown
high				

Comments:
unit K(ft/day) T (ft2/day)
C1 0.00028
0.0036
M1
0.009
0.09
S1 5

Attachments:

Thermal Treatment - Design   Facility ID#: 0810

x Thermal treatment:
- ____ Conductive ____________
- x Electrical Resistance Main Waste area
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- ____ Steam ____________
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ____________

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: Dec-01   Duration: 27 months

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	____________	____ Unknown	(____ x ____ ft)
Thickness of target zone (ft):	22	____ Unknown	
Depth to top of target zone (ft bgs):	2	____ Unknown	
Thickness of target zone below water table (ft):	12	____ Unknown	
Number of energy delivery points:	8	____ Unknown	
Number of extraction points:	29	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	____________	x Unknown
Maximum representative formation temperature (deg C):	____________	x Unknown
Time to reach maximum representative temperature (days):	____________	x Unknown
Duration of treatment at representative temperature (days):	____________	x Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____________	____________
Formation temperature post-treatment monitoring event 1:	____________	____________
Duration of post-treatment monitoring (days):	____________	____________

x Mass of contaminant removed:

Via liquid pumping:	____________	____ lb	____ kg	x Unknown
In vapor stream:	____________	____ lb	____ kg	x Unknown
Total:	____________	____ lb	____ kg	x Unknown

Comments: ____________

Attachments: ____________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Thermal Treatment - Design Facility ID#: 0810

x Thermal treatment: ____ Conductive ____________________

x Electrical Resistance West waste area

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____________________

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____________________

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

x Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: Oct-98 Duration: 43 months

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	____________	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	28	____ Unknown	
Depth to top of target zone (ft bgs):	0	____ Unknown	
Thickness of target zone below water table (ft):	16	____ Unknown	
Number of energy delivery points:	12	____ Unknown	
Number of extraction points:	16	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	____________	x Unknown
Maximum representative formation temperature (deg C):	____________	x Unknown
Time to reach maximum representative temperature (days):	____________	x Unknown
Duration of treatment at representative temperature (days):	____________	x Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____________	____________
Formation temperature post-treatment monitoring event 1:	____________	____________
Duration of post-treatment monitoring (days):	____________	____________

x Mass of contaminant removed:

Via liquid pumping:	____________	____ lb	____ kg	x Unknown
In vapor stream:	____________	____ lb	____ kg	x Unknown
Total:	____________	____ lb	____ kg	x Unknown

Comments:

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Thermal Treatment - Design   Facility ID#: 0810

x Thermal treatment: ____ Conductive ____________

x Electrical Resistance Office trailer area

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____________

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____________

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

s Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: Oct-98 Duration: 39 months

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	____________	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	22	____ Unknown	
Depth to top of target zone (ft bgs):	2	____ Unknown	
Thickness of target zone below water table (ft):	12	____ Unknown	
Number of energy delivery points:	12	____ Unknown	
Number of extraction points:	37	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	____________	x Unknown
Maximum representative formation temperature (deg C):	____________	x Unknown
Time to reach maximum representative temperature (days):	____________	x Unknown
Duration of treatment at representative temperature (days):	____________	x Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____________	____________
Formation temperature post-treatment monitoring event 1:	____________	____________
Duration of post-treatment monitoring (days):	____________	____________

x Mass of contaminant removed:

Via liquid pumping:	____________	____ lb	____ kg	x Unknown
In vapor stream:	____________	____ lb	____ kg	x Unknown
Total:	____________	____ lb	____ kg	x Unknown

Comments:

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Thermal Treatment - Design　　　　Facility ID#: 0810

x Thermal treatment:
- ____ Conductive ____________________
- x Electrical Resistance　Easement North
  - ____ 3 phase　____ 6 phase　____ AC power　____ DC power
- ____ Steam ____________________
  - ____ Steam　____ Steam + air　____ Steam + O2
- ____ Other (describe) ____________________

x Type of Test:　x Pilot test　____ Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone:　____ Saturated only　____ Vadose only　x Both (Saturated and Vadose zones)

x Start of Thermal Test:　Oct-98　　Duration: 39 months

x Hydraulic Control　x Yes　____ No

x Treatment Cell Design:

Size of target zone (ft2):	____________	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	22	____ Unknown	
Depth to top of target zone (ft bgs):	2	____ Unknown	
Thickness of target zone below water table (ft):	12	____ Unknown	
Number of energy delivery points:	12	____ Unknown	
Number of extraction points:	25	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	____________	x Unknown
Maximum representative formation temperature (deg C):	____________	x Unknown
Time to reach maximum representative temperature (days):	____________	x Unknown
Duration of treatment at representative temperature (days):	____________	x Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____________	____________
Formation temperature post-treatment monitoring event 1:	____________	____________
Duration of post-treatment monitoring (days):	____________	____________

x Mass of contaminant removed:

Via liquid pumping:	____________	____ lb	____ kg	x Unknown
In vapor stream:	____________	____ lb	____ kg	x Unknown
Total:	____________	____ lb	____ kg	x Unknown

Comments:

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Thermal Treatment - Design　　　　Facility ID#: 0810

x Thermal treatment: ____ Conductive ________

x Electrical Resistance Easement South

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ________

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ________

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: Oct-98 Duration: 39 months

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	________	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	22	____ Unknown	
Depth to top of target zone (ft bgs):	2	____ Unknown	
Thickness of target zone below water table (ft):	12	____ Unknown	
Number of energy delivery points:	9	____ Unknown	
Number of extraction points:	36	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	________	x Unknown
Maximum representative formation temperature (deg C):	________	x Unknown
Time to reach maximum representative temperature (days):	________	x Unknown
Duration of treatment at representative temperature (days):	________	x Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	________	________
Formation temperature post-treatment monitoring event 1:	________	________
Duration of post-treatment monitoring (days):	________	________

x Mass of contaminant removed:

Via liquid pumping:	________	____ lb	____ kg	x Unknown
In vapor stream:	________	____ lb	____ kg	x Unknown
Total:	________	____ lb	____ kg	x Unknown

Comments:

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance   Facility ID#: 0810

____ Performance

Remediation Goal:

____ In Groundwater:

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Lessons Learned

____ Energy

Total Energy Used: ____________ ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____________ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____________ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy: ____________

____ Cost

Total Project Cost: ____________

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

____ Energy Cost: ____________ ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

General Site Information　　　　Facility ID#: 0815

x File Analyzed By: JT x PD ____ 　　Date: 10/26/2006

Type of treatment: x Conductive ____ Steam ____ ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test ___ Full Scale System

Start of Test: ____________ End of Test: ____________ Duration: ________

Type of Site: x Non-DOD ____ DoD

x Facility Name: Shell's Gasmer Rd; R&D Facility

Address: ____________

City, State, Zip Code: TX

OU# or Site #: ____________

x Primary point of contact: Denis Conley

Organization: Haley & Aldrich

Address: 200 Town Centre Dr.

City, State, Zip Code: Rochester, NY 14623

Phone #: 585-321-4246 　　email: dconley@haleyaldrich.com

____ Other contacts or vendors who worked on site 　　____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data
____ Good pre- and post-treatment soil data
____ Good temperature profile vs. time information
____ Flux assessment
____ Groundwater elevations
____ Geologic cross-section
____ Hydraulic Conductivity information

General Site Assessment Data | Facility ID#: 0815

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

____ Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____ ________	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ________	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ________	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ________	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ________	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ________	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ________	None	None	None	None
	____ 1,1,2-trichloroethane	____ ________	____ ________	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ________	____ ________	None	None	None	None
	____ Vinyl Chloride	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0815

____ Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design Facility ID#: 0815

x Thermal treatment: x Conductive ____

____ Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

x Type of Test: x Pilot test ____ Full-scale System

____ Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ____ Duration: ____

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2):	____	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	____	____ Unknown	
Depth to top of target zone (ft bgs):	____	____ Unknown	
Thickness of target zone below water table (ft):	____	____ Unknown	
Number of energy delivery points:	____	____ Unknown	
Number of extraction points:	____	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	____	____ Unknown
Maximum representative formation temperature (deg C):	____	____ Unknown
Time to reach maximum representative temperature (days):	____	____ Unknown
Duration of treatment at representative temperature (days):	____	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

____ Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	____	____ lb	____ kg	____ Unknown
Total:	____	____ lb	____ kg	____ Unknown

Comments: ____

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0815

____ Performance

Remediation Goal:

____ In Groundwater: ____________________

____ In Soil: ____________________

Was the Remediation Goal Achieved:

____ In Groundwater ____________________

Comment: ____________________

____ In Soil ____________________

Comment: ____________________

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____________ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____________________

____ Cost

Total Project Cost: ____________

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

____ Energy Cost: ____________ ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ____________________

____ Other Cost 2: ____________________

____ Other Cost 3: ____________________

General Site Information | Facility ID#: 0820

x File Analyzed By: JT x PD ____ | Date: 1/25/2007

Type of treatment: ____ Conductive x Steam x ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: 1997 | End of Test: 1997 | Duration: varied

Type of Site: ____ Non-DOD x DoD

x Facility Name: Ft. Hood / Robert Gray Army Field

Address: ____________

City, State, Zip Code: Killian, TX

OU# or Site #: ____________

x Primary point of contact: Book: Steam and Electroheating Remediation of Tight Soils

Organization: copyright 2000 by CRC Press, LLC

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

x Other contacts or vendors who worked on site ____ None

Point of contact: Dr. C. Herb Ward

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: Rice University

Address: ____________

City, State, Zip Code: ____________

Phone #: 713-348-4086 email: wardch@rice.edu

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good temperature profile vs. time information

____ Groundwater elevations

____ Hydraulic Conductivity information

____ Good pre- and post-treatment soil data

____ Flux assessment

____ Geologic cross-section

General Site Assessment Data — Facility ID#: 0820

____ Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 1 Post-treatment: 1

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 7

Number of relevant soil borings with post-treatment data: 5

Number inside treatment zone: 7 / 5 Number outside treatment zone: 0

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel		None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene		None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene		None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune		None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane	x Total Recoverable Petroleum		None	1,000 mg/kg	None	100 mg/kg
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	____ Vinyl Chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

Cross-secton on pag 9-12

Pre-treatment mass estimate of 19919.58 pounds

Attachments:

General Site Assessment Data

Facility ID#: 0820

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 1 Post-treatment: 1

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 11

Number of relevant soil borings with post-treatment data: 7

Number inside treatment zone: 11 / 7 Number outside treatment zone: 0

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	x Total Recoverable Petroleum	____	None	1,000 mg/kg	None	100 mg/kg
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Cross-secton on pag 9-12

Pre-treatment mass estimate of 8984.92 pounds

Attachments:

General Site Assessment Data

Facility ID#: 0820

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 4 Post-treatment: 4

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 11

Number of relevant soil borings with post-treatment data: 7

Number inside treatment zone: 11 / 7 Number outside treatment zone: 0

x Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____ ________	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ________	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ________	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ________	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ________	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ________	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ________	None	None	None	None
	____ 1,1,2-trichloroethane	x Total Recoverable Petroleum	____ ________	None	1,000 mg/kg	None	50 mg/kg
	____ 1,1,2,2-tetrachloroethane	____ ________	____ ________	None	None	None	None
	____ Vinyl Chloride	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None

Comments:

Cross-secton on pag 9-12

Pre-treatment mass estimate of 3234.38 pounds

Attachments:

Hydrogeologic Conceptual Model — Facility ID#: 0820

x Geology:

Zone		Unconsolidated Sediments
Vadose Zone:	____	Relatively homogeneous and permeable unconsolidated sediments
	x	Relatively homogeneous and impermeable unconsolidated sediments
	____	Largely permeable sediments with inter-bedded lenses of lower permeability material
	____	Largely impermeable sediments with inter-bedded layers of higher permeability material
	____	Competent, but fractured bedrock (i.e. crystalline rock)
	____	Weathered bedrock, limestone, sandstone
Saturated Zone:	____	Relatively homogeneous and permeable unconsolidated sediments
	x	Relatively homogeneous and impermeable unconsolidated sediments
	____	Largely permeable sediments with inter-bedded lenses of lower permeability material
	____	Largely impermeable sediments with inter-bedded layers of higher permeability material
	____	Competent, but fractured bedrock (i.e. crystalline rock)
	____	Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl   x Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present?   ____ No   ____ Yes (number): ________   ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	9.5			
	high value (ft bgs):	18			
	Unknown:				
x Flow direction		E			
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

x K range (ft/day)   Measured using: ____ Slug Test   ____ Laboratory   ____ Field data

low	5.95E-06	0.28		____ Unknown
high	9.30E-05			

Transmissivity (ft2/day):   Measured using: ____ Slug Test   ____ Laboratory   ____ Field data

low				____ Unknown
high				

Comments:
K = 1e-4 cm/sec for weathered shale/limestone K=3.3e-8 to 2.1e-9 cm/sec for slug tests.

Attachments:

Thermal Treatment - Design Facility ID#: 0820

x Thermal treatment: ____ Conductive ______

x Electrical Resistance Cell A

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ______

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ______

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

x Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 3-1997 (ended 9/5/97) Duration: 6 months

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2): 900 ____ Unknown (30 x 30 ft)

Thickness of target zone (ft): 24 ____ Unknown

Depth to top of target zone (ft bgs): ______ ____ Unknown

Thickness of target zone below water table (ft): ______ ____ Unknown

Number of energy delivery points: 6 ____ Unknown

Number of extraction points: 4 ____ Unknown

x Temperature Profile:

Initial formation temperature (deg C): 20.5 ____ Unknown

Maximum representative formation temperature (deg C): 54.4 ____ Unknown

Time to reach maximum representative temperature (days): ______ ____ Unknown

Duration of treatment at representative temperature (days): ______ ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

Via liquid pumping: ______ ____ lb ____ kg ____ Unknown

In vapor stream: ______ ____ lb ____ kg ____ Unknown

Total: 15150 x lb ____ kg ____ Unknown

Comments: Hydraulic Fractures at 12, 15, 18, and 21 ft. GW recovery well was upgradient (GW-A) Post mass of 4770.18 pounds

Attachments: ______

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Thermal Treatment - Design Facility ID#: 0820

x Thermal treatment: ____ Conductive ____

____ Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

x Steam Cell B

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

x Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: Apr-97 Duration: ____

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2): 570 ____ Unknown (24 x 24 ft)

Thickness of target zone (ft): 22 ____ Unknown

Depth to top of target zone (ft bgs): ____ ____ Unknown

Thickness of target zone below water table (ft): ____ ____ Unknown

Number of energy delivery points: 4 ____ Unknown

Number of extraction points: 4 ____ Unknown

x Temperature Profile:

Initial formation temperature (deg C): 21 ____ Unknown

Maximum representative formation temperature (deg C): ____ ____ Unknown

Time to reach maximum representative temperature (days): ____ ____ Unknown

Duration of treatment at representative temperature (days): ____ ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

Via liquid pumping: ____ ____ lb ____ kg ____ Unknown

In vapor stream: ____ ____ lb ____ kg ____ Unknown

Total: 7820 x lb ____ kg ____ Unknown

Comments: Hydraulic Fractures at 12, 15, 18, and 21 ft. the steam injection well (SIM) was completed at 16 ft ------------------------------------ GW recovery well was upgradient (GW-A) Post mass of 1165.37

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Thermal Treatment - Design Facility ID#: 0820

x Thermal treatment: ____ Conductive ____

____ Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

x Steam Cell C

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

x Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 7/1/1997 (ended 9/5/97) Duration: 67 days

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	580	____ Unknown	(24 x 24 ft)
Thickness of target zone (ft):	22	____ Unknown	
Depth to top of target zone (ft bgs):	____	____ Unknown	
Thickness of target zone below water table (ft):	____	____ Unknown	
Number of energy delivery points:	11	____ Unknown	
Number of extraction points:	5	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	20.5	____ Unknown
Maximum representative formation temperature (deg C):	93.3	____ Unknown
Time to reach maximum representative temperature (days):	____	____ Unknown
Duration of treatment at representative temperature (days):	____	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	____	____ lb	____ kg	____ Unknown
Total:	2766	x lb	____ kg	____ Unknown

Comments: Hydraulic Fractures at 12, 15, 18, and 21 ft. the steam injection well (SIM) was completed at 15 and 18 ft and at 12ft GW recovery well was upgradient (GW-A) Post mass of 468.30

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance | Facility ID#: 0820

____ Performance

Remediation Goal:

____ In Groundwater: ____

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

Cells A and B were spaced 41.5 ft apart (center to center) and cells B and C were spaced 31 ft apart (center to center). Demonstrate the viability of newly developed remedaiton methods and to promote more widespread use of effective innovative technologies. Objectives: 1) reduce TRPH to 1000 mg/kg or less 2) measure extent of treatment zone 3) id design characteristics important for site selection and scale-up and 4) determine operating costs under normal conditions

Lessons Learned

Measures of success (technical): 1) determine recovery rates of vapor and liquide 2) determine distribution of extracted volatiles and SVOCs by means of vapor-phase chromatographic boil point analysis and 3) determine if heating (soil) front could be monitored by measurements of soil temperature.

x Energy

Total Energy Used: 17612 x kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information　　　　Facility ID#: 0830

x File Analyzed By: JT x PD ____　　　　Date: 11/14/2006

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active ___ Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: 1997　　End of Test: 1997　　Duration: ________

Type of Site: ____ Non-DOD x DoD

x Facility Name: Hill Air Force Base

Address: ____________

City, State, Zip Code: Odgen, UT

OU# or Site #: OU-1

x Primary point of contact: Dr. Lloyd Stewart

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: 877-763-8564　　email: bo@praxis-enviro.com

____ Other contacts or vendors who worked on site　　____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________　　email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data   Facility ID#: 0830

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

____ Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____ ________	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ________	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ________	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ________	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ________	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ________	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ________	None	None	None	None
	____ 1,1,2-trichloroethane	____ ________	____ ________	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ________	____ ________	None	None	None	None
	____ Vinyl Chloride	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0830

x Geology: Zone: Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design

Facility ID#: 0830

x Thermal treatment:
- ____ Conductive ____
- ____ Electrical Resistance ____
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- x Steam ____
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ____

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ____ Duration: ____

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	160	____ Unknown	(10 x 16 ft)
Thickness of target zone (ft):	30	____ Unknown	
Depth to top of target zone (ft bgs):	0	____ Unknown	
Thickness of target zone below water table (ft):	____	x Unknown	
Number of energy delivery points:	____	x Unknown	
Number of extraction points:	____	x Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	____	____ Unknown
Maximum representative formation temperature (deg C):	____	____ Unknown
Time to reach maximum representative temperature (days):	____	____ Unknown
Duration of treatment at representative temperature (days):	____	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	x Unknown
In vapor stream:	34	____ lb	x kg	____ Unknown
Total:	____	____ lb	____ kg	x Unknown

Comments: ____

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0830

____ Performance

Remediation Goal:

____ In Groundwater:

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information Facility ID#: 0840

x File Analyzed By: JT x PD ____ Date: 10/26/2006

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: Sep-00 End of Test: ____________ Duration: 3.5 Years

Type of Site: ____ Non-DOD x DoD

x Facility Name: Yorktown Naval Shipyards

Address: ____________

City, State, Zip Code: Norfolk, VA

OU# or Site #: ____________

x Primary point of contact: Linda Cole

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: 752-322-4734 email: ____________

x Other contacts or vendors who worked on site ____ None

Point of contact: Jennifer Davis

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications x Other ____________

Organization: Navy

Address: ____________

City, State, Zip Code: ____________

Phone #: 757-322-4775 email: ____________

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0840

x Impacted Zone: Length (parallel to flow direction)(ft.): below Width (ft): ____ Thickness (ft): ____ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ____ Post-treatment: ____

Number of wells relative to treatment zone:

	In:	Upgradient:	Downgradient:	Crossgradient:
Pre-treatment	____	____	____	____
Post-treatment	____	____	____	____

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____

Number of relevant soil borings with post-treatment data: ____

Number inside treatment zone: ____ Number outside treatment zone: ____

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	x Bunker Fuel	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

8000 L of Bunker Fuel estimated to have been released

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0840

x Geology: Zone Unconsolidated Sediments

Vadose Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
x Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

Saturated Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
x Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3
Depth to water:	low value (ft bgs):	15		
	high value (ft bgs):	25		
	Unknown:			

____ Flow direction ________ ________ ________

	Aquifer 1	Aquifer 2	Aquifer 3	
____ Horizontal hydraulic gradient (feet/foot):				____ Unknown
Vertical hydraulic gradient (feet/foot):				____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design Facility ID#: 0840

x Thermal treatment:
- ____ Conductive ________________________________
- ____ Electrical Resistance ________________________________
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- x Steam ________________________________
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ________________________________

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: Sep-00 Duration: 3.5 yrs

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	900	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	20	____ Unknown	
Depth to top of target zone (ft bgs):	10	____ Unknown	
Thickness of target zone below water table (ft):	________	____ Unknown	
Number of energy delivery points:	________	____ Unknown	
Number of extraction points:	________	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	________	____ Unknown
Maximum representative formation temperature (deg C):	________	____ Unknown
Time to reach maximum representative temperature (days):	________	____ Unknown
Duration of treatment at representative temperature (days):	________	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	________	________
Formation temperature post-treatment monitoring event 1:	________	________
Duration of post-treatment monitoring (days):	________	________

x Mass of contaminant removed:

Via liquid pumping:	5000 gal / month	____ lb	____ kg	____ Unknown
In vapor stream:	500000 gal / month	____ lb	____ kg	____ Unknown
Total:	________	____ lb	____ kg	____ Unknown

Comments: ________________________________

Attachments: ________________________________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0840

x Performance

Remediation Goal:

x In Groundwater: 0.1 ft of free product or asymptotic removal rates of fuel

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy:

x Cost

Total Project Cost: 10000000

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

x Other Cost 1: 1000000 / yr

x Other Cost 2: 6000000

____ Other Cost 3:

x Please note other cost:

x Other Cost 1: O&M

x Other Cost 2: Construction

____ Other Cost 3:

General Site Information | Facility ID#: 0845

x File Analyzed By: JT x PD ____ Date: 10/30/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: x Active ___ Post

Type of Test: ____ Pilot Test ___ Full Scale System

Start of Test: ____________ End of Test: ____________ Duration: ________

Type of Site: ____ Non-DOD ____ DoD

x Facility Name: Richmond, VA

Address: ____________

City, State, Zip Code: Richmond, VA

OU# or Site #: ____________

x Primary point of contact: David Fleming

Organization: TRS

Address: 7421-A Warren SE

City, State, Zip Code: Snoqualmie, WA 98065

Phone #: 425-396-4266 email: dfleming@thermalrs.com

x Other contacts or vendors who worked on site ____ None

Point of contact: Art Taddeo

Type: x Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: ENSR

Address: ____________

City, State, Zip Code: ____________

Phone #: 978-589-3095 email: ataddeo@ensr.com

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0845

____ Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ______

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: ______ Number outside treatment zone: ______

x Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	5 mg/L	None	None	None
	x Tetrachloroethene	____ Jet Fuel	____ ______	50 mg/L	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ______	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ______	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ______	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ______	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ______	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ______	None	None	None	None
	____ 1,1,2-trichloroethane	____ ______	____ ______	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ______	____ ______	None	None	None	None
	____ Vinyl Chloride	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0845

x Geology: Zone: Unconsolidated Sediments

Vadose Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
x Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

Saturated Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
x Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	8			
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design　　　　Facility ID#: 0845

x Thermal treatment:
____ Conductive ____________________
x Electrical Resistance ____________________
____ 3 phase ____ 6 phase ____ AC power ____ DC power
____ Steam ____________________
____ Steam ____ Steam + air ____ Steam + O2
____ Other (describe) ____________________

____ Type of Test: ____ Pilot test ____ Full-scale System

x Geology of Treatment Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
x Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

____ Start of Thermal Test: ____________ Duration: ____________

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	12040	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	28	____ Unknown	
Depth to top of target zone (ft bgs):	2	____ Unknown	
Thickness of target zone below water table (ft):	22	____ Unknown	
Number of energy delivery points:	60	____ Unknown	
Number of extraction points:	60	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	____________	____ Unknown
Maximum representative formation temperature (deg C):	____________	____ Unknown
Time to reach maximum representative temperature (days):	____________	____ Unknown
Duration of treatment at representative temperature (days):	____________	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____________	____________
Formation temperature post-treatment monitoring event 1:	____________	____________
Duration of post-treatment monitoring (days):	____________	____________

____ Mass of contaminant removed:

Via liquid pumping:	____________	____ lb	____ kg	____ Unknown
In vapor stream:	____________	____ lb	____ kg	____ Unknown
Total:	____________	____ lb	____ kg	____ Unknown

Comments:

Attachments: 15 foot electrode spacing

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0845

x Performance

Remediation Goal:

x In Groundwater:

PCE at 5 ug/L or 99.93% reduction

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information | Facility ID#: 0860

x File Analyzed By: JT x PD ____ Date: 11/15/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ________

Type of Contaminant: x Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 12/17/2003 End of Test: 8/4/2004 Duration: 231 d

Type of Site: ____ Non-DOD x DoD

x Facility Name: Ft. Lewis, Washington Area 1

Address: ________

City, State, Zip Code: Ft. Lewis, Washington

OU# or Site #: East Gate Disposal Yard NAPL Area 1

x Primary point of contact: Travis Shaw

Organization: USACE - Seattle

Address: ________

City, State, Zip Code: ________

Phone #: 206-764-3527 email: travis.c.shaw@usace.army.mil

____ Other contacts or vendors who worked on site ____ None

Point of contact: ________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: ________

Address: ________

City, State, Zip Code: ________

Phone #: ________ email: ________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0860

____ Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 35 Post-treatment: 35

Number of wells relative to treatment zone:

	In:	Upgradient:	Downgradient:	Crossgradient:
Pre-treatment	12	3	16	4
Post-treatment	12	3	16	4

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ______

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: ______ Number outside treatment zone: ______

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	1 mg/L	None	0.05 mg/L	None
	x Tetrachloroethene	____ Jet Fuel	____	0.001 mg/L	None	0.001 mg/L	None
	x 1,1-dichloroethene	____ Napthalene	____	0.5 mg/L	None	0.01 mg/L	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	x 1,1,1-trichloroethane	____ o-xylene	____	0.01 mg/L	None	0.001 mg/L	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	x Vinyl Chloride	____	____	0.005 mg/L	None	0.001 mg/L	None
	x TCE - deep	____	____	0.01 mg/L	None	0.05 mg/L	None
	x cis-1,2-DCE - deep	____	____	0.001 mg/L	None	0.001 mg/L	None
	x 1,1,1-TCA - deep	____	____	0.001 mg/L	None	0.001 mg/L	None
	x PCE - deep	____	____	0.001 mg/L	None	0.001 mg/L	None
	x Vinyl chloride - deep	____	____	0.001 mg/L	None	0.001 mg/L	None
	____	____	____	None	None	None	None

Comments:

Post-treatment samples for 1,1,1-TCA and vinyl chloride in shallow - non-detect Post treatment samples in cis-1,2-Dce, PCE, TCE, vinyl chloride in deep wells - non-detect Pre-treatment samples in 1,1,1-TCA and vinyl chloride in deep wells - non-detect

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0860

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 278 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	11			
	high value (ft bgs):				
	Unknown:				
x Flow direction		SW			
x Horizontal hydraulic gradient (feet/foot):		0.001			____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 0860

x Thermal treatment:
- ____ Conductive ____________________
- x Electrical Resistance ____________________
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- ____ Steam ____________________
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ____________________

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 12/17/2003   Duration: 231 day

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	25400	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	36	____ Unknown	
Depth to top of target zone (ft bgs):	2	____ Unknown	
Thickness of target zone below water table (ft):	25	____ Unknown	
Number of energy delivery points:	106	____ Unknown	
Number of extraction points:	106	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	22	____ Unknown
Maximum representative formation temperature (deg C):	56	____ Unknown
Time to reach maximum representative temperature (days):	161	____ Unknown
Duration of treatment at representative temperature (days):	70	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

Via liquid pumping:	2.0785	____ lb	x kg	____ Unknown
In vapor stream:	43152	____ lb	x kg	____ Unknown
Total:	43154	____ lb	x kg	____ Unknown

Comments:

Attachments: Total volume - 30900 yd3

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0860

____ Performance

Remediation Goal:

____ In Groundwater: ____________________

____ In Soil: ____________________

Was the Remediation Goal Achieved:

____ In Groundwater ____________________

Comment: ____________________

____ In Soil ____________________

Comment: ____________________

General comments on the thermal application:

Target temps - 100C in saturated zone and 90C in vadose zone, then temperature specifics will be maintained for 60 days

Lessons Learned

____

x Energy

Total Energy Used: 8387050 x kWhr ____ kWhr/m^3 ____ kWhr/yd^3

x Total energy applied to treatment zone: 7913000 kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____________________

____ Cost

Total Project Cost: ____________

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

____ Energy Cost: ____________ ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ____________________

____ Other Cost 2: ____________________

____ Other Cost 3: ____________________

General Site Information Facility ID#: 0863

x File Analyzed By: JT x PD ____ Date: 11/15/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ________________

Type of Contaminant: x Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ______________________________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 2/14/2005 End of Test: 8/5/2005 Duration: 172 day

Type of Site: ____ Non-DOD x DoD

x Facility Name: Ft. Lewis, Washington Area 2

Address: ______________________________

City, State, Zip Code: Ft. Lewis, Washington

OU# or Site #: East Gate Disposal Yard NAPL Area 2

x Primary point of contact: Travis Shaw

Organization: USACE - Seattle

Address: ______________________________

City, State, Zip Code: ______________________________

Phone #: 206-764-3527 email: travis.c.shaw@usace.army.mil

____ Other contacts or vendors who worked on site ____ None

Point of contact: ______________________________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: ______________________________

Address: ______________________________

City, State, Zip Code: ______________________________

Phone #: ____________________ email: ______________________________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data Facility ID#: 0863

x Impacted Zone: Length (parallel to flow direction)(ft.): 125 Width (ft): 250 Thickness (ft): varies/up to 52 ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 22 Post-treatment: 22

Number of wells relative to treatment zone:

	In	Upgradient	Downgradient	Crossgradient
Pre-treatment	13	1	6	2
Post-treatment	13	1	6	2

x Soil Borings: Number of relevant soil borings with pre-treatment data: 6

Number of relevant soil borings with post-treatment data: 6

Number inside treatment zone: 12 Number outside treatment zone: 0

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	5 mg/L	100 mg/kg	0.1 mg/L	0.1 mg/kg
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	x cis-1,2-dichloroethene	____ Benzene	____	0.5 mg/L	1 mg/kg	0.01 mg/L	0.01 mg/kg
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

x Geology:

Zone: Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 278 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? x No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	9			
	high value (ft bgs):	10			
	Unknown:				
x Flow direction		SW			
x Horizontal hydraulic gradient (feet/foot):		0.001 to 0.004			____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

x K range (ft/day) Measured using: x Slug Test x Laboratory x Field data

low	24.2			____ Unknown
high	200			

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments: Shallow aquifer only is affected by NAPL. There is a deeper aquifer separated by a glacial till & lacustrine silt unit but it is not believed to be impacted by NAPL.

Attachments:

Thermal Treatment - Design Facility ID#: 0863

x Thermal treatment:
- ____ Conductive
- x Electrical Resistance
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- ____ Steam
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe)

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 2/14/2005 Duration: 172 day

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	22390	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	52	____ Unknown	
Depth to top of target zone (ft bgs):	2	____ Unknown	
Thickness of target zone below water table (ft):	42	____ Unknown	
Number of energy delivery points:	101	____ Unknown	
Number of extraction points:	56	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	17	____ Unknown
Maximum representative formation temperature (deg C):	85	____ Unknown
Time to reach maximum representative temperature (days):	152	____ Unknown
Duration of treatment at representative temperature (days):	30	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

Via liquid pumping:	13.826	____ lb	x kg	____ Unknown
In vapor stream:	1340	____ lb	x kg	____ Unknown
Total:	14025	____ lb	x kg	____ Unknown

Comments: 1089 kg - TCE, 245 kg - cis-1,2-DCE, 11337 kg - TPH = 12671 kg

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance   Facility ID#: 0863

x Performance

Remediation Goal:

x In Groundwater:

Remove CVOCs to maximum extent practicable (No strict numerical goal)

x In Soil:

Same as above

Was the Remediation Goal Achieved:

x In Groundwater

Comment:

Yes

x In Soil

Comment:

Yes

General comments on the thermal application:

Performance goals: 100C in saturated zone, 90C in vadose zone, and keep temperature at these for 7 days.

Lessons Learned

Performance goals of 100/90-deg C within treatment zone were not achieved although remedy goal still achieved; restate performance goal requirements in contract

x Energy

Total Energy Used: 9,547,000 x kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

x Total energy applied to treatment zone: 9,181,000 kwhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ________________ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy: ________________

____ Cost

Total Project Cost: ________________

____ Consultant Cost: ________________

____ Thermal Vendor Cost: ________________

____ Energy Cost: ________________ ____ m^3 ____ yd^3

____ Other Cost 1: ________________

____ Other Cost 2: ________________

____ Other Cost 3: ________________

____ Please note other cost: ____ Other Cost 1: ________________

____ Other Cost 2: ________________

____ Other Cost 3: ________________

General Site Information Facility ID#: 0865

x File Analyzed By: JT x PD ____ Date: 11/15/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 10/10/2006 End of Test: 1/26/2007 Duration: 108 days

Type of Site: ____ Non-DOD x DoD

x Facility Name: Ft. Lewis, Washington Area 3

Address: ____________

City, State, Zip Code: Ft. Lewis, Washington

OU# or Site #: East Gate Disposal Yard NAPL Area 3

x Primary point of contact: Kira Lynch

Organization: USACE - Seattle

Address: ____________

City, State, Zip Code: ____________

Phone #: 206-764-6918 email: kira.p.lynch@nws02.usace.army.mil

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0865

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 39 Post-treatment: 39

Number of wells relative to treatment zone:

	In:	Upgradient:	Downgradient:	Crossgradient:
Pre-treatment	13	9	8	9
Post-treatment	13	9	8	9

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

x Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	x Tetrachloroethene	____ Jet Fuel	____ ________	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ________	None	None	None	None
	x cis-1,2-dichloroethene	____ Benzene	____ ________	None	None	None	None
	x trans-1,2-dichloroethene	____ Tolune	____ ________	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ________	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ________	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ________	None	None	None	None
	____ 1,1,2-trichloroethane	x 135-trimethylbenzene	____ ________	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	x 124-trimethylbenzene	____ ________	None	None	None	None
	x Vinyl Chloride	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0865

x Geology: Zone Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: 278 ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
x Flow direction		NW			
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design　　Facility ID#: 0865

x Thermal treatment: ____ Conductive ____

x Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

x Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 10/10/2006　　Duration: 108 days

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	18200	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	30	____ Unknown	
Depth to top of target zone (ft bgs):	0	____ Unknown	
Thickness of target zone below water table (ft):	21	____ Unknown	
Number of energy delivery points:	93	____ Unknown	
Number of extraction points:	93	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	13	____ Unknown
Maximum representative formation temperature (deg C):	89	____ Unknown
Time to reach maximum representative temperature (days):	38	____ Unknown
Duration of treatment at representative temperature (days):	13	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	1/27/2007	68
Formation temperature post-treatment monitoring event 1:	4/9/2007	39
Duration of post-treatment monitoring (days):	186+	____

x Mass of contaminant removed:

Via liquid pumping:	____	____ lb	x kg	____ Unknown
In vapor stream:	____	____ lb	x kg	____ Unknown
Total:	____	____ lb	x kg	____ Unknown

Comments: ____

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0865

____ Performance

Remediation Goal:

____ In Groundwater:

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information | Facility ID#: 0870

x File Analyzed By: JT x PD ____ Date: 10/30/2006

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ________

Type of Contaminant: ____ Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

x Wood Treating ____ Other: ________

Treatment Status: x Active ___ Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: 5/24/2004 End of Test: ongoing Duration: ________

Type of Site: x Non-DOD ____ DoD

x Facility Name: Lake River Industrial Site

Address: ________

City, State, Zip Code: Ridgefield, WA

OU# or Site #: ________

x Primary point of contact: Steve Taylor

Organization: ________

Address: ________

City, State, Zip Code: ________

Phone #: ________ email: ________

____ Other contacts or vendors who worked on site ____ None

Point of contact: ________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: ________

Address: ________

City, State, Zip Code: ________

Phone #: ________ email: ________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data   Facility ID#: 0870

x Impacted Zone: Length (parallel to flow direction)(ft.): below   Width (ft): ____   Thickness (ft): ____   ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ____   Post-treatment: ____

Number of wells relative to treatment zone:

Pre-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______
Post-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____

Number of relevant soil borings with post-treatment data: ____

Number inside treatment zone: ____   Number outside treatment zone: ____

x Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	x Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	x PCP	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ____	None	None	None	None
	____ 1,1,2-trichloroethane	____ ____	____ ____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ____	____ ____	None	None	None	None
	____ Vinyl Chloride	____ ____	____ ____	None	None	None	None
	____ ____	____ ____	____ ____	None	None	None	None
	____ ____	____ ____	____ ____	None	None	None	None
	____ ____	____ ____	____ ____	None	None	None	None
	____ ____	____ ____	____ ____	None	None	None	None
	____ ____	____ ____	____ ____	None	None	None	None
	____ ____	____ ____	____ ____	None	None	None	None

Comments:

Impacted area of 4 acres and may contain 100,000 gallons of wood-treating chemcials

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0870

____ Geology: Zone / Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

	low				____ Unknown
	high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

	low				____ Unknown
	high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 0870

x Thermal treatment: ____ Conductive ______

____ Electrical Resistance ______

____ 3 phase ____ 6 phase ____ AC power ____ DC power

x Steam Phase I

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ______

x Type of Test: ____ Pilot test x Full-scale System

____ Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ______ Duration: ______

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2): ______ ____ Unknown (___ x ___ ft)

Thickness of target zone (ft): ______ ____ Unknown

Depth to top of target zone (ft bgs): ______ ____ Unknown

Thickness of target zone below water table (ft): ______ ____ Unknown

Number of energy delivery points: 6 ____ Unknown

Number of extraction points: 17 ____ Unknown

____ Temperature Profile:

Initial formation temperature (deg C): ______ ____ Unknown

Maximum representative formation temperature (deg C): ______ ____ Unknown

Time to reach maximum representative temperature (days): ______ ____ Unknown

Duration of treatment at representative temperature (days): ______ ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

____ Mass of contaminant removed:

Via liquid pumping: ______ ____ lb ____ kg ____ Unknown

In vapor stream: ______ ____ lb ____ kg ____ Unknown

Total: ______ ____ lb ____ kg ____ Unknown

Comments: ______

Attachments: ______

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0870

____ Performance

Remediation Goal:

____ In Groundwater:

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information   Facility ID#: 0880

x File Analyzed By: JT x PD ____ Date: ________

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ________

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: Jul-96 End of Test: Jun-97 Duration: 9 months

Type of Site: ____ Non-DOD x DoD

x Facility Name: Bremerton Naval Complex: Puget Sound Naval Shipyard (Pilot)

Address: ________

City, State, Zip Code: Washington

OU# or Site #: OU C

x Primary point of contact: Brad Gross

Organization: Navy

Address: ________

City, State, Zip Code: Washington

Phone #: 360-396-0028 email: r.gross@navy.mil

x Other contacts or vendors who worked on site ____ None

Point of contact: Cindy O'Hare

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications x Other ________

Organization: Navy

Address: Engineering Field Acitivity Northwest; Naval Facilities Engineering Command; 19917 7th Avenue NE

City, State, Zip Code: Poulsbo, WA 98370

Phone #: 360-396-0014 email: cindy.o'hare@navy.mil

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 0880

x Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ x Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ______

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: ______ Number outside treatment zone: ______

x Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	x No. 6 Fuel Oil	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	x Diesel	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene		None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune		None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane			None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	____ Vinyl Chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0880

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:

- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:

- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ~35 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	100			
	high value (ft bgs):				
	Unknown:				
x Flow direction		SE			
x Horizontal hydraulic gradient (feet/foot):					x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design

Facility ID#: 0880

x Thermal treatment:

____ Conductive ____________

____ Electrical Resistance ____________

____ 3 phase ____ 6 phase ____ AC power ____ DC power

x Steam ____________

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____________

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

x Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: Jul-96 Duration: 9 months

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	____________	x Unknown	(___ x ___ ft)
Thickness of target zone (ft):	____________	x Unknown	
Depth to top of target zone (ft bgs):	50	____ Unknown	
Thickness of target zone below water table (ft):	10	____ Unknown	
Number of energy delivery points:	8	____ Unknown	
Number of extraction points:	3	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	____________	x Unknown
Maximum representative formation temperature (deg C):	____________	x Unknown
Time to reach maximum representative temperature (days):	____________	x Unknown
Duration of treatment at representative temperature (days):	____________	x Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____________	____________
Formation temperature post-treatment monitoring event 1:	____________	____________
Duration of post-treatment monitoring (days):	____________	____________

x Mass of contaminant removed:

Via liquid pumping:	____________	____ lb	____ kg	x Unknown
In vapor stream:	____________	____ lb	____ kg	x Unknown
Total:	35,000 gal	____ lb	____ kg	____ Unknown

Comments:

The extraction and injection wells were at depths of 50, 80 and 110 feet.

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0880

____ Performance

Remediation Goal:

____ In Groundwater: ____

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

System was expanded in August 1997

Lessons Learned

cost during 1st nine months = $61/yd3

____ Energy

Total Energy Used: ____ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information Facility ID#: 0881

x File Analyzed By: JT x PD ____ Date: ________

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ________

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: Aug-97 End of Test: Sep-99 Duration: 2 years 1 month

Type of Site: ____ Non-DOD x DoD

x Facility Name: Bremerton Naval Complex: Puget Sound Naval Shipyard (Full)

Address: ________

City, State, Zip Code: Washington

OU# or Site #: OU C

x Primary point of contact: Brad Gross

Organization: Navy

Address: ________

City, State, Zip Code: Washington

Phone #: 360-396-0028 email: r.gross@navy.mil

x Other contacts or vendors who worked on site ____ None

Point of contact: Cindy O'Hare

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications x Other ________

Organization: Navy

Address: Engineering Field Acitivity Northwest; Naval Facilities Engineering Command; 19917 7th Avenue NE

City, State, Zip Code: Poulsbo, WA 98370

Phone #: 360-396-0014 email: cindy.o'hare@navy.mil

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data　　　　Facility ID#: 0881

x Impacted Zone: Length (parallel to flow direction)(ft.): ____ Width (ft): ____ Thickness (ft): ____ x Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ____ Post-treatment: ____

Number of wells relative to treatment zone:

Pre-treatment In: ____ Upgradient: ____ Downgradient: ____ Crossgradient: ____

Post-treatment In: ____ Upgradient: ____ Downgradient: ____ Crossgradient: ____

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____

Number of relevant soil borings with post-treatment data: ____

Number inside treatment zone: ____ Number outside treatment zone: ____

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	x No. 6 Fuel Oil	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	x Diesel	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene		None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune		None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane			None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	____ Vinyl Chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0881

x Geology: Zone: Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ~35 ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	100			
	high value (ft bgs):				
	Unknown:				
x Flow direction		SE			
x Horizontal hydraulic gradient (feet/foot):					x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design

Facility ID#: 0881

x Thermal treatment:

____ Conductive ____

____ Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

x Steam ____

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

x Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: Aug-97 Duration: 2 years 1 month

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	____	x	Unknown (___ x ___ ft)
Thickness of target zone (ft):	____	x	Unknown
Depth to top of target zone (ft bgs):	____	x	Unknown
Thickness of target zone below water table (ft):	____	x	Unknown
Number of energy delivery points:	____	x	Unknown
Number of extraction points:	____	x	Unknown

x Temperature Profile:

Initial formation temperature (deg C):	____	x	Unknown
Maximum representative formation temperature (deg C):	____	x	Unknown
Time to reach maximum representative temperature (days):	____	x	Unknown
Duration of treatment at representative temperature (days):	____	x	Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	x	Unknown
In vapor stream:	____	____ lb	____ kg	x	Unknown
Total:	____	____ lb	____ kg	x	Unknown

Comments: ____

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0881

____ Performance

Remediation Goal:

____ In Groundwater: ____

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

The system ended in Sept. 199 because the expanded system was ineffective at extraction more petroleum products from the groundwater table. The system was averageing slightly more than 800 gallons per month removal. The reasons for the ineffective extraction were: 1) equipment difficulties, 2) unknown site conditions, 3) impacts of groundwater flow from teh drydock operation - all of these were condsidered the primary production problems of the expanded system.

Lessons Learned

____

____ Energy

Total Energy Used: ____ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information Facility ID#: 0890

x File Analyzed By: JT x PD ____ Date: 10/18/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: May-99 End of Test: Aug-99 Duration: 75 d

Type of Site: x Non-DOD ____ DoD

x Facility Name: Former Dry Cleaners

Address: ____________

City, State, Zip Code: Western Washington

OU# or Site #: ____________

x Primary point of contact: Bill Heath

Organization: CES

Address: 419 Entiat St., Suite A

City, State, Zip Code: Kennewick, WA 99336

Phone #: 509-727-4276 email: bill@cesiweb.com

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good temperature profile vs. time information

____ Groundwater elevations

____ Hydraulic Conductivity information

____ Good pre- and post-treatment soil data

____ Flux assessment

____ Geologic cross-section

General Site Assessment Data Facility ID#: 0890

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

	In:	Upgradient:	Downgradient:	Crossgradient:
Pre-treatment	______	______	______	______
Post-treatment	______	______	______	______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	x Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	x cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0890

x Geology: Zone Unconsolidated Sediments

Vadose Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
x Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

Saturated Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
x Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	2			
	high value (ft bgs):	4			
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 0890

x Thermal treatment: ____ Conductive ______

x Electrical Resistance ______

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ______

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ______

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

x Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: May-99 Duration: 75 d

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	______	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	20	____ Unknown	
Depth to top of target zone (ft bgs):	2	____ Unknown	
Thickness of target zone below water table (ft):	20	____ Unknown	
Number of energy delivery points:	12	____ Unknown	
Number of extraction points:	4	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	______	____ Unknown
Maximum representative formation temperature (deg C):	______	____ Unknown
Time to reach maximum representative temperature (days):	______	____ Unknown
Duration of treatment at representative temperature (days):	______	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	______	______
Formation temperature post-treatment monitoring event 1:	______	______
Duration of post-treatment monitoring (days):	______	______

____ Mass of contaminant removed:

Via liquid pumping:	______	____ lb	____ kg	____ Unknown
In vapor stream:	______	____ lb	____ kg	____ Unknown
Total:	______	x lb	____ kg	____ Unknown

Comments: ______

Attachments: ______

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0890

x Performance

Remediation Goal:

____ In Groundwater:

PCE = 5 ug/L

x In Soil:

PCE = 500 ug/kg

Was the Remediation Goal Achieved:

____ In Groundwater ______________________________

Comment: ______________________________

____ In Soil ______________________________

Comment: ______________________________

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____________ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ______________________________

____ Cost

Total Project Cost: ____________

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

____ Energy Cost: ____________ ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ______________________________

____ Other Cost 2: ______________________________

____ Other Cost 3: ______________________________

General Site Information Facility ID#: 0900

X File Analyzed By: JT X PD ____ Date: 11/9/2006

Type of treatment: ____ Conductive X Steam ____ ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

X Wood Treating ____ Other: ____________

Treatment Status: ____ Active X Post

Type of Test: X Pilot Test ___ Full Scale System

Start of Test: 10/1/2002 End of Test: 4/15/2003 Duration: 6.5 months

Type of Site: ____ Non-DOD X DoD

X Facility Name: Wyckoff / Eagle Harbor

Address: ____________

City, State, Zip Code: Bainbridge Island, Washington

OU# or Site #: Former Process Area

X Primary point of contact: Mary Jane Nearman

Organization: EPA

Address: ____________

City, State, Zip Code: ____________

Phone #: 206-553-6642 email: ____________

X Other contacts or vendors who worked on site ____ None

Point of contact: Matt Allen

Type: X Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: US Army Corp of Engineers

Address: ____________

City, State, Zip Code: ____________

Phone #: 206-764-3697 email: matthew.s.allen@usace.army.mil

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data Facility ID#: 0900

X Impacted Zone: Length (parallel to flow direction)(ft.): ____ Width (ft): ____ Thickness (ft): ____ X Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

X Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 15 Post-treatment: 15

Number of wells relative to treatment zone:

Pre-treatment In: 15 Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: 15 Upgradient: ______ Downgradient: ______ Crossgradient: ______

X Soil Borings: Number of relevant soil borings with pre-treatment data: 15

Number of relevant soil borings with post-treatment data: 15

Number inside treatment zone: ______ Number outside treatment zone: ______

X Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	X Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____ ______	None	None	None	None
	____ 1,1-dichloroethene	X Napthalene	____ ______	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ______	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ______	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ______	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ______	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ______	None	None	None	None
	____ 1,1,2-trichloroethane	____ ______	____ ______	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ______	____ ______	None	None	None	None
	____ Vinyl Chloride	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None

Comments:

Estimated loss of 17,000 to 41,000 gallons of product. No real pre-treatment GW samples. Temperatures as high as 50 to 60 deg C in upper aquifer around injection well, whereas temperatures around extraction well remained close to ambient temperatures.

Attachments:

Hydrogeologic Conceptual Model — Facility ID#: 0900

X Geology: — Zone: Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- X Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- X Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

X Aquifer Characteristics:

Is more than 1 aquifer present? ____ No X Yes (number): 3 ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	6	80	200	
	high value (ft bgs):	10	200	1500+	
	Unknown:				
X Flow direction		Radially toward Eagle	Harbor and Puget	Sound	
X Horizontal hydraulic gradient (feet/foot):					X Unknown
Vertical hydraulic gradient (feet/foot):					X Unknown

X K range (ft/day) — Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	15			____ Unknown
high	30			

Transmissivity (ft2/day): — Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Average K=26 ft/day. Vertical anisotropy = 4.7

Attachments:

Thermal Treatment - Design Facility ID#: 0900

X Thermal treatment:
- ____ Conductive ____
- ____ Electrical Resistance ____
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- X Steam ____
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ____

X Type of Test: X Pilot test ____ Full-scale System

X Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- X Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

X Treatment Targe Zone: ____ Saturated only ____ Vadose only X Both (Saturated and Vadose zones)

X Start of Thermal Test: ____ Duration: ____

X Hydraulic Control X Yes ____ No

X Treatment Cell Design:

Size of target zone (ft2):	20125	____ Unknown	(____ x ____ ft)
Thickness of target zone (ft):	19 to 29	____ Unknown	
Depth to top of target zone (ft bgs):	6	____ Unknown	
Thickness of target zone below water table (ft):	10 to 20	____ Unknown	
Number of energy delivery points:	16	____ Unknown	
Number of extraction points:	7	____ Unknown	

X Temperature Profile:

Initial formation temperature (deg C):	15	____ Unknown
Maximum representative formation temperature (deg C):	70	____ Unknown
Time to reach maximum representative temperature (days):	128	____ Unknown
Duration of treatment at representative temperature (days):	42	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

X Mass of contaminant removed:

Via liquid pumping:	~9300	____ lb	X kg	____ Unknown
In vapor stream:	____	____ lb	____ kg	____ Unknown
Total:	~11000+	____ lb	X kg	____ Unknown

Comments: ____

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0900

X Performance

Remediation Goal:

X In Groundwater:

Meet Puget Sound marine water quality and surface water quality.

X In Soil:

Puget Sound marine sediment standards at the mud line.

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

Objectives: 1) demonstrate that steam will remove almost all mobile NAPL; 2) show post treatment GW concentrations will not exceed Puget Sound marine water quality, surface water quality, and sediment standards at the mud line; 3) demo that surface soil (0-15') concentrations within pilot test area attain WA State Mode 1 Toxic Control Act (MTCA) Method B cleanup levels. Costs as of summer 2004. Notes: system injection and extraction rates were not achieved.

Lessons Learned

____

X Energy

Total Energy Used: ____ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

X Please note other energy: 9400 x 10E6 BTU ????

X Cost

Total Project Cost: 9,750,000

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

X Other Cost 1: 1,193,000

X Other Cost 2: 5,644,000

X Other Cost 3: 2,370,000

X Please note other cost:

X Other Cost 1: Steam operation and maintenance

X Other Cost 2: Installation and treatment systme upgrades

X Other Cost 3: Resign and planning and construction oversight

General Site Information Facility ID#: 0910

x File Analyzed By: JT x PD ____ Date: ________

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: Nov-00 End of Test: Mar-01 Duration: 4 months

Type of Site: x Non-DOD ____ DoD

x Facility Name: Delevan Municipal Well No. 4

Address: ________

City, State, Zip Code: Delevan, WI

OU# or Site #: ________

x Primary point of contact: Tom Wentland

Organization: WI Department of Natural Resources

Address: 115 Pilgram Road

City, State, Zip Code: Plymouth, WI 53073-4294

Phone #: 920-892-8756 x 3028 email: wentlt@dnr.state.wi.us

x Other contacts or vendors who worked on site ____ None

Point of contact: Jon Raymond

Type: x Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: Pentair Water

Address: ________

City, State, Zip Code: ________

Phone #: 262-728-7216 email: jon.raymond@pentairwater.com

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data Facility ID#: 0910

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	1,000 mg/L	None	1 mg/L	None
	x Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	x Total VOCs at 16 ft	____	____	None	10,000 mg/kg	None	0.5 mg/kg
	x Total VOCs at 20 ft	____	____	None	100 mg/kg	None	1 mg/kg
	x Total VOCs at 24 ft	____	____	None	100 mg/kg	None	1 mg/kg
	x Total VOCs at 26 ft	____	____	None	1,000 mg/kg	None	5 mg/kg
	x Total VOCs	____	____	0.5 mg/L	None	0.05 mg/L	None
	____	____	____	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model　　　　Facility ID#: 0910

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- x Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- x Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl　____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No　____ Yes (number): ____________　____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown
____ K range (ft/day)	Measured using:	____ Slug Test	____ Laboratory	____ Field data	
	low				____ Unknown
	high				
Transmissivity (ft2/day):	Measured using:	____ Slug Test	____ Laboratory	____ Field data	
	low				____ Unknown
	high				

Comments: ____________________

Attachments: ____________________

Thermal Treatment - Design | Facility ID#: 0910

x Thermal treatment: ____ Conductive ____

x Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

x Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only x Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ____ Duration: ____

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2): ____ ____ Unknown (40 x 40 ft)

Thickness of target zone (ft): 22 ____ Unknown

Depth to top of target zone (ft bgs): 6 ____ Unknown

Thickness of target zone below water table (ft): 0 ____ Unknown

Number of energy delivery points: 6 ____ Unknown

Number of extraction points: 4 ____ Unknown

x Temperature Profile:

Initial formation temperature (deg C): ____ ____ Unknown

Maximum representative formation temperature (deg C): 66 ____ Unknown

Time to reach maximum representative temperature (days): 7 ____ Unknown

Duration of treatment at representative temperature (days): 120 ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	912 (2.5 years)	____

____ Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	____	____ lb	____ kg	____ Unknown
Total:	____	____ lb	____ kg	____ Unknown

Comments:

1540 yd3 - treated

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0910

____ Performance

Remediation Goal:

____ In Groundwater: ____

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

x Cost

Total Project Cost: $42/yd3

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

x Other Cost 1: 50000

x Other Cost 2: 20000

____ Other Cost 3: ____

x Please note other cost:

x Other Cost 1: capital cost

x Other Cost 2: O&M cost

____ Other Cost 3: ____

General Site Information Facility ID#: 0915

x File Analyzed By: JT x PD ____ Date: 10/30/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test ___ Full Scale System

Start of Test: ____________ End of Test: ____________ Duration: 60 d

Type of Site: x Non-DOD ____ DoD

x Facility Name: Confidential; Racine, Wi

Address: ____________

City, State, Zip Code: Racine, WI

OU# or Site #: ____________

x Primary point of contact: Dacre Bush

Organization: McMillian-McGee

Address: ____________

City, State, Zip Code: ____________

Phone #: 805-295-9071 email: dacre.bush@mcmillian-mcgee.com

x Other contacts or vendors who worked on site ____ None

Point of contact: Mark M. Mejac

Type: x Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: STS Consulting

Address: 11425 West lake Park Drive

City, State, Zip Code: Milwaukee, WI 53224-3025

Phone #: 414-359-3030 email: mejac@stsconsultants.com

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data   Facility ID#: 0915

x Impacted Zone: Length (parallel to flow direction)(ft.): below   Width (ft): ______   Thickness (ft): 18 to 24   ___ Unknown

x Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ______   Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment   In: ______   Upgradient: ______   Downgradient: ______   Crossgradient: ______

Post-treatment   In: ______   Upgradient: ______   Downgradient: ______   Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ______

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: ______   Number outside treatment zone: ______

____ Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____ ______	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ x	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ______	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ______	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ______	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ______	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ______	None	None	None	None
	____ 1,1,2-trichloroethane	____ ______	____ ______	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ______	____ ______	None	None	None	None
	____ Vinyl Chloride	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None

Comments:

Impacted area - 10,500 ft2 to depth ranging between 18 and 24 ft (ie 7200 yd3 impacted)

Attachments: ______

Hydrogeologic Conceptual Model Facility ID#: 0915

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	0.5			
	high value (ft bgs):	5			
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design Facility ID#: 0915

x Thermal treatment:
- ____ Conductive ____________
- x Electrical Resistance ____________
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- ____ Steam ____________
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ____________

____ Type of Test: ____ Pilot test ____ Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ____________ Duration: ____________

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2):		____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):		____ Unknown	
Depth to top of target zone (ft bgs):		____ Unknown	
Thickness of target zone below water table (ft):		____ Unknown	
Number of energy delivery points:	31	____ Unknown	
Number of extraction points:	12	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):		____ Unknown
Maximum representative formation temperature (deg C):		____ Unknown
Time to reach maximum representative temperature (days):		____ Unknown
Duration of treatment at representative temperature (days):		____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

____ Mass of contaminant removed:

Via liquid pumping:		____ lb	____ kg	____ Unknown
In vapor stream:		____ lb	____ kg	____ Unknown
Total:		____ lb	____ kg	____ Unknown

Comments:

Spacing 23'

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0915

____ Performance

Remediation Goal:

____ In Groundwater: ______

____ In Soil: ______

Was the Remediation Goal Achieved:

____ In Groundwater ______

Comment: ______

____ In Soil ______

Comment: ______

General comments on the thermal application:

______

Lessons Learned

______

x Energy

Total Energy Used: 215 ____ kWhr ____ $kWhr/m^3$ x $kWhr/yd^3$

____ Total energy applied to treatment zone: ______ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ______ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy: ______

____ Cost

Total Project Cost: ______

____ Consultant Cost: ______

____ Thermal Vendor Cost: ______

____ Energy Cost: ______ ____ m^3 ____ yd^3

____ Other Cost 1: ______

____ Other Cost 2: ______

____ Other Cost 3: ______

____ Please note other cost: ____ Other Cost 1: ______

____ Other Cost 2: ______

____ Other Cost 3: ______

General Site Information　　　　Facility ID#: 0920

x File Analyzed By: JT x PD ____ 　Date: ________

Type of treatment: ____ Conductive ____ Steam ____ ERH x Other: RFH

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating x Other: JP-4

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: ________ End of Test: ________ Duration: ________

Type of Site: ____ Non-DOD x DoD

x Facility Name: Volk Airfield National Guard

Address: ________

City, State, Zip Code: Camp Douglas, WI

OU# or Site #: ________

x Primary point of contact: Steve Buston

Organization: National Guard

Address: ________

City, State, Zip Code: ________

Phone #: 608-427-1587 email: ________

____ Other contacts or vendors who worked on site ____ None

Point of contact: ________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: ________

Address: ________

City, State, Zip Code: ________

Phone #: ________ email: ________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data | Facility ID#: 0920

x Impacted Zone: Length (parallel to flow direction)(ft.): ____ Width (ft): ____ Thickness (ft): ____ x Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ____ Post-treatment: ____

Number of wells relative to treatment zone:

Pre-treatment In: ____ Upgradient: ____ Downgradient: ____ Crossgradient: ____

Post-treatment In: ____ Upgradient: ____ Downgradient: ____ Crossgradient: ____

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____

Number of relevant soil borings with post-treatment data: ____

Number inside treatment zone: ____ Number outside treatment zone: ____

x Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	x JP-4	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0920

x Geology: Zone Unconsolidated Sediments

Vadose Zone:
- x Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl x Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
x Horizontal hydraulic gradient (feet/foot):					x Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				x Unknown
high				

Comments: ______________________________

Attachments: ______________________________

Thermal Treatment - Design Facility ID#: 0920

x Thermal treatment: ____ Conductive ____________________

____ Electrical Resistance ____________________

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____________________

____ Steam ____ Steam + air ____ Steam + O2

x Other (describe) RFH

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone: x Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only x Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ____________ Duration: ____________

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2): 72 ____ Unknown (___ x ___ ft)

Thickness of target zone (ft): 7 ____ Unknown

Depth to top of target zone (ft bgs): 0 ____ Unknown

Thickness of target zone below water table (ft): ____________ x Unknown

Number of energy delivery points: ____________ x Unknown

Number of extraction points: ____________ x Unknown

x Temperature Profile:

Initial formation temperature (deg C): ____________ x Unknown

Maximum representative formation temperature (deg C): 150 ____ Unknown

Time to reach maximum representative temperature (days): 8 ____ Unknown

Duration of treatment at representative temperature (days): 4 ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

x Mass of contaminant removed:

Via liquid pumping: ____________ ____ lb ____ kg ____ Unknown

In vapor stream: ____________ ____ lb ____ kg ____ Unknown

Total: ____________ ____ lb ____ kg x Unknown

Comments: ____________________

Attachments: ____________________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0920

____ Performance

Remediation Goal:

____ In Groundwater: ____

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

x In Soil

Comment: Unknown but did see 99% reduction in volatile hydrocarbons, 94 to 99% reduction in semi-volatile hydrocarbons, and 83% reduction on average in hexadecane with a boiling point of 289C

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information　　　　Facility ID#: 0930

x File Analyzed By: JT x PD ____　　　　Date: 10/30/2006

Type of treatment: ____ Conductive ____ Steam ____ ERH x Other: RFH

Type of Contaminant: ____ Chlorinated Solvents X Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: ____________ End of Test: ____________ Duration: ______

Type of Site: x Non-DOD ____ DoD

x Facility Name: Mobil Oil

Address: ____________________

City, State, Zip Code: TX

OU# or Site #: ____________________

x Primary point of contact: Ray Kasevich

Organization: KSN Energies

Address: 291 Main St., 3rd Floor, PO Box 612

City, State, Zip Code: Great Barrington, MA 01230

Phone #: 413-528-4651　　email: rkasevich@ksnenergies.com

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ______

Organization: ____________________

Address: ____________________

City, State, Zip Code: ____________________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data Facility ID#: 0930

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ________

Number of relevant soil borings with post-treatment data: ________

Number inside treatment zone: ________ Number outside treatment zone: ________

x Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____ ________	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ________	None	None	None	None
	____ cis-1,2-dichloroethene	x Benzene	____ ________	None	None	None	None
	____ trans-1,2-dichloroethene	x Tolune	____ ________	None	None	None	None
	____ 1,1-dichloroethane	x Ethylbenzene	____ ________	None	None	None	None
	____ 1,2-dichloroethane	x m/p-xylene	____ ________	None	None	None	None
	____ 1,1,1-trichloroethane	x o-xylene	____ ________	None	None	None	None
	____ 1,1,2-trichloroethane	____ ________	____ ________	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ________	____ ________	None	None	None	None
	____ Vinyl Chloride	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 0930

____ Geology: Zone Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	____________	____________	____________	
	high value (ft bgs):	____________	____________	____________	
	Unknown:	____________	____________	____________	
____ Flow direction		____________	____________	____________	
____ Horizontal hydraulic gradient (feet/foot):		____________	____________	____________	____ Unknown
Vertical hydraulic gradient (feet/foot):		____________	____________	____________	____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	____________	____________	____________	____ Unknown
high	____________	____________	____________	

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	____________	____________	____________	____ Unknown
high	____________	____________	____________	

Comments: ____

Attachments: ____

Thermal Treatment - Design   Facility ID#: 0930

x Thermal treatment: ____ Conductive ____________
____ Electrical Resistance ____________
____ 3 phase ____ 6 phase ____ AC power ____ DC power
____ Steam ____________
____ Steam ____ Steam + air ____ Steam + O2
x Other (describe) RFH

x Type of Test: ____ Pilot test x Full-scale System

____ Geology of Treatment Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ____________ Duration: ____________

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2):	____________	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	____________	____ Unknown	
Depth to top of target zone (ft bgs):	____________	____ Unknown	
Thickness of target zone below water table (ft):	____________	____ Unknown	
Number of energy delivery points:	____________	____ Unknown	
Number of extraction points:	____________	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	____________	____ Unknown
Maximum representative formation temperature (deg C):	____________	____ Unknown
Time to reach maximum representative temperature (days):	____________	____ Unknown
Duration of treatment at representative temperature (days):	____________	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____________	____________
Formation temperature post-treatment monitoring event 1:	____________	____________
Duration of post-treatment monitoring (days):	____________	____________

____ Mass of contaminant removed:

Via liquid pumping:	____________	____ lb	____ kg	____ Unknown
In vapor stream:	____________	____ lb	____ kg	____ Unknown
Total:	____________	____ lb	____ kg	____ Unknown

Comments: ____________

Attachments: ____________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0930

____ Performance

Remediation Goal:

____ In Groundwater:

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information Facility ID#: 0940

x File Analyzed By: JT x PD ____ Date: 10/18/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test ___ Full Scale System

Start of Test: 1-Nov End of Test: 1-Jun Duration: 9 months

Type of Site: x Non-DOD ____ DoD

x Facility Name: Baker Petrolite

Address: ____________

City, State, Zip Code: Calgary, Alberta, Canada

OU# or Site #: ____________

x Primary point of contact: Lacy Rosson

Organization: Baker Petrolite

Address: ____________

City, State, Zip Code: ____________

Phone #: 281-276-5400 email: lacy.rosson@bakerpetrolite.com

x Other contacts or vendors who worked on site ____ None

Point of contact: Katherine Lundy

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: Kaizen Environmental Services

Address: ____________

City, State, Zip Code: ____________

Phone #: 403-297-0216 (1-888-525-5902) email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data | Facility ID#: 0940

____ Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ______

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: ______ Number outside treatment zone: ______

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
				Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____ ______	None	None	None	None
	____ 1,1-dichloroethene	x Napthalene	____ ______	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ______	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ______	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ______	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ______	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ______	None	None	None	None
	____ 1,1,2-trichloroethane	x xylenes	____ ______	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ______	____ ______	None	None	None	None
	____ Vinyl Chloride	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None

Comments: ______

Attachments: ______

Hydrogeologic Conceptual Model Facility ID#: 0940

x Geology: Zone Unconsolidated Sediments

Vadose Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
x Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

Saturated Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
x Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

x Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl x Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	13			
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

	low	0.028			____ Unknown
	high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

	low				____ Unknown
	high				

Comments:

K = 10E-6 cm/s

Attachments:

Thermal Treatment - Design — Facility ID#: 0940

x Thermal treatment:
- ____ Conductive ____
- x Electrical Resistance ____
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- ____ Steam ____
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ____

____ Type of Test: ____ Pilot test ____ Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- x Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 1-Nov — Duration: 9 months

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	6458	____ Unknown (____ x ____ ft)
Thickness of target zone (ft):	____	____ Unknown
Depth to top of target zone (ft bgs):	____	____ Unknown
Thickness of target zone below water table (ft):	____	____ Unknown
Number of energy delivery points:	18	____ Unknown
Number of extraction points:	10	____ Unknown

____ Temperature Profile:

Initial formation temperature (deg C):	____	____ Unknown
Maximum representative formation temperature (deg C):	____	____ Unknown
Time to reach maximum representative temperature (days):	____	____ Unknown
Duration of treatment at representative temperature (days):	____	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	____	____ lb	____ kg	____ Unknown
Total:	204000	x lb	____ kg	____ Unknown

Comments: ____

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 0940

x Performance

Remediation Goal:

x In Groundwater:

source reduction target >95% total recovery

____ In Soil:

Was the Remediation Goal Achieved:

x In Groundwater

Comment:

>99.99% source reduction, all MCLs met

____ In Soil

Comment:

General comments on the thermal application:

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information Facility ID#: 1000

x File Analyzed By: JT x PD ____ Date: 10/26/2006

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating x Other: PCBs

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: ____________ End of Test: ____________ Duration: ________

Type of Site: x Non-DOD ____ DoD

x Facility Name: Safety Kleen

Address: ____________

City, State, Zip Code: Breslau, Ontario, Canada

OU# or Site #: ____________

x Primary point of contact: Lynn Longshore

Organization: Safety Kleen Environmental Health and Safety

Address: ____________

City, State, Zip Code: ____________

Phone #: 18006695740 email: ____________

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data   Facility ID#: 1000

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______
Post-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

____ Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____ ________	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ________	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ________	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ________	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ________	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ________	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ________	None	None	None	None
	____ 1,1,2-trichloroethane	____ ________	____ ________	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ________	____ ________	None	None	None	None
	____ Vinyl Chloride	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None

Comments: ____

Attachments: ____

Hydrogeologic Conceptual Model Facility ID#: 1000

____ Geology: Zone: Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	________	________	________	
	high value (ft bgs):	________	________	________	
	Unknown:	________	________	________	
____ Flow direction		________	________	________	
____ Horizontal hydraulic gradient (feet/foot):		________	________	________	____ Unknown
Vertical hydraulic gradient (feet/foot):		________	________	________	____ Unknown
____ K range (ft/day)	Measured using:	____ Slug Test	____ Laboratory	____ Field data	
	low	________	________	________	____ Unknown
	high	________	________	________	
Transmissivity (ft2/day):	Measured using:	____ Slug Test	____ Laboratory	____ Field data	
	low	________	________	________	____ Unknown
	high	________	________	________	

Comments: ____________________

Attachments: ____________________

Thermal Treatment - Design   Facility ID#: 1000

x Thermal treatment:

- ____ Conductive ______________________________
- ____ Electrical Resistance ______________________________
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- x Steam ______________________________
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ______________________________

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:

- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ______________ Duration: ______________

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	1250	____ Unknown (___ x ___ ft)
Thickness of target zone (ft):	________	____ Unknown
Depth to top of target zone (ft bgs):	________	____ Unknown
Thickness of target zone below water table (ft):	________	____ Unknown
Number of energy delivery points:	4	____ Unknown
Number of extraction points:	6	____ Unknown

____ Temperature Profile:

Initial formation temperature (deg C):	________	____ Unknown
Maximum representative formation temperature (deg C):	________	____ Unknown
Time to reach maximum representative temperature (days):	________	____ Unknown
Duration of treatment at representative temperature (days):	________	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	________	________
Formation temperature post-treatment monitoring event 1:	________	________
Duration of post-treatment monitoring (days):	________	________

____ Mass of contaminant removed:

Via liquid pumping:	________	____ lb	____ kg	____ Unknown
In vapor stream:	________	____ lb	____ kg	____ Unknown
Total:	________	____ lb	____ kg	____ Unknown

Comments: ______________________________

Attachments: ______________________________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance   Facility ID#: 1000

____ Performance

Remediation Goal:

____ In Groundwater:

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Lessons Learned

____ Energy

Total Energy Used: ____________ ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____________ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____________ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy: ____________

____ Cost

Total Project Cost: ____________

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

____ Energy Cost: ____________ ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

General Site Information — Facility ID#: 1010

X File Analyzed By: JT X PD ____ — Date: 11/6/2006

Type of treatment: ____ Conductive X Steam ____ ERH ____ Other: ____________

Type of Contaminant: X Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active X Post

Type of Test: X Pilot Test ___ Full Scale System

Start of Test: Aug-99 — End of Test: 1-Sep — Duration: ~2 years

Type of Site: X Non-DOD ____ DoD

X Facility Name: Muehlacher Germany

Address: ____________

City, State, Zip Code: Muehlacher Germany

OU# or Site #: ____________

X Primary point of contact: Dr. Hans-Peter Koschitsky

Organization: University of Stuttgart

Address: Pfaffenwaldring 61 D-70569

City, State, Zip Code: Stuttgart, Germany

Phone #: ____________ email: kasch@iws.uni-stuttgart.de

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data | Facility ID#: 1010

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______
Post-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

X Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	X Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	X Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	X Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	X m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	X o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 1010

X Geology: Zone Unconsolidated Sediments

Vadose Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
X Weathered bedrock, limestone, sandstone

Saturated Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
X Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design

Facility ID#: 1010

X Thermal treatment:
____ Conductive ____
____ Electrical Resistance ____
____ 3 phase ____ 6 phase ____ AC power ____ DC power
X Steam ____
____ Steam ____ Steam + air ____ Steam + O2
____ Other (describe) ____

X Type of Test: X Pilot test ____ Full-scale System

X Geology of Treatment Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
X Weathered bedrock, limestone, sandstone

X Treatment Targe Zone: ____ Saturated only X Vadose only ____ Both (Saturated and Vadose zones)

X Start of Thermal Test: Aug-99 Duration: ~2 years

X Hydraulic Control X Yes ____ No

X Treatment Cell Design:

Size of target zone (ft2):	4036	____ Unknown	(66 x 66 ft)
Thickness of target zone (ft):	26.2	____ Unknown	
Depth to top of target zone (ft bgs):	23	____ Unknown	
Thickness of target zone below water table (ft):	0	____ Unknown	
Number of energy delivery points:	1	____ Unknown	
Number of extraction points:	6	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	____	____ Unknown
Maximum representative formation temperature (deg C):	____	____ Unknown
Time to reach maximum representative temperature (days):	____	____ Unknown
Duration of treatment at representative temperature (days):	____	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

X Mass of contaminant removed:

Via liquid pumping:	140	____ lb	X kg	____ Unknown
In vapor stream:	2660	____ lb	X kg	____ Unknown
Total:	2800	____ lb	X kg	____ Unknown

Comments:

Treated approximately 3000 m3 (3924 yd3)

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 1010

____ Performance

Remediation Goal:

____ In Groundwater: ______________________

____ In Soil: ______________________

Was the Remediation Goal Achieved:

____ In Groundwater ______________________

Comment: ______________________

____ In Soil ______________________

Comment: ______________________

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____________ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ______________________

X Cost

Total Project Cost: 950,900

____ Consultant Cost: ____________

____ Thermal Vendor Cost: 290.81 / yd3

____ Energy Cost: ____________ ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ______________________

____ Other Cost 2: ______________________

____ Other Cost 3: ______________________

General Site Information — Facility ID#: 1030

X File Analyzed By: JT X PD ____ — Date: 10/18/2006

Type of treatment: ____ Conductive ____ Steam X ERH ____ Other: ________

Type of Contaminant: ____ Chlorinated Solvents X Petroleum Hydrocarbons ____ Pesticides ____ Wood Treating ____ Other: ________

Treatment Status: ____ Active X Post

Type of Test: ____ Pilot Test X Full Scale System

Start of Test: 9/26/2001 — End of Test: 4/30/2002 — Duration: 217 d

Type of Site: X Non-DOD ____ DoD

X Facility Name: North Hill Manor

Address: ________

City, State, Zip Code: Calgary, Alberta, Canada

OU# or Site #: ________

X Primary point of contact: Randall Warren

Organization: Shell Canada

Address: ________

City, State, Zip Code: ________

Phone #: 403-691-2954 — email: ________

X Other contacts or vendors who worked on site ____ None

Point of contact: Gary Millard

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: Shell Canada

Address: ________

City, State, Zip Code: ________

Phone #: 403-216-5558 — email: gary.millard@shell.com

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 1030

X Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): 13.5 ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

X Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 5 Post-treatment: 15

Number of wells relative to treatment zone:

Pre-treatment In: 5 Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: 15 Upgradient: ______ Downgradient: ______ Crossgradient: ______

X Soil Borings: Number of relevant soil borings with pre-treatment data: 22

Number of relevant soil borings with post-treatment data: 7

Number inside treatment zone: ________ Number outside treatment zone: ________

X Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____ ______	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ______	None	None	None	None
	____ cis-1,2-dichloroethene	X Benzene	____ ______	0.1 mg/L	1 mg/kg	0.001 mg/L	0.01 mg/kg
	____ trans-1,2-dichloroethene	X Tolune	____ ______	0.01 mg/L	0.5 mg/kg	0.001 mg/L	0.1 mg/kg
	____ 1,1-dichloroethane	X Ethylbenzene	____ ______	0.05 mg/L	5 mg/kg	0.001 mg/L	0.1 mg/kg
	____ 1,2-dichloroethane	X m/p-xylene	____ ______	None	None	None	None
	____ 1,1,1-trichloroethane	X o-xylene	____ ______	None	None	None	None
	____ 1,1,2-trichloroethane	X xylenes	____ ______	0.1 mg/L	5 mg/kg	0.001 mg/L	0.1 mg/kg
	____ 1,1,2,2-tetrachloroethane	X TPH	____ ______	1 mg/L	500 mg/kg	0.1 mg/L	10 mg/kg
	____ Vinyl Chloride	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model — Facility ID#: 1030

X Geology:

Zone	Unconsolidated Sediments	
Vadose Zone:	____	Relatively homogeneous and permeable unconsolidated sediments
	X	Relatively homogeneous and impermeable unconsolidated sediments
	____	Largely permeable sediments with inter-bedded lenses of lower permeability material
	____	Largely impermeable sediments with inter-bedded layers of higher permeability material
	____	Competent, but fractured bedrock (i.e. crystalline rock)
	____	Weathered bedrock, limestone, sandstone
Saturated Zone:	____	Relatively homogeneous and permeable unconsolidated sediments
	X	Relatively homogeneous and impermeable unconsolidated sediments
	____	Largely permeable sediments with inter-bedded lenses of lower permeability material
	____	Largely impermeable sediments with inter-bedded layers of higher permeability material
	____	Competent, but fractured bedrock (i.e. crystalline rock)
	____	Weathered bedrock, limestone, sandstone

X Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl X Unknown

X Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ X Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	14.1			
	high value (ft bgs):	16.7			
	Unknown:				
X Flow direction		West			
X Horizontal hydraulic gradient (feet/foot):					X Unknown
Vertical hydraulic gradient (feet/foot):					X Unknown

X K range (ft/day) — Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				X Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments: k=10e-6 cm/s

Thermal Treatment - Design   Facility ID#: 1030

X Thermal treatment: ____ Conductive ______
X Electrical Resistance ______
____ 3 phase ____ 6 phase ____ AC power ____ DC power
____ Steam ______
____ Steam ____ Steam + air ____ Steam + O2
____ Other (describe) ______

X Type of Test: ____ Pilot test X Full-scale System

X Geology of Treatment Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
X Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

X Treatment Targe Zone: ____ Saturated only ____ Vadose only X Both (Saturated and Vadose zones)

X Start of Thermal Test: 9/26/2001 Duration: 217 d

X Hydraulic Control X Yes ____ No

X Treatment Cell Design:

Size of target zone (ft2):	4000	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	13	____ Unknown	
Depth to top of target zone (ft bgs):	8	____ Unknown	
Thickness of target zone below water table (ft):	5	____ Unknown	
Number of energy delivery points:	10	____ Unknown	
Number of extraction points:	35	____ Unknown	

X Temperature Profile:

Initial formation temperature (deg C):	______	____ Unknown
Maximum representative formation temperature (deg C):	78	____ Unknown
Time to reach maximum representative temperature (days):	______	____ Unknown
Duration of treatment at representative temperature (days):	______	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	______	______
Formation temperature post-treatment monitoring event 1:	______	______
Duration of post-treatment monitoring (days):	______	______

X Mass of contaminant removed:

Via liquid pumping:	______	____ lb	____ kg	____ Unknown
In vapor stream:	1740 Liters	____ lb	____ kg	____ Unknown
Total:	______	____ lb	____ kg	____ Unknown

Comments:

15 vapor extraction wells and 20 groundwater extraction wells

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance   Facility ID#: 1030

X Performance

Remediation Goal:

X In Groundwater: Alberta, Canada Tier 1 - <5 ppb benzene.
Benzene-0.4mg/L, toluene-25mg/L, ethylbenzene-50mg/L, xylenes-80mg/L

XX In Soil:
Benzene-0.2mg/Kg, toluene-40mg/Kg, ehtylbenzene-300mg/Kg, xylene-110mg/Kg, TPH-2000mg/Kg

Was the Remediation Goal Achieved:

X In Groundwater

Comment:

Yes

X In Soil

Comment:

Yes

General comments on the thermal application:

Lessons Learned

____ Energy

Total Energy Used: ________ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ________

____ Cost

Total Project Cost: ________

____ Consultant Cost: ________

____ Thermal Vendor Cost: ________

____ Energy Cost: ________ ____ m^3 ____ yd^3

____ Other Cost 1: ________

____ Other Cost 2: ________

____ Other Cost 3: ________

____ Please note other cost: ____ Other Cost 1: ________

____ Other Cost 2: ________

____ Other Cost 3: ________

General Site Information Facility ID#: 1040

X File Analyzed By: JT X PD ____ Date: 10/18/2006

Type of treatment: ____ Conductive ____ Steam X ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents X Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active X Post

Type of Test: ____ Pilot Test ___ Full Scale System

Start of Test: 8/14/2003 End of Test: 3/xx/04 Duration: ________

Type of Site: X Non-DOD ____ DoD

X Facility Name: Rosslyn Turbo

Address: ____________

City, State, Zip Code: Edmonton, Canada

OU# or Site #: ____________

X Primary point of contact: Randall Warren

Organization: Shell Canada Products, Ltd.

Address: ____________

City, State, Zip Code: ____________

Phone #: 403-691-2954 email: ____________

X Other contacts or vendors who worked on site ____ None

Point of contact: Gary Millard

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: Shell Canada Products, Ltd.

Address: ____________

City, State, Zip Code: ____________

Phone #: 403-216-5558 403-560-4340 email: gary.millard@shell.com

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data — Facility ID#: 1040

X Impacted Zone: Length (parallel to flow direction)(ft.): see below — Width (ft): ____ — Thickness (ft): ____ — ___ Unknown

X Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ____ Post-treatment: ____

Number of wells relative to treatment zone:

	In:	Upgradient:	Downgradient:	Crossgradient:
Pre-treatment				
Post-treatment				

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____

Number of relevant soil borings with post-treatment data: ____

Number inside treatment zone: ____ Number outside treatment zone: ____

X Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel		None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene		None	None	None	None
	____ cis-1,2-dichloroethene	X Benzene		None	None	None	None
	____ trans-1,2-dichloroethene	X Tolune		None	None	None	None
	____ 1,1-dichloroethane	X Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	X m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	X o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane			None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	____ Vinyl Chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

Impacted area of 1500 m3

Attachments:

Hydrogeologic Conceptual Model   Facility ID#: 1040

X Geology:

Zone	Unconsolidated Sediments
Vadose Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	X Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone
Saturated Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	X Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl   ____ Unknown

X Aquifer Characteristics:

Is more than 1 aquifer present? ____ No   ____ Yes (number): ____________   X Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	13			
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day)   Measured using: ____ Slug Test   ____ Laboratory   ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day):   Measured using: ____ Slug Test   ____ Laboratory   ____ Field data

low				____ Unknown
high				

Comments:

K=10E-6 cm/s

Attachments:

Thermal Treatment - Design Facility ID#: 1040

X Thermal treatment: ____ Conductive ______

X Electrical Resistance ______

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ______

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ______

____ Type of Test: ____ Pilot test ____ Full-scale System

X Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

X Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

X Treatment Targe Zone: ____ Saturated only ____ Vadose only X Both (Saturated and Vadose zones)

____ Start of Thermal Test: ______ Duration: ______

____ Hydraulic Control ____ Yes ____ No

X Treatment Cell Design:

Size of target zone (ft2):	3000	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	18	____ Unknown	
Depth to top of target zone (ft bgs):	0	____ Unknown	
Thickness of target zone below water table (ft):	5	____ Unknown	
Number of energy delivery points:	10	____ Unknown	
Number of extraction points:	5	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	______	____ Unknown
Maximum representative formation temperature (deg C):	______	____ Unknown
Time to reach maximum representative temperature (days):	______	____ Unknown
Duration of treatment at representative temperature (days):	______	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	______	______
Formation temperature post-treatment monitoring event 1:	______	______
Duration of post-treatment monitoring (days):	______	______

____ Mass of contaminant removed:

Via liquid pumping:	______	____ lb	____ kg	____ Unknown
In vapor stream:	______	____ lb	____ kg	____ Unknown
Total:	______	____ lb	____ kg	____ Unknown

Comments: ______

Attachments: ______

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance   Facility ID#: 1040

X Performance

Remediation Goal:

X In Groundwater:

Alberta, Canada Tier 1 remediation - <5 ppb benzene

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____ ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information　　　　Facility ID#: 1050

x File Analyzed By: JT x PD ____　　Date: 10/30/2006

Type of treatment: ____ Conductive ____ Steam ____ ERH x Other: RFH

Type of Contaminant: ____ Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: 1990 End of Test: ____________ Duration: ______

Type of Site: ____ Non-DOD x DoD

x Facility Name: East Coast Naval Shipyard

Address: ______________________________

City, State, Zip Code: ______________________________

OU# or Site #: ______________________________

____ Primary point of contact: ______________________________

Organization: ______________________________

Address: ______________________________

City, State, Zip Code: ______________________________

Phone #: ________________ email: ______________________

____ Other contacts or vendors who worked on site ____ None

Point of contact: ______________________________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ______

Organization: ______________________________

Address: ______________________________

City, State, Zip Code: ______________________________

Phone #: ________________ email: ______________________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 1050

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

____ Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____ ________	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ________	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ________	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ________	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ________	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ________	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ________	None	None	None	None
	____ 1,1,2-trichloroethane	____ ________	____ ________	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ________	____ ________	None	None	None	None
	____ Vinyl Chloride	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 1050

____ Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

	low				____ Unknown
	high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

	low				____ Unknown
	high				

Comments:

Attachments:

Thermal Treatment - Design Facility ID#: 1050

x Thermal treatment:
- ____ Conductive ________
- ____ Electrical Resistance ________
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- ____ Steam ________
  - ____ Steam ____ Steam + air ____ Steam + O2
- x Other (describe) RFH

x Type of Test: x Pilot test ____ Full-scale System

____ Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ________ Duration: ________

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2):	________	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	________	____ Unknown	
Depth to top of target zone (ft bgs):	________	____ Unknown	
Thickness of target zone below water table (ft):	________	____ Unknown	
Number of energy delivery points:	________	____ Unknown	
Number of extraction points:	________	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	________	____ Unknown
Maximum representative formation temperature (deg C):	________	____ Unknown
Time to reach maximum representative temperature (days):	________	____ Unknown
Duration of treatment at representative temperature (days):	________	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	________	________
Formation temperature post-treatment monitoring event 1:	________	________
Duration of post-treatment monitoring (days):	________	________

____ Mass of contaminant removed:

Via liquid pumping:	________	____ lb	____ kg	____ Unknown
In vapor stream:	________	____ lb	____ kg	____ Unknown
Total:	________	____ lb	____ kg	____ Unknown

Comments: ________

Attachments: ________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 1050

____ Performance

Remediation Goal:

____ In Groundwater: ____________________

____ In Soil: ____________________

Was the Remediation Goal Achieved:

____ In Groundwater ____________________

Comment: ____________________

____ In Soil ____________________

Comment: ____________________

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____________ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____________________

____ Cost

Total Project Cost: ____________

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

____ Energy Cost: ____________ ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ____________________

____ Other Cost 2: ____________________

____ Other Cost 3: ____________________

General Site Information | Facility ID#: 1060

x File Analyzed By: JT x PD ____ | Date: 11/16/2006

Type of treatment: x Conductive ____ Steam ____ ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: 12/5/2005 End of Test: 1/10/2006 Duration: 36 d

Type of Site: x Non-DOD ____ DoD

x Facility Name: UK Atomic Energy Authority's Harwell Site

Address: ____________

City, State, Zip Code: Oxfordshire, England

OU# or Site #: Western storage area

x Primary point of contact: Steve Langford

Organization: AIG Engineering Group

Address: 9 Kingsdale Business Centre Regina Road Chelmsford Essex CM1 1PE

City, State, Zip Code: ____________

Phone #: 01245 505 601 email: steve.langford@aig.com

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data Facility ID#: 1060

x Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ x Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 1 Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: 1 Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 1

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: 1 Number outside treatment zone: ______

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	0.1 mg/L	None	None	None
	x Tetrachloroethene	____ Jet Fuel	____	0.01 mg/L	None	None	None
	x 1,1-dichloroethene	____ Napthalene	____	0.005 mg/L	None	None	None
	x cis-1,2-dichloroethene	____ Benzene	____	0.05 mg/L	None	None	None
	____ trans-1,2-dichloroethene	x Tolune	____	0.1 mg/L	None	None	None
	x 1,1-dichloroethane	____ Ethylbenzene	____	0.01 mg/L	None	None	None
	x 1,2-dichloroethane	____ m/p-xylene	____	0.05 mg/L	None	None	None
	x 1,1,1-trichloroethane	____ o-xylene	____	0.1 mg/L	None	None	None
	____ 1,1,2-trichloroethane	x Benzene	____	0.01 mg/L	None	None	None
	x 1,1,2,2-tetrachloroethane	____	____	0.05 mg/L	None	None	None
	____ Vinyl Chloride	x m/p-xylene	____	0.05 mg/L	None	None	None
	____	x Ethylbenzene	____	0.1 mg/L	None	None	None
	x chloroform	____	____	0.5 mg/L	None	None	None
	x dichloromethane	____	____	0.1 mg/L	None	None	None
	____	x o-xylene	____	0.01 mg/L	None	None	None
	____	x 12-dichlorobenzene	____	0.05 mg/L	None	None	None
	____	____ Napthalene	____	0.005 mg/L	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 1060

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- x Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- x Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	16.4			
	high value (ft bgs):	75.5			
	Unknown:				
x Flow direction		below			
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

x K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

	low				____ Unknown
	high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

	low	6458			____ Unknown
	high				

Comments:

Flow direction for high groundwater levels - N to NE for low groundwater levels - E to SE

Attachments:

Thermal Treatment - Design   Facility ID#: 1060

x Thermal treatment: x Conductive ____
____ Electrical Resistance ____
____ 3 phase ____ 6 phase ____ AC power ____ DC power
____ Steam ____
____ Steam ____ Steam + air ____ Steam + O2
____ Other (describe) ____

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
x Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only x Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 12/5/2005 Duration: 36d

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	30	____ Unknown	(____ x ____ ft)
Thickness of target zone (ft):	46	____ Unknown	
Depth to top of target zone (ft bgs):	16	____ Unknown	
Thickness of target zone below water table (ft):	0	____ Unknown	
Number of energy delivery points:	3	____ Unknown	
Number of extraction points:	1	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	____	____ Unknown
Maximum representative formation temperature (deg C):	90	____ Unknown
Time to reach maximum representative temperature (days):	60	____ Unknown
Duration of treatment at representative temperature (days):	1	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	____	____ lb	____ kg	____ Unknown
Total:	214	____ lb	x kg	____ Unknown

Comments:

Total volume treated - 35.2 cubic meters (46 yd3, 1243 ft3)
2.5 m spacing of heater wells (16 ft)

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 1060

____ Performance

Remediation Goal:

____ In Groundwater: ______________________________

____ In Soil: ______________________________

Was the Remediation Goal Achieved:

____ In Groundwater ______________________________

Comment: ______________________________

____ In Soil ______________________________

Comment: ______________________________

General comments on the thermal application:

Objective: reduce mass of VOCs in unsaturated zone in the source area to the extent economically feasible resulting in a diminshing flux of mass to groundwater over time.

Lessons Learned

____

____ Energy

Total Energy Used: ____________ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ______________________________

____ Cost

Total Project Cost: ____________

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

____ Energy Cost: ____________ ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ______________________________

____ Other Cost 2: ______________________________

____ Other Cost 3: ______________________________

General Site Information | | Facility ID#: 1070

x File Analyzed By: JT x PD ____ Date: 10/26/2006

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: Jan-01 End of Test: ________ Duration: 3 monts

Type of Site: x Non-DOD ____ DoD

x Facility Name: Prague, Czech

Address: ________

City, State, Zip Code: Czech Republic

OU# or Site #: ________

x Primary point of contact: Pavel Dusilek

Organization: AQUATEST

Address: ________

City, State, Zip Code: ________

Phone #: 420 234 607 151 email: dusilek@aquatest.cz

x Other contacts or vendors who worked on site ____ None

Point of contact: Petr Kvapil

Type: x Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: AQUATEST

Address: ________

City, State, Zip Code: ________

Phone #: 420 485 152 652 email: kvapil@aquatest.cz

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 1070

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______
Post-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	x Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	x Vinyl Chloride	____	____	None	None	None	None
	x DCE	____	____	None	None	None	None
	____	____	____	None	None	None	None
	x Total CHCs	____	____	100 mg/L	None	0.01 mg/L	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 1070

x Geology: Zone Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- x Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- x Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No x Yes (number): 4 ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	16.4	9.84	____	
	high value (ft bgs):	23	16.4	____	
	Unknown:	____	____	____	
____ Flow direction		____	____	____	
____ Horizontal hydraulic gradient (feet/foot):		____	____	____	____ Unknown
Vertical hydraulic gradient (feet/foot):		____	____	____	____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	____	____	____	____ Unknown
high	____	____	____	

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	____	____	____	____ Unknown
high	____	____	____	

Comments:

2nd aquifer permeability - 10^-5 m/s Contamination in first 2 aquifers

Attachments:

Thermal Treatment - Design   Facility ID#: 1070

x Thermal treatment: ____ Conductive ____________
____ Electrical Resistance ____________
____ 3 phase ____ 6 phase ____ AC power ____ DC power
x Steam ____________
x Steam ____ Steam + air ____ Steam + O2
____ Other (describe) ____________

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
____ Largely impermeable sediments with inter-bedded layers of higher permeability material
x Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: Jan-01 Duration: 3 months

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	____	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	____	____ Unknown	
Depth to top of target zone (ft bgs):	____	____ Unknown	
Thickness of target zone below water table (ft):	1.5	____ Unknown	
Number of energy delivery points:	6	____ Unknown	
Number of extraction points:	16	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	____	____ Unknown
Maximum representative formation temperature (deg C):	____	____ Unknown
Time to reach maximum representative temperature (days):	____	____ Unknown
Duration of treatment at representative temperature (days):	____	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	____	____ lb	____ kg	____ Unknown
Total:	10000	x lb	____ kg	____ Unknown

Comments:

10 water and vapor extraction wells and 6 vapor extraction wells only
3 steam and 3 water injection wells

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance　　　　Facility ID#: 1070

x Performance

Remediation Goal:

x In Groundwater: 1) Facility area = total (CHCs) = 0.8 mg/L 2) Environment of facility area where domestic wells are located. Total (CHCs) = 0.2 mg/L

____ In Soil: ______________________

Was the Remediation Goal Achieved:

____ In Groundwater ______________________

Comment: ______________________

____ In Soil ______________________

Comment: ______________________

General comments on the thermal application:

Target temperature of - 89-100C

Lessons Learned

____

____ Energy

Total Energy Used: ____________ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ______________________

____ Cost

Total Project Cost: ____________

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

____ Energy Cost: ____________ ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ______________________

____ Other Cost 2: ______________________

____ Other Cost 3: ______________________

General Site Information Facility ID#: 1075

x File Analyzed By: JT x PD ____ Date: 10/30/2006

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test ___ Full Scale System

Start of Test: ____________ End of Test: ____________ Duration: 6 months

Type of Site: x Non-DOD ____ DoD

x Facility Name: Bruel &Kjaer A/S (Project No. 552)

Address: ____________

City, State, Zip Code: Denmark

OU# or Site #: ____________

x Primary point of contact: ____________

Organization: Danish Epa, Soil Contamination Division

Address: ____________

City, State, Zip Code: ____________

Phone #: +45 3266 0100 email: ____________

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data ____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information ____ Flux assessment

____ Groundwater elevations ____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data — Facility ID#: 1075

____ Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ______

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: ______ Number outside treatment zone: ______

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	x Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	x Sum TCE and PCE	____	____	None	50 mg/kg	None	0.5 mg/kg
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 1075

x Geology: Zone Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 1075

x Thermal treatment:
- ____ Conductive ____________
- ____ Electrical Resistance ____________
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- x Steam ____________
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ____________

____ Type of Test: ____ Pilot test ____ Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only x Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: ____________ Duration: 6 months

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	____________	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	____________	____ Unknown	
Depth to top of target zone (ft bgs):	50	____ Unknown	
Thickness of target zone below water table (ft):	____________	____ Unknown	
Number of energy delivery points:	____________	____ Unknown	
Number of extraction points:	____________	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	____________	____ Unknown
Maximum representative formation temperature (deg C):	____________	____ Unknown
Time to reach maximum representative temperature (days):	____________	____ Unknown
Duration of treatment at representative temperature (days):	____________	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____________	____________
Formation temperature post-treatment monitoring event 1:	____________	____________
Duration of post-treatment monitoring (days):	____________	____________

x Mass of contaminant removed:

Via liquid pumping:	____________	____ lb	____ kg	____ Unknown
In vapor stream:	____________	____ lb	____ kg	____ Unknown
Total:	3000 to 4000	x lb	____ kg	____ Unknown

Comments:

Treated 12,000m3 (15695 yd3)

Attachments: ____________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 1075

____ Performance

Remediation Goal:

____ In Groundwater: ____________________

____ In Soil: ____________________

Was the Remediation Goal Achieved:

____ In Groundwater ____________________

Comment: ____________________

____ In Soil ____________________

Comment: ____________________

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____________ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____________________

____ Cost

Total Project Cost: ____________

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

____ Energy Cost: ____________ ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ____________________

____ Other Cost 2: ____________________

____ Other Cost 3: ____________________

General Site Information   Facility ID#: 1080

x File Analyzed By: JT x PD ____   Date: 10/26/2006

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ____________

Type of Contaminant: X Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active ___ Post

Type of Test: ____ Pilot Test ___ Full Scale System

Start of Test: ____________ End of Test: 2003 Duration: 3.5 months

Type of Site: x Non-DOD ____ DoD

x Facility Name: Odense, Denmark

Address: ____________

City, State, Zip Code: Denmark

OU# or Site #: ____________

x Primary point of contact: Danish EPA website

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data | Facility ID#: 1080

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: __________ Number outside treatment zone: __________

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	10 mg/L	10 mg/kg	0.1 mg/L	1 mg/kg
	____ Tetrachloroethene	____ Jet Fuel		None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene		None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene		None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune		None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane			None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	____ Vinyl Chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 1080

____ Geology:

Zone	Unconsolidated Sediments
Vadose Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone
Saturated Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design Facility ID#: 1080

x Thermal treatment: ____ Conductive ____

____ Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

x Steam ____

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

____ Type of Test: ____ Pilot test ____ Full-scale System

____ Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ____ Duration: 3.5 months

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2):	____	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	____	____ Unknown	
Depth to top of target zone (ft bgs):	____	____ Unknown	
Thickness of target zone below water table (ft):	____	____ Unknown	
Number of energy delivery points:	140	____ Unknown	
Number of extraction points:	____	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	____	____ Unknown
Maximum representative formation temperature (deg C):	____	____ Unknown
Time to reach maximum representative temperature (days):	____	____ Unknown
Duration of treatment at representative temperature (days):	____	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	____	____ lb	____ kg	____ Unknown
Total:	3000	c lb	____ kg	____ Unknown

Comments: ____

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 1080

____ Performance

Remediation Goal:

____ In Groundwater: ____

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information — Facility ID#: 1090

x File Analyzed By: JT x PD ____ — Date: 10/26/2006

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ___ Full Scale System

Start of Test: 2003 — End of Test: 2003 — Duration: 3.5 months

Type of Site: x Non-DOD ____ DoD

x Facility Name: United Kingdom

Address: ____________

City, State, Zip Code: United Kingdom

OU# or Site #: ____________

x Primary point of contact: Helen Stevens

Organization: IMS Marketing Communications

Address: ____________

City, State, Zip Code: ____________

Phone #: 0117 929 3041 — email: helen.stevens@imsplc.com

x Other contacts or vendors who worked on site ____ None

Point of contact: Duncan Sanders

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: Churngold Remediation Ltd

Address: ____________

City, State, Zip Code: ____________

Phone #: 07881 815391 or 0117 916 0510 — email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data — Facility ID#: 1090

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

____ Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 1090

____ Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown
____ K range (ft/day)	Measured using:	____ Slug Test	____ Laboratory	____ Field data	
	low				____ Unknown
	high				
Transmissivity (ft2/day):	Measured using:	____ Slug Test	____ Laboratory	____ Field data	
	low				____ Unknown
	high				

Comments: ________

Attachments: ________

Thermal Treatment - Design — Facility ID#: 1090

x Thermal treatment:
- ____ Conductive ____________
- ____ Electrical Resistance ____________
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- x Steam ____________
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ____________

x Type of Test: x Pilot test ____ Full-scale System

____ Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ____________ Duration: ____________

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2):	____________	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	____________	____ Unknown	
Depth to top of target zone (ft bgs):	____________	____ Unknown	
Thickness of target zone below water table (ft):	____________	____ Unknown	
Number of energy delivery points:	____________	____ Unknown	
Number of extraction points:	____________	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	____________	____ Unknown
Maximum representative formation temperature (deg C):	____________	____ Unknown
Time to reach maximum representative temperature (days):	____________	____ Unknown
Duration of treatment at representative temperature (days):	____________	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____________	____________
Formation temperature post-treatment monitoring event 1:	____________	____________
Duration of post-treatment monitoring (days):	____________	____________

____ Mass of contaminant removed:

Via liquid pumping:	____________	____ lb	____ kg	____ Unknown
In vapor stream:	____________	____ lb	____ kg	____ Unknown
Total:	____________	____ lb	____ kg	____ Unknown

Comments: ____________

Attachments: ____________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 1090

____ Performance

Remediation Goal:

____ In Groundwater: ____

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____ ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy: ____

x Cost

Total Project Cost: 292950 (155000 GBP)

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information

Facility ID#: 1100

x File Analyzed By: JT x PD ____ Date: ________

Type of treatment: ____ Conductive x Steam ____ ERH ____ Other: ________

Type of Contaminant: ____ Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

x Wood Treating ____ Other: ________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ____ Full Scale System

Start of Test: 5/12/99 End of Test: 10/30/1999 Duration: 5.5 months

Type of Site: x Non-DOD ____ DoD

x Facility Name: Taiwan

Address: ________

City, State, Zip Code: Taiwan

OU# or Site #: ________

x Primary point of contact: Ken K. C. Tse

Organization: Institute of Environmental Engineering, National Taiwan University, Taipei

Address: 106 Taiwan

City, State, Zip Code: Republic of China

Phone #: 886-2-23963505 email: ktse@ms17.hinet.net

x Other contacts or vendors who worked on site ____ None

Point of contact: Jerry W. H. Wang

Type: x Vendor, Consultant ____ Vendor, Technical Applications ____ Other ________

Organization: Wang Engineering Inc

Address: 105 Sherry Dr.

City, State, Zip Code: West Chicago, IL 60185

Phone #: 630-953-9928 email: ________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data　　　　Facility ID#: 1100

____ Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 5 Post-treatment: 5

Number of wells relative to treatment zone:

Pre-treatment In: 2 Upgradient: ______ Downgradient: 2 Crossgradient: ______

Post-treatment In: 2 Upgradient: ______ Downgradient: 2 Crossgradient: ______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 2

Number of relevant soil borings with post-treatment data: 2

Number inside treatment zone: 2 Number outside treatment zone: ______

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	x PCP	10 mg/L	10 mg/kg	5 mg/L	5 mg/kg
	____ 1,1-dichloroethene	____ Napthalene		None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene		None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune		None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane			None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	____ Vinyl Chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 1100

x Geology: Zone — Unconsolidated Sediments

Vadose Zone:

- x Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:

- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? x No ____ Yes (number): ____ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	3			
	high value (ft bgs):				
	Unknown:				
x Flow direction		SE			
x Horizontal hydraulic gradient (feet/foot):		0.001 to 0.00033			____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

x K range (ft/day) Measured using: x Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low	0.0709			____ Unknown
high	0.1672			

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

	Aquifer 1	Aquifer 2	Aquifer 3	
low				x Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 1100

x Thermal treatment:
- ____ Conductive ____________________
- ____ Electrical Resistance ____________________
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- x Steam ____________________
  - x Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ____________________

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- x Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only x Both (Saturated and Vadose zones)

x Start of Thermal Test: 5/12/1999   Duration: 5.5 months

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	2401	____ Unknown	(49 x 49 ft)
Thickness of target zone (ft):	33	____ Unknown	
Depth to top of target zone (ft bgs):	0	____ Unknown	
Thickness of target zone below water table (ft):	30	____ Unknown	
Number of energy delivery points:	1	____ Unknown	
Number of extraction points:	________	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	________	____ Unknown
Maximum representative formation temperature (deg C):	100	____ Unknown
Time to reach maximum representative temperature (days):	30	____ Unknown
Duration of treatment at representative temperature (days):	135	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	________	________
Formation temperature post-treatment monitoring event 1:	________	________
Duration of post-treatment monitoring (days):	________	________

____ Mass of contaminant removed:

Via liquid pumping:	________	____ lb	____ kg	____ Unknown
In vapor stream:	________	____ lb	____ kg	____ Unknown
Total:	________	____ lb	____ kg	____ Unknown

Comments: ____________________

Attachments: ____________________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 1100

____ Performance

Remediation Goal:

____ In Groundwater: 1 Mg/L

____ In Soil: 1 Mg/kg

Was the Remediation Goal Achieved:

____ In Groundwater g p p g

Comment: S

____ In Soil pp q p

Comment: been done if groundwater had been pumped at the upper aquifer during the period of steam injection.

General comments on the thermal application:

Cost doesn't include technical consulation or design cost.

Lessons Learned

When treating SVOCs like PCP, soil vapor extraction system is not enough to remove all the steam stripped contaminants. Groundwater pumping is still crucial for the success of in-situ thermal treatment. Besides the locations of pumping wells, the extraction depth is also important.

____ Energy

Total Energy Used: ____ kWhr 100 kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy:

x Cost

Total Project Cost:

____ Consultant Cost:

x Thermal Vendor Cost: 17/m3

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information   Facility ID#: 1200

x File Analyzed By: JT x PD ____   Date: 10/18/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: Nov-02 End of Test: ____________ Duration: 60 d

Type of Site: x Non-DOD ____ DoD

x Facility Name: Residential Site in Holland

Address: ____________

City, State, Zip Code: Zwijndrecht, Netherlands

OU# or Site #: ____________

x Primary point of contact: Bill Heath

Organization: CES

Address: 419 Entiat St., Suite A

City, State, Zip Code: Kennewick, WA 99336

Phone #: 509-727-4276 email: bill@cesiweb.com

x Other contacts or vendors who worked on site ____ None

Point of contact: Ing. Marcel Kolle

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: TerraVista, BV

Address: ____________

City, State, Zip Code: Hoofdoorp, Netherlands

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data — Facility ID#: 1200

x Impacted Zone: Length (parallel to flow direction)(ft.): below Width (ft): ______ Thickness (ft): ______ ___ Unknown

x Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ______

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: ______ Number outside treatment zone: ______

x Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	x Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	x Tetrachloroethene	____ Jet Fuel	____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	x cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	x Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

2000 m3 impacted (2615 yd3)

Attachments: ______

Hydrogeologic Conceptual Model Facility ID#: 1200

____ Geology: Zone Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	5			
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design — Facility ID#: 1200

x Thermal treatment:
- ____ Conductive ______
- x Electrical Resistance ______
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- ____ Steam ______
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ______

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: Nov-02 Duration: 60 d

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	______	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	23	____ Unknown	
Depth to top of target zone (ft bgs):	0	____ Unknown	
Thickness of target zone below water table (ft):	______	____ Unknown	
Number of energy delivery points:	16	____ Unknown	
Number of extraction points:	______	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	______	____ Unknown
Maximum representative formation temperature (deg C):	______	____ Unknown
Time to reach maximum representative temperature (days):	______	____ Unknown
Duration of treatment at representative temperature (days):	______	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	______	______
Formation temperature post-treatment monitoring event 1:	______	______
Duration of post-treatment monitoring (days):	______	______

____ Mass of contaminant removed:

Via liquid pumping:	______	____ lb	____ kg	____ Unknown
In vapor stream:	______	____ lb	____ kg	____ Unknown
Total:	______	x lb	____ kg	____ Unknown

Comments:

19 ft spacing: Treated - 2.000m3

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 1200

x Performance

Remediation Goal:

x In Groundwater:

Meet Dutch "C" MCLs

x In Soil:

Meet Dutch "C" MCLs

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information　　　　Facility ID#: 1210

x File Analyzed By: JT x PD ____　　　　Date: 10/18/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____

Type of Contaminant: x Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating x Other: PAHs

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test x Full Scale System

Start of Test: Dec-03　End of Test: May-04　Duration: 28 weeks

Type of Site: x Non-DOD ____ DoD

x Facility Name: Former Tarmac Plant

Address: ____

City, State, Zip Code: Zoetermeer, Netherlands

OU# or Site #: ____

x Primary point of contact: Bill Heath

Organization: CES

Address: 419 Entiat St., Suite A

City, State, Zip Code: Kennewick, WA 99336

Phone #: 509-727-4276　email: bill@cesiweb.com

____ Other contacts or vendors who worked on site　____ None

Point of contact: ____

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____

Organization: ____

Address: ____

City, State, Zip Code: ____

Phone #: ____　email: ____

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data | Facility ID#: 1210

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

	In:	Upgradient:	Downgradient:	Crossgradient:
Pre-treatment	______	______	______	______
Post-treatment	______	______	______	______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	x PAHs	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	x Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	x Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	x Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	x m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	x o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	x Vinyl Chloride	____	____	None	None	None	None
	x dichloroethene	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Attachments:

____ Geology:

Zone	Unconsolidated Sediments
Vadose Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	x Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone
Saturated Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	x Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	2			
	high value (ft bgs):	3.6			
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments: ____________________

Attachments: ____________________

Thermal Treatment - Design   Facility ID#: 1210

x Thermal treatment:
- ____ Conductive ________
- x Electrical Resistance ________
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- ____ Steam ________
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ________

x Type of Test: ____ Pilot test x Full-scale System

x Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- x Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: Dec-03   Duration: 28 weeks

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	10868	____ Unknown	(207 x 53 ft)
Thickness of target zone (ft):	33	____ Unknown	
Depth to top of target zone (ft bgs):	1	____ Unknown	
Thickness of target zone below water table (ft):	32	____ Unknown	
Number of energy delivery points:	43	____ Unknown	
Number of extraction points:	________	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	________	____ Unknown
Maximum representative formation temperature (deg C):	________	____ Unknown
Time to reach maximum representative temperature (days):	________	____ Unknown
Duration of treatment at representative temperature (days):	________	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	________	________
Formation temperature post-treatment monitoring event 1:	________	________
Duration of post-treatment monitoring (days):	________	________

____ Mass of contaminant removed:

Via liquid pumping:	________	____ lb	____ kg	____ Unknown
In vapor stream:	________	____ lb	____ kg	____ Unknown
Total:	________	x lb	____ kg	____ Unknown

Comments:

28 weeks of operation with three phases of heating

Attachments:

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance   Facility ID#: 1210

x Performance

Remediation Goal:

x In Groundwater:

DCE = 10 ppb; VC = 2.5 ppb

____ In Soil:

Was the Remediation Goal Achieved:

x In Groundwater

Comment:

yes

____ In Soil

Comment:

General comments on the thermal application:

$38.87/ton

Lessons Learned

x Energy

Total Energy Used: 1200000 ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

x Total energy applied to treatment zone: 135 x kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information

Facility ID#: 1220

x File Analyzed By: JT x PD ____

Date: 10/26/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test ___ Full Scale System

Start of Test: ____________ End of Test: ____________ Duration: 60 d

Type of Site: x Non-DOD ____ DoD

x Facility Name: Confidential (Exxon)

Address: ____________

City, State, Zip Code: Regina, SK

OU# or Site #: ____________

x Primary point of contact: Dacre Bush

Organization: McMillian-McGee

Address: ____________

City, State, Zip Code: ____________

Phone #: 805-295-9071 email: dacre.bush@mcmillian-mcgee.com

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data   Facility ID#: 1220

____ Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ______

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: ______ Number outside treatment zone: ______

____ Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____ ______	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ______	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ______	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ______	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ______	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ______	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ______	None	None	None	None
	____ 1,1,2-trichloroethane	____ ______	____ ______	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ______	____ ______	None	None	None	None
	____ Vinyl Chloride	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None
	____ ______	____ ______	____ ______	None	None	None	None

Comments: ______

Attachments: ______

Hydrogeologic Conceptual Model Facility ID#: 1220

____ Geology: Zone Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	________	________	________	
	high value (ft bgs):	________	________	________	
	Unknown:	________	________	________	
____ Flow direction		________	________	________	
____ Horizontal hydraulic gradient (feet/foot):		________	________	________	____ Unknown
Vertical hydraulic gradient (feet/foot):		________	________	________	____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	________	________	________	____ Unknown
high	________	________	________	

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low	________	________	________	____ Unknown
high	________	________	________	

Comments: ____

Attachments: ____

Thermal Treatment - Design — Facility ID#: 1220

x Thermal treatment:
- ____ Conductive ____________________
- x Electrical Resistance ____________________
  - ____ 3 phase ____ 6 phase ____ AC power ____ DC power
- ____ Steam ____________________
  - ____ Steam ____ Steam + air ____ Steam + O2
- ____ Other (describe) ____________________

____ Type of Test: ____ Pilot test ____ Full-scale System

____ Geology of Treatment Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ____________ Duration: ____________

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2): ____________ ____ Unknown (___ x ___ ft)

Thickness of target zone (ft): ____________ ____ Unknown

Depth to top of target zone (ft bgs): ____________ ____ Unknown

Thickness of target zone below water table (ft): ____________ ____ Unknown

Number of energy delivery points: ____________ ____ Unknown

Number of extraction points: ____________ ____ Unknown

____ Temperature Profile:

Initial formation temperature (deg C): ____________ ____ Unknown

Maximum representative formation temperature (deg C): ____________ ____ Unknown

Time to reach maximum representative temperature (days): ____________ ____ Unknown

Duration of treatment at representative temperature (days): ____________ ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

____ Mass of contaminant removed:

Via liquid pumping:	____________	____ lb	____ kg	____ Unknown
In vapor stream:	____________	____ lb	____ kg	____ Unknown
Total:	____________	____ lb	____ kg	____ Unknown

Comments: ____________________

Attachments: ____________________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 1220

____ Performance

Remediation Goal:

____ In Groundwater: ____

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

Removed 99.9% of the VOCs

Lessons Learned

____

x Energy

Total Energy Used: 215 ____ kWhr ____ kWhr/m^3 x kWhr/yd^3

____ Total energy applied to treatment zone: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information　　Facility ID#: 1230

X File Analyzed By: JT X PD ____ 　Date: 11/13/2006

Type of treatment: ____ Conductive ____ Steam X ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents X Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active X Post

Type of Test: X Pilot Test ___ Full Scale System

Start of Test: 2/19/1999 End of Test: 6/16/1999 Duration: 108 d

Type of Site: X Non-DOD ____ DoD

X Facility Name: CFB Calgary

Address: ____________

City, State, Zip Code: ____________

OU# or Site #: Calgary, Alberta, Canada

X Primary point of contact: Randall Warren

Organization: Shell Canada

Address: ____________

City, State, Zip Code: ____________

Phone #: 403-691-2954 email: ____________

X Other contacts or vendors who worked on site ____ None

Point of contact: Gary Millard

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: Shell Canada

Address: ____________

City, State, Zip Code: ____________

Phone #: 403-216-5558 email: gary.millard@shell.com

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data

Facility ID#: 1230

X Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ X Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

X Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 4 Post-treatment: 4

Number of wells relative to treatment zone:

Pre-treatment In: 4 Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: 4 Upgradient: ______ Downgradient: ______ Crossgradient: ______

X Soil Borings: Number of relevant soil borings with pre-treatment data: 26

Number of relevant soil borings with post-treatment data: 12

Number inside treatment zone: 26 Number outside treatment zone: 12

X Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____ ____	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ____	None	None	None	None
	____ cis-1,2-dichloroethene	X Benzene	____ ____	0.1 mg/L	1 mg/kg	0.1 mg/L	5 mg/kg
	____ trans-1,2-dichloroethene	X Tolune	____ ____	0.001 mg/L	0.05 mg/kg	0.001 mg/L	0.05 mg/kg
	____ 1,1-dichloroethane	X Ethylbenzene	____ ____	0.005 mg/L	1 mg/kg	0.005 mg/L	5 mg/kg
	____ 1,2-dichloroethane	____ m/p-xylene	____ ____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ____	None	None	None	None
	____ 1,1,2-trichloroethane	X Xylenes	____ ____	0.01 mg/L	1 mg/kg	0.005 mg/L	5 mg/kg
	____ 1,1,2,2-tetrachloroethane	X TPH	____ ____	None	10 mg/kg	None	None
	____ Vinyl Chloride	____ ____	____ ____	None	None	None	None
	____ ____	____ ____	____ ____	None	None	None	None
	____ ____	____ ____	____ ____	None	None	None	None
	____ ____	____ ____	____ ____	None	None	None	None
	____ ____	____ ____	____ ____	None	None	None	None
	____ ____	____ ____	____ ____	None	None	None	None
	____ ____	____ ____	____ ____	None	None	None	None

Comments:

Attachments:

Hydrogeologic Conceptual Model Facility ID#: 1230

X Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- X Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- X Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

	low				____ Unknown
	high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

	low				____ Unknown
	high				

Comments:

Attachments:

Thermal Treatment - Design Facility ID#: 1230

X Thermal treatment: ____ Conductive ____________

X Electrical Resistance ____________

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____________

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____________

X Type of Test: X Pilot test ____ Full-scale System

X Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

X Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: 19-Feb-99 Duration: 108 d

____ Hydraulic Control ____ Yes ____ No

X Treatment Cell Design:

Size of target zone (ft2):	3390	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	9	____ Unknown	
Depth to top of target zone (ft bgs):	5	____ Unknown	
Thickness of target zone below water table (ft):	____________	____ Unknown	
Number of energy delivery points:	6	____ Unknown	
Number of extraction points:	5	____ Unknown	

X Temperature Profile:

Initial formation temperature (deg C):	10	____ Unknown
Maximum representative formation temperature (deg C):	60	____ Unknown
Time to reach maximum representative temperature (days):	96	____ Unknown
Duration of treatment at representative temperature (days):	12	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____________	____________
Formation temperature post-treatment monitoring event 1:	____________	____________
Duration of post-treatment monitoring (days):	____________	____________

X Mass of contaminant removed:

Via liquid pumping:	48.5 Liters + 117 Liters	____ lb	____ kg	____ Unknown
In vapor stream:	34.4 Liters	____ lb	____ kg	____ Unknown
Total:	199.9 Liters	____ lb	____ kg	____ Unknown

Comments:

20 ft electrode spacing. Actually 7 extraction points, but only 5 could be hooked up at any one time.

Attachments: ____________

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 1230

X Performance

Remediation Goal:

X In Groundwater:

Benzene-4.2 mg/L, toluene-240 mg/L, ethylbenzene-50 mg/L, xylenes-80 mg/L.

X In Soil:

Benzene-1.5 mg/Kg, toluene-340 mg/kg, ethylbenzene-400 mg/Kg, xylenes-130 mg/Kg.

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Objective: Evaluate the ability and efficiency of McMillan-McGee ETDSP; determine effect of heating on disorption of petroleum hydrocarbons; evaluate conditions when ERH will be an effective tool in remediation; and evaluate effect of heating on the indigenous microorganisms.

Lessons Learned

X Energy

Total Energy Used: 163,000 X kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: 178 ____ kWhr/m^3 X kWhr/yd^3

____ Other energy: ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information Facility ID#: 1240

X File Analyzed By: JT X PD ____ Date: 11/13/2006

Type of treatment: ____ Conductive ____ Steam X ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents X Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active X Post

Type of Test: X Pilot Test ___ Full Scale System

Start of Test: ____________ End of Test: ____________ Duration: 60 d

Type of Site: ____ Non-DOD ____ DoD

X Facility Name: Crowchild

Address: ____________

City, State, Zip Code: ____________

OU# or Site #: ____________

X Primary point of contact: Randall Warren

Organization: Shell Canada

Address: ____________

City, State, Zip Code: ____________

Phone #: 403-691-2954 email: ____________

X Other contacts or vendors who worked on site ____ None

Point of contact: Gary Millard

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: Shell Canada

Address: ____________

City, State, Zip Code: ____________

Phone #: 403-216-5558 email: gary.millard@shell.com

QA/QC

____ Characteristics of Interest

____ Good pre- and post-treatment groundwater data

____ Good pre- and post-treatment soil data

____ Good temperature profile vs. time information

____ Flux assessment

____ Groundwater elevations

____ Geologic cross-section

____ Hydraulic Conductivity information

General Site Assessment Data Facility ID#: 1240

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______
Post-treatment	In: ______	Upgradient: ______	Downgradient: ______	Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ____________

Number of relevant soil borings with post-treatment data: ____________

Number inside treatment zone: ________ Number outside treatment zone: ________

____ Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____ ________	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ________	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ________	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ________	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ________	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ________	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ________	None	None	None	None
	____ 1,1,2-trichloroethane	____ ________	____ ________	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ________	____ ________	None	None	None	None
	____ Vinyl Chloride	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None

Comments: ________________________________

Attachments: ________________________________

Hydrogeologic Conceptual Model Facility ID#: 1240

____ Geology:

Zone	Unconsolidated Sediments
Vadose Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone
Saturated Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ____________ ft amsl ____ Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ____________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day)	Measured using:	____ Slug Test	____ Laboratory	____ Field data	
	low				____ Unknown
	high				
Transmissivity (ft2/day):	Measured using:	____ Slug Test	____ Laboratory	____ Field data	
	low				____ Unknown
	high				

Comments: ____

Attachments: ____

Thermal Treatment - Design Facility ID#: 1240

X Thermal treatment: ____ Conductive ____________________

X Electrical Resistance ____________________

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____________________

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____________________

X Type of Test: X Pilot test ____ Full-scale System

____ Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ____________ Duration: ____________

____ Hydraulic Control ____ Yes ____ No

____ Treatment Cell Design:

Size of target zone (ft2): ____________ ____ Unknown (___ x ___ ft)

Thickness of target zone (ft): ____________ ____ Unknown

Depth to top of target zone (ft bgs): ____________ ____ Unknown

Thickness of target zone below water table (ft): ____________ ____ Unknown

Number of energy delivery points: ____________ ____ Unknown

Number of extraction points: ____________ ____ Unknown

X Temperature Profile:

Initial formation temperature (deg C): ____________ ____ Unknown

Maximum representative formation temperature (deg C): 100 ____ Unknown

Time to reach maximum representative temperature (days): ____________ ____ Unknown

Duration of treatment at representative temperature (days): ____________ ____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:		
Formation temperature post-treatment monitoring event 1:		
Duration of post-treatment monitoring (days):		

____ Mass of contaminant removed:

Via liquid pumping: ____________ ____ lb ____ kg ____ Unknown

In vapor stream: ____________ ____ lb ____ kg ____ Unknown

Total: ____________ ____ lb ____ kg ____ Unknown

Comments:

Attachments: 19 ft electrode spacing

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 1240

____ Performance

Remediation Goal:

____ In Groundwater: ____

____ In Soil: ____

Was the Remediation Goal Achieved:

____ In Groundwater ____

Comment: ____

____ In Soil ____

Comment: ____

General comments on the thermal application:

____

Lessons Learned

____

X Energy

Total Energy Used: ____ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: 227 X kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____

____ Cost

Total Project Cost: ____

____ Consultant Cost: ____

____ Thermal Vendor Cost: ____

____ Energy Cost: ____ ____ m^3 ____ yd^3

____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

____ Please note other cost: ____ Other Cost 1: ____

____ Other Cost 2: ____

____ Other Cost 3: ____

General Site Information — Facility ID#: 1250

x File Analyzed By: JT x PD ____ — Date: 10/18/2006

Type of treatment: ____ Conductive ____ Steam x ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: ____ Pilot Test ____ Full Scale System

Start of Test: ____________ End of Test: ____________ Duration: ____________

Type of Site: x Non-DOD ____ DoD

x Facility Name: Operating Texaco Gas Station

Address: ____________

City, State, Zip Code: Luxembourg

OU# or Site #: ____________

x Primary point of contact: Bill Heath

Organization: CES

Address: 419 Entiat St., Suite A

City, State, Zip Code: Kennewick, WA 99336

Phone #: 509-727-4276 email: bill@cesiweb.com

____ Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant ____ Vendor, Technical Applications ____ Other ____________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

____ Characteristics of Interest

- ____ Good pre- and post-treatment groundwater data
- ____ Good pre- and post-treatment soil data
- ____ Good temperature profile vs. time information
- ____ Flux assessment
- ____ Groundwater elevations
- ____ Geologic cross-section
- ____ Hydraulic Conductivity information

General Site Assessment Data — Facility ID#: 1250

____ Impacted Zone: Length (parallel to flow direction)(ft.): ______ Width (ft): ______ Thickness (ft): ______ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ______ Post-treatment: ______

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ______

Number of relevant soil borings with post-treatment data: ______

Number inside treatment zone: ______ Number outside treatment zone: ______

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel		None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene		None	None	None	None
	____ cis-1,2-dichloroethene	x Benzene		None	None	None	None
	____ trans-1,2-dichloroethene	x Tolune		None	None	None	None
	____ 1,1-dichloroethane	x Ethylbenzene		None	None	None	None
	____ 1,2-dichloroethane	x m/p-xylene		None	None	None	None
	____ 1,1,1-trichloroethane	x o-xylene		None	None	None	None
	____ 1,1,2-trichloroethane			None	None	None	None
	____ 1,1,2,2-tetrachloroethane			None	None	None	None
	____ Vinyl Chloride			None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None
				None	None	None	None

Comments:

Attachments:

____ Geology: Zone — Unconsolidated Sediments

Vadose Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

Saturated Zone:
- ____ Relatively homogeneous and permeable unconsolidated sediments
- ____ Relatively homogeneous and impermeable unconsolidated sediments
- ____ Largely permeable sediments with inter-bedded lenses of lower permeability material
- ____ Largely impermeable sediments with inter-bedded layers of higher permeability material
- ____ Competent, but fractured bedrock (i.e. crystalline rock)
- ____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl ____ Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No ____ Yes (number): ________ x Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	36			
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown

____ K range (ft/day) Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 1250

x Thermal treatment: ____ Conductive ____

x Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

____ Type of Test: ____ Pilot test ____ Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

____ Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

____ Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: ____ Duration: ____

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	1615	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	____	____ Unknown	
Depth to top of target zone (ft bgs):	____	____ Unknown	
Thickness of target zone below water table (ft):	____	____ Unknown	
Number of energy delivery points:	13	____ Unknown	
Number of extraction points:	____	____ Unknown	

____ Temperature Profile:

Initial formation temperature (deg C):	____	____ Unknown
Maximum representative formation temperature (deg C):	____	____ Unknown
Time to reach maximum representative temperature (days):	____	____ Unknown
Duration of treatment at representative temperature (days):	____	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

____ Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	____	____ lb	____ kg	____ Unknown
Total:	____	x lb	____ kg	____ Unknown

Comments:

19 ft spacing

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 1250

____ Performance

Remediation Goal:

____ In Groundwater:

____ In Soil:

Was the Remediation Goal Achieved:

____ In Groundwater

Comment:

____ In Soil

Comment:

General comments on the thermal application:

Lessons Learned

____ Energy

Total Energy Used: ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy:

____ Cost

Total Project Cost:

____ Consultant Cost:

____ Thermal Vendor Cost:

____ Energy Cost: ____ m^3 ____ yd^3

____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

____ Please note other cost: ____ Other Cost 1:

____ Other Cost 2:

____ Other Cost 3:

General Site Information Facility ID#: 1260

x File Analyzed By: JT x PD ____ Date: 10/30/2006

Type of treatment: x Conductive ____ Steam ____ ERH ____ Other: ________________

Type of Contaminant: x Chlorinated Solvents ____ Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ________________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ____ Full Scale System

Start of Test: Aug-06 End of Test: Oct-06 Duration: 2 months

Type of Site: x Non-DOD ____ DoD

x Facility Name: Skuldelev

Address: Vestergade

City, State, Zip Code: Skuldelev

OU# or Site #: Denmark

x Primary point of contact: Gorm Heron

Organization: TerraTherm

Address: 10 Stevens Rd

City, State, Zip Code: Fitchburg, MA 01420

Phone #: 978-343-0300 email: gheron@terratherm.com

x Other contacts or vendors who worked on site ____ None

Point of contact: Niels Ploug

Type: ____ Vendor, Consultant x Vendor, Technical Applications ____ Other ________

Organization: Kruger A/S

Address: ________________

City, State, Zip Code: Gladsaxe, Denmark

Phone #: 011-45-39572061 email: NIP@kruger.dk

QA/QC

x Characteristics of Interest

- x Good pre- and post-treatment groundwater data
- x Good pre- and post-treatment soil data
- x Good temperature profile vs. time information
- x Flux assessment
- x Groundwater elevations
- x Geologic cross-section
- x Hydraulic Conductivity information

General Site Assessment Data Facility ID#: 1260

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

x Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: 6 Post-treatment: 1

Number of wells relative to treatment zone:

	In:	Upgradient:	Downgradient:	Crossgradient:
Pre-treatment	1	2	1	2
Post-treatment	1	______	______	______

x Soil Borings: Number of relevant soil borings with pre-treatment data: 4

Number of relevant soil borings with post-treatment data: 3

Number inside treatment zone: 3 Number outside treatment zone: 0

x Types of Contaminants

	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Average Pre-treatment Concentration per Chemical: Groundwater (mg/L)	Average Pre-treatment Concentration per Chemical: Soil (mg/kg)	Average Post-treatment Concentration per Chemical: Groundwater (mg/L)	Average Post-treatment Concentration per Chemical: Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	x Tetrachloroethene	____ Jet Fuel	____	1,000 mg/L	5,000 mg/kg	10 mg/L	100 mg/kg
	____ 1,1-dichloroethene	____ Napthalene	____	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____	None	None	None	None
	____ 1,1,2-trichloroethane	____	____	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____	____	None	None	None	None
	____ Vinyl Chloride	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None
	____	____	____	None	None	None	None

Comments:

Pilot test with only 4 heater wells inside larger DNAPL area - impossible to achieve low concentrations due to inflow

Attachments:

Hydrogeologic Conceptual Model — Facility ID#: 1260

x Geology:

Zone	Unconsolidated Sediments
Vadose Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	x Largely permeable sediments with inter-bedded lenses of lower permeability material
	____ Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone
Saturated Zone:	____ Relatively homogeneous and permeable unconsolidated sediments
	____ Relatively homogeneous and impermeable unconsolidated sediments
	____ Largely permeable sediments with inter-bedded lenses of lower permeability material
	x Largely impermeable sediments with inter-bedded layers of higher permeability material
	____ Competent, but fractured bedrock (i.e. crystalline rock)
	____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl x Unknown

x Aquifer Characteristics:

Is more than 1 aquifer present? ____ No x Yes (number): ________ ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):	3	25		
	high value (ft bgs):	6	30		
	Unknown:				
____ Flow direction					
x Horizontal hydraulic gradient (feet/foot):		0.01			____ Unknown
Vertical hydraulic gradient (feet/foot):					x Unknown

____ K range (ft/day) — Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Transmissivity (ft2/day): — Measured using: ____ Slug Test ____ Laboratory ____ Field data

low				____ Unknown
high				

Comments:

Attachments:

Thermal Treatment - Design   Facility ID#: 1260

x Thermal treatment: x Conductive ____
____ Electrical Resistance ____
____ 3 phase ____ 6 phase ____ AC power ____ DC power
____ Steam ____
____ Steam ____ Steam + air ____ Steam + O2
____ Other (describe) ____

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
x Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: x Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

x Start of Thermal Test: Oct-06 Duration: 2 months

x Hydraulic Control x Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	200	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	15	____ Unknown	
Depth to top of target zone (ft bgs):	7	____ Unknown	
Thickness of target zone below water table (ft):	15	____ Unknown	
Number of energy delivery points:	4	____ Unknown	
Number of extraction points:	4	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	10	____ Unknown
Maximum representative formation temperature (deg C):	100	____ Unknown
Time to reach maximum representative temperature (days):	60	____ Unknown
Duration of treatment at representative temperature (days):	1	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	60	80-100
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	11	____ lb	x kg	____ Unknown
In vapor stream:	24	____ lb	x kg	____ Unknown
Total:	35	____ lb	x kg	____ Unknown

Comments: ____

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 1260

____ Performance

Remediation Goal:

____ In Groundwater: ______________________________

____ In Soil: ______________________________

Was the Remediation Goal Achieved:

____ In Groundwater ______________________________

Comment: ______________________________

____ In Soil ______________________________

Comment: ______________________________

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____________ ____ kWhr ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Total energy applied to treatment zone: ____________ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Other energy: ____________ ____ $kWhr/m^3$ ____ $kWhr/yd^3$

____ Please note other energy: ______________________________

____ Cost

Total Project Cost: ____________

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

____ Energy Cost: ____________ ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ______________________________

____ Other Cost 2: ______________________________

____ Other Cost 3: ______________________________

General Site Information | | Facility ID#: 1270

x File Analyzed By: JT x PD ____ Date: 10/30/2006

Type of treatment: x Conductive ____ Steam ____ ERH ____ Other: ____________

Type of Contaminant: ____ Chlorinated Solvents x Petroleum Hydrocarbons ____ Pesticides

____ Wood Treating ____ Other: ____________

Treatment Status: ____ Active x Post

Type of Test: x Pilot Test ____ Full Scale System

Start of Test: ____________ End of Test: Dec-07 Duration: ________

Type of Site: x Non-DOD ____ DoD

x Facility Name: Dyrup

Address: ____________

City, State, Zip Code: Dyrup

OU# or Site #: Denmark

x Primary point of contact: Gorm Heron

Organization: TerraTherm

Address: 10 Stevens Rd

City, State, Zip Code: Fitchburg, MA 01420

Phone #: 978-343-0300 email: gheron@terratherm.com

x Other contacts or vendors who worked on site ____ None

Point of contact: ____________

Type: ____ Vendor, Consultant x Vendor, Technical Applications ____ Other ________

Organization: ____________

Address: ____________

City, State, Zip Code: ____________

Phone #: ____________ email: ____________

QA/QC

x Characteristics of Interest

- x Good pre- and post-treatment groundwater data
- x Good pre- and post-treatment soil data
- x Good temperature profile vs. time information
- x Flux assessment
- x Groundwater elevations
- x Geologic cross-section
- x Hydraulic Conductivity information

General Site Assessment Data   Facility ID#: 1270

____ Impacted Zone: Length (parallel to flow direction)(ft.): ________ Width (ft): ________ Thickness (ft): ________ ___ Unknown

____ Impacted zone as defined by documentation

____ Alternative method for determining size of impacted zone (See source zone definition attachments)

____ Map attachment

____ Monitor Wells: Number of relevant monitoring wells with groundwater data: ___ None

Pre-treatment: ________ Post-treatment: ________

Number of wells relative to treatment zone:

Pre-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

Post-treatment In: ______ Upgradient: ______ Downgradient: ______ Crossgradient: ______

____ Soil Borings: Number of relevant soil borings with pre-treatment data: ________

Number of relevant soil borings with post-treatment data: ________

Number inside treatment zone: ________ Number outside treatment zone: ________

____ Types of Contaminants

				Average Pre-treatment Concentration per Chemical:		Average Post-treatment Concentration per Chemical:	
	Chlorinated Solvents	Petroleum Hydrocarbons	Other	Groundwater (mg/L)	Soil (mg/kg)	Groundwater (mg/L)	Soil (mg/kg)
Chemicals of Concern	____ Trichloroethene	____ Hexane	____ Creosote	None	None	None	None
	____ Tetrachloroethene	____ Jet Fuel	____ ________	None	None	None	None
	____ 1,1-dichloroethene	____ Napthalene	____ ________	None	None	None	None
	____ cis-1,2-dichloroethene	____ Benzene	____ ________	None	None	None	None
	____ trans-1,2-dichloroethene	____ Tolune	____ ________	None	None	None	None
	____ 1,1-dichloroethane	____ Ethylbenzene	____ ________	None	None	None	None
	____ 1,2-dichloroethane	____ m/p-xylene	____ ________	None	None	None	None
	____ 1,1,1-trichloroethane	____ o-xylene	____ ________	None	None	None	None
	____ 1,1,2-trichloroethane	____ ________	____ ________	None	None	None	None
	____ 1,1,2,2-tetrachloroethane	____ ________	____ ________	None	None	None	None
	____ Vinyl Chloride	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None
	____ ________	____ ________	____ ________	None	None	None	None

Comments: ________

Attachments: ________

Hydrogeologic Conceptual Model   Facility ID#: 1270

x Geology: Zone   Unconsolidated Sediments

Vadose Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
x Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

Saturated Zone:
____ Relatively homogeneous and permeable unconsolidated sediments
____ Relatively homogeneous and impermeable unconsolidated sediments
____ Largely permeable sediments with inter-bedded lenses of lower permeability material
x Largely impermeable sediments with inter-bedded layers of higher permeability material
____ Competent, but fractured bedrock (i.e. crystalline rock)
____ Weathered bedrock, limestone, sandstone

____ Ground surface elevation based on wells in or adjacent to treatment zone: ________ ft amsl   x Unknown

____ Aquifer Characteristics:

Is more than 1 aquifer present? ____ No   x Yes (number): ________   ____ Unknown (assume single aquifer)

		Aquifer 1	Aquifer 2	Aquifer 3	
Depth to water:	low value (ft bgs):				
	high value (ft bgs):				
	Unknown:				
____ Flow direction					
____ Horizontal hydraulic gradient (feet/foot):					____ Unknown
Vertical hydraulic gradient (feet/foot):					____ Unknown
____ K range (ft/day)	Measured using:	____ Slug Test	____ Laboratory	____ Field data	
	low				____ Unknown
	high				
Transmissivity (ft2/day):	Measured using:	____ Slug Test	____ Laboratory	____ Field data	
	low				____ Unknown
	high				

Comments: ____________________

Attachments: ____________________

Thermal Treatment - Design Facility ID#: 1270

x Thermal treatment: x Conductive ____

____ Electrical Resistance ____

____ 3 phase ____ 6 phase ____ AC power ____ DC power

____ Steam ____

____ Steam ____ Steam + air ____ Steam + O2

____ Other (describe) ____

x Type of Test: x Pilot test ____ Full-scale System

x Geology of Treatment Zone:

____ Relatively homogeneous and permeable unconsolidated sediments

____ Relatively homogeneous and impermeable unconsolidated sediments

____ Largely permeable sediments with inter-bedded lenses of lower permeability material

x Largely impermeable sediments with inter-bedded layers of higher permeability material

____ Competent, but fractured bedrock (i.e. crystalline rock)

____ Weathered bedrock, limestone, sandstone

x Treatment Targe Zone: ____ Saturated only ____ Vadose only ____ Both (Saturated and Vadose zones)

____ Start of Thermal Test: ____ Duration: ____

____ Hydraulic Control ____ Yes ____ No

x Treatment Cell Design:

Size of target zone (ft2):	500	____ Unknown	(___ x ___ ft)
Thickness of target zone (ft):	20	____ Unknown	
Depth to top of target zone (ft bgs):	20	____ Unknown	
Thickness of target zone below water table (ft):	0	____ Unknown	
Number of energy delivery points:	6	____ Unknown	
Number of extraction points:	____	____ Unknown	

x Temperature Profile:

Initial formation temperature (deg C):	____	____ Unknown
Maximum representative formation temperature (deg C):	100	____ Unknown
Time to reach maximum representative temperature (days):	60	____ Unknown
Duration of treatment at representative temperature (days):	5	____ Unknown

	Date	Temperature (deg C)
Formation temperature immediately post-treatment:	____	____
Formation temperature post-treatment monitoring event 1:	____	____
Duration of post-treatment monitoring (days):	____	____

x Mass of contaminant removed:

Via liquid pumping:	____	____ lb	____ kg	____ Unknown
In vapor stream:	____	____ lb	____ kg	____ Unknown
Total:	____	____ lb	____ kg	____ Unknown

Comments: ____

Attachments: ____

Note: When applicable, mass flux measurements from Groundwater Services, Inc. freeware is attached.

Cost and Performance Facility ID#: 1270

____ Performance

Remediation Goal:

____ In Groundwater: ____________________

____ In Soil: ____________________

Was the Remediation Goal Achieved:

____ In Groundwater ____________________

Comment: ____________________

____ In Soil ____________________

Comment: ____________________

General comments on the thermal application:

____

Lessons Learned

____

____ Energy

Total Energy Used: ____________ ____ kWhr ____ kWhr/m^3 ____ kWhr/yd^3

____ Total energy applied to treatment zone: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Other energy: ____________ ____ kWhr/m^3 ____ kWhr/yd^3

____ Please note other energy: ____________________

____ Cost

Total Project Cost: ____________

____ Consultant Cost: ____________

____ Thermal Vendor Cost: ____________

____ Energy Cost: ____________ ____ m^3 ____ yd^3

____ Other Cost 1: ____________

____ Other Cost 2: ____________

____ Other Cost 3: ____________

____ Please note other cost: ____ Other Cost 1: ____________________

____ Other Cost 2: ____________________

____ Other Cost 3: ____________________

APPENDIX D

Site Specific Demonstration Plans and Data Analysis Reports:

- Camp LeJeune
- NAS Alameda Bldg. 5
- Air Force Plant 4
- Hunter Army Airfield
- Ft. Lewis East Gate Disposal Yard Area 3

Draft Final

Site Specific Demonstration Plan
Camp LeJeune – Site 89

Critical Evaluation of the State of In Situ Thermal Treatment Technologies for DNAPL Source Zone Treatment

Prepared for:

Environmental Security Technology Certification Program
Arlington, VA

Prepared by:

Arizona State University
Battelle Memorial Institute

Site 89 at the Camp Geiger portion of Marine Corps Base (MCB) Camp LeJeune is located near the intersection of "G" and Eighth Streets as shown in Figure 1. Site 89 property consists of the fenced portion of the former Defense Reutilization Marketing Office (DRMO); however, the area of impact associated with Site 89 extends beyond the fence to Edwards Creek and includes the wooded area to the east and south of the DRMO as well as a portion of Camp Geiger to the west.

Until June 2000, Site 89 was used primarily as a storage yard for the DRMO. The primary function of the former DRMO was one of managing scrap and surplus metal. Rubber tires, fuel bladders (mobile fuel storage tanks), and other materials were also managed alt the site. Previous to DRMO operations, Site 89 was the site of the Base Motor Pool operations through approximately 1988, when it was relocated.

Through multiple investigations beginning in 1996, Site 89 was identified as the major source of chlorinated groundwater and surface water contamination. The later investigation identified free-phase dense non-aqueous phase liquids (DNAPL) present below the water table, with the DNAPL consisting mainly of 1,1,2,2-tetrachloroethane (PCA) and trichloroethene (TCE). The DNAPL source area was determined to be about 8,900 square feet in size.

The conceptual subsurface model for Site 89 includes three underlying geological formations and surface water bordering the area. The undifferentiated formation (surficial aquifer) occurs at a depth of approximately five feet below land surface (bls). The Belgrade formation (Castle Hayne confining unit) begins at a depth of approximately 8 to 15 feet bls, and the River Bend formation (Castle Hayne aquifer) begins at a depth of approximately 14 to 20 feet bls.

Electrical resistive heating (ERH) was selected as the technology to remove the free-phase DNAPL. Installation of the pilot test ERH system began in April 2006. The system consisted of 43 deep heating electrodes installed to a depth of 26 feet bls and 48 shallow heating electrodes installed to a depth of 19 feet bls. The total treatment area, shown in Figure 2, was roughly 15,900 square feet.

An additional 23 monitoring wells were installed both inside and immediately surrounding the pilot test area. These monitoring wells were classified as shallow type II monitoring wells and deep type III monitoring wells. Both type II and III monitoring wells were constructed with 2-inch diameter stainless steel screen, riser, and end cap. The type II wells screen section was 10-feet long extending from 5 to 15 feet bls with 0.010-inch wire wrap slots. The type III wells screen section was 5-feet long extending from 20 to 25 feet bls with 0.010-inch wire wrap screen. These monitoring wells along with four existing monitoring wells (MW-16, MW16IW, MW-17, and MW-17IW) were used to assess the effectiveness of the ERH technology as well as monitoring DNAPL and any possible dissolved phase contaminant migration.

The pilot system was brought on-line in September 2003 and was operated until the beginning of May 2004. The remedial system performance was continuously monitored during operation, and an estimated 48,000 pounds of volatile organic compound (VOC) contamination were removed in recovered volatile vapors and 428 pounds of chlorinated compounds were recovered from the groundwater during the pilot.

After the shutdown of the pilot system, the monitoring well network was monitored for 1 year. After a year the electrodes were covered by digging down 1 foot and cutting off the casing then covering with soil. All the monitoring wells were left in place.

The available documentation for Camp LeJeune suggests that it is a good site for further investigation because:

- The hydrogeology of the site is reasonably well-characterized
- The aerial extent of the source zone was reasonably defined prior to treatment
- Full treatment of a source zone was attempted
- The depth to groundwater is 5 feet
- The total depth to impacted groundwater is about 38 feet
- There is access to sampling locations immediately down-gradient of the remediated source zone
- The system employed at this site represents a state-of-the-art ERH system
- Pre- and post-treatment groundwater data are available
- Direct-push technologies can be used for sampling
- The monitoring well network is still present and accessible

Consistent with the already-approved generic demonstration plan for this project, the following site-specific activities are proposed:

(1) Verification of the site geological conceptual model before any new investigative work by:
   a. Measurement of depths to groundwater in nearby wells (to determine depth to groundwater, flow direction, and hydraulic gradient). See Table 1 for details on the monitoring wells and Figure 2 for measurement location.
   b. Collection of one continuous soil core near the dissolved plume core at the down-gradient edge of the treated source zone (to qualitatively confirm the site geology and to identify depths for subsequent groundwater sampling). Additional cores will be collected if time permits. See Table 1 for details on the monitoring wells and Figure 2 for measurement location.
   c. Slug tests conducted in existing groundwater monitoring wells in the area to get estimates of hydraulic conductivity over the screened intervals of those wells (to help identify if any zones are more conductive than others). See Table 1 for details on the monitoring wells and Figure 2 for measurement location.

(2) Collection of data necessary to determine groundwater concentrations and fluxes leaving the treated source zone:
   a. Groundwater samples collected from existing groundwater monitoring wells with available historical data See Table 1 for details on the monitoring wells and Figure 2 for measurement location.
   b. Groundwater samples will be collected using direct-push tools along a transect perpendicular to the direction of groundwater flow and across the width of the original source zone. See Figure 2 for groundwater sampling locations. The boreholes will be approximately 50 feet apart and will be sampled at least every 4 feet down to a depth of 38 ft (and at least once in each distinct lithologic change

suggested by the soil core). Groundwater will be collected in 40 mL volatile organic analysis (VOA) bottles with a peristaltic pump. The samples will be analyzed via a headspace analysis on a gas chromatograph (GC) equipped with electron capture (ECD) and flame-ionization (FID) detectors. If time permits, samples will be collected at other locations as well. The specific depths and numbers of samples collected at each location may be adjusted depending on the analysis results in the field.

c. Aquifer specific-capacity tests will be conducted at each depth where a groundwater sample is collected. These tests are to be conducted using the direct-push groundwater sampler. Specific capacity tests involve the measurement of the steady flow rate achieved with a fixed drawdown; ideally, all tests will be conducted with the same fixed drawdown (usually 0.3 – 1.0 feet).

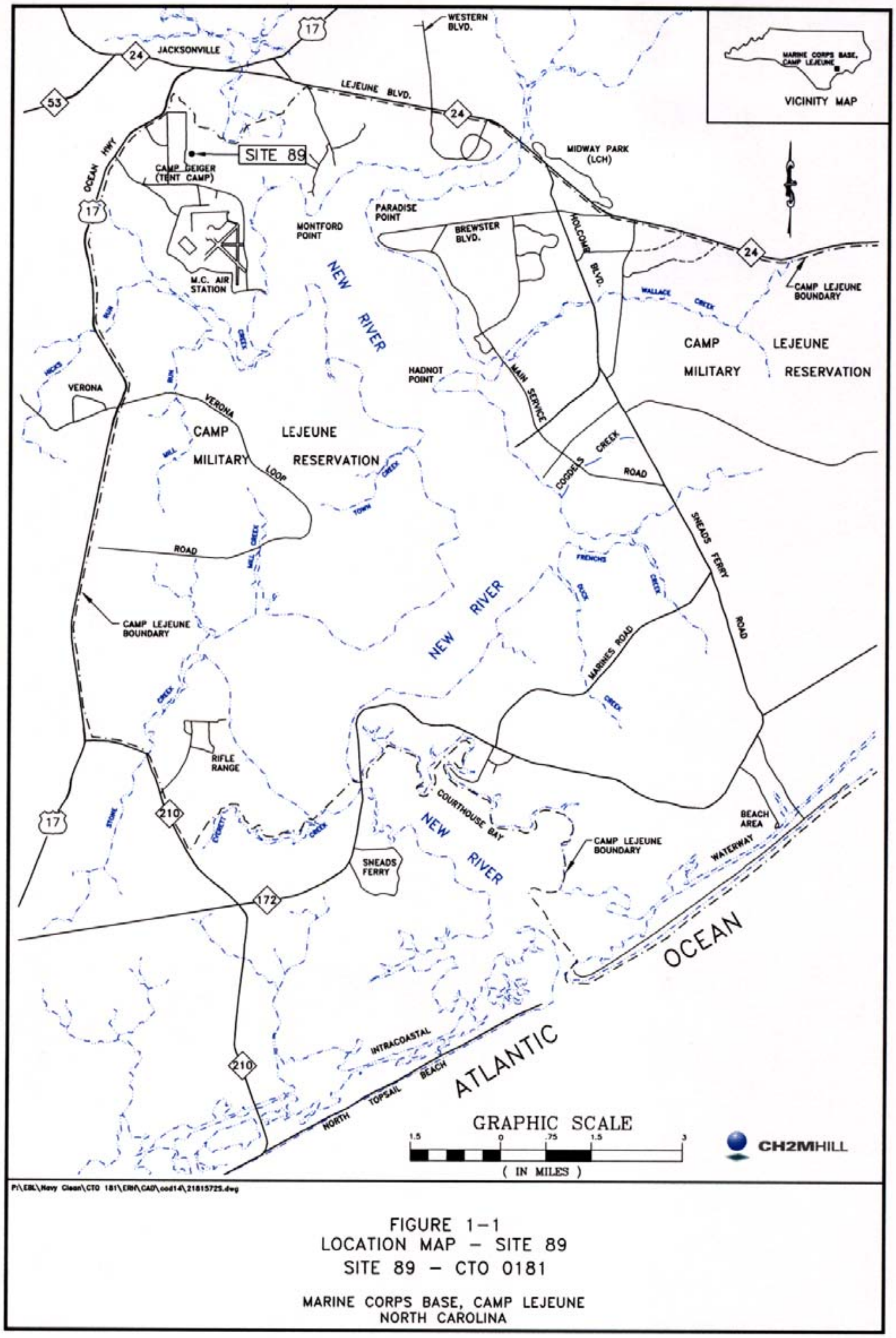


Figure 1: Site location map

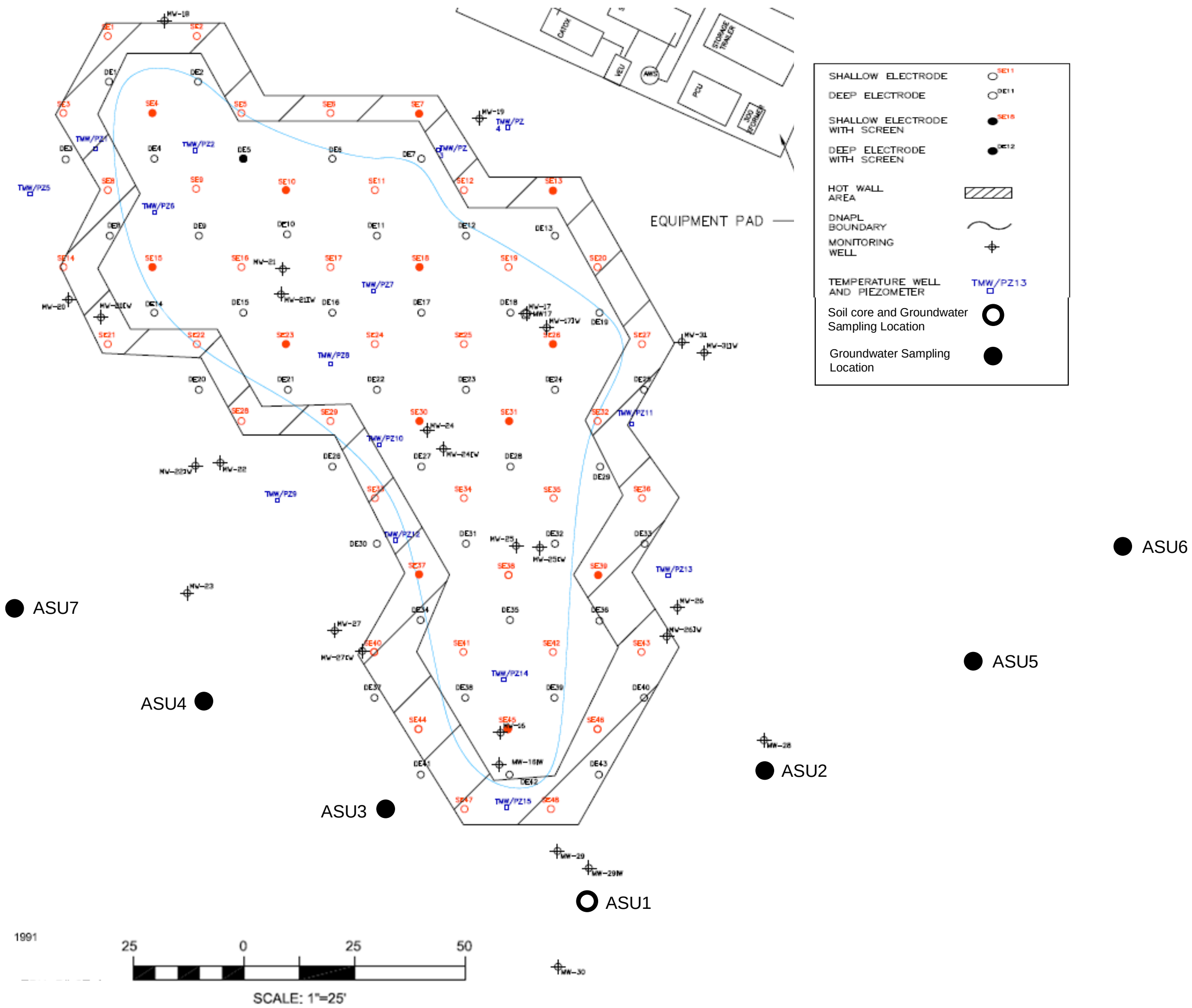


Figure 2. Direct-Push Locations

Health and Safety Plan (HASP)
Camp LeJeune – Site 89

SECTION 1: GENERAL INFORMATION AND DISCLAIMER

CLIENT NAME: Environmental Security Technology Certification Program (ESTCP) PROJECT NAME: ESTCP Thermal Evaluation

PRINCIPAL INVESTIGATORS: Bruce Alleman (Battelle) and Paul Johnson (Arizona State University)

PROJECT LEADER: Sam Yoon

PREPARED BY: Sam Yoon DATE: 09/15/2005

NOTE: This Site Specific Health and Safety Plan - (HASP) has been prepared for use by Battelle employees for work at this site. Battelle is not responsible for its use by others. The plan is written for the specific LEVEL D site conditions, purposes, tasks, dates and personnel specified. If these conditions change, a new plan must be utilized and reviewed by those named in Section 17.

Subcontractors shall be solely responsible for the health and safety of their employees and shall comply with all applicable laws and regulations. In accordance with 1910.120(b)(1)(iv) and (v), Battelle will inform subcontractors of the site emergency response procedures, and any potential fire, explosion, health, safety or other hazards by making this Site Specific Safety and Health Plan and site information obtained by others available during regular business hours. All contractors and subcontractors are responsible for: (1) developing their own Health and Safety Plan including a written Hazard Communication Program and any other written hazard specific programs required by federal, state and local laws and regulations; (2) providing their own personal protective equipment (PPE); (3) providing documentation that their employees have been health and safety trained in accordance with applicable federal, state and local laws and regulations; (4) providing evidence of medical surveillance and medical approvals for their employees; and (5) designating their own site safety officer (SSO) responsible for ensuring that their employees comply with their own Health and Safety Plan and taking any other additional measures required by their site activities.

SECTION 2: PROJECT INFORMATION

(1) SITE INFORMATION

Site Name: OU16 (Site 89) Former DRMO Site

Address: Camp Lejuene, North Carolina 28542

Site Project Contact: Daniel Hood

Phone Number: 757-322-4630

Site Safety & Health Contact: Sam Yoon

Phone Number 614-424-4569/ 614-537-5658

(2) SITE CLASSIFICATION (check or circle all that apply)

√ Hazardous (RCRA/CERCLA/State)
☐ Construction
☐ Landfill (Non-Hazardous)
☐ UST/LUST
☐ Manufacturing
☐ Active
√ Inactive
☐ Other:
military installation

(3) ENTRY OBJECTIVES (check or circle all that apply)

√ Site Inspection (General)
☐ Well Drilling Observation
☐ Sampling, Air
√ Sampling, Water
√ Sampling, Soil
☐ Other:

DATE(S) OF FIELD VISIT(S):

(4) BATTELLE/ASU TASKS

B1. Groundwater Investigation
B2. Groundwater sampling
B3. Water level survey and slug tests
B4. Analytical activities

TASK PERFORMED BY OTHERS

01. Direct push activities for gw sample collection
02. IDW disposal
03.
04.

(5) PROJECT ORGANIZATION AND COORDINATION – The following personnel are designated to carry out the stated project job functions on site. (Note: One person may carry out more than one job function.)

PRINCIPAL INVESTIGATORS Bruce Alleman/Paul Johnson

SITE SAFETY OFFICER Sam Yoon

ALTERNATIVE SITE SAFETY OFFICER(S)	Jennifer Triplett/Paul Dahlen
PUBLIC INFORMATION OFFICER	N/A
SITE RECORD KEEPER	Sam Yoon/Jennifer Triplett
SITE PERSONNEL WITH CPR/FA	Sam Yoon
FIELD TEAM LEADER(S)	Sam Yoon
OTHER FIELD TEAM MANAGERS	

(6) ON SITE CONTROL

Sam Yoon has been designated to coordinate access control and security for Battelle operations on site. A safe perimeter has been established at the work area by delineating the work area with traffic cones and/or high-visibility barrier tape.

No unauthorized person should be within this area.

The on site Command Post and staging area have been established at the former ERH treatment area at Site 89 (OU16).

The prevailing wind conditions are east. A wind direction indicator is used to determine daily wind directions. The Command Post is located upwind from the Exclusion Zone or at a sufficient distance to prevent exposure should a release occur.

Control boundaries have been established and include southern portion of OU16. These boundaries are identified in the field by: traffic cones and/or high-visibility barrier tape.

SECTION 3: PHYSICAL HAZARDS

(1) IDENTIFY POTENTIAL PHYSICAL HAZARDS TO WORKERS (check or circle all that apply)

□	Confined Space	□	Steep/Uneven Terrain	√	Drums Handling*
√	Heavy Equipment	□	Heat Stress	□	Noise
□	Moving Parts	√	Extreme Cold	□	Non-Ionizing Radiation
□	Heavy Lifting	□	Ionizing Radiation	□	Other:
□	Electrical	□	Traffic		
□	Overhead Hazards	□	Biological Hazards		
□	Fall (>6; Vertical)	□	Surface Water (Immersion)		

Site hazards will be mitigated by:

(1) Briefing site personnel as to identified physical hazards within the work area.
(2) Identifying the "kill switch" on the drilling rig.
(3) Personal protection equipment such as ear muffs, ear plugs, winter jakets, etc. will be don to site personnel.
(4) Antiseptic ointment, solution, and bug repellent (especially for ticks) will be included in the first aid kit for insect stings.

(2) SAFETY EQUIPMENT REQUIRED FOR BATTELLE/ASU EMPLOYEES (check or circle all that apply)

□	Explosimeter	□	Eye Wash	□	Confined Space Warning Signs
□	Fall Protection Equipment	□	Emergency Shower	√	Communications – On Site
√	Barrier Tape	√	Emergency Air Horn	√	Communications – Off Site
√	Traffic Cones	□	Lights	□	Other:
□	Stretcher	□	Lights – emergency		
√	First Aid Kit	□	Ladder		
□	A-B-C- Fire Extinguisher	√	Tick Repellant		
□	Snake Bite Kit	□	Flotation Device (USCG Type III)		

Emergency equipment will be located in the cab of the drilling rig. See Sections 10 and 12 for communication procedures. The field crew will be equipped with cellular telephones, walkie-talkies, and emergency air horn for communication.

SECTION 4: CHEMICAL HAZARDS INFORMATION

(1) IDENTIFIED CONTAMINANTS

Known or suspected hazardous/toxic material (attached historical information, physical description, map of contamination and tabulated date, if available).

Media	Substances Involved	Characteristics	Estimated Concentrations	PEL
GW	Chlorinated hydrocarbons	VO and TO	As much as 18,900 µg/L during the ERH operation	

SL	Chlorinated hydrocarbons	VO and TO	520 mg/kg of TCE	

Media types — GW (ground water), SW (surface water), WW (wastewater), AIR (air), SL (soil), SD (sediments), WL (waste, liquid), WS (waste, solid), WD (waste, sludge), WG (waste, gas) OT (other).

Characterizations — CA (corrosive, acid) CC, (corrosive, caustic), IG (ignitable), RA (radioactive), VO (volatile), TO (toxic), RE (reactive), BIO (infectious), UN (unknown), OT (other, describe)

Material Safety Data Sheets (MSDSs) for the contaminants of concern are attached. The data sheets include information on the chemical/toxicological properties of the site contaminants and signs and symptoms of over exposure.

(2) DESCRIBE POTENTIAL FOR CONTACT WITH EACH MEDIA TYPE FOR EACH OF THE BATTELLE/ASU TASKS LISTED IN SEC 2.4:

BATTELLE TASK #	ROUTE OF EXPOSURE	POTENTIAL FOR CONTACT	METHOD OF CONTROL
B1	Inhal/Ingest/Contact/Absorb	High/Medium/Low	Level D PPE
B2	Inhal/Ingest/Contact/Absorb	High/Medium/Low	Level D PPE
B3	Inhal/Ingest/Contact/Absorb	High/Medium/Low	Level D PPE
B4	Inhal/Ingest/Contact/Absorb	High/Medium/Low	Level D PPE

The SSO will brief the field team on interpretation of the attached MSDSs and particularly on symptoms and signs of over exposure to chemical hazards.

SECTION 5: HAZARD COMMUNICATION PROGRAM

If chemicals are introduced to the site by Battelle (e.g., decontamination liquids, preservatives, etc.), bring a copy of the Battelle Hazardous Communication Program and associate MSDSs to the site. The SSO will review this information with all field personnel. The current list of chemicals for this site is:

1,1,2-Trichloroethane	Alcohol
1,1,2,2-Tetrachloroethane	Trichloroethene
HCL (preservative)	Tetrachloroethene
Liquinox®	1,2-dichloroethene (cis- and trans-), Vinyl chloride

SECTION 6: ENVIRONMENTAL MONITORING

(1) The following environmental monitoring instruments shall be used on site at the specified intervals for breathing zone monitoring:

	EQUIPMENT	MONITORING PERIOD		ACTION LEVEL
□	Combustible Gas Indicator	daily/hourly/continuous/other		
□	O_2 Meter	daily/hourly/continuous/other		
□	PID (Lamp ____10.6_ eV)	daily/~~hourly/continuous/other~~		
□	FID	daily/hourly/continuous/other		
□	Radiation Meter (Gamma)	daily/hourly/continuous/other		
□	Respirable Dust Meter	daily/hourly/continuous/other		
□	GC/ECD/FID	daily/hourly/continuous/other		
√	GC/FID/PID/DELCD	daily/~~hourly/continuous/other~~		
		daily/hourly/continuous/other		

(2) Monitoring equipment is to be calibrated according to the manufacturers' instructions daily prior to and after each day of use. Record calibration data and air concentration in the Health and Safety on-site logbook.

(3) Action Levels for work shutdown and excavation. These are average values. Consideration should be given to the potential for release of highly toxic compounds from the waste or from reaction by-products. Levels are for persistence (> 10 min).

	ACTION LEVEL
Uncharacterized Airborne Vapors or Gases	>Background
Characterized Airborne Gases, Vapor, Particulates	**>50% PEL, REL, TLV**
Oxygen	< 19.5; >23.5
Flammability	> 10% LEL

(4) Military and/or civilian personnel in charge of buildings adjacent to invasive monitoring activities will be notified via a health and safety kick-off meeting of site activities. A copy of this HASP will be provided. If any action levels are reached at the work area as described above or if discernible odors are released as a result of field activities, the personnel in charge or their designated representative will be notified immediately. Hourly perimeter monitoring (support zone) will be conducted to assess whether organic vapors or odors are leaving the work area.

SECTION 7: HEALTH AND SAFETY TRAINING/MEDICAL MONITORING PROGRAM

The project staff is included in the Battelle Health and Safety Training and Medical Monitoring Programs in conformance with 29 CFR 1910.R.

HAZWOPPER TRAINING

NAME	MEDICAL (Date)	INITIAL (Hrs/Date)	REFRESHER (Date)	CPR/FA/ (Dates)
Sam Yoon	Feb 2005	40 hours/Jan 16, 1997	June 17, 2005	8/25/2005; 6/27/2003 (good for 3 years)
Shane Walton	Nov 2004	40 hours/April 1994	January 13, 2006	10/27/2005; 5/28/2004 (good for 3 years)
Jennifer Triplett		40 hours/June 2001	August 7, 2005	
Paul Dahlen		40 hours/Nov 1992	January, 2005 (Refresher sched. for Feb 2006)	

SECTION 8: PERSONAL MONITORING

☐ No personal exposure monitoring or heat/cold stress monitoring will take place on site. If the need for such monitoring is anticipated, this HASP will be modified as accordingly.

SECTION 9: CONFINED SPACE ENTRY

☐ No confined space and/or trench entries will take place on site. If the possibility of such entries taking place exists, this HASP will be modified accordingly.

SECTION 10: COMMUNICATION PROCEDURES

The following standard hand signals will be used in case of failure to radio communications in each contaminant reduction zone:

Hand gripping throat	Can't Talk, Having difficulty breathing
Grip partner's wrist and both hands around wrist	Can't Talk, Leave area immediately
Hands on top of head	Need assistance
Thumbs up	OK, I am all right, I understand
Thumbs down	No, negative

If applicable, telephone communications to the Command Post Should be Established as soon as possible. The stationary and/or mobile phone number(s) will be available one week prior to the start of field work. The HASP will be amended when these numbers are available.

The command post telephone is 757-322-4630

The mobile phone is ____________________

SECTION 11: DECONTAMINATION PROCEDURES

Personnel and equipment leaving an exclusion zone shall be thoroughly decontaminated at the decontamination facility constructed at the command post. The SSO is responsible for monitoring adherence with this decontamination plan. A Modified Level D decontamination protocol shall be used with the following decontamination stations:

(1) Equipment Drop (IF NECESSARY)
(2) Boot Covers, and Glove Wash and Rinse (IF NECESSARY)
(3) Outer Boot and Glove Removal (IF NECESSARY)
(4) Outer Garment Removal (IF NECESSARY)
(5) Inner Glove Removal (IF NECESSARY)
(6) Field Hand Wash

The following decontamination equipment is required (check or circle all that apply)

√	Decon Pad (Plastic Sheet)	☐	Dry Brushes	√	Detergent Soap
√	Trash Cans/Bags	√	Wet Brushes	☐	Other Decontamination Solution
√	Buckets	√	Water		____________________
					____________________

SECTION 12: EMERGENCY PROCEDURES

On site personnel will use the following standard emergency procedures. The SSO shall be notified of any on site emergencies and be responsible for ensuring that the procedures are followed.

Personal Injury in the Exclusion Zone

DESIGNATED EMERGENCY SIGNAL: Air Horn

Upon notification of an injury in the Exclusion Zone, the designated emergency signal shall be sounded. All site personnel shall assemble at the decontamination line. The SSO or alternate should evaluate the nature of the injury, and the affected person should be decontaminated to the extent possible prior to movement to the Support Zone. The on site CPR/FA personnel shall initiate the appropriate first aid, and contact should be made for an ambulance (and other emergency services as needed) and with the designated medical facility (if required). No persons shall reenter the Exclusion Zone until the cause of the injury or symptoms is determined.

Fire/Explosion

DESIGNATED EMERGENCY SIGNAL: Air Horn

Upon notification of a fire or explosion on site, the designated emergency signal shall be sounded and all site personnel assembled at the decontamination line. The fire department shall be alerted and all personnel moved to a safe distance from the involved area.

Equipment Failure

If any other equipment (i.e., air monitoring) on site fails to operate properly, the Field Team Leader and SSO shall be notified and then determine the effect of this failure on continuing operations on site. If the failure affects the safety of personnel or prevents completion of the Work Plan tasks, all personnel shall leave the Exclusion Zone until the situation is evaluated and appropriate actions taken.

Emergency escape routes are designated for use in those situations where egress from the Exclusion Zone cannot occur through the decontamination line

In all situations, when an on site emergency results in evacuation of the Exclusion Zone, personnel shall not reenter until:

(1) The conditions resulting in the emergency have been corrected.
(2) The hazards have been reassessed by the SSO.
(3) The Site Safety Plan has been reviewed by the SSO and Corporate Health and Safety Manager.

SECTION 13: SPILL CONTROL PROCEDURES

☐ No containers of liquid or solids exist on site, and no spill control plan is necessary. If the possibility of such conditions exist on site, this HASP will be modified accordingly.

SECTION 14: EMERGENCY INFORMATION

(1) LOCAL RESOURCES

Ambulance (name):	Onslow Memorial Hospital Ambulance	Phone:	911
Hospital (name):	Onslow Memorial Hospital	Phone:	911 or (910) 577-2345
Police (local or state):	MC Camp Lejeune Police	Phone:	911
Fire (name):	MC Camp Lejeune	Phone:	911
HAZ MAT Responder:	National Response Center, Toxic Chemicals and Oil Spills	Phone:	911
On-Site CPR/FA(s):	Sam Yoon	Phone:	614-537-5658

* For life-threatening emergencies or emergency trauma care.
The above hospital is approximately 10 miles from the furthest work area and the ambulance response time is approximately 15 minutes.

** For non-life threatening medical care.
The above hospital is approximately 30 minutes from the furthest work area. Injured workers will be transported here for non-emergency treatment only.

DIRECTIONS TO NEAREST HOSPITAL – SEE ATTACHED MAP:

(2) Figure 1.

(3) BATTELLE RESOURCES

Manager, Corporate Health and Safety (ETE Division) Site Contact: Sam Yoon: 614-424-4569

Gary Carlin, 614-424-4929

Battelle Security Office
(614) 424-4444

SECTION 15: PERSONAL PROTECTIVE EQUIPMENT (check or circle all that apply)

☐ No type of respiratory protection is required on this site. If the possibility of the need for respiratory protection is anticipated, this HASP will be modified accordingly.

CLOTHING		GLOVES		BOOTS		OTHER	
☐	Coveralls	☐	Cotton	☐	Safety	√	Hard Hat
☐	Tyvek	√	Leather	☐	Fireman/Hip	√	Glasses
☐	Saranex	√	Nitrile	☐	Neoprene	☐	Goggles
☐	PE Tyvek	☐	Butyl	√	Steel Toe	☐	Face Shield
☐	Other:	☐	Neoprene			√	Hearing Protection
	____________	☐	Viton				
	____________	☐	PVC				
	____________	☐	PVA				
		☐	Latex				

SECTION 16: SAFE WORK PRACTICES

THE FOLLOWING PRACTICES MUST BE FOLLOWED BY PERSONNEL ON SITE

1. Smoking, eating, chewing gum or tobacco, or drinking are forbidden except in clean or designated areas.
2. Ignition of flammable liquids within or through improvised heating devices (e.g., barrels) is forbidden.
3. Contact with samples, excavated materials, or other contaminated materials must be minimized.
4. Use of contact lenses is prohibited at all times.
5. Do not kneel on the ground when collecting samples.
6. If drilling equipment is involved, know where the kill switch is.
7. All electrical equipment used in outside locations, wet areas, or near water must be plugged into ground fault circuit interrupter (GFCI) protected outlets.
8. A "Buddy System" in which another worker is close enough to render immediate aid will be in effect.
9. Good housekeeping practices are to be maintained.
10. Where the eyes or body may be exposed to corrosive materials, water suitable for quick drenching or flushing shall be available for immediate use.
11. In the event of treacherous weather-related working conditions (i.e., thunderstorm, limited visibility, extreme cold or heat) the field task will be suspended until conditions improve or appropriate protection from the elements is provided.

SECTION 17: EMPLOYEE ACKNOWLEDGMENTS

PLAN REVIEWED BY:		DATE
H&S Manager:	Linc Remmert	
Principal Investigator	Bruce Alleman; Paul Johnson	
Project Leader:	Sam Yoon	
Site Safety Officer:	Sam Yoon	

I acknowledge that I have read the information in this HASP form and the attached MSDSs. I understand the site hazards as described and agree to comply with the contents of the plan.

FIELD PERSONNEL (Print Name)	SIGNATURE	DATE

VISITOR (Print Name)	SIGNATURE	DATE
Organization/Agency		
Organization/Agency		

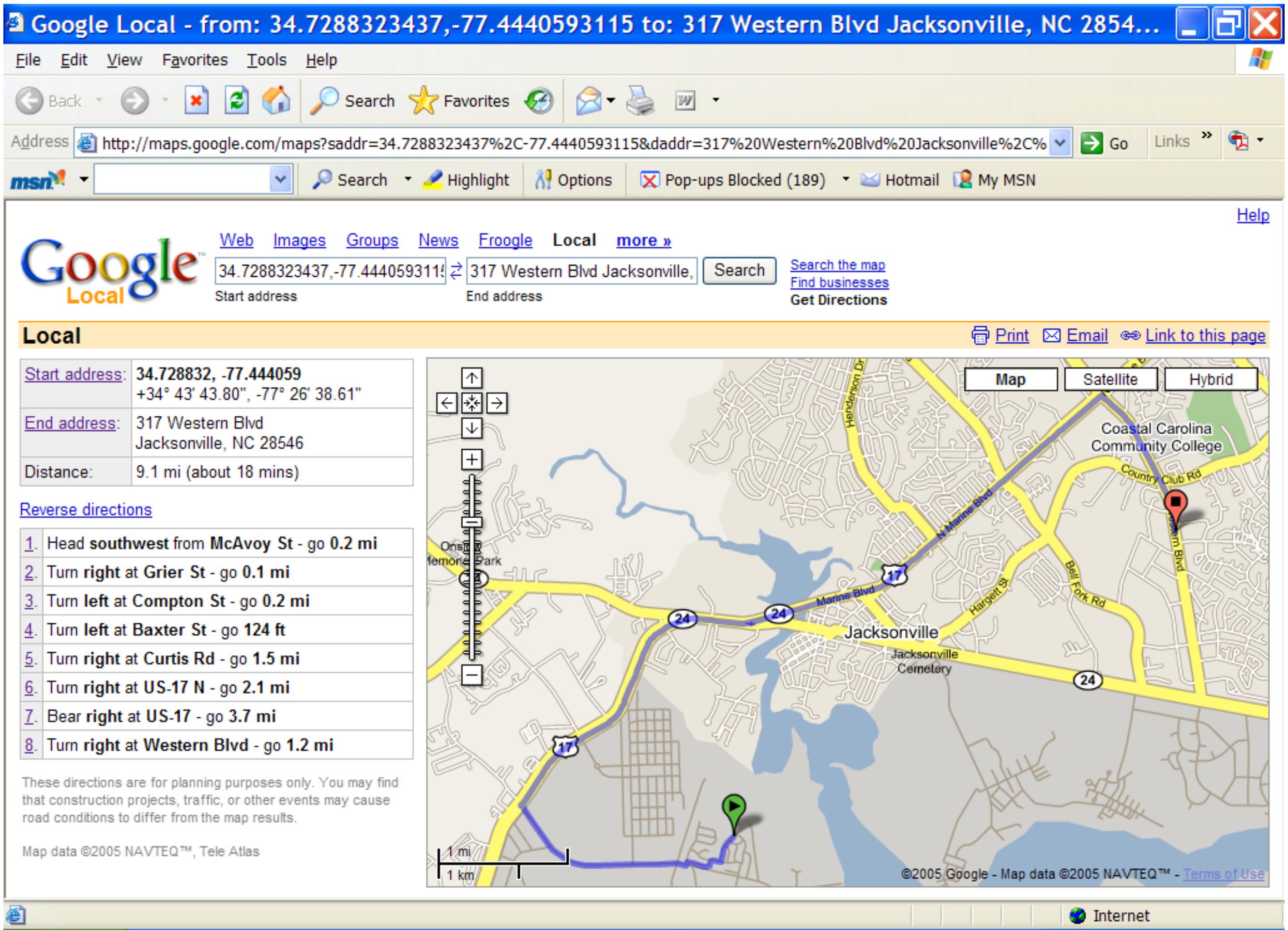


Figure 1. Directions to Onslow Memorial Hospital

Draft Final

Data Analysis Report
Camp LeJeune – Site 89

Critical Evaluation of the State of In Situ Thermal Treatment Technologies for DNAPL Source Zone Treatment

Prepared for:

Environmental Security Technology Certification Program
Arlington, VA

Prepared by:

Arizona State University
Battelle Memorial Institute

June 2006

The vendors and products, including the equipment, system components, and other materials identified in this report, are primarily for information purposes only. Although some of these vendors and products may have been used in the past, mention in this report does not constitute a recommendation for using these vendors or products.

Contents

Figures

Tables

Acronyms and Abbreviations

bgs	below ground surface
cis-1,2-DCE	cis-1,2-dichloroethene
DELCD	dry electrolytic conductivity detector
DO	dissolved oxygen
EC	electrical conductivity
ERH	electrical resistance heating
ESTCP	Environmental Security Technology Certification Program
FID	flame-ionization detector
ft	feet
GC	gas chromatography
kg	kilogram
NAPL	non-aqueous phase liquid
ORP	oxidation reduction potential
PID	photo-ionization detector
temp	temperature
TCE	trichloroethylene
VOA	volatile organic analysis
yr	year

1. Introduction

The post treatment field investigation of Camp LeJeune under ESTCP project CU-0314, *Critical Evaluation of State of In Situ Thermal Treatment Technologies*, was performed February 23 through March 3, 2006. Figure 1 identifies the extent of the previous electrical resistance heating (ERH) remediation area, which was also the specific area of interest for this particular field investigation.

Consistent with the objectives set forth under the CU-0314 Demonstration Plan, the field investigation at this site included the following:

- Verification of the site hydrogeological conceptual model
- Groundwater sampling of monitoring wells
- Depth-discrete analysis of hydraulic conductivity and dissolved petroleum hydrocarbons at temporary sampling locations downgradient of the treatment zone.

2. Field Investigations

In accordance with the approved generic demonstration plan for this project, the following site-specific activities were conducted:

(1) Verification of the site hydrogeological conceptual model:

a. For confirmation of geology, one continuous soil cores was collected at direct-push sampling locations GP1 shown in Figure 2. The continuous soil core/ direct-push sampling location was located at the down-gradient edge of the treatment zone. Table 1 presents qualitative geologic descriptions from visual observations of the continuous soil core.

b. Hydraulic conductivity slug testing was conducted in 14 monitoring wells as identified in Table 2 and in Figure 3. The slug test data were analyzed using both the Hvorslev and the Bouwer and Rice Methods; results are presented in Table 3. The Hvorslev' expression for determining hydraulic conductivity from slug test data is:

$$K=(r^2\ln(L_e/R))/(2L_et_{37})$$

Where K = hydraulic conductivity (L/T)
r = radius of well casing (L) (0.083 ft)
R = radius of well screen (L) (0.50 ft)
L_e = length of well screen (L) (5 or 10 ft)
t_{37} = time for water level to rise or fall 37% of the initial change (T) (from data set)
(Fetter, 2000).

The Bouwer and Rice expression for determining hydraulic conductivity from slug test data is:

$$K=(r_c^2 \ln(R_e/R) / (2L_e)) * ((1/t) \ln(H_o/H_t))$$

Where K = hydraulic conductivity (L/T)
r_c = radius of well casing (L) (0.083 ft)
R = radius of gravel envelope (L) (0.50 ft)
R_e = effective radial distance over which head is dissipated (L) (from data set)
L_e = length of well screen (L) (5 or 10 ft)
H_o = drawdown at t=0 (L) (from data set)
H_t = drawdown at t=t (L) (from data set)
t = time since $H = H_o$ (T) (from data set)
(Fetter, 2000).

c. Depth-to-groundwater was measured in the 14 groundwater monitoring wells identified in Table 2 and in Figure 4. Depth-to-water measurements are summarized in Table 4.

(2) Collection of water quality samples from 26 groundwater monitoring wells within the treatment zone for analysis of dissolved chlorinated hydrocarbon groundwater concentrations:

a. Table 2 identifies the groundwater monitoring wells from which samples were collected. Prior to sample collection, three well-volumes were purged. Groundwater was then collected for analysis of field parameters and stored in volatile organic analysis (VOA) vials for analysis of dissolved chlorinated hydrocarbon concentrations. General water quality field parameters including pH, electrical conductivity (EC), temperature, dissolved oxygen (DO), and oxidation reduction potential (ORP) were measured using an Horiba U-22 meter. Petroleum hydrocarbon analysis was performed on-site by heated-headspace analysis and gas chromatography (GC) using a dry electrolytic conductivity detector (DELCD), photo-ionization detector (PID) and a flame-ionization detector (FID). General water quality data for permanent groundwater monitoring well installations can be found in Table 5 and chemical concentration data can be found in Table 6. All non-detect samples are listed as less than the detection limit.

(3) Depth-discrete hydraulic conductivity and dissolved chlorinated hydrocarbon concentration data were collected on four foot intervals as possible from 3 ft below ground surface (bgs) to 40 ft bgs at all seven direct-push sampling locations.

a. Groundwater quality data were collected from depth-specific intervals at all direct-push sampling locations (See Table 2 and Figure 2). Sampling locations were spaced on approximately 50 ft centers, as possible, along a transect downgradient of the source zone and perpendicular to the direction of groundwater flow. Figure 2 presents the direct-push sampling locations. Using percussion assisted direct-push technology and a modified Geoprobe Groundwater Profiler, groundwater samples were collected using a peristaltic pump on 4-ft intervals from 3 ft bgs to 40 ft bgs. The location of the depth-discrete groundwater samples are shown in Figure 5. Dissolved chlorinated hydrocarbon concentration analysis was conducted, as described above, and the results are summarized in Table 7. General water quality parameters (e.g. pH, EC, temp, DO, and ORP) were also collected during depth-specific sampling, and those data are presented in Table 8.

b. Aquifer specific-capacity tests were conducted at depth-specific intervals at direct push sampling locations GP1 through GP7 as indicated in Table 2 and Figure 3. Specific-capacity tests involve the measurement of the flow rate achieved under fixed drawdown and are analyzed using the Theim Equation to estimate hydraulic conductivity. The field data and results for aquifer testing are shown in Table 9. The Theim equation for hydraulic conductivity is:

$$T = (Q / (2(h_2 - h_1)) * \ln(r_2/r_1)$$

Where T = transmissivity (L^2/T)
Q = pumping rate (L^3/T)
h_1 = head at distance r_1 from the pumping well (L)
h_2 = head at distance r_2 from the pumping well (L)

and $K = T/b$

Where K = hydraulic conductivity (L/T)
b = length of sampler or screen section (L) (0.5 ft or length of screen)

(Fetter, 2000).

The monitoring well chemical concentration data collected in February/March 2006 by the ASU/Battelle team were compared to the previous monitoring well chemical concentration data available for the site. The analytical results for each are shown in Table 10. The comparability of these results can also be seen in Figure 6 (a through g). Note that the ASU/Battelle February/March 2006 results for vinyl chloride appear higher than previous Site 89 results and low concentration values of cis-1,2-DCE also appear to be higher, but all other chemical concentrations are comparable. Also note that the analytical detection limit was used to plot Figure 6 (a through g) when an exact concentration was not provided and estimated values were used, if possible. The results of MW-20 are not provided in the monitoring well chemical concentration data because non-aqueous phase liquid (NAPL) was pumped from the well during the purging process.

Figures 7 to 14 present contour plots of the chemical concentrations for each of the eight chemicals measured at the depth-discrete direct push sampling locations. Figure 15 presents the specific capacity pump test results for each discrete-depth direct push sampling interval overlaid on the trichloroethylene (TCE) concentration plot.

A TCE mass flux calculation was performed using the Mass Flux Toolkit, Version 1.0. This program is a freeware program developed by Groundwater Services, Inc. and others under a contract funded by the Environmental Security Technology Certification Program (ESTCP). Figure 16 is a snapshot of the input screen with TCE being used to perform the mass flux analysis. A linear spatial and vertical interpolation of the data was used for the mass flux analysis. The TCE mass flux was estimated to be 3.34E+01 kg/yr.

3. References

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

Figures

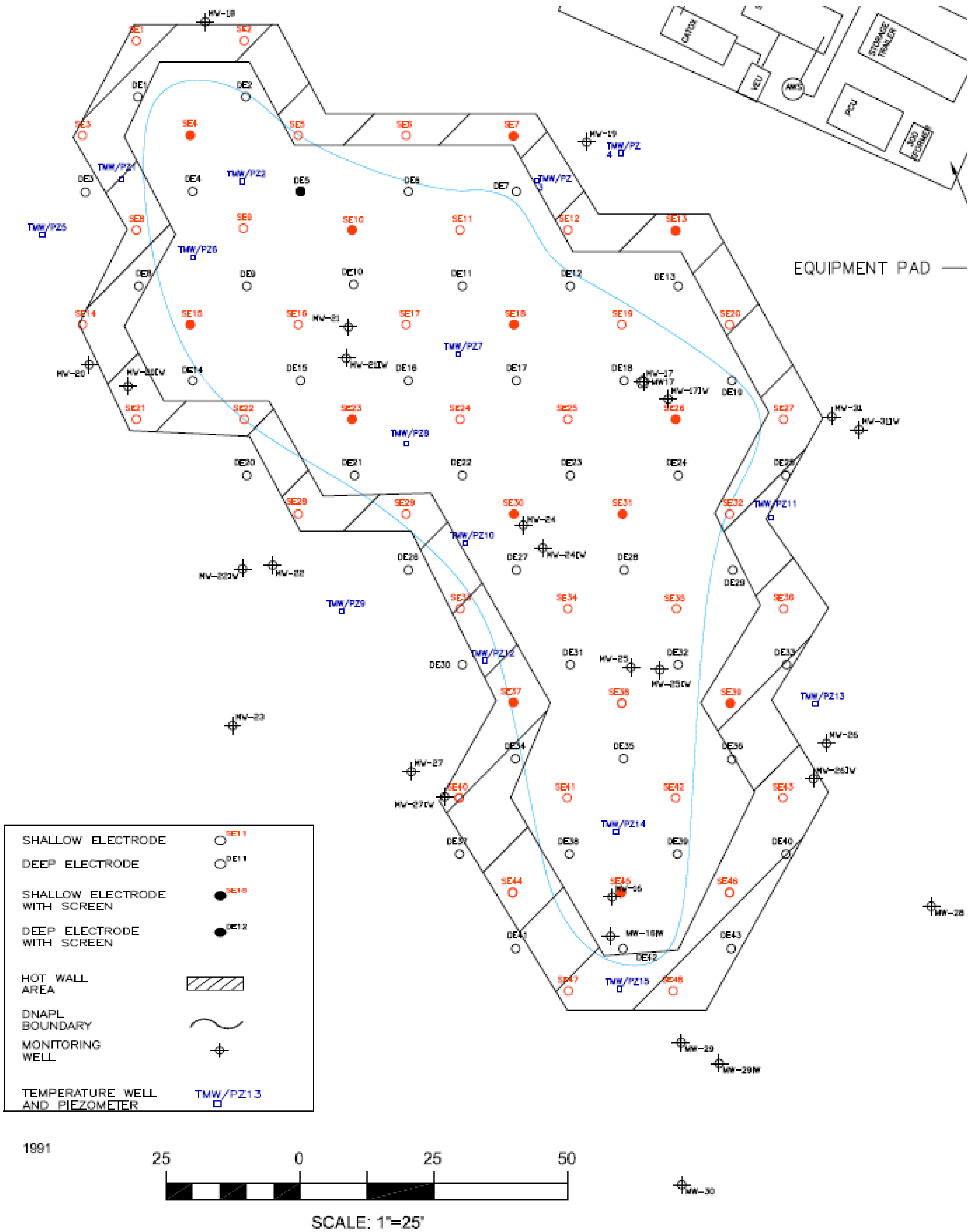


Figure 1. Site Map

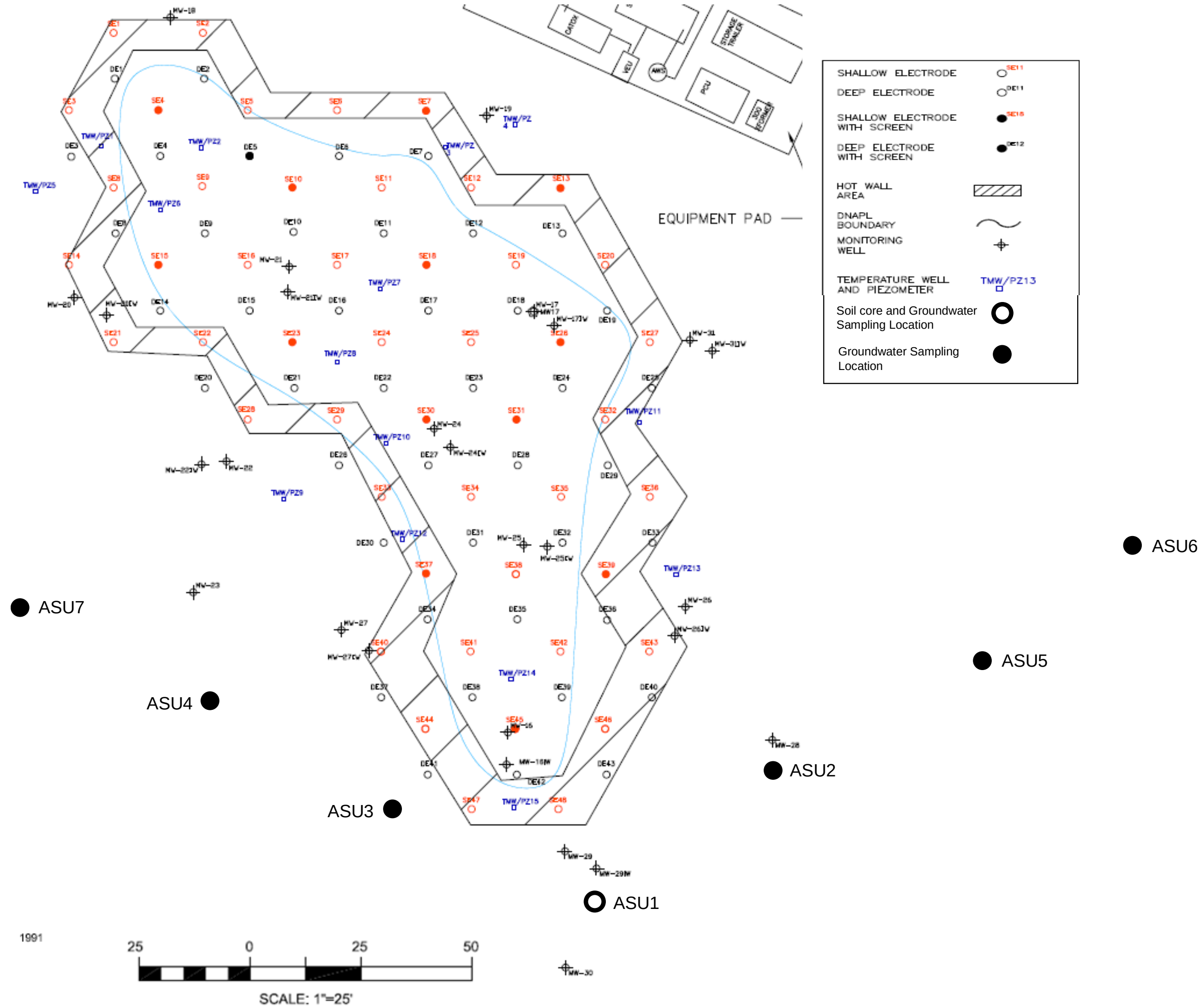


Figure 2. Direct-Push Locations

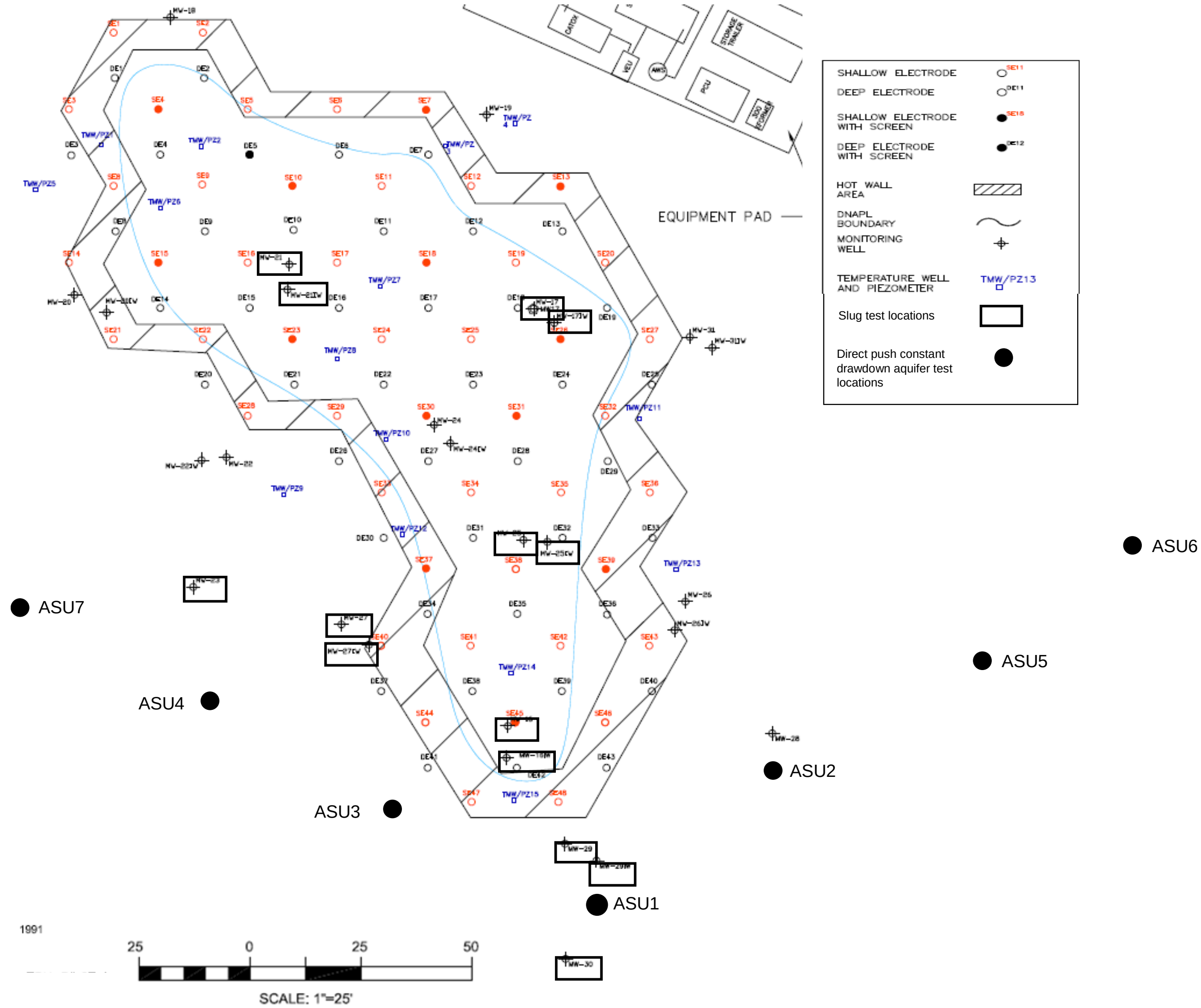


Figure 3. Hydraulic Conductivity Measurement Locations

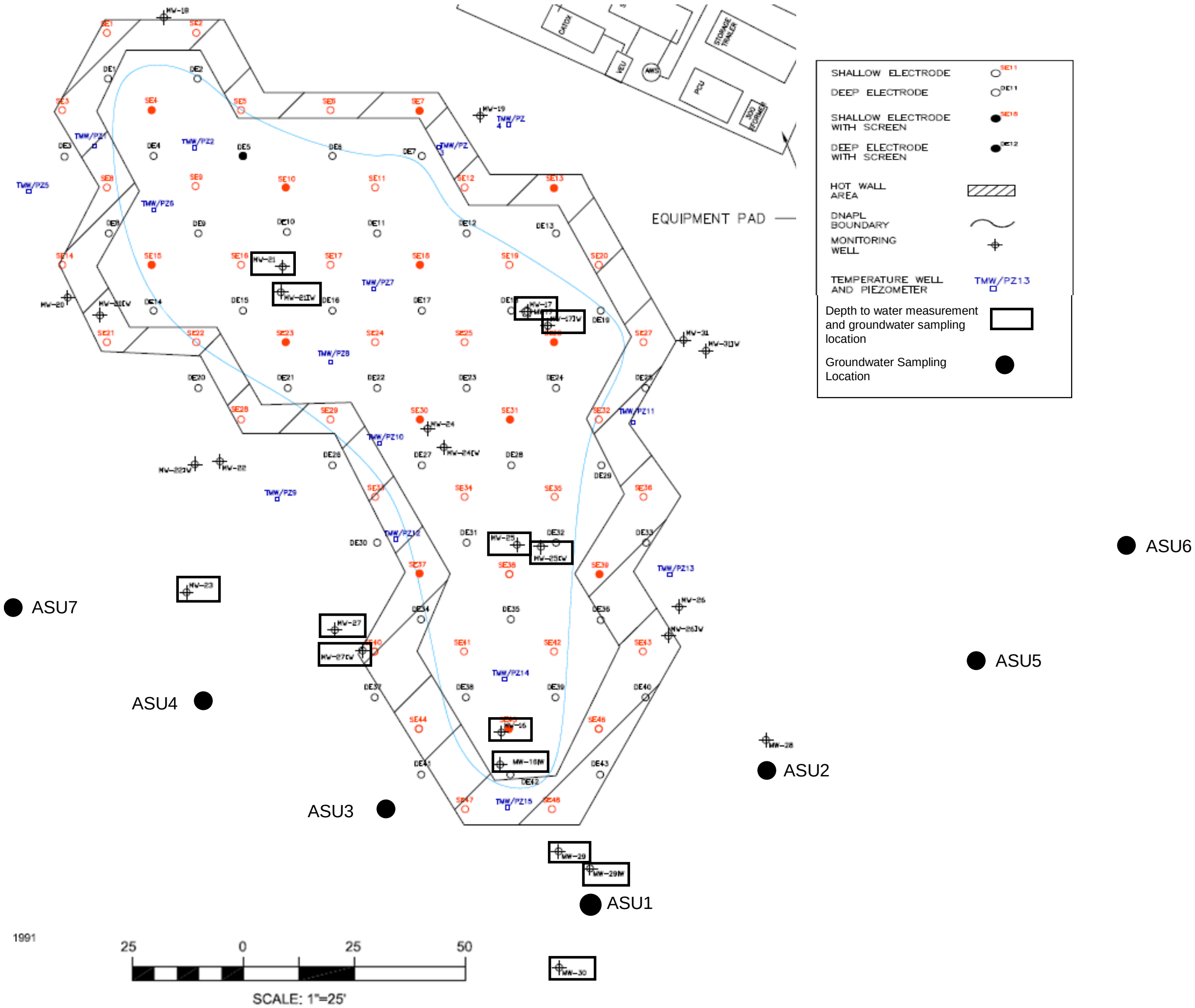
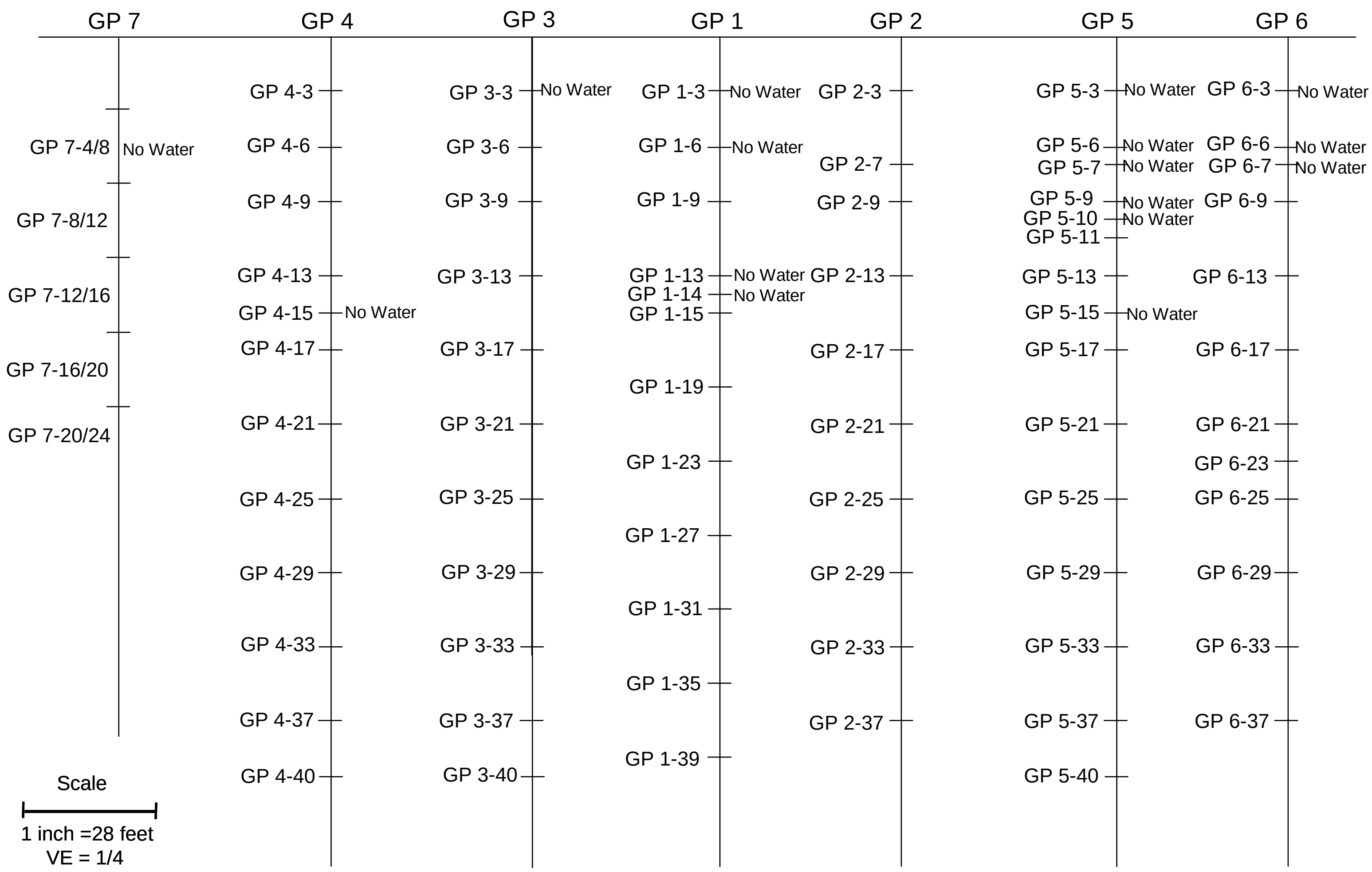


Figure 4. Monitoring Well Depth-to-Water Measurement and Groundwater Sampling Locations

Figure 5. Cross-section of Direct Push Sampling Locations



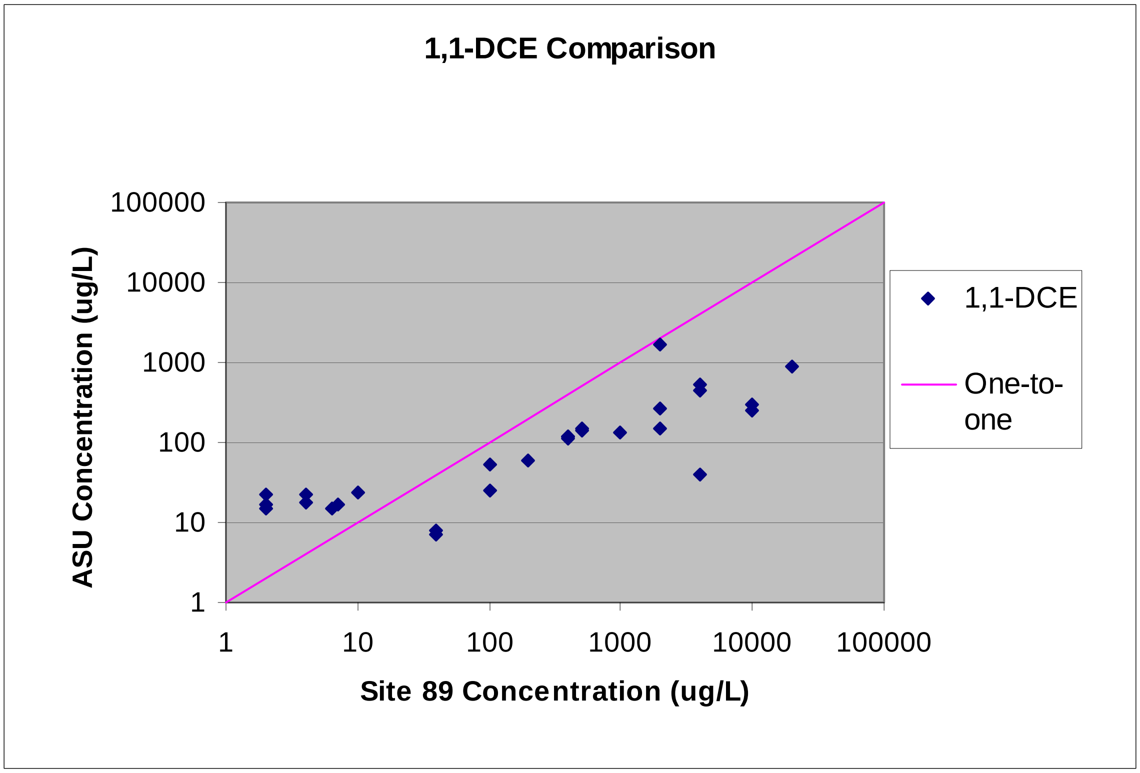


Figure 6(a)

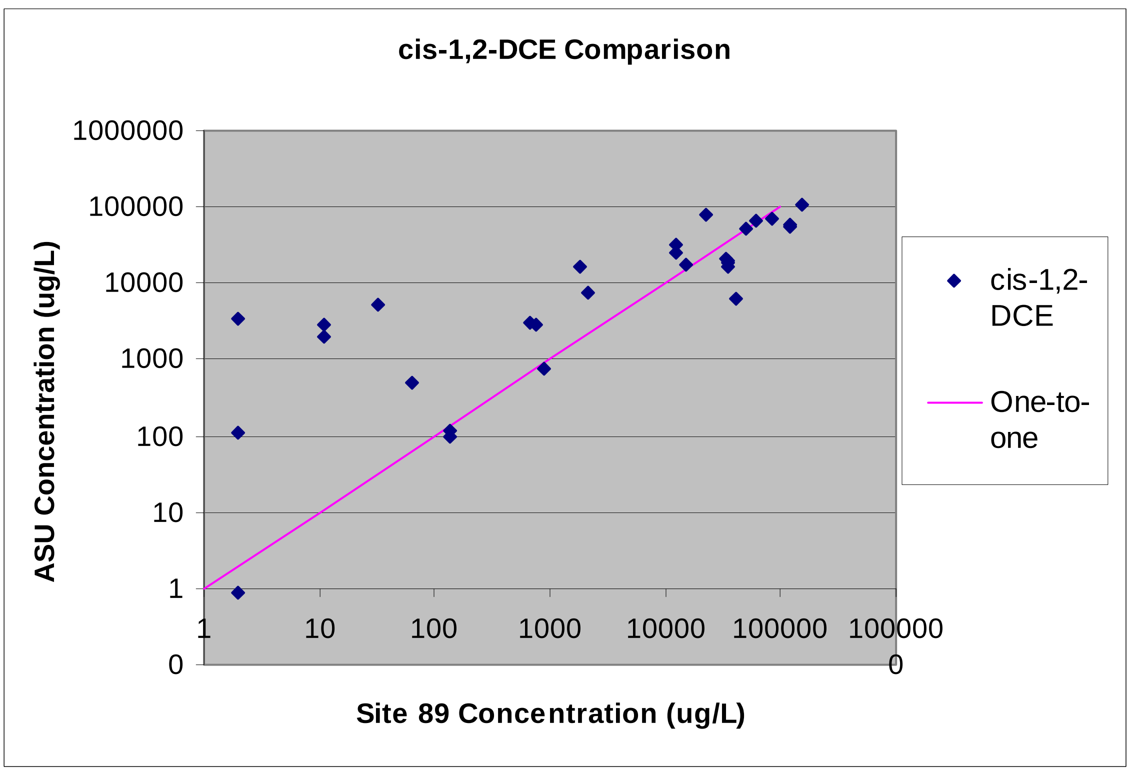


Figure 6(b)

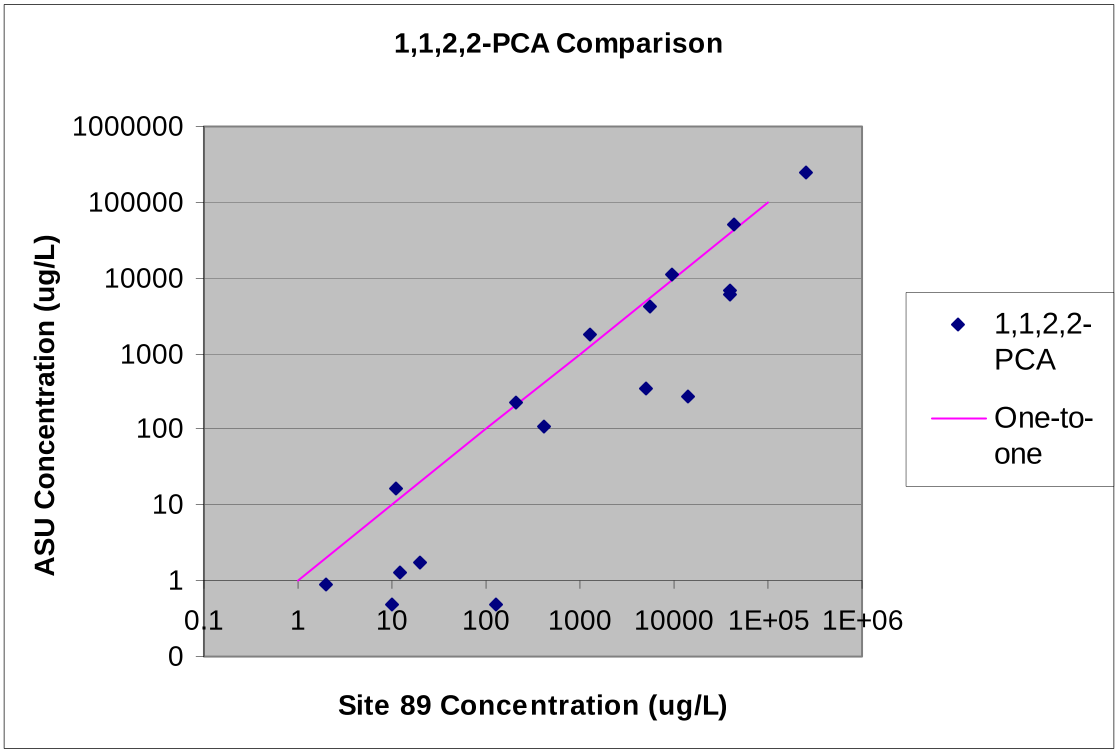


Figure 6(c)

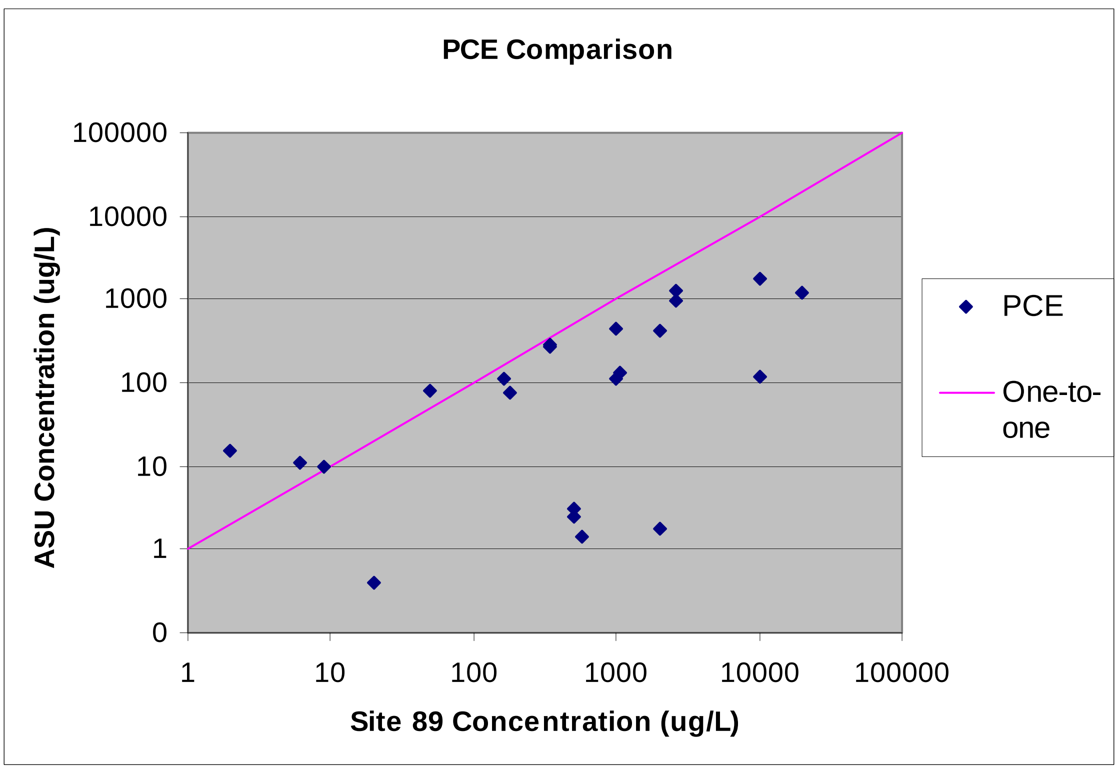


Figure 6(d)

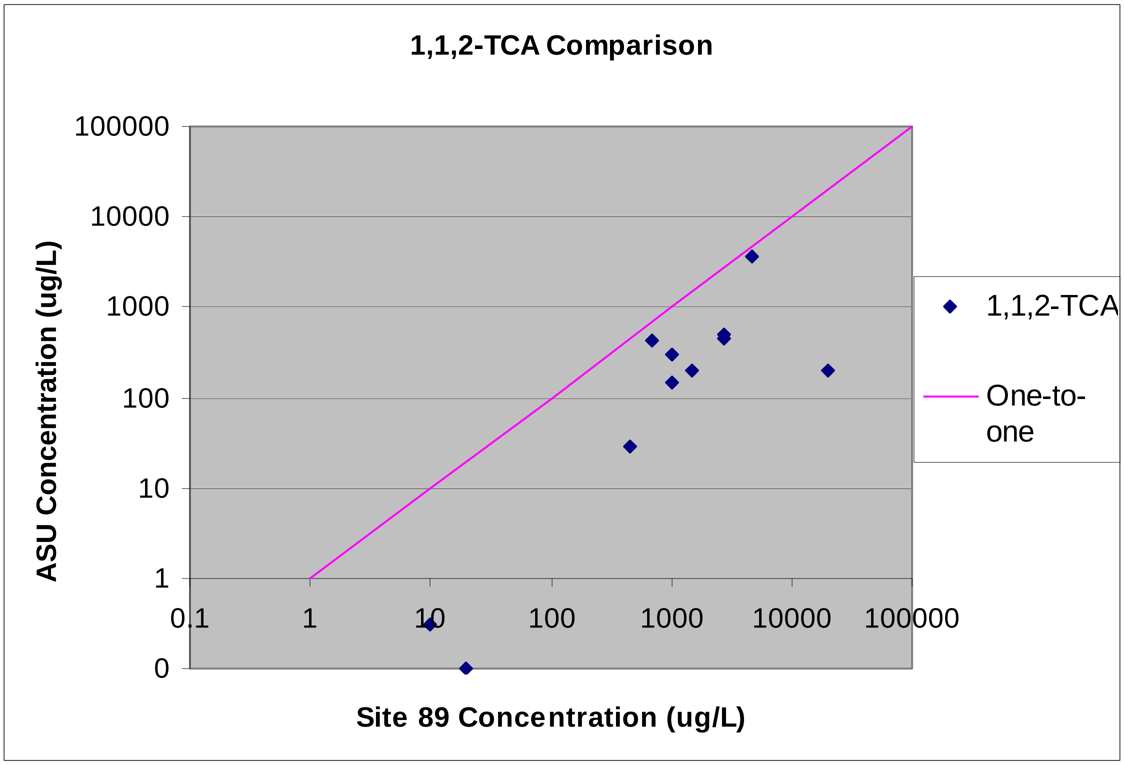


Figure 6(e)

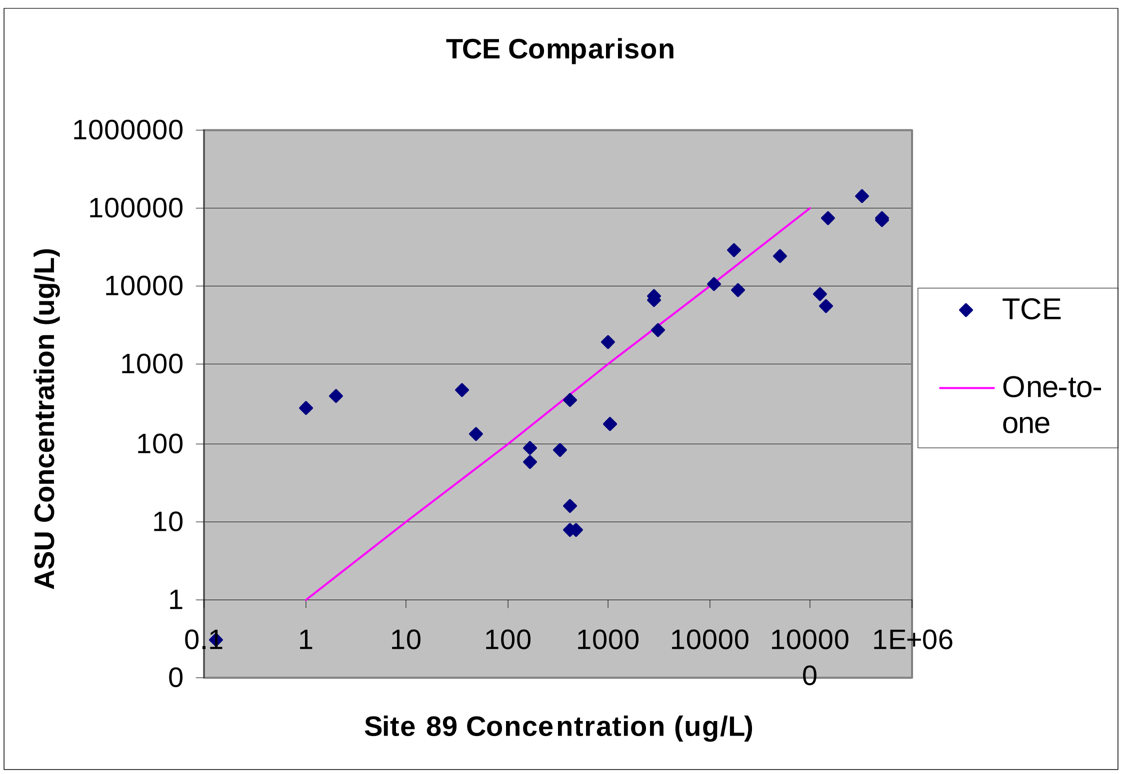


Figure 6(f)

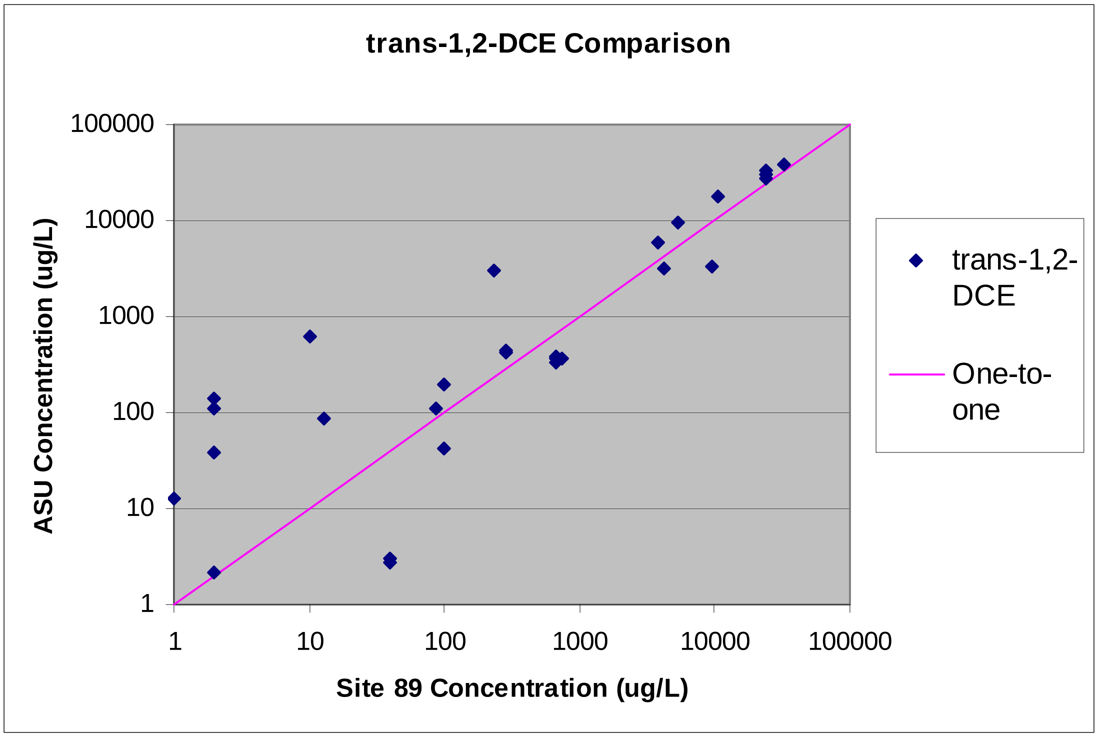


Figure 6(g)

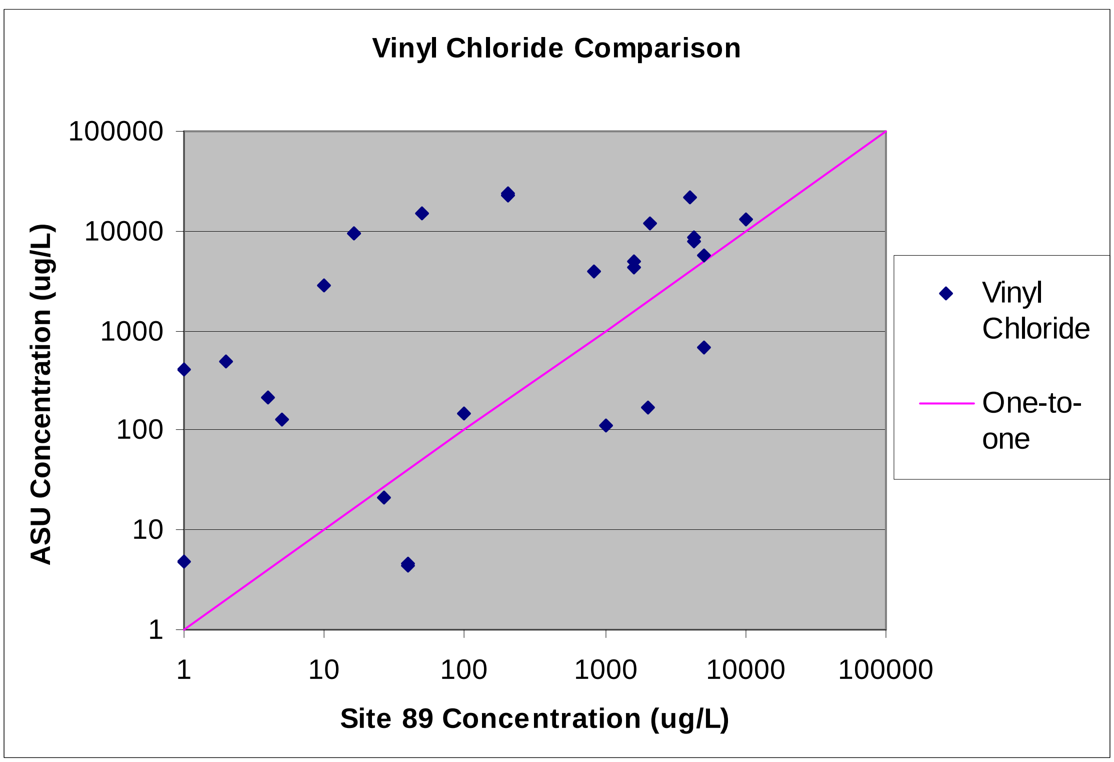


Figure 6(h)

Figure 6. Chemical-Specific Monitoring Well Concentration Data Comparison

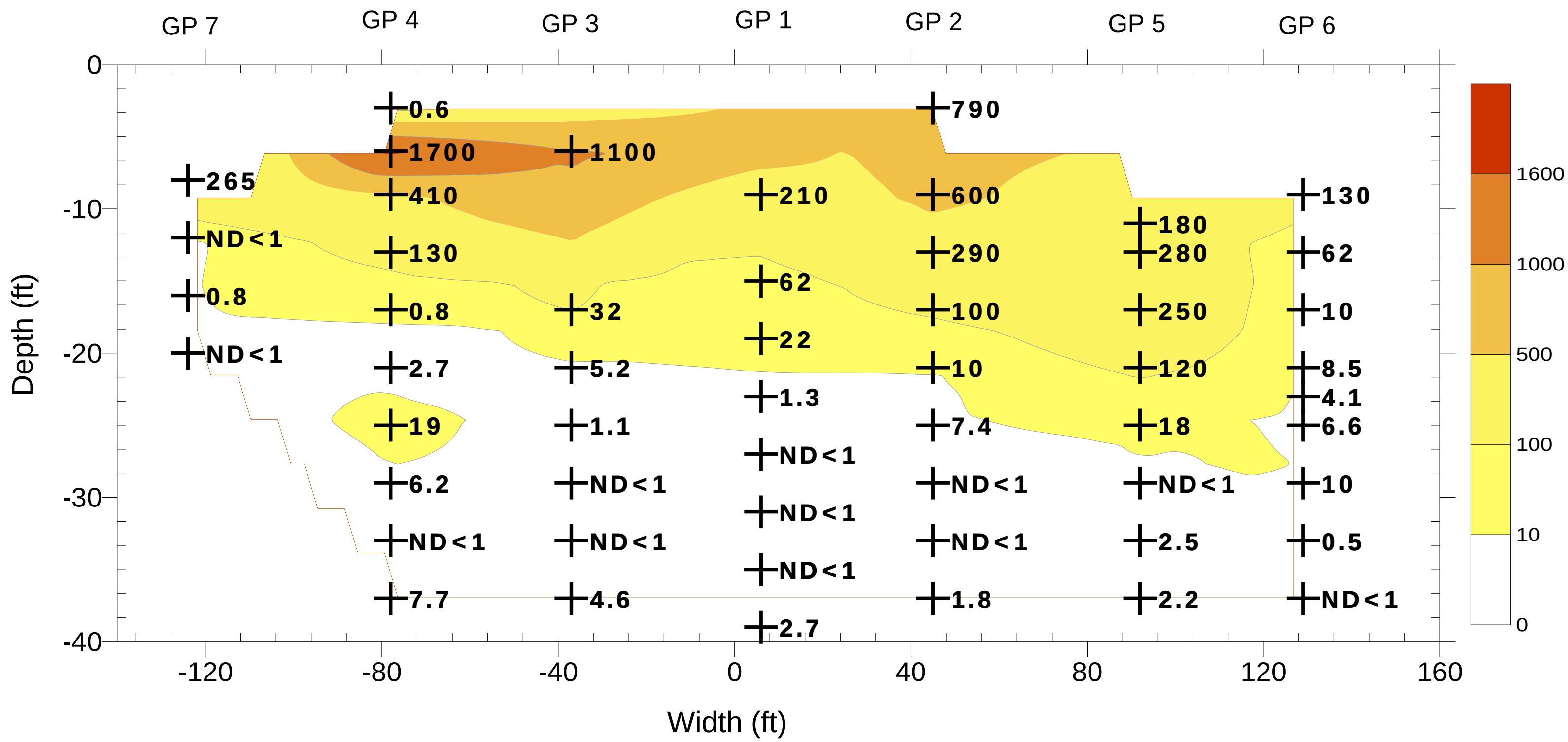


Figure 7. 1,1-Dichloroethene Direct-Push Groundwater Concentrations (µg/L)

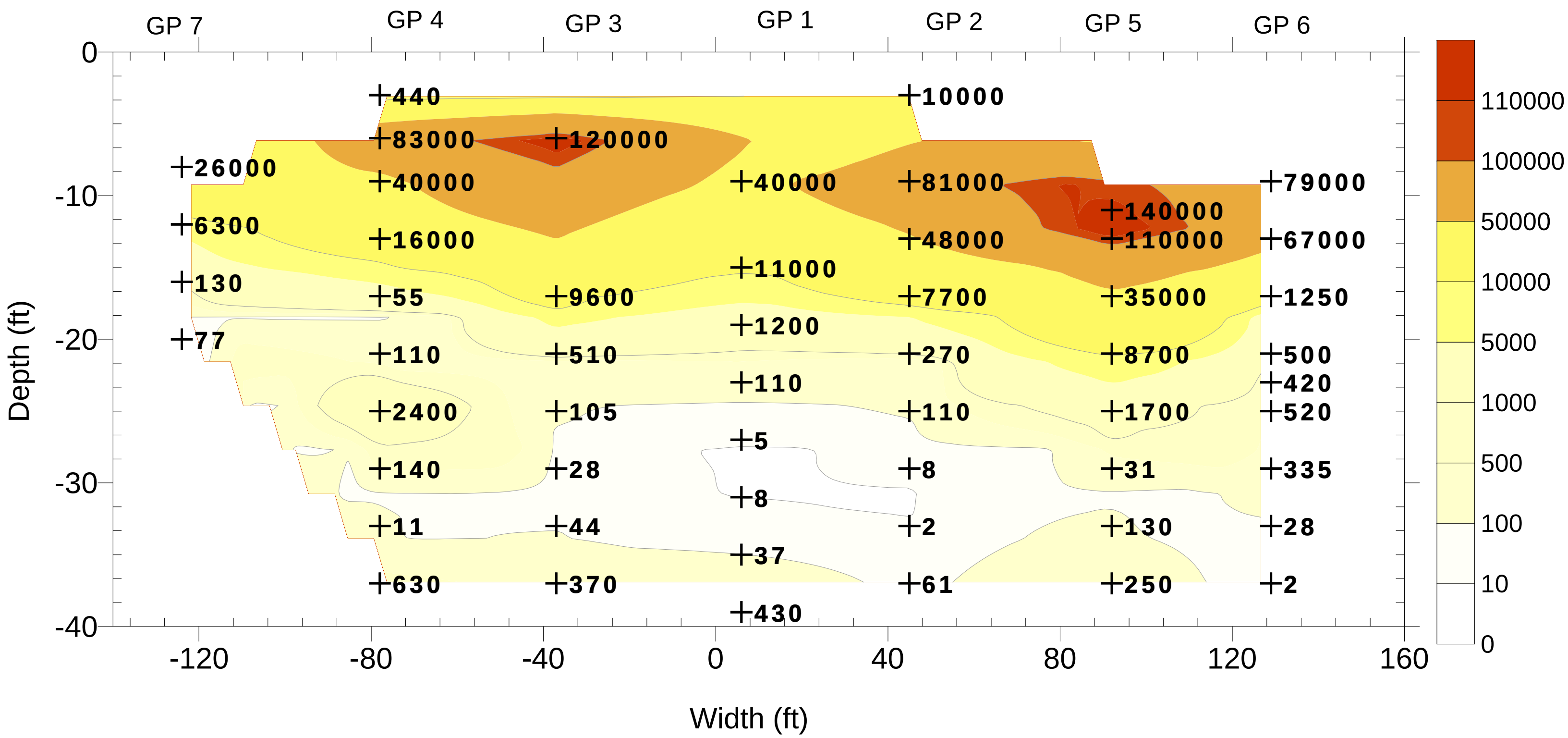


Figure 8. cis-1,2-Dichloroethene Direct-Push Groundwater Concentrations (µg/L)

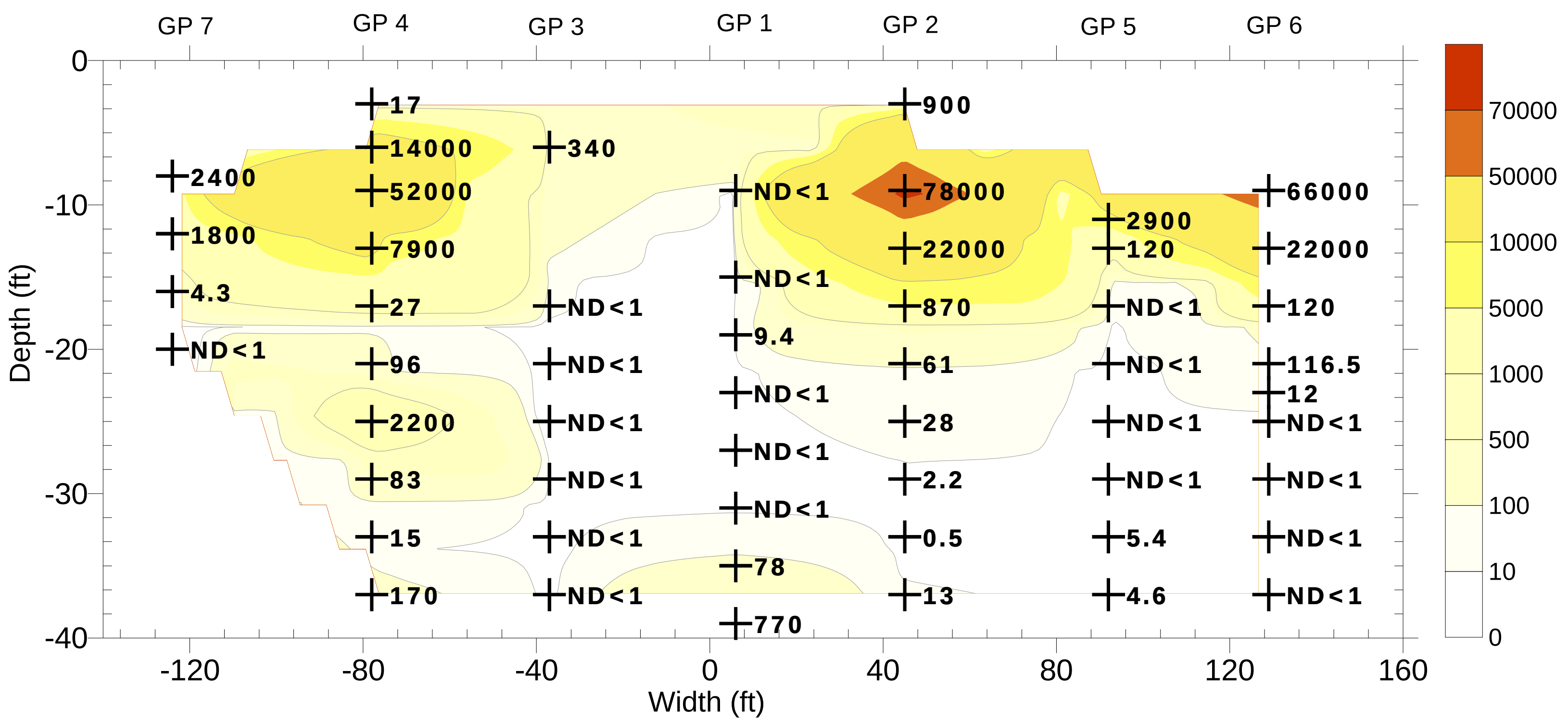


Figure 9. 1,1,2,2-Tetrachloroethane Direct-Push Groundwater Concentrations (µg/L)

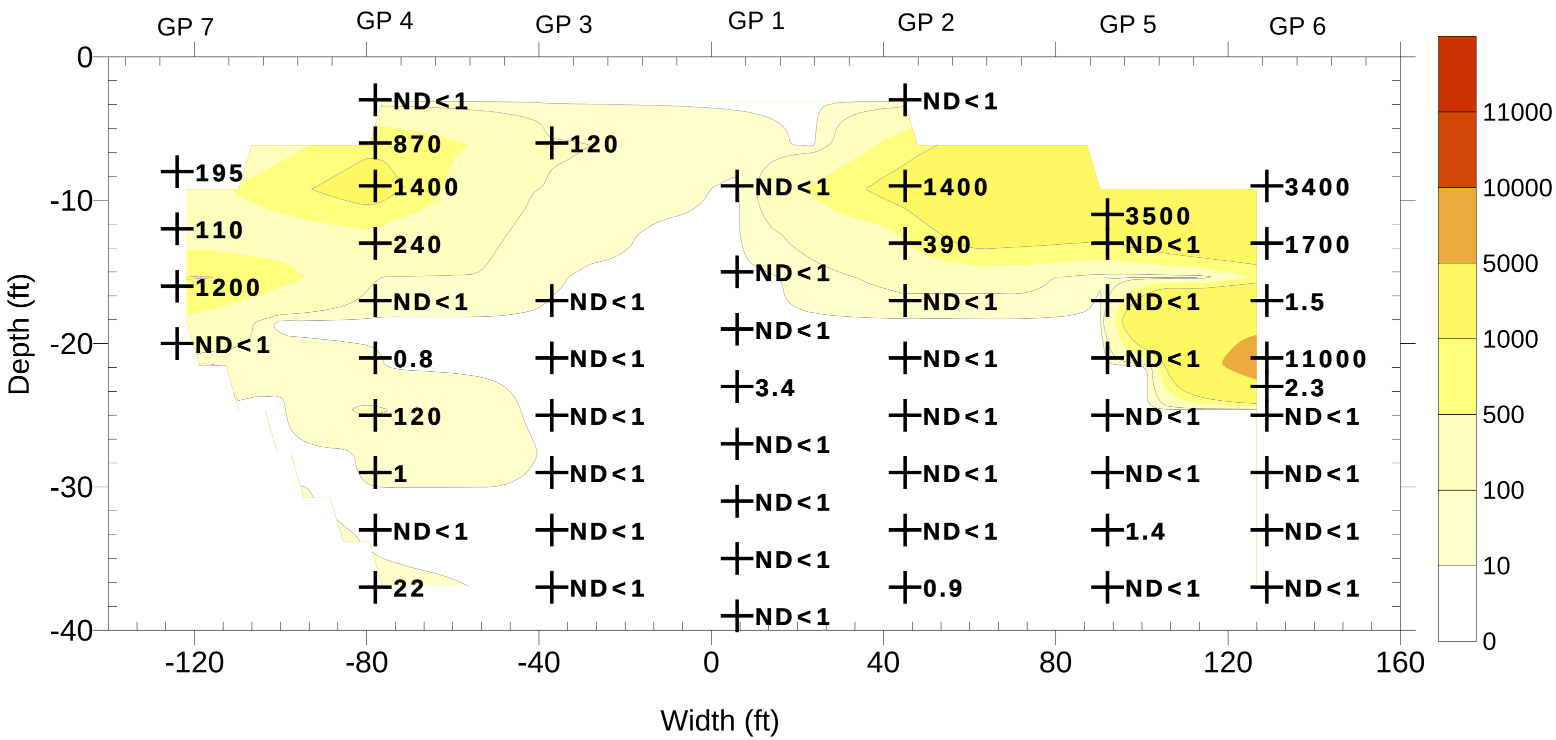


Figure 10. 1,1,2-Trichloroethane Direct-Push Groundwater Concentrations (μg/L)

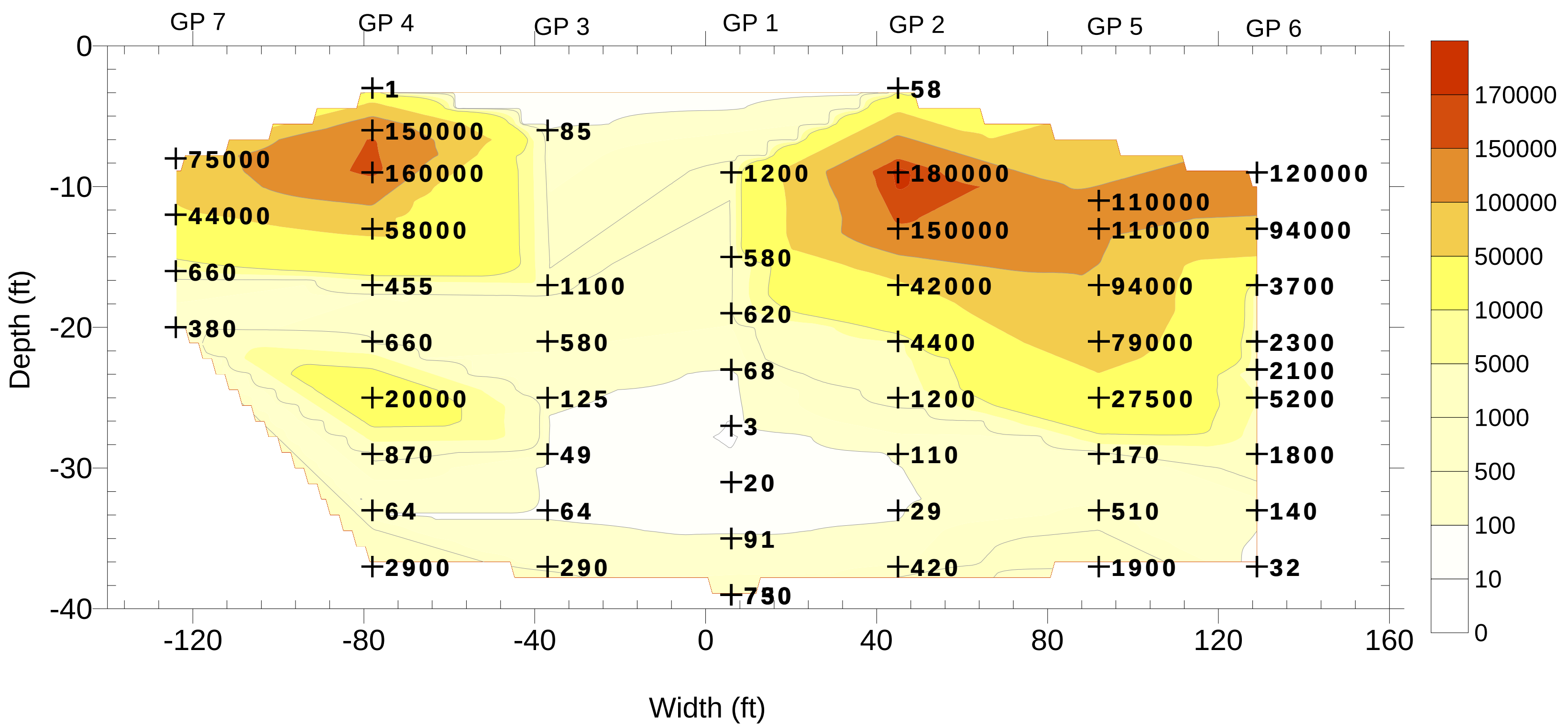


Figure 11. Trichloroethylene Direct-Push Groundwater Concentrations (µg/L)

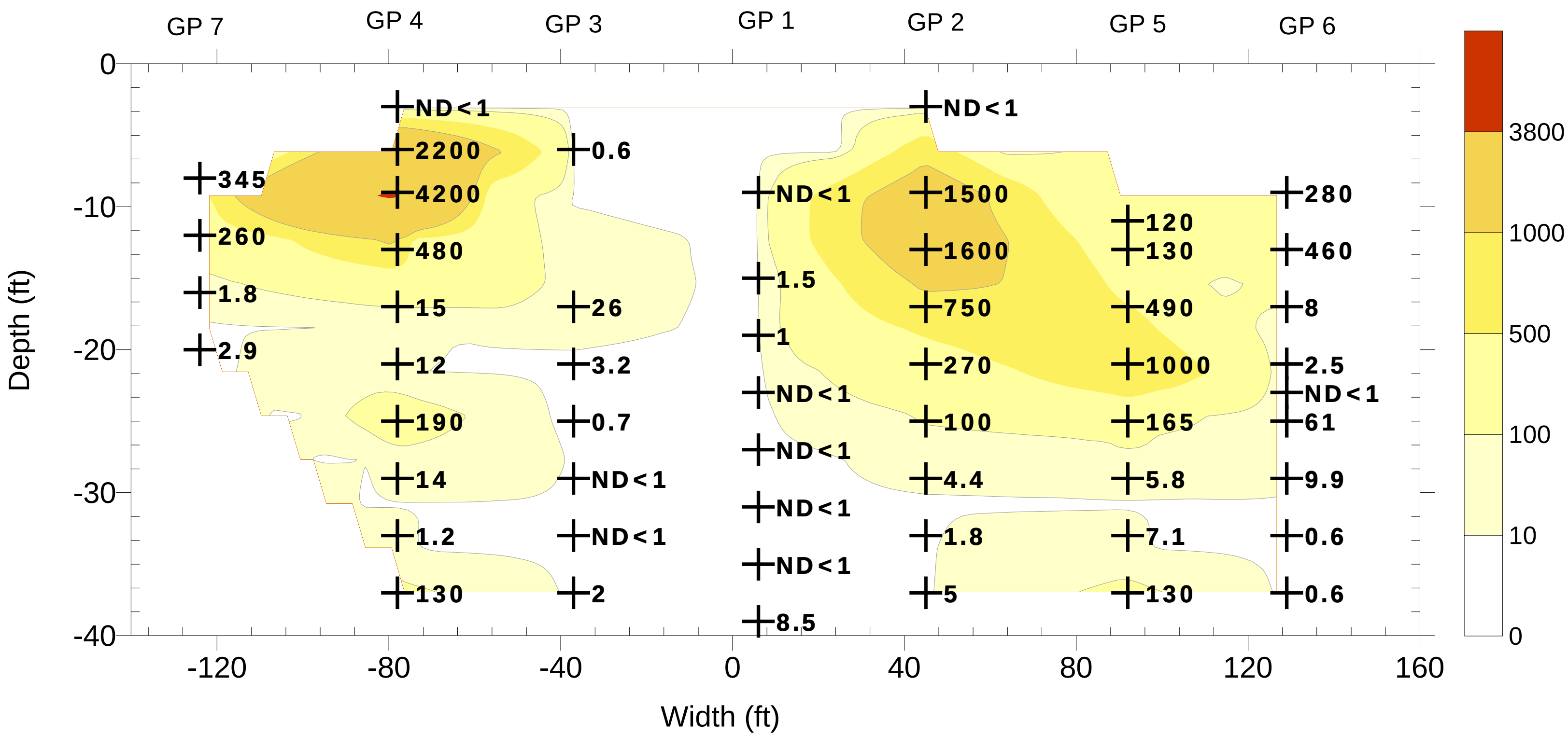


Figure 12. Tetrachloroethene Direct-Push Groundwater Concentrations (μg/L)

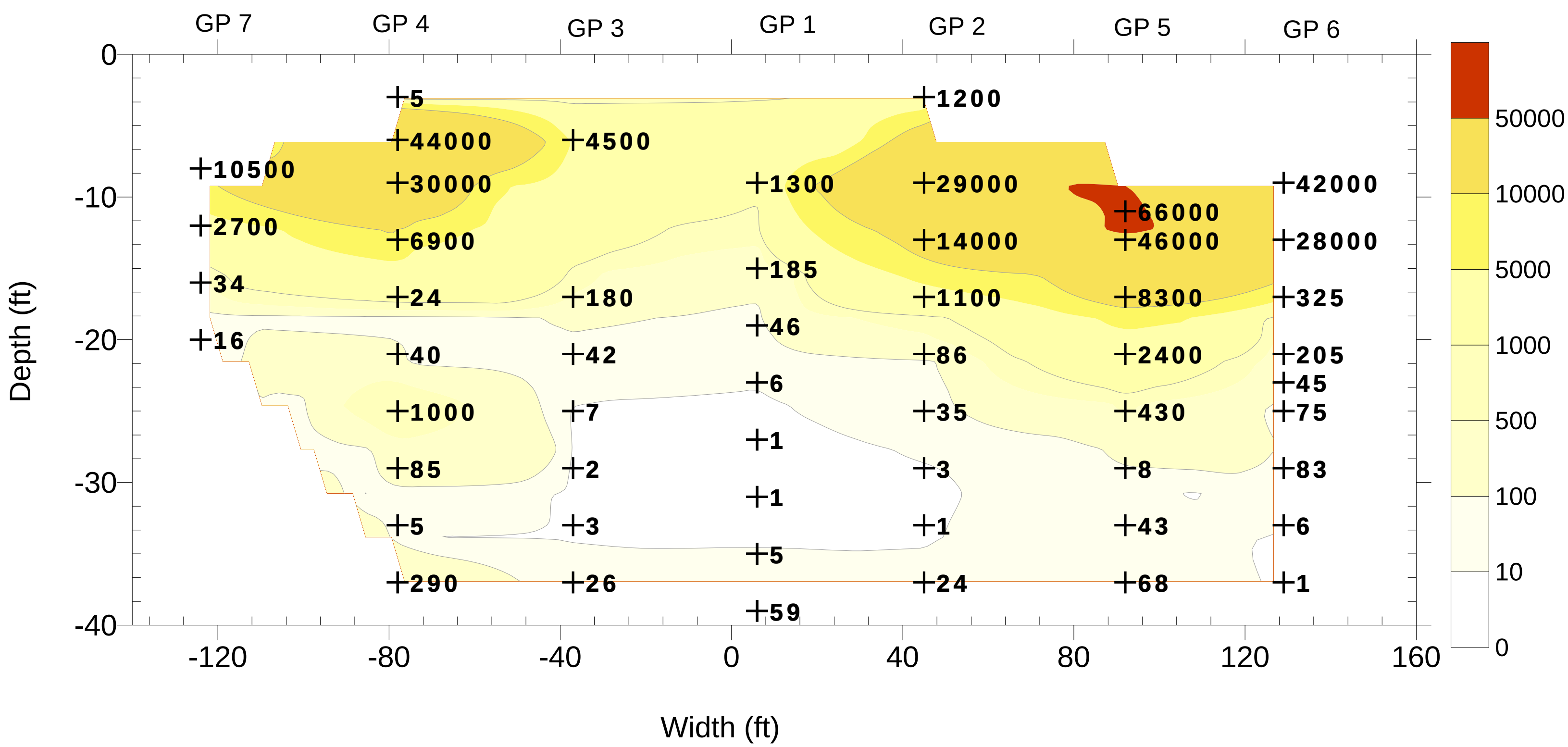


Figure 13. trans-1,2-Dichloroethene Direct-Push Groundwater Concentrations (µg/L)

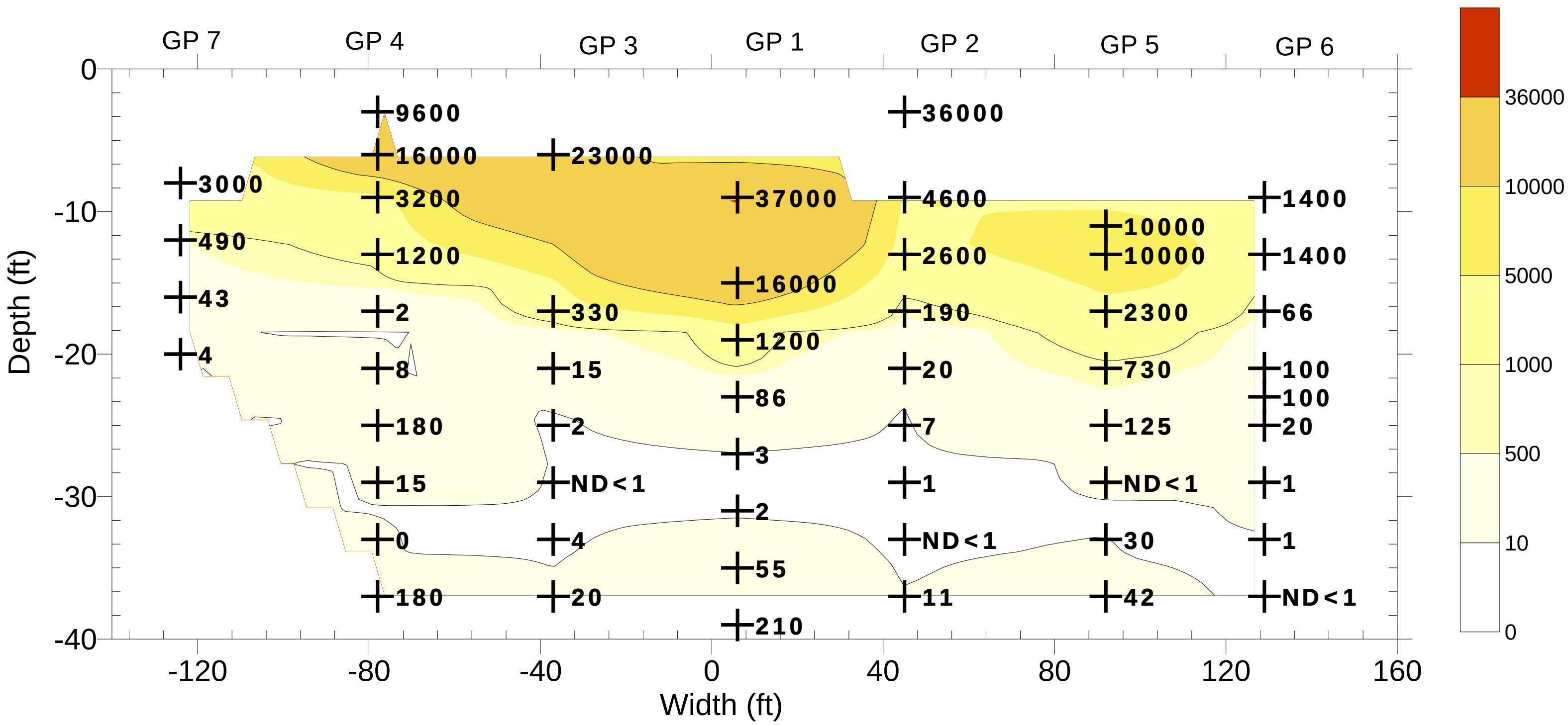


Figure 14. Vinyl Chloride Direct-Push Groundwater Concentrations (μg/L)

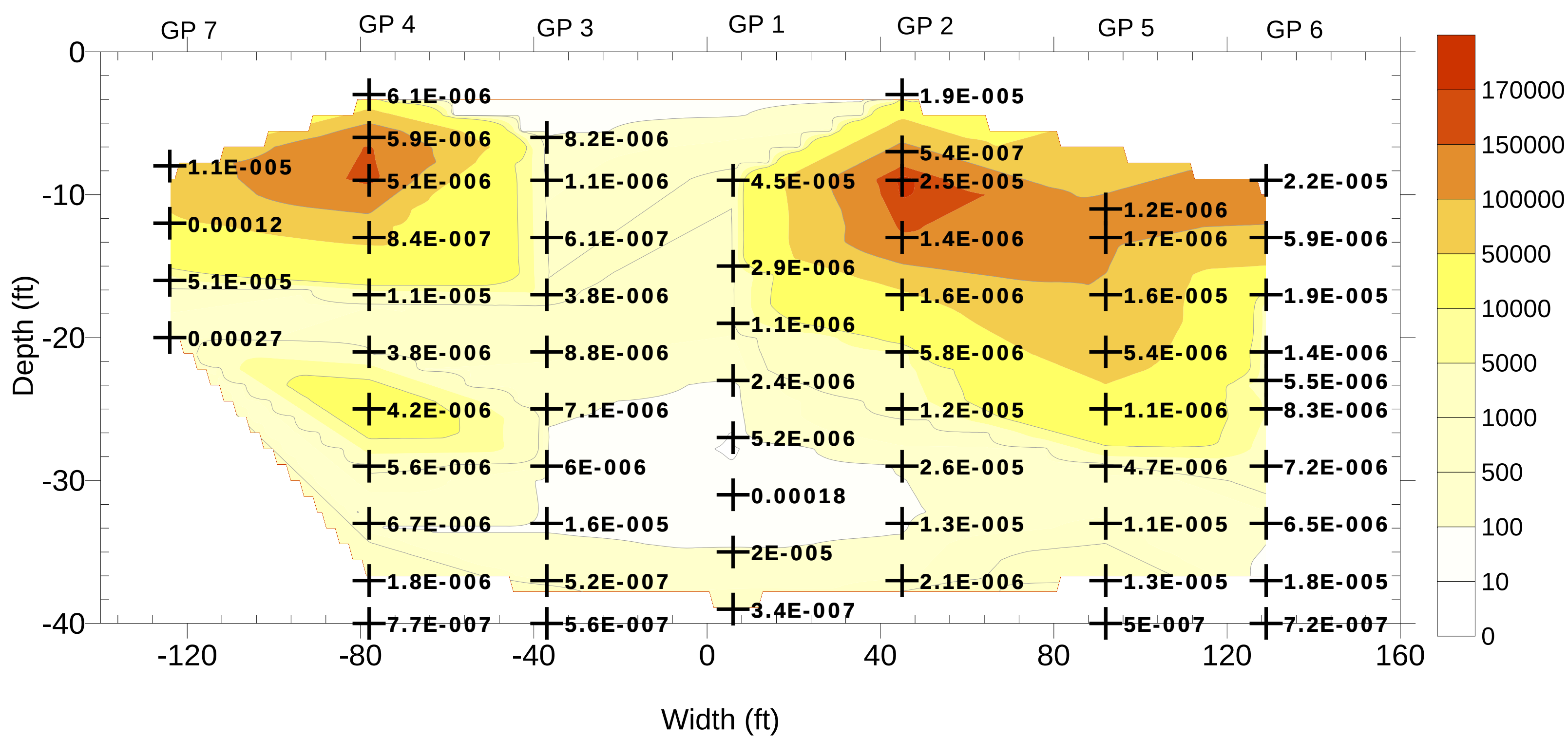
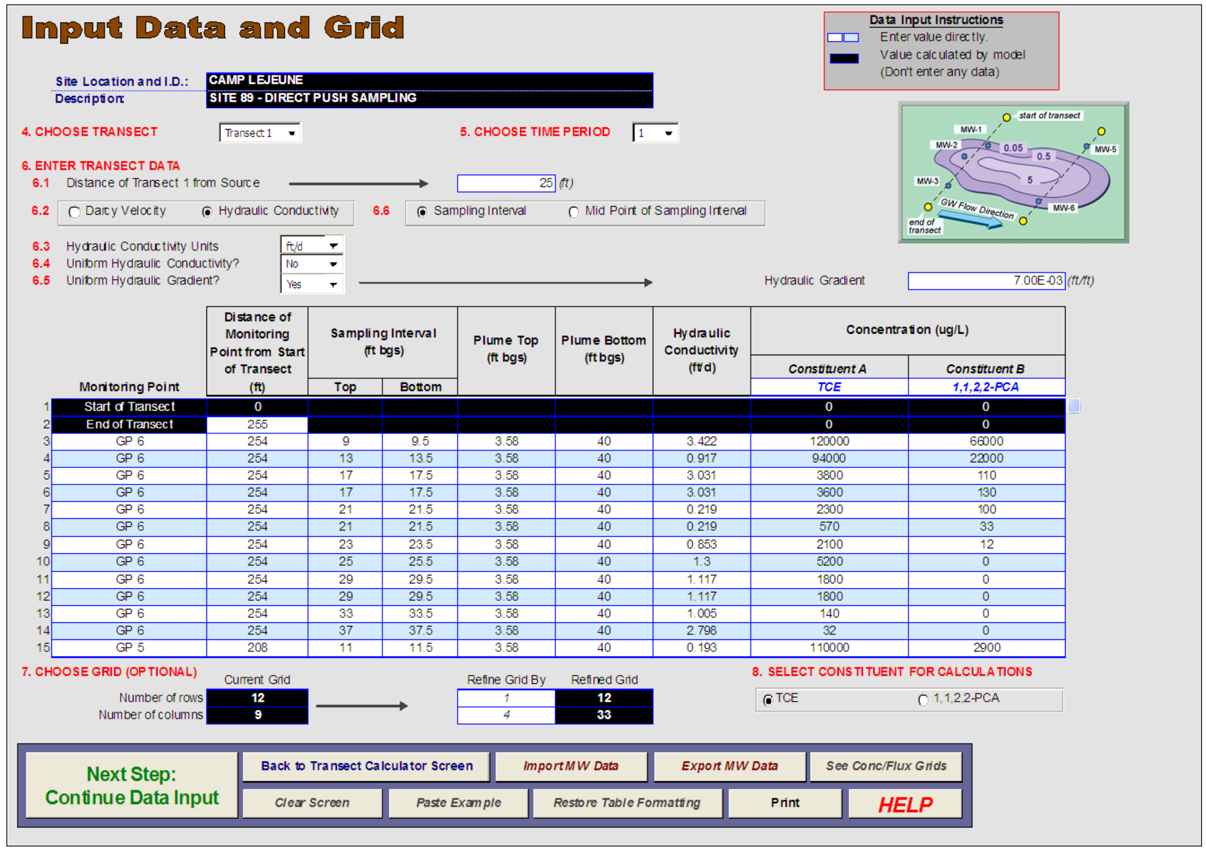


Figure 15. Hydraulic Conductivity Test Data (cm/s) Overlain on Trichloroethylene Contour Plot



	Monitoring Point	Distance of Monitoring Point from Start of Transect (ft)	Sampling Interval (ft bgs) Top	Sampling Interval (ft bgs) Bottom	Plume Top (ft bgs)	Plume Bottom (ft bgs)	Hydraulic Conductivity (ft/d)	Concentration (ug/L) Constituent A TCE	Concentration (ug/L) Constituent B 1,1,2,2-PCA
1	Start of Transect	0						0	0
2	End of Transect	255						0	0
3	GP 6	254	9	9.5	3.58	40	3.422	120000	66000
4	GP 6	254	13	13.5	3.58	40	0.917	94000	22000
5	GP 6	254	17	17.5	3.58	40	3.031	3800	110
6	GP 6	254	17	17.5	3.58	40	3.031	3600	130
7	GP 6	254	21	21.5	3.58	40	0.219	2300	100
8	GP 6	254	21	21.5	3.58	40	0.219	570	33
9	GP 6	254	23	23.5	3.58	40	0.853	2100	12
10	GP 6	254	25	25.5	3.58	40	1.3	5200	0
11	GP 6	254	29	29.5	3.58	40	1.117	1800	0
12	GP 6	254	29	29.5	3.58	40	1.117	1800	0
13	GP 6	254	33	33.5	3.58	40	1.005	140	0
14	GP 6	254	37	37.5	3.58	40	2.798	32	0
15	GP 5	208	11	11.5	3.58	40	0.193	110000	2900

Figure 16. Mass Flux Toolkit Inputs

Tables

Table 1. Geologic Descriptions of Continuous Soil Cores (February/March 2006)

Boring Depth (ft)	Subsurface Features
Continuous Soil Core GP 1	
0-2	Silty find sand with some clay
4-5	Fine sandy silt with some clay
6-7	Clayey silt with some fine sands
8	Silty fine sand
9	Clayey silt with some fine sands
10	Fine sand
11-13	Silty fine sand
14	Silt
15	Sand and gravel with traces of clay
16-20	Sandy clay with fine to medium sand
22	Clay sands and gravels
24	Sands and gravels with some clay
26	Clayey sands with some gravel
28	Course sand with some clay
32	Sands and gravels with trace silts and clay
34	Clayey sands and gravel
36-40	Silty fine sands with some clay

Table 2. Sampling Locations and Types of Test Performed (February/March 2006)

Groundwater Monitoring Well or Direct-push Sampling Location	Physical Assessment			Water Quality Assessment	
	Depth-To-Water Measurement	Slug Testing	Constant Drawdown Aquifer Testing	Field Parameters[c]	Dissolved Petroleum Hydrocarbon Analysis
MW-16	Yes	Yes		Yes	Yes
MW-16IW	Yes	Yes		Yes	Yes
MW-17	Yes	Yes		Yes	Yes
MW-17IW	Yes	Yes		Yes	Yes
MW-18				Yes	Yes
MW-19				Yes	Yes
MW-20				Yes	Yes
MW-20IW				Yes	Yes
MW-21	Yes	Yes		Yes	Yes
MW-21IW	Yes	Yes		Yes	Yes
MW-22				Yes	Yes
MW-22IW				Yes	Yes
MW-22				Yes	Yes
MW-23	Yes	Yes		Yes	Yes
MW-24				Yes	Yes
MW-24IW				Yes	Yes
MW-25	Yes	Yes		Yes	Yes
MW-25IW	Yes	Yes		Yes	Yes
MW-27	Yes	Yes		Yes	Yes
MW-27IW	Yes	Yes		Yes	Yes
MW-28				Yes	Yes
MW-29	Yes	Yes		Yes	Yes
MW-29IW	Yes	Yes		Yes	Yes
MW-30	Yes	Yes		Yes	Yes
MW-31				Yes	Yes
MW-31IW				Yes	Yes
GP-1*			Yes	Yes	Yes
GP-2*			Yes	Yes	Yes
GP-3*			Yes	Yes	Yes
GP-4*			Yes	Yes	Yes
GP-5*			Yes	Yes	Yes
GP-6*			Yes	Yes	Yes
GP-7*			Yes	Yes	Yes

[a] Water quality assessments and constant drawdown tests at direct-push locations were performed on 4-ft intervals from the phreatic surface (~3' bgs) to 40’ bgs.

[b] Depth to water measurements are approximate and not intended for groundwater elevation calculations.

[c] Field parameters include: pH, electrical conductivity, temperature, dissolved oxygen, and oxidation reduction potential.

Table 3. Slug Test Results (February/March 2006)

Monitoring Well	Well Screen (ft)	Hvorslev K (cm/s)	Hvorslev K (ft/d)	Bouwer and Rice K (cm/s)	Bouwer and Rice K (ft/d)
MW-16	5-15	2.76E-03	7.81	7.74E-04	2.19
MW-16IW	20-25	5.70E-04	1.62	2.96E-04	0.84
MW-17	5-15	4.59E-04	1.30	8.03E-05	0.23
MW-17IW	20-25	3.75E-03	10.63	7.56E-04	2.14
MW-21	5-15	2.05E-03	5.80	1.12E-04	0.32
MW-21IW	20-25	2.79E-03	7.89	4.50E-04	1.28
MW-23	5-15	3.16E-05	0.09	8.75E-06	0.02
MW-25	5-15	6.89E-04	1.95	1.85E-04	0.52
MW-25IW	20-25	1.87E-03	5.31	5.91E-04	1.67
MW-27	5-15	6.82E-04	1.93	1.40E-04	0.40
MW-27IW	20-25	1.30E-03	3.68	2.75E-04	0.78
MW-29	5-15	8.13E-04	2.30	2.57E-04	0.73
MW-29IW	20-25	1.68E-03	4.76	6.65E-04	1.88
MW-30	5-15	5.87E-04	1.66	1.20E-04	0.34

Table 4. Depth-to-Groundwater for Monitoring Wells (February/March 2006)

Monitoring Well	DTW (m BTOC)	DTW (ft BTOC)
MW-16	0.58	1.89
MW-16IW	0.87	2.85
MW-17	1.53	5.00
MW-17IW	1.66	5.43
MW-21	1.65	5.43
MW-21IW	1.79	5.88
MW-23	1.11	3.64
MW-25	1.36	4.46
MW-25IW	1.35	4.41
MW-27	1.09	3.58
MW-27IW	1.11	3.65
MW-29	0.65	2.13
MW-29IW	0.70	2.30
MW-30	0.55	1.80

DTW - Depth-to-water
BTOC - Below top of casing

Table 5. Water Quality Data for Monitoring Wells (February/March 2006)

Monitoring Well	Water Quality Data[a]				
	pH	EC (mS)	Temperature (°C)	DO (mg/L)	ORP (mV)
MW-16	6.9	1.40	10.8	1.2	-199
MW-16IW	7.1	0.59	14.3	0.8	-166
MW-17	5.4	3.24	18.2	1.8	-178
MW-17IW	6.7	0.56	22.7	1.7	-147
MW-18	5.5	2.12	7.6	1.0	2
MW-19	5.0	1.05	9.9	1.1	164
MW-20	---	---	---	---	---
MW-20IW	6.7	0.71	7.1	0.0	-127
MW-21	6.0	8.70	7.1	0.7	-99
MW-21IW	6.8	1.90	9.0	0.7	-153
MW-22	6.0	3.61	10.6	0.3	-56
MW-22IW	6.6	0.65	9.5	0.0	-133
MW-23	6.6	2.00	3.7	1.6	-40
MW-24	6.1	3.26	10.2	0.0	-114
MW-24IW	6.8	0.78	15.1	0.5	-131
MW-25	6.2	4.05	17.5	1.1	-107
MW-25IW	7.0	0.78	20.2	1.2	-124
MW-27	6.3	1.60	6.4	0.6	-15
MW-27IW	6.8	0.70	8.9	0.8	-122
MW-28	5.7	2.60	14.5	1.0	-81
MW-29	6.9	1.20	9.8	0.5	-126
MW-29IW	7.1	0.60	11.6	0.5	-135
MW-30	7.0	0.89	7.9	1.3	-130
MW-31	5.8	1.04	11.7	1.6	24
MW-31IW	6.2	1.80	13.0	1.6	-123

[a] All measurements were made with a Horiba U-22 meter.
EC = electrical conductivity
DO = dissolved oxygen
ORP = oxidation-reduction potential

Table 6. Chemical Concentration Data for Monitoring Wells (February/March 2006)

Monitoring Well	Date Analyzed	Concentration (ug/L)							
		Vinyl Chloride	1,1-DCE	trans-1,2-DCE	cis-1,2-DCE	TCE	1,1,2-TCA	PCE	1,1,2,2-PCA
MW-16	2/26/06	24000	110	330	16000	360	ND <1	ND <1	110
MW-16	3/3/06	23000	120	370	19000	16	ND <1	ND <1	ND <1
MW-16IW	2/26/06	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1
MW-16QC	3/3/06	23000	120	380	20000	8	ND <1	ND <1	ND <1
MW-17	2/26/06	150	59	3000	16000	2000	28	1	220
MW-17IW	2/26/06	21	25	42	740	2800	0	82	1
MW-18	3/1/06	670	250	33000	71000	140000	3600	1800	240000
MW-19	3/1/06	110	150	5800	17000	30000	420	410	51000
MW-20	NA	DNAPL present in well							
MW-20IW	3/3/06	210	15	13	510	130	ND <1	10	17
MW-21	2/27/06	9500	17	110	2900	82	ND <1	0	1
MW-21IW	2/27/06	500	23	39	2000	57	ND <1	77	ND <1
MW-21QC	2/27/06	9300	18	110	2900	86	ND <1	ND <1	ND <1
MW-22	3/3/06	22000	1700	38000	110000	5700	300	130	270
MW-23	2/27/06	4400	440	28000	56000	72000	460	960	6000
MW-23	3/3/06	5000	520	30000	59000	75000	510	1300	6900
MW-24	3/3/06	15000	54	200	7600	8	ND <1	0	ND <1
MW-24IW	3/3/06	400	22	140	3500	400	ND <1	11	ND <1
MW-25	2/26/06	2900	15	88	3100	0	ND <1	ND <1	2
MW-25IW	2/26/06	130	24	610	5200	480	ND <1	110	1
MW-27	2/27/06	13000	910	9700	80000	74000	200	1200	4200
MW-27IW	2/27/06	5	8	3	120	180	ND <1	270	ND <1
MW-27IW DUP	2/27/06	4	7	3	100	180	ND <1	290	ND <1
MW-28	2/28/06	5700	300	3100	52000	8200	ND <1	120	340
MW-29	2/27/06	12000	130	370	21000	9200	ND <1	110	ND <1
MW-29IW	2/27/06	5	17	2	110	280	ND <1	15	1
MW-30	2/28/06	7900	140	420	25000	6600	ND <1	2	ND <1
MW-30 DUP	2/28/06	8600	150	440	32000	7600	ND <1	3	ND <1
MW-31	3/1/06	170	40	3300	6400	24000	150	450	11000
MW-31IW	3/1/06	4000	260	18000	66000	11000	200	2	1800

DUP - Duplicate sample
REP - Quality control sample (second analysis of same water sample)
ND – non detect at the limit of 1 ug/L

Table 7. Chemical Concentration Data for Direct-Push Downgradient Transect Locations (February/March 2006)

Sampling Location*	Concentration (ug/L)							
	Vinyl Chloride	1,1 DCE	trans-1,2 DCE	cis-1,2 DCE	TCE	1,1,2 TCA	PCE	1,1,2,2 PCA
GP 1-9	37000	210	1300	40000	1200	ND<1	ND<1	ND<1
GP 1-15	17000	52	180	11000	620	ND<1	1	ND<1
GP 1-15	15000	72	190	11000	540	ND<1	2	ND<1
GP 1-19	1200	22	46	1200	620	ND<1	1	ND<1
GP 1-23	86	1	6	110	68	3	ND<1	ND<1
GP 1-27	3	ND<1	1	5	3	ND<1	ND<1	ND<1
GP 1-31	2	ND<1	1	8	20	ND<1	ND<1	ND<1
GP 1-35	7	ND<1	3	22	72	ND<1	ND<1	150
GP 1-35	110	ND<1	7	52	110	ND<1	ND<1	6
GP 1-39	210	3	60	430	730	ND<1	4	610
GP 1-39 QC	210	3	58	430	750	ND<1	13	930
GP 2-3	36000	790	1200	10000	58	ND<1	ND<1	900
GP 2-9	4600	600	29000	81000	180000	1400	1500	78000
GP 2-13	2600	290	14000	48000	150000	390	1600	22000
GP 2-17	190	100	1100	7700	42000	ND<1	750	870
GP 2-21	17	10	86	270	4400	ND<1	270	61
GP 2-25	7	7	35	110	1200	ND<1	100	28
GP 2-29	1	ND<1	3	8	110	ND<1	4	2
GP 2-33	ND<1	ND<1	ND<1	2	27	ND<1	2	ND<1
GP 2-33 QC	ND<1	ND<1	1	2	30	ND<1	2	1
GP 2-37	11	2	24	61	420	1	5	13
GP 3-6	23000	1100	4500	120000	85	120	1	340
GP 3-17	330	32	180	9600	1100	ND<1	26	ND<1
GP 3-21	15	5	42	510	580	ND<1	3	ND<1
GP 3-25	3	1	7	99	120	ND<1	1	ND<1
GP 3-25QC	1	1	7	110	130	ND<1	1	ND<1
GP 3-29	ND<1	ND<1	2	28	49	ND<1	ND<1	ND<1
GP 3-33	4	ND<1	3	44	64	ND<1	ND<1	ND<1
GP 3-37	20	5	26	370	290	ND<1	2	ND<1
GP 4-3	9600	1	5	440	1	ND<1	ND<1	17
GP 4-6	16000	1700	44000	83000	150000	870	2200	14000
GP 4-9	3200	410	30000	40000	160000	1400	4200	52000
GP 4-13	1200	130	6900	16000	58000	240	480	7900
GP 4-17	1	1	23	53	450	ND<1	15	32
GP 4-17QC	2	1	25	57	460	ND<1	15	22
GP 4-21	9	3	40	110	660	1	12	96
GP 4-25	180	19	1000	2400	20000	120	190	2200
GP 4-29	15	6	85	140	870	1	14	83
GP 4-33	1	ND<1	5	11	64	ND<1	1	15
GP 4-37	180	8	290	630	2900	22	130	170
GP 5-11	10000	180	66000	140000	110000	3500	120	2900
GP 5-13	10000	280	46000	110000	110000	ND<1	130	120
GP 5-17	2300	250	8300	35000	94000	ND<1	490	ND<1
GP 5-21	730	120	2400	8700	79000	ND<1	1000	ND<1
GP 5-25	130	18	430	1700	28000	ND<1	170	ND<1
GP 5-25QC	120	18	430	1700	27000	ND<1	160	ND<1
GP 5-29	2	ND<1	8	31	170	ND<1	6	ND<1
GP 5-33	30	3	43	130	510	1	7	5
GP 5-37	42	2	68	250	1900	ND<1	130	5
GP 6-9	1400	130	42000	79000	120000	3400	280	66000

Sampling Location*	Concentration (ug/L)							
	Vinyl Chloride	1,1 DCE	trans-1,2 DCE	cis-1,2 DCE	TCE	1,1,2 TCA	PCE	1,1,2,2 PCA
GP 6-13	1400	62	28000	67000	94000	1700	460	22000
GP 6-17	38	13	340	1300	3800	3	7	110
GP 6-17	130	6	310	1200	3600	ND<1	9	130
GP 6-21	100	5	190	740	2300	ND<1	0	100
GP 6-21	31	12	220	260	570	11000	5	33
GP 6-23	100	4	45	420	2100	2	ND<1	12
GP 6-25	290	7	75	520	5200	ND<1	61	ND<1
GP 6-29	20	10	81	350	1800	ND<1	10	ND<1
GP 6-29QC	22	10	84	320	1800	ND<1	10	ND<1
GP 6-33	1	1	6	28	140	ND<1	1	ND<1
GP 6-37	1	ND<1	1	2	32	ND<1	1	ND<1
GP 7-8	3000	270	11000	27000	76000	180	350	2400
GP 7-8	2800	260	10000	25000	74000	210	340	2400
GP 7-12	490	ND<1	2700	6300	44000	110	260	1800
GP 7-16	43	1	34	130	660	1200	2	4
GP 7-20	4	ND<1	16	77	380	ND<1	3	ND<1

DUP - Duplicate sample
REP - Quality control sample (second analysis of same water sample)
ND – non detect at the limit of 1 ug/L

Table 8. Water Quality Data for Direct-Push Downgradient Transect Locations (February/March 2006)

Sampling Location*	Water Quality Data[a]				
	pH	EC (mS)	Temperature (°C)	DO (mg/L)	ORP (mV)
GP 1-3	---	---	---	---	---
GP 1-6	---	---	---	---	---
GP 1-9	6.2	1.20	14.7	0.5	-63
GP 1-13	---	---	---	---	---
GP 1-14	---	---	---	---	---
GP 1-15	7.0	0.83	13.3	<1.5	-134
GP 1-19	---	---	---	---	---
GP 1-23	---	---	---	---	---
GP 1-27	7.3	0.67	13.1	1.1	-118
GP 1-31	7.3	0.67	12.8	0.9	-177
GP 1-35	7.5	0.61	11.8	0.9	-206
GP 1-39	---	---	---	---	---
GP 2-3	---	---	---	---	---
GP 2-7	---	---	---	---	---
GP 2-9	5.4	1.92	8.8	1.0	17
GP 2-13	---	---	---	---	---
GP 2-17	---	---	---	---	---
GP 2-21	6.5	0.65	13.1	0.9	-150
GP 2-25	6.6	0.64	14.1	1.0	-152
GP 2-29	6.7	0.63	15.5	0.7	-183
GP 2-33	6.8	0.60	15.7	0.6	-153
GP 2-37	7.2	0.64	12.6	0.6	-287
GP 3-3	---	---	---	---	---
GP 3-6	---	---	---	---	---
GP 3-9	---	---	---	---	---
GP 3-13	---	---	---	---	---
GP 3-17	---	---	---	---	---
GP 3-21	6.7	0.67	10.0	0.0	-143
GP 3-25	6.7	0.73	8.2	<0.5	-140
GP 3-29	6.8	0.73	7.5	0.0	-142
GP 3-33	6.8	0.70	7.9	0.0	-165
GP 3-37	---	---	---	---	---
GP 3-40	---	---	---	---	---
GP 4-3	---	---	---	---	---
GP 4-6	---	---	---	---	---
GP 4-9	---	---	---	---	---
GP 4-13	---	---	---	---	---
GP 4-15	---	---	---	---	---
GP 4-17	6.6	0.54	9.0	0.1	-139
GP 4-21	6.8	0.53	8.9	0.4	-151
GP 4-25	6.9	0.55	8.4	0.5	-153
GP 4-25*	7.1	0.59	10.4	0.5	-198
GP 4-29	---	---	---	---	---
GP 4-29*	7.2	0.62	7.5	0.2	-171
GP 4-29**	---	---	---	---	---
GP 4-33	7.2	0.59	6.5	0.0	-167
GP 4-37	---	---	---	---	---

Sampling Location*	Water Quality Data[a]				
	pH	EC (mS)	Temperature (°C)	DO (mg/L)	ORP (mV)
GP 4-40	---	---	---	---	---
GP 5-3	---	---	---	---	---
GP 5-6	---	---	---	---	---
GP 5-7	---	---	---	---	---
GP 5-9	---	---	---	---	---
GP '5-10	---	---	---	---	---
GP 5-11	---	---	---	---	---
GP 5-13	---	---	---	---	---
GP 5-15	---	---	---	---	---
GP '5-15	---	---	---	---	---
GP 5-17	7.0	1.77	11.0	0.0	-128
GP 5-21	7.1	0.68	11.0	0.5	-148
GP 5-25	---	---	---	---	---
GP 5-29	---	---	---	---	---
GP 5-29	6.1	0.56	12.2	0.3	-132
GP 5-33	6.7	0.59	10.8	0.0	-189
GP 5-37	6.9	0.58	10.0	0.0	-186
GP 5-40	---	---	---	---	---
GP 6-3	---	---	---	---	---
GP 6-6	---	---	---	---	---
GP 6-7	---	---	---	---	---
GP 6-9	5.5	1.29	5.7	0.4	7
GP 6-13	---	---	---	---	---
GP 6-17	6.7	0.61	10.6	0.4	-149
GP 6-21	---	---	---	---	---
GP 6-23	6.8	0.63	8.9	0.3	-138
GP 6-25	6.9	0.64	8.4	0.3	-129
GP 6-29	6.9	0.60	9.6	0.0	-168
GP 6-33	6.9	0.62	8.3	0.2	-154
GP 6-37	7.0	0.57	9.8	0.3	-135
GP 6-40	---	---	---	---	---
GP 7-4/8	---	---	---	---	---
GP 7-8/12	---	---	---	---	---
GP 7-12/16	---	---	---	---	---
GP 7-16/20	---	---	---	---	---
GP 7-20/24	---	---	---	---	---

[a] All measurements were made with a Horiba U-22 meter.
--- No water quality data taken
EC = electrical conductivity
DO = dissolved oxygen
ORP = oxidation-reduction potential

Table 9. Field Data And Results for Constant Drawdown Aquifer Testing in Direct-push Downgradient Transect Locations (February/March 2006)

Sampling Location*	Drawdown (ΔH) (ft BSWS**)	Volume purged (ml)	Time (min)	Time (sec)	Total Time (sec)	Q (ft3/s)	Q/ΔH ($ft^3/ft/s$)	K (cm/sec)	K (ft/d)
GP 1-9	1	240	3	10	190	4.5E-05	4.5E-05	2.5E-03	6.9E+00
GP 1-15	15	140	1	53	113	4.4E-05	2.9E-06	1.6E-04	4.5E-01
GP 1-19	19	100	2	50	170	2.1E-05	1.1E-06	6.0E-05	1.7E-01
GP 1-23	23	190	2	0	120	5.6E-05	2.4E-06	1.3E-04	3.8E-01
GP 1-27	27	300	1	15	75	1.4E-04	5.2E-06	2.9E-04	8.1E-01
GP 1-31	1	300	1	0	60	1.8E-04	1.8E-04	9.7E-03	2.7E+01
GP 1-35	6.6	280	1	16	76	1.3E-04	2.0E-05	1.1E-03	3.1E+00
GP 1-39	28	80	5	0	300	9.4E-06	3.4E-07	1.8E-05	5.2E-02
GP 2-3	1.5	110	2	15	135	2.9E-05	1.9E-05	1.1E-03	3.0E+00
GP 2-7	5.5	20	4	0	240	2.9E-06	5.4E-07	2.9E-05	8.3E-02
GP 2-9	7.5	300	0	56	56	1.9E-04	2.5E-05	1.4E-03	3.9E+00
GP 2-13	11.5	80	3	0	180	1.6E-05	1.4E-06	7.5E-05	2.1E-01
GP 2-17	15.5	130	3	0	180	2.6E-05	1.6E-06	9.0E-05	2.6E-01
GP 2-21	19.5	365	1	53	113	1.1E-04	5.8E-06	3.2E-04	9.1E-01
GP 2-25	23.5	330	0	40	40	2.9E-04	1.2E-05	6.8E-04	1.9E+00
GP 2-29	6	265	1	0	60	1.6E-04	2.6E-05	1.4E-03	4.0E+00
GP 2-33	9.8	320	1	30	90	1.3E-04	1.3E-05	7.0E-04	2.0E+00
GP 2-37	26.2	275	3	0	180	5.4E-05	2.1E-06	1.1E-04	3.2E-01
GP 3-6	5	140	2	0	120	4.1E-05	8.2E-06	4.5E-04	1.3E+00
GP 3-9	8	60	4	0	240	8.8E-06	1.1E-06	6.1E-05	1.7E-01
GP 3-13	12	25	2	0	120	7.4E-06	6.1E-07	3.4E-05	9.5E-02
GP 3-17	16	260	2	30	150	6.1E-05	3.8E-06	2.1E-04	6.0E-01
GP 3-21	20	300	1	0	60	1.8E-04	8.8E-06	4.9E-04	1.4E+00
GP 3-25	24	340	1	10	70	1.7E-04	7.1E-06	3.9E-04	1.1E+00
GP 3-29	23	235	1	0	60	1.4E-04	6.0E-06	3.3E-04	9.4E-01
GP 3-33	16.4	290	0	40	40	2.6E-04	1.6E-05	8.6E-04	2.4E+00
GP 3-37	25.6	45	2	0	120	1.3E-05	5.2E-07	2.8E-05	8.1E-02
GP 3-40	27.9	80	3	0	180	1.6E-05	5.6E-07	3.1E-05	8.8E-02
GP 4-3	2	55	2	40	160	1.2E-05	6.1E-06	3.3E-04	9.5E-01
GP 4-6	5	100	2	0	120	2.9E-05	5.9E-06	3.2E-04	9.2E-01
GP 4-9	8	140	2	0	120	4.1E-05	5.1E-06	2.8E-04	8.0E-01
GP 4-13	12	60	3	30	210	1.0E-05	8.4E-07	4.6E-05	1.3E-01

Sampling Location*	Drawdown (ΔH) (ft BSWS**)	Volume purged (ml)	Time (min)	Time (sec)	Total Time (sec)	Q (ft3/s)	Q/ΔH (ft^3/ft/s)	K (cm/sec)	K (ft/d)
GP 4-17	16	300	1	0	60	1.8E-04	1.1E-05	6.1E-04	1.7E+00
GP 4-21	20	260	2	0	120	7.7E-05	3.8E-06	2.1E-04	6.0E-01
GP 4-25	24	190	2	0	120	5.6E-05	2.3E-06	1.3E-04	3.6E-01
GP 4-25*	23	325	2	0	120	9.6E-05	4.2E-06	2.3E-04	6.5E-01
GP 4-29	21.3	100	3	0	180	2.0E-05	9.2E-07	5.1E-05	1.4E-01
GP 4-29*	21.3	240	2	0	120	7.1E-05	3.3E-06	1.8E-04	5.2E-01
GP 4-29**	23	220	1	0	60	1.3E-04	5.6E-06	3.1E-04	8.8E-01
GP 4-33	23	260	1	0	60	1.5E-04	6.7E-06	3.7E-04	1.0E+00
GP 4-37	21.3	160	2	30	150	3.8E-05	1.8E-06	9.7E-05	2.8E-01
GP 4-40	23	60	2	0	120	1.8E-05	7.7E-07	4.2E-05	1.2E-01
GP 5-11	9.5	80	4	0	240	1.2E-05	1.2E-06	6.8E-05	1.9E-01
GP 5-13	11.5	115	3	30	210	1.9E-05	1.7E-06	9.2E-05	2.6E-01
GP 5-17	15.5	310	0	45	45	2.4E-04	1.6E-05	8.6E-04	2.4E+00
GP 5-21	19.5	180	1	0	60	1.1E-04	5.4E-06	3.0E-04	8.5E-01
GP 5-25	23.5	130	3	0	180	2.6E-05	1.1E-06	6.0E-05	1.7E-01
GP 5-29	23	70	2	0	120	2.1E-05	9.0E-07	4.9E-05	1.4E-01
GP 5-29	26.2	260	1	15	75	1.2E-04	4.7E-06	2.6E-04	7.3E-01
GP 5-33	13.1	250	1	0	60	1.5E-04	1.1E-05	6.2E-04	1.7E+00
GP 5-37	13.1	290	1	0	60	1.7E-04	1.3E-05	7.2E-04	2.0E+00
GP 5-40	19.7	50	3	0	180	9.8E-06	5.0E-07	2.7E-05	7.8E-02
GP 6-9	7.5	280	1	0	60	1.6E-04	2.2E-05	1.2E-03	3.4E+00
GP 6-13	11.5	230	2	0	120	6.8E-05	5.9E-06	3.2E-04	9.2E-01
GP 6-17	15.5	410	0	48	48	3.0E-04	1.9E-05	1.1E-03	3.0E+00
GP 6-21	19.5	140	3	0	180	2.7E-05	1.4E-06	7.7E-05	2.2E-01
GP 6-23	21.5	300	1	30	90	1.2E-04	5.5E-06	3.0E-04	8.5E-01
GP 6-25	23.5	250	0	45	45	2.0E-04	8.3E-06	4.6E-04	1.3E+00
GP 6-29	19.7	300	1	15	75	1.4E-04	7.2E-06	3.9E-04	1.1E+00
GP 6-33	19.7	270	1	15	75	1.3E-04	6.5E-06	3.5E-04	1.0E+00
GP 6-37	19	290	0	30	30	3.4E-04	1.8E-05	9.9E-04	2.8E+00
GP 6-40	27.2	100	3	0	180	2.0E-05	7.2E-07	4.0E-05	1.1E-01
GP 7-8/12	11	250	1	15	75	1.2E-04	1.1E-05	5.9E-04	1.7E+00
GP 7-12/16	3.9	200	0	15	15	4.7E-04	1.2E-04	6.6E-03	1.9E+01
GP 7-16/20	10.6	380	0	25	25	5.4E-04	5.1E-05	2.8E-03	7.9E+00
GP 7-20/24	1.3	300	0	30	30	3.5E-04	2.7E-04	1.5E-02	4.2E+01

* See Figure 2
** BSWS – Below estimated static water surface

Table 10. Monitoring Well Chemical Concentration Data Comparison

Chemical (ug/L)	1,1-DCE		Date Site 89	cis-1,2-DCE		Date Site 89	1,1,2,2-PCA		Date Site 89	PCE		Date Site 89
Collection By	ASU Feb/Mar '06	Site 89		ASU Feb/Mar '06	Site 89		ASU Feb/Mar '06	Site 89		ASU Feb/Mar '06	Site 89	
MW-16	110	<400	Nov '04	16000	35200	Nov '04	110	<420	Dec '05	<1	<400	Nov '04
MW-16	120	<400	Nov '04	19000	35200	Nov '04	<1	<420	Dec '05	<1	<400	Nov '04
MW-16IW	<1	<2	Nov '04	1	<2	Nov '04	<1	<0.5	Dec '05	<1	<2	Nov '04
MW-16QC	120	<400	Nov '04	20000	35200	Nov '04	<1	<420	Dec '05	<1	<400	Nov '04
MW-17	59	<200	Nov '04	16000	1820	Nov '04	220	210 J	Dec '05	1	571	Nov '04
MW-17IW	25	<100	Nov '04	740	890	Nov '04	1	<130	Dec '05	82	49	Nov '04
MW-18	250	<10000	Nov '04	71000	85700	Nov '04	240000	250000	Dec '05	1800	<10000	Nov '04
MW-19	150	<2000	Nov '04	17000	15200	Nov '04	51000	43000	Dec '05	410	<2000	Nov '04
MW-20	NAPL	<20000	Nov '04	NAPL	55200	Nov '04	NAPL	65000	Dec '05	NAPL	<20000	Nov '04
MW-20IW	15	<2	Nov '04	510	63	Nov '04	17	11	Nov '04	10	9	Nov '04
MW-21	17	7.1	Nov '04	2900	748	Nov '04	1	12	Nov '04	<1	<20	Nov '04
MW-21QC	18	<4	Nov '04	2900	11	Nov '04	<1	<4	Nov '04	<1	181	Nov '04
MW-21IW	23	<4	Nov '04	2000	11	Nov '04	<1	<4	Nov '04	77	181	Nov '04
MW-22	1700	<2000	Nov '04	110000	156000	Nov '04	270	14000	Dec '05	130	1070 J	Nov '04
MW-23	440	<4000	Nov '04	56000	121000	Nov '04	6000	39600	Nov '04	960	2580 J	Nov '04
MW-23	520	<4000	Nov '04	59000	121000	Nov '04	6900	39600	Nov '04	1300	2580 J	Nov '04
MW-24	54	<100	Nov '04	7600	2160	Nov '04	<1	<100	Nov '04	<1	<100	Nov '04
MW-24IW	22	<2	Nov '04	3500	2	Nov '04	<1	<2	Nov '04	11	6	Nov '04
MW-25	15	6.4	Nov '04	3100	665	Nov '04	2	<20	Nov '04	<1	<20	Nov '04
MW-25IW	24	<10	Nov '04	5200	32	Nov '04	1	<10	Nov '04	110	162	Nov '04
MW-27	910	<20000	Nov '04	80000	22600	Nov '04	4200	5500	Dec '05	1200	<20000	Nov '04
MW-27IW	8	<40	Nov '04	120	137	Nov '04	<1	<40	Nov '04	270	339	Nov '04
MW-27IW DUP	7	<40	Nov '04	100	137	Nov '04	<1	<40	Nov '04	290	339	Nov '04
MW-28	300	<10000	Nov '04	52000	49100	Nov '04	340	5150	Nov '04	120	<10000	Nov '04
MW-29	130	<1000	Nov '04	21000	33100	Nov '04	<1	2300	Dec '05	110	<1000	Nov '04
MW-29IW	17	<2	Nov '04	110	2	Nov '04	1	<2	Nov '04	15	<2	Nov '04
MW-30	140	<500	Nov '04	25000	12500	Nov '04	<1	<1000	Dec '05	2	<500	Nov '04
MW-30 DUP	150	<500	Nov '04	32000	12500	Nov '04	<1	<1000	Dec '05	3	<500	Nov '04
MW-31	40	<4000	Nov '04	6400	40400	Nov '04	11000	9700	Dec '05	450	<1000	Nov '04
MW-31IW	260	<2000	Nov '04	66000	61300	Nov '04	1800	1300 J	Dec '05	2	<2000	Nov '04

N/A – No Data Available, Dup – Duplicate Sample, REP – Quality Control Sample (second analysis of same sample), ND – Non-Detect (detection limit not available)

Table 10. Monitoring Well Chemical Concentration Data Comparison (cont.)

Chemical (ug/L)	1,1,2-TCA		Date Site 89	TCE		Date Site 89	trans-1,2-DCE		Date Site 89	Vinyl Chloride		Date Site 89
Collection By	ASU Feb/Mar '06	Site 89		ASU Feb/Mar '06	Site 89		ASU Feb/Mar '06	Site 89		ASU Feb/Mar '06	Site 89	
MW-16	<1	<400	Nov '04	360	<420	Dec '05	330	669	Nov '04	24000	<200	Nov '04
MW-16	<1	<400	Nov '04	16	<420	Dec '05	370	669	Nov '04	23000	<200	Nov '04
MW-16IW	<1	<2	Nov '04	<1	0.13 J	Dec '05	<1	<2	Nov '04	<1	<1	Nov '04
MW-16QC	<1	<400	Nov '04	8	<420	Dec '05	380	669	Nov '04	23000	<200	Nov '04
MW-17	28	455	Nov '04	2000	1000	Dec '05	3000	230	Nov '04	150	<100	Nov '04
MW-17IW	<1	<100	Nov '04	2800	3100	Dec '05	42	<100	Nov '04	21	27	Nov '04
MW-18	3600	4600	Nov '04	140000	320000	Dec '05	33000	23600	Nov '04	670	<5000	Nov '04
MW-19	420	680	Nov '04	30000	17000	Dec '05	5800	3780	Nov '04	110	<1000	Nov '04
MW-20	NAPL	<20000	Nov '04	NAPL	390000	Dec '05	NAPL	9880 J	Nov '04	NAPL	<10000	Nov '04
MW-20IW	<1	<2	Nov '04	130	49	Nov '04	13	1 J	Nov '04	210	4	Nov '04
MW-21	<1	<20	Nov '04	82	330	Nov '04	110	87	Nov '04	9500	16	Nov '04
MW-21QC	<1	<4	Nov '04	86	170	Nov '04	110	2	Nov '04	9300	16	Nov '04
MW-21IW	<1	<4	Nov '04	57	170	Nov '04	39	2	Nov '04	500	<2	Nov '04
MW-22	300	1000 J	Nov '04	5700	140000	Dec '05	38000	32300	Nov '04	22000	4060	Nov '04
MW-23	460	2750 J	Nov '04	72000	498000	Nov '04	28000	24000	Nov '04	4400	1580 J	Nov '04
MW-23	510	2750 J	Nov '04	75000	498000	Nov '04	30000	24000	Nov '04	5000	1580 J	Nov '04
MW-24	<1	<100	Nov '04	8	475	Nov '04	200	<100	Nov '04	15000	<50	Nov '04
MW-24IW	<1	<2	Nov '04	400	2	Nov '04	140	<2	Nov '04	400	<1	Nov '04
MW-25	<1	<20	Nov '04	0	30	Nov '04	88	13	Nov '04	2900	<10	Nov '04
MW-25IW	<1	<10	Nov '04	480	35	Nov '04	610	<10	Nov '04	130	<5	Nov '04
MW-27	200	<20000	Nov '04	74000	150000	Dec '05	9700	5390 J	Nov '04	13000	<10000	Nov '04
MW-27IW	<1	<40	Nov '04	180	1010	Nov '04	3	<40	Nov '04	5	39	Nov '04
MW-27IW DUP	<1	<40	Nov '04	180	1010	Nov '04	3	<40	Nov '04	4	39	Nov '04
MW-28	<1	<10000	Nov '04	8200	121000	Nov '04	3100	4160 J	Nov '04	5700	<5000	Nov '04
MW-29	<1	<1000	Nov '04	9200	19000	Dec '05	370	738 J	Nov '04	12000	2090	Nov '04
MW-29IW	<1	<2	Nov '04	280	1	Nov '04	2	<2	Nov '04	5	<1	Nov '04
MW-30	<1	<500	Nov '04	6600	2800	Dec '05	420	282	Nov '04	7900	4290	Nov '04
MW-30 DUP	<1	<500	Nov '04	7600	2800	Dec '05	440	282	Nov '04	8600	4290	Nov '04
MW-31	150	<1000	Nov '04	24000	49000	Dec '05	3300	9490	Nov '04	170	<2000	Nov '04
MW-31IW	200	1480 J	Nov '04	11000	11000	Dec '05	18000	10600	Nov '04	4000	840 J	Nov '04

N/A – No Data Available, Dup – Duplicate Sample, REP – Quality Control Sample (second analysis of same sample), ND – Non-Detect (detection limit not available)

Draft Final

Site Specific Demonstration Plan
NAS Alameda – Site 5

Critical Evaluation of the State of In Situ Thermal Treatment Technologies for DNAPL Source Zone Treatment

Prepared for:

Environmental Security Technology Certification Program
Arlington, VA

Prepared by:

Arizona State University
Battelle Memorial Institute

Site 5 at the Naval Air Station (NAS), Alameda Point is located in Alameda, California. The site consists of more than 18 acres of land located in the central portion of Alameda Point (Figure 1) and includes Building 5, the largest building at Alameda Point which covers approximately 12.5 acres.

Building 5 housed specialty shops for aircraft component repair and maintenance from 1942 until the base was closed in April 1997. Building 5 also housed a plating shop and a "selective" plating shop where small parts were plated by hand. These shops were closed in 1990 and 1993. A wastewater treatment facility for industrial wastewater was located near the southwestern corner of Building 5. A hazardous water storage area at Site 5 was closed in mid-1988. This area was located outside of Building 5 in the southeastern corner of the site. Access to this area is fenced and access is restricted. Additional activities at site 5 included a lead-acid and nickel-cadmium batteries service area.

Chemical contaminants from the various industrial processes inside Building 5 are believed to have been released directly to the subsurface beneath certain operational areas. Solvents are believed to have been released as spills and as leakage from a solvent tank in the hazardous waste storage area outside the southeast corner of Building 5. Solvent releases are also believed to have occurred from a solvent tank located on the eastern side of Building 5, and solvents and metals are believed to have been released from the plating shop via floor drains.

Multiple investigations have shown plume 5-1 and 5-3 to be known dense non-aqueous phase liquid (DNAPL) plumes. Plume 5-1 is located on the eastern side of Building 5 and plume 5-3 is located within Building 5 as shown in Figure 2. Plume 5-1 investigations showed the DNAPL consisted mainly of trichloroethylene (TCE) and trichloroethane (TCA) and the degradation products from these compounds. The DNAPL plume area was determined to be about 1/3 of an acre. A pilot scale six phase heating (SPH) application was performed in plume 5-1 in June of 2002. Based on the results of the pilot, full-scale SPH applications were performed at plume 5-1 and will be performed at plume 5-3.

The conceptual subsurface model for Site 5 includes five geologic units. The Lower San Antonio Unite, or Yerba Buena Mud, is a clay that extends from a depth of approximately 125 feet (ft) below ground surface (bgs) to 170 to 200 ft bgs. The Upper San Antonio Unite overlies the Yerba Buena Mud and extends from 100 ft bgs to about 125 ft bgs. It consists of interbedded very fine-grained, silty sand and green-grey silty clay. The Merritt Sand Formation overlies the San Antonio Formation and extends from 35 ft bgs to about 100 ft bgs and contains 3 sediment types: 1) yellow-brown clayey sand, with approximately 5 percent clay, 2) moist, silty sand, and 3) fine-grained, well-sorted sand with some shell fragments. The Bay Sediment Unit (BSU) overlies the Merritt Sand formation and extends from 15 ft bgs to about 35 ft bgs and is composed of three sediment types: 1) a stiff, moist, dark olive clay, 2) sand and clay with a number of shell fragments, and 3) silty sand with interbedded layers of fine-grained sand. Artificial fill overlies the BSU and is composed of olive brown, unconsolidated fine to medium-grained sand with lenses of silty sand, gravelly sand, or sandy gravel. Groundwater is encountered in the artificial fill between 4 and 7 ft bgs. The BSU separates the first (FWBZ) and second water-bearing zones (SWBZ) with low-permeability sediments. The FWBZ is located in the artificial fill and upper part of the BSU. The FWBZ general flow direction is to the northeast. The SWBZ is situated within the lower part of the BSU, the Merritt Sand, and the Upper San Antonio Unit. The SWBZ general flow direction is to the south.

Installation for full-scale six-phase heating at began in 2004. The system consisted of 7 electrodes installed to a depth of 19 ft bgs and 28 electrodes installed to a depth of 14 ft bgs and 1 electrode installed to 15 ft bgs. The total treatment area was approximately 1/3acre (Figure 3).

In addition, 2 monitoring wells were installed inside the treatment area. These two monitoring wells were used along with 12 monitoring wells installed during the pilot scale SPH application. Table 1 shows the screened intervals of the wells along with their diameter.

The full-scale system was brought on-line in July 2004 and was operated until November 2004. The remedial system performance was continuously monitored during operation, and an estimated 3,000 pounds of volatile organic compound (VOC) contamination were removed in recovered volatile vapors and groundwater.

After shutdown, monitoring wells were monitored for four months. All monitoring wells and electrodes were left in place for possible use at a later time.

The available documentation for NAS Alameda, Site 5 suggests that it is a good site for further investigation because:

- The hydrogeology of the site is reasonably well-characterized
- The aerial extent of the source zone was reasonably defined prior to treatment
- Full treatment of a source zone was performed
- The depth to groundwater is 4 to 7 feet
- The total depth of impacted groundwater is about 30 feet
- There is access to sampling locations immediately down-gradient of the remediated source zone
- The system employed at this site represents a state-of-the-art ERH system
- Pre- and post-treatment groundwater data are available
- Direct-push technologies can be used for sampling
- The monitoring well network is still present and accessible

Consistent with the already-approved generic demonstration plan for this project, the following site-specific activities are proposed:

(1) Verification of the site geological conceptual model before any new investigative work by:
    a. Measurement of depths to groundwater in nearby wells (to determine depth to groundwater, flow direction, and hydraulic gradient). See Table 1 for monitoring well details and Figure 4 for measurement locations.
    b. Collection of one continuous soil core at the down-gradient edge of the treated source zone (to qualitatively confirm the site geology and to identify depths for subsequent groundwater vertical profile sampling). One or two additional cores will be collected if time permits. See Figure 4 for sampling location.

c. Slug tests conducted in existing groundwater monitoring wells in the area to get estimates of hydraulic conductivity over the screened intervals for those wells (to help identify if any zones are more conductive than others). See Table 1 for details on the monitoring wells and Figure 4 for measurement location.

(2) Collection of data necessary to determine groundwater concentrations and fluxes leaving the treated source zone:

a. Groundwater samples collected from existing groundwater monitoring wells with available historical data. See Table 1 for details on the monitoring wells and Figure 4 for their locations.
b. Groundwater samples will be collected using direct-push tools along a transect perpendicular to the direction of groundwater flow at the down-gradient edge of the original source zone. See Figure 4 for groundwater sampling locations. Sampling locations will be approximately 40 feet apart, and at each location samples will be collected, as possible, at least every 4 feet down to a maximum depth of 30 ft (and at least once in each distinct lithologic change suggested by the soil core). The samples will be analyzed via a headspace analysis on a gas chromatograph (GC) equipped with dry electrolytic conductivity detector (DELCD), photo-ionization detector (PID), and flame-ionization (FID) detectors. If time permits, samples will be collected at additional locations as well. The specific depths and numbers of samples collected at each location may be adjusted depending on the analytical results in the field.
c. Aquifer specific-capacity tests will be conducted at each depth where a groundwater sample is collected. These tests will be conducted using the direct-push groundwater sampler and will involve the measurement of the steady flow rate achieved with a fixed drawdown; ideally, all tests will be conducted with the same fixed drawdown (usually 0.3 – 1.0 feet).

Health and Safety Plan (HASP)
NAS Alameda – Site 5

SECTION 1: GENERAL INFORMATION AND DISCLAIMER

CLIENT NAME: Environmental Security Technology Certification Program (ESTCP) PROJECT NAME: ESTCP Thermal Evaluation

PRINCIPAL INVESTIGATORS: Bruce Alleman (Battelle) and Paul Johnson (Arizona State University)

PROJECT LEADER: Sam Yoon

PREPARED BY: Sam Yoon DATE: 04/12/2006

NOTE: This Site Specific Health and Safety Plan - (HASP) has been prepared for use by Battelle employees for work at this site. Battelle is not responsible for its use by others. The plan is written for the specific LEVEL D site conditions, purposes, tasks, dates and personnel specified. If these conditions change, a new plan must be utilized and reviewed by those named in Section 17.

Subcontractors shall be solely responsible for the health and safety of their employees and shall comply with all applicable laws and regulations. In accordance with 1910.120(b)(1)(iv) and (v), Battelle will inform subcontractors of the site emergency response procedures, and any potential fire, explosion, health, safety or other hazards by making this Site Specific Safety and Health Plan and site information obtained by others available during regular business hours. All contractors and subcontractors are responsible for: (1) developing their own Health and Safety Plan including a written Hazard Communication Program and any other written hazard specific programs required by federal, state and local laws and regulations; (2) providing their own personal protective equipment (PPE); (3) providing documentation that their employees have been health and safety trained in accordance with applicable federal, state and local laws and regulations; (4) providing evidence of medical surveillance and medical approvals for their employees; and (5) designating their own site safety officer (SSO) responsible for ensuring that their employees comply with their own Health and Safety Plan and taking any other additional measures required by their site activities.

SECTION 2: PROJECT INFORMATION

(1) SITE INFORMATION

Site Name:	ERH Pilot Test Site near BLDG 5	Site Project Contact:	Glenna Clark
Address	IR Site 5	Phone Number:	619-532-0951
	Former Naval Air Station Alameda	Site Safety & Health Contact:	Sam Yoon
	Alameda Point, CA 92101	Phone Number	O: 614-424-4569/ C: 614-218-0627

(2) SITE CLASSIFICATION (check or circle all that apply)

- √ Hazardous (RCRA/CERCLA/State)
- ☐ Construction
- ☐ Landfill (Non-Hazardous)
- ☐ UST/LUST
- ☐ Manufacturing
- ☐ Active
- √ Inactive
- ☐ Other: military installation

(3) ENTRY OBJECTIVES (check or circle all that apply)

- √ Site Inspection (General)
- ☐ Well Drilling Observation
- ☐ Sampling, Air
- √ Sampling, Water
- √ Sampling, Soil
- ☐ Other:

DATE(S) OF FIELD VISIT(S):

(4) BATTELLE/ASU TASKS

- B1. Groundwater Investigation
- B2. Groundwater sampling
- B3. Water level survey and slug tests
- B4. Analytical activities

TASK PERFORMED BY OTHERS

- 01. Direct push activities for gw sample collection
- 02. IDW disposal
- 03.
- 04.

(5) PROJECT ORGANIZATION AND COORDINATION – The following personnel are designated to carry out the stated project job functions on site. (Note: One person may carry out more than one job function.)

PRINCIPAL INVESTIGATORS	Bruce Alleman/Paul Johnson
SITE SAFETY OFFICER	Sam Yoon
ALTERNATIVE SITE SAFETY OFFICER(S)	Jennifer Triplett/Paul Dahlen
PUBLIC INFORMATION OFFICER	N/A
SITE RECORD KEEPER	Sam Yoon/Jennifer Triplett
SITE PERSONNEL WITH CPR/FA	Sam Yoon
FIELD TEAM LEADER(S)	Sam Yoon
OTHER FIELD TEAM MANAGERS	

(6) ON SITE CONTROL

Sam Yoon has been designated to coordinate access control and security for Battelle operations on site. A safe perimeter has been established at the work area by delineating the work area with traffic cones and/or high-visibility barrier tape.

No unauthorized person should be within this area.

The on site Command Post and staging area have been established at the pilot ERH test area near Building 5 at IR Site 5 .

The prevailing wind conditions are west . A wind direction indicator is used to determine daily wind directions. The Command Post is located upwind from the Exclusion Zone or at a sufficient distance to prevent exposure should a release occur.

Control boundaries have been established and include West of the ERH test area . These boundaries are identified in the field by: traffic cones and/or high-visibility barrier tape.

SECTION 3: PHYSICAL HAZARDS

(1) IDENTIFY POTENTIAL PHYSICAL HAZARDS TO WORKERS (check or circle all that apply)

☐	Confined Space	☐	Steep/Uneven Terrain	√	Drums Handling*
√	Heavy Equipment	☐	Heat Stress	☐	Noise
☐	Moving Parts	√	Extreme Cold	☐	Non-Ionizing Radiation
☐	Heavy Lifting	☐	Ionizing Radiation	☐	Other:
☐	Electrical	☐	Traffic		
☐	Overhead Hazards	☐	Biological Hazards		
☐	Fall (>6; Vertical)	☐	Surface Water (Immersion)		

Site hazards will be mitigated by:

(5) Briefing site personnel as to identified physical hazards within the work area.
(6) Identifying the "kill switch" on the drilling rig.
(7) Personal protection equipment such as ear muffs, ear plugs, winter jakets, etc. will be don to site personnel.
(8) Antiseptic ointment, solution, and bug repellent (especially for ticks) will be included in the first aid kit for insect stings.

(2) SAFETY EQUIPMENT REQUIRED FOR BATTELLE/ASU EMPLOYEES (check or circle all that apply)

☐	Explosimeter	☐	Eye Wash	☐	Confined Space Warning Signs
☐	Fall Protection Equipment	☐	Emergency Shower	√	Communications – On Site
√	Barrier Tape	√	Emergency Air Horn	√	Communications – Off Site
√	Traffic Cones	☐	Lights	☐	Other:
☐	Stretcher	☐	Lights – emergency		
√	First Aid Kit	☐	Ladder		
☐	A-B-C- Fire Extinguisher	√	Tick Repellant		
☐	Snake Bite Kit	☐	Flotation Device (USCG Type III)		

Emergency equipment will be located in the cab of the drilling rig. See Sections 10 and 12 for communication procedures. The field crew will be equipped with cellular telephones, walkie-talkies, and emergency air horn for communication.

SECTION 4: CHEMICAL HAZARDS INFORMATION

(1) IDENTIFIED CONTAMINANTS

Known or suspected hazardous/toxic material (attached historical information, physical description, map of contamination and tabulated date, if available).

Media	Substances Involved	Characteristics	Estimated Concentrations	PEL
GW	Chlorinated hydrocarbons (1,1-dichloroethane,	VO and TO	Total chlorinated VOCs up to 35,000	

	1,1-dichloroethene, 1,1,1-trichloroethane)		µg/L prior to the ERH operation, recent monitoring was at 700 µg/L.	
SL	Chlorinated hydrocarbons	VO and TO	NA	

Media types — GW (ground water), SW (surface water), WW (wastewater), AIR (air), SL (soil), SD (sediments), WL (waste, liquid), WS (waste, solid), WD (waste, sludge), WG (waste, gas) OT (other).

Characterizations — CA (corrosive, acid) CC, (corrosive, caustic), IG (ignitable), RA (radioactive), VO (volatile), TO (toxic), RE (reactive), BIO (infectious), UN (unknown), OT (other, describe)

Material Safety Data Sheets (MSDSs) for the contaminants of concern are attached. The data sheets include information on the chemical/toxicological properties of the site contaminants and signs and symptoms of over exposure.

(2) DESCRIBE POTENTIAL FOR CONTACT WITH EACH MEDIA TYPE FOR EACH OF THE BATTELLE/ASU TASKS LISTED IN SEC 2.4:

BATTELLE TASK #	ROUTE OF EXPOSURE	POTENTIAL FOR CONTACT	METHOD OF CONTROL
B1	Inhal/Ingest/Contact/Absorb	High/Medium/Low	Level D PPE
B2	Inhal/Ingest/Contact/Absorb	High/Medium/Low	Level D PPE
B3	Inhal/Ingest/Contact/Absorb	High/Medium/Low	Level D PPE
B4	Inhal/Ingest/Contact/Absorb	High/Medium/Low	Level D PPE

The SSO will brief the field team on interpretation of the attached MSDSs and particularly on symptoms and signs of over exposure to chemical hazards.

SECTION 5: HAZARD COMMUNICATION PROGRAM

If chemicals are introduced to the site by Battelle (e.g., decontamination liquids, preservatives, etc.), bring a copy of the Battelle Hazardous Communication Program and associate MSDSs to the site. The SSO will review this information with all field personnel. The current list of chemicals for this site is:

1,1,1-Trichloroethane (TCA)	1,2-dichloroethene (cis- and trans-), Vinyl chloride
1,1,2-Trichloroethane (TCA)	Trichloroethene, Tetrachloroethene
1,1-Dichloroethane, 1,2-dichloroethane (DCA)	Methanol
1,1-dichloroethene (DCE)	Alcohol, Liquinox®, HCL (preservative)

SECTION 6: ENVIRONMENTAL MONITORING

(1) The following environmental monitoring instruments shall be used on site at the specified intervals for breathing zone monitoring:

	EQUIPMENT	MONITORING PERIOD		ACTION LEVEL
☐	Combustible Gas Indicator	daily/hourly/continuous/other		
☐	O_2 Meter	daily/hourly/continuous/other		
√	PID (Lamp ____10.6_ eV)	daily/~~hourly/continuous/other~~		
☐	FID	daily/hourly/continuous/other		
☐	Radiation Meter (Gamma)	daily/hourly/continuous/other		
☐	Respirable Dust Meter	daily/hourly/continuous/other		
☐	GC/ECD/FID	daily/hourly/continuous/other		
√	GC/FID/PID/DELCD	daily/~~hourly/continuous/other~~		
		daily/hourly/continuous/other		

(4) Monitoring equipment is to be calibrated according to the manufacturers' instructions daily prior to and after each day of use. Record calibration data and air concentration in the Health and Safety on-site logbook.

(5) Action Levels for work shutdown and excavation. These are average values. Consideration should be given to the potential for release of highly toxic compounds from the waste or from reaction by-products. Levels are for persistence (> 10 min).

	ACTION LEVEL
Uncharacterized Airborne Vapors or Gases	>Background
Characterized Airborne Gases, Vapor, Particulates	**>50% PEL, REL, TLV**
Oxygen	< 19.5; >23.5
Flammability	> 10% LEL

(5) Military and/or civilian personnel in charge of buildings adjacent to invasive monitoring activities will be notified via a health and safety kick-off meeting of site activities. A copy of this HASP will be provided. If any action levels are reached at the work area as described above or if discernible odors are released as a result of field activities, the

personnel in charge or their designated representative will be notified immediately. Hourly perimeter monitoring (support zone) will be conducted to assess whether organic vapors or odors are leaving the work area.

SECTION 7: HEALTH AND SAFETY TRAINING/MEDICAL MONITORING PROGRAM

The project staff is included in the Battelle Health and Safety Training and Medical Monitoring Programs in conformance with 29 CFR 1910.R.

		HAZWOPER TRAINING		
NAME	MEDICAL (Date)	INITIAL (Hrs/Date)	REFRESHER (Date)	CPR/FA/ (Dates)
Sam Yoon	March 2006	40 hours/Jan 16, 1997	June 17, 2005	8/25/2005; 6/27/2003 (good for 3 years)
Shane Walton	Nov 2004	40 hours/April 1994	January 13, 2006	10/27/2005; 5/28/2004 (good for 3 years)
Jennifer Triplett		40 hours/June 2001	August 7, 2005	
Paul Dahlen		40 hours/Nov 1992	February 2006	

SECTION 8: PERSONAL MONITORING

☐ No personal exposure monitoring or heat/cold stress monitoring will take place on site. If the need for such monitoring is anticipated, this HASP will be modified as accordingly.

SECTION 9: CONFINED SPACE ENTRY

☐ No confined space and/or trench entries will take place on site. If the possibility of such entries taking place exists, this HASP will be modified accordingly.

SECTION 10: COMMUNICATION PROCEDURES

The following standard hand signals will be used in case of failure to radio communications in each contaminant reduction zone:

Hand gripping throat	Can't Talk, Having difficulty breathing
Grip partner's wrist and both hands around wrist	Can't Talk, Leave area immediately
Hands on top of head	Need assistance
Thumbs up	OK, I am all right, I understand
Thumbs down	No, negative

If applicable, telephone communications to the Command Post Should be Established as soon as possible. The stationary and/or mobile phone number(s) will be available one week prior to the start of field work. The HASP will be amended when these numbers are available.

The command post telephone is ____________

The mobile phone is ____________

SECTION 11: DECONTAMINATION PROCEDURES

Personnel and equipment leaving an exclusion zone shall be thoroughly decontaminated at the decontamination facility constructed at the command post. The SSO is responsible for monitoring adherence with this decontamination plan. A Modified Level D decontamination protocol shall be used with the following decontamination stations:

(7) Equipment Drop (IF NECESSARY)
(8) Boot Covers, and Glove Wash and Rinse (IF NECESSARY)
(9) Outer Boot and Glove Removal (IF NECESSARY)
(10) Outer Garment Removal (IF NECESSARY)
(11) Inner Glove Removal (IF NECESSARY)
(12) Field Hand Wash

The following decontamination equipment is required (check or circle all that apply)

√	Decon Pad (Plastic Sheet)	☐	Dry Brushes	√	Detergent Soap
√	Trash Cans/Bags	√	Wet Brushes	☐	Other Decontamination Solution
√	Buckets	√	Water		____________

SECTION 12: EMERGENCY PROCEDURES

On site personnel will use the following standard emergency procedures. The SSO shall be notified of any on site emergencies and be responsible for ensuring that the procedures are followed.

Personal Injury in the Exclusion Zone

DESIGNATED EMERGENCY SIGNAL: Air Horn

Upon notification of an injury in the Exclusion Zone, the designated emergency signal shall be sounded. All site personnel shall assemble at the decontamination line. The SSO or alternate should evaluate the nature of the injury, and the affected person should be decontaminated to the extent possible prior to movement to the Support Zone. The on site CPR/FA personnel shall initiate the appropriate first aid, and contact should be made for an ambulance (and other emergency services as needed) and with the designated medical facility (if required). No persons shall reenter the Exclusion Zone until the cause of the injury or symptoms is determined.

Fire/Explosion

DESIGNATED EMERGENCY SIGNAL: Air Horn

Upon notification of a fire or explosion on site, the designated emergency signal shall be sounded and all site personnel assembled at the decontamination line. The fire department shall be alerted and all personnel moved to a safe distance from the involved area.

Equipment Failure

If any other equipment (i.e., air monitoring) on site fails to operate properly, the Field Team Leader and SSO shall be notified and then determine the effect of this failure on continuing operations on site. If the failure affects the safety of personnel or prevents completion of the Work Plan tasks, all personnel shall leave the Exclusion Zone until the situation is evaluated and appropriate actions taken.

Emergency escape routes are designated for use in those situations where egress from the Exclusion Zone cannot occur through the decontamination line

In all situations, when an on site emergency results in evacuation of the Exclusion Zone, personnel shall not reenter until:

(4) The conditions resulting in the emergency have been corrected.
(5) The hazards have been reassessed by the SSO.
(6) The Site Safety Plan has been reviewed by the SSO and Corporate Health and Safety Manager.

SECTION 13: SPILL CONTROL PROCEDURES

☐ No containers of liquid or solids exist on site, and no spill control plan is necessary. If the possibility of such conditions exist on site, this HASP will be modified accordingly.

SECTION 14: EMERGENCY INFORMATION

(1) LOCAL RESOURCES

Ambulance (name):	Alameda Hospital	Phone:	911
Hospital (name):	Alameda Hospital	Phone:	911 or (510) 522-3700
Police (local or state):	Alameda City Police	Phone:	911 or (510) 522-2423
Fire (name):	Alameda Fire Department	Phone:	911 or (510) 337-2100
HAZ MAT Responder:	National Response Center, Toxic Chemicals and Oil Spills	Phone:	911
On-Site CPR/FA(s):	Sam Yoon	Phone:	614-218-0627

* For life-threatening emergencies or emergency trauma care.
The above hospital is approximately 10 miles from the furthest work area and the ambulance response time is approximately 15 minutes.

** For non-life threatening medical care.
The above hospital is approximately 30 minutes from the furthest work area. Injured workers will be transported here for non-emergency treatment only.

DIRECTIONS TO NEAREST HOSPITAL – SEE ATTACHED MAP:

(2) Figure 1.

(3) BATTELLE RESOURCES

Manager, Corporate Health and Safety (ETE Division)
Gary Carlin, 614-424-4929

Site Contact: Sam Yoon: 614-424-4569

Battelle Security Office
(614) 424-4444

SECTION 15: PERSONAL PROTECTIVE EQUIPMENT (check or circle all that apply)

☐ No type of respiratory protection is required on this site. If the possibility of the need for respiratory protection is anticipated, this HASP will be modified accordingly.

CLOTHING	GLOVES	BOOTS	OTHER
☐ Coveralls	☐ Cotton	☐ Safety	√ Hard Hat
☐ Tyvek	√ Leather	☐ Fireman/Hip	√ Glasses
☐ Saranex	√ Nitrile	☐ Neoprene	☐ Goggles
☐ PE Tyvek	☐ Butyl	√ Steel Toe	☐ Face Shield
☐ Other:	☐ Neoprene		√ Hearing Protection
	☐ Viton		
	☐ PVC		
	☐ PVA		
	√ Latex		

SECTION 16: SAFE WORK PRACTICES

THE FOLLOWING PRACTICES MUST BE FOLLOWED BY PERSONNEL ON SITE

12. Smoking, eating, chewing gum or tobacco, or drinking are forbidden except in clean or designated areas.
13. Ignition of flammable liquids within or through improvised heating devices (e.g., barrels) is forbidden.
14. Contact with samples, excavated materials, or other contaminated materials must be minimized.
15. Use of contact lenses is prohibited at all times.
16. Do not kneel on the ground when collecting samples.
17. If drilling equipment is involved, know where the kill switch is.
18. All electrical equipment used in outside locations, wet areas, or near water must be plugged into ground fault circuit interrupter (GFCI) protected outlets.
19. A "Buddy System" in which another worker is close enough to render immediate aid will be in effect.
20. Good housekeeping practices are to be maintained.
21. Where the eyes or body may be exposed to corrosive materials, water suitable for quick drenching or flushing shall be available for immediate use.
22. In the event of treacherous weather-related working conditions (i.e., thunderstorm, limited visibility, extreme cold or heat) the field task will be suspended until conditions improve or appropriate protection from the elements is provided.

SECTION 17: EMPLOYEE ACKNOWLEDGMENTS

PLAN REVIEWED BY:

		DATE
H&S Manager:	Linc Remmert	
Principal Investigator	Bruce Alleman; Paul Johnson	
Project Leader:	Sam Yoon	
Site Safety Officer:	Sam Yoon	

I acknowledge that I have read the information in this HASP form and the attached MSDSs. I understand the site hazards as described and agree to comply with the contents of the plan.

FIELD PERSONNEL (Print Name)	SIGNATURE	DATE

VISITOR (Print Name)	SIGNATURE	DATE
Organization/Agency		
Organization/Agency		

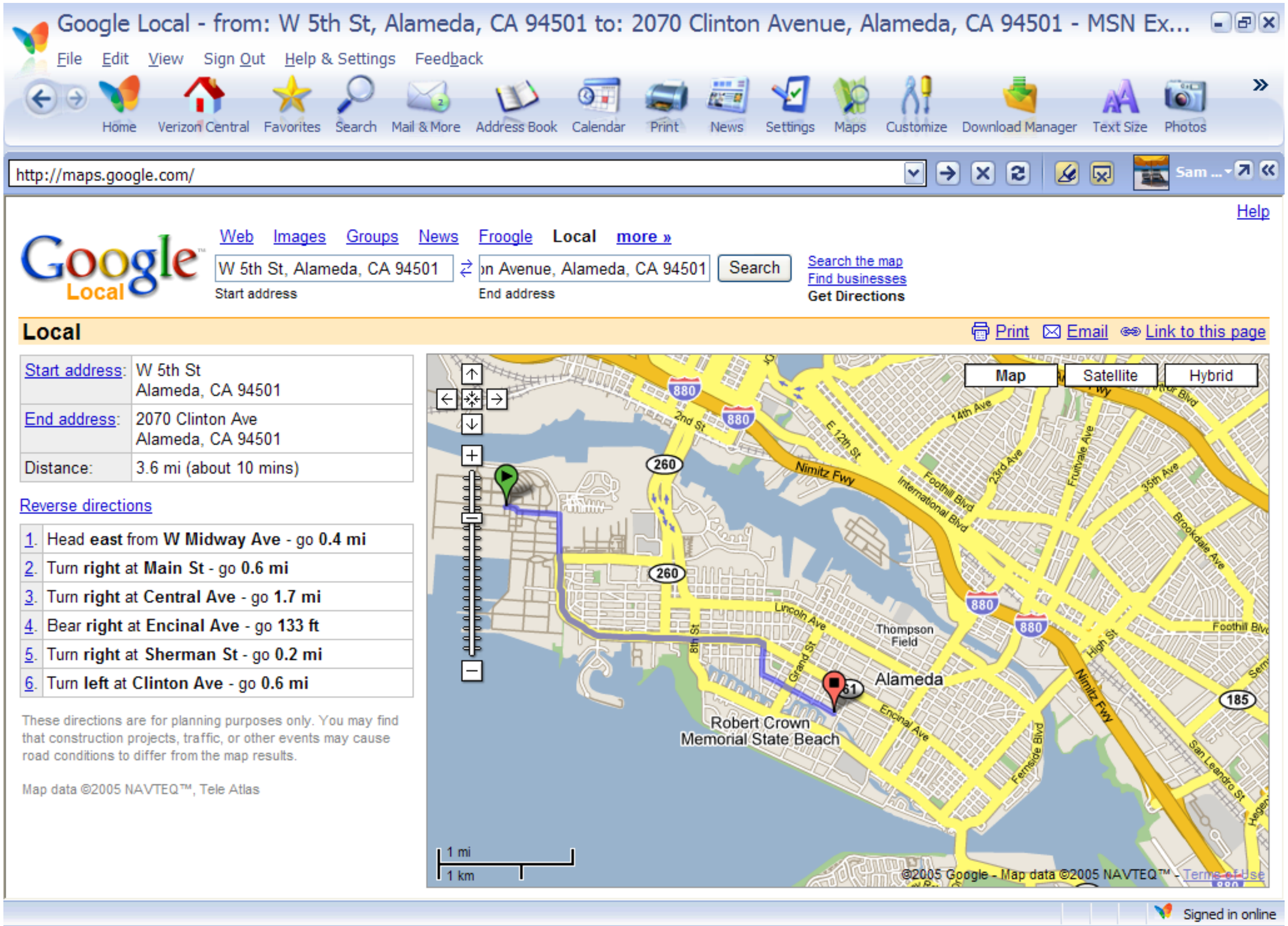


Figure 1. Directions to Alameda Hospital

Draft Final

Data Analysis Report
NAS Alameda – Site 5

Critical Evaluation of the State of In Situ Thermal Treatment Technologies for DNAPL Source Zone Treatment

Prepared for:

Environmental Security Technology Certification Program
Arlington, VA

Prepared by:
Arizona State University
Battelle Memorial Institute

August 2006

The vendors and products, including the equipment, system components, and other materials identified in this report, are primarily for information purposes only. Although some of these vendors and products may have been used in the past, mention in this report does not constitute a recommendation for using these vendors or products.

Contents

Figures

Tables

Acronyms and Abbreviations

bgs	below ground surface
cis-1,2-DCE	cis-1,2-dichloroethene
DELCD	dry electrolytic conductivity detector
DO	dissolved oxygen
EC	electrical conductivity
ERH	electrical resistance heating
ESTCP	Environmental Security Technology Certification Program
FID	flame-ionization detector
ft	feet
GC	gas chromatography
kg	kilogram
NAPL	non-aqueous phase liquid
ORP	oxidation reduction potential
PID	photo-ionization detector
temp	temperature
TCE	trichloroethylene
VOA	volatile organic analysis
yr	year

1. Introduction

The post treatment field investigation of NAS Alameda under the Environmental Security Technology Certification Program (ESTCP) project CU-0314, *Critical Evaluation of State of the In-Situ Thermal Treatment Technologies*, was performed June 1 through June 9, 2006. Figure 1 identifies the extent of the previous electrical resistance heating (ERH) remediation area, which was also the specific area of interest for this particular field investigation.

Consistent with the objectives set forth under the CU-0314 Demonstration Plan, the field investigation at this site included the following:

- Verification of the site hydrogeological conceptual model
- Groundwater sampling of monitoring wells
- Depth-discrete analysis of hydraulic conductivity and dissolved petroleum hydrocarbons at temporary sampling locations downgradient of the treatment zone.

2. Field Investigation

In accordance with the approved generic demonstration plan for this project, the following site-specific activities were conducted:

1) Verification of the site hydrogeological conceptual model:

   a. For confirmation of geology, two continuous soil cores was collected at direct-push sampling locations GP10 and GP11 shown in Figure 2. The continuous soil cores/ direct-push sampling locations were located at the down-gradient edge of the treatment zone. Table 1 presents qualitative geologic descriptions from visual observations of the continuous soil core.

   b. Hydraulic conductivity slug testing was conducted in 11 monitoring wells as identified in Table 2 and in Figure 3. The slug test data were analyzed using both the Hvorslev and the Bouwer and Rice Methods; results are presented in Table 3. The Hvorslev' expression for determining hydraulic conductivity from slug test data is:

$$K=(r^2\ln(L_e/R))/(2L_e t_{37})$$

Where K = hydraulic conductivity (L/T)
r = radius of well casing (L) (0.083 ft)
R = radius of well screen (L) (0.50 ft)
L_e = length of well screen (L) (5 or 10 ft)
t_{37} = time for water level to rise or fall 37% of the initial change (T) (from data set)

(Fetter, 2000).

The Bouwer and Rice expression for determining hydraulic conductivity from slug test data is:

$$K=(r_c^2 \ln(R_e/R) / (2L_e)) * ((1/t) \ln(H_o/H_t))$$

Where K = hydraulic conductivity (L/T)
r_c = radius of well casing (L) (0.083 ft)
R = radius of gravel envelope (L) (0.50 ft)
R_e = effective radial distance over which head is dissipated (L) (from data set)
L_e = length of well screen (L) (5 or 10 ft)
H_o = drawdown at t=0 (L) (from data set)
H_t = drawdown at t=t (L) (from data set)
t = time since $H = H_o$ (T) (from data set)

(Fetter, 2000).

c. Depth-to-groundwater was measured in the 15 groundwater monitoring wells identified in Table 2 and in Figure 4. Depth-to-water measurements and groundwater elevations are summarized in Table 4.

2) Collection of water quality samples from 11 groundwater monitoring wells within the treatment zone for analysis of dissolved chlorinated hydrocarbon groundwater concentrations:

   a. Table 2 identifies the groundwater monitoring wells from which samples were collected. Prior to sample collection, three well-volumes were purged. Groundwater was then collected for analysis of field parameters and stored in volatile organic analysis (VOA) vials for analysis of dissolved chlorinated hydrocarbon concentrations. General water quality field parameters including pH, electrical conductivity (EC), temperature, dissolved oxygen (DO), and oxidation reduction potential (ORP) were measured using an Horiba U-22 meter. Petroleum hydrocarbon analysis was performed on-site by heated-headspace analysis and gas chromatography (GC) using a dry electrolytic conductivity detector (DELCD), photo-ionization detector (PID) and a flame-ionization detector (FID). General water quality data for permanent groundwater monitoring well installations can be found in Table 5 and chemical concentration data can be found in Table 6. All non-detect samples are listed as less than the detection limit.

3) Depth-discrete hydraulic conductivity and dissolved chlorinated hydrocarbon concentration data were collected on three foot intervals as possible from 6.5 ft below ground surface (bgs) to 21 ft bgs at all seven direct-push sampling locations.

a. Groundwater quality data were collected from depth-specific intervals at all direct-push sampling locations (See Table 2 and Figure 2). Sampling locations were spaced on approximately 15 ft centers, as possible, along a transect downgradient of the source zone and perpendicular to the direction of groundwater flow. Figure 2 presents the direct-push sampling locations. Using percussion assisted direct-push technology and a modified Geoprobe Groundwater Profiler, groundwater samples were collected using a peristaltic pump on 3-ft intervals from 6.5 ft bgs to 21 ft bgs. The location of the depth-discrete groundwater samples are shown in Figure 5. Dissolved chlorinated hydrocarbon concentration analysis was conducted, as described above, and the results are summarized in Table 7.

   Aquifer specific-capacity tests were conducted at depth-specific intervals at direct push sampling locations GP1 through GP6 and GP8 as indicated in Table 2. Specific-capacity tests involve the measurement of the flow rate achieved under fixed drawdown and are analyzed using the Theim Equation to estimate hydraulic conductivity. The field data and results for aquifer testing are shown in Table 9. The Theim equation for hydraulic conductivity is:

$$T= (Q /(2(h_2-h_1))* \ln(r_2/r_1)$$

   Where
   T = transmissivity (L^2/T)
   Q = pumping rate (L^3/T)
   h_1 = head at distance r_1 from the pumping well (L)
   h_2 = head at distance r_2 from the pumping well (L)

   and $K = T/b$

   Where
   K = hydraulic conductivity (L/T)
   b = length of sampler or screen section (L) (0.5 ft or length of screen)

   (Fetter, 2000).

The monitoring well chemical concentration data collected in June 2006 by the ASU/Battelle team were compared to the previous monitoring well chemical concentration data available for the site (March 2005). The analytical results for each are shown in Table 10.

Figures 6 to 13 present contour plots of the chemical concentrations for eight of the ten chemicals measured at the depth-discrete direct push sampling locations. Two of chemicals, 1,1,2-Trichloroethane (TCA) and tetrachloroethene (PCE), were not contoured because all groundwater samples were non-detect (less than detection limit of 1 ug/L). Figure 14 presents the specific capacity pump test results for each discrete-depth direct push sampling interval overlaid on the trichloroethylene (TCE) concentration plot.

A TCE mass flux calculation was performed using the Mass Flux Toolkit, Version 1.0. The gradient was calculated using Devlin (2003) and the three wells with the greatest lateral separation with ASU depth to water measurements and grade elevations from previous work at NAS Alameda (grade elevations were not available for all monitoring wells). This program is a freeware program developed by Groundwater Services, Inc. and others under a contract funded by the Environmental Security Technology Certification Program (ESTCP). Figure 15 is a snapshot of the input screen with TCE being used to perform the mass flux analysis. A linear spatial and vertical interpolation of the data was used for the mass flux analysis. The TCE mass flux was estimated to be 2.56E-02 kg/yr.

3. References

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

Devlin, J.F. 2003. "A Spreadsheet Method of Estimating Best-fit Hydraulic Gradients Using Head Data from Multiple Wells." Groundwater, 41(3): 316-320.

Figures

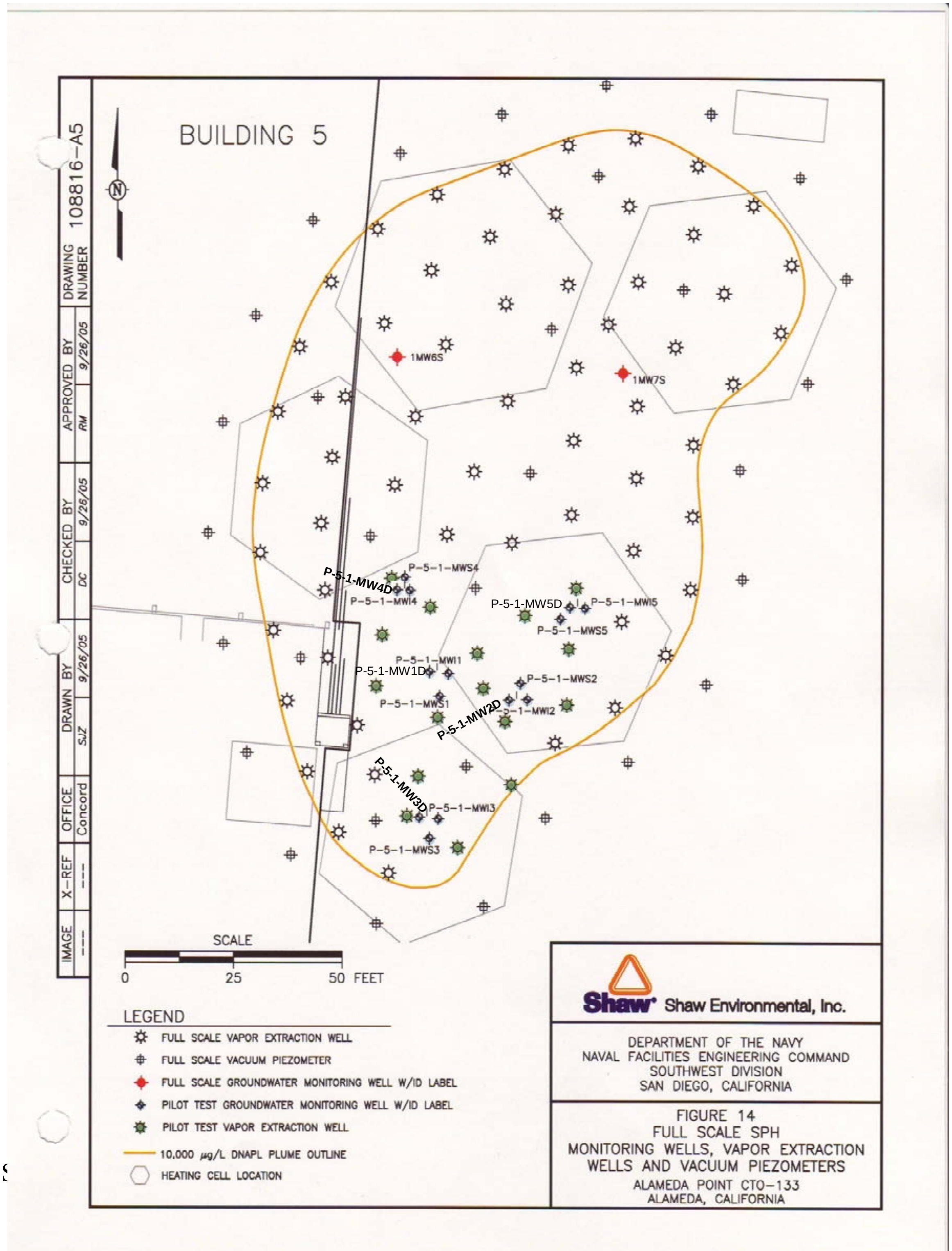
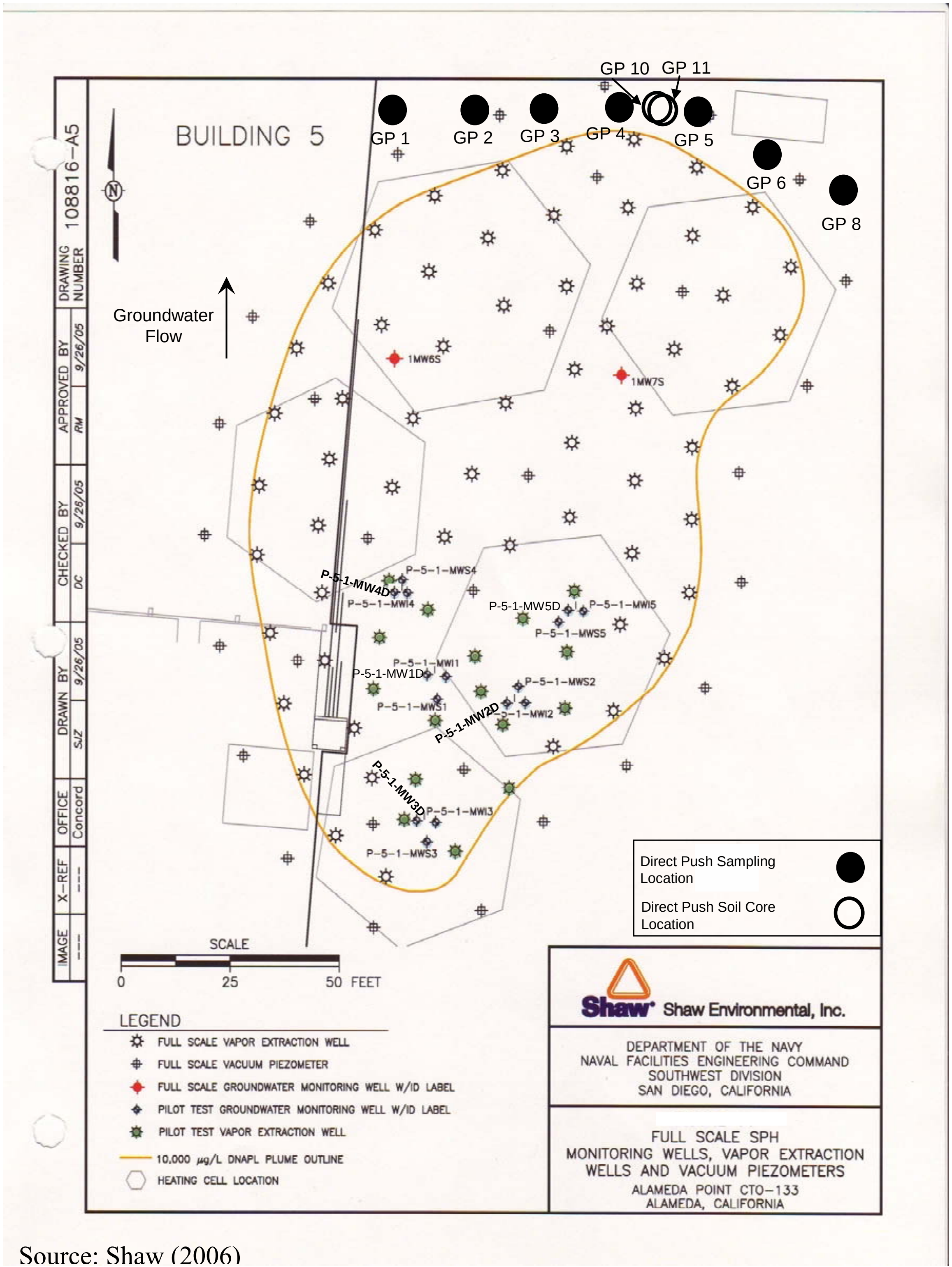


Figure 1. Site Map



Source: Shaw (2006)

Figure 2. Direct-Push Locations

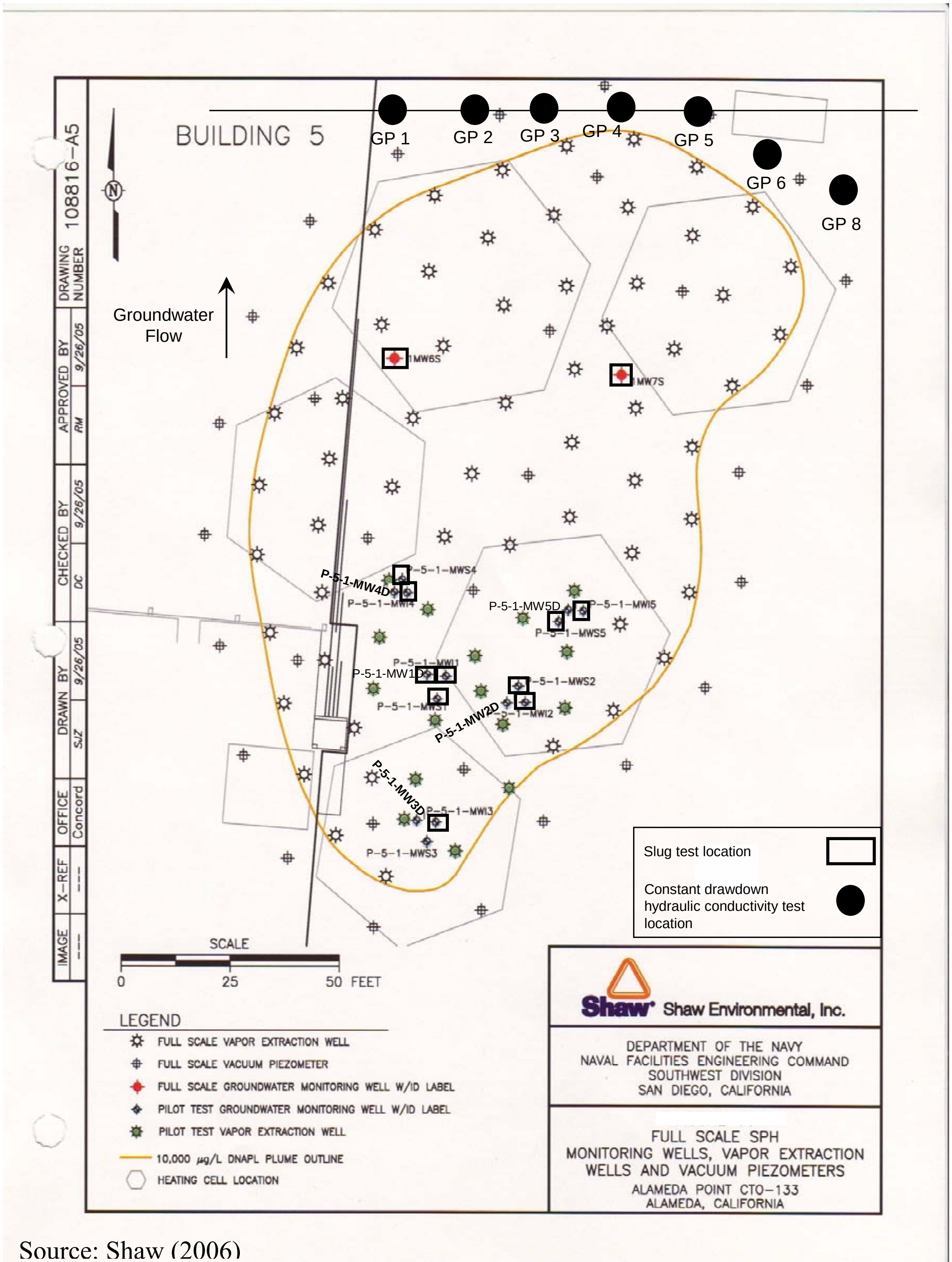
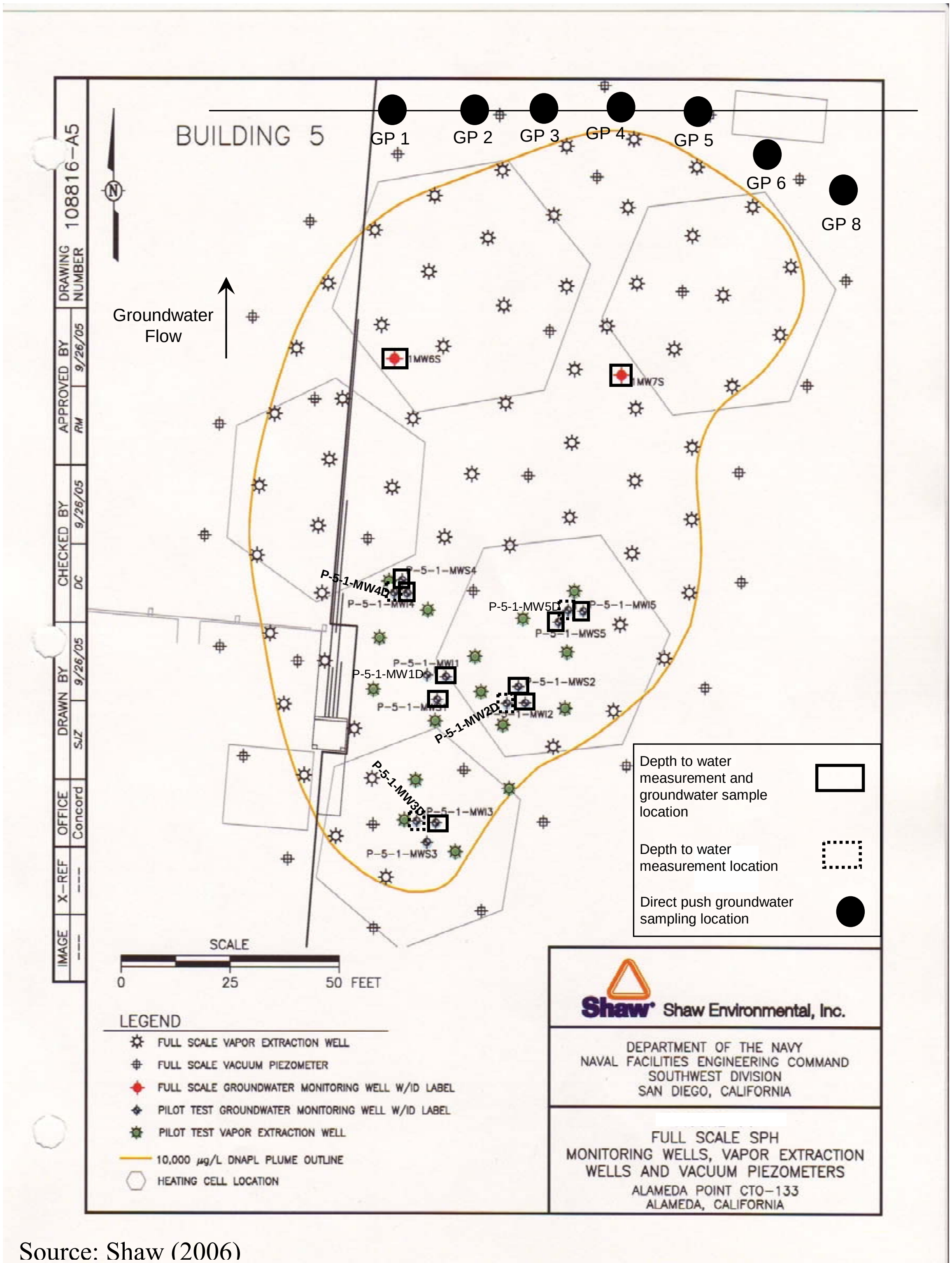


Figure 3. Hydraulic Conductivity Measurement Locations



Source: Shaw (2006)

Figure 4. Monitoring Well Depth-to-Water Measurement and Groundwater Sampling Locations

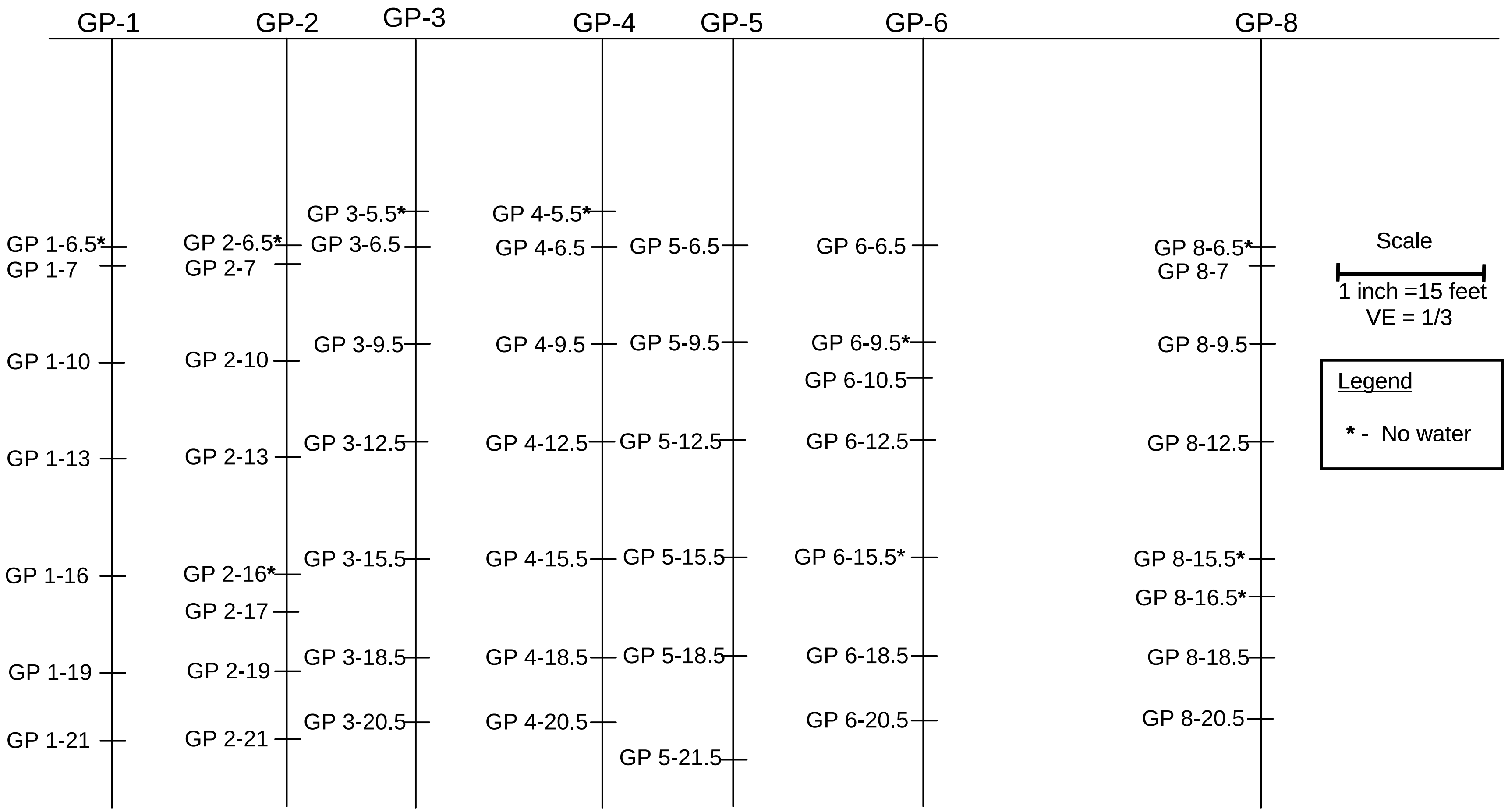


Figure 5. Cross-section of Direct Push Sampling Locations

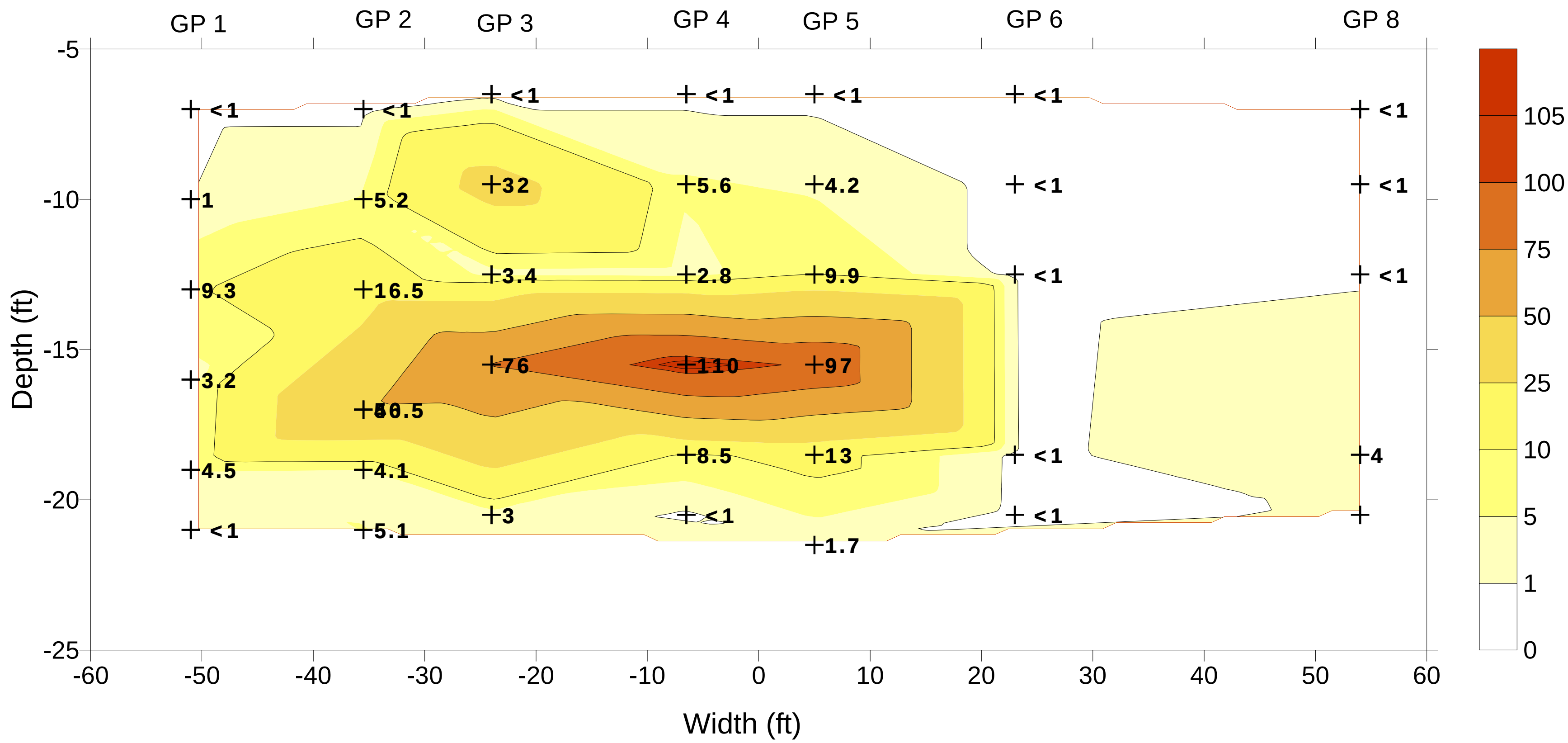


Figure 6. Vinyl Chloride Direct-Push Groundwater Concentrations (µg/L)

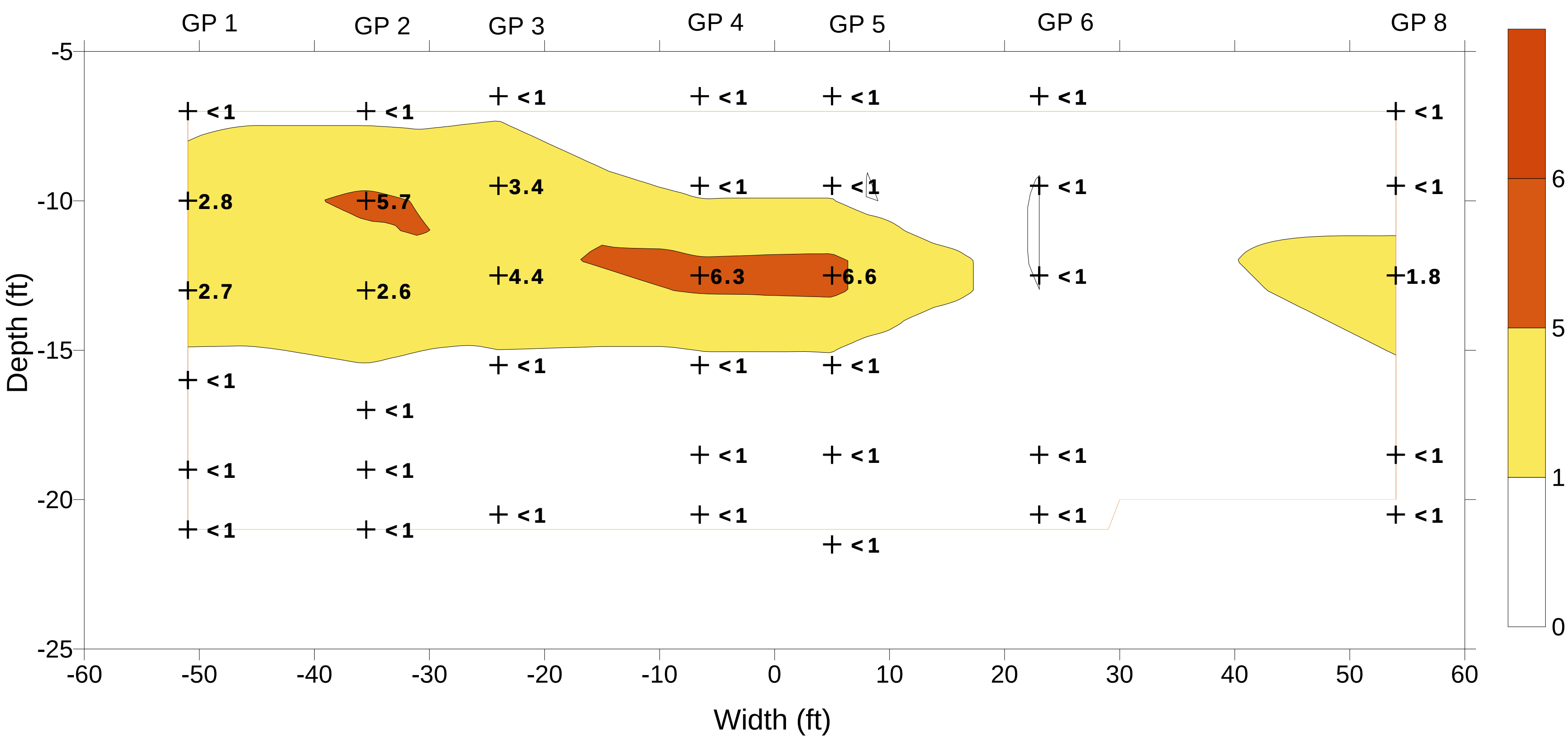


Figure 7. 1,1-Dichloroethene Direct-Push Groundwater Concentrations (μg/L)

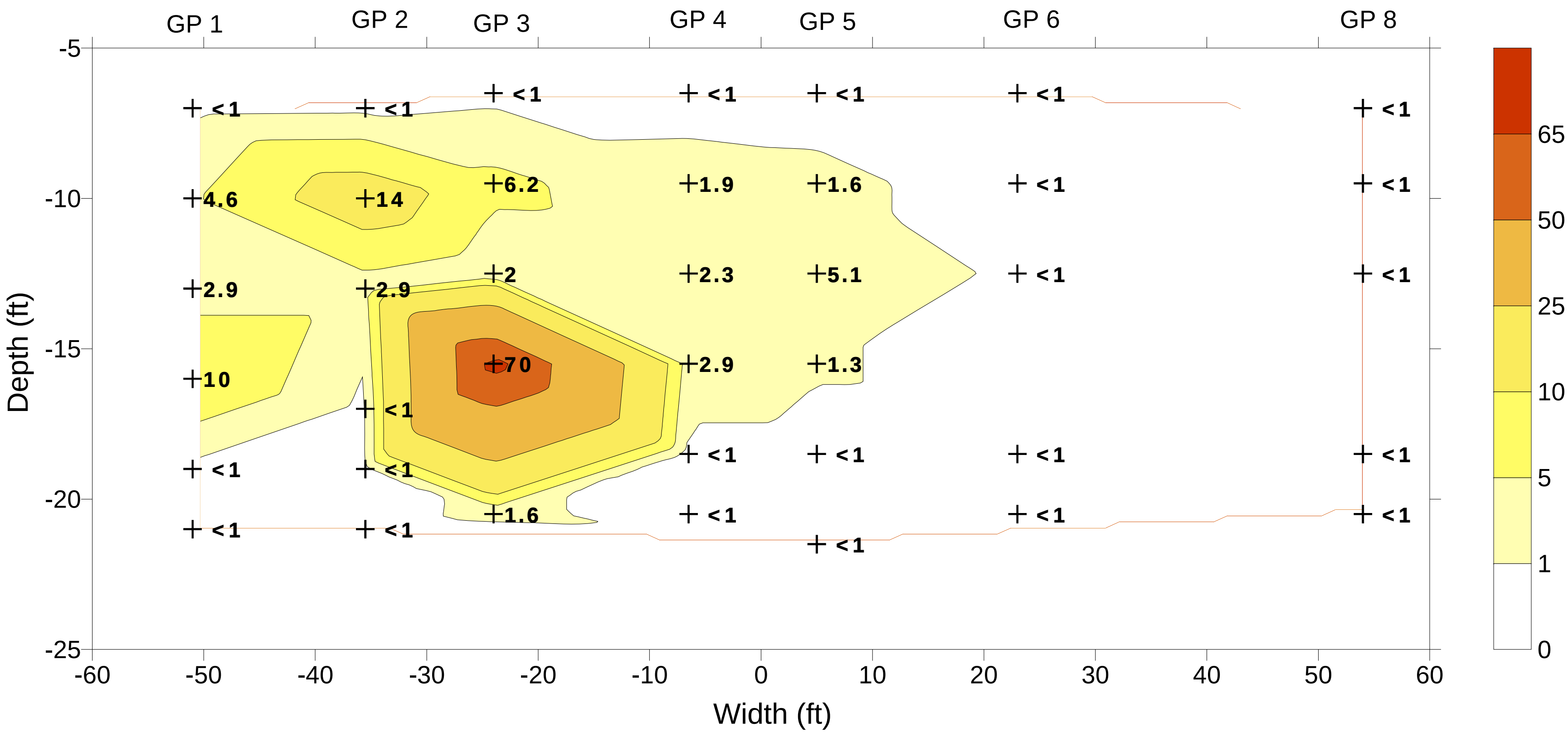


Figure 8. trans-1,2-Dichloroethene Direct-Push Groundwater Concentrations (μg/L)

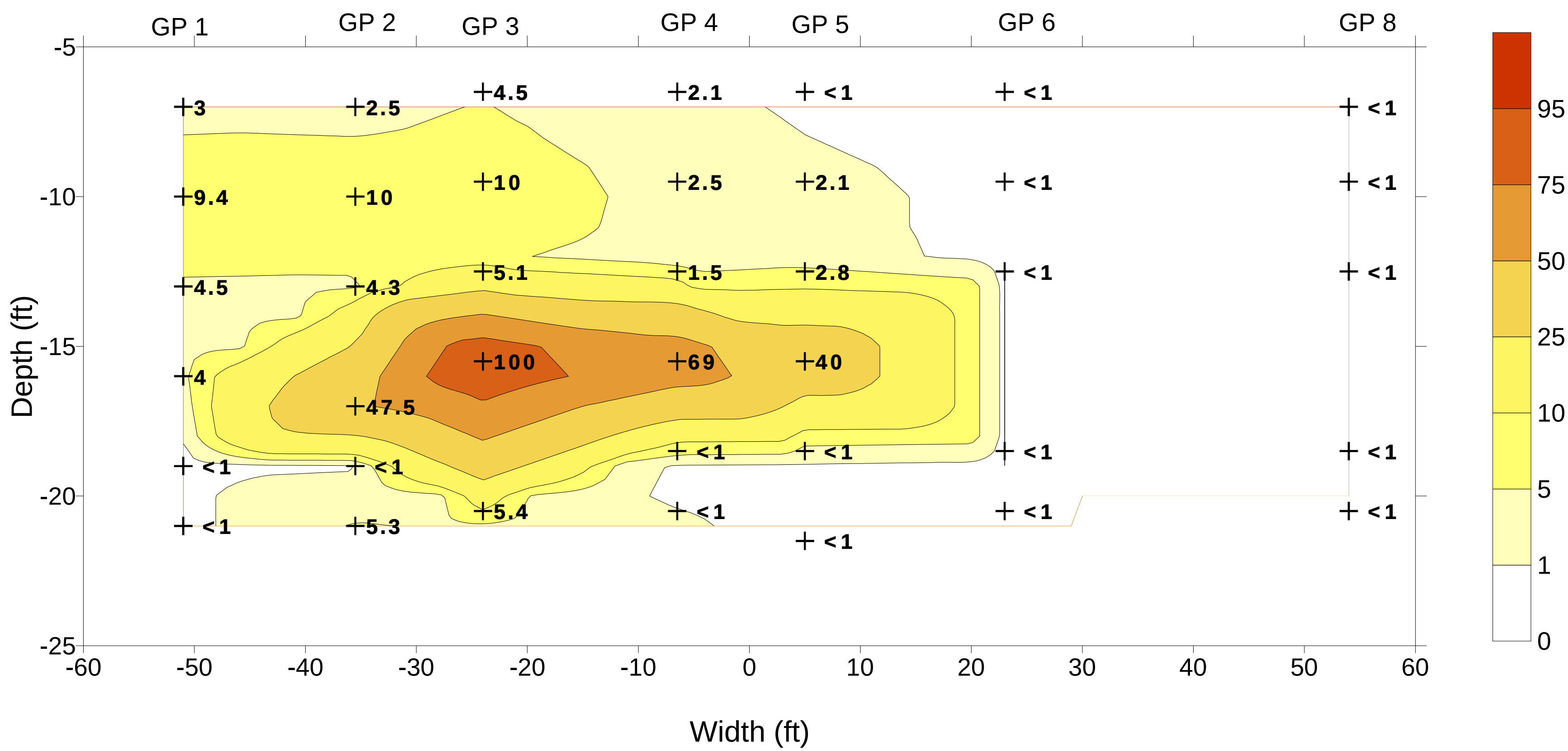


Figure 9. 1,1-Dichloroethane Direct-Push Groundwater Concentrations (µg/L)

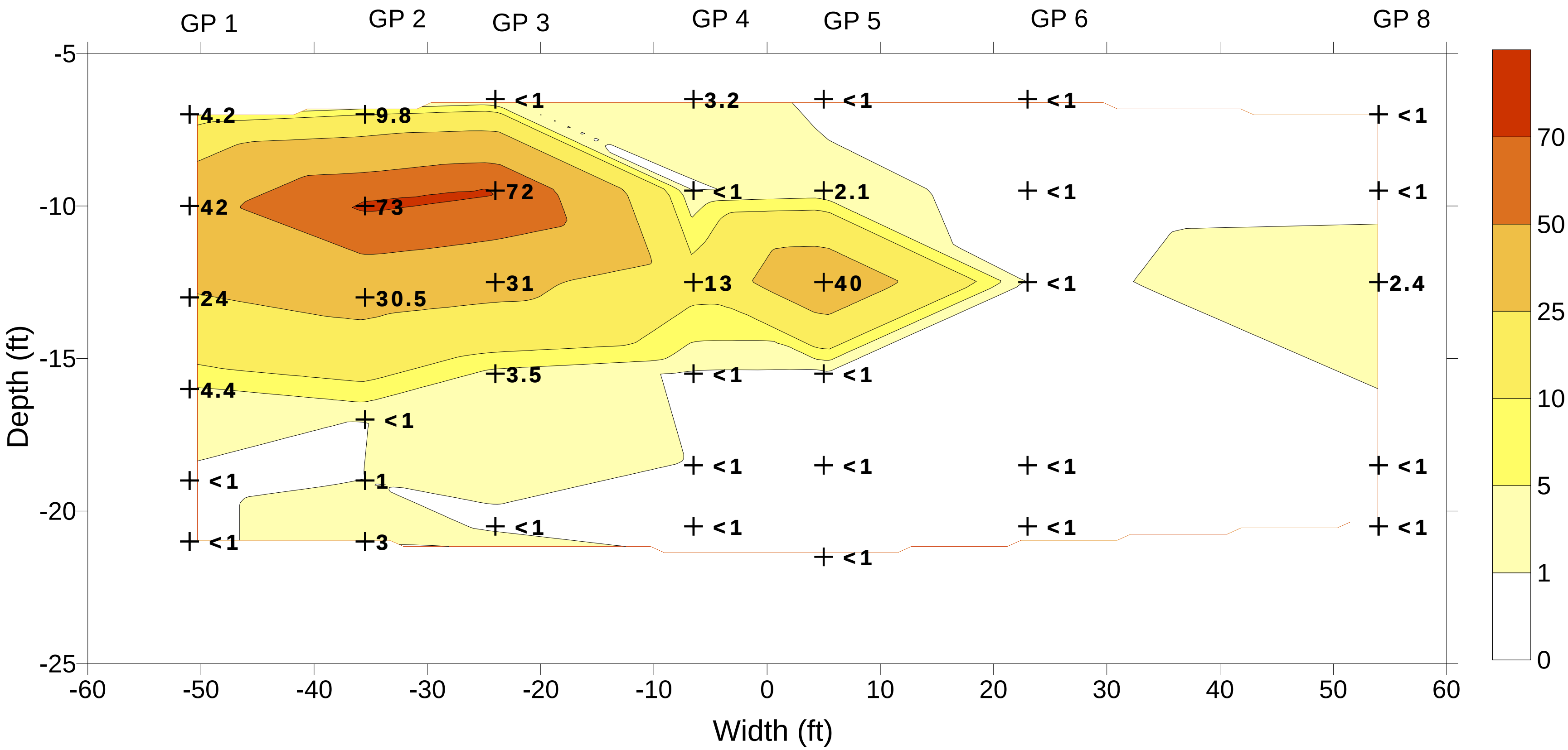


Figure 10. cis-1,2-Dichloroethene Direct-Push Groundwater Concentrations (µg/L)

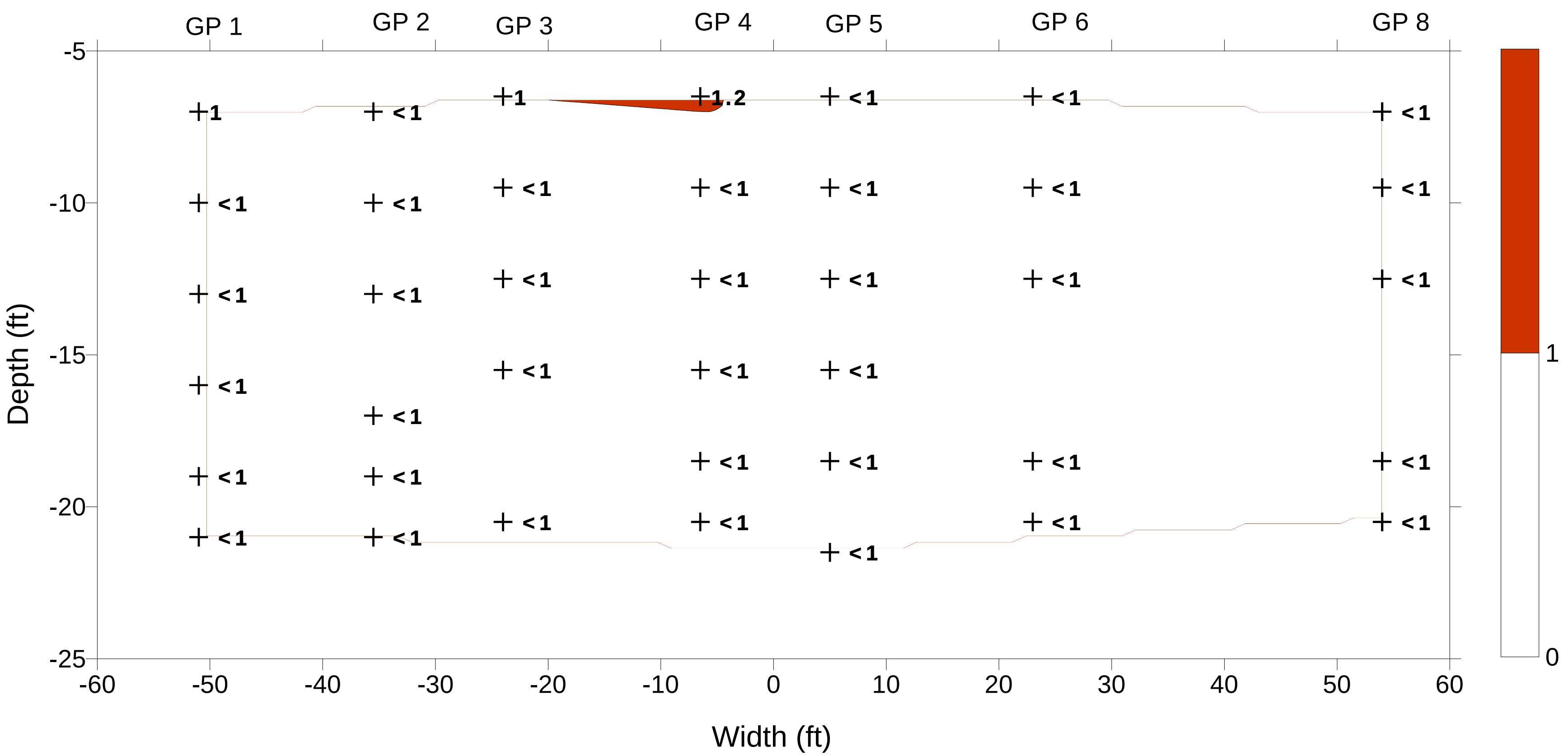


Figure 11. 1,2-Dichloroethane Direct-Push Groundwater Concentrations (µg/L)

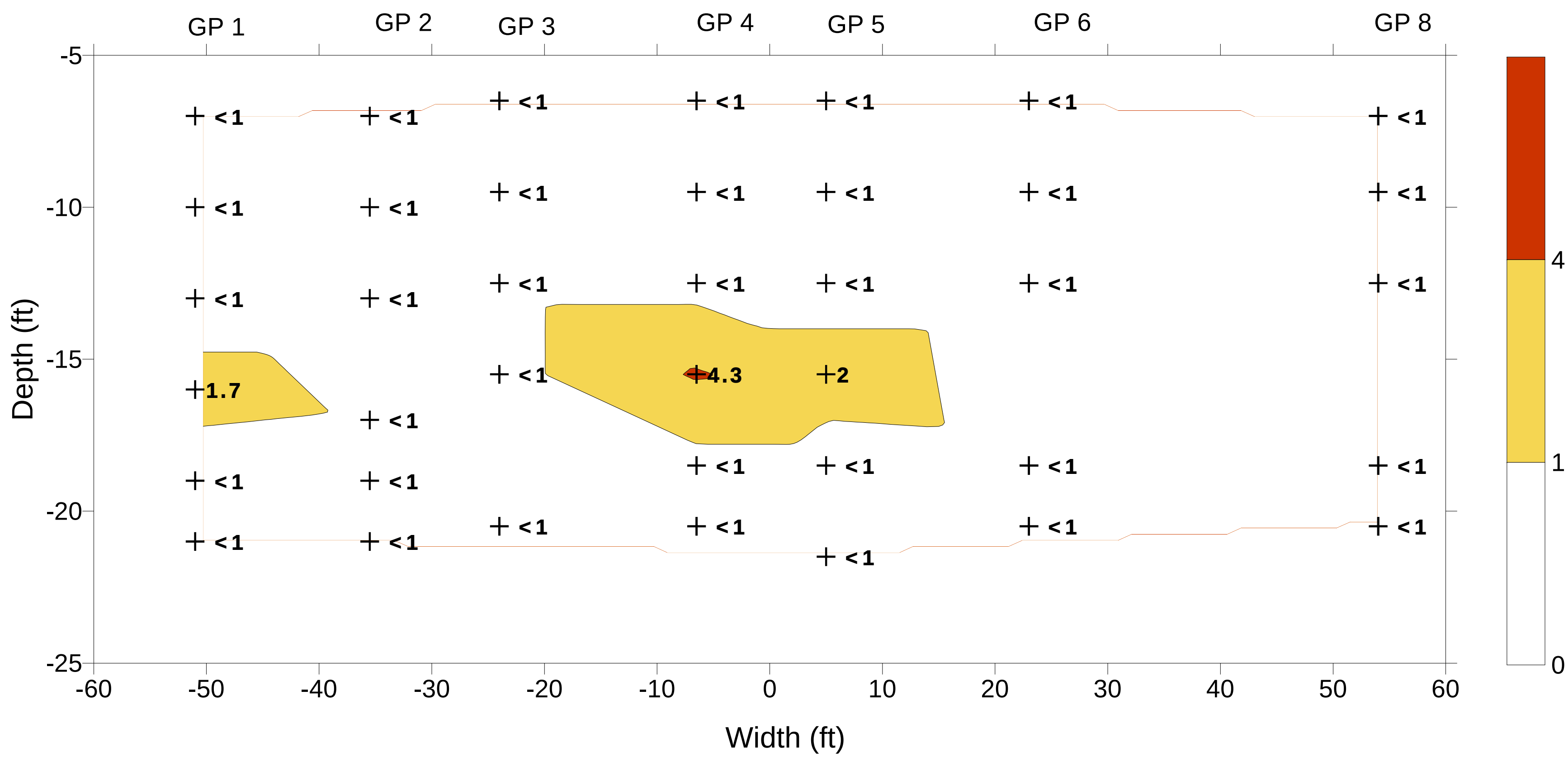


Figure 12. 1,1,2-Trichloroethane Direct-Push Groundwater Concentrations (μg/L)

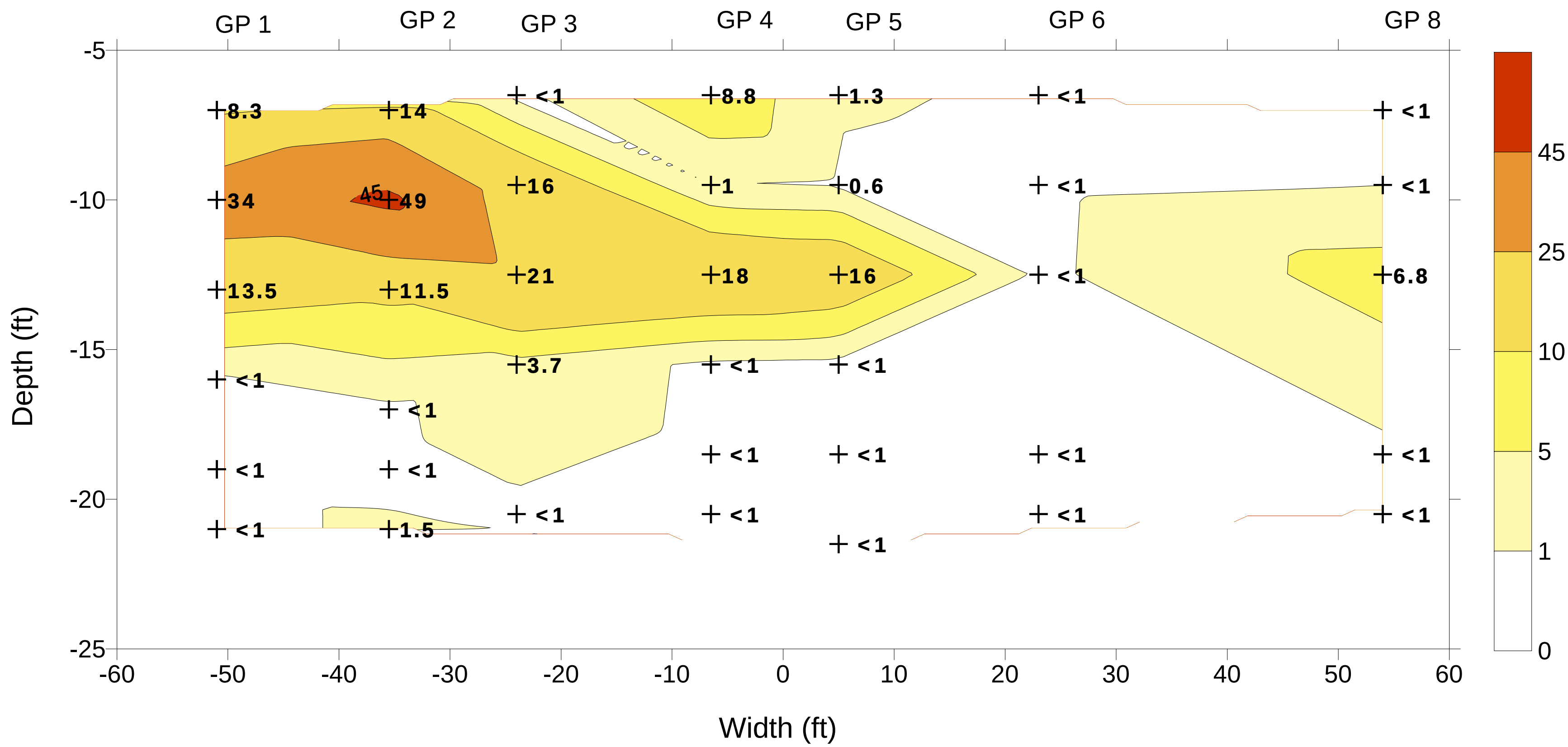


Figure 13. Trichloroethylene Direct-Push Groundwater Concentrations (µg/L)

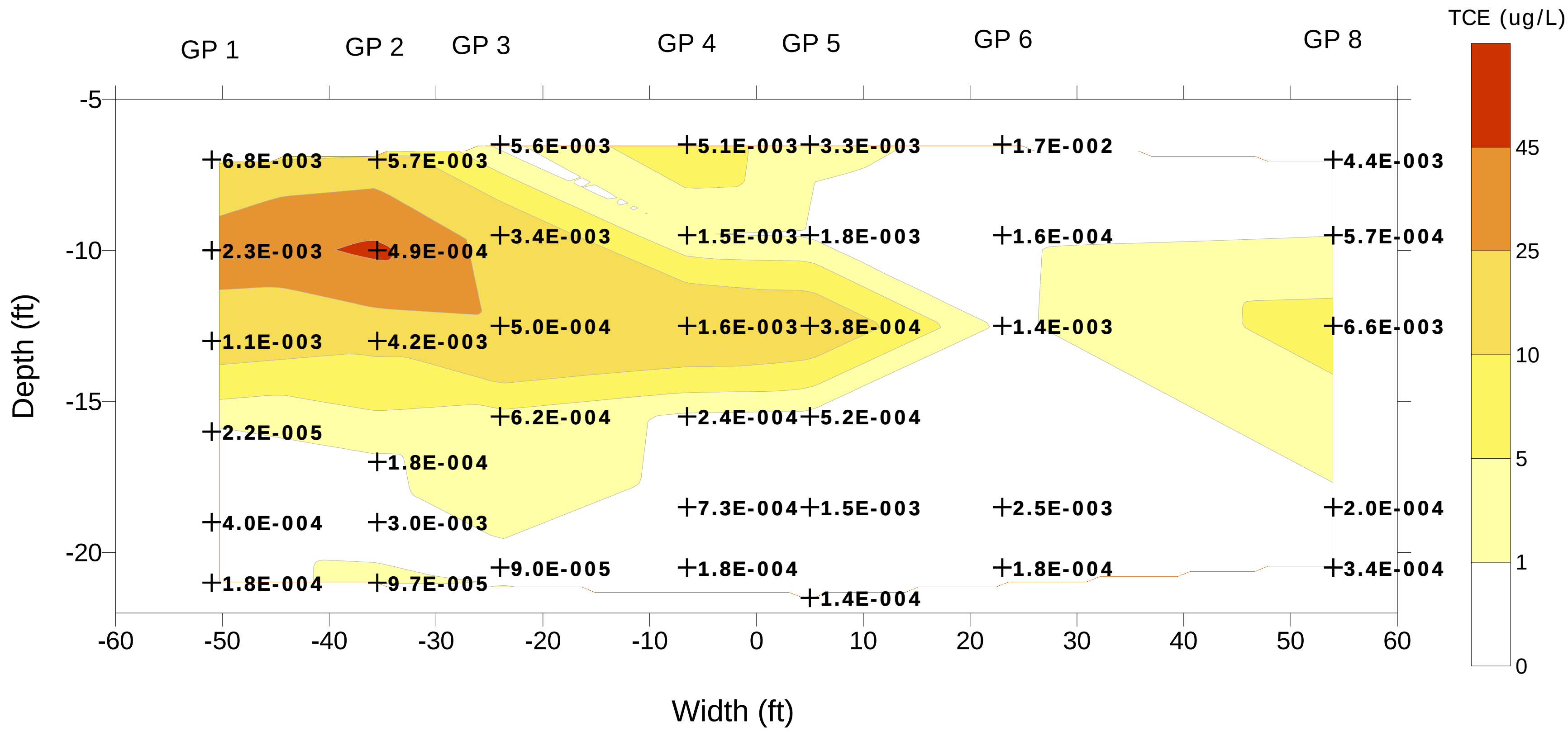
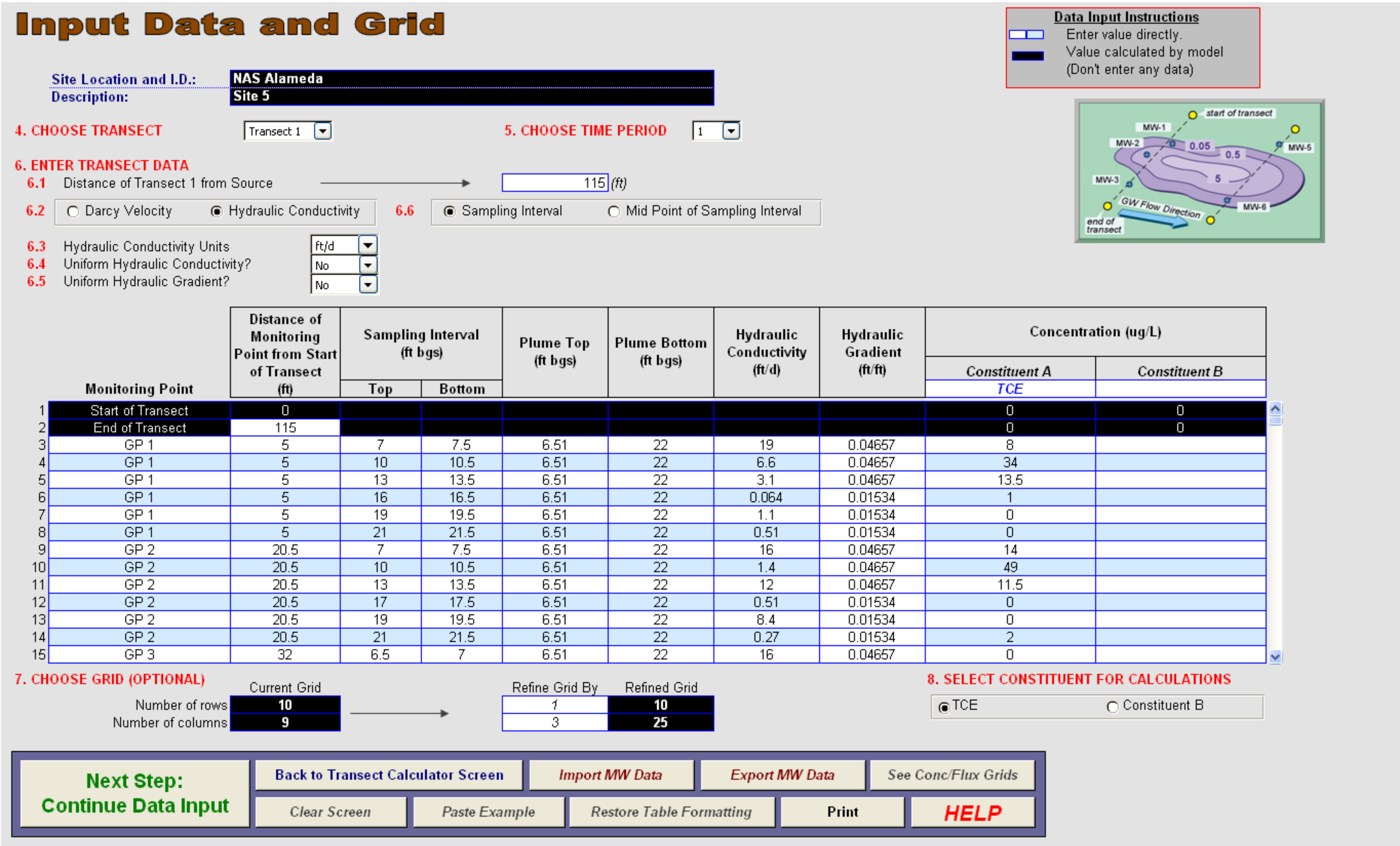


Figure 14. Hydraulic Conductivity Test Data (cm/s) Overlain on Trichloroethylene Contour Plot



Input Data and Grid

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

Site Location and I.D.: NAS Alameda
Description: Site 5

4. CHOOSE TRANSECT Transect 1

5. CHOOSE TIME PERIOD 1

6. ENTER TRANSECT DATA

6.1 Distance of Transect 1 from Source → 115 (ft)

6.2 ○ Darcy Velocity ◉ Hydraulic Conductivity

6.6 ◉ Sampling Interval ○ Mid Point of Sampling Interval

6.3 Hydraulic Conductivity Units: ft/d
6.4 Uniform Hydraulic Conductivity? No
6.5 Uniform Hydraulic Gradient? No

	Monitoring Point	Distance of Monitoring Point from Start of Transect (ft)	Sampling Interval (ft bgs) Top	Sampling Interval (ft bgs) Bottom	Plume Top (ft bgs)	Plume Bottom (ft bgs)	Hydraulic Conductivity (ft/d)	Hydraulic Gradient (ft/ft)	Concentration (ug/L) Constituent A TCE	Concentration (ug/L) Constituent B
1	Start of Transect	0							0	0
2	End of Transect	115							0	0
3	GP 1	5	7	7.5	6.51	22	19	0.04657	8	
4	GP 1	5	10	10.5	6.51	22	6.6	0.04657	34	
5	GP 1	5	13	13.5	6.51	22	3.1	0.04657	13.5	
6	GP 1	5	16	16.5	6.51	22	0.064	0.01534	1	
7	GP 1	5	19	19.5	6.51	22	1.1	0.01534	0	
8	GP 1	5	21	21.5	6.51	22	0.51	0.01534	0	
9	GP 2	20.5	7	7.5	6.51	22	16	0.04657	14	
10	GP 2	20.5	10	10.5	6.51	22	1.4	0.04657	49	
11	GP 2	20.5	13	13.5	6.51	22	12	0.04657	11.5	
12	GP 2	20.5	17	17.5	6.51	22	0.51	0.01534	0	
13	GP 2	20.5	19	19.5	6.51	22	8.4	0.01534	0	
14	GP 2	20.5	21	21.5	6.51	22	0.27	0.01534	2	
15	GP 3	32	6.5	7	6.51	22	16	0.04657	0	

7. CHOOSE GRID (OPTIONAL)

	Current Grid	Refine Grid By	Refined Grid
Number of rows	10	1	10
Number of columns	9	3	25

8. SELECT CONSTITUENT FOR CALCULATIONS
◉ TCE ○ Constituent B

Next Step: Continue Data Input

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

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

Figure 15. Mass Flux Toolkit Inputs

Tables

Table 1. Geologic Descriptions of Continuous Soil Cores (June 2006)

Boring Depth (ft)	Subsurface Features
Continuous Soil Core GP 10	
0-1	Sands and gravels
1-2	Sands
2-3	Fine sands
3-4	Fine sands
4-5	Gravelly sands with some silt
5-6	Medium to course sand with some gravel
6-7	Fine sands
7-8	Fine sands
8-9	Fine sands
9-10	Silty fine sands
10-11	Fine sands
11-12	Fine sands
12-13	Fine sands
13-14	Fine sands
14-15	Fine sands with some silt
15-16	Silty clay
16-17	Silty clay
17-18	Silty clay
18-19	Transition from silty clay to fine sands
19-20	Fine sands
20-21	Silty fine sands with some clay
21-22	Clay

Table 2. Sampling Locations and Types of Test Performed (June 2006)

Groundwater Monitoring Well or Direct-push Sampling Location	Physical Assessment			Water Quality Assessment	
	Depth-To-Water Measurement	Slug Testing	Constant Drawdown Aquifer Testing	Field Parameters[b]	Dissolved Chlorinated Solvent Analysis
MW1S	Yes	Yes		Yes	Yes
MW1I	Yes	Yes		Yes	Yes
MW2S	Yes	Yes		Yes	Yes
MW2I	Yes			Yes	Yes
MW2D	Yes				
MW3I	Yes			Yes	Yes
MW3D	Yes				
MW4S	Yes	Yes		Yes	Yes
MW4I	Yes	Yes		Yes	Yes
MW4D	Yes				
MW5S	Yes	Yes		Yes	Yes
MW5I	Yes	Yes		Yes	Yes
MW5D	Yes				
MW6S	Yes	Yes		Yes	Yes
MW7S	Yes	Yes		Yes	Yes
GP1[a]			Yes		Yes
GP2[a]			Yes		Yes
GP3[a]			Yes		Yes
GP4[a]			Yes		Yes
GP5[a]			Yes		Yes
GP6[a]			Yes		Yes
GP8[a]			Yes		Yes

[a] Water quality assessments and constant drawdown tests at direct-push locations were performed on 3-ft intervals from the phreatic surface (~6' bgs) to 21-22’ bgs.

[b] Field parameters include: pH, electrical conductivity, temperature, dissolved oxygen, and oxidation reduction potential.

Table 3. Slug Test Results (June 2006)

Monitoring Well	Well Screen (ft)	Hvorslev K (cm/s)	Hvorslev K (ft/d)	Bouwer and Rice K (cm/s)	Bouwer and Rice K (ft/d)
MW1S	9-14	4.43E-03	12.56	8.27E-04	2.35
MW1I	18-21	6.20E-04	1.76	6.12E-04	1.73
MW2S	9.5-14.5	4.43E-03	12.56	2.19E-03	6.21
MW2I	18.5-21.5	6.20E-04	1.76	4.12E-04	1.17
MW3I	19-22	1.59E-04	0.45	1.46E-04	0.41
MW4S	10-15	3.25E-03	9.21	1.53E-03	4.35
MW4I	19-22	4.51E-04	1.28	2.67E-04	0.76
MW5S	9.5-14.5	4.43E-03	12.56	1.27E-03	3.59
MW5I	18.5-21.5	5.36E-04	1.52	2.34E-04	0.66
MW6S	9.5-14.5	4.64E-03	13.16	1.69E-03	4.78
MW7S	9-14	8.12E-03	23.03	1.06E-03	3.01

Table 4. Depth-to-Groundwater and Groundwater Elevations for Monitoring Wells (June 2006)

Monitoring Well	Grade* (m)	Grade* (ft)	DTW (m BTOC)	DTW (ft BTOC)	DTW (m BGS)	DTW (ft BGS)	Groundwater Elevation* (m)	Groundwater Elevation* (ft)
MW1S	3.32	10.90	1.55	5.09	1.80	5.91	1.52	4.99
MW1I	3.32	10.88	1.61	5.28	1.86	6.11	1.45	4.77
MW2S	3.16	10.38	1.49	4.88	1.73	5.66	1.44	4.72
MW2I	3.24	10.63	1.58	5.20	1.84	6.02	1.41	4.61
MW2D	3.16	10.37	1.63	5.34	1.89	6.18	1.28	4.19
MW3I	3.08	10.10	1.63	5.35	1.89	6.19	1.19	3.91
MW3D	2.96	9.70	1.69	5.55	1.98	6.51	0.97	3.19
MW4S	2.94	9.64	1.67	5.47	1.91	6.28	1.02	3.36
MW4I	2.93	9.60	1.72	5.65	1.98	6.48	0.95	3.12
MW4D	3.24	10.63	1.69	5.53	2.02	6.61	1.23	4.02
MW5S	2.80	9.17	1.52	4.98	1.77	5.82	1.02	3.35
MW5I	2.86	9.37	1.64	5.38	1.88	6.17	0.98	3.20
MW5D	2.91	9.55	1.62	5.31	1.91	6.26	1.00	3.29
MW6S	3.08	10.09**	1.83	6.00	1.99	6.51	1.09	3.58
MW7S	2.92	9.58***	1.71	5.60	1.85	6.07	1.07	3.51

DTW - Depth-to-water
BTOC - Below top of casing
BGS - Below ground surface

Table 5. Water Quality Data for Monitoring Wells (June 2006)

Monitoring Well	Water Quality Data[a]				
	pH	EC (mS)	Temperature (°C)	DO (mg/L)	ORP (mV)
MW1S	8.9	0.10	21.20	0.2	-138
MW1I	7.2	11.80	24.50	0.2	-198
MW2S	8.2	0.10	20.90	0.4	-94
MW2I	8.3	7.73	22.40	0.4	-136
MW3I	7.8	43.00	23.60	0.5	-117
MW4S	7.9	0.10	23.60	0.6	-90
MW4I	6.5	33.70	26.70	0.3	-148
MW5S	9.14	0.163	20.8	0.36	-122
MW5I	7.9	18.70	23.30	0.5	-113
MW6S	6.6	1.08	26.90	0.5	-145
MW7S	6.6	0.61	24.60	0.4	-66

[a] All measurements were made with a Horiba U-22 meter.
EC = electrical conductivity
DO = dissolved oxygen
ORP = oxidation-reduction potential

Table 6. Chemical Concentration Data for Monitoring Wells (June 2006)

Monitoring Well	Concentration (ug/L)									
	VC	1,1-DCE	trans-1,2-DCE	1,1-DCA	cis-1,2-DCE	1,2-DCA	1,1,1-TCA	TCE	1,1,2-TCA	PCE
MW1S	ND <1	ND <1	ND <1	ND <1	71	ND <1	ND <1	1	ND <1	ND <1
MW1I	ND <1	ND <1	ND <1	ND <1	2	ND <1	ND <1	2	ND <1	ND <1
MW1I DUP	ND <1	ND <1	ND <1	ND <1	2	ND <1	ND <1	2	ND <1	ND <1
MW2S	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	1	ND <1	ND <1
MW2I	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	1	ND <1	ND <1
MW2I REP	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	1	ND <1	ND <1
MW3I	1	ND <1	ND <1	ND <1	11	ND <1	ND <1	2	ND <1	ND <1
MW3I DUP	1	ND <1	ND <1	ND <1	11	ND <1	ND <1	2	ND <1	ND <1
MW4S	ND <1	ND <1	ND <1	ND <1	1	ND <1	ND <1	4	ND <1	ND <1
MW4I	15	ND <1	ND <1	ND <1	3	ND <1	ND <1	2	ND <1	ND <1
MW5S	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	1	ND <1	ND <1
MW5I	1	1	ND <1	1	6	ND <1	ND <1	3	ND <1	ND <1
MW6S	29	2	2	2	29	ND <1	ND <1	76	ND <1	47
MW6S DUP	29	2	1	1	28	ND <1	ND <1	78	ND <1	46
MW7S	1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	3	ND <1	1

DUP - Duplicate sample
REP - Quality control sample (second analysis of same water sample)
VC - Vinyl chloride
DCE - Dichloroethene
DCA - Dichloroethane
TCA - Trichloroethane
TCE - Trichloroethene
PCE - Tetrachloroethene
ND – non detect at the limit of 1 ug/L

Table 7. Chemical Concentration Data for Direct-Push Downgradient Transect Locations (June 2006)

Sampling Location*	Concentration (ug/L)									
	VC	1,1-DCE	trans-1,2-DCE	1,1-DCA	cis-1,2-DCE	1,2-DCA	1,1,1-TCA	TCE	1,1,2-TCA	PCE
GP 1-7	ND <1	ND <1	ND <1	3	4	1	ND <1	8	ND <1	ND <1
GP 1-10	1	3	5	9	42	ND <1	ND <1	34	ND <1	ND <1
GP 1-13	9	3	3	4	23	ND <1	ND <1	13	ND <1	ND <1
GP 1-13 REP	9	3	3	5	25	ND <1	ND <1	14	ND <1	ND <1
GP 1-16	3	ND <1	10	4	4	ND <1	2	1	ND <1	ND <1
GP 1-19	5	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1
GP 1-19 DUP	4	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1
GP 1-21	1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1
GP 2-7	ND <1	ND <1	ND <1	3	10	1	ND <1	14	ND <1	ND <1
GP 2-10	5	6	14	10	73	ND <1	ND <1	49	ND <1	1
GP 2-13	17	3	3	4	31	ND <1	ND <1	12	ND <1	ND <1
GP 2-13 REP	16	3	3	4	30	ND <1	ND <1	11	ND <1	ND <1
GP 2-17	43	ND <1	ND <1	47	1	ND <1	1	ND <1	ND <1	ND <1
GP 2-17	50	ND <1	ND <1	48	1	ND <1	1	ND <1	ND <1	ND <1
GP 2-19	4	ND <1	ND <1	1	1	ND <1	ND <1	ND <1	ND <1	ND <1
GP 2-19 DUP	4	ND <1	ND <1	1	1	ND <1	ND <1	ND <1	ND <1	ND <1
GP 2-21	5	ND <1	ND <1	5	3	ND <1	ND <1	2	ND <1	ND <1
GP 3-6.5	ND <1	ND <1	ND <1	5	1	1	ND <1	ND <1	ND <1	ND <1
GP 3-9.5	32	3	6	10	72	ND <1	ND <1	16	ND <1	ND <1
GP 3-12.5	3	4	2	5	31	ND <1	ND <1	21	ND <1	ND <1
GP 3-15.5	76	ND <1	70	100	4	ND <1	ND <1	4	ND <1	ND <1
GP 3-20.5	3	ND <1	2	5	1	ND <1	ND <1	ND <1	ND <1	ND <1
GP 4-6.5	ND <1	ND <1	ND <1	2	3	1	ND <1	9	ND <1	ND <1
GP 4-9.5	6	ND <1	2	3	1	ND <1	ND <1	1	ND <1	ND <1
GP 4-12.5	3	6	2	2	13	ND <1	ND <1	18	ND <1	ND <1
GP 4-15.5	100	ND <1	3	68	1	ND <1	4	ND <1	ND <1	ND <1
GP 4-15.5 REP	120	ND <1	3	70	1	ND <1	4	ND <1	ND <1	ND <1
GP 4-18.5	9	ND <1	ND <1	1	1	ND <1	ND <1	ND <1	ND <1	ND <1

Table 7. Chemical Concentration Data for Direct-Push Downgradient Transect Locations (Continued)

Sampling Location*	Concentration (ug/L)									
	VC	1,1-DCE	trans-1,2-DCE	1,1-DCA	cis-1,2-DCE	1,2-DCA	1,1,1-TCA	TCE	1,1,2-TCA	PCE
GP 4-20.5	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1
GP 5-6.5	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	1	ND <1	ND <1
GP 5-9.5	4	ND <1	2	2	2	ND <1	ND <1	1	ND <1	ND <1
GP 5-12.5	10	7	5	3	40	ND <1	ND <1	16	ND <1	ND <1
GP 5-15.5	97	ND <1	1	40	ND <1	ND <1	2	ND <1	ND <1	ND <1
GP 5-18.5	14	ND <1	ND <1	1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1
GP 5-18.5 REP	12	ND <1	ND <1	1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1
GP 5-21.5	2	ND <1	ND <1	1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1
GP 6-6.5	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	1	ND <1	ND <1
GP 6-6.5 DUP	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	1	ND <1	ND <1
GP 6-10.5	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1
GP 6-12.5	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1
GP 6-18.5	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1
GP 6-18.5 REP	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1
GP 6-20.5	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1
GP 8-7	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	1	ND <1	ND <1
GP 8-9.5	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	1	ND <1	ND <1
GP 8-12.5	1	2	1	1	2	ND <1	ND <1	7	ND <1	ND <1
GP 8-18.5	4	ND <1	ND <1	1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1
GP 8-20.5	1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1

DUP - Duplicate sample
REP - Quality control sample (second analysis of same water sample)
VC - Vinyl chloride
DCE - Dichloroethene
DCA - Dichloroethane
TCA - Trichloroethane
TCE - Trichloroethene
PCE - Tetrachloroethene
ND – non detect at the limit of 1 ug/L

Table 8. Field Data And Results for Constant Drawdown Aquifer Testing in Direct-push Downgradient Transect Locations (June 2006)

Sampling Location*	Drawdown (ΔH) (ft BSWS**)	Volume purged (ml)	Time (min)	Time (sec)	Total Time (sec)	Q (ft3/s)	Q/ΔH (ft^3/ft/s)	K (cm/sec)	K (ft/d)
GP 1-7	0.25	105	2	0	120	3.1E-05	1.2E-04	6.8E-03	1.9E+01
GP 1-10	2	215	1	30	90	8.4E-05	4.2E-05	2.3E-03	6.6E+00
GP 1-13	3	150	1	30	90	5.9E-05	2.0E-05	1.1E-03	3.1E+00
GP 1-16	3	10	5	0	300	1.2E-06	3.9E-07	2.2E-05	6.1E-02
GP 1-19	3	75	2	0	120	2.2E-05	7.4E-06	4.0E-04	1.1E+00
GP 1-21	3	50	3	0	180	9.8E-06	3.3E-06	1.8E-04	5.1E-01
GP 2-7	0.75	200	1	30	90	7.8E-05	1.0E-04	5.7E-03	1.6E+01
GP 2-10	1	45	3	0	180	8.8E-06	8.8E-06	4.9E-04	1.4E+00
GP 2-13	3	195	0	30	30	2.3E-04	7.7E-05	4.2E-03	1.2E+01
GP 2-17	3	50	3	0	180	9.8E-06	3.3E-06	1.8E-04	5.1E-01
GP 2-19	3	275	1	0	60	1.6E-04	5.4E-05	3.0E-03	8.4E+00
GP 2-21	3	45	5	0	300	5.3E-06	1.8E-06	9.7E-05	2.7E-01
GP 3-6.5	0.33	115	2	0	120	3.4E-05	1.0E-04	5.6E-03	1.6E+01
GP 3-9.5	2	210	1	0	60	1.2E-04	6.2E-05	3.4E-03	9.6E+00
GP 3-12.5	3	140	3	0	180	2.7E-05	9.2E-06	5.0E-04	1.4E+00
GP 3-15.5	3	115	2	0	120	3.4E-05	1.1E-05	6.2E-04	1.8E+00
GP 3-20.5	3	25	3	0	180	4.9E-06	1.6E-06	9.0E-05	2.5E-01
GP 4-6.5	0.33	105	2	0	120	3.1E-05	9.4E-05	5.1E-03	1.5E+01
GP 4-9.5	2	140	1	30	90	5.5E-05	2.7E-05	1.5E-03	4.3E+00
GP 4-12.5	3	220	1	30	90	8.6E-05	2.9E-05	1.6E-03	4.5E+00
GP 4-15.5	10	150	2	0	120	4.4E-05	4.4E-06	2.4E-04	6.9E-01
GP 4-18.5	3	135	2	0	120	4.0E-05	1.3E-05	7.3E-04	2.1E+00
GP 4-20.5	3	50	3	0	180	9.8E-06	3.3E-06	1.8E-04	5.1E-01
GP 5-6.5	0.33	100	3	0	180	2.0E-05	5.9E-05	3.3E-03	9.3E+00
GP 5-9.5	2	170	1	30	90	6.7E-05	3.3E-05	1.8E-03	5.2E+00
GP 5-12.5	3	105	3	0	180	2.1E-05	6.9E-06	3.8E-04	1.1E+00
GP 5-15.5	3	145	3	0	180	2.8E-05	9.5E-06	5.2E-04	1.5E+00
GP 5-18.5	3	215	1	30	90	8.4E-05	2.8E-05	1.5E-03	4.4E+00
GP 5-21.5	3	65	5	0	300	7.7E-06	2.6E-06	1.4E-04	4.0E-01
GP 6-6.5	0.33	170	1	0	60	1.0E-04	3.0E-04	1.7E-02	4.7E+01
GP 6-10.5	0.67	10	3	0	180	2.0E-06	2.9E-06	1.6E-04	4.6E-01
GP 6-12.5	3	195	1	30	90	7.7E-05	2.6E-05	1.4E-03	4.0E+00
GP 6-18.5	3	230	1	0	60	1.4E-04	4.5E-05	2.5E-03	7.0E+00
GP 6-20.5	2	55	5	0	300	6.5E-06	3.2E-06	1.8E-04	5.0E-01
GP 8-7	0.583	120	1	30	90	4.7E-05	8.1E-05	4.4E-03	1.3E+01
GP 8-9.5	2	70	2	0	120	2.1E-05	1.0E-05	5.7E-04	1.6E+00
GP 8-12.5	3	305	0	30	30	3.6E-04	1.2E-04	6.6E-03	1.9E+01
GP 8-18.5	3.25	60	3	0	180	1.2E-05	3.6E-06	2.0E-04	5.6E-01
GP 8-20.5	3	95	3	0	180	1.9E-05	6.2E-06	3.4E-04	9.7E-01

* See Figure 2
** BSWS – Below estimated static water surface

Table 9. Monitoring Well Chemical Concentration Data Comparison

Sample Locations	Vinyl Chloride		1,1-DCE		trans-1,2-DCE		1,1-DCA		cis-1,2-DCE	
	ASU	NAS Alameda	ASU	NAS Alameda	ASU	NAS Alameda	ASU	NAS Alameda	ASU	NAS Alameda
	June '06	Mar '05	June '06	Mar '05	June '06	Mar '05	June '06	Mar '05	June '06	Mar '05
	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
MW7S	1	3.8	ND <1	2.5	ND <1	1.5	ND <1	1.7	ND <1	4
MW6S	29	ND <5	2	22	2	16	2	4.3J	29	110
MW6S DUP	29	ND <5	2	22	1	16	1	4.3J	28	110
MW4S	ND <1	NP	ND <1	NP	ND <1	NP	ND <1	NP	1	NP
MW4I	15	ND <1	ND <1	ND <2	ND <1	ND <2	ND <1	ND <2	3	4.6
MW1S	ND <1	ND <0.5	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	71	ND <1
MW1I	ND <1	ND <0.5	ND <1	ND <1	ND <1	0.3J	ND <1	ND <1	2	7.7
MW1I DUP	ND <1	ND <0.5	ND <1	ND <1	ND <1	0.3J	ND <1	ND <1	2	7.7
MW2S	ND <1	ND <0.5	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1
MW2I	ND <1	ND <5	ND <1	ND <10	ND <1	ND <10	ND <1	ND <10	ND <1	ND <10
MW2I REP	ND <1	ND <5	ND <1	ND <10	ND <1	ND <10	ND <1	ND <10	ND <1	ND <10
MW5S	ND <1	ND <0.5	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1	ND <1
MW5I	1	ND <1	1	ND <2	ND <1	ND <2	1	0.61J	6	2.9
MW3I	1	ND <1	ND <1	ND <2	ND <1	ND <2	ND <1	ND <2	11	49
MW3I DUP	1	ND <1	ND <1	ND <2	ND <1	ND <2	ND <1	ND <2	11	49

Dup – Duplicate Sample, REP – Quality Control Sample (second analysis of same sample), ND – Non-Detect (detection limit not available);
DCE - Dichloroethene; DCA - Dichloroethane; TCA - Trichloroethane; TCE - Trichloroethylene; PCE - Tetrachloroethene

Sample Locations	1,2-DCA		1,1,1-TCA		TCE		1,1,2-TCA		PCE	
	ASU	NAS Alameda	ASU	NAS Alameda	ASU	NAS Alameda	ASU	NAS Alameda	ASU	NAS Alameda
	June '06	Mar '05	June '06	Mar '05	June '06	Mar '05	June '06	Mar '05	June '06	Mar '05
	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
MW7S	ND <1	ND <0.5	ND <1	ND <1	3	4.7	ND <1	ND <1	1	ND <1
MW6S	ND <1	ND <5	ND <1	ND <10	76	1,200	ND <1	ND <10	47	62
MW6S DUP	ND <1	ND <5	ND <1	ND <10	78	1,200	ND <1	ND <10	46	62
MW4S	ND <1	NP	ND <1	NP	4	NP	ND <1	NP	ND <1	NP
MW4I	ND <1	ND <1	ND <1	ND <2	2	ND <2	ND <1	ND <2	ND <1	ND <2
MW1S	ND <1	ND <0.5	ND <1	ND <1	1	ND <1	ND <1	ND <1	ND <1	ND <1
MW1I	ND <1	ND <0.5	ND <1	ND <1	2	0.4J	ND <1	ND <1	ND <1	ND <1
MW1I DUP	ND <1	ND <0.5	ND <1	ND <1	2	0.4J	ND <1	ND <1	ND <1	ND <1
MW2S	ND <1	ND <1	ND <1	ND <1	1	ND <1	ND <1	ND <1	ND <1	ND <1
MW2I	ND <1	ND <5	ND <1	ND <10	1	ND <10	ND <1	ND <10	ND <1	ND <10
MW2I REP	ND <1	ND <5	ND <1	ND <10	1	ND <10	ND <1	ND <10	ND <1	ND <10
MW5S	ND <1	ND <0.5	ND <1	ND <1	1	ND <1	ND <1	ND <1	ND <1	ND <1
MW5I	ND <1	ND <1	ND <1	ND <2	3	ND <2	ND <1	ND <2	ND <1	ND <2
MW3I	ND <1	ND <1	ND <1	ND <2	2	ND <2	ND <1	ND <2	ND <1	ND <2
MW3I DUP	ND <1	ND <1	ND <1	ND <2	2	ND <2	ND <1	ND <2	ND <1	ND <2

Dup – Duplicate Sample, REP – Quality Control Sample (second analysis of same sample), ND – Non-Detect (detection limit not available);
DCE - Dichloroethene; DCA - Dichloroethane; TCA - Trichloroethane; TCE - Trichloroethylene; PCE - Tetrachloroethene

Draft

Site Specific Work Plan
Air Force Plant 4 – Building 181

Critical Evaluation of the State of In Situ Thermal Treatment Technologies for DNAPL Source Zone Treatment

Prepared for:

Environmental Security Technology Certification Program
Arlington, VA

Prepared by:
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1.0 Introduction

Air Force Plant 4 (AFP 4) is located in Tarrant County, Texas, seven miles northwest of the City of Fort Worth. The plant is bounded by Lake Worth on the north, Naval Air Station Fort Worth (NASFW), formerly Carswell AFB to the east, the community of White Settlement on the south and west, and the City of Fort Worth on the west. The facility occupies 602 acres. The Air Force, based out of Wright Patterson AFB Ohio, is the owner of the facility, built in 1941 as part of the World War II needs for aircraft production. The mile long structure currently is operated by Lockheed Martin Aeronautics Company, where the F-16 is in production, parts of the F-22 are built, and the future home of the Joint Strike Fighter (and various other programs). Past management of waste oil, solvents, and fuels generated during the manufacturing operations have resulted in multiple separate sites of investigation, including landfills, fire training areas, underground storage tanks, and other areas.

The Air Force Installation Restoration Program (IRP) efforts began in 1983 with the Preliminary Assessment/Site Investigation. AFP 4 was placed on the National Priorities List in August of 1990. In 1995, the Final Remedial Investigation was approved and in 1996 the Record of Decision (ROD) was signed by the Environmental Protection Agency (EPA) Region VI and the Texas Natural Resources Conservation Commission (TNRCC).

The primary contaminant at AFP 4 in Building 181 is trichloroethylene (TCE) and is associated with the EPL groundwater plume. TCE source is believed to be degreaser tanks in Building 181 which have since been removed. In May 1991, a TCE vapor degreaser tank (T-534) was discovered to be leaking and an estimated 20,000 gallons of TCE was released.

Several subsequent investigations found that releases of TCE had migrated through cracks in the concrete building floor resulting in contamination in the unsaturated zone, including Terrace Alluvium and overlying fill dirt under Building 181. The contaminated unsaturated zone beneath Building 181 was though to be a source of contamination to Terrace Alluvial groundwater. A pilot scale six phase heating (SPH) application was performed completed in the winter of 2001. Based on the results of the pilot, a full-scale SPH application was performed in Building 181 in 2002.

The conceptual subsurface model for AFP4 includes two geologic units. Tertiary age Terrace Alluvium is exposed at ground surface, or lies beneath fill material that is generally comprised of the same Terrace Alluvium. Beneath the Terrace Alluvium lie weathered and competent bedrock consisting of Cretaceous age Goodland Limestone Formation and Walnut Clay Formation, undifferentiated at the site. Drilling logs from Building 181 record the presence of weathered limestone layers at 15 to 20 ft below ground surface (bgs) in the western portion of the site, and at 30 to 35 ft bgs in the east portion of the site. In the SPH coverage area, an approximately 5-ft thick fill layer underlies the building floor and competent bedrock is at 30 to 35 ft bgs.

The SPH application targeted an interval which included the Terrace Alluvium and weathered bedrock to a depth of approximately 35 ft bgs. The depth to groundwater is approximately 25 ft bgs during the SPH application with an east-northeast hydraulic gradient of 0.008 ft/ft with a corresponding hydraulic conductivity between 13 and 132 ft/day.

2.0 System Description

Installation for the full-scale SPH system began in 2002. The system consisted of 73 electrodes installed to a depth of 32 ft bgs, including 7 electrodes from the pilot-scale test and 2 electrodes installed during operation to enhance heat generation in target areas. The total treatment area was approximately 22,000 square feet (Figure 1).

Additionally, a monitoring network of 12 wells was used during the treatment, including five pre-existing wells and 7 newly installed monitoring wells. Table 1 shows the screened intervals of the wells along with their diameter.

The full-scale system was brought on-line in May 2002 and was operated until December 2002. The remedial system performance was continuously monitored during operation, and an estimated 1,417 pounds of TCE was removed via steam and vapor extraction systems.

The available documentation for AFP4 suggests that it is a good site for further investigation because:

- The hydrogeology of the site is reasonably well-characterized
- The aerial extent of the source zone was reasonably defined prior to treatment
- Full treatment of a source zone was performed
- The total depth of impacted groundwater is about 30 feet
- There is access to sampling locations immediately down-gradient of the remediated source zone
- The system employed at this site represents a state-of-the-art ERH system
- Pre- and post-treatment groundwater data are available
- Direct-push technologies can be used for sampling
- The monitoring well network is still present and accessible

3.0 Current Investigations

Consistent with the already-approved generic demonstration plan for this project, the following site-specific activities are proposed:

(3) Verification of the site geological conceptual model before any new investigative work by:

a. Measurement of depths to groundwater in nearby wells (to determine depth to groundwater, flow direction, and hydraulic gradient). See Table 1 for monitoring well details and Figure 1 for measurement locations.
b. Collection of one continuous soil core at the down-gradient edge of the treated source zone (to qualitatively confirm the site geology and to identify depths for subsequent groundwater vertical profile sampling). One or two additional cores will be collected if time permits. See Figure 1 for sampling location.
c. Slug tests conducted in existing groundwater monitoring wells in the area to get estimates of hydraulic conductivity over the screened intervals for those wells (to help identify if any zones are more conductive than others). See Table 1 for details on the monitoring wells and Figure 1 for measurement location.

(4) Collection of data necessary to determine groundwater concentrations and fluxes leaving the treated source zone:

a. Groundwater samples collected from existing groundwater monitoring wells with available historical data. See Table 1 for details on the monitoring wells and Figure 1 for their locations. These locations may be adjusted with new information on monitoring well conditions and locations.

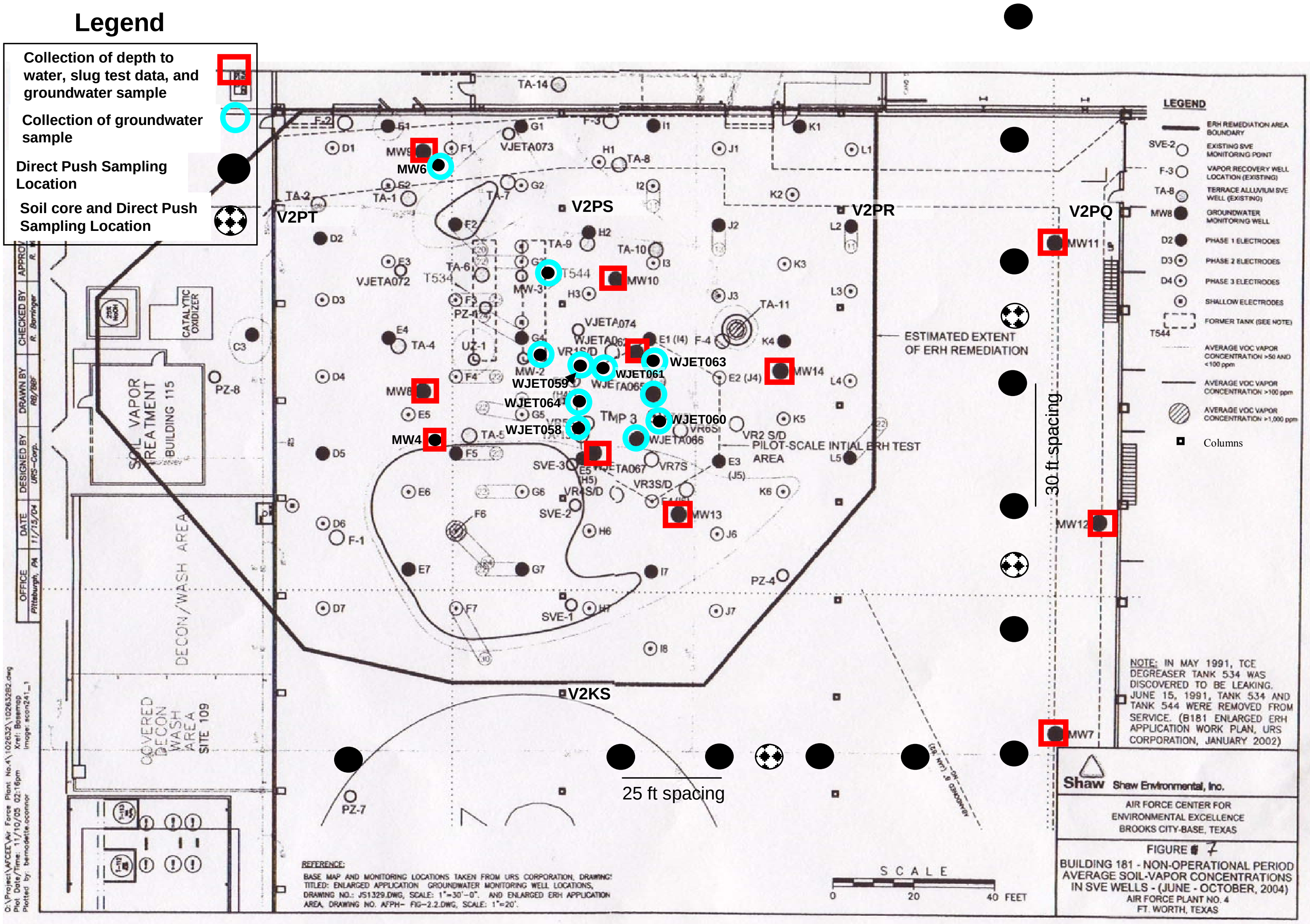
b. Groundwater samples will be collected using direct-push tools along a transect perpendicular to the direction of groundwater flow at the down-gradient edge of the original source zone. See Figure 2 for groundwater sampling locations. Sampling locations will be approximately 20 feet apart, and at each location samples will be collected, as possible, on approximately 2 feet centers down to a maximum depth of 40 ft (and at least once in each distinct lithologic change suggested by the soil core). The samples will be analyzed via a headspace analysis on a gas chromatograph (GC) equipped with dry electrolytic conductivity detector (DELCD), photo-ionization detector (PID), and flame-ionization (FID) detectors. Analytes may include any or all of the following: trichloroethene, tetrachloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, 1,1-dichloroethene, 1,1-dichloroethane, 1,2-dichloroethane, 1,1,1-trichloroethane, 1,1,2-trichloroethane, and vinyl chloride. If time permits, samples will be collected at additional locations as well. The specific depths and numbers of samples collected at each location may be adjusted depending on the analytical results in the field.

c. Aquifer specific-capacity tests will be conducted at each depth where a groundwater sample is collected. These tests will be conducted using the direct-push groundwater sampler and will involve the measurement of the steady flow rate achieved with a fixed drawdown; ideally, all tests will be conducted with the same fixed drawdown (usually 0.3 – 1.0 feet).

Table 1

	Existing Monitoring Well	Screen Interval (ft bls)	Well Diameter (in)	Water Level Measurement	Slug Test	Groundwater Sample
Full-scale Application Monitoring Wells	MW-7	19.5-34.5	4	x	x	x
	MW-8	13-19	2	x	x	x
	MW-9	26-32	2	x	x	x
	MW-10	28-34	2	x	x	x
	MW-11	30-36	2	x	x	x
	MW-12	28-34	2	x	x	x
	MW-13	30-36	2	x	x	x
	MW-14	29.5-35.5	2	x	x	x
	WJETA062	24.9-29.9	4	x	x	x
	WJETA065	24.9-29.9	4	x		x
	WJETA066	24.7-30.2	4	x		x
	WJETA067	25.5-30.5	4	x	x	x
Additional Monitoring Wells	MW-2	--	2	x		x
	MW-3	--	2	x		x
	MW-4	--	2	x	x	x
	MW-6	--	2	x		x
	WJET058	24.9-29.9	4	x		x
	WJET059	24.15-28.65	4	x		x
	WJET060	25.05-30.05	4	x		x
	WJET061	25.2-29.7	4	x		x
	WJET063	23.1-28.1	4	x		x
	WJET064	24.1-29-1	4	x		x

Note: -- Screened interval is unknown



Legend
Collection of depth to water, slug test data, and groundwater sample
Collection of groundwater sample
Direct Push Sampling Location
Soil core and Direct Push Sampling Location
V2PT
V2PS
V2PR
V2PQ
V2KS
MW4
MW6
MW7
MW8
MW10
MW11
MW12
MW13
MW14
WJET058
WJET059
WJET060
WJET061
WJET063
WJET064
ESTIMATED EXTENT OF ERH REMEDIATION
PILOT-SCALE INITIAL ERH TEST AREA
30 ft spacing
25 ft spacing
Shaw Environmental, Inc.
AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE BROOKS CITY-BASE, TEXAS
BUILDING 181 - NON-OPERATIONAL PERIOD AVERAGE SOIL-VAPOR CONCENTRATIONS IN SVE WELLS - (JUNE - OCTOBER, 2004)
AIR FORCE PLANT NO. 4 FT. WORTH, TEXAS
NOTE: IN MAY 1991, TCE DEGREASER TANK 534 WAS DISCOVERED TO BE LEAKING. JUNE 15, 1991, TANK 534 AND TANK 544 WERE REMOVED FROM SERVICE. (B181 ENLARGED ERH APPLICATION WORK PLAN, URS CORPORATION, JANUARY 2002)
SCALE
0
20
40 FEET

Figure 1

Health and Safety Plan (HASP)
Air Force Plant 4 – Building 181

SECTION 1: GENERAL INFORMATION AND DISCLAIMER

CLIENT NAME: Environmental Security Technology Certification Program (ESTCP)

PROJECT NAME: ESTCP Thermal Evaluation

PRINCIPAL INVESTIGATORS: Eric Foote (Battelle) and Paul Johnson (Arizona State University)

PROJECT LEADER: Paul Dahlen

PREPARED BY: Sam Yoon

DATE: 10/09/2006

NOTE: This Site Specific Health and Safety Plan - (HASP) has been prepared for use by Battelle employees for work at this site. Battelle is not responsible for its use by others. The plan is written for the specific LEVEL D site conditions, purposes, tasks, dates and personnel specified. If these conditions change, a new plan must be utilized and reviewed by those named in Section 17.

Subcontractors shall be solely responsible for the health and safety of their employees and shall comply with all applicable laws and regulations. In accordance with 1910.120(b)(1)(iv) and (v), Battelle will inform subcontractors of the site emergency response procedures, and any potential fire, explosion, health, safety or other hazards by making this Site Specific Safety and Health Plan and site information obtained by others available during regular business hours. All contractors and subcontractors are responsible for: (1) developing their own Health and Safety Plan including a written Hazard Communication Program and any other written hazard specific programs required by federal, state and local laws and regulations; (2) providing their own personal protective equipment (PPE); (3) providing documentation that their employees have been health and safety trained in accordance with applicable federal, state and local laws and regulations; (4) providing evidence of medical surveillance and medical approvals for their employees; and (5) designating their own site safety officer (SSO) responsible for ensuring that their employees comply with their own Health and Safety Plan and taking any other additional measures required by their site activities.

SECTION 2: PROJECT INFORMATION

(1) SITE INFORMATION

Site Name:	ERH Test Site at AF Plant 4	Site Project Contact:	Richard Wice
Address	Building 181	Phone Number:	412-858-3309
	Air Force Plant 4	Site Safety & Health Contact:	Shane Williams
	Fort Worth, TX 76108	Phone Number	O: 614-424-5792/ C: 614-348-4437

(2) SITE CLASSIFICATION (check or circle all that apply)

√ Hazardous (RCRA/CERCLA/State)
□ Construction
□ Landfill (Non-Hazardous)
□ UST/LUST
√ Manufacturing
√ Active
√ Inactive
√ Other:
military installation

(3) ENTRY OBJECTIVES (check or circle all that apply)

√ Site Inspection (General)
√ Well Drilling Observation
□ Sampling, Air
√ Sampling, Water
√ Sampling, Soil
□ Other:

DATE(S) OF FIELD VISIT(S):

(4) BATTELLE/ASU TASKS

Groundwater Investigation
B1.
B2. Groundwater sampling
B3. Water level survey and slug tests
B4. Analytical activities

TASK PERFORMED BY OTHERS

01. Direct push activities for gw sample collection
02. IDW disposal
03.
04.

(5) PROJECT ORGANIZATION AND COORDINATION – The following personnel are designated to carry out the stated project job functions on site. (Note: One person may carry out more than one job function.)

PRINCIPAL INVESTIGATORS Eric Foote/Paul Johnson
SITE SAFETY OFFICER Shane Williams

ALTERNATIVE SITE SAFETY OFFICER(S)	Jennifer Triplett/Paul Dahlen
PUBLIC INFORMATION OFFICER	N/A
SITE RECORD KEEPER	Paul Dahlen/Jennifer Triplett
SITE PERSONNEL WITH CPR/FA	Shane Williams
FIELD TEAM LEADER(S)	Paul Dahlen
OTHER FIELD TEAM MANAGERS	Shane Williams

(6) ON SITE CONTROL

Shane Williams has been designated to coordinate access control and security for Battelle operations on site. A safe perimeter has been established at the work area by delineating the work area with traffic cones and/or high-visibility barrier tape.

No unauthorized person should be within this area.

The on site Command Post and staging area have been established at the ERH treatment area near Building 181 at AF Plant 4.

The prevailing wind conditions are southwest. A wind direction indicator is used to determine daily wind directions. The Command Post is located upwind from the Exclusion Zone or at a sufficient distance to prevent exposure should a release occur.

Control boundaries have been established and include south and west of the ERH test area. These boundaries are identified in the field by: traffic cones and/or high-visibility barrier tape.

SECTION 3: PHYSICAL HAZARDS

(1) IDENTIFY POTENTIAL PHYSICAL HAZARDS TO WORKERS (check or circle all that apply)

□	Confined Space	□	Steep/Uneven Terrain	√	Drums Handling*
√	Heavy Equipment	□	Heat Stress	√	Noise
√	Moving Parts	√	Extreme Cold	□	Non-Ionizing Radiation
□	Heavy Lifting	□	Ionizing Radiation	□	Other:
□	Electrical	√	Traffic		
√	Overhead Hazards	□	Biological Hazards		
□	Fall (>6; Vertical)	□	Surface Water (Immersion)		

Site hazards will be mitigated by:

(9) Briefing site personnel as to identify physical hazards within the work area.
(10) Identifying the "kill switch" on the drilling rig.
(11) Personal protection equipment such as ear muffs, ear plugs, winter jackets, etc. will be don to site personnel.
(12) Antiseptic ointment, solution, and bug repellent (especially for ticks) will be included in the first aid kit for insect stings.

(2) SAFETY EQUIPMENT REQUIRED FOR BATTELLE/ASU EMPLOYEES (check or circle all that apply)

□	Explosimeter	□	Eye Wash	□	Confined Space Warning Signs
□	Fall Protection Equipment	□	Emergency Shower	√	Communications – On Site
√	Barrier Tape	√	Emergency Air Horn	√	Communications – Off Site
√	Traffic Cones	√	Lights	□	Other:
□	Stretcher	□	Lights – emergency		
√	First Aid Kit	□	Ladder		
√	A-B-C- Fire Extinguisher	□	Tick Repellant		
□	Snake Bite Kit	□	Flotation Device (USCG Type III)		

Emergency equipment will be located in the cab of the drilling rig. See Sections 10 and 12 for communication procedures. The field crew will be equipped with cellular telephones, walkie-talkies, and emergency air horn for communication.

SECTION 4: CHEMICAL HAZARDS INFORMATION

(1) IDENTIFIED CONTAMINANTS

Known or suspected hazardous/toxic material (attached historical information, physical description, map of contamination and tabulated date, if available).

Media	Substances Involved	Characteristics	Estimated Concentrations	PEL

GW	Chlorinated hydrocarbons (PCE, TCE, *cis*-1,2-DCE, *trans*-1,2-DCE, Vinyl chloride,1,1,1-TCA 1,1-DCE)	VO and TO	Total chlorinated VOCs up to 95,100 µg/L prior to the ERH operation, recent monitoring was at 4,000 µg/L.
SL	Chlorinated hydrocarbons	VO and TO	As much as 55,000 µg/kg prior to the ERH operation.

Media types — GW (ground water), SW (surface water), WW (wastewater), AIR (air), SL (soil), SD (sediments), WL (waste, liquid), WS (waste, solid), WD (waste, sludge), WG (waste, gas) OT (other).

Characterizations — CA (corrosive, acid) CC, (corrosive, caustic), IG (ignitable), RA (radioactive), VO (volatile), TO (toxic), RE (reactive), BIO (infectious), UN (unknown), OT (other, describe)

Material Safety Data Sheets (MSDSs) for the contaminants of concern are attached. The data sheets include information on the chemical/toxicological properties of the site contaminants and signs and symptoms of over exposure.

(2) DESCRIBE POTENTIAL FOR CONTACT WITH EACH MEDIA TYPE FOR EACH OF THE BATTELLE/ASU TASKS LISTED IN SEC 2.4:

BATTELLE TASK #	ROUTE OF EXPOSURE	POTENTIAL FOR CONTACT	METHOD OF CONTROL
B1	Inhal/Ingest/Contact/Absorb	High/Medium/Low	Level D PPE
B2	Inhal/Ingest/Contact/Absorb	High/Medium/Low	Level D PPE
B3	Inhal/Ingest/Contact/Absorb	High/Medium/Low	Level D PPE
B4	Inhal/Ingest/Contact/Absorb	High/Medium/Low	Level D PPE

The SSO will brief the field team on interpretation of the attached MSDSs and particularly on symptoms and signs of over exposure to chemical hazards.

SECTION 5: HAZARD COMMUNICATION PROGRAM

If chemicals are introduced to the site by Battelle/ASU (e.g., decontamination liquids, preservatives, etc.), bring a copy of the Battelle Hazardous Communication Program and associate MSDSs to the site. The SSO will review this information with all field personnel. The current list of chemicals for this site is:

1,1,1-Trichloroethane (TCA)	Alcohol
1,1-Dichloroethane, 1,1-dichloroethene (DCE)	Trichloroethene
HCL (preservative)	Tetrachloroethene
Liquinox®	1,2-dichloroethene (cis- and trans-), Vinyl chloride

SECTION 6: ENVIRONMENTAL MONITORING

(1) The following environmental monitoring instruments shall be used on site at the specified intervals for breathing zone monitoring:

	EQUIPMENT	MONITORING PERIOD		ACTION LEVEL
□	Combustible Gas Indicator	daily/hourly/continuous/other		
□	O_2 Meter	daily/hourly/continuous/other		
√	PID (Lamp ____10.6_ eV)	daily/~~hourly/continuous/other~~		
□	FID	daily/hourly/continuous/other		
□	Radiation Meter (Gamma)	daily/hourly/continuous/other		
□	Respirable Dust Meter	daily/hourly/continuous/other		
□	GC/ECD/FID	daily/hourly/continuous/other		
√	GC/FID/PID/DELCD	daily/~~hourly/continuous/other~~		
		daily/hourly/continuous/other		

(6) Monitoring equipment is to be calibrated according to the manufacturers' instructions daily prior to and after each day of use. Record calibration data and air concentration in the Health and Safety on-site logbook.

(7) Action Levels for work shutdown and excavation. These are average values. Consideration should be given to the potential for release of highly toxic compounds from the waste or from reaction by-products. Levels are for persistence (> 10 min).

	ACTION LEVEL
Uncharacterized Airborne Vapors or Gases	>Background
Characterized Airborne Gases, Vapor, Particulates	**>50% PEL, REL, TLV**
Oxygen	< 19.5; >23.5
Flammability	> 10% LEL

(6) Military and/or civilian personnel in charge of buildings adjacent to invasive monitoring activities will be notified via a health and safety kick-off meeting of site activities. A copy of this HASP will be provided. If any action levels are reached at the work area as described above or if discernible odors are released as a result of field activities, the personnel in charge or their designated representative will be notified immediately. Hourly perimeter monitoring (support zone) will be conducted to assess whether organic vapors or odors are leaving the work area.

SECTION 7: HEALTH AND SAFETY TRAINING/MEDICAL MONITORING PROGRAM

The project staff is included in the Battelle Health and Safety Training and Medical Monitoring Programs in conformance with 29 CFR 1910.R.

		HAZWOPPER TRAINING		
NAME	MEDICAL (Date)	INITIAL (Hrs/Date)	REFRESHER (Date)	CPR/FA/ (Dates)
Eric Foote	August 2006	40 hours/ 1992	June 2006	May 2004 (good for 3 years)
Shane Williams	February 2006	40 hours/April 1994	July 14, 2006	July 2006 (good for 3 years)
Jennifer Triplett		40 hours/June 2001	August 7, 2005 (Refresher sched. For Nov. 2006)	
Paul Dahlen		40 hours/Nov 1992	February, 2006	
Paul Johnson		40 hours/ 1987	August 12, 2005 (Refresher sched. For Jan. 2007)	

SECTION 8: PERSONAL MONITORING

√ No personal exposure monitoring or heat/cold stress monitoring will take place on site. If the need for such monitoring is anticipated, this HASP will be modified as accordingly.

SECTION 9: CONFINED SPACE ENTRY

√ No confined space and/or trench entries will take place on site. If the possibility of such entries taking place exists, this HASP will be modified accordingly.

SECTION 10: COMMUNICATION PROCEDURES

The following standard hand signals will be used in case of failure to radio communications in each contaminant reduction zone:

Hand gripping throat	Can't Talk, Having difficulty breathing
Grip partner's wrist and both hands around wrist	Can't Talk, Leave area immediately
Hands on top of head	Need assistance
Thumbs up	OK, I am all right, I understand
Thumbs down	No, negative

If applicable, telephone communications to the Command Post Should be Established as soon as possible. The stationary and/or mobile phone number(s) will be available one week prior to the start of field work. The HASP will be amended when these numbers are available.

The command post telephone is 480-516-1422

The mobile phone is 480-516-1422

SECTION 11: DECONTAMINATION PROCEDURES

Personnel and equipment leaving an exclusion zone shall be thoroughly decontaminated at the decontamination facility constructed at the command post. The SSO is responsible for monitoring adherence with this decontamination plan. A Modified Level D decontamination protocol shall be used with the following decontamination stations:

(13) Equipment Drop (IF NECESSARY)
(14) Boot Covers, and Glove Wash and Rinse (IF NECESSARY)
(15) Outer Boot and Glove Removal (IF NECESSARY)
(16) Outer Garment Removal (IF NECESSARY)
(17) Inner Glove Removal (IF NECESSARY)
(18) Field Hand Wash

The following decontamination equipment is required (check or circle all that apply)

√	Decon Pad (Plastic Sheet)	☐	Dry Brushes	√	Detergent Soap
√	Trash Cans/Bags	√	Wet Brushes	☐	Other Decontamination Solution
√	Buckets	√	Water		

SECTION 12: EMERGENCY PROCEDURES

On site personnel will use the following standard emergency procedures. The SSO shall be notified of any on site emergencies and be responsible for ensuring that the procedures are followed.

Personal Injury in the Exclusion Zone

DESIGNATED EMERGENCY SIGNAL: Air Horn

Upon notification of an injury in the Exclusion Zone, the designated emergency signal shall be sounded. All site personnel shall assemble at the decontamination line. The SSO or alternate should evaluate the nature of the injury, and the affected person should be decontaminated to the extent possible prior to movement to the Support Zone. The on site CPR/FA personnel shall initiate the appropriate first aid, and contact should be made for an ambulance (and other emergency services as needed) and with the designated medical facility (if required). No persons shall reenter the Exclusion Zone until the cause of the injury or symptoms are determined.

Fire/Explosion

DESIGNATED EMERGENCY SIGNAL: Air Horn

Upon notification of a fire or explosion on site, the designated emergency signal shall be sounded and all site personnel assembled at the decontamination line. The fire department shall be alerted and all personnel moved to a safe distance from the involved area.

Equipment Failure

If any other equipment (i.e., air monitoring) on site fails to operate properly, the Field Team Leader and SSO shall be notified and then determine the effect of this failure on continuing operations on site. If the failure affects the safety of personnel or prevents completion of the Work Plan tasks, all personnel shall leave the Exclusion Zone until the situation is evaluated and appropriate actions taken.

Emergency escape routes are designated for use in those situations where egress from the Exclusion Zone cannot occur through the decontamination line

In all situations, when an on site emergency results in evacuation of the Exclusion Zone, personnel shall not reenter until:

(7) The conditions resulting in the emergency have been corrected.
(8) The hazards have been reassessed by the SSO.
(9) The Site Safety Plan has been reviewed by the SSO and Corporate Health and Safety Manager.

SECTION 13: SPILL CONTROL PROCEDURES

√ No containers of liquid or solids exist on site and no spill control plan is necessary. If the possibility of such conditions exists on site, this HASP will be modified accordingly.

SECTION 14: EMERGENCY INFORMATION

(1) LOCAL RESOURCES

Ambulance (name):	LM Aero Emergency Services	Phone:	911 or (817) 777-3473
Hospital (name):	Harris Methodist Hospital	Phone:	911 or (817) 250-3333
Police (local or state):	LM Aero Security	Phone:	911 or (817) 777-2567
Fire (name):	LM Aero Fire Department	Phone:	911 or (817) 777-2163
HAZ MAT Responder:	National Response Center, Toxic Chemicals and Oil Spills	Phone:	911 or (800)424-8802
On-Site CPR/FA(s):	Shane Williams	Phone:	614-348-4437

* For life-threatening emergencies or emergency trauma care.
The above hospital is approximately9.4 miles from the furthest work area and the ambulance response time is approximately 17 minutes.

** For non-life threatening medical care.
The above hospital is approximately 30 minutes from the furthest work area. Injured workers will be transported here for non-emergency treatment only.

DIRECTIONS TO NEAREST HOSPITAL – SEE ATTACHED MAP:

(2) Figure 1.

(3) BATTELLE RESOURCES

Manager, Corporate Health and Safety (ETE Division)
Gary Carlin, 614-424-4929

Site Contact: Eric Foote: 614-424-7939

Battelle Security Office
(614) 424-4444

SECTION 15: PERSONAL PROTECTIVE EQUIPMENT (check or circle all that apply)

√ No type of respiratory protection is required on this site. If the possibility of the need for respiratory protection is anticipated, this HASP will be modified accordingly.

	CLOTHING		GLOVES		BOOTS		OTHER
□	Coveralls	□	Cotton	√	Safety	√	Hard Hat
□	Tyvek	√	Leather	□	Fireman/Hip	√	Glasses
□	Saranex	√	Nitrile	□	Neoprene	□	Goggles
□	PE Tyvek	□	Butyl	√	Steel Toe	□	Face Shield
□	Other:	□	Neoprene			√	Hearing Protection
	______________	□	Viton				
	______________	□	PVC				
	______________	□	PVA				
		□	Latex				

SECTION 16: SAFE WORK PRACTICES

THE FOLLOWING PRACTICES MUST BE FOLLOWED BY PERSONNEL ON SITE

23. Smoking, eating, chewing gum or tobacco, or drinking are forbidden except in clean or designated areas.
24. Ignition of flammable liquids within or through improvised heating devices (e.g., barrels) is forbidden.
25. Contact with samples, excavated materials, or other contaminated materials must be minimized.
26. Use of contact lenses is prohibited at all times.
27. Do not kneel on the ground when collecting samples.
28. If drilling equipment is involved, know where the kill switch is.
29. All electrical equipment used in outside locations, wet areas, or near water must be plugged into ground fault circuit interrupter (GFCI) protected outlets.
30. A “Buddy System” in which another worker is close enough to render immediate aid will be in effect.
31. Good housekeeping practices are to be maintained.
32. Where the eyes or body may be exposed to corrosive materials, water suitable for quick drenching or flushing shall be available for immediate use.
33. In the event of treacherous weather-related working conditions (i.e., thunderstorm, limited visibility, extreme cold or heat) the field task will be suspended until conditions improve or appropriate protection from the elements is provided.

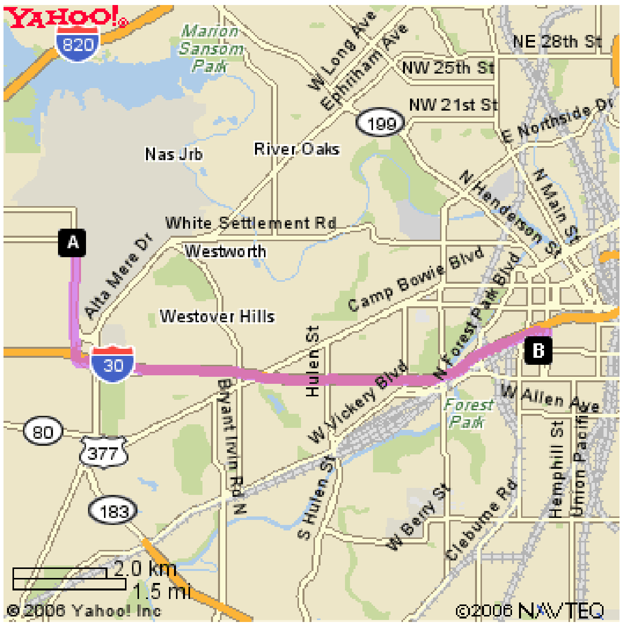
SECTION 17: EMPLOYEE ACKNOWLEDGMENTS

PLAN REVIEWED BY:		DATE
H&S Manager:	Linc Remmert	______________
Principal Investigator	Eric Foote; Paul Johnson	______________
Project Leader:	Paul Dahlen	______________
Site Safety Officer:	Shane Williams	______________

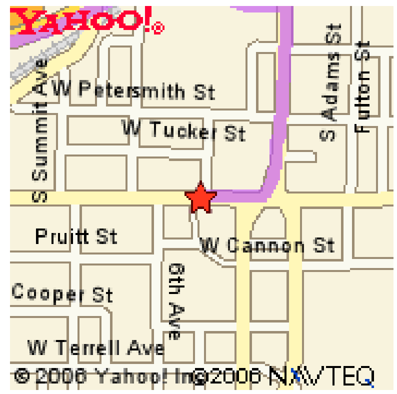
I acknowledge that I have read the information in this HASP form and the attached MSDSs. I understand the site hazards as described and agree to comply with the contents of the plan.

FIELD PERSONNEL (Print Name)	SIGNATURE	DATE
______________	______________	______________
______________	______________	______________
______________	______________	______________
______________	______________	______________

VISITOR (Print Name)	SIGNATURE	DATE
______________	______________	______________
Organization/Agency	______________	______________
______________		
Organization/Agency		



Harris Methodist Hospital
1301 Pennsylvania Avenue
Fort Worth, TX 76104-2122 Emergency Room
Phone No. (817) 882-3333



1.	Start at **1 S GRANTS LN, FORT WORTH** on **S** Grants Ln going toward Wyatt Dr - go **0.2** mi
2.	Bear Left on Ramp - go **0.1** mi
3.	Continue on **S** Spur **341** - go **1.1** mi
4.	**S** Spur **341** becomes Ramp - go **0.4** mi
5.	Bear Right on Interstate **30 W** - go **0.2** mi
6.	Take Left ramp onto **I-30** - go **5.2** mi
7.	Take the Summit Ave/Henderson St exit onto Ramp - go **0.5** mi
8.	Take ramp onto Ramp - go **0.2** mi
9.	Turn Right on **S** Henderson St - go **0.2** mi
10.	Turn Right on Pennsylvania Ave - go **0.1** mi
11.	Arrive at **1301 PENNSYLVANIA AVE, FORT WORTH,** on the Left

Figure 1. Directions to a nearest clinic

Draft Final

Data Analysis Report of
Air Force Plant 4 – Building 181

Critical Evaluation of the State of
In Situ Thermal Treatment Technologies
for DNAPL Source Zone Treatment

Prepared for:

Environmental Security Technology Certification Program
Arlington, VA

Prepared by:
Arizona State University
Battelle Memorial Institute

February 2007

The vendors and products, including the equipment, system components, and other materials identified in this report, are primarily for information purposes only. Although some of these vendors and products may have been used in the past, mention in this report does not constitute a recommendation for using these vendors or products.

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TABLE 10. FIELD DATA RESULTS FOR PNEUMATIC SLUG TESTING
TABLE 11. MONITORING WELL CHEMICAL CONCENTRATION DATA COMPARISON
TABLE 12. MASS FLUX ANALYSIS

Acronyms and Abbreviations

AFP	Air Force Plant
bgs	below ground surface
DCA	1,1-dichloroethane
DCE	1,2-dichloroethene
DNAPL	dense non-aqueous phase liquid
DO	dissolved oxygen
DELCD	dry electrolytic conductivity detector
EC	electrical conductivity
ERH	electrical resistance heating
ESTCP	Environmental Security Technology Certification Program
FID	flame-ionization detector
GC	gas chromatography
ORP	oxidation reduction potential
PID	photo-ionization detector
TCA	trichloroethane
TCE	trichloroethylene
VOA	volatile organic analysis

1. Introduction

The post-treatment field investigation of Air Force Plant 4 (AFP4) – Building 181, under the Environmental Security Technology Certification Program (ESTCP) project CU-0314, *Critical Evaluation of State of the In-Situ Thermal Treatment Technologies*, was performed December 4 through December 14, 2006. Figure 1 is a site map that identifies the extent of the previous electrical resistance heating (ERH) remediation area, which was the specific area of interest for this particular field investigation.

Consistent with the objectives set forth under the CU-0314 Demonstration Plan, the field investigation at this site included the following:

- Verification of site hydrogeological conceptual model
- Groundwater sampling of monitoring wells
- Depth-discrete analysis of hydraulic conductivity and dissolved chlorinated hydrocarbons at temporary sampling locations downgradient of the treatment zone.

2. Field Investigations

In accordance with the approved generic demonstration plan for this project, the following site-specific activities were conducted:

(3) Verification of the site hydrogeological conceptual model:

b. For confirmation of geology, three continuous soil cores were collected at direct-push sampling locations GP1, GP3 and GP6. The continuous soil cores/ direct-push sampling locations were located at the down-gradient edge of the treatment zone. Figure 2 shows the location of each direct-push location. Table 1 presents qualitative geologic descriptions from visual observations of the three continuous soil cores.

c. Hydraulic conductivity slug tests were conducted in the nine monitoring wells identified in Table 2 and illustrated in Figure 3. The slug test data was analyzed using both the Hvorslev and the Bouwer and Rice Methods; results are presented in Table 3. Hvorslev's expression for hydraulic conductivity is:

$$K=(r^2\ln(L_e/R))/(2L_e t_{37})$$

Where K = hydraulic conductivity (L/T)
r = radius of well casing (L) (0.083 or 0.1667 ft)
R = radius of well screen (L) (0.50 ft)
L_e = length of well screen (L) (4.5, 5, 6, 10 ft or the saturated thickness if well screen was not completely covered)
t_{37} = time for water level to rise or fall 37% of the initial change (T) (from data set)

(Fetter, 2000).

The Bouwer and Rice expression for hydraulic conductivity is:

$$K=(r_c^2 \ln(R_e/R) / (2L_e)) * ((1/t) \ln(H_o/H_t))$$

Where K = hydraulic conductivity (L/T)
r_c = radius of well casing (L) (0.083 or 0.1667 ft)
R = radius of gravel envelope (L) (0.50 ft)
R_e = effective radial distance over which head is dissipated (L) (from data set)
L_e = length of well screen (L) (4.5, 5, 6, 10 ft or the saturated thickness if well screen was not completely covered)
H_o = drawdown at t=0 (L) (from data set)
H_t = drawdown at t=t (L) (from data set)
t = time since $H = H_o$ (T) (from data set)
(Fetter, 2000).

It should be noted that two of the slug test locations, monitoring well WJETA062 and WJETA067, were partially-penetrating wells having only partially-submerged screens and about 1.5 ft of water in each. In contrast, two other slug test locations, monitoring well MW-7 and MW-12, were fully-penetrating wells with partially submerged screens. Corrections were made in the Bouwer and Rice analysis for these two types of wells:

i. For the partially-penetrating wells, the approach discussed in Bouwer (1989) was used, and

ii. For MW-7 and MW-12, the fully-penetrating wells with only partially-submerged screens, a correction to the porosity was made by replacing it with the specific yield as suggested by Binkhorst and Robbins (1998).

The Bouwer and Rice expression modified for partially-submerged screens is:

$$K=(r_{ce}^2 \ln(R_e/R) / (2L_e)) * ((1/t) \ln(H_o/H_t))$$

Where
$r_{ce}^2 = r_c^2+S_y\,(R^2-r_c^2)$
$S_y = (V_{wc}/V_{s)}=(r_c^2\,(H_{oc}-H_i)) / ((R^2-r_c^2)H_i)$
$V_{wc} = \pi*r_c^2\,(H_{oc}-H_i)$
$V_s = \pi\,(R^2-r_c^2)H_i$
$H_{oc} = V_{sr}/(\pi*r_c^2)$

Where K = hydraulic conductivity (L/T)
H_i = length of desaturated sand column (L) (from data set)
H_{oc} = calculated initial head difference (L)
V_{sr} = volume of slug removed (L^3)
V_s = volume of sand (L^3)

V_{wc} = volume drained into casing (L^3)
S_y = specific yield
r_{ce} = effective casing radius (L)
r_c = radius of well casing (L) (0.083 or 0.1667 ft)
R = radius of gravel envelope (L) (0.50 ft)
R_e = effective radial distance over which head is dissipated (L) (from data set)
L_e = length of well screen (L) (saturated thickness of screened interval)
H_o = drawdown at t=0 (L) (from data set)
H_t = drawdown at t=t (L) (from data set)
t = time since $H = H_o$ (T) (from data set)

(Binkhorst and Robbins. 1998).

d. Depth-to-groundwater was measured in the 18 groundwater monitoring wells identified in Table 2 and illustrated in Figure 4. Depth-to-water measurements, groundwater elevations, and survey coordinates are summarized in Table 4. An interpolated groundwater elevation map is presented in Figure 5.

(4) Collection of water quality samples from 15 groundwater monitoring wells within the treatment zone and 3 monitoring wells downgradient of the treatment zone for analysis of chlorinated hydrocarbon groundwater concentrations:

a. Table 2 identifies the groundwater monitoring wells from which samples were collected. Prior to sample collection, three well-volumes were purged. Groundwater was then collected for analysis of field parameters and stored in volatile organic analysis (VOA) vials for analysis of dissolved chlorinated hydrocarbon concentrations. General water quality field parameters including pH, electrical conductivity (EC), temperature, dissolved oxygen (DO), and oxidation reduction potential (ORP) were measured using an Horiba U-22 meter. Chlorinated hydrocarbon analysis was performed on-site by heated-headspace analysis and gas chromatography (GC) using a dry electrolytic conductivity detector (DELCD), a photo-ionization detector (PID), and a flame-ionization detector (FID). General water quality data for permanent groundwater monitoring well installations can be found in Table 5 and chemical concentration data can be found in Table 6. All non-detect samples are listed as less than the detection limit.

(5) Depth-discrete hydraulic conductivity and dissolved chlorinated hydrocarbon concentration data were collected on one foot intervals as possible from 29 ft below ground surface (bgs) to refusal (<35 ft bgs) at four of the 11 direct-push sampling locations, many of which produced no water. Depth-discrete intervals at 7 of the 11 sampling locations produced no water at any interval tested. Additionally, 10 composite samples were collected from the borehole open to approximately 35 ft bgs at 10 of the 11 direct-push sampling locations.

a. Groundwater quality data were collected from depth-specific intervals at direct-push sampling locations GP3, GP4, GP6, and GP7 and open-borehole, composite samples were collected at GP1 through GP9 and GP11 (See Table 2 and Figure 2). GP10 was not sampled because there was no groundwater recovery in the borehole. Sampling locations were spaced on approximately 30 ft centers, as possible, along a transect downgradient of the source zone and perpendicular to the direction of groundwater flow. Figures 2, 6, and 7 illustrate the location of the direct-push sampling locations. Sample locations were also placed along an east/west transect at the southern border of the treatment zone because previous work by others suggested the presence of a paleo channel and chlorinated solvent migration in that direction. Using percussion assisted direct-push technology and a modified Geoprobe Groundwater Profiler, groundwater samples were collected as possible using a check valve on 1-ft intervals from 29 ft bgs to refusal (less than 35 ft bgs). The location of the depth-discrete groundwater samples are illustrated in Figures 6 and 7. Table 7 provides survey data for the direct-push locations. Chlorinated hydrocarbon concentration analysis was conducted, as described above, and the results are summarized in Table 8. General water quality parameters (e.g. pH, EC, temp, DO, and ORP) were also collected during depth-specific sampling, and those data are presented in Table 9.

b. Pneumatic slug tests were conducted at depth-specific intervals at locations GP3, GP4, GP6, GP7 and GP11 using a Geoprobe Pneumatic Slug Test Kit. Slug test data were analyzed using both the Hvorslev and the Bouwer and Rice Methods, and the results are shown in Table 10. A comparison of the hydraulic conductivities derived from direct-push pneumatic slug test and monitoring well slug tests reveals that direct-push aquifer test data suggest less variable and higher hydraulic conductivity values than those derived from the monitoring well data. It is possible that this is an artifact of the direct-push pneumatic test method, which displaces much smaller volumes of water than the monitoring well tests.

Additional field work included soil conductivity measurements at GP1 and GP6 using a Geoprobe Direct Image Electrical Conductivity Probe (Wenner array). Results of the soil conductivity tests are shown in Figure 8.

The monitoring well chemical concentration data collected in December 2006 by the ASU/Battelle team were compared to the previous monitoring well chemical concentration data available for the site. The results for each are compared in Table 11.

Figures 9 through 13 show vertical chemical concentration contour plots in a transect perpendicular to the dominant groundwater flow direction for five of the ten analytes measured in depth-discrete direct-push samples. Vinyl chloride, trans-1,2-dichloroethene (DCE), 1,1-dichloroethane (DCA), 1,2-DCA, and 1,1,2-Trichloroethane (TCA) were not contoured because all groundwater samples were non-detect (<1 µg /L) for these constituents. Vertical contouring did not include locations GP1, GP2 or GP9 along the southern border of the treatment zone since no depth specific samples could be collected from these locations and chemical and hydrogeologic data suggested that the dominant flow direction for this site was to the east-northeast. Figure 14 presents the hydraulic conductivity data from the pneumatic slug testing for each depth-discrete direct-push sampling interval overlaid on the trichloroethylene (TCE) chemical concentration contour plot.

Plan view contour plots of the chemical concentrations for 8 of 10 analytes measured in 15 monitoring wells and at direct-push sampling locations GP1 through GP9 and GP11 are shown in Figures 15 through 22. Vinyl chloride and 1,1,2-TCA were not contoured because all groundwater samples were non-detect (<1 μg/L) for these constituents.

Using the TCE groundwater concentration data, the hydraulic conductivity estimates calculated from the depth-discrete direct-push sampling and monitoring well slug tests, and a calculated gradient, a TCE mass flux calculation was performed using the Mass Flux Toolkit, Version 1.0. The gradient was calculated using Devlin (2003) and was based on current depth-to-water measurements and available historical top-of-casing elevations for all monitoring wells except MW-9 and MW-10. Depth-to-water data in MW-9 and MW-10 showed a steep gradient across that portion of the site, suggesting a localized hydrogeologic environment that was incongruent with that associated with the remainder of the monitoring wells. The Mass Flux Toolkit is a freeware program developed by Groundwater Services, Inc. and others under a contract funded by ESTCP. A linear spatial and vertical interpolation of the concentration, hydraulic conductivity, hydraulic gradient, and mass flux data was used for the analysis. For intervals with no groundwater production, a hydraulic conductivity value of 10^{-6} cm/s (average value, MW-9 and MW-10, the least conductive wells). The analysis was completed four times to include all data taken at the site. The first analysis used the Bouwer and Rice Method hydraulic conductivity values with monitoring wells, MW-11, MW-12, and MW-7. The second analysis used the Bouwer and Rice Method results for the direct-push locations only (no monitoring well results). The same two analyses were performed again using the Hvorslev Method hydraulic conductivity values. Table 12 presents the mass flux results for TCE in each of the four analyses. For these four calculations, the estimated TCE mass flux ranged from 4.92E+00 kg/yr to 1.09E+01 kg/yr. The highest value corresponds to the case where the monitoring well data is used, and it is dominated by the large hydraulic conductivity calculated by the Bouwer (1989) approach using MW-12 slug test data.

3. References

Devlin, J.F. 2003. "A Spreadsheet Method of Estimating Best-fit Hydraulic Gradients Using Head Data from Multiple Wells." Groundwater, 41(3): 316-320.

Binkhorst, G.K. and G.A. Robbins. 1998. "Conducting and Interpreting Slug Tests in Monitoring Wells with Partially Submerged Screens." Groundwater, 36(2): 225-229.

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

Bouwer, H. 1989. "The Bouwer and Rice Slug test – An Update." Groundwater, 27(3): 304-309.

Figures

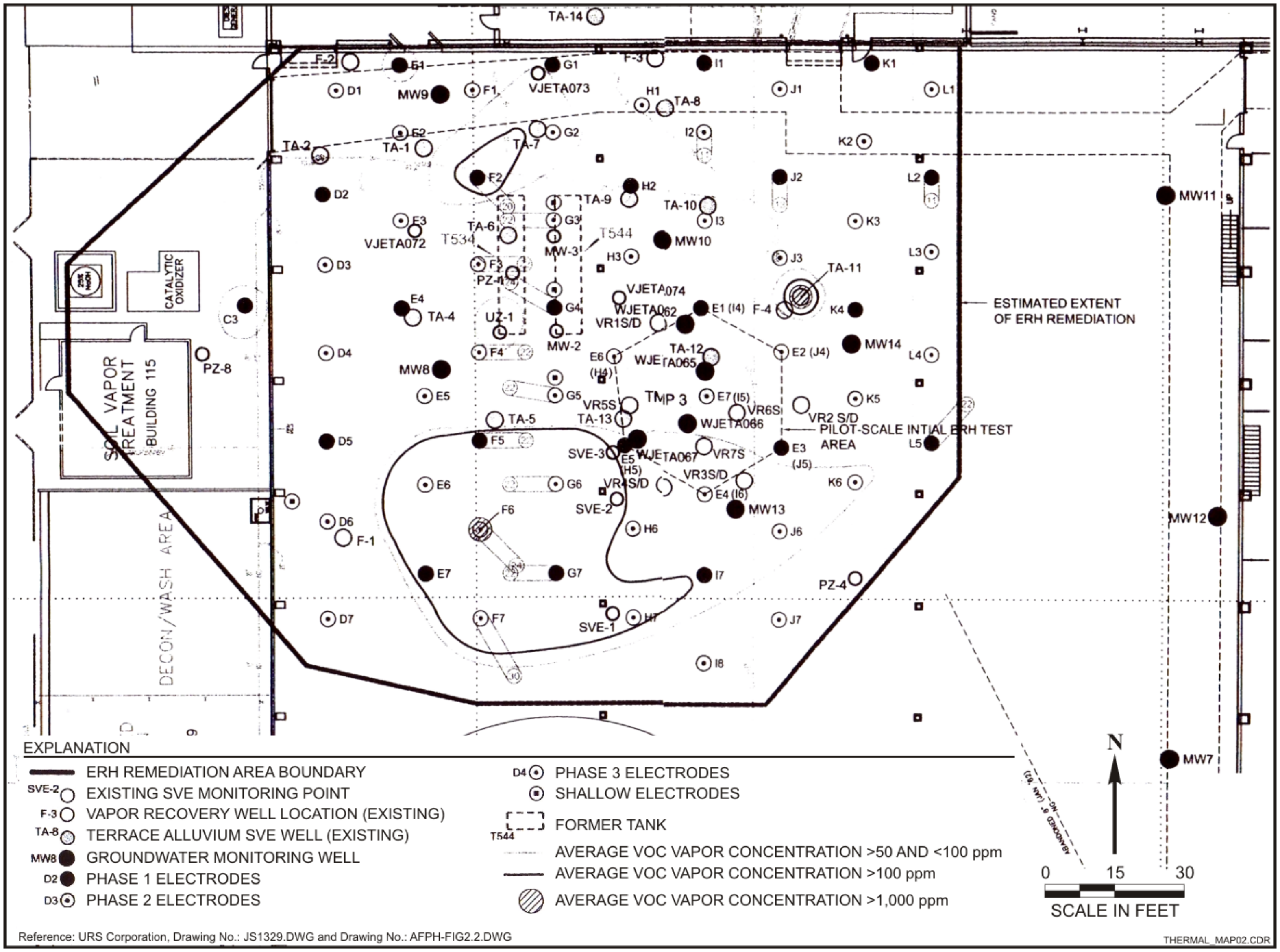


Figure 1. Site Map

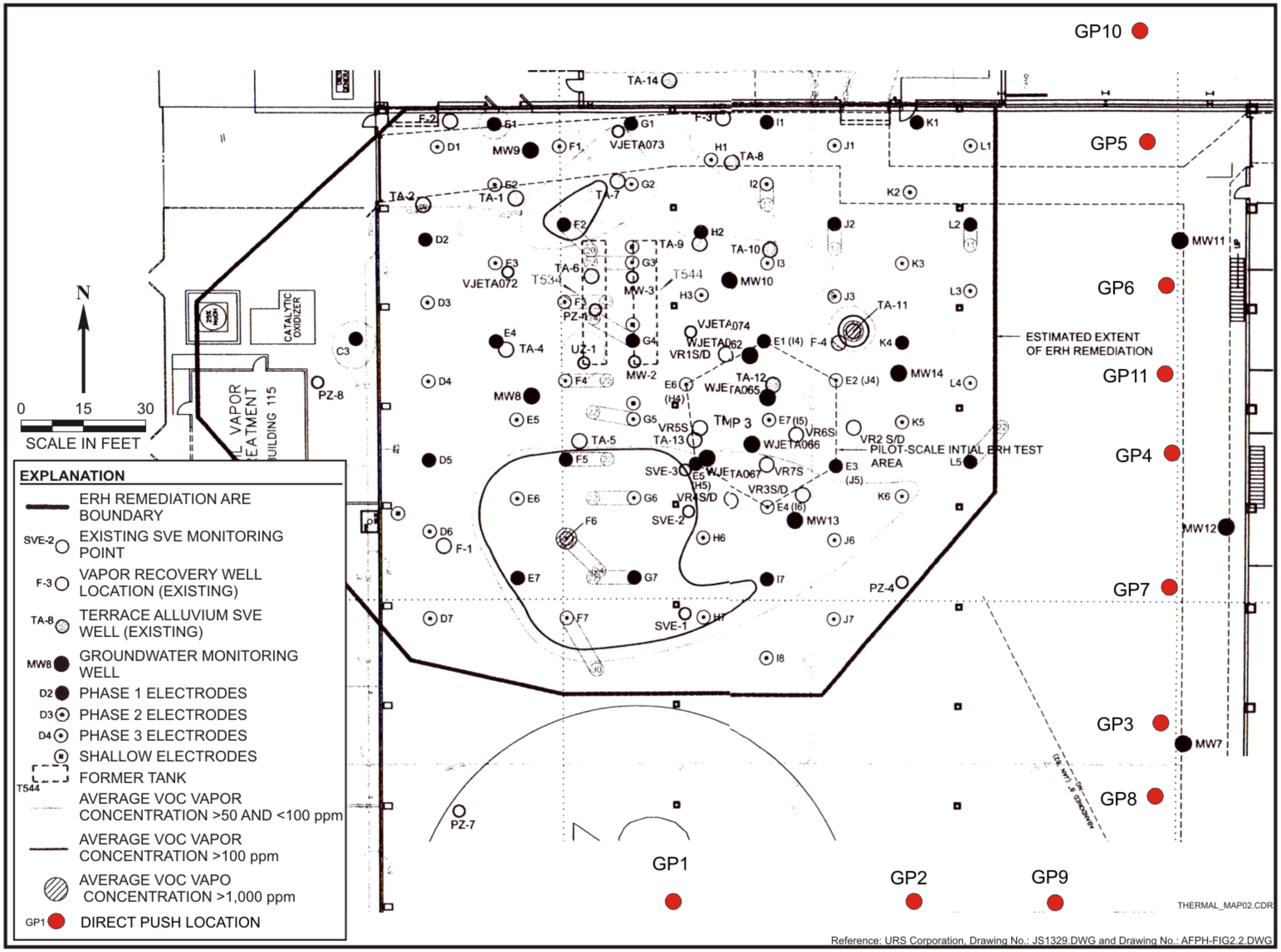


Figure 2. Direct-Push Locations

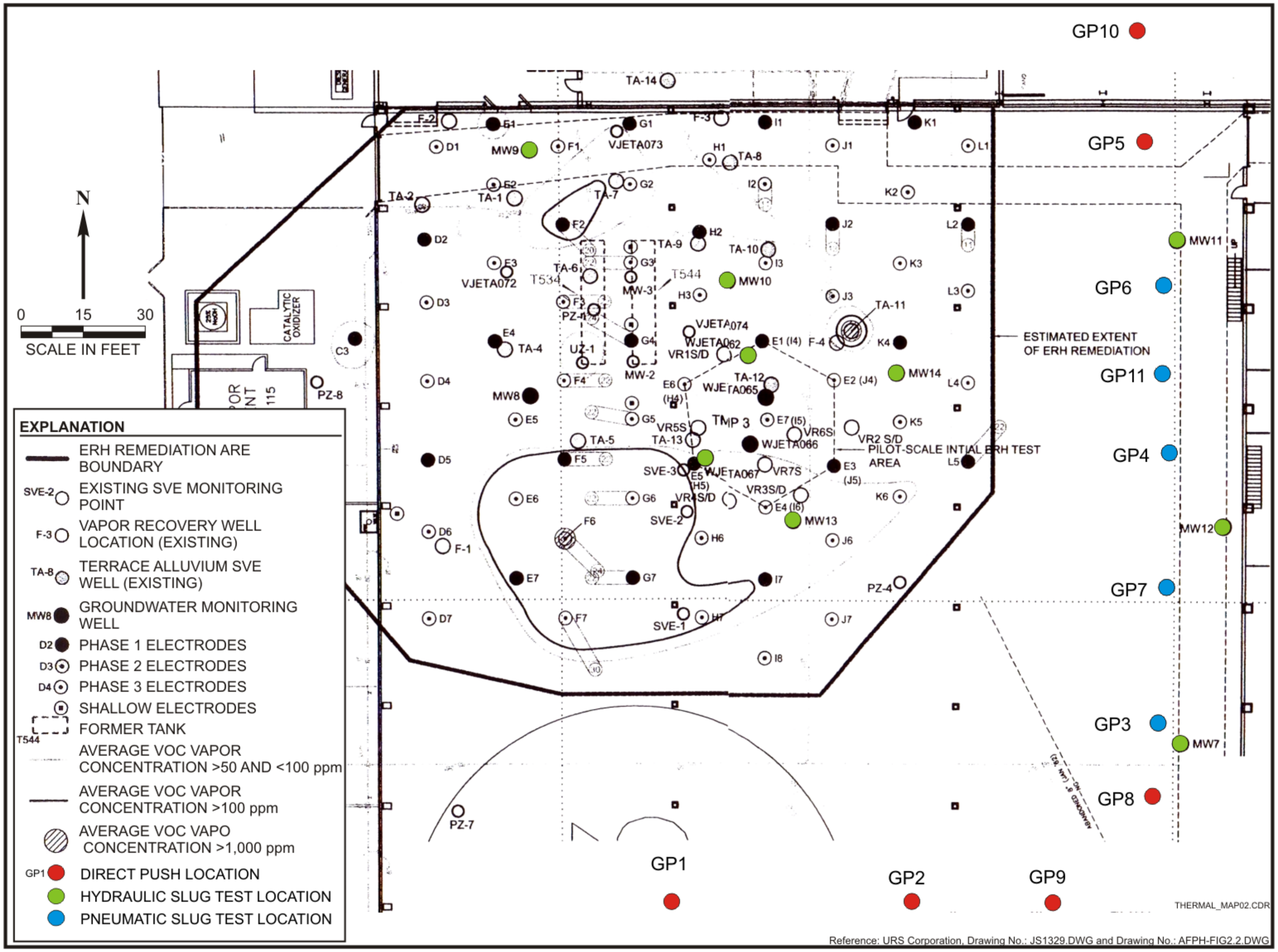


Figure 3. Slug Test Locations

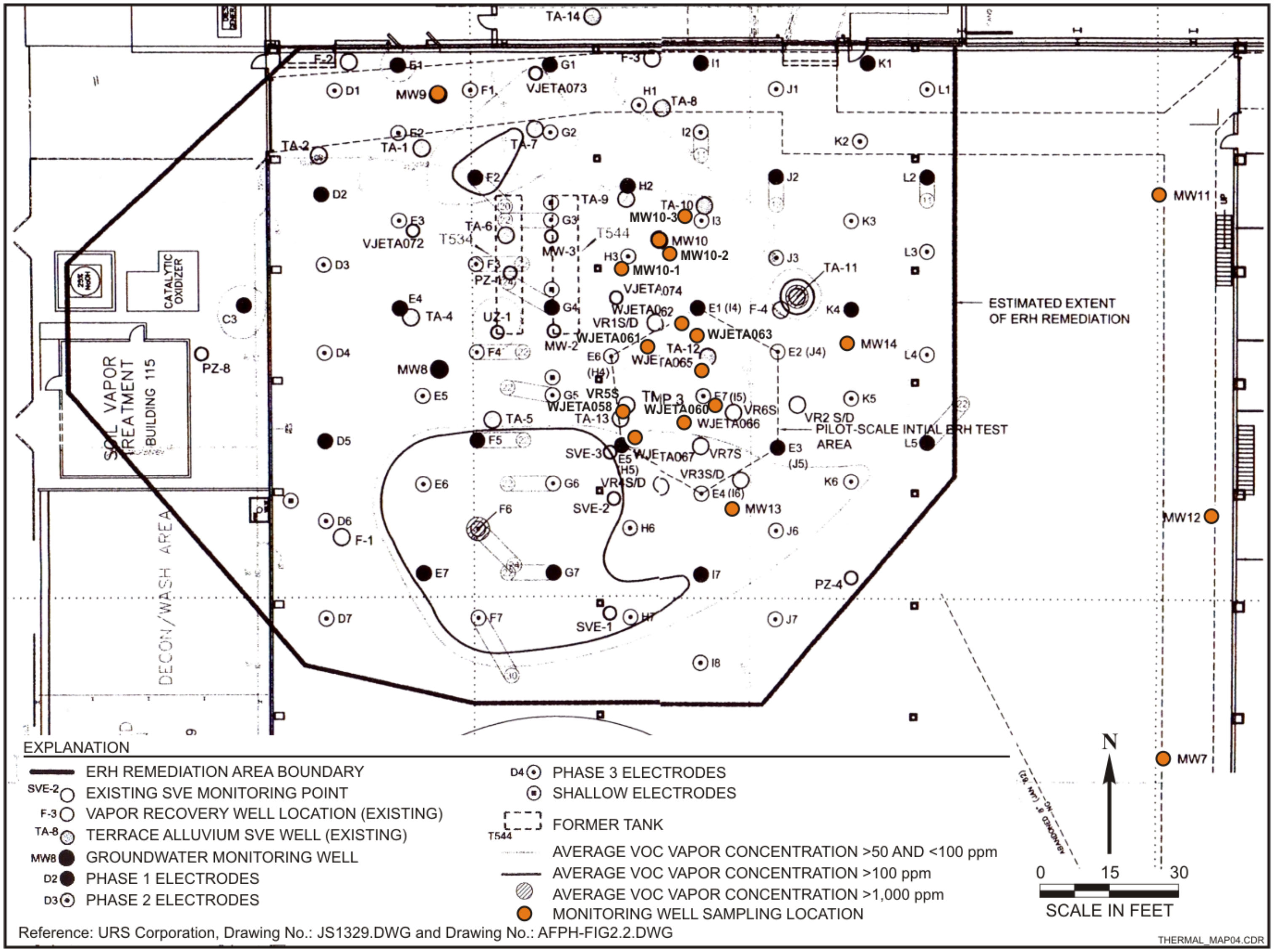


Figure 4. Sampling Locations

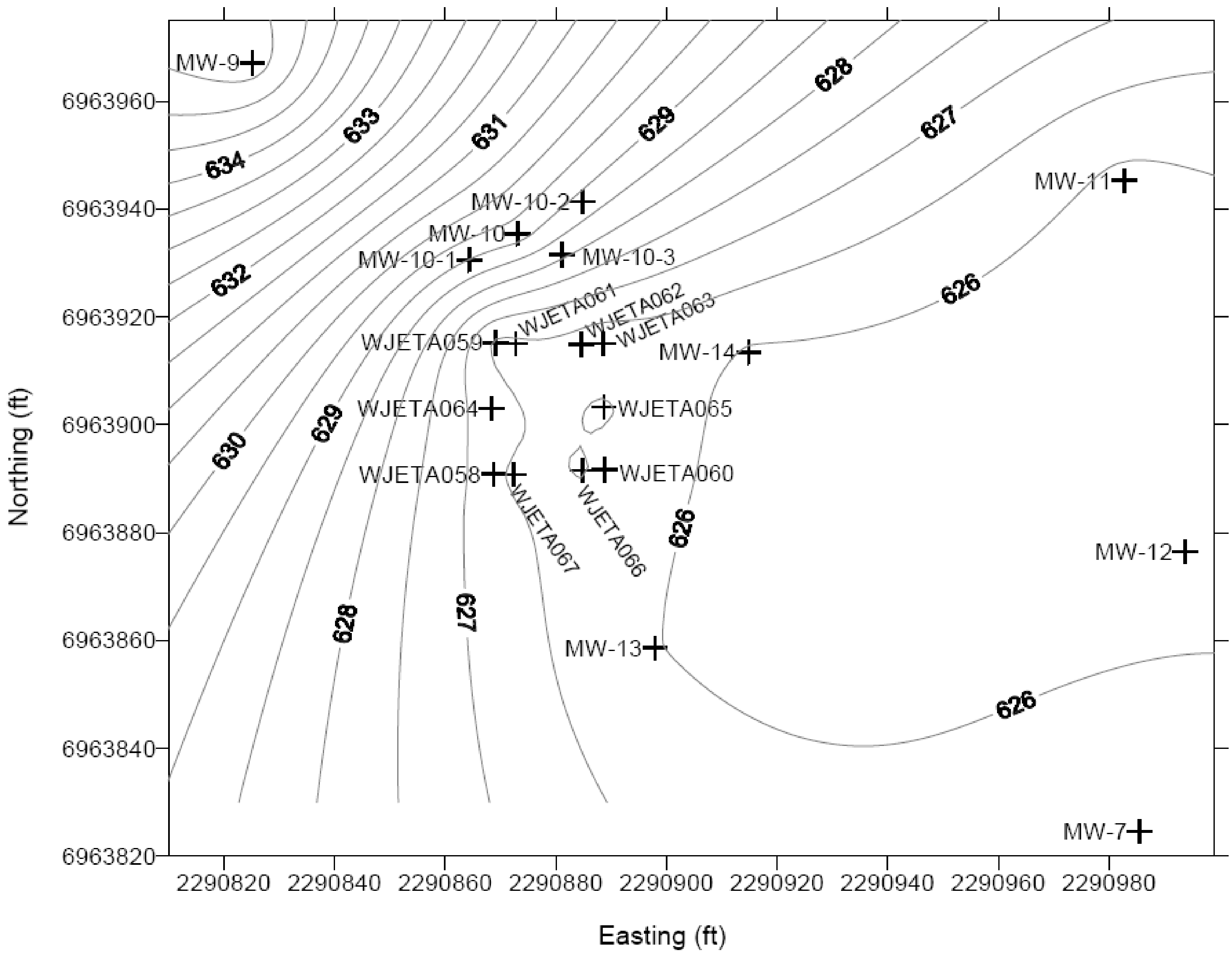


Figure 5. Interpolated Groundwater Elevation Map

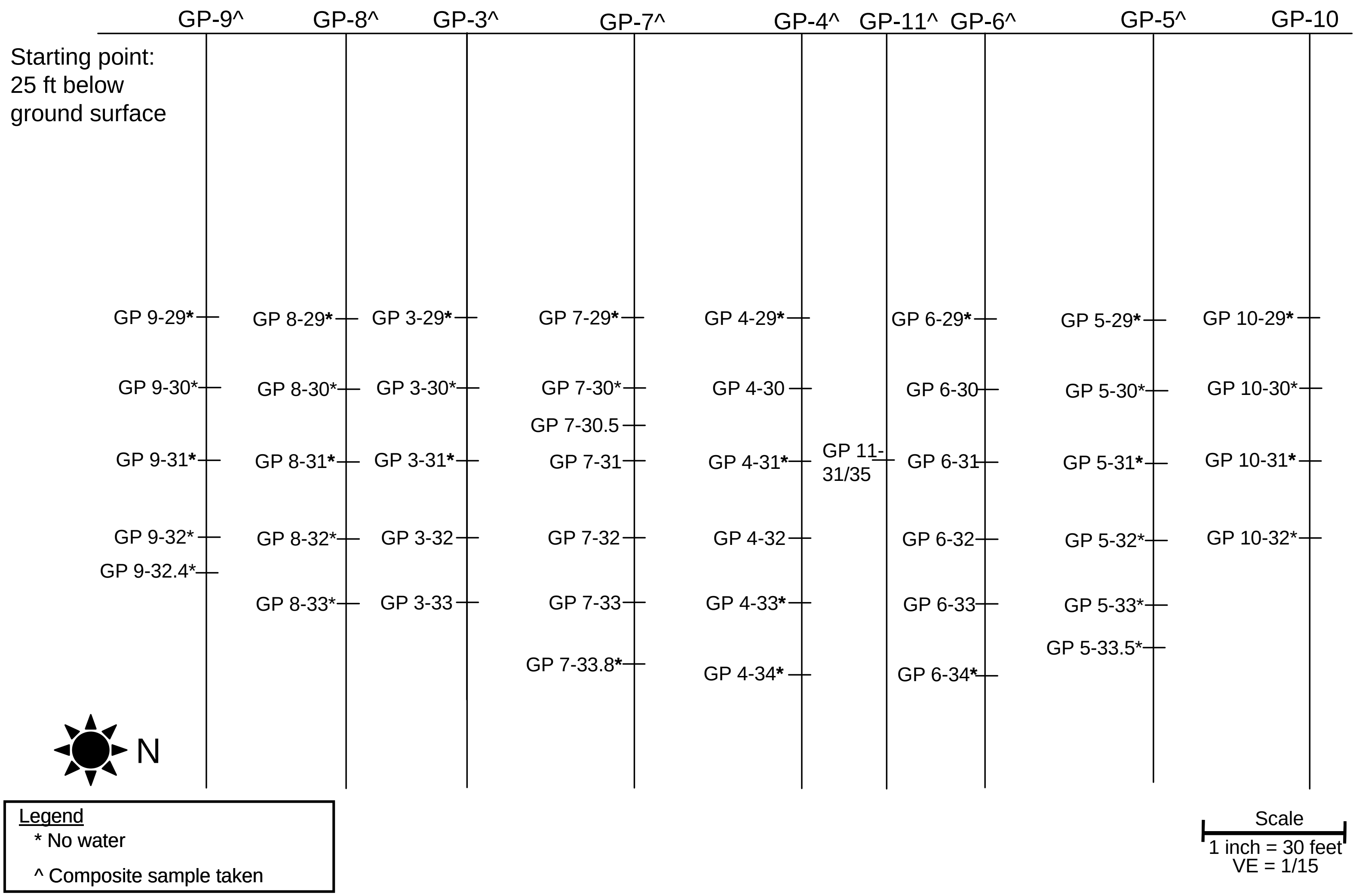


Figure 6. North/South Cross-Section of Direct-Push Sampling Locations (East of the Electrical Resistance Heating Application)

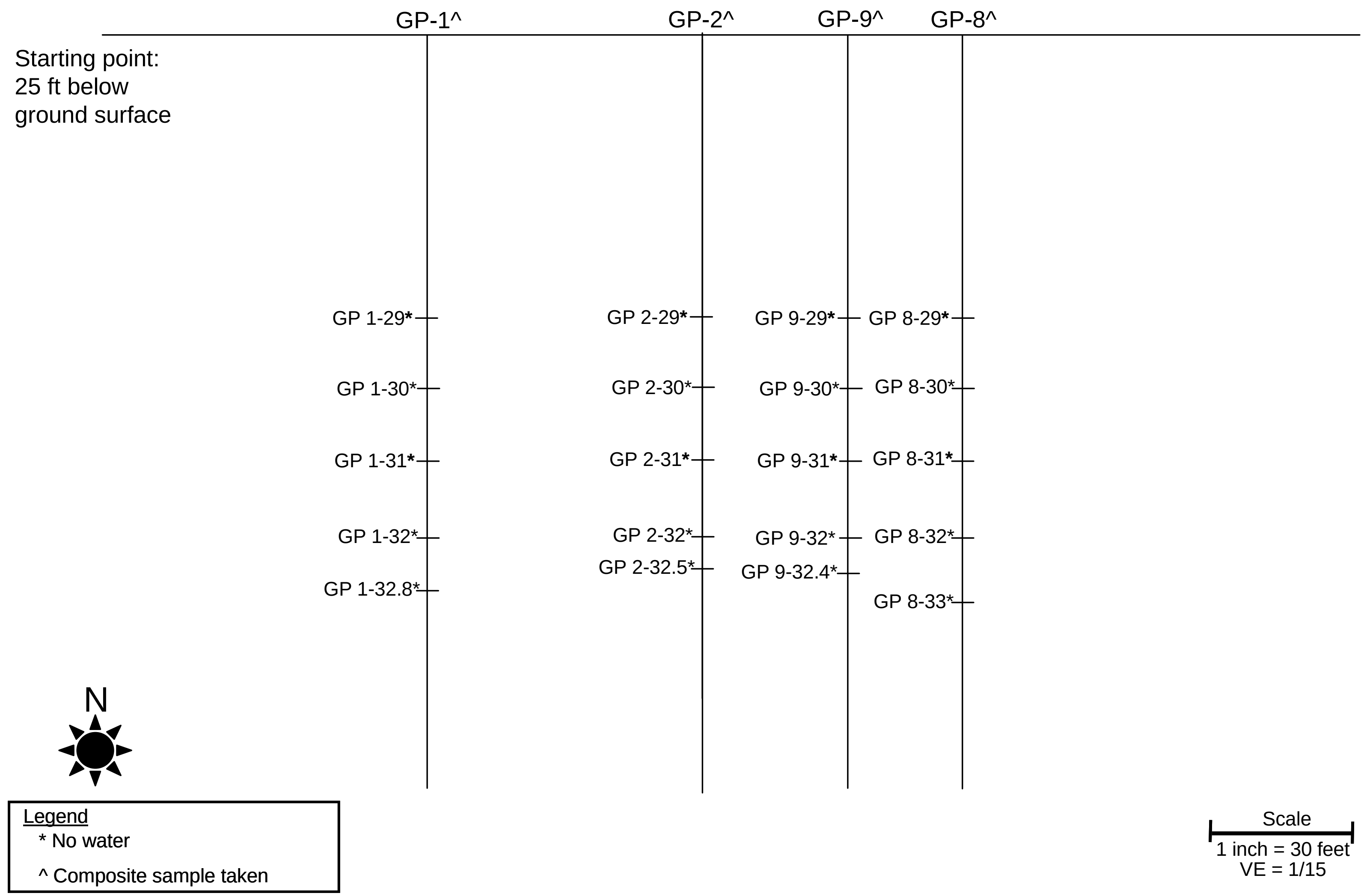
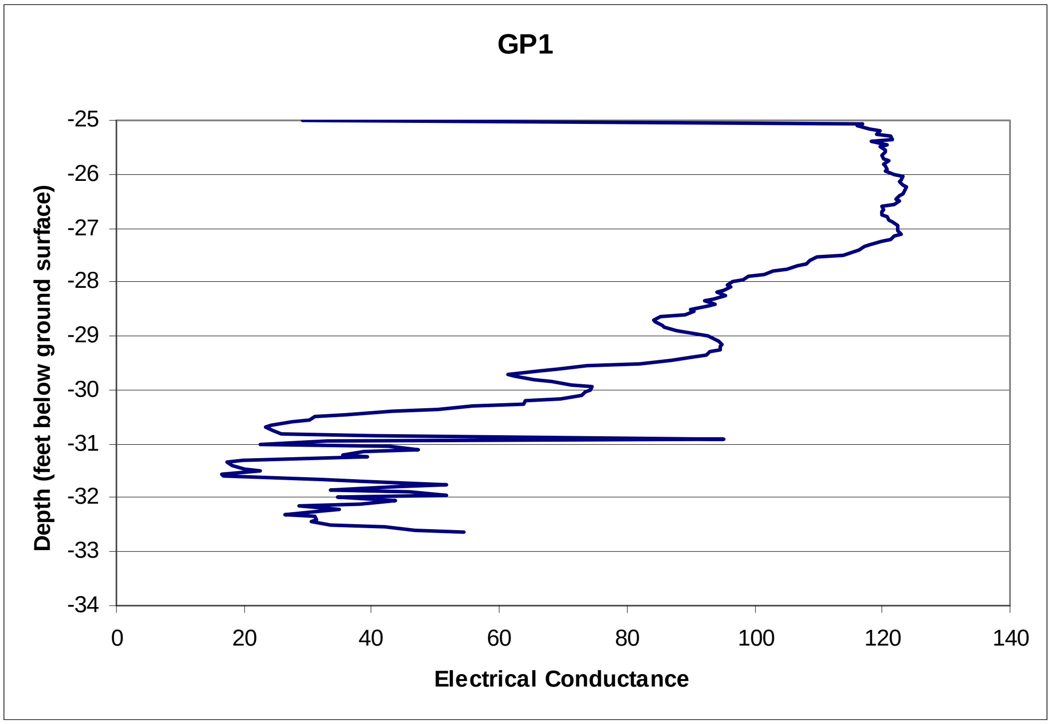
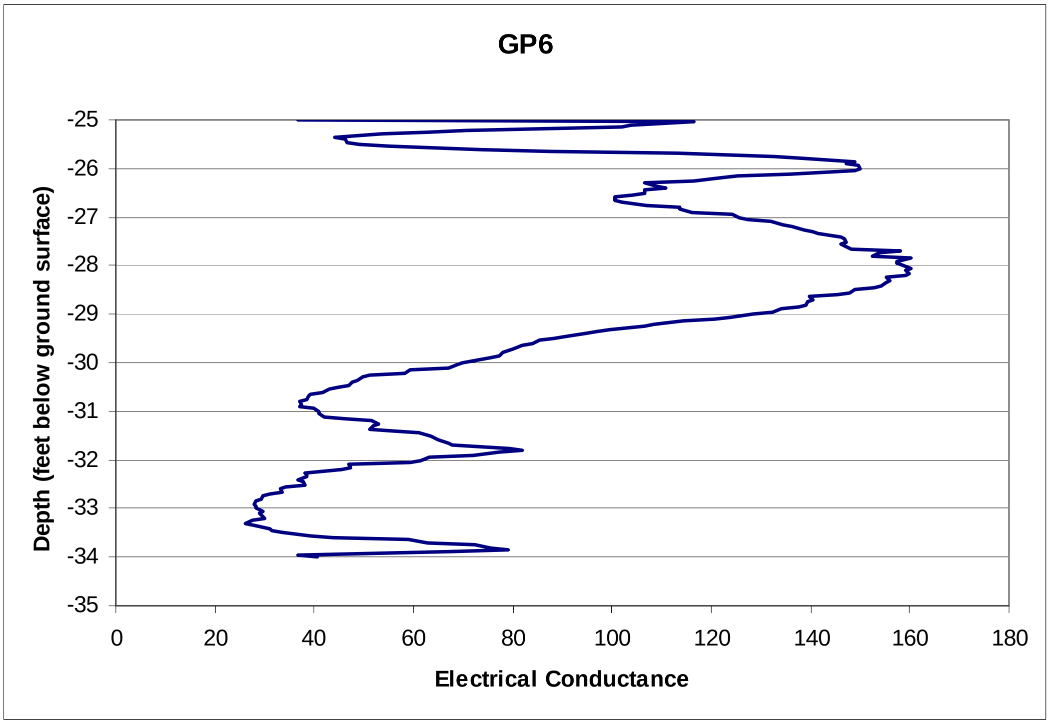


Figure 7. East/West Cross-Section of Direct-Push Sampling Locations (South of the Electrical Resistance Heating Application)

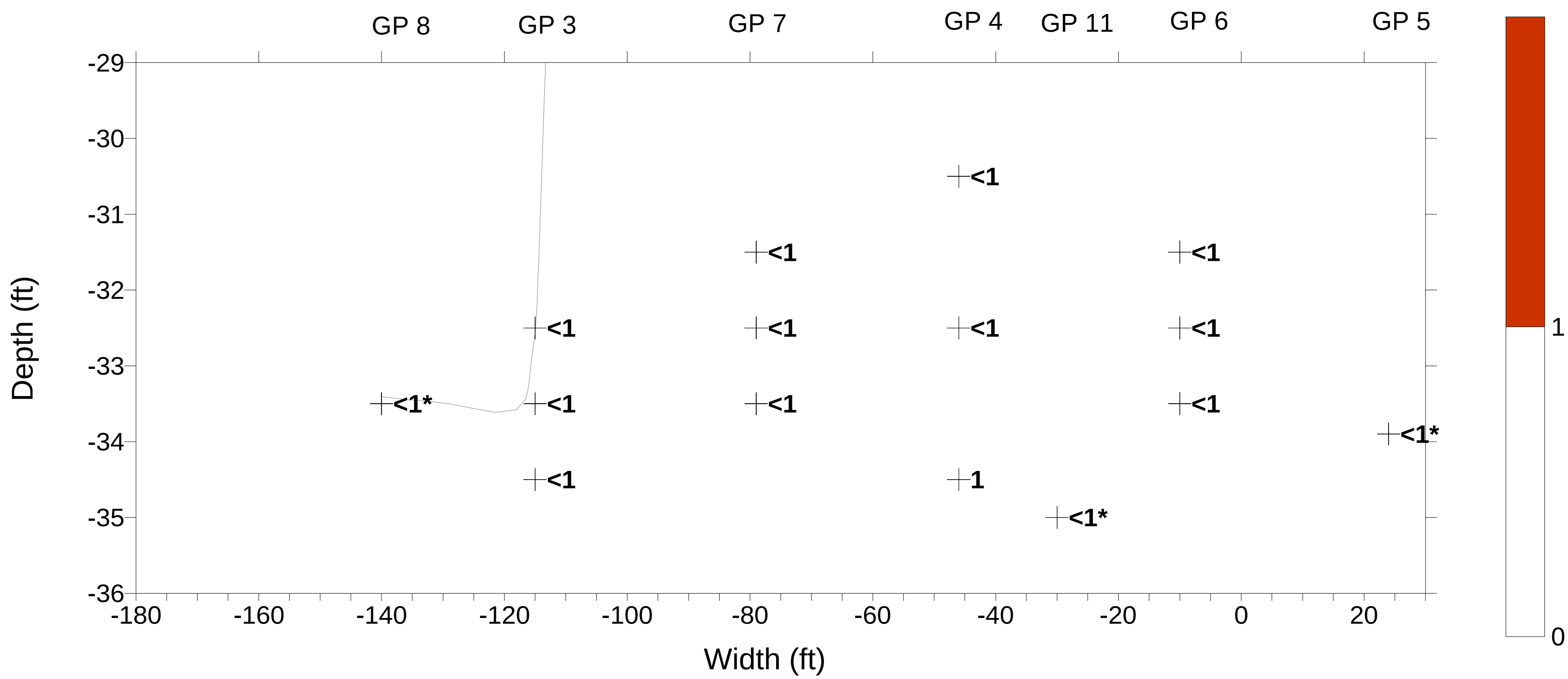


(a) Electrical Conductivity results for GP1



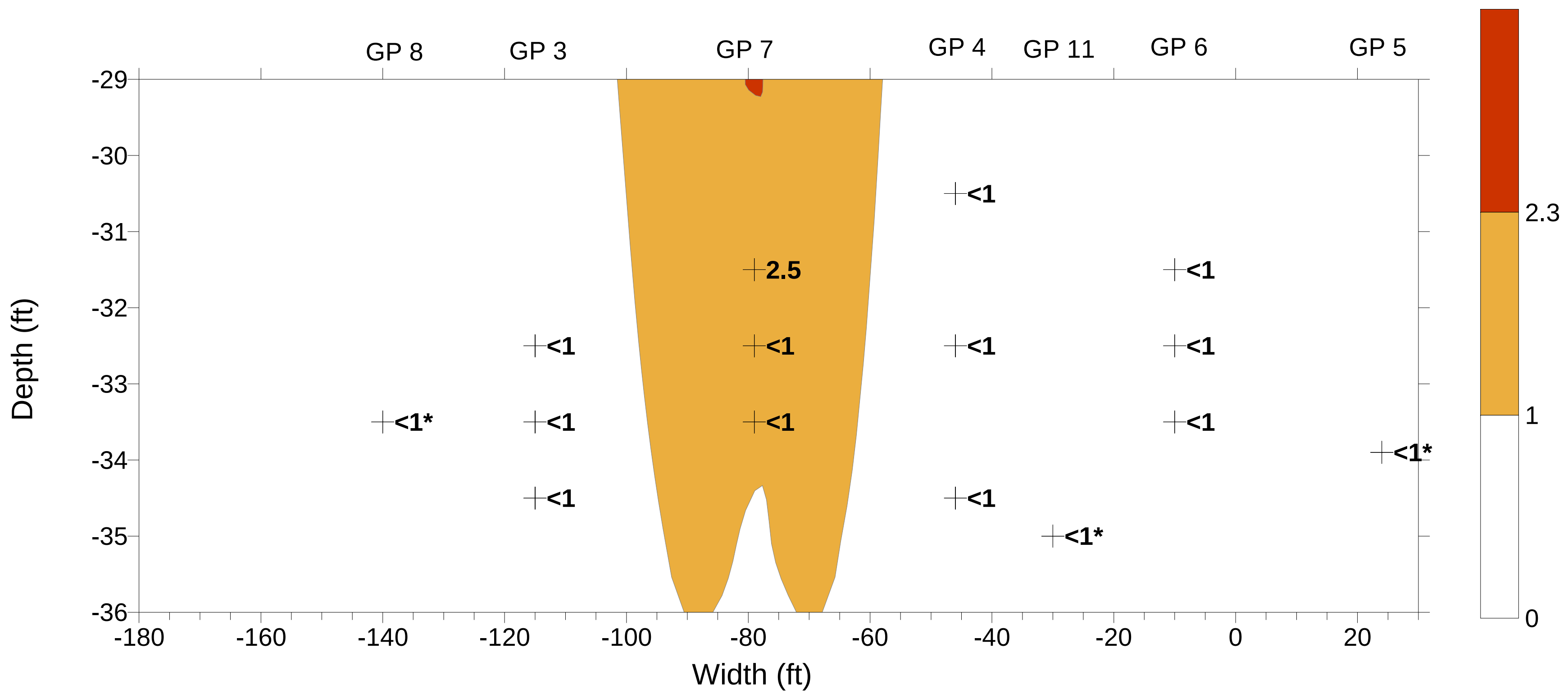
(b) Electrical Conductivity results for GP6

Figure 8. Electrical Conductivity Results



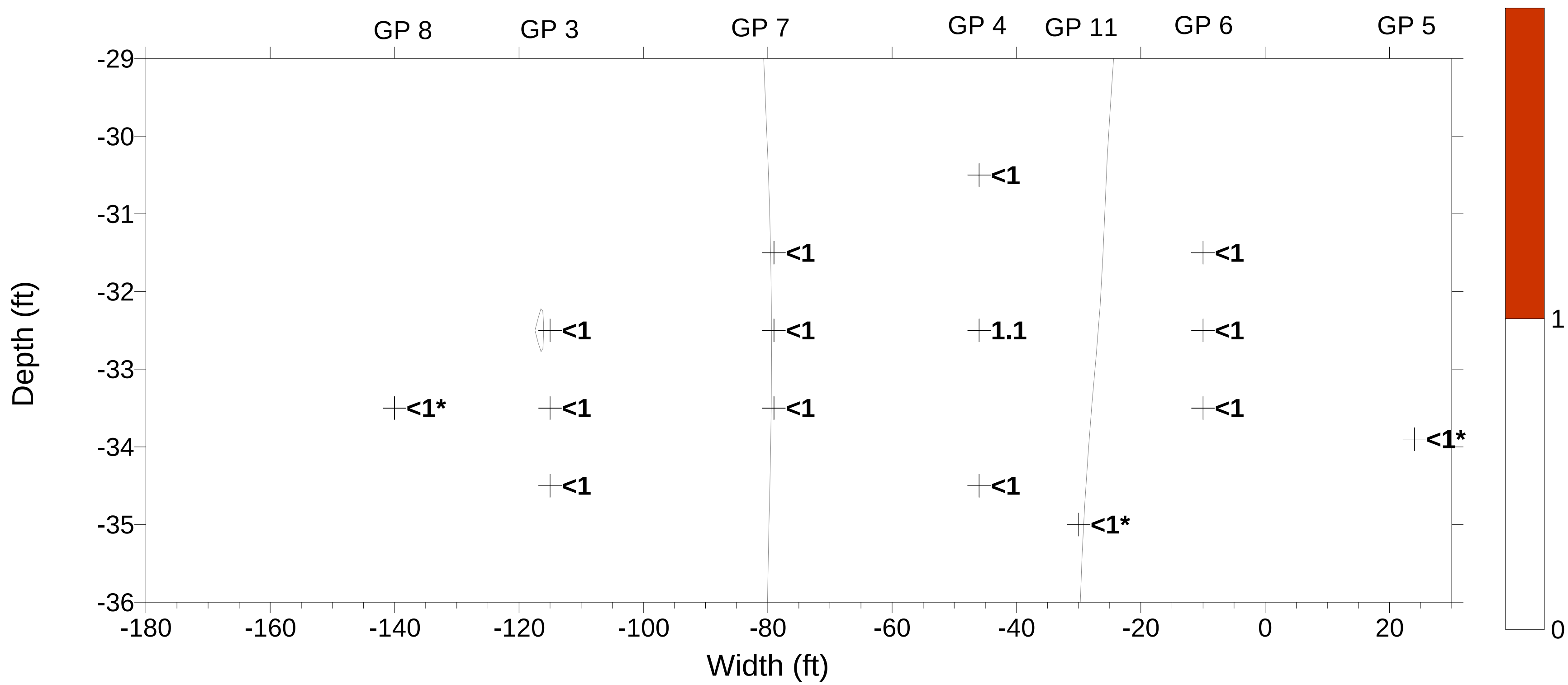
Note:
* Composite sample of the open borehole

Figure 9. 1,1-DCE Direct-Push Groundwater Concentrations (µg/L)



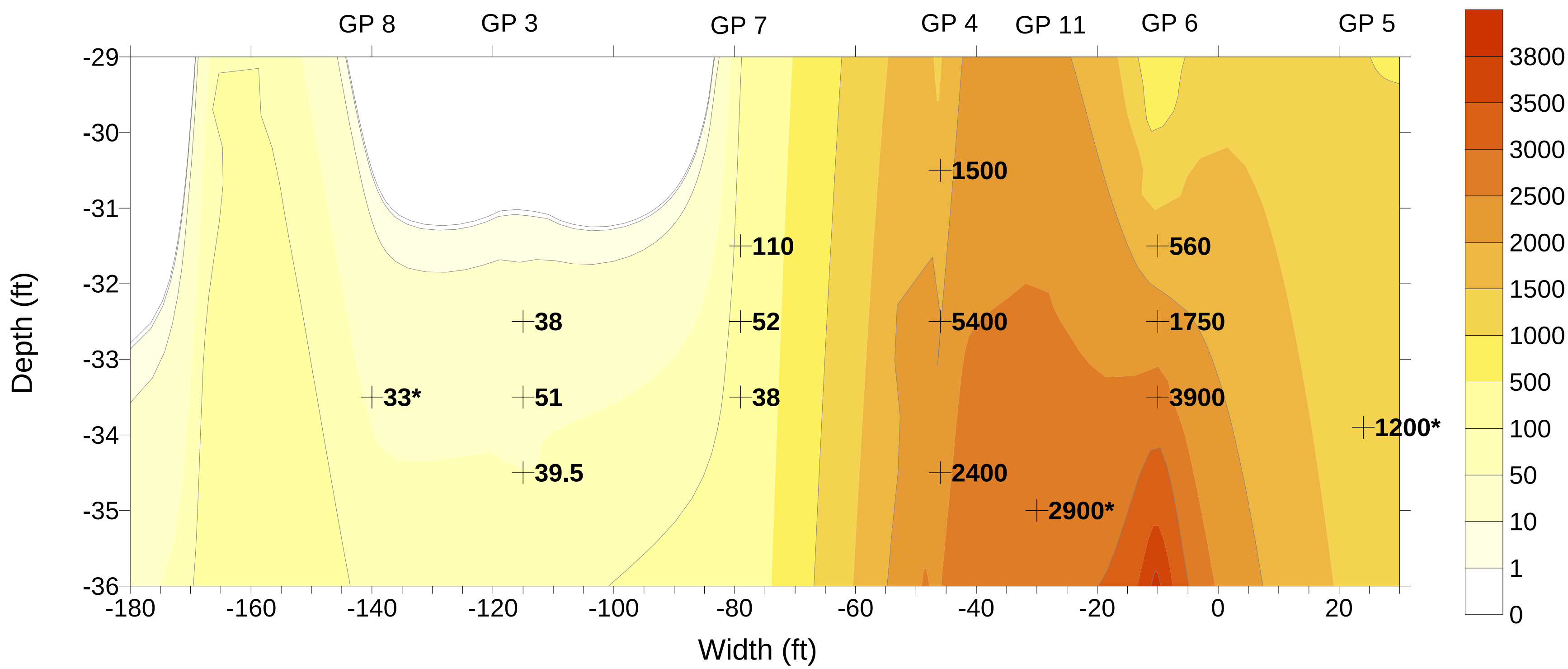
Note:
* Composite sample of the open borehole

Figure 10. cis-1,2-DCE Direct-Push Groundwater Concentrations (µg/L)



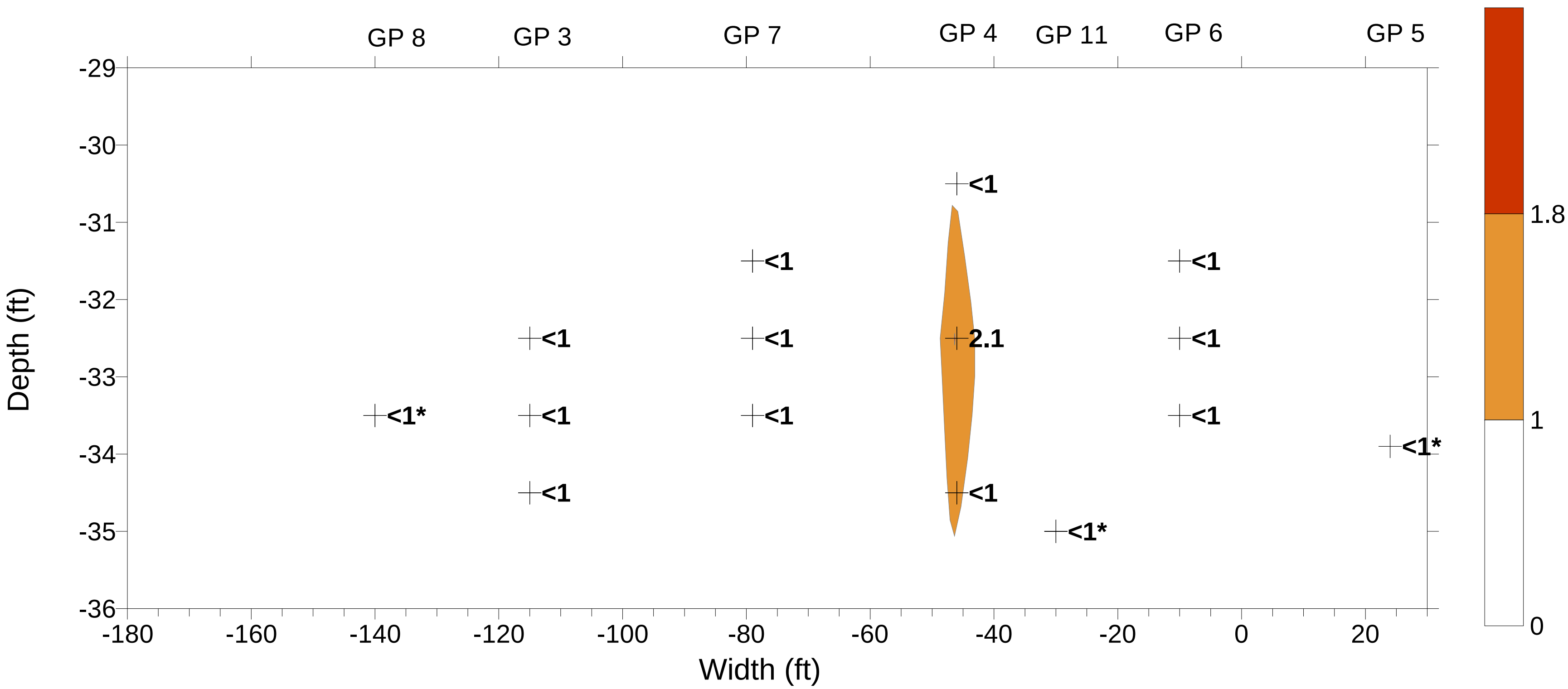
Note:
* Composite sample of the open borehole

Figure 11. 1,1,1-TCA Direct-Push Groundwater Concentrations (µg/L)



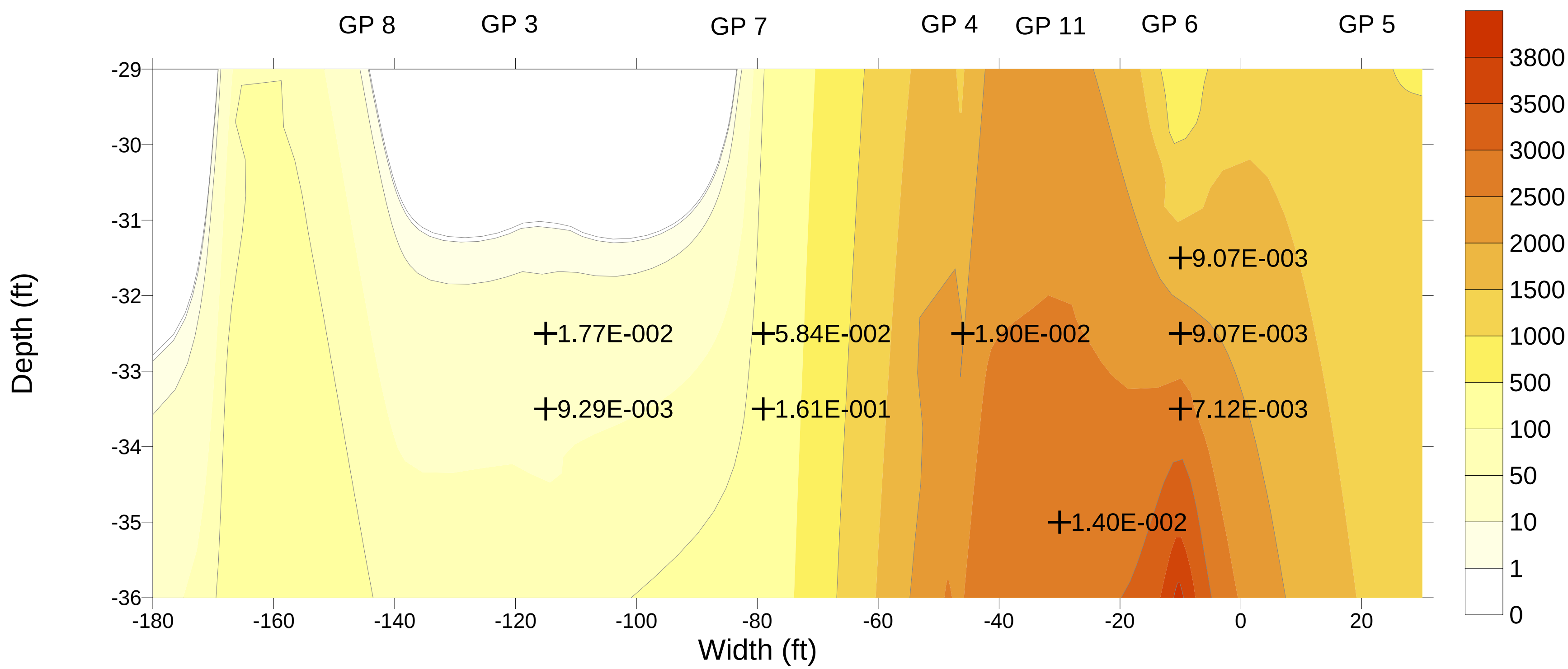
Note:
* Composite sample of the open borehole

Figure 12. TCE Direct-Push Groundwater Concentrations (µg/L)



Note:
* Composite sample of the open borehole

Figure 13. PCE Direct-Push Groundwater Concentrations (µg/L)



Note:
* Composite sample of the open borehole

Figure 14. Hydraulic Conductivity Pneumatic Slug Test Data (cm/s) Overlain on TCE Contour Plot

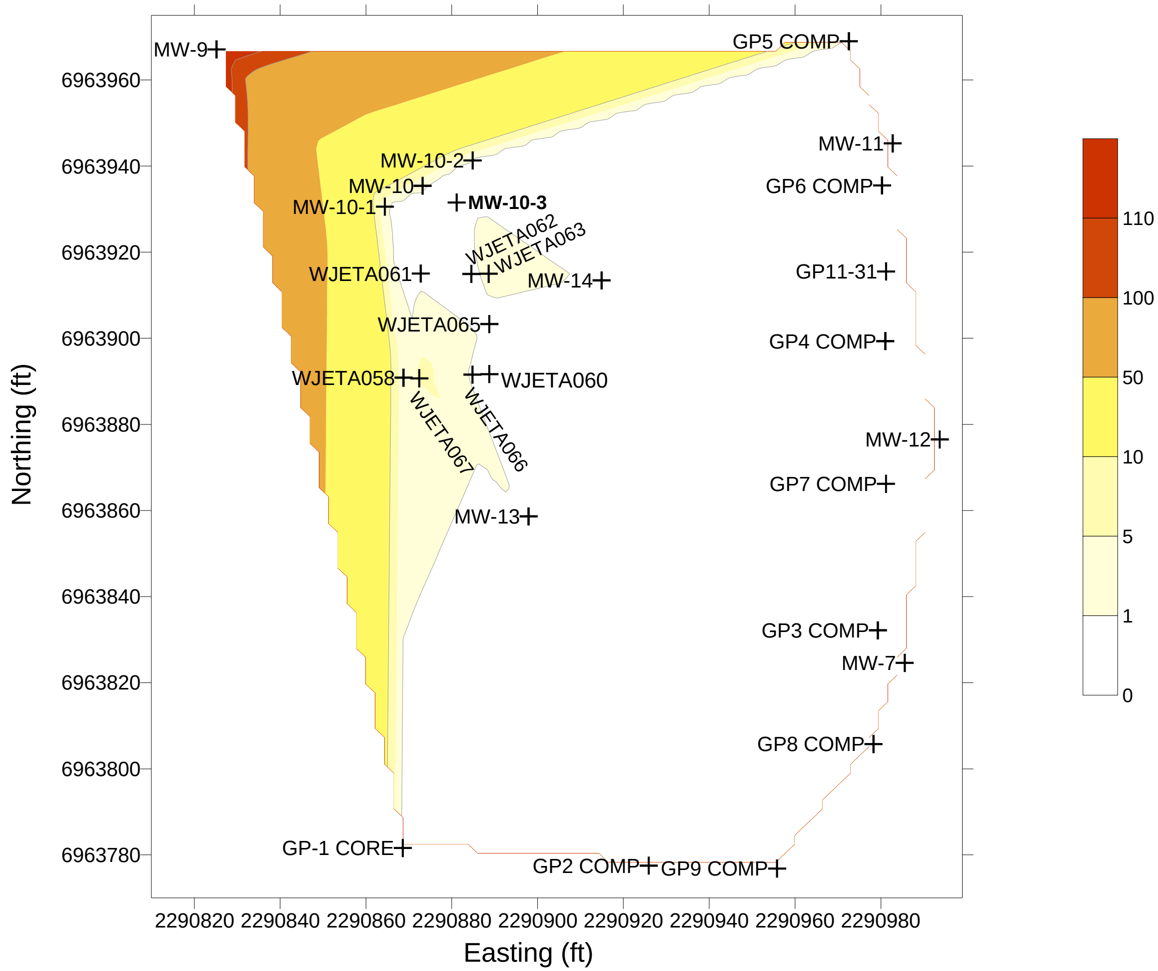


Figure 15. Aerial Contour Map of 1,1-DCE Groundwater Concentrations (μg/L) for Monitoring Wells and Composite Direct-Push Sampling Locations

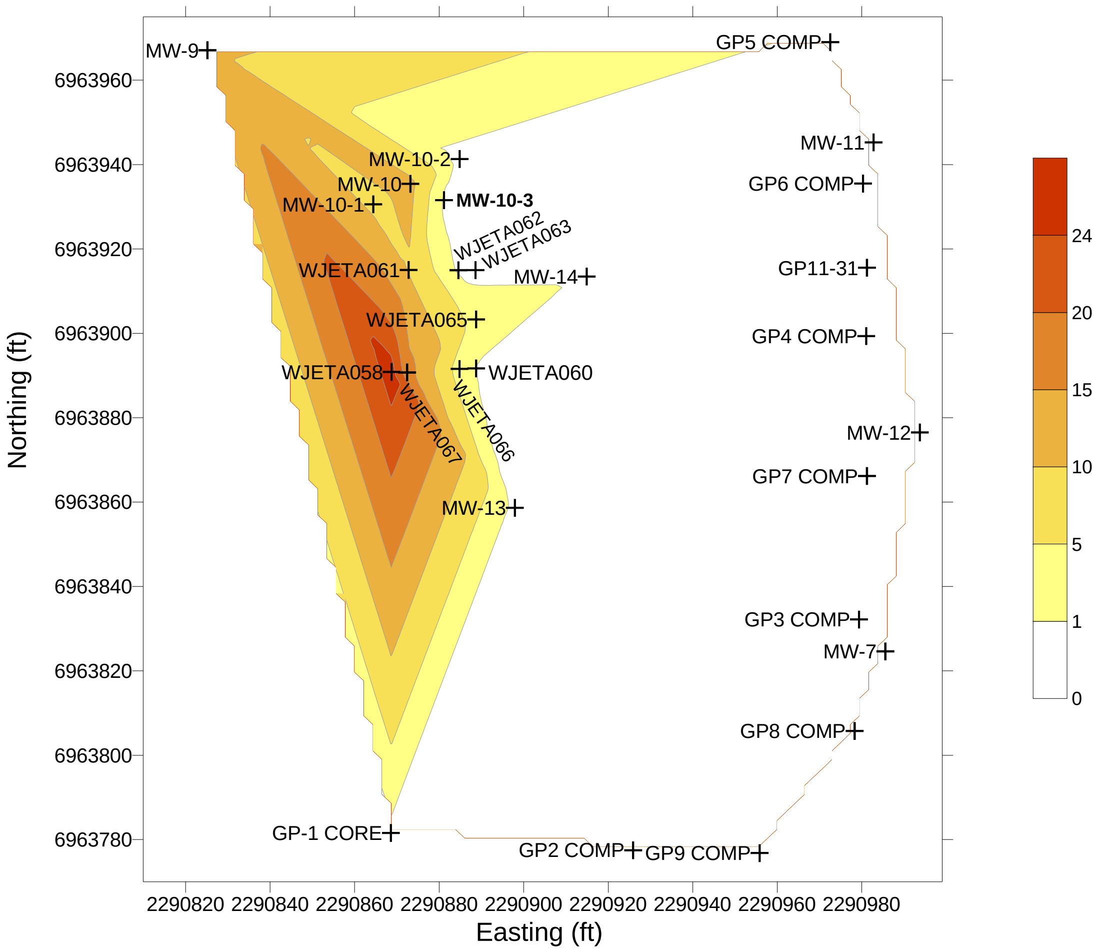


Figure 16. Aerial Contour Map of trans-1,2-DCE Groundwater Concentrations (µg/L) for Monitoring Wells and Composite Direct-Push Sampling Locations

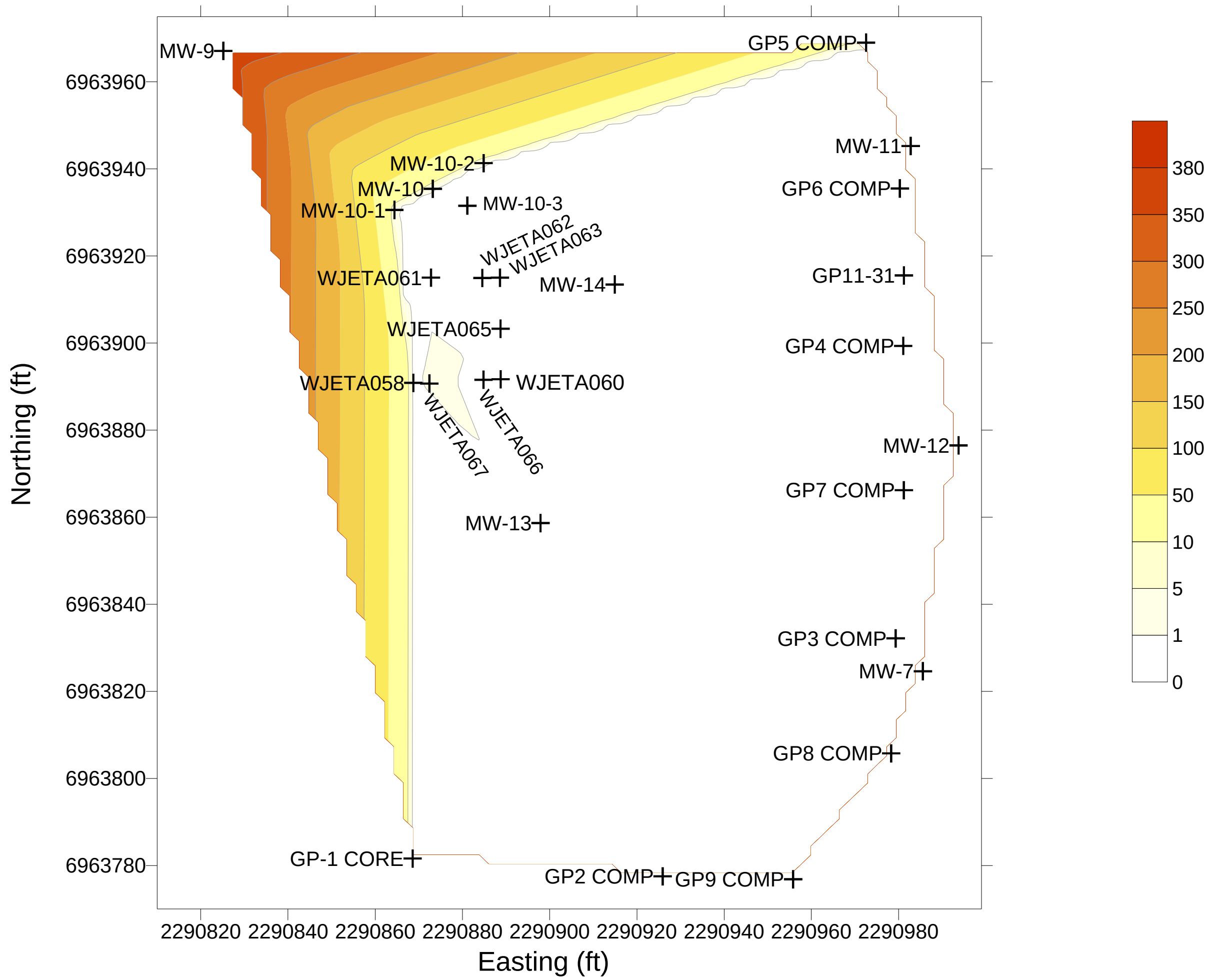


Figure 17. Aerial Contour Map of 1,1-DCA Groundwater Concentrations (µg/L) for Monitoring Wells and Composite Direct-Push Sampling Locations

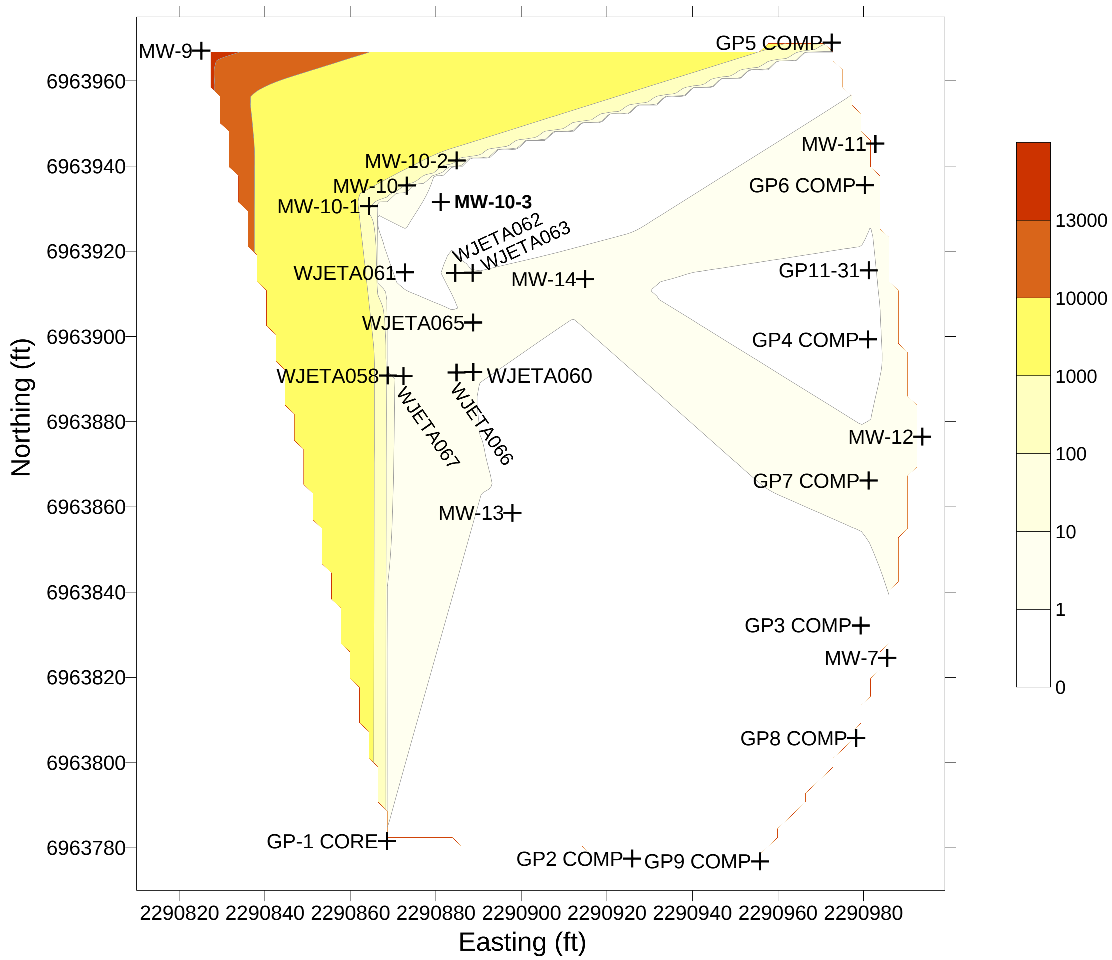


Figure 18. Aerial Contour Map of cis-1,2-DCE Groundwater Concentrations (µg/L) for Monitoring Wells and Composite Direct-Push Sampling Locations

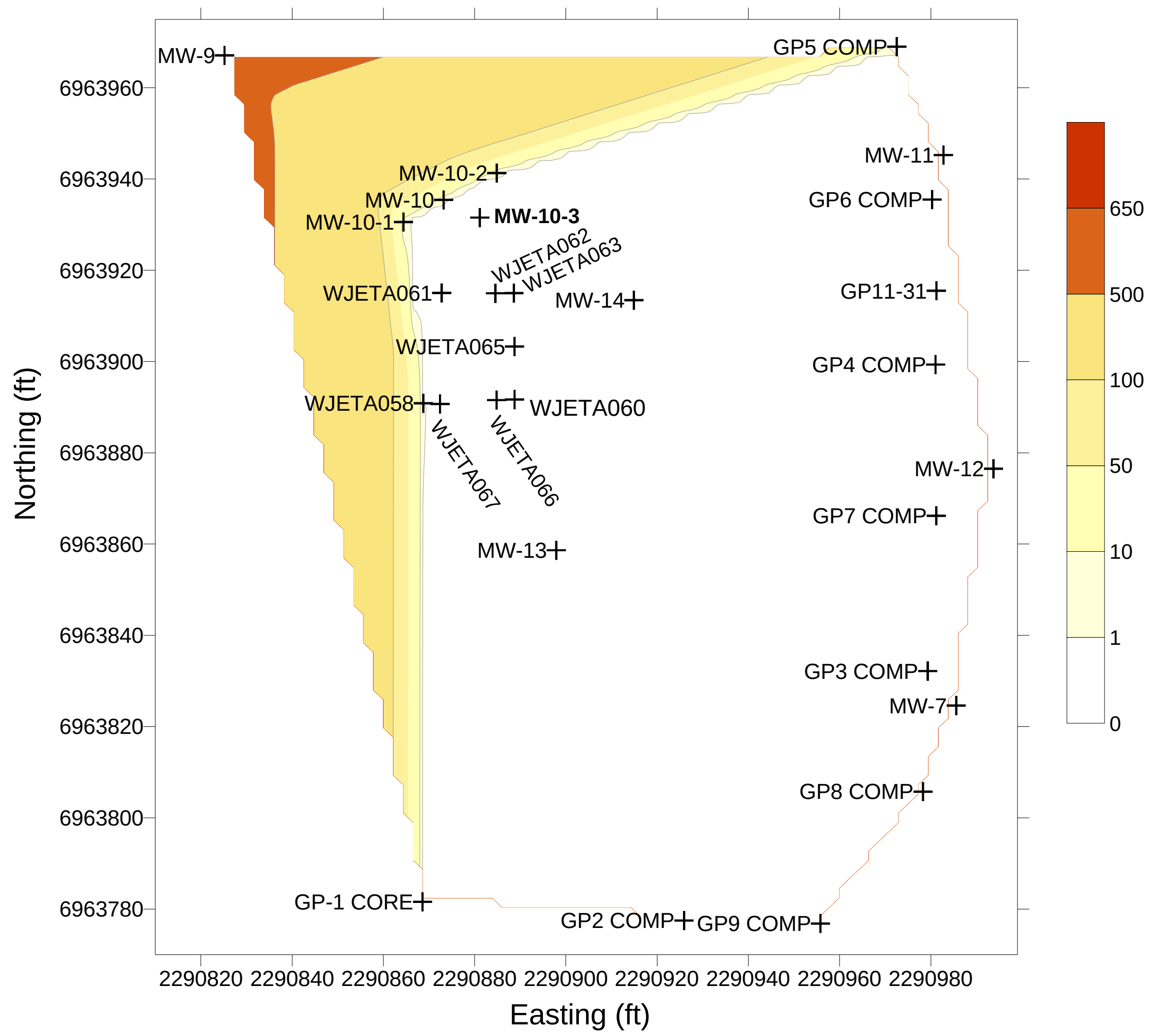


Figure 19. Aerial Contour Map of 1,2-DCA Groundwater Concentrations (µg/L) for Monitoring Wells and Composite Direct-Push Sampling Locations

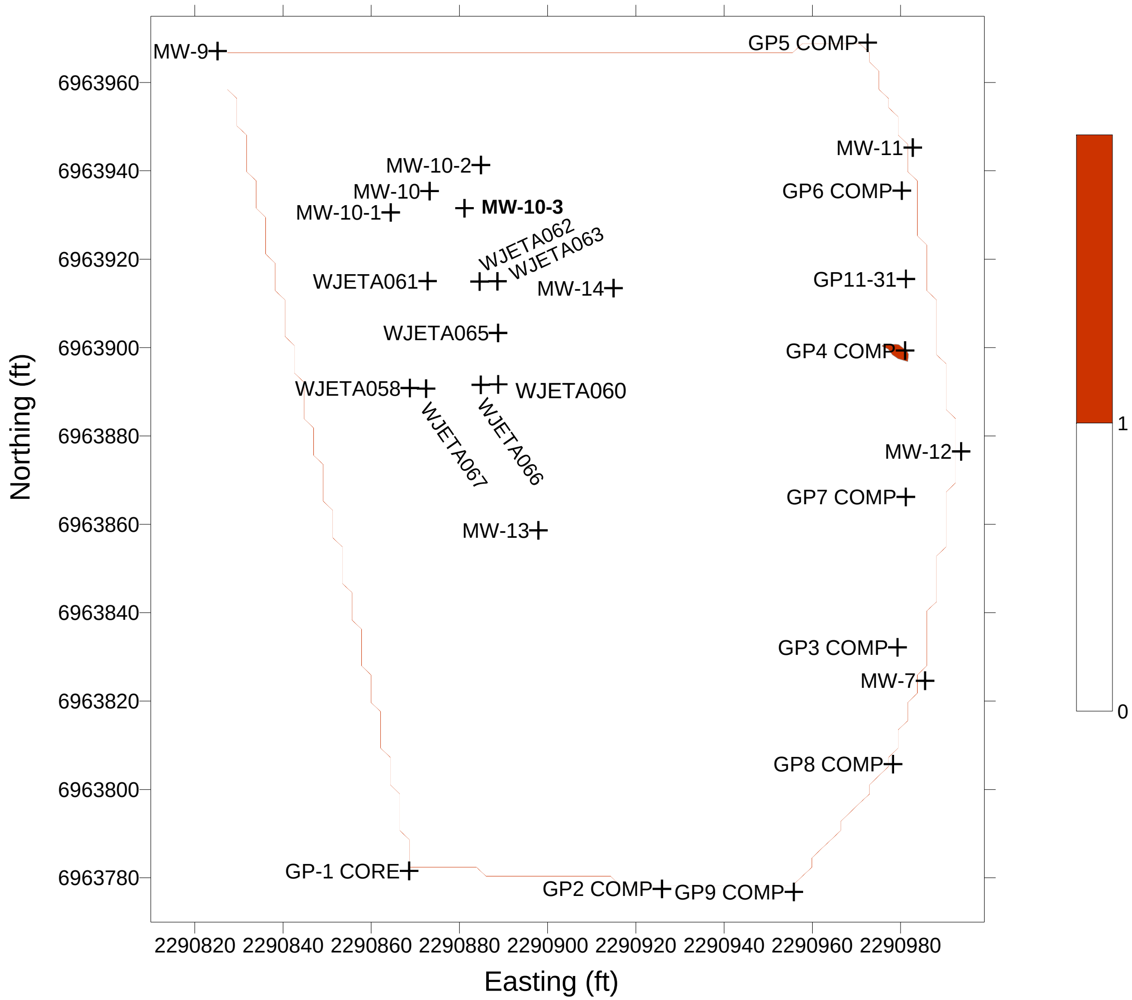


Figure 20. Aerial Contour Map of 1,1,1-TCA Groundwater Concentrations (μg/L) for Monitoring Wells and Composite Direct-Push Sampling Locations

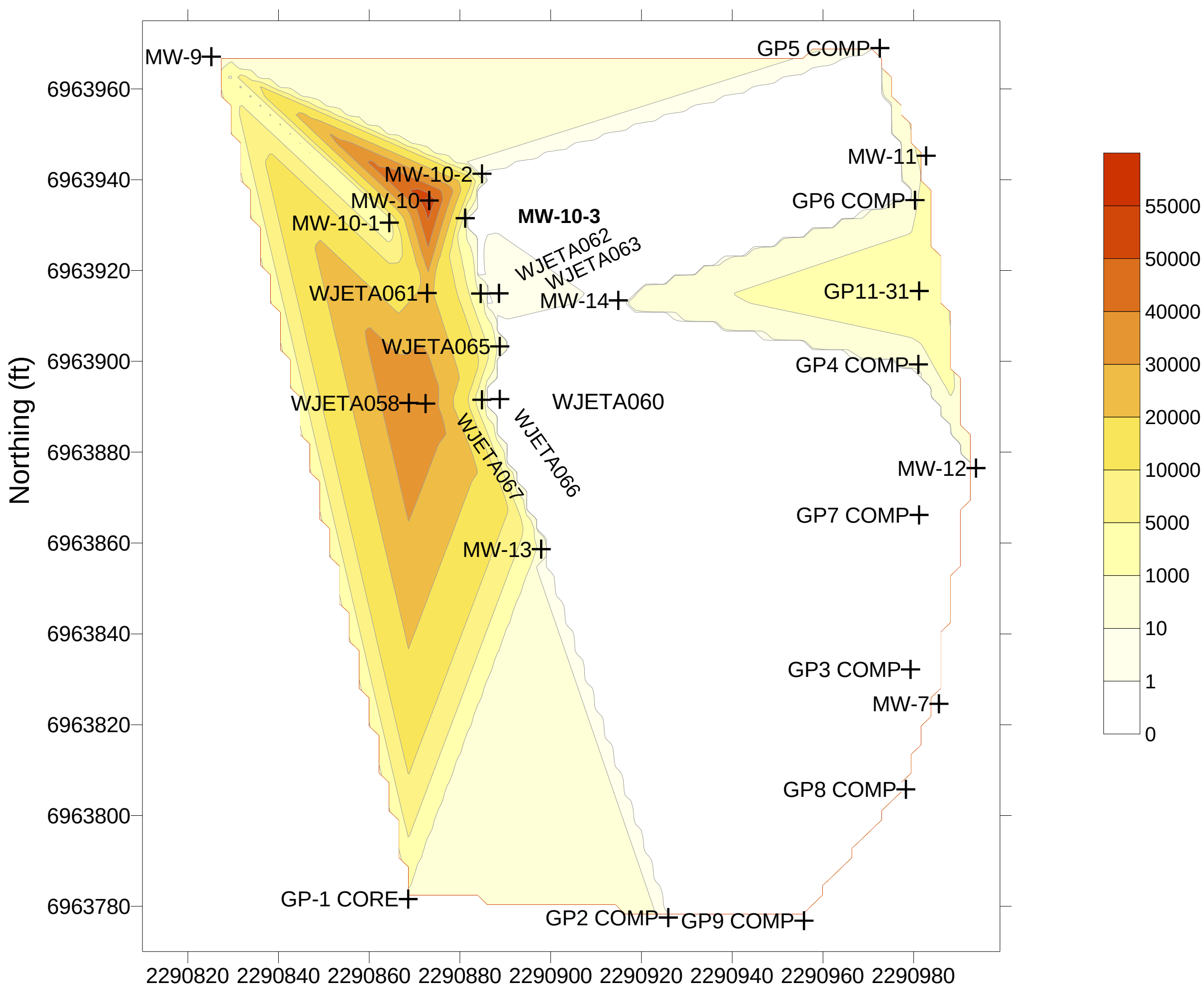


Figure 21. Aerial Contour Map of TCE Groundwater Concentrations (μg/L) for Monitoring Wells and Composite Direct-Push Sampling Locations

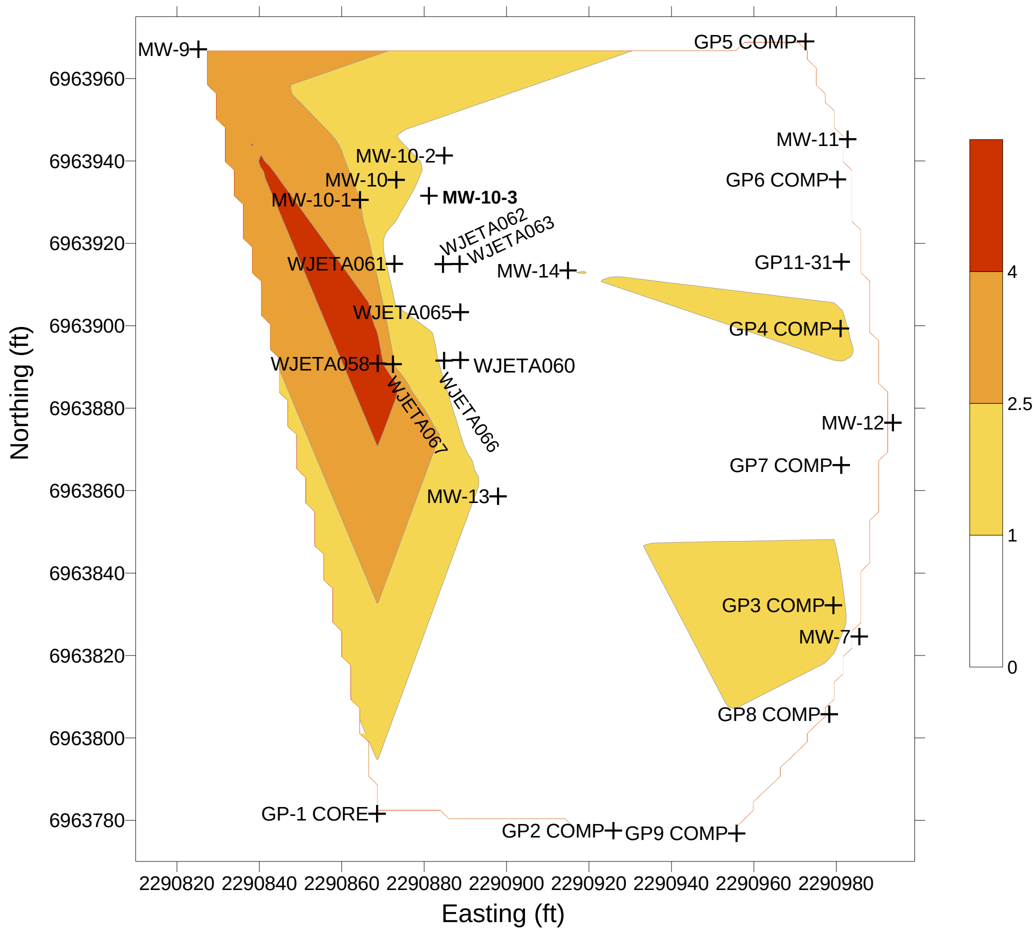


Figure 22. Aerial Contour Map of PCE Groundwater Concentrations (µg/L) for Monitoring Wells and Composite Direct-Push Sampling Locations

Tables

Table 1. Geologic Descriptions of Continuous Soil Cores (December 2006)

Boring Depth (ft)	Subsurface Features
Continuous Soil Core GP1	
26-31.5	Silty clay
31.5-32.5	Silty sandy clay
32.5-33.5	Silty sandy clay transitioning to limestone
33.5-35	Limestone
Continuous Soil Core GP3	
25-30.5	Silty clay
30.5-33.5	Silty clay with gravels
Continuous Soil Core GP6	
25-26.5	Silty clay
26.5-27.5	Silty clay with sands and gravels
27.5-30.5	Silty clay
30.5-33.5	Silty sandy clay transitioning to limestone
33.5-34	Limestone

Table 2. Sampling Locations and Types of Test Performed (December 2006)

Groundwater Monitoring Well or Direct-push Sampling Location	Physical Assessment			Water Quality Assessment	
	Depth-To-Water Measurement	Hydraulic Slug Test	Pneumatic Slug Test	Field Parameters[d]	Chlorinated Solvent Analysis
MW-7	Yes	Yes		Yes	Yes
MW-8[a]	Yes				
MW-9	Yes	Yes		Yes	Yes
MW-10	Yes	Yes		Yes	Yes
MW-10-1					Yes
MW-10-2					Yes
MW-10-3					Yes
MW-11	Yes	Yes		Yes	Yes
MW-12	Yes	Yes		Yes	Yes
MW-13	Yes	Yes		Yes	Yes
MW-14	Yes	Yes		Yes	Yes
WJETA058	Yes			Yes	Yes
WJETA059	Yes				
WJETA060	Yes			Yes	Yes
WJETA061	Yes			Yes	Yes
WJETA062	Yes	Yes		Yes	Yes
WJETA063	Yes			Yes	Yes
WJETA064	Yes				
WJETA065	Yes			Yes	Yes
WJETA066	Yes			Yes	Yes
WJETA067	Yes	Yes		Yes	Yes
GP-1[b]	Yes[c]				Yes
GP-2[b]	Yes[c]			Yes	Yes
GP-3[b]	Yes[c]			Yes	Yes
GP-4[b]	Yes[c]		Yes	Yes	Yes
GP-5[b]	Yes[c]		Yes		Yes
GP-6[b]	Yes[c]			Yes	Yes
GP-7[b]	Yes[c]		Yes	Yes	Yes
GP-8[b]	Yes[c]		Yes	Yes	Yes
GP-9[b]	Yes[c]				Yes
GP-10[b]	Yes[c]				
GP-11[b]	Yes[c]			Yes	Yes

[a] Monitoring well was dry.
[b] Water quality assessments and pneumatic slug testing at direct-push locations were performed on 1-ft intervals from the phreatic surface (~28' bgs) to the point of drilling refusal (33-35' bgs).
[c] Depth to water measurements are approximate and not intended for groundwater elevation calculations.
[d] Field parameters include: pH, electrical conductivity, temperature, dissolved oxygen, and oxidation reduction potential.

Table 3. Slug Test Field Results (December 2006)

Monitoring Well	Well Screen (ft)	Hvorslev K (cm/s)	Hvorslev K (ft/d)	Bouwer and Rice K (cm/s)	Bouwer and Rice K (ft/d)
MW-7	19.5-34.5	1.64E-02	46.52	4.20E-02	119.02
MW-9	26-32	2.90E-05	0.08	5.07E-04	1.44
MW-10	28-34	4.30E-07	0.0012	1.12E-06	0.0032
MW-11	30-36	1.82E-03	5.16	4.19E-03	11.87
MW-12	28-34	9.68E-02	274.38	3.40E-01	962.37
MW-13	30-36	2.55E-02	72.26	9.80E-02	277.68
MW-14	29.5-35.5	6.54E-04	1.85	3.69E-03	10.46
WJETA062	25.2-29.7	6.04E-03	17.13	1.79E-03	5.07
WJETA067	25.5-30.5	6.47E-03	18.33	4.41E-04	1.25

Table 4. Depth-to-Groundwater Measurements for Monitoring Wells (December 2006)

Monitoring Well	Casing Diameter (inches)	Elevation from Top of Casing (ft MSL)	NAD83 Coordinates		Measured Total Depth of MW (m BTOC)	Measured Total Depth of MW (ft BTOC)	DTW (m BTOC)	DTW (ft BTOC)	DTW (m BGS)	DTW (ft BGS)	DTW (ft MSL)
			Northing	Easting							
MW-7	4	655.46	6963825	2290986	9.37	30.74	8.87	29.09	9.03	29.63	626.37
MW-8	2	N/A	N/A	N/A	6.4	21.00	Dry	Dry	Dry	Dry	N/A
MW-9	2	654.9	6963967	2290825	9.31	30.54	5.81	19.07	6.00	19.68	635.83
MW-10	2	654.96	6963935	2290873	---	---	7.84	25.71	7.96	26.10	629.25
MW-10-1	2	654.94	6963931	2290864	---	---	---	---	---	---	N/A
MW-10-2	2	654.99	6963941	2290885	---	---	---	---	---	---	N/A
MW-10-3	2	655.27	6963932	2290881	---	---	---	---	---	---	N/A
MW-11	2	655.15	6963945	2290983	10.51	34.48	8.92	29.28	9.04	29.67	625.87
MW-12	2	655.11	6963876	2290994	9.83	32.25	8.91	29.24	9.06	29.72	625.87
MW-13	2	654.7	6963859	2290898	10.52	34.51	8.74	28.68	8.89	29.15	626.02
MW-14	2	655.02	6963913	2290915	10.4	34.12	8.86	29.07	8.93	29.30	625.95
WJETA058	4	654.99	6963891	2290869	---	---	8.61	28.23	8.85	29.05	626.76
WJETA059	4	655.06	6963915	2290869	---	---	8.74	28.68	8.90	29.20	626.38
WJETA060	4	655.07	6963892	2290889	---	---	8.75	28.69	8.78	28.80	626.38
WJETA061	4	655.04	6963915	2290873	---	---	8.72	28.62	8.86	29.05	626.42
WJETA062	4	655.11	6963915	2290885	9.23	30.28	8.77	28.77	8.88	29.13	626.34
WJETA063	4	655.14	6963915	2290889	---	---	8.81	28.92	8.89	29.18	626.22
WJETA064	4	655.01	6963903	2290868	---	---	8.61	28.25	8.84	28.99	626.76
WJETA065	4	655.11	6963903	2290889	---	---	8.70	28.54	8.89	29.15	626.57
WJETA066	4	655.07	6963892	2290885	---	---	8.69	28.52	8.87	29.11	626.55
WJETA067	4	655.03	6963891	2290872	---	---	8.75	28.69	8.86	29.07	626.34

DTW - Depth-to-water
BTOC - Below top of casing
BGS - Below ground surface
N/A - Data not available
MSL - mean sea level
--- No data available
NAD83 – North American Datum of 1983

Table 5. Water Quality Data for Monitoring Wells (December 2006)

Monitoring Well	Water Quality Data[b]				
	pH	EC (mS)	Temperature (°C)	DO (mg/L)	ORP (mV)
MW-7	6.9	0.79	21.6	5.7	249
MW-8[a]	---	---	---	---	---
MW-9	7.0	2.02	22.7	2.3	-24
MW-10	6.3	2.23	21.9	6.7	238
MW-10-1	---	---	---	---	---
MW-10-2	---	---	---	---	---
MW-10-3	---	---	---	---	---
MW-11	7.0	0.61	23.7	6.0	202
MW-12	6.8	1.09	22.1	6.4	211
MW-13	7.1	0.48	22.6	7.4	208
MW-14	7.0	0.64	23.3	1.7	188
WJETA058	7.6	1.32	25.4	2.1	155
WJETA059	---	---	---	---	---
WJETA060	7.1	0.68	22.7	4.7	191
WJETA061	7.5	1.39	25.4	1.3	157
WJETA062	7.6	0.68	25.2	2.1	168
WJETA063	7.8	0.50	23.9	<4	166
WJETA064	---	---	---	---	---
WJETA065	7.5	1.34	24.7	1.6	173
WJETA066	7.82	1.33	---	---	159
WJETA067	7.6	1.35	24.8	<1	160

-- indicates no water quality parameters were taken due to lack of water.
[a] Monitoring well was dry
[b] All measurements were made with a Horiba U-22 meter.
EC = electrical conductivity
D.O. = dissolved oxygen
ORP = oxidation-reduction potential

Table 6. Chemical Concentration Data for Monitoring Wells (December 2006)

Monitoring Well	Date Analyzed	Concentration (µg/L)									
		Vinyl Chloride	1,1-DCE	trans-1,2-DCE	1,1-DCA	cis-1,2-DCE	1,2-DCA	1,1,1-TCA	TCE	1,1,2-TCA	PCE
MW-7	12.7.06	<1	<1	<1	ND <1	1	ND <1	<1	140	<1	<1
MW-9 (1)	12.7.06	<1	120	11	390	14000	670	<1	18000	<1	4
MW-9 (1) REP	12.7.06	<1	120	12	370	13000	610	<1	16000	<1	3
MW-9 (2)	12.8.06	<1	16	8	<1	7200	110	<1	13000	<1	3
MW-10	12.6.06	<1	<1	8	<1	<1	<1	<1	59000	<1	3
MW-10 DUP	12.8.06	1	2	10	<1	1	<1	<1	56000	<1	3
MW-10 (2)	12.12.06	<1	2	15	<1	4	<1	<1	58000	<1	1
MW-10-1	12.12.06	<1	1	9	<1	1	<1	<1	36000	<1	3
MW-10-2	12.12.06	<1	<1	<1	<1	<1	<1	<1	2500	<1	<1
MW-10-3	12.12.06	<1	<1	<1	<1	<1	<1	<1	3000	<1	<1
MW-11	12.7.06	<1	<1	<1	<1	2	<1	1	1800	<1	4
MW-11 DUP	12.12.06	<1	<1	<1	<1	<1	<1	<1	1700	<1	<1
MW-12	12.7.06	<1	<1	<1	<1	4	<1	<1	130	<1	<1
MW-13	12.6.06	<1	<1	<1	<1	<1	71	<1	1900	<1	<1
MW-13 REP	12.6.06	<1	<1	1	<1	<1	<1	<1	1900	<1	<1
MW-14	12.7.06	<1	1	1	<1	1	<1	<1	2200	<1	1
WJETA058	12.6.06	<1	2	26	<1	5	<1	<1	39000	<1	5
WJETA058 DUP	12.8.06	<1	2	17	<1	4	<1	<1	40000	<1	3
WJETA060	12.6.06	<1	1	1	<1	1	<1	<1	2500	<1	1
WJETA061	12.6.06	<1	<1	10	<1	<1	<1	<1	22000	<1	<1
WJETA061 DUP	12.8.06	<1	2	5	<1	8	1	<1	23000	<1	3
WJETA062	12.6.06	<1	<1	<1	<1	1	<1	<1	12000	<1	<1
WJETA062 DUP	12.8.06	<1	<1	2	2	1	<1	<1	12000	<1	1
WJETA063	12.7.06	<1	2	<1	<1	1	1	<1	6000	<1	<1
WJETA065	12.7.06	<1	<1	3	<1	1	<1	<1	16000	<1	<1
WJETA066 (1)	12.6.06	<1	3	3	1	3	2	<1	6000	<1	1
WJETA066 (2)	12.6.06	<1	<1	3	<1	2	<1	<1	7100	<1	1
WJETA067	12.6.06	<1	8	16	4	5	<1	<1	37000	<1	<1
WJETA067 DUP	12.7.06	<1	5	18	<1	7	1	<1	38000	<1	5

DUP - Duplicate sample
REP - Quality control sample (second analysis of same water sample)
TCA – Trichloroethane
DCE – Dichloroethene
DCA – Dichloroethane
TCE - Trichloroethene
PCE - Tetrachloroethene

Table 7. Survey Data for Direct-Push Downgradient Transect Locations

Sampling Location	Elevation from Ground Surface (ft MSL)	NAD83 Coordinates		Borehole Depth (ft BGS)	Water Sample Collected	WQ Data Collected
		Northing	Easting			
GP1 CORE	655.11	6963781.58	2290868.59	33.3	Yes	No
GP2 COMP	655.24	6963777.49	2290925.90	33	Yes	No
GP3 COMP	655.54	6963832.16	2290979.31	34	Yes	Yes
GP4 COMP	655.58	6963899.33	2290981.04	34.5	Yes	Yes
GP5 COMP	655.52	6963969.00	2290972.54	33.9	Yes	No
GP6 COMP	655.55	6963935.50	2290980.28	34.5	Yes	Yes
GP7 COMP	655.58	6963866.19	2290981.19	34.3	Yes	Yes
GP8 COMP	655.54	6963805.74	2290978.29	33.5	Yes	Yes
GP9 COMP	655.42	6963776.82	2290955.81	32.9	Yes	No
GP10[a]	655.62	6964000.55	2290971.79	32.5	No	No
GP11-31/35	655.56	6963915.52	2290981.21	35	Yes	Yes

[a] No water recovery in open borehole for water sampling
BGS = below ground surface
MSL = Mean Sea Level
COMP = Composite Sample
NAD83 = North American Datum of 1983

Table 8. Chemical Concentration Data for Direct-Push Downgradient Transect Locations (December 2006)

Sampling Location	Concentration (µg/L)									
	Vinyl Chloride	1,1-DCE	trans-1,2-DCE	1,1-DCA	cis-1,2-DCE	1,2-DCA	1,1,1-TCA	TCE	1,1,2-TCA	PCE
GP1 CORE	8	<1	<1	<1	1	<1	<1	220	<1	1
GP1 CORE (2)	6	<1	<1	<1	1	<1	49	230	<1	10
GP2 COMP	<1	<1	<1	<1	<1	<1	74	7	<1	<1
GP3 COMP	<1	<1	<1	<1	<1	<1	19	43	<1	4
GP3-32	5	<1	<1	<1	<1	<1	40	39	1	1
GP3-32 REP	4	<1	<1	<1	<1	<1	38	37	<1	1
GP3-33	<1	<1	<1	<1	1	<1	36	51	<1	<1
GP3-34	6	<1	<1	<1	<1	<1	30	40	<1	<1
GP3-34 DUP	4	<1	<1	<1	<1	<1	<1	39	<1	<1
GP4 COMP	<1	<1	<1	<1	<1	<1	1	4700	<1	1
GP4-30	<1	<1	<1	<1	<1	<1	<1	1500	<1	<1
GP4-32	<1	<1	<1	<1	1	<1	1	5400	<1	2
GP4-34	<1	1	<1	<1	1	<1	<1	2400	<1	1
GP5 COMP	<1	<1	<1	<1	<1	<1	<1	1100	<1	<1
GP5 COMP REP	<1	<1	<1	<1	<1	<1	<1	1300	<1	<1
GP6 COMP	<1	<1	<1	<1	2	<1	<1	710	<1	1
GP6-31	<1	<1	<1	<1	1	<1	100	560	<1	<1
GP6-32	<1	<1	<1	<1	13	<1	<1	2200	<1	<1
GP6-32 REP	<1	<1	<1	<1	<1	<1	<1	1300	<1	<1
GP6-33	<1	<1	<1	<1	1	<1	<1	3900	<1	1
GP7 COMP	5	<1	<1	<1	3	<1	<1	100	<1	<1
GP7-31	18	2	<1	<1	3	<1	<1	110	<1	<1
GP7-31 REDO	23	<1	<1	<1	3	<1	<1	16	<1	<1
GP7-32	<1	<1	<1	<1	1	<1	<1	52	<1	<1
GP7-33	<1	<1	<1	<1	1	<1	<1	39	<1	<1
GP7-33 DUP	<1	<1	<1	<1	1	<1	<1	37	1	<1
GP8 COMP	<1	<1	<1	<1	<1	<1	<1	33	<1	<1
GP9 COMP[a]	<1	<1	<1	<1	<1	<1	<1	5	<1	<1
GP11-31/35	<1	<1	<1	<1	1	<1	<1	2500	<1	1
GP11-31/35 DUP	<1	<1	<1	<1	<1	<1	<1	3300	1	1

[a] Minimal groundwater recovery in borehole GP9. Distilled water was added to the borehole to provide enough water for sampling. Based on an estimated volume of groundwater in the borehole, distilled water was added to create a 1:10 dilution.

DUP = Duplicate sample, REP = Quality control sample (second analysis of same water sample), COMP = Composite sample of the open borehole

DCE = Dichloroethene, DCA = Dichloroethane, TCE = Trichloroethene, TCA = Trichloroethane, PCE = Tetrachloroethene

Table 9. Water Quality Data for Direct-Push Downgradient Transect Locations (December 2006)

Sampling Location	Borehole Depth (ft BGS)	Water Sample Collected	WQ Data Collected	pH	EC (mS)	Temperature (°C)	DO (mg/L)	ORP (mV)
GP1 CORE	33.3	Yes	No	---	---	---	---	---
GP1 CORE (2)	33.3	Yes	Yes	7.05	0.625	21	---	144
GP2 COMP	33	Yes	No	---	---	---	---	---
GP3 COMP	34	Yes	Yes	6.76	0.806	22.4	5.28	151
GP3-32	32.5	Yes	Yes	6.86	0.97	21.7	6.88	51
GP3-33	33.5	Yes	Yes	6.98	0.832	22.5	4.13	78
GP3-34	34	Yes	No	---	---	---	---	---
GP4 COMP	34.5	Yes	Yes	7.2	0.719	23.4	3.22	39
GP 4-30	30.5	Yes	No	---	---	---	---	---
GP 4-32	32.5	Yes	Yes	7.13	0.739	23.6	1.95	44
GP4-34	34.5	Yes	No	---	---	---	---	---
GP5 COMP	33.9	Yes	No	---	---	---	---	---
GP6 COMP	34.5	Yes	Yes	7.06	0.587	24.4	6	94
GP6-31	31.5	Yes	No	---	---	---	---	---
GP6-32	32.5	Yes	Yes	7.13	0.583	23.8	5.4	63
GP6-33	33.5	Yes	Yes	7.13	0.582	24	4.02	22
GP7 COMP	34.3	Yes	Yes	7	0.906	23.4	1.92	32
GP7-31	31.5	Yes	No	---	---	---	---	---
GP7-32	32.5	Yes	Yes	6.85	1.03	23.4	---	70
GP7-33	33.5	Yes	Yes	6.83	1.03	23.6	6.15	57
GP8 COMP	33.5	Yes	Yes	6.95	0.784	23.5	4.65	181
GP9 COMP	32.9	Yes	No	---	---	---	---	---
GP10 [a]	32.5	No	No	---	---	---	---	---
GP11-31/35	35	Yes	Yes	5.7	0.606	25	8.32	191

-- indicates no water quality parameters were taken due to lack of water.
NAD83 = North American Datum of 1983
(2) = second sample from the same location
[a] No water recovery in open borehole for water sampling
[b] Measurements were made with a Horiba U-22 meter.

EC = electrical conductivity
D.O. = dissolved oxygen
ORP = oxidation-reduction potential
BGS = below ground surface
COMP = composite sample
MSL = Mean Sea Level

Table 10. Field Data Results for Pneumatic Slug Testing (December 2006)

Sampling Location*	Well Screen (ft)	Hvorslev K (cm/s)	Hvorslev K (ft/d)	Bouwer and Rice K (cm/s)	Bouwer and Rice K (ft/d)
GP3-32	32-32.5	6.25E-03	17.72	1.77E-02	50.13
GP3-33	33-33.5	3.31E-03	9.38	9.29E-03	26.35
GP4-32	32-32.5	2.81E-02	79.73	1.90E-02	53.96
GP6-31	31-31.5	4.33E-03	12.27	9.07E-03	25.72
GP6-32	32-32.5	1.61E-02	45.56	9.07E-03	25.72
GP6-33	33-33.5	4.47E-03	12.68	7.12E-03	20.18
GP7-32	32-32.5	1.00E-02	28.48	5.84E-02	165.54
GP7-33	33-33.5	5.98E-02	169.65	1.61E-01	457.66
GP11-31/35	31-35	8.57E-03	24.29	1.40E-02	39.76

Table 11. Monitoring Well Chemical Concentration Data Comparison

Sample Location	Vinyl Chloride			1,1-DCE			trans-1,2-DCE			cis-1,2-DCE		
	ASU (Dec '06)	AFP4 Bldg. 181		ASU (Dec '06)	AFP4 Bldg. 181		ASU (Dec '06)	AFP4 Bldg. 181		ASU (Dec '06)	AFP4 Bldg. 181	
	μg/L	μg/L	Date	μg/L	μg/L	Date	ug/L	ug/L	Date	ug/L	ug/L	Date
MW-7	<1	N/A	-	<1	N/A	-	<1	N/A	-	1	N/A	-
MW-9 (1)	120	N/A	-	120	N/A	-	11	N/A	-	14000	N/A	-
MW-9 (1) REP	120	N/A	-	120	N/A	-	12	N/A	-	13000	N/A	-
MW-9 (2)	16	N/A	-	16	N/A	-	8	N/A	-	7200	N/A	-
MW-10	<1	<130	Oct '04	<1	<130	Oct '04	8	28	Oct '04	<1	<130	Oct '04
MW-10 DUP	2	N/A	-	2	N/A	-	10	N/A	-	1	N/A	-
MW-10 (2)	2	N/A	-	2	N/A	-	15	N/A	-	4	N/A	-
MW-10-1[a]	1	N/A	-	1	N/A	-	9	N/A	-	1	N/A	-
MW-10-2[a]	<1	N/A	-	<1	N/A	-	<1	N/A	-	<1	N/A	-
MW-10-3[a]	<1	N/A	-	<1	N/A	-	<1	N/A	-	<1	N/A	-
MW-11	<1	<6.7	Oct '04	<1	<6.7	Oct '04	<1	<6.7	Oct '04	2	4.9	Oct '04
MW-11 DUP	<1	N/A	-	<1	N/A	-	<1	N/A	-	<1	N/A	-
MW-12	<1	N/A	-	<1	N/A	-	<1	N/A	-	4	N/A	-
MW-13	<1	N/A	-	<1	N/A	-	<1	N/A	-	<1	N/A	-
MW-13 REP	<1	N/A	-	<1	N/A	-	1	N/A	-	<1	N/A	-
MW-14	1	N/A	-	1	N/A	-	1	N/A	-	1	N/A	-
WJETA058	2	N/A	-	2	N/A	-	26	N/A	-	5	N/A	-
WJETA058 DUP	2	N/A	-	2	N/A	-	17	N/A	-	4	N/A	-
WJETA060	1	<10	May '03	1	<10	May '03	1	<10	May '03	1	<10	May '03
WJETA061	<1	<20	Oct '04	<1	<20	Oct '04	10	<200	Oct '04	<1	4.7	Oct '04
WJETA061 DUP	2	N/A	-	2	N/A	-	5	N/A	-	8	N/A	-
WJETA062	<1	N/A	-	<1	N/A	-	<1	N/A	-	1	N/A	-
WJETA062 DUP	<1	N/A	-	<1	N/A	-	2	N/A	-	1	N/A	-
WJETA063	2	N/A	-	2	N/A	-	<1	N/A	-	1	N/A	-
WJETA065	<1	N/A	-	<1	N/A	-	3	N/A	-	1	N/A	-
WJETA066 (1)	3	N/A	-	3	N/A	-	3	N/A	-	3	N/A	-
WJETA066 (2)	<1	N/A	-	<1	N/A	-	3	N/A	-	2	N/A	-
WJETA067	8	N/A	-	8	N/A	-	16	N/A	-	5	N/A	-
WJETA067 DUP	5	N/A	-	5	N/A	-	18	N/A	-	7	N/A	-

N/A – No Data Available, Dup – Duplicate Sample, REP – Quality Control Sample (second analysis of same sample), DCE – Dichloroethene, DCA – Dichloroethane, TCE – Trichloroethene, TCA – Trichloroethane, PCE - Tetrachloroethene, ND – Non-Detect (detection limit not available).
"(1)" and "(2)" was used in the sample location nomenclature, by ASU, when more than one sample was collected from the same location.
The analytical results for 1,1-DCA and 1,1,2-TCA were not included in the comparison table, because historical data not available.
[a] Monitoring wells were installed 2-weeks prior to the December 2006 field investigation, therefore historical analytical data was not available

Table 11. Monitoring Well Chemical Concentration Data Comparison Continued

Sample Location	1,2-DCA			1,1,1-TCA			TCE			PCE		
	ASU (Dec '06)	AFP4 Bldg. 181		ASU (Dec '06)	AFP4 Bldg. 181		ASU (Dec '06)	AFP4 Bldg. 181		ASU (Dec '06)	AFP4 Bldg. 181	
	μg/L	μg/L	Date	μg/L	μg/L	Date	μg/L	μg/L	Date	μg/L	μg/L	Date
MW-7	<1	N/A	-	<1	N/A	-	140	72.5	Nov '02	<1	N/A	-
MW-9 (1)	670	N/A	-	<1	N/A	-	18000	7280	Nov '02	4	N/A	-
MW-9 (1) REP	610	N/A	-	<1	N/A	-	16000	N/A	-	3	N/A	-
MW-9 (2)	110	N/A	-	<1	N/A	-	13000	N/A	-	3	N/A	-
MW-10	<1	1200	Oct '04	<1	ND	Oct '04	59000	31000	Oct '04	3	<130	Oct '04
MW-10 DUP	<1	N/A	-	<1	N/A	-	56000	N/A	-	3	N/A	-
MW-10 (2)	<1	N/A	-	<1	N/A	-	58000	N/A	-	1	N/A	-
MW-10-1[a]	<1	N/A	-	<1	N/A	-	36000	N/A	-	3	N/A	-
MW-10-2[a]	<1	N/A	-	<1	N/A	-	2500	N/A	-	<1	N/A	-
MW-10-3[a]	<1	N/A	-	<1	N/A	-	3000	N/A	-	<1	N/A	-
MW-11	<1	56	Oct '04	1	ND	Oct '04	1800	1600	Oct '04	4	<6.7	Oct '04
MW-11 DUP	<1	N/A	-	<1	N/A	-	1700	N/A	-	<1	N/A	-
MW-12	<1	N/A	-	<1	N/A	-	130	93.9	Nov '02	<1	N/A	-
MW-13	71	N/A	-	<1	N/A	-	1900	756	Nov '02	<1	N/A	-
MW-13 REP	<1	N/A	-	<1	N/A	-	1900	N/A	-	<1	N/A	-
MW-14	<1	N/A	-	<1	N/A	-	2200	1620	Nov '02	1	N/A	-
WJETA058	<1	N/A	-	<1	N/A	-	39000	N/A	-	5	N/A	-
WJETA058 DUP	<1	N/A	-	<1	N/A	-	40000	N/A	-	3	N/A	-
WJETA060	<1	9.67	May '03	<1	ND	May '03	2500	4335	May '03	1	<10	May '03
WJETA061	<1	170	Oct '04	<1	ND	Oct '04	22000	4600	Oct '04	<1	<20	Oct '04
WJETA061 DUP	1	N/A	-	<1	N/A	-	23000	N/A	-	3	N/A	-
WJETA062	<1	N/A	-	<1	N/A	-	12000	1580	Nov '02	<1	N/A	-
WJETA062 DUP	<1	N/A	-	<1	N/A	-	12000	N/A	-	1	N/A	-
WJETA063	1	N/A	-	<1	N/A	-	6000	N/A	-	<1	N/A	-
WJETA065	<1	N/A	-	<1	N/A	-	16000	2210	Nov '02	<1	N/A	-
WJETA066 (1)	2	N/A	-	<1	N/A	-	6000	1100	Nov '02	1	N/A	-
WJETA066 (2)	<1	N/A	-	<1	N/A	-	7100	N/A	-	1	N/A	-
WJETA067	<1	N/A	-	<1	N/A	-	37000	334	Nov '02	<1	N/A	-
WJETA067 DUP	1	N/A	-	<1	N/A	-	38000	N/A	-	5	N/A	-

N/A – No Data Available, Dup – Duplicate Sample, REP – Quality Control Sample (second analysis of same sample), DCE – Dichloroethene, DCA – Dichloroethane, TCE – Trichloroethene, TCA – Trichloroethane, PCE - Tetrachloroethene, ND – Non-Detect (detection limit not available).
"(1)" and "(2)" was used in the sample location nomenclature, by ASU, when more than one sample was collected from the same location.
The analytical results for 1,1-DCA and 1,1,2-TCA were not included in the comparison table, because historical data not available.
[a] Monitoring wells were installed 2-weeks prior to the December 2006 field investigation, therefore historical analytical data was no

Table 12. Mass Flux Analysis for TCE

Hydraulic Conductivity Method	Sampling Locations Included	Discharge (kg/yr)
Bouwer and Rice Method	Discrete-depth Samples and Monitoring Wells	1.09E+01
Bouwer and Rice Method	Discrete-depth Samples only	4.92E+00
Horslev Method	Discrete-depth Samples and Monitoring Wells	5.55E+00
Horslev Method	Discrete-depth Samples only	4.57E+00

Draft

Site Specific Work Plan
Former Pumphouse #2
Hunter Army Airfield (HAAF)
Savannah, Georgia

Critical Evaluation of the State of In Situ Thermal Treatment Technologies for DNAPL Source Zone Treatment

Prepared for:

Environmental Security Technology Certification Program
Arlington, VA

Prepared by:
Arizona State University
Battelle

February 27, 2007

1.0 Site Description

Former Pumphouse #2 at Hunter Army Airfield (HAAF) is located in Savannah, Georgia, near former Building 8065, and lies along the east-west taxiway of HAAF (See **Figure 1**).

Former Pumphouse #2 was an aviation-gas fuel island that was used from 1953 until the early 1970s. The site consisted of ten 25,000-gallon (gal) underground storage tanks (USTs). The pumphouse was inactive from the 1970s to 1995 when eight of the 25,000-gal USTs were removed. Two 25,000-gal tanks remained in-place because they were partially under the pumphouse structure.

During previous investigations at the Former Pumphouse #2, petroleum contaminates were identified in the soil and groundwater, including benzene, toluene, ethylbenzene, and xylenes (BTEX), as well as polynuclear aromatic hydrocarbon (PAH) constituents. The extent of the plume was identified during these investigations to cover an area of approximately 85,800 square feet (ft^2). The groundwater is migrating towards the drainage ditch, which is located to the east and south of the site. Previous investigations established that the groundwater plume had not migrated past the drainage ditch.

During the previous investigations, free product was identified. It was recommended that electrical resistance heating (ERH) be implemented to remove the free product, reduce the benzene concentration in groundwater below the alternate concentration limit (ACL) of 469 micrograms per liter (ug/L), and reduce the benzene and indeno (1,2,3-cd)pyrene concentrations in soil to below the proposed alternate threshold limits (ATLs) of 0.44 and 0.66 milligrams per kilogram (mg/kg), respectively.

Interim corrective actions consisted of free product recovery using absorbent socks. The free product in the wells increased, so product delineation piezometers were installed in 200 locations to determine the horizontal extent of the free product. The product covered an area of approximately 3,825 ft^2 (45 by 85 ft) around monitoring well, P2-MW27. In August 2001, the free product was shown to cover an area of 4,900 ft^2 and by the baseline sampling for the ERH application the free product covered an area of 11,500 ft^2.

The conceptual subsurface model for the Former Pumphouse #2 includes two aquifer systems. The lower aquifer is the principal artesian aquifer (Floridan) and it is approximately 800 ft in total thickness and is confined by a layer of phosphatic clay from the Hawthorn Group. This water is used primarily for drinking water. The second aquifer is the surficial aquifer, which was treated during the ERH.

The surficial aquifer overlies the Hawthorn confining unit and supplies water primarily for domestic lawn and agricultural irrigation. The top of the water table ranges from 9 to 16 ft bgs (specifically at Former Pumphouse #2). The groundwater in the surficial aquifer is typically unconfined with locally, thin clay beds creating confined and semiconfined conditions. The surficial aquifer at the Former Pumphouse #2 site's flow direction is driven by a nearby drainage ditch forcing groundwater to flow to the east and south into the drainage ditch.

2.0 System Description

A full-scale (completely covering the source area) ERH system was started in March 2002 and operated for four months. The system consisted of 111 electrodes at a spacing of 18 feet. The electrodes were spaced to treat and area of 30,000 ft^2, as seen in **Figure 2**. The electrodes were installed in unconsolidated material to a depth of 16 ft below ground surface (bgs) with the conductive interval set from 8 to 16 ft bgs. Eighteen of the electrodes were installed as a combination of electrode and dual vapor extraction (DVE) wells. Twenty-three vapor recovery wells (VRWs) were installed at a spacing of 40 ft. Additionally, 15 temporary piezometers were installed for groundwater samples. **Table 1** lists the screened intervals of the wells along with their diameter. After shutdown, the temporary piezometers were left in place and are still being sampled semi-annually.

3.0 Current Investigations

The available documentation for HAAF, Former Pumphouse #2 suggests that it is a good site for further investigation because:

- The hydrogeology of the site is reasonably well-characterized
- The aerial extent of the source zone was reasonably defined prior to treatment
- Full treatment of a source zone was performed
- The depth to groundwater is approximately 9 feet.
- The total depth of impacted groundwater is about 20 feet
- There is access to sampling locations immediately down-gradient of the remediated source zone
- The system employed at this site represents a state-of-the-art ERH system
- Pre- and post-treatment groundwater data are available
- Direct-push technologies can be used for sampling
- The monitoring well network is still present and accessible

Consistent with the already-approved generic demonstration plan for this project, the following site-specific activities are proposed:

(5) Verification of the site geological conceptual model before any new investigative work by:

   a. Measurement of depths to groundwater in nearby wells (to determine depth to groundwater, flow direction, and hydraulic gradient). See **Table 1** for monitoring well details and **Figure 3** for measurement locations.
   b. Collection of one continuous soil core at the down-gradient edge of the treated source zone (to qualitatively confirm the site geology and to identify depths for subsequent groundwater vertical profile sampling). One or two additional cores will be collected if time permits. See **Figure 3** for sampling locations.
   c. Slug tests or aquifer specific-capacity tests will be conducted in existing groundwater monitoring wells and temperature monitoring points in the area to get estimates of hydraulic conductivity over the screened intervals for those wells (to help identify if any zones are more conductive than others). See

Table 1 for details on the monitoring wells and **Figure 3** for measurement location. Aquifer specific-capacity tests will involve the measurement of the steady flow rate achieved with a fixed drawdown; ideally, all tests will be conducted with the same fixed drawdown (usually 0.3 – 1.0 feet)

(6) Collection of data necessary to determine groundwater concentrations and fluxes leaving the treated source zone:

a. Groundwater samples collected from existing groundwater monitoring wells and temperature monitoring points with available historical data and analyzed for benzene, toluene, ethylbenzene, m-, p-, and o-xylene and naphthalene (BTEXN). See **Table 1** for details on the monitoring wells and **Figure 3** for their locations.
b. Groundwater samples will be collected using direct-push tools along a transect perpendicular to the direction of groundwater flow at the down-gradient edge of the original source zone. See Aquifer specific-capacity tests for groundwater sampling locations. Sampling locations will be approximately 60ft apart, and at each location samples will be collected, as possible, at least every 2 feet down to a maximum depth of 20 ft (and at least once in each distinct lithologic change suggested by the soil core). The samples will be analyzed via a headspace analysis on a gas chromatograph (GC) equipped with photo-ionization detector (PID) and flame-ionization (FID) detectors. If time permits, samples will be collected at additional locations as well. The specific depths and numbers of samples collected at each location may be adjusted depending on the analytical results in the field.
c. Aquifer specific-capacity tests will be conducted at each depth where a groundwater sample is collected. These tests will be conducted using the direct-push groundwater sampler and will involve the measurement of the steady flow rate achieved with a fixed drawdown; ideally, all tests will be conducted with the same fixed drawdown (usually 0.3 – 1.0 feet).

4.0 References

SAIC. 2005. "Sixth Semiannual Progress Report, Former Pumphouse #2, Facility ID #9-025086, Former Building 8065, Hunter Army Airfield, Georgia." November.

United States Environmental Protection Agency (EPA). 2005. "Cost and Performance Report: Electrical Resistive Heating at Former Pumphouse #2, Hunter Army Airfield, Georgia." June.

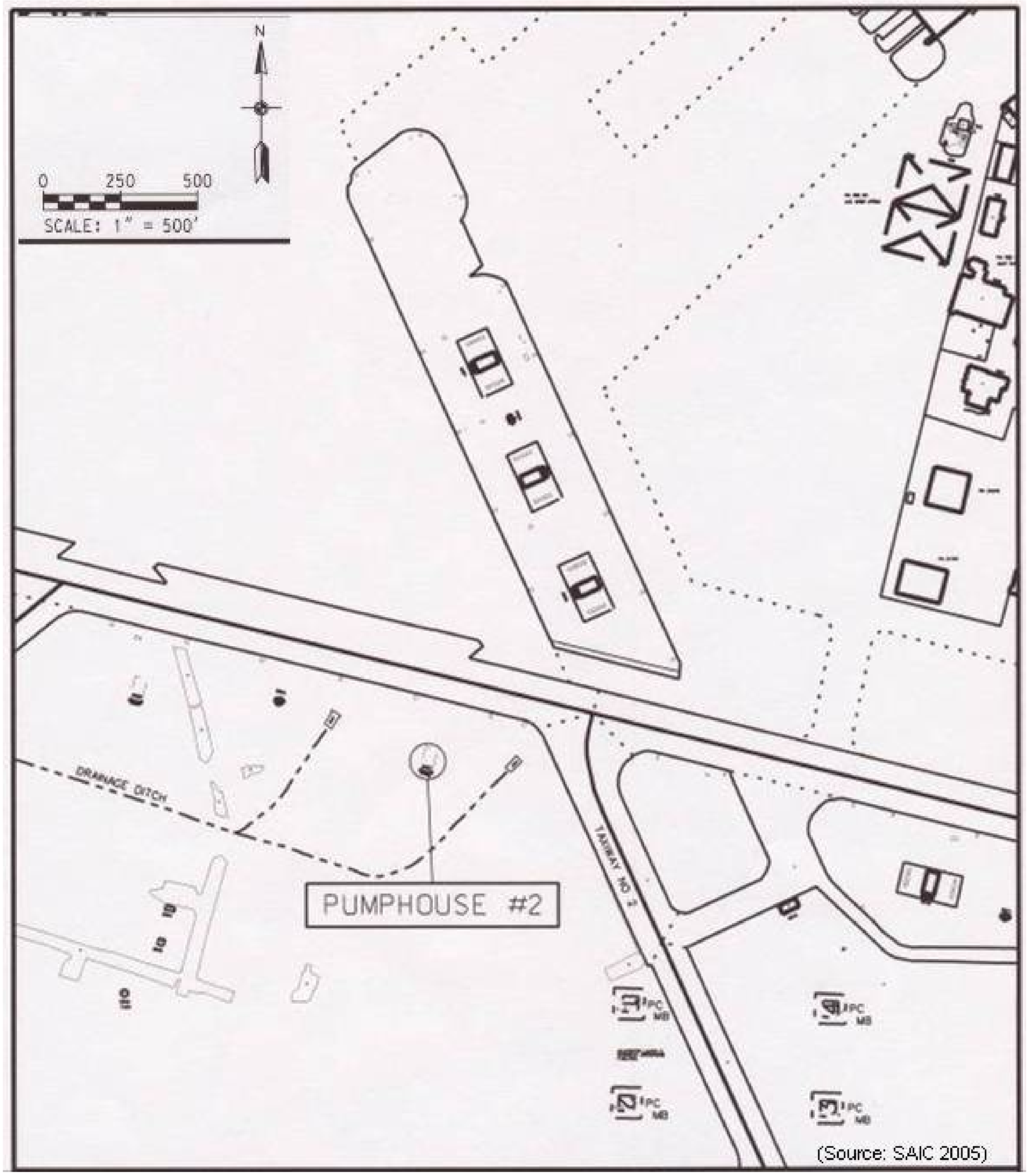


Figure 1. Site Map

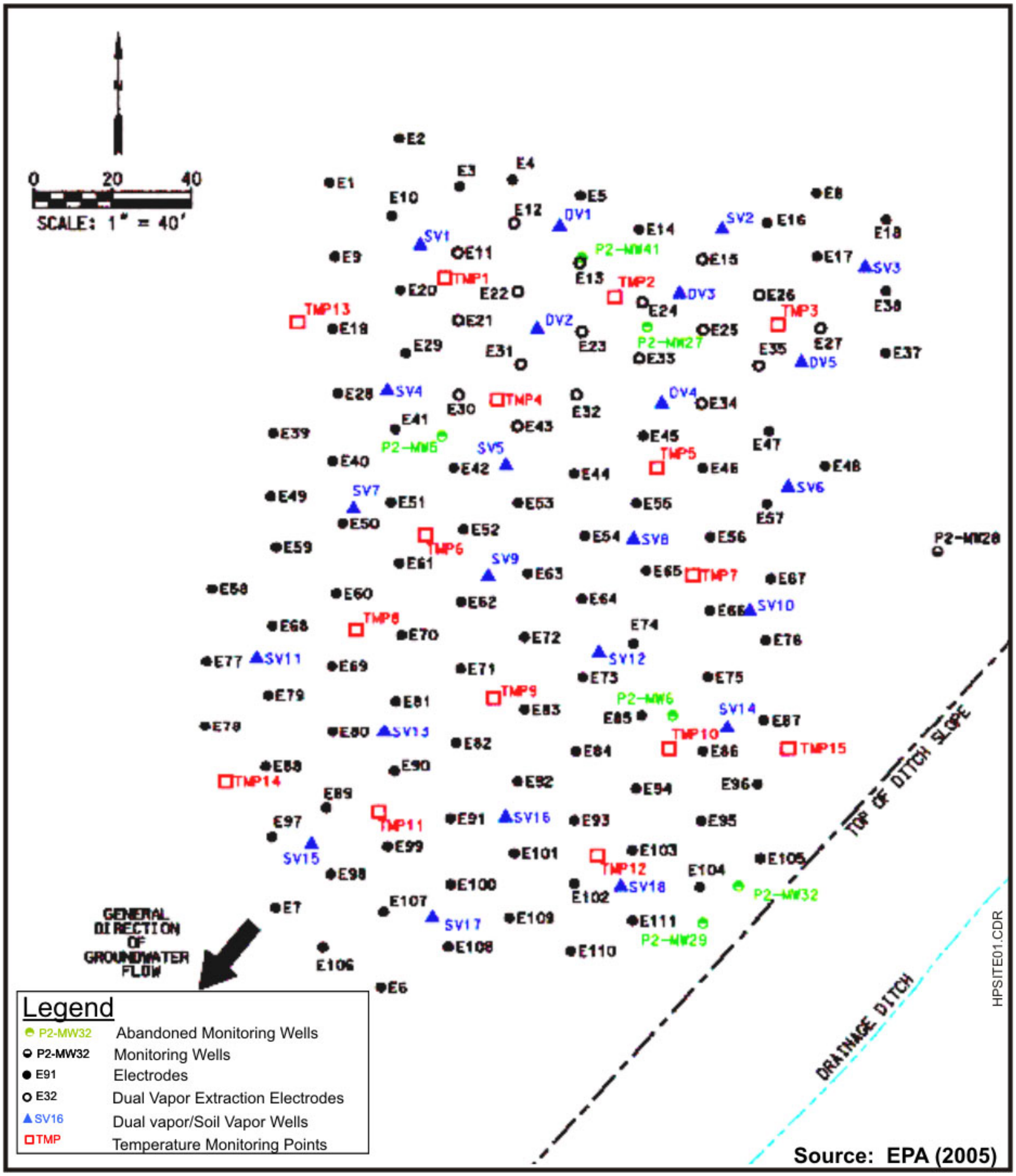


Figure 2. Electrical Resistance Heating Layout and Configuration

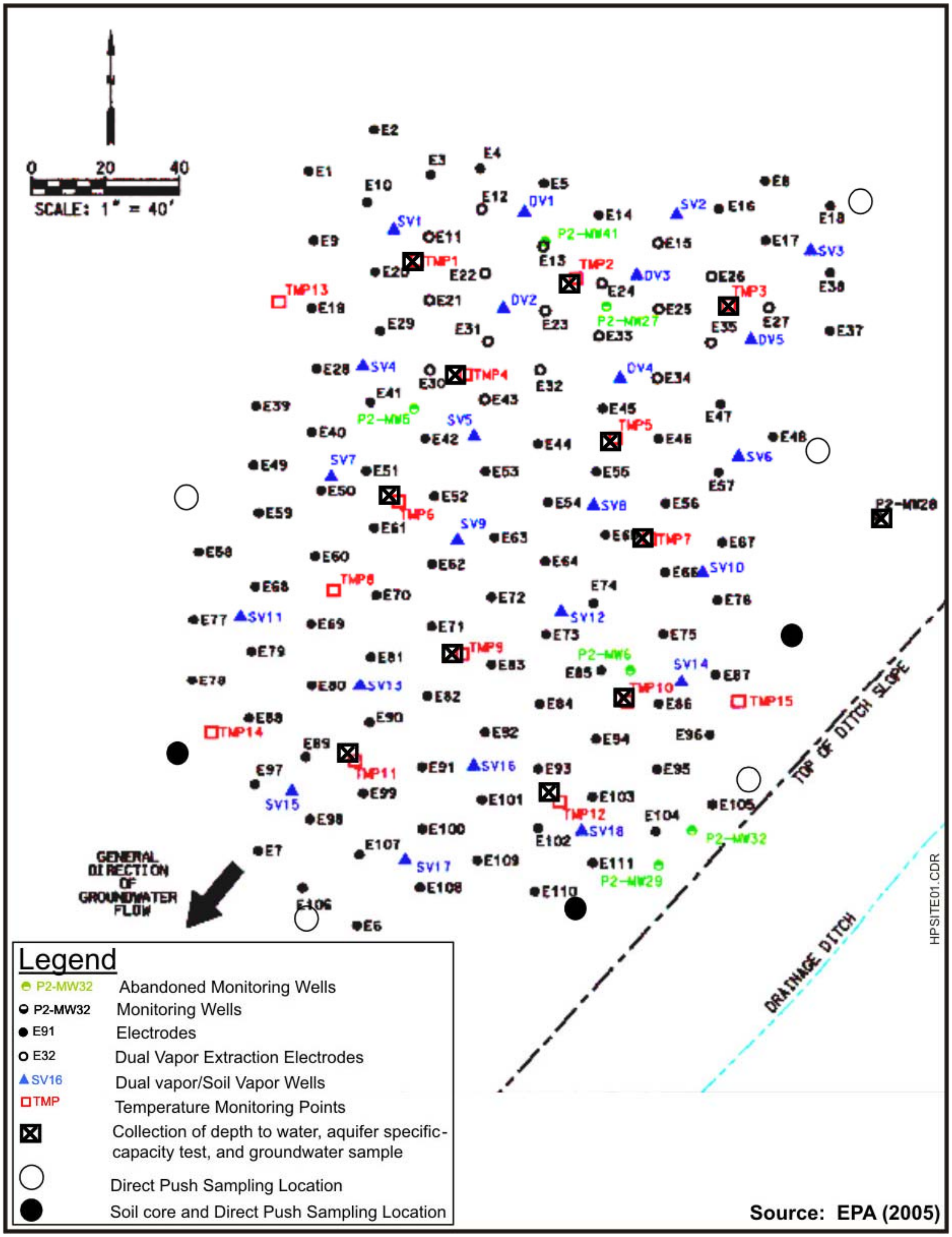


Figure 3. Sampling Locations

Table 1. Monitoring Well Details

Existing Monitoring Well	Screened Interval (ft bgs)	Well Diameter (in)	Water Level Measurement	Slug Test / Aquifer Specific-Capacity Test	Groundwater Sample
TMP-01	3-16	0.75	X	X	X
TMP-02	3-16	0.75	X	X	X
TMP-03	3-16	0.75	X	X	X
TMP-04R	4.8-14.8	N/A	X	X	X
TMP-05	3-16	0.75	X	X	X
TMP-07	3-16	0.75	X	X	X
TMP-09R	4.4-14	N/A	X	X	X
TMP-10	3-16	0.75	X	X	X
TMP-11	3-16	0.75	X	X	X
TMP-12	3-16	0.75	X	X	X
P2-MW28	3-16	0.75	X	X	X

N/A – Not Available
bgs – below ground surface

Health and Safety Plan (HASP)
Former Pumphouse #2
Hunter Army Airfield (HAAF)

SECTION 1: GENERAL INFORMATION AND DISCLAIMER

CLIENT NAME: Environmental Security Technology Certification Program (ESTCP) PROJECT NAME: ESTCP Thermal Evaluation

PRINCIPAL INVESTIGATORS: Eric Foote (Battelle) and Paul Johnson (Arizona State University)

PROJECT LEADER: Paul Dahlen

PREPARED BY: Shane Williams DATE: 03/12/2007

NOTE: This Site Specific Health and Safety Plan - (HASP) has been prepared for use by Battelle employees for work at this site. Battelle is not responsible for its use by others. The plan is written for the specific LEVEL D site conditions, purposes, tasks, dates and personnel specified. If these conditions change, a new plan must be utilized and reviewed by those named in Section 17.

Subcontractors shall be solely responsible for the health and safety of their employees and shall comply with all applicable laws and regulations. In accordance with 1910.120(b)(1)(iv) and (v), Battelle will inform its subcontractors of the site emergency response procedures, and any potential fire, explosion, health, safety or other hazards by making this Site Specific Safety and Health Plan and site information obtained by others available during regular business hours. All contractors and subcontractors are responsible for: (1) developing their own Health and Safety Plan including a written Hazard Communication Program and any other written hazard specific programs required by federal, state and local laws and regulations; (2) providing their own personal protective equipment (PPE); (3) providing documentation that their employees have been health and safety trained in accordance with applicable federal, state and local laws and regulations; (4) providing evidence of medical surveillance and medical approvals for their employees; and (5) designating their own site safety officer (SSO) responsible for ensuring that their employees comply with their own Health and Safety Plan and taking any other additional measures required by their site activities.

SECTION 2: PROJECT INFORMATION

(1) SITE INFORMATION

Site Name: Hunter Army Airfield
Address: Savannah, Georgia

Site Project Contact: Algeana Stevenson
Phone Number: 912-315-4226
Site Safety & Health Contact: Shane Williams
Phone Number: O: 614-424-5792/ C: 614-348-4437

(2) SITE CLASSIFICATION (check or circle all that apply)

- √ Hazardous (RCRA/CERCLA/State)
- ☐ Construction
- ☐ Landfill (Non-Hazardous)
- ☐ UST/LUST
- √ Manufacturing
- √ Active
- √ Inactive
- √ Other: military installation

(3) ENTRY OBJECTIVES (check or circle all that apply)

- √ Site Inspection (General)
- √ Well Drilling Observation
- ☐ Sampling, Air
- √ Sampling, Water
- √ Sampling, Soil
- ☐ Other:

DATE(S) OF FIELD VISIT(S):

(4) BATTELLE/ASU TASKS

B1. Groundwater Investigation
B2. Groundwater sampling
B3. Water level survey and slug tests
B4. Analytical activities

TASK PERFORMED BY OTHERS

01. Direct push activities for gw sample collection
02. IDW disposal
03.
04.

(5) PROJECT ORGANIZATION AND COORDINATION – The following personnel are designated to carry out the stated project job functions on site. (Note: One person may carry out more than one job function.)

PRINCIPAL INVESTIGATORS	Eric Foote/Paul Johnson
SITE SAFETY OFFICER	Shane Williams
ALTERNATIVE SITE SAFETY OFFICER(S)	Jennifer Triplett/Paul Dahlen
PUBLIC INFORMATION OFFICER	N/A
SITE RECORD KEEPER	Paul Dahlen/Jennifer Triplett
SITE PERSONNEL WITH CPR/FA	Shane Williams
FIELD TEAM LEADER(S)	Paul Dahlen
OTHER FIELD TEAM MANAGERS	Shane Williams

(6) ON SITE CONTROL

Shane Williams has been designated to coordinate access control and security for Battelle operations on site. A safe perimeter has been established at the work area by delineating the work area with traffic cones and/or high-visibility barrier tape.

No unauthorized person should be within this area.

The on site Command Post and staging area has been established at the previous ERH treatment area.

The prevailing wind conditions are west. A wind direction indicator is used to determine daily wind directions. The Command Post is located upwind from the Exclusion Zone or at a sufficient distance to prevent exposure should a release occur.

Control boundaries have been established and include south and east of the ERH test area. These boundaries are identified in the field by: traffic cones and/or high-visibility barrier tape.

SECTION 3: PHYSICAL HAZARDS

(1) IDENTIFY POTENTIAL PHYSICAL HAZARDS TO WORKERS (check or circle all that apply)

❑	Confined Space	❑	Steep/Uneven Terrain	√	Drums Handling*
√	Heavy Equipment	√	Heat Stress	√	Noise
√	Moving Parts	❑	Extreme Cold	❑	Non-Ionizing Radiation
❑	Heavy Lifting	❑	Ionizing Radiation	❑	Other:
❑	Electrical	√	Traffic		
√	Overhead Hazards	❑	Biological Hazards		
❑	Fall (>6; Vertical)	❑	Surface Water (Immersion)		

Site hazards will be mitigated by:

(1) Briefing site personnel as to identify physical hazards within the work area.
(2) Identifying the "kill switch" on the drilling rig.
(3) Personal protection equipment such as ear muffs, ear plugs, winter jackets, etc. will be donned by site personnel.

(2) SAFETY EQUIPMENT REQUIRED FOR BATTELLE/ASU EMPLOYEES (check or circle all that apply)

❑	Explosimeter	❑	Eye Wash	❑	Confined Space Warning Signs
❑	Fall Protection Equipment	❑	Emergency Shower	√	Communications – On Site
√	Barrier Tape	√	Emergency Air Horn	√	Communications – Off Site
√	Traffic Cones	√	Lights	❑	Other:
❑	Stretcher	❑	Lights – emergency		
√	First Aid Kit	❑	Ladder		
√	A-B-C- Fire Extinguisher	❑	Tick Repellant		
❑	Snake Bite Kit	❑	Flotation Device (USCG Type III)		

Emergency equipment will be located in the cab of the drilling rig. See Sections 10 and 12 for communication procedures. The field crew will be equipped with cellular telephones and an emergency air horn for communication.

SECTION 4: CHEMICAL HAZARDS INFORMATION

(1) IDENTIFIED CONTAMINANTS

Known or suspected hazardous/toxic material (attached historical information, physical description, map of contamination and tabulated data, if available).

Media	Substances Involved	Characteristics	Estimated Concentrations	PEL
GW	BTEX (benzene, toluene, ethylbenzene, xylene), Polycyclic aromatic hydrocarbons (PAHs)	VO and TO	Not Available	
SL	BTEX and PAH's	VO and TO	Not Available	

Media types: GW (ground water), SW (surface water), WW (wastewater), AIR (air), SL (soil), SD (sediments), WL (waste, liquid), WS (waste, solid), WD (waste, sludge), WG (waste, gas) OT (other).

Characterizations: CA (corrosive, acid) CC, (corrosive, caustic), IG (ignitable), RA (radioactive), VO (volatile), TO (toxic), RE (reactive), BIO (infectious), UN (unknown), OT (other, describe)

Material Safety Data Sheets (MSDSs) for the contaminants of concern are attached. The data sheets include information on the chemical/toxicological properties of the site contaminants and signs and symptoms of over exposure.

(2) DESCRIBE POTENTIAL FOR CONTACT WITH EACH MEDIA TYPE FOR EACH OF THE BATTELLE/ASU TASKS LISTED IN SEC 2.4:

BATTELLE TASK #	ROUTE OF EXPOSURE	POTENTIAL FOR CONTACT	METHOD OF CONTROL
B1	Inhal/Ingest/Contact/Absorb	High/Medium/Low	Level D PPE
B2	Inhal/Ingest/Contact/Absorb	High/Medium/Low	Level D PPE
B3	Inhal/Ingest/Contact/Absorb	High/Medium/Low	Level D PPE
B4	Inhal/Ingest/Contact/Absorb	High/Medium/Low	Level D PPE

The SSO will brief the field team on interpretation of the attached MSDSs and particularly on symptoms and signs of over exposure to chemical hazards.

SECTION 5: HAZARD COMMUNICATION PROGRAM

If chemicals are introduced to the site by Battelle/ASU (e.g., decontamination liquids, preservatives, equipment calibration standards, etc.), bring a copy of the Battelle Hazardous Communication Program and associate MSDSs to the site. The SSO will review this information with all field personnel. The current list of chemicals for this site is:

BTEX	Alcohol
PAHs	Liquinox®
HCL (preservative)	

SECTION 6: ENVIRONMENTAL MONITORING

(1) The following environmental monitoring instruments shall be used on site at the specified intervals for breathing zone monitoring:

	EQUIPMENT	MONITORING PERIOD		ACTION LEVEL
❑	Combustible Gas Indicator	daily/hourly/continuous/other		
❑	O_2 Meter	daily/hourly/continuous/other		
√	PID (Lamp ____10.6_ eV)	daily/~~hourly/continuous/other~~	3 times per day	
❑	FID	daily/hourly/continuous/other		
❑	Radiation Meter (Gamma)	daily/hourly/continuous/other		
❑	Respirable Dust Meter	daily/hourly/continuous/other		
❑	GC/ECD/FID	daily/hourly/continuous/other		
√	GC/FID/PID/DELCD	daily/~~hourly/continuous/other~~	3 times per day	
		daily/hourly/continuous/other		

(2) Monitoring equipment is to be calibrated according to the manufacturers' instructions daily prior to and after each day of use. Record calibration data and air concentration in the Health and Safety on-site logbook.

(3) Action Levels for work shutdown and excavation. These are average values. Consideration should be given to the potential for release of highly toxic compounds from the waste or from reaction by-products. Levels are for persistence (> 10 min). Refer to the attached MSDSs for the TLVs.

	ACTION LEVEL
Uncharacterized Airborne Vapors or Gases	>Background
Characterized Airborne Gases, Vapor, Particulates	>50% **PEL, REL, TLV**
Oxygen	< 19.5; >23.5
Flammability	> 10% LEL

(4) Military and/or civilian personnel in charge of buildings adjacent to invasive monitoring activities will be notified via a health and safety kick-off meeting of site activities. A copy of this HASP will be provided. If any action levels are reached at the work area as described above or if discernible odors are released as a result of field activities, the personnel in charge or their designated representative will be notified immediately. **Perimeter monitoring (support zone) will be conducted, at a minimum of 3 times per day, to assess whether organic vapors or odors are leaving the work area.**

SECTION 7: HEALTH AND SAFETY TRAINING/MEDICAL MONITORING PROGRAM

The project staff is included in the Battelle Health and Safety Training and Medical Monitoring Programs in conformance with 29 CFR 1910.R.

NAME	MEDICAL (Date)	HAZWOPPER TRAINING INITIAL (Hrs/Date)	HAZWOPPER TRAINING REFRESHER (Date)	CPR/FA/ (Dates)
Eric Foote	August 2006	40 hours/ 1992	June 2006	May 2004 (good for 3 years)
Shane Williams	February 2006	40 hours/April 1994	July 14, 2006	July 2006 (good for 3 years)
Jennifer Triplett		40 hours/June 2001	August 7, 2005	
Paul Dahlen		40 hours/Nov 1992	February, 2006	
Paul Johnson		40 hours/ 1987	August 12, 2005	

SECTION 8: PERSONAL MONITORING

√ No personal exposure monitoring or heat/cold stress monitoring will take place on site. If the need for such monitoring is anticipated, this HASP will be modified as accordingly.

SECTION 9: CONFINED SPACE ENTRY

√ No confined space and/or trench entries will take place on site. If the possibility of such entries taking place exists, this HASP will be modified accordingly.

SECTION 10: COMMUNICATION PROCEDURES

The following standard hand signals will be used in case of failure to radio communications in each contaminant reduction zone:

Hand gripping throat	–	Can't Talk, Having difficulty breathing
Grip partner's wrist and both hands around wrist	–	Can't Talk, Leave area immediately
Hands on top of head	–	Need assistance
Thumbs up	–	OK, I am all right, I understand
Thumbs down	–	No, negative

If applicable, telephone communications to the Command Post Should be Established as soon as possible. The stationary and/or mobile phone number(s) will be available one week prior to the start of field work. The HASP will be amended when these numbers are available.

The command post telephone is 480-516-1422

The mobile phone is 480-516-1422

SECTION 11: DECONTAMINATION PROCEDURES

Personnel and equipment leaving an exclusion zone shall be thoroughly decontaminated at the decontamination facility constructed at the command post. The SSO is responsible for monitoring adherence with this decontamination plan. A Modified Level D decontamination protocol shall be used with the following decontamination stations:

(1) Equipment Drop (IF NECESSARY)
(2) Boot Covers, and Glove Wash and Rinse (IF NECESSARY)
(3) Outer Boot and Glove Removal (IF NECESSARY)
(4) Outer Garment Removal (IF NECESSARY)
(5) Inner Glove Removal (IF NECESSARY)
(6) Field Hand Wash

The following decontamination equipment is required (check or circle all that apply)

√	Decon Pad (Plastic Sheet)	❑	Dry Brushes	√	Detergent Soap
√	Trash Cans/Bags	√	Wet Brushes	❑	Other Decontamination Solution
√	Buckets	√	Water		

SECTION 12: EMERGENCY PROCEDURES

On site personnel will use the following standard emergency procedures. The SSO shall be notified of any on site emergencies and be responsible for ensuring that the procedures are followed.

Personal Injury in the Exclusion Zone — DESIGNATED EMERGENCY SIGNAL: Air Horn

Upon notification of an injury in the Exclusion Zone, the designated emergency signal shall be sounded. All site personnel shall assemble at the decontamination line. The SSO or alternate should evaluate the nature of the injury, and the affected person should be decontaminated to the extent possible prior to movement to the Support Zone. The on site CPR/FA personnel shall initiate the appropriate first aid, and contact should be made for an ambulance (and other emergency services as needed) and with the designated medical facility (if required). No persons shall reenter the Exclusion Zone until the cause of the injury or symptoms are determined.

Fire/Explosion — DESIGNATED EMERGENCY SIGNAL: Air Horn

Upon notification of a fire or explosion on site, the designated emergency signal shall be sounded and all site personnel assembled at the decontamination line. The fire department shall be alerted and all personnel moved to a safe distance from the involved area.

Equipment Failure

If any other equipment (i.e., air monitoring) on site fails to operate properly, the Field Team Leader and SSO shall be notified and then determine the effect of this failure on continuing operations on site. If the failure affects the safety of personnel or prevents completion of the Work Plan tasks, all personnel shall leave the Exclusion Zone until the situation is evaluated and appropriate actions taken.

Emergency escape routes are designated for use in those situations where egress from the Exclusion Zone cannot occur through the decontamination line

In all situations, when an on site emergency results in evacuation of the Exclusion Zone, personnel shall not reenter until:

(1) The conditions resulting in the emergency have been corrected.
(2) The hazards have been reassessed by the SSO.
(3) The Site Safety Plan has been reviewed by the SSO and Corporate Health and Safety Manager.

SECTION 13: SPILL CONTROL PROCEDURES

√ No containers of liquid or solids exist on site and no spill control plan is necessary. If the possibility of such conditions exists on site, this HASP will be modified accordingly.

SECTION 14: EMERGENCY INFORMATION

(1) LOCAL RESOURCES

Ambulance (name):	Emergency Services	Phone:	911
Hospital (name):	St. Joseph/ Candler Hospital	Phone:	911 or (912) 819-6000
Police (local or state):	Savannah Police Department	Phone:	911 or (912) 232-4141
Fire (name):	Savannah Fire & Emergency Services	Phone:	911 or (912) 651-6758
HAZ MAT Responder:	Savannah Special Operations Division	Phone:	911 or (912) 651-6758
On-Site CPR/FA(s):	Shane Williams	Phone:	614-348-4437

* For life-threatening emergencies or emergency trauma care.
The above hospital is approximately 4.8 miles from the furthest work area and the ambulance response time is approximately 13 minutes.

** For non-life threatening medical care.

The above hospital is approximately 13 minutes from the furthest work area. Injured workers will be transported here for non-emergency treatment only.

(2) DIRECTIONS TO NEAREST HOSPITAL – SEE ATTACHED MAP:

Figure 1.

(3) BATTELLE RESOURCES
Health and Safety Representative (BSTI)
Stephanie Helgerman, CSP,
614-424-7363

Site Contact: Eric Foote: 614-374-2729

Battelle Security Office
(614) 424-4444

SECTION 15: PERSONAL PROTECTIVE EQUIPMENT (check or circle all that apply)

√ No type of respiratory protection is required on this site. If the possibility of the need for respiratory protection is anticipated, this HASP will be modified accordingly.

CLOTHING	GLOVES	BOOTS	OTHER
❑ Coveralls	❑ Cotton	√ Safety	√ Hard Hat
❑ Tyvek	❑ Leather	❑ Fireman/Hip	√ Safety Glasses (with side shields)
❑ Saranex	√ Nitrile	❑ Neoprene	❑ Goggles
❑ PE Tyvek	❑ Butyl	√ Steel Toe	❑ Face Shield
❑ Other: ______	❑ Neoprene		√ Hearing Protection
______	❑ Viton		
______	❑ PVC		
	❑ PVA		
	❑ Latex		

SECTION 16: SAFE WORK PRACTICES

THE FOLLOWING PRACTICES MUST BE FOLLOWED BY PERSONNEL ON SITE

1. Smoking, eating, chewing gum or tobacco, or drinking are forbidden except in clean or designated areas.
2. Ignition of flammable liquids within or through improvised heating devices (e.g., barrels) is forbidden.
3. Contact with samples, excavated materials, or other contaminated materials must be minimized.
4. Do not kneel on the ground when collecting samples.
5. If drilling equipment is involved, know where the kill switch is.
6. All electrical equipment used in outside locations, wet areas, or near water must be plugged into ground fault circuit interrupter (GFCI) protected outlets.
7. A "Buddy System" in which another worker is close enough to render immediate aid will be in effect.
8. Good housekeeping practices are to be maintained.
9. Where the eyes or body may be exposed to corrosive materials, water suitable for quick drenching or flushing shall be available for immediate use.
10. In the event of treacherous weather-related working conditions (i.e., thunderstorm, limited visibility, extreme cold or heat) the field task will be suspended until conditions improve or appropriate protection from the elements is provided.

SECTION 17: EMPLOYEE ACKNOWLEDGMENTS

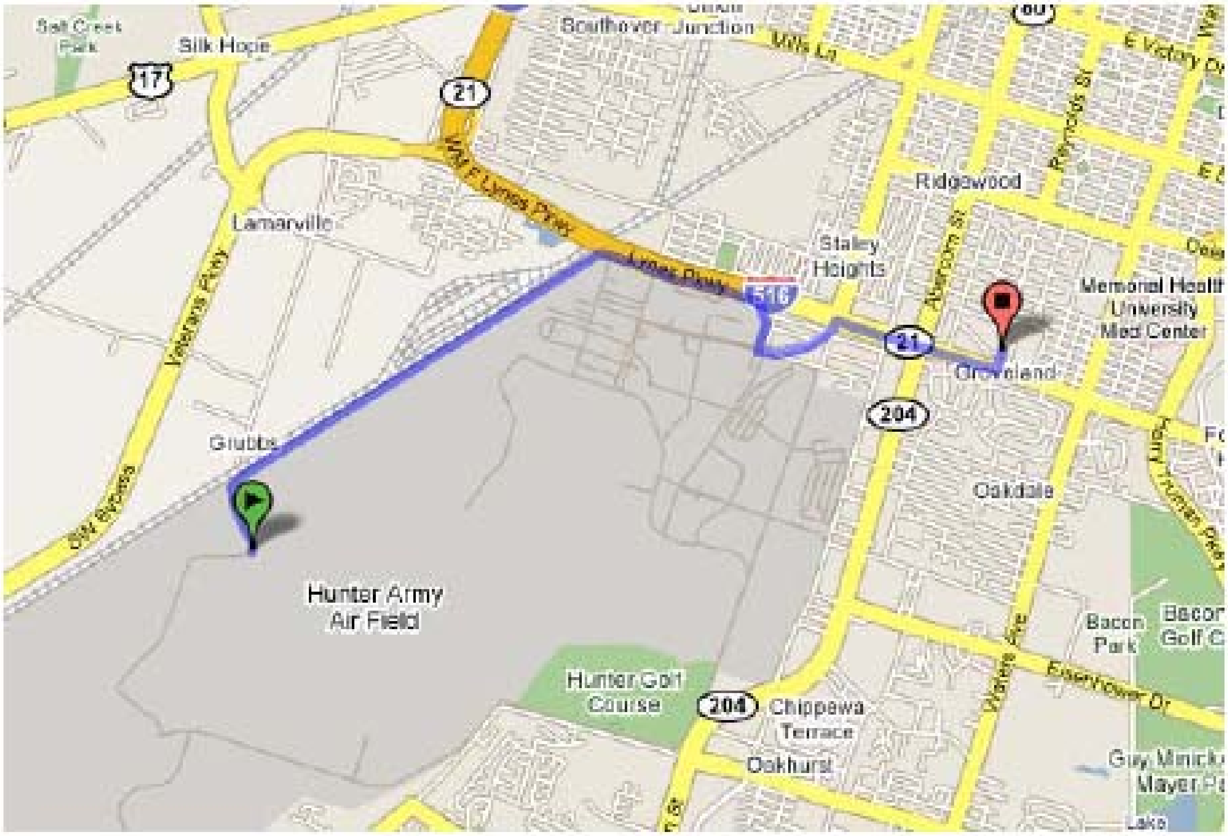
PLAN REVIEWED BY:		DATE
H&S Representative:	Stephanie Helgerman, CSP	______
Principal Investigator	Eric Foote; Paul Johnson	______
Project Leader:	Paul Dahlen	______
Site Safety Officer:	Shane Williams	______

I acknowledge that I have read the information in this HASP form and the attached MSDSs. I understand the site hazards as described and agree to comply with the contents of the plan.

FIELD PERSONNEL (Print Name)	SIGNATURE	DATE
______	______	______
______	______	______
______	______	______
______	______	______

VISITOR (Print Name)	SIGNATURE	DATE
______	______	______
______ Organization/Agency		
______	______	______
______ Organization/Agency		

Figure 1



From: Hunter Army Airfield
Drive: 4.8 miles (about 13 minutes) to St. Joseph's/ Candler Hospital
1) Head northeast on S Perimeter Road toward Stephen Douglas Street: 3.5 mi.
2) Turn left at Duncan Drive: 190 ft.
3) Continue on Montgomery Street: 0.4 mi.
4) Turn right at W. Derenne Avenue/ GA-21 S: 0.8 mi.
5) Turn left at Reynolds Street: 486 ft.
Arrive: St. Joseph/Candler Hospital, 5356 Reynolds St., Savannah, GA 31419

Draft Final

Data Analysis Report of
Hunter Army Airfield – Former Pumphouse #2

Critical Evaluation of the State of
In Situ Thermal Treatment Technologies
for DNAPL Source Zone Treatment

Prepared for:

Environmental Security Technology Certification Program
Arlington, VA

Prepared by:

Arizona State University
Battelle

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The vendors and products, including the equipment, system components, and other materials identified in this report, are primarily for information purposes only. Although some of these vendors and products may have been used in the past, mention in this report does not constitute a recommendation for using these vendors or products.

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Acronyms and Abbreviations

bgs	below ground surface
DO	dissolved oxygen
EC	electrical conductivity
ERH	electrical resistance heating
ESTCP	Environmental Security Technology Certification Program
FID	flame-ionization detector
ft	feet
GC	gas chromatography
kg	kilogram
ORP	oxidation reduction potential
PID	photo-ionization detector
temp	temperature
VOA	volatile organic analysis
yr	year

1. Introduction

The post-treatment field investigation of Hunter Army Airfield – Former Pumphouse #2, under the Environmental Security Technology Certification Program (ESTCP) project ER-0314, *Critical Evaluation of State of the In-Situ Thermal Treatment Technologies*, was performed March 26 through April 2, 2007. Figure 1 is a site map that identifies the extent of the previous electrical resistance heating (ERH) remediation area, which was also the specific area of interest for this particular field investigation.

Consistent with the objectives set forth under the ER-0314 Demonstration Plan, the field investigation at this site included the following:

Verification of the site hydrogeological conceptual model
Groundwater sampling of monitoring wells
Depth-discrete analysis of hydraulic conductivity and dissolved petroleum hydrocarbons at temporary sampling locations downgradient of the treatment zone.

2. Field Investigations

In accordance with the approved generic demonstration plan for this project, the following site-specific activities were conducted:

(6) Verification of the site hydrogeological conceptual model:

c. For confirmation of geology, two continuous soil cores were collected at direct-push sampling locations GP3 and GP6 shown in Figure 2. The continuous soil cores/ direct-push sampling locations were located at the down-gradient edge of the treatment zone. Table 1 presents qualitative geologic descriptions from visual observations of the two continuous soil cores.

d. Hydraulic conductivity slug testing was conducted in monitoring well, P2-MW28 identified in Table 2 and in Figure 3. The slug test data were analyzed using both the Hvorslev and the Bouwer and Rice Methods; results are presented in Table 3. The Hvorslev' expression for determining hydraulic conductivity from slug test data is:

$$K=(r^2\ln(L_e/R))/(2L_e t_{37})$$

Where K = hydraulic conductivity (L/T)
r = radius of well casing (L) (0.083 ft)
R = radius of well screen (L) (0.50 ft)
L_e = length of well screen (L) (10 ft or the saturated thickness if well screen was not completely covered)
t_{37} = time for water level to rise or fall 37% of the initial change (T) (from data set)
(Fetter, 2000).

The Bouwer and Rice expression for determining hydraulic conductivity from slug test data is:

$$K=(r_c^2 \ln(R_e/R) / (2L_e)) * ((1/t) \ln(H_o/H_t))$$

Where K = hydraulic conductivity (L/T)

r_c = radius of well casing (L) (0.083 ft)

R = radius of gravel envelope (L) (0.50 ft)

R_e = effective radial distance over which head is dissipated (L) (from data set)

L_e = length of well screen (L) (10 ft or the saturated thickness if well screen was not completely covered)

H_o = drawdown at t=0 (L) (from data set)

H_t = drawdown at t=t (L) (from data set)

t = time since $H = H_o$ (T) (from data set)

(Fetter, 2000).

In addition, aquifer specific-capacity tests were conducted on 11 monitoring wells, which were unsuitable for performing slug tests. Nine (9) of the eleven (11) monitoring wells were unsuitable due to insufficient casing diameter (1-inch). The remaining two (2) monitoring wells had sufficient casing diameters (2-inch), however the water column measured in the wells were of insufficient depth for performing slug tests. Specific-capacity tests involve measurements of the flow rate achieved under fixed drawdown and are analyzed using the Theim Equation to estimate hydraulic conductivity. The results are presented in Table 4. The Theim equation for hydraulic conductivity is:

$$T= (Q /(2(h_2-h_1))* \ln(r_2/r_1)$$

Where T = transmissivity (L^2/T)

Q = pumping rate (L^3/T)

h_1 = head at distance r_1 from the pumping well (L)

h_2 = head at distance r_2 from the pumping well (L)

$$K = T/b$$

Where K = hydraulic conductivity (L/T)

b = length of sampler or screen section (L) (0.5 ft or length of screen)

(Fetter, 2000).

e. Depth-to-groundwater was measured in the 12 groundwater monitoring wells identified in Table 2 and in Figure 4. Depth-to-water measurements, groundwater elevations, and survey coordinates are summarized in Table 5. An interpolated groundwater elevation map is presented in Figure 5.

(7) Collection of water quality samples from 11 groundwater monitoring wells within the treatment zone and one monitoring well cross-gradient of the treatment zone for analysis of dissolved petroleum hydrocarbon groundwater concentrations:

f. Table 2 identifies the groundwater monitoring wells from which samples were collected. Prior to sample collection, three well-volumes were purged. Groundwater was then collected for analysis of field parameters and stored in volatile organic analysis (VOA) vials for analysis of dissolved petroleum hydrocarbon concentrations. General water quality field parameters including pH, electrical conductivity (EC), temperature, dissolved oxygen (DO), and oxidation reduction potential (ORP) were measured using an Horiba U-22 meter. Petroleum hydrocarbon analysis was performed on-site by heated-headspace analysis and gas chromatography (GC) using a photo-ionization detector (PID) and a flame-ionization detector (FID). General water quality data for permanent groundwater monitoring well installations can be found in Table 6 and chemical concentration data can be found in Table 7. All non-detect samples are listed as less than the detection limit.

(8) Depth-discrete hydraulic conductivity and dissolved petroleum hydrocarbon concentration data were collected on one or two foot intervals as possible from 12 ft below ground surface (bgs) to ~22 ft bgs at all 10 direct-push sampling locations.

g. Groundwater quality data were collected from depth-specific intervals at all direct-push sampling locations (See Table 2 and Figure 2). Sampling locations were spaced on approximately 50 ft centers, as possible, along a transect downgradient of the source zone and perpendicular to the direction of groundwater flow. Figure 2 presents the direct-push sampling locations. Sample locations were placed around the treatment zone because previous work by others suggested the drainage ditch surrounding the site caused radial flow and dissolved petroleum hydrocarbon migration could be radially outward. Using percussion assisted direct-push technology and a modified Geoprobe Groundwater Profiler, groundwater samples were collected using a peristaltic pump on 2-ft intervals from 13 ft bgs to ~22 ft bgs. The location of the depth-discrete groundwater samples are shown in Figure 6. Dissolved petroleum hydrocarbon concentration analysis was conducted, as described above, and the results are summarized in Table 8. General water quality parameters (e.g. pH, EC, temp, DO, and ORP) were also collected during depth-specific sampling, and those data are presented in Table 9.

h. Aquifer specific-capacity tests were conducted at depth-specific intervals at all direct push sampling locations, as indicated in Table 2. Specific-capacity tests involve the measurement of the flow rate achieved under fixed drawdown and are analyzed using the Theim Equation to estimate hydraulic conductivity. The field data and results for aquifer testing are shown in Table 10.

Additional field work included soil conductivity measurements at GP3 and GP6 using a Geoprobe Direct Image Electrical Conductivity Probe (Wenner array). Results of the soil conductivity tests are shown in Figure 7.

The monitoring well chemical concentration data collected in March/April 2007 by the ASU/Battelle team were compared to the previous monitoring well chemical concentration data available for the site. The analytical results for each are shown in Table 11.

Figures 8 through 13 show vertical chemical concentration contour plots in a transect perpendicular to the dominant groundwater flow direction for seven analytes measured in depth-discrete direct-push samples. Figure 14 presents the hydraulic conductivity data from the aquifer specific-capacity tests for each depth-discrete direct-push sampling interval overlaid on the Benzene chemical concentration contour plot.

Plan view contour plots of the chemical concentrations for the analytes (benzene, toluene, ethylbenzene, m/p-xylene, o-xylene, and naphthalene) are shown in Figures 15 through 20. These contour plots were constructed using the concentration data from 11 monitoring wells and the highest discrete-depth concentration from each direct-push sampling location. Using the benzene groundwater concentration data, the hydraulic conductivity estimates (Table 10) calculated from the depth-discrete direct-push sampling and an average calculated gradient, a benzene mass flux calculation was performed using the Mass Flux Toolkit, Version 1.0. The average gradient of 0.01 ft/ft was chosen because each individual direct-push sampling location had a hydraulic gradient of approximately 0.01 ft/ft based on an extrapolated groundwater elevation map. The groundwater elevation map was used because the treatment zone had a surface elevation that varied significantly and the depth-to-water measurements were thus, unusable because no survey data was available for the temporary sampling locations. The Mass Flux Toolkit is a freeware program developed by Groundwater Services, Inc. and others under a contract funded by ESTCP. Figure 21 is a snapshot of the Benzene inputs used to perform the mass flux analysis. Linear spatial and vertical interpolation of the concentration, hydraulic conductivity, hydraulic gradient, and mass flux data were used for the analysis. Figures 22 and 23 show the interpolated concentration grid and the interpolated hydraulic conductivity grid, respectively. Finally, Figure 24 shows the mass flux result for Benzene, which is estimated to be 3.75E-02 kg/yr.

3. References

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

Figures

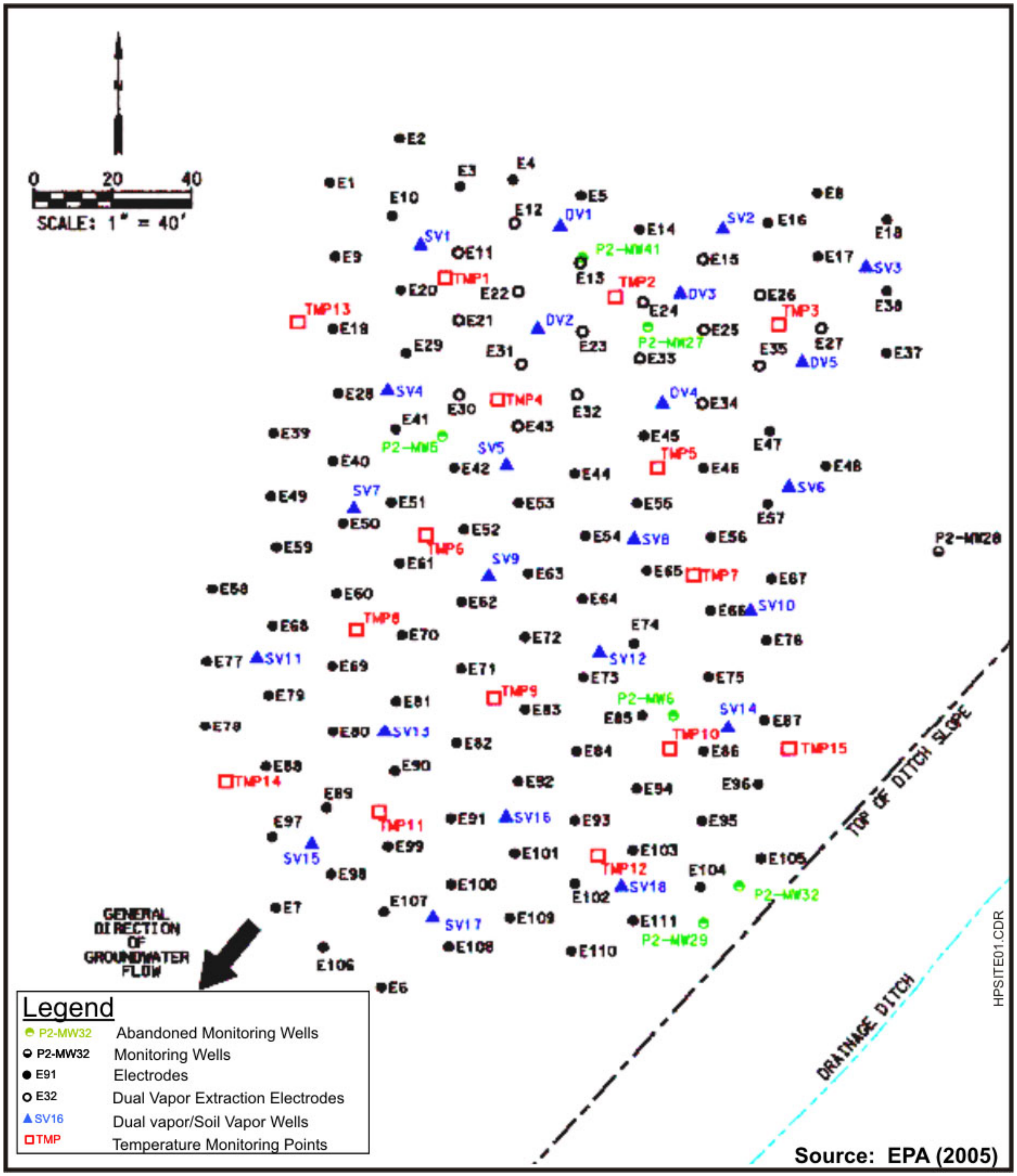


Figure 1. Site Map

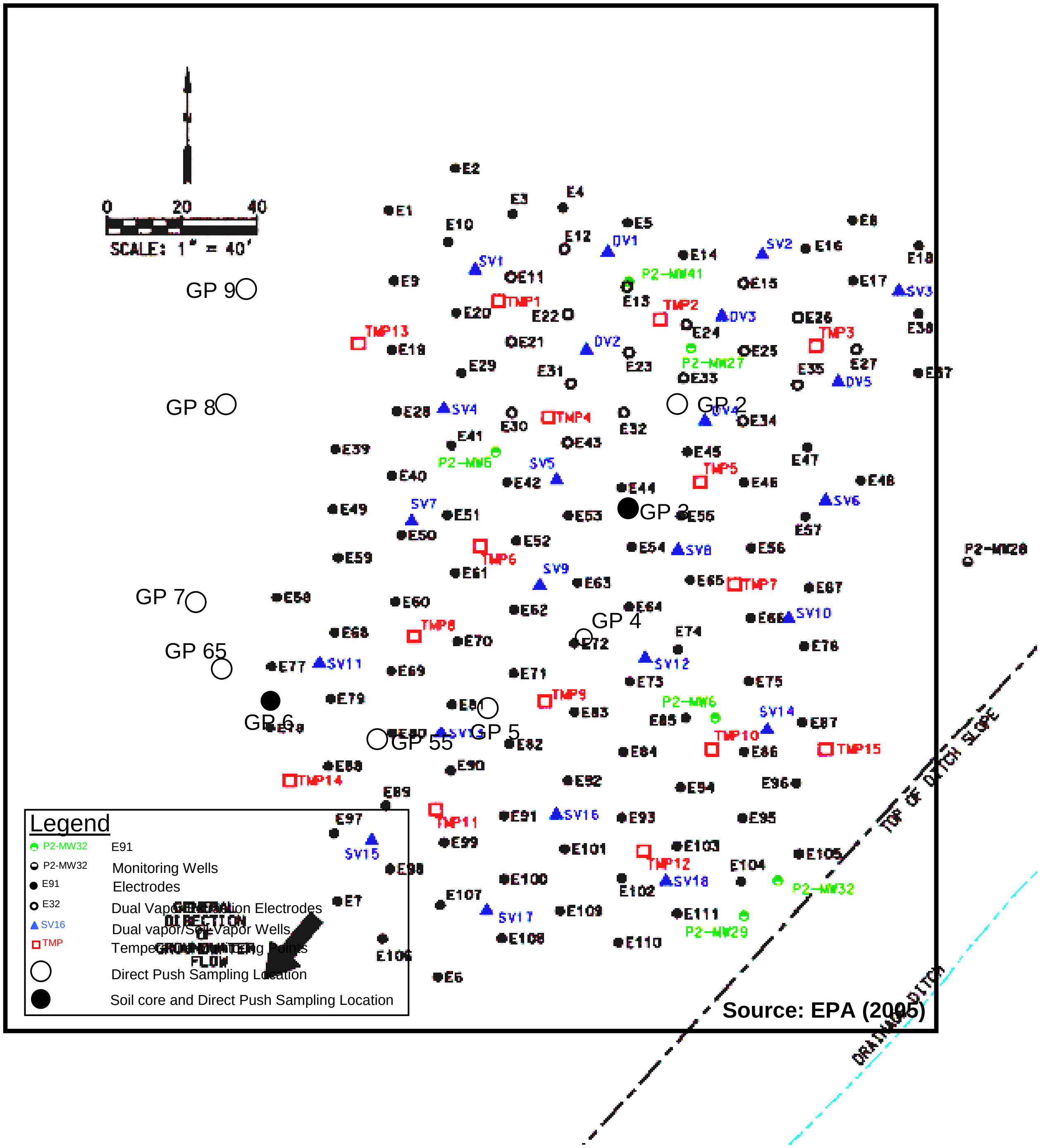


Figure 2. Direct-Push Locations

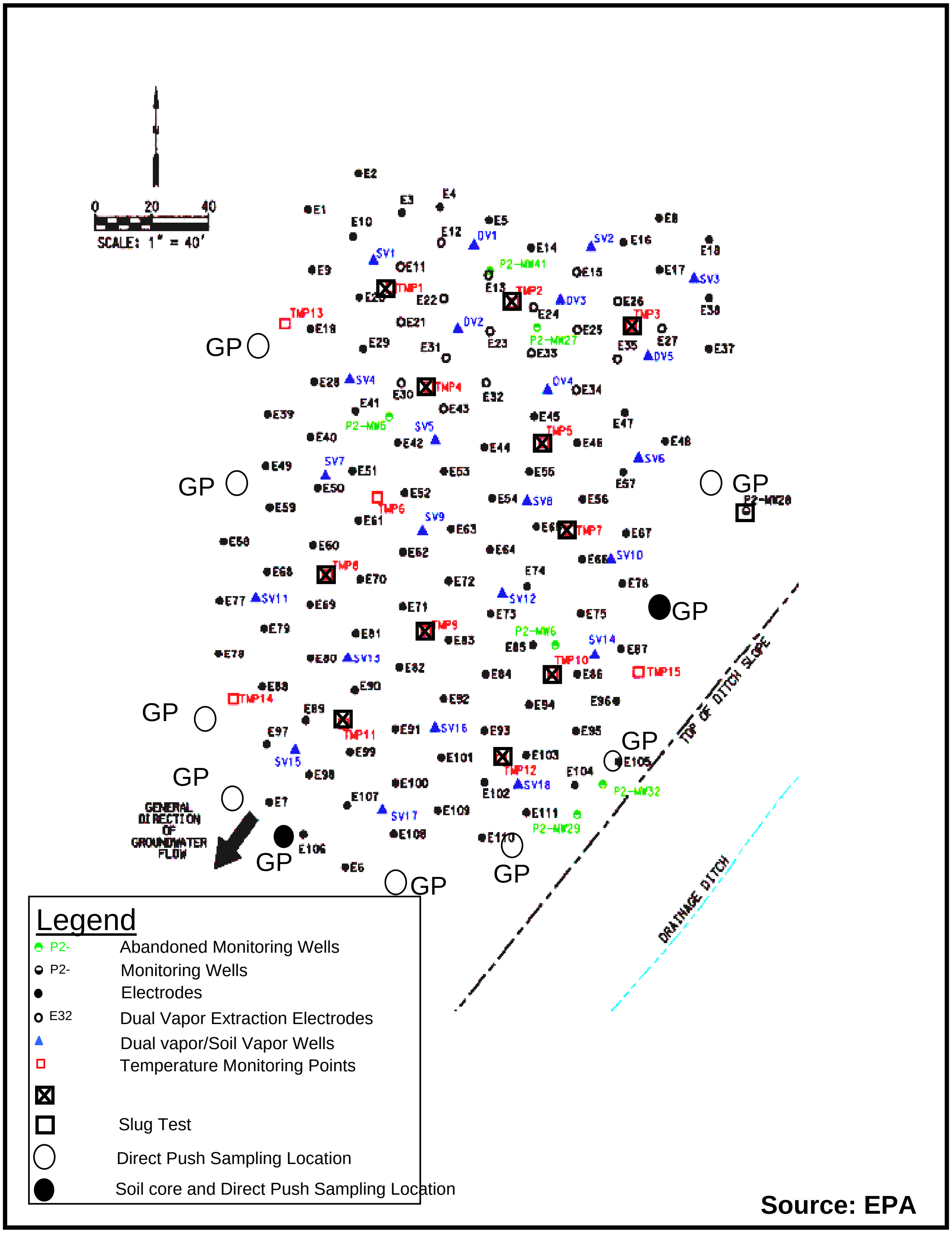


Figure 3. Hydraulic Conductivity Measurement Locations

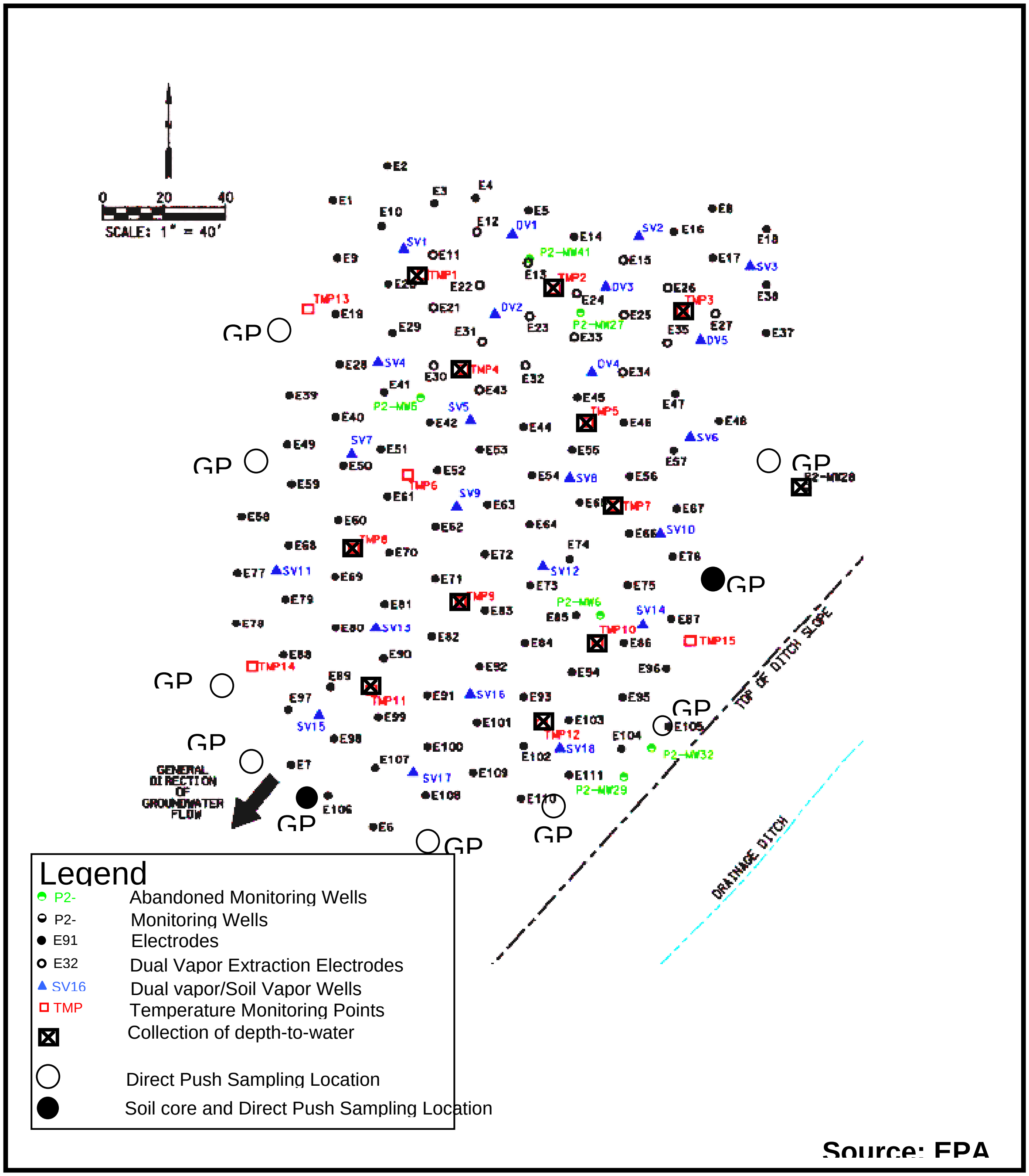


Figure 4. Monitoring Well Depth-to-Water Measurements and Groundwater Sampling Locations

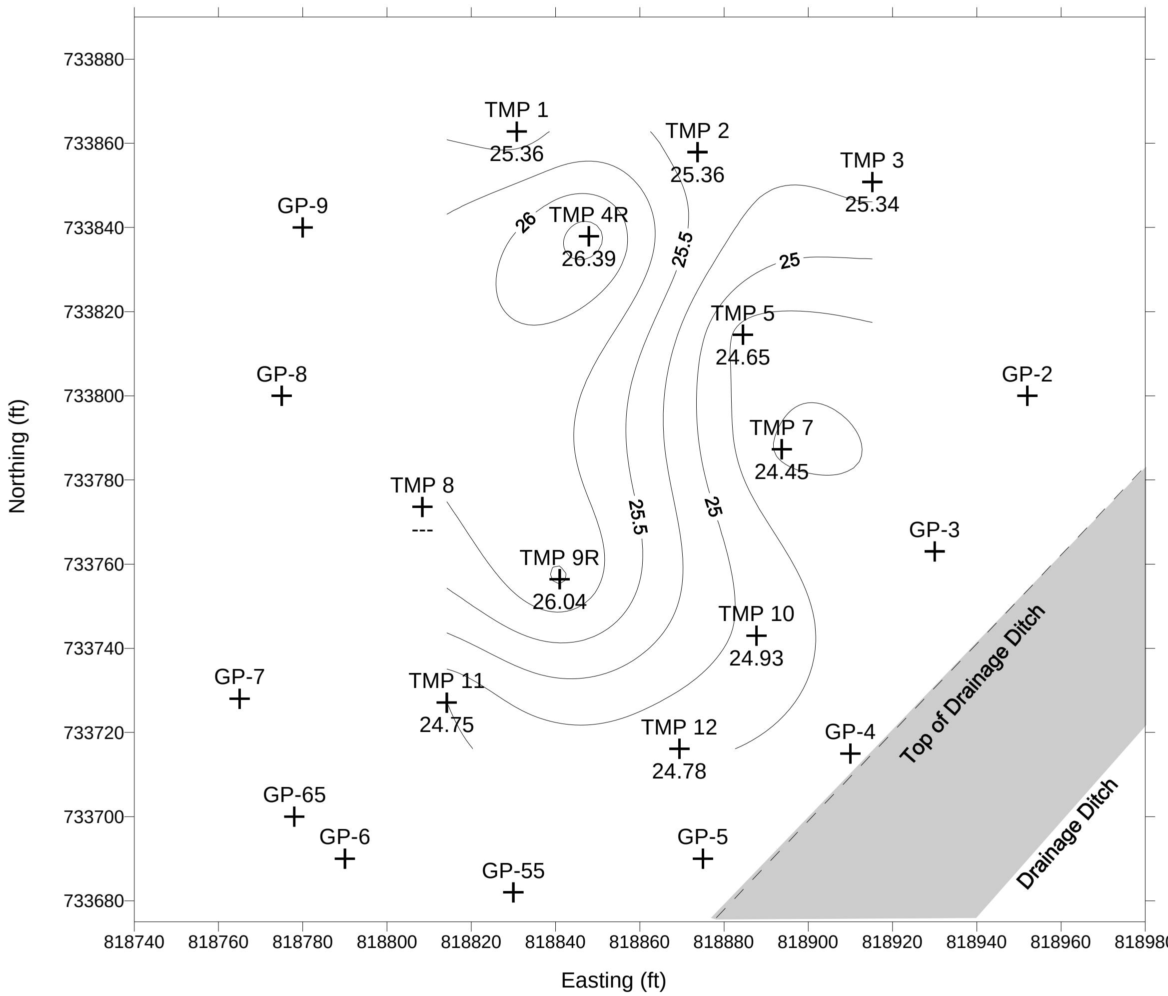


Figure 5. Interpolated Groundwater Elevation Map

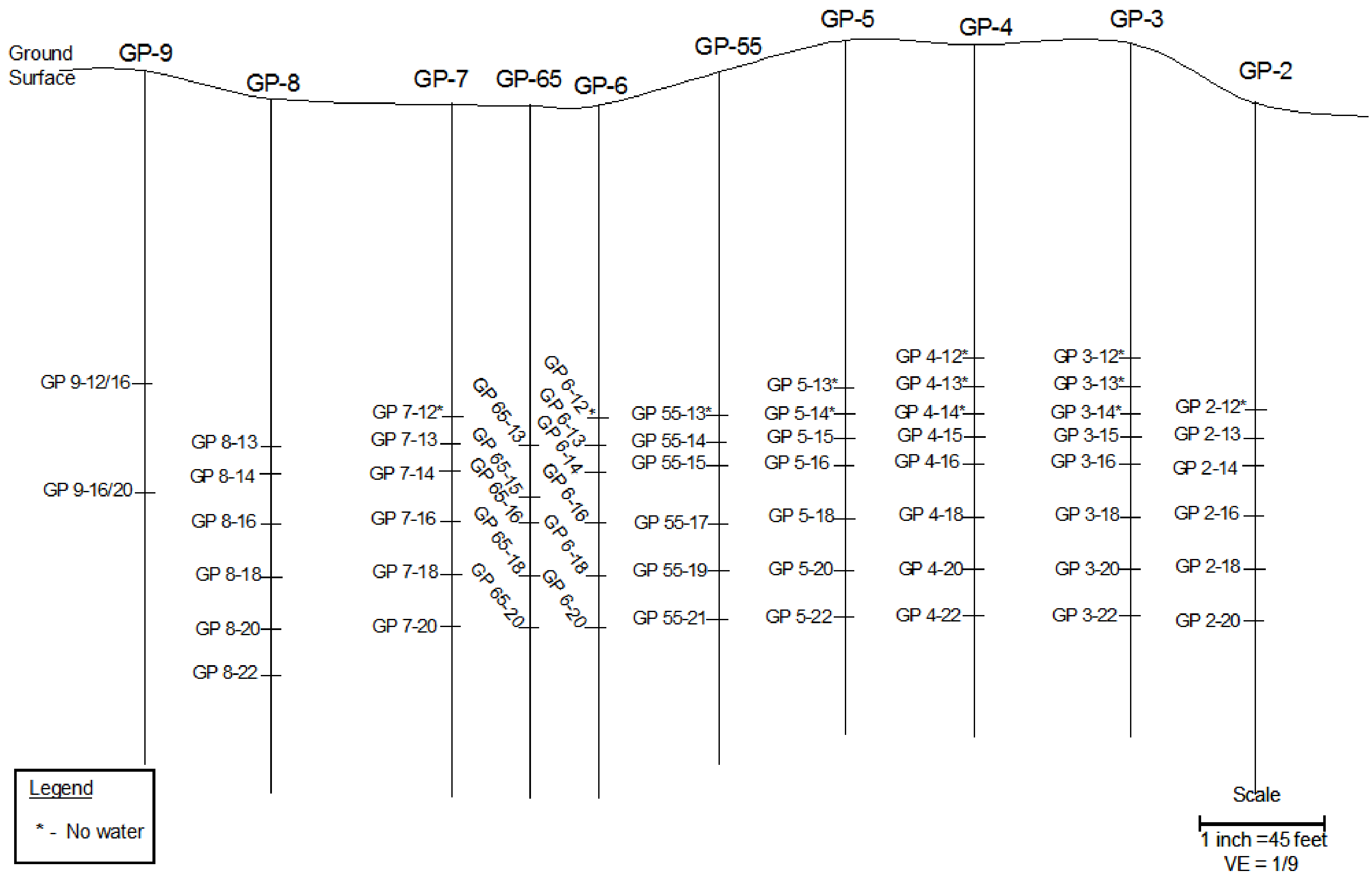
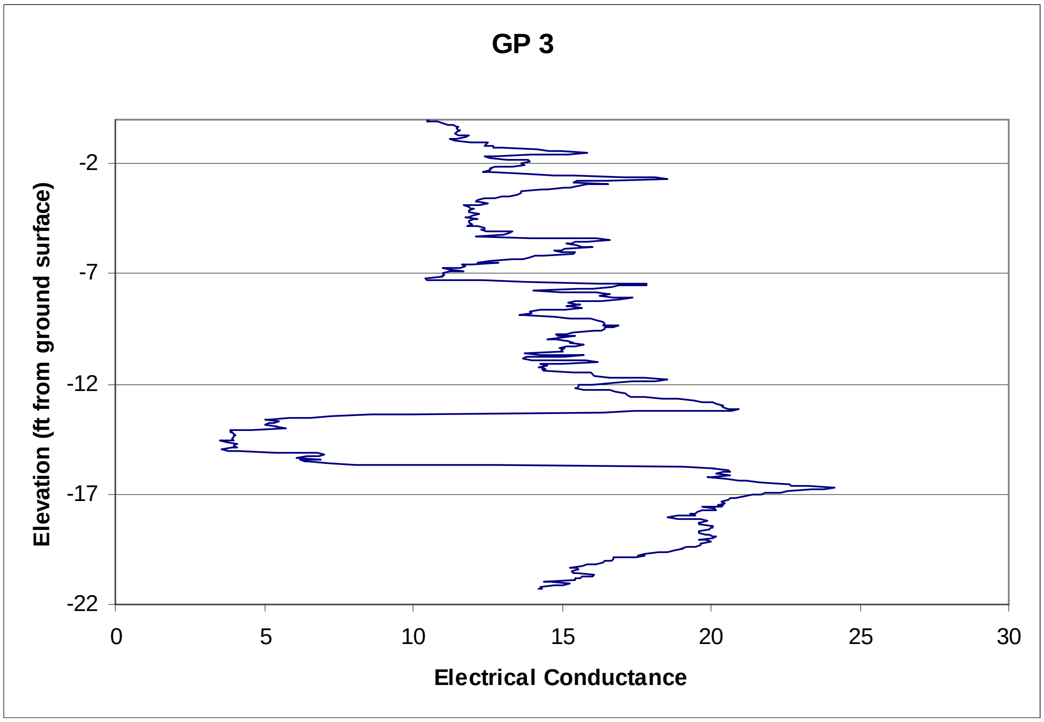
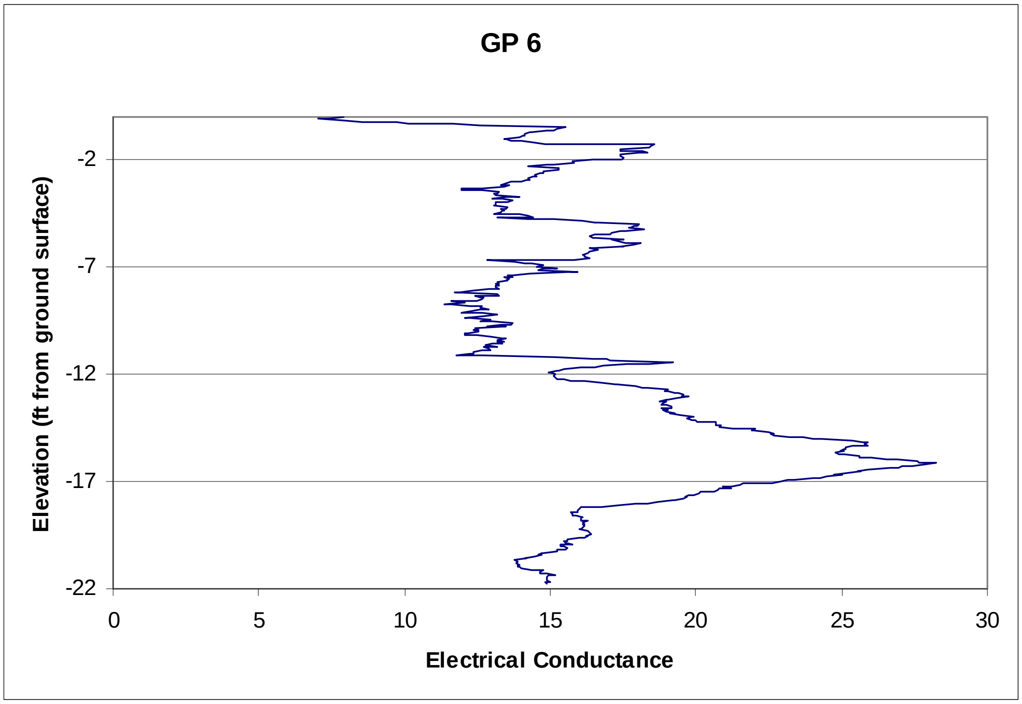


Figure 6. Cross-section of Direct Push Sampling Locations



Electrical Conductivity results for GP 3



Electrical Conductivity results for GP 6

Figure 7. Electrical Conductivity Results

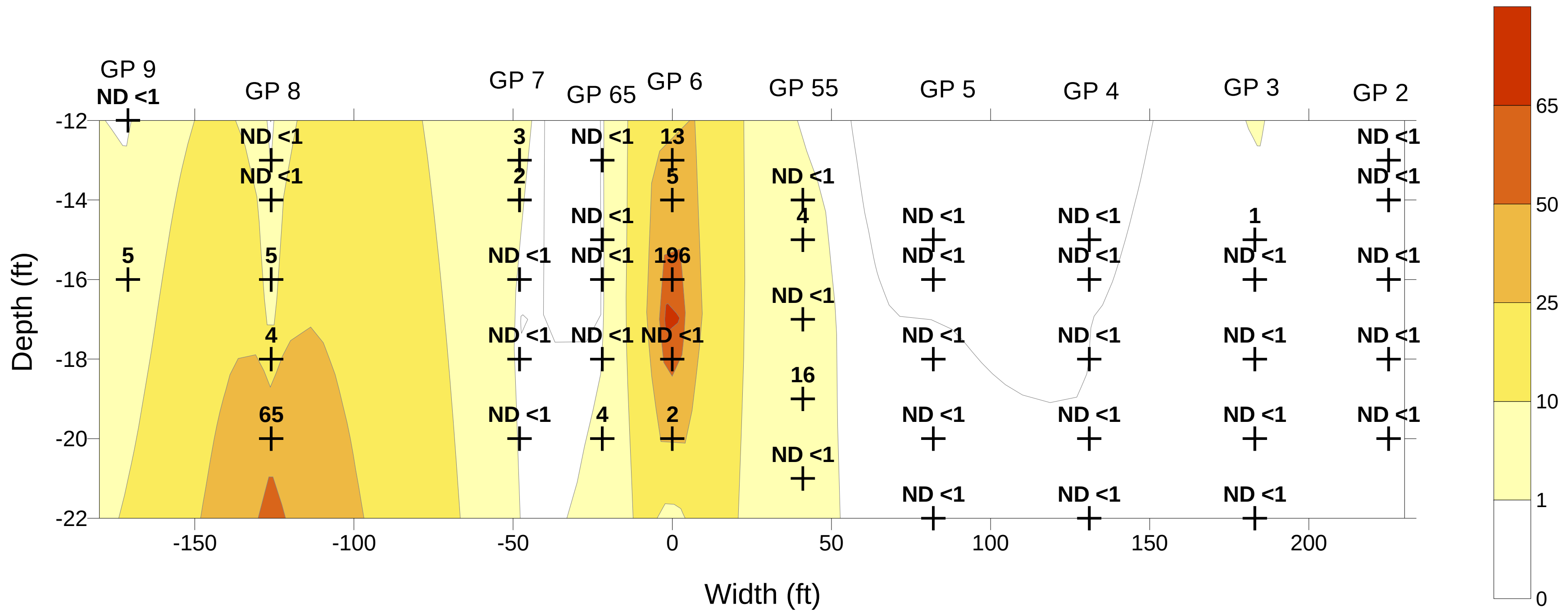


Figure 8. Benzene Direct-Push Groundwater Concentrations (µg/L)

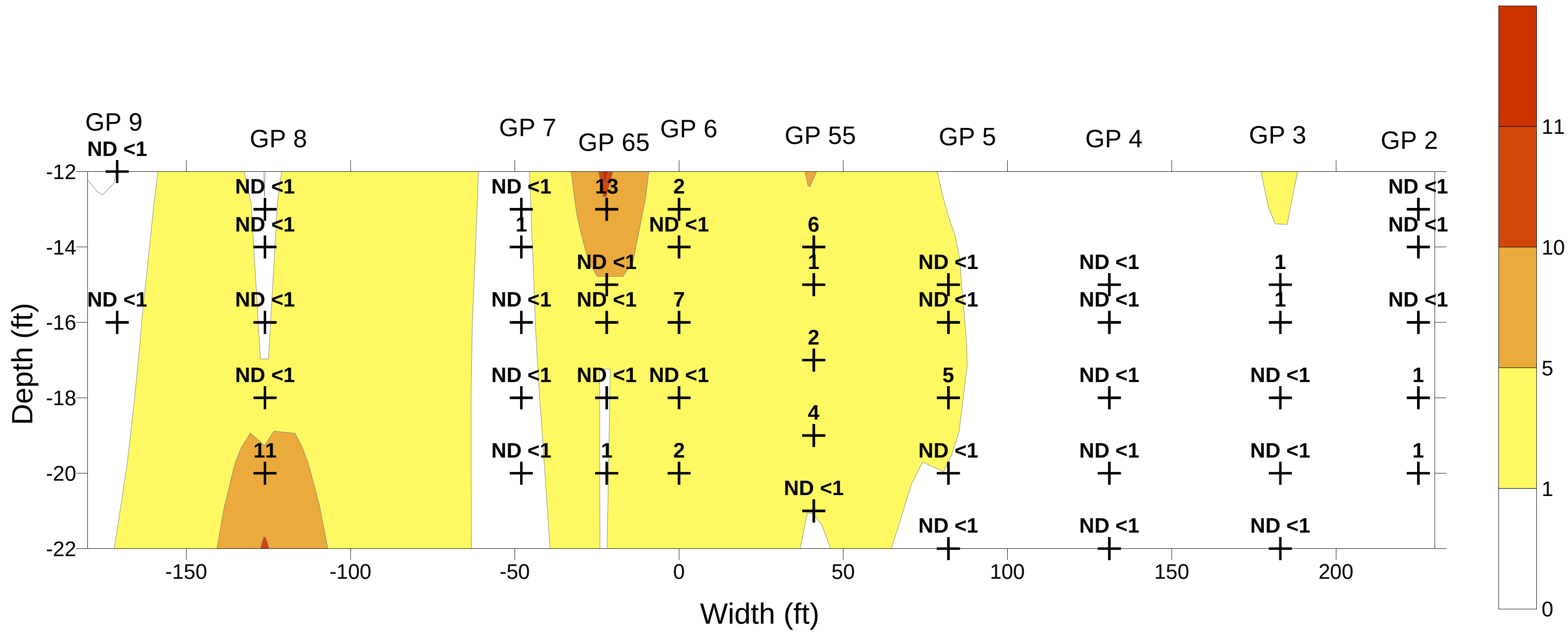


Figure 9. Toluene Direct-Push Groundwater Concentrations (µg/L)

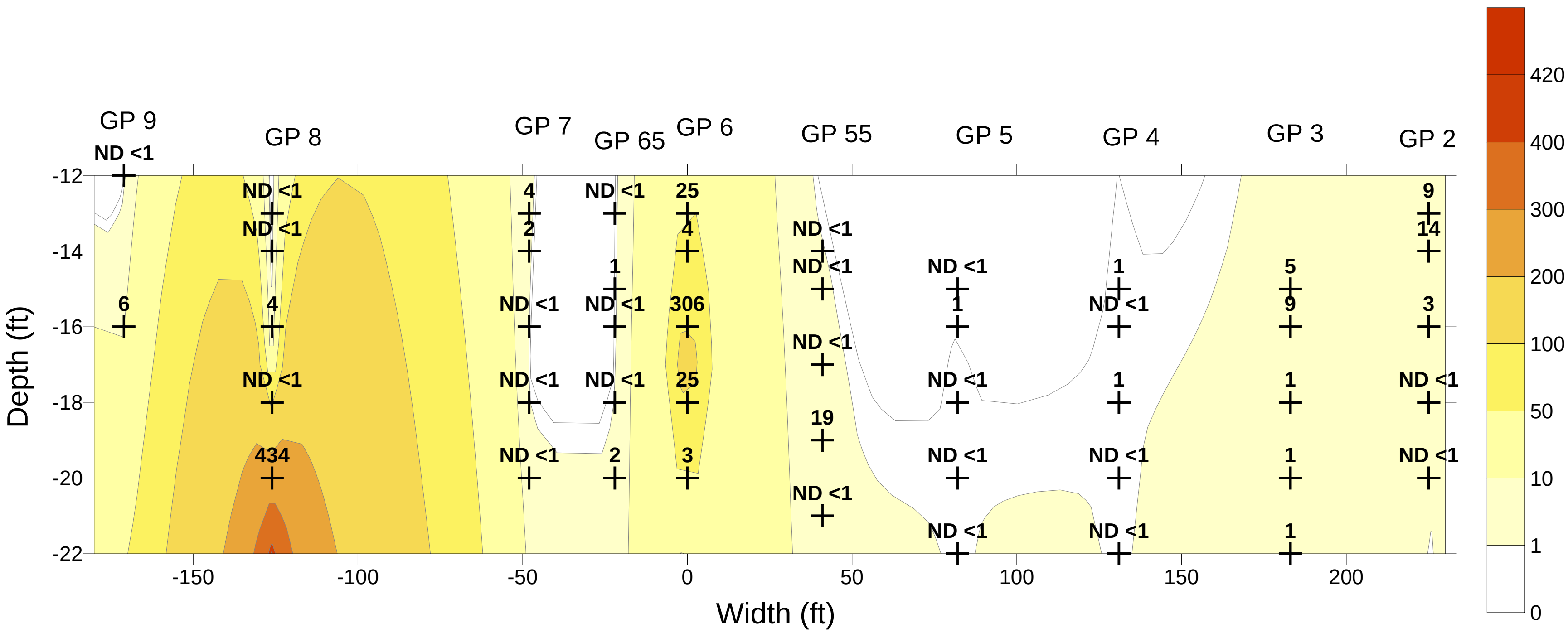


Figure 10. Ethylbenzene Direct-Push Groundwater Concentrations (µg/L)

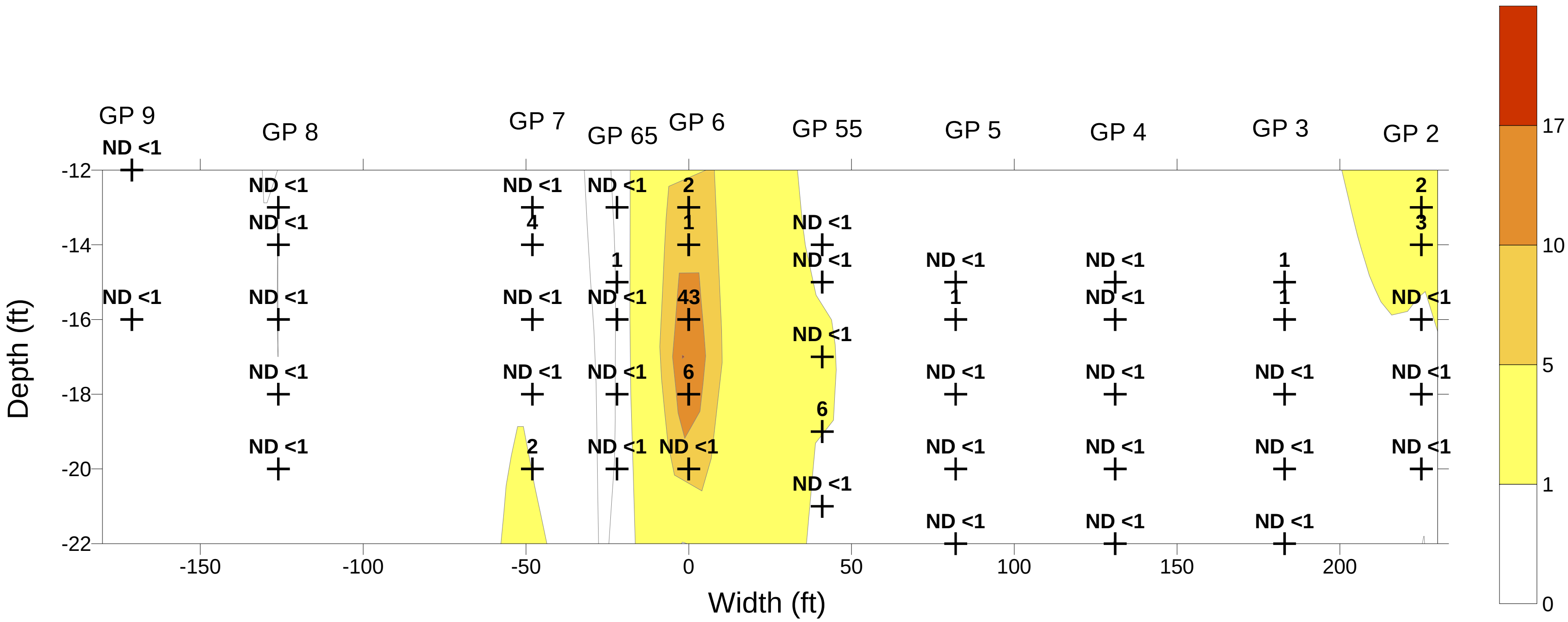


Figure 11. m/p-Xylene Direct-Push Groundwater Concentrations (µg/L)

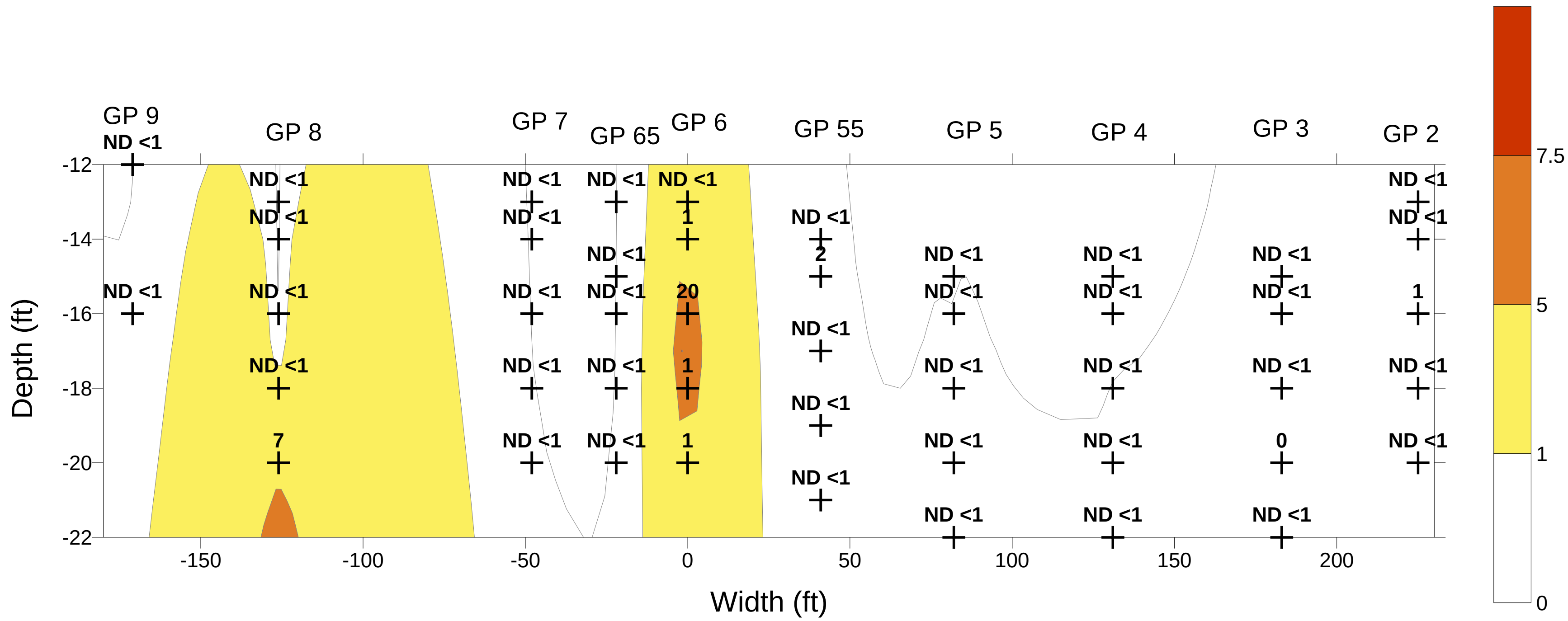


Figure 12. o-Xylene Direct-Push Groundwater Concentrations (µg/L)

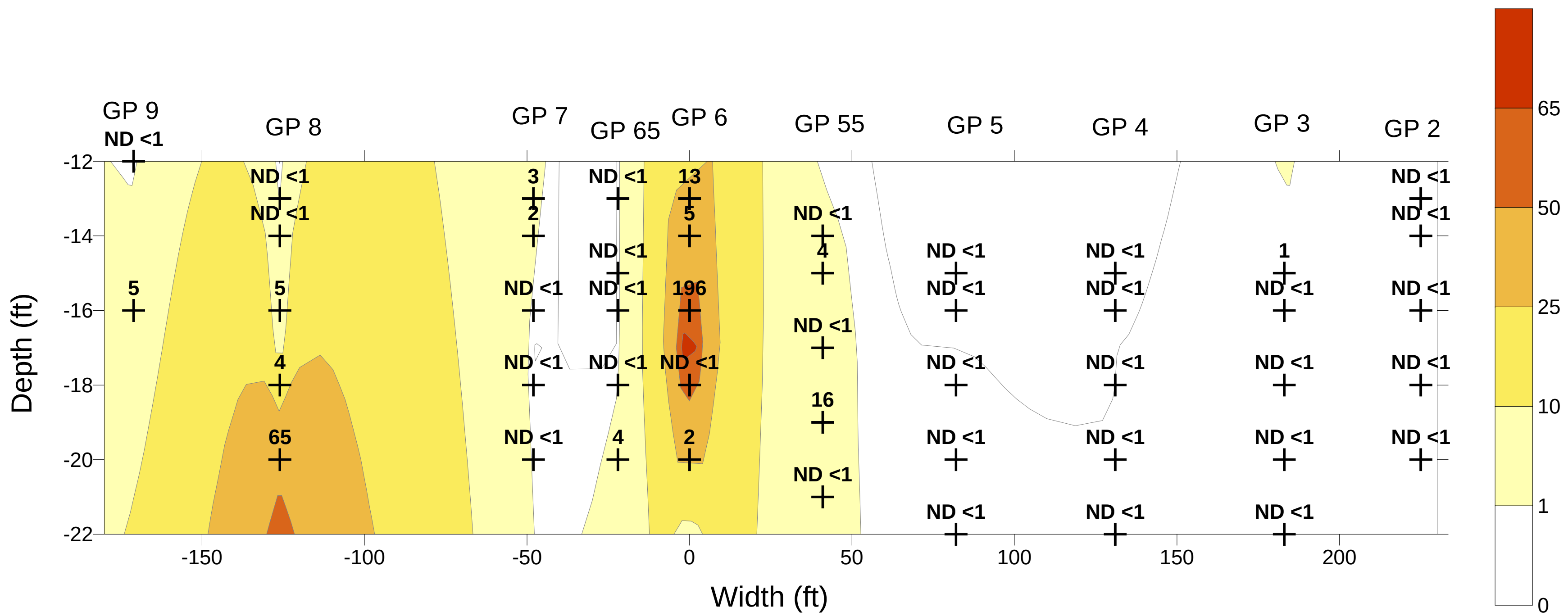


Figure 13. Naphthalene Direct-Push Groundwater Concentrations (µg/L)

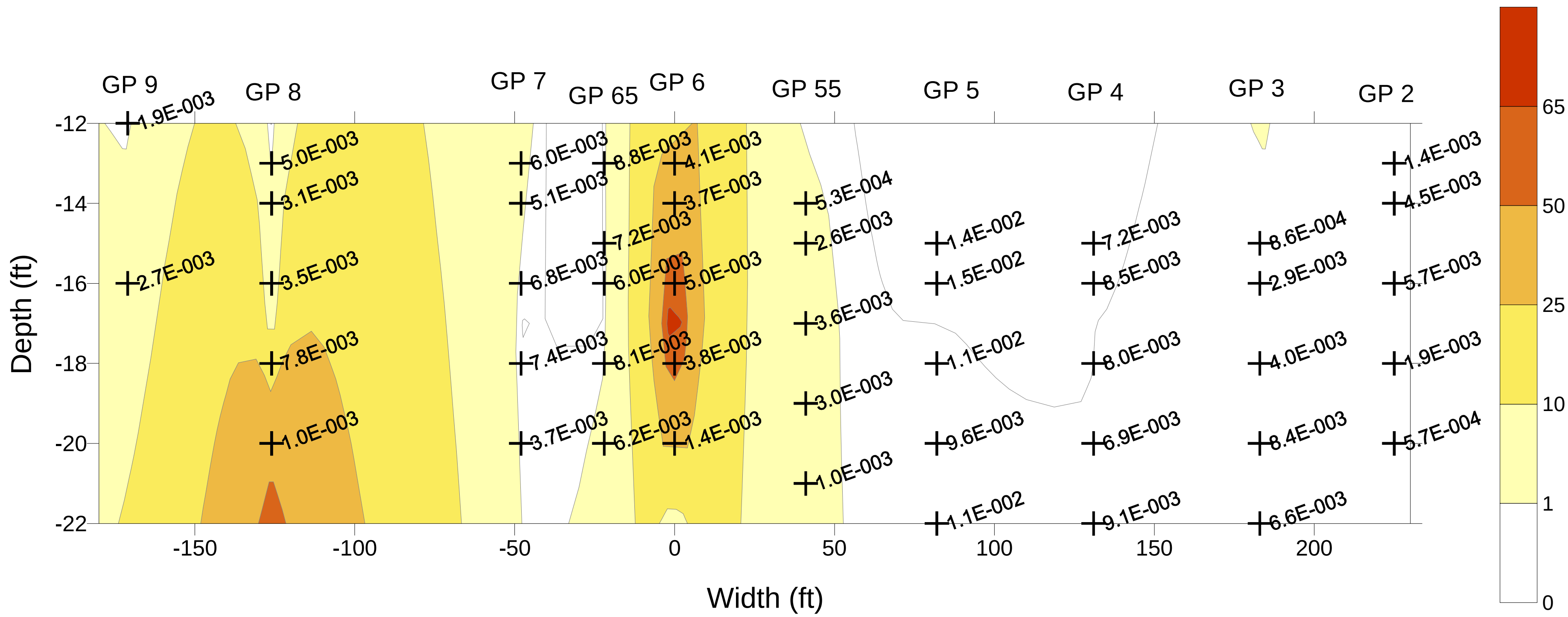


Figure 14. Hydraulic Conductivity Test Data (cm/s) Overlain on Benzene Contour Plot

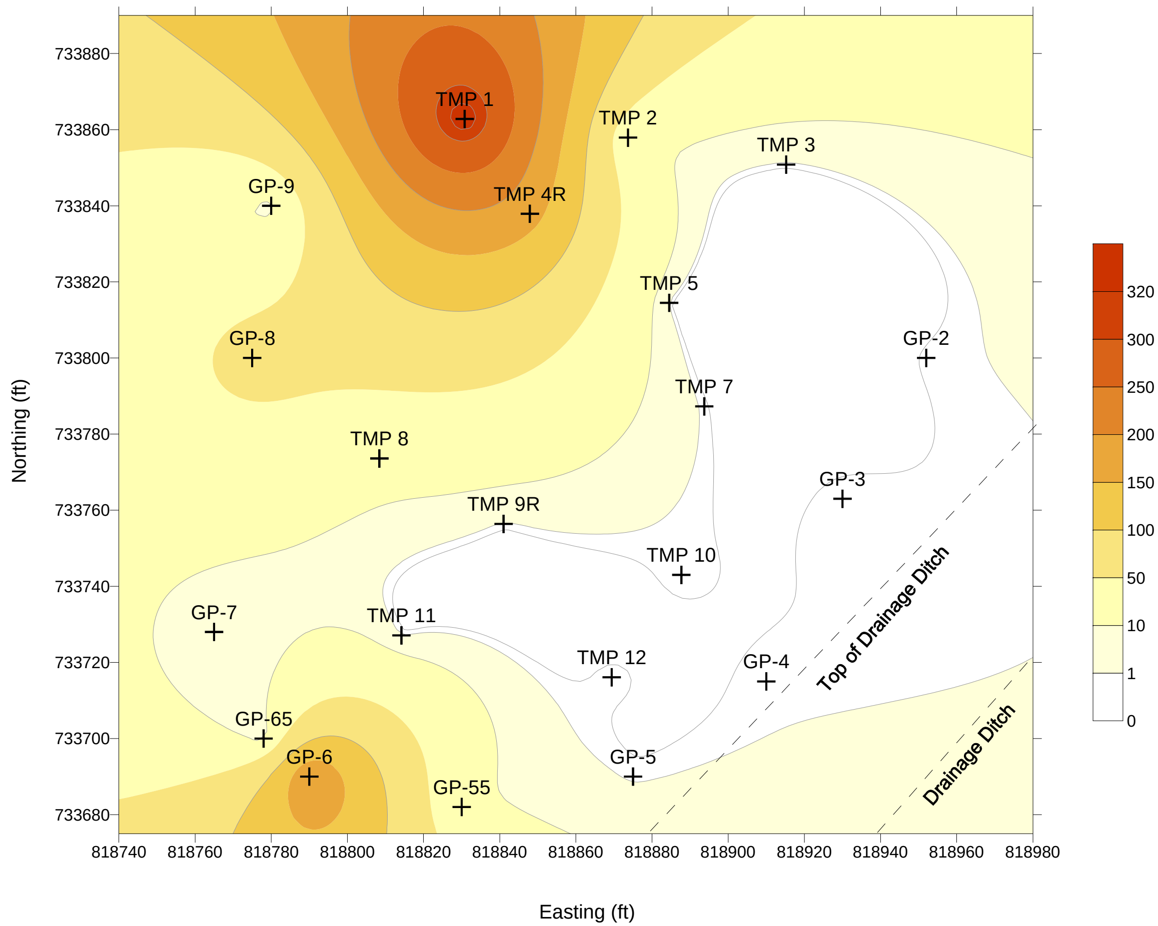


Figure 15. Benzene Contour Plot

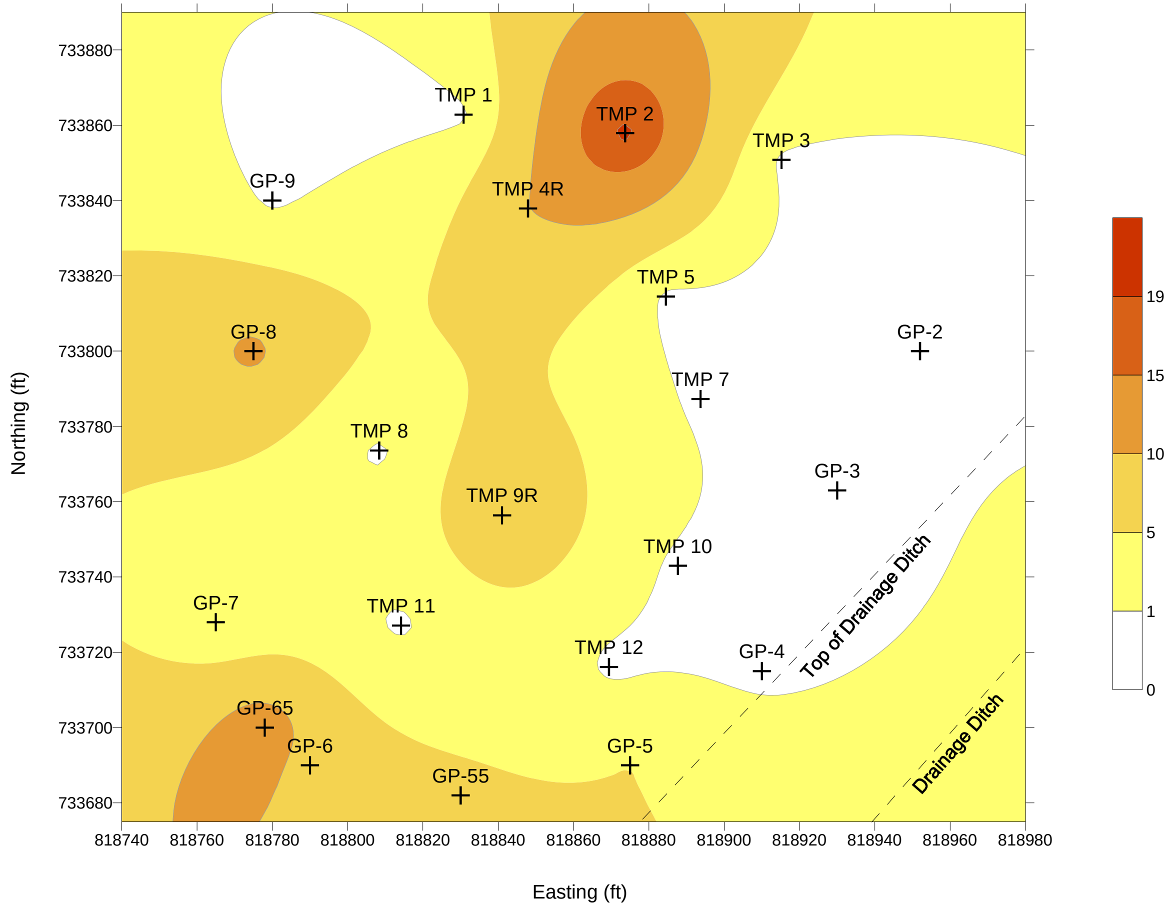


Figure 16. Toluene Contour Plot

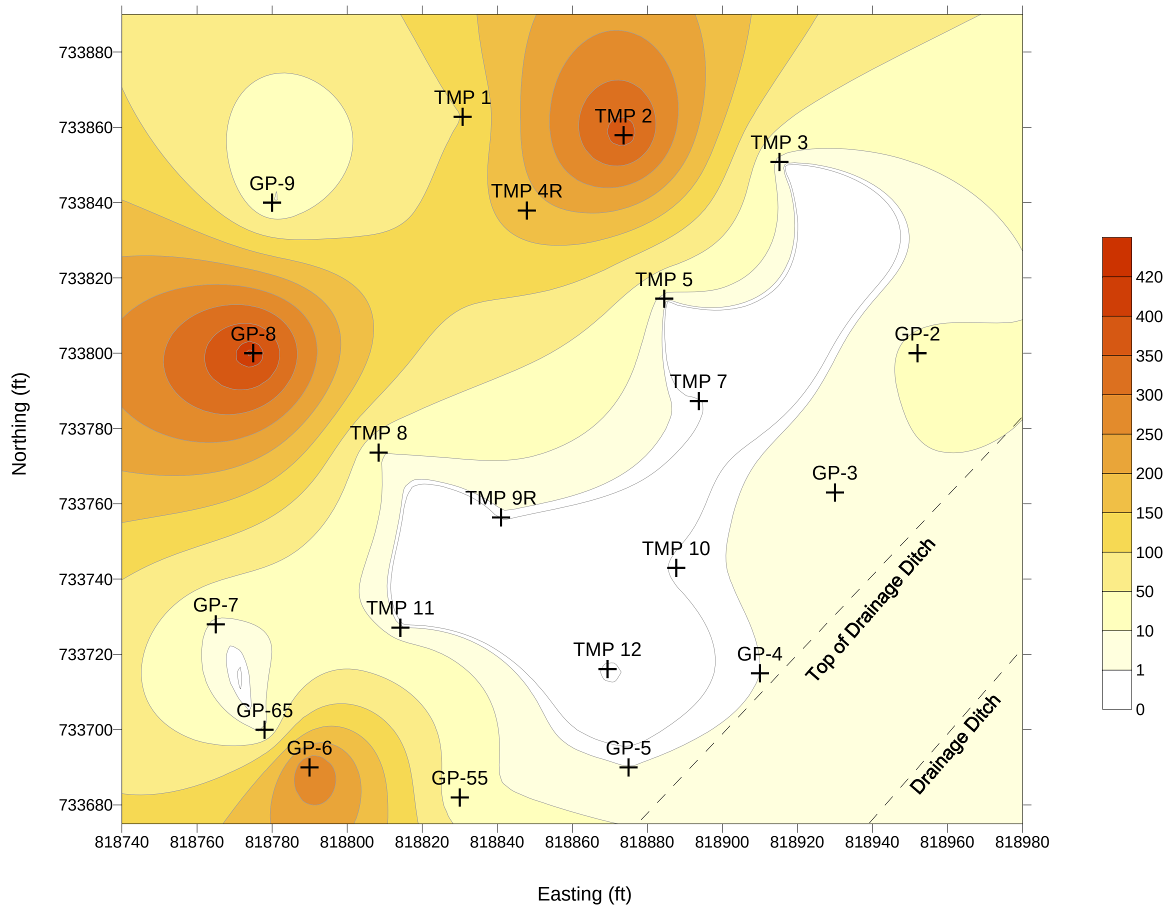


Figure 17. Ethylbenzene Contour Plot

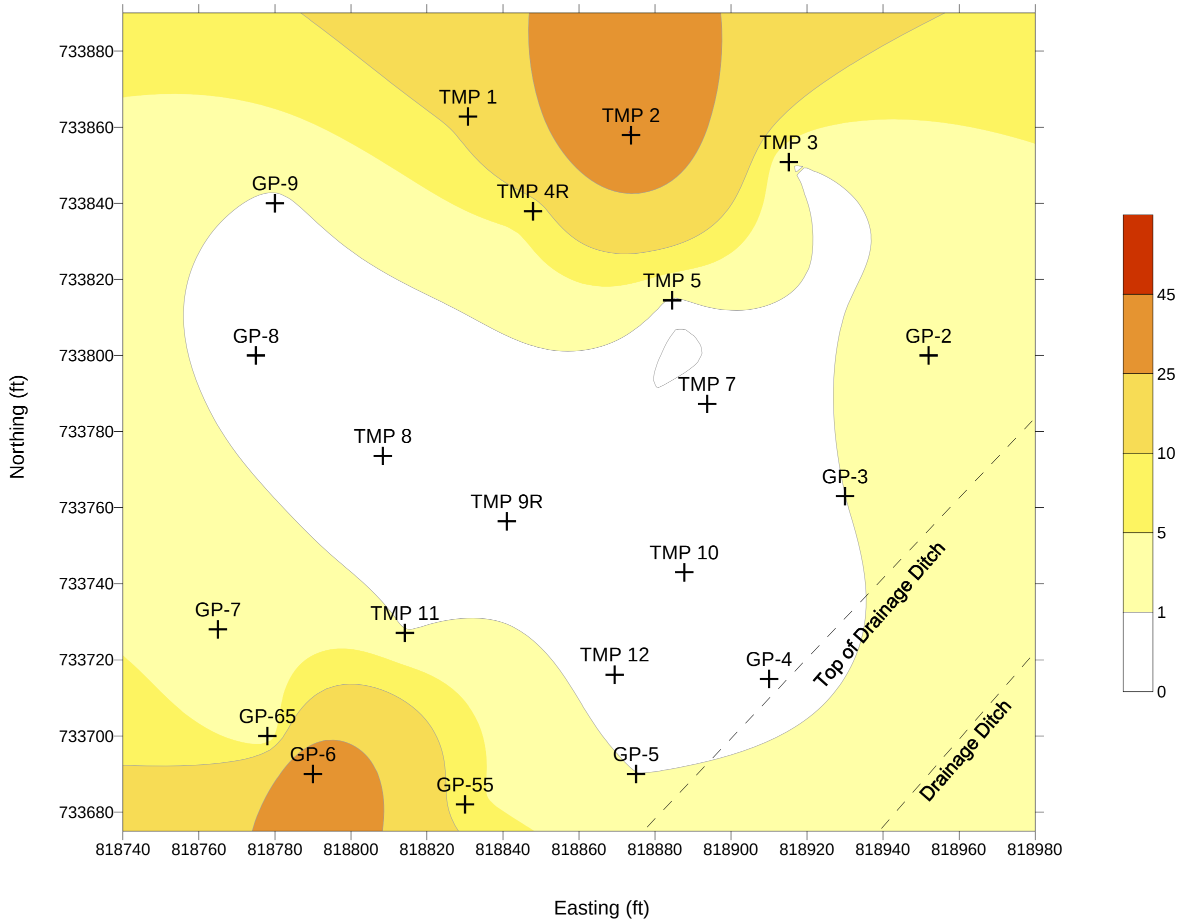


Figure 18. m/p Xylenes Contour Plot

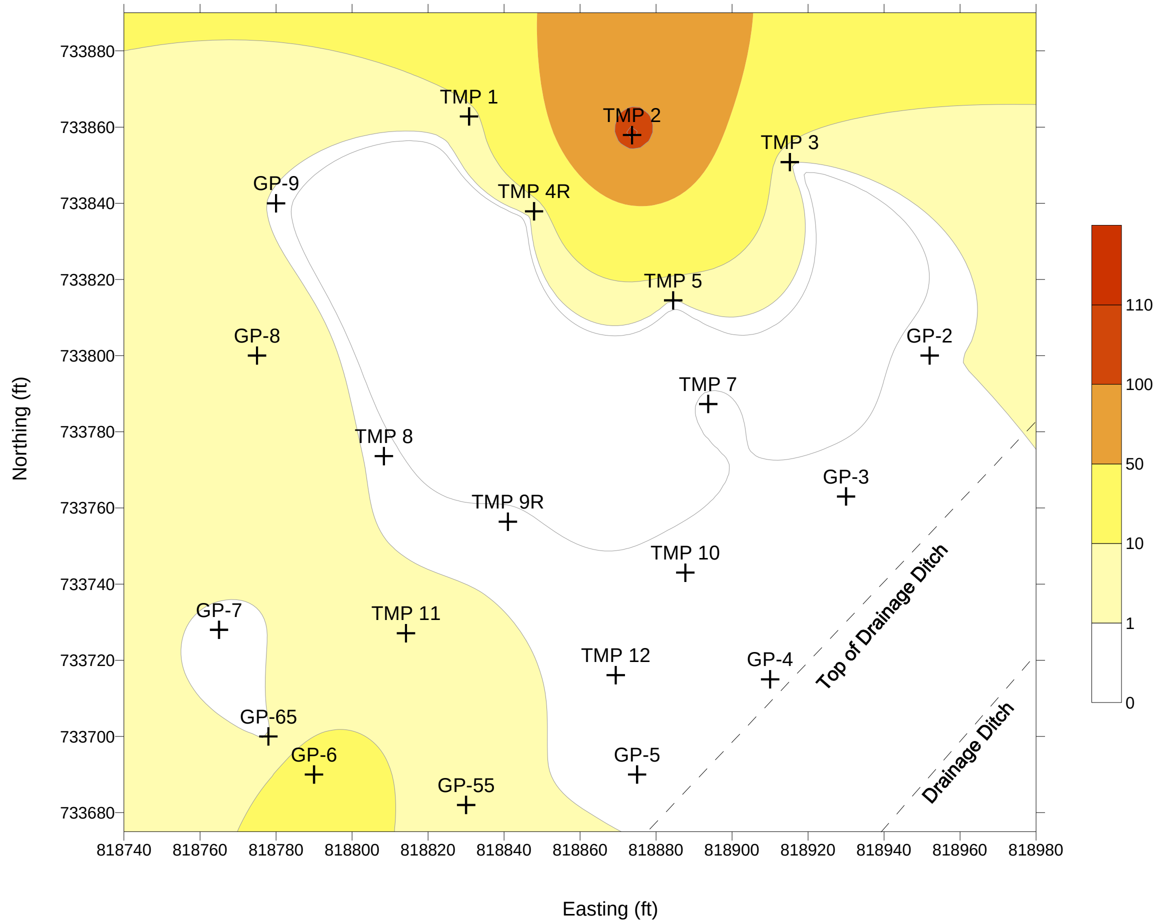


Figure 19. O Xylenes Contour Plot

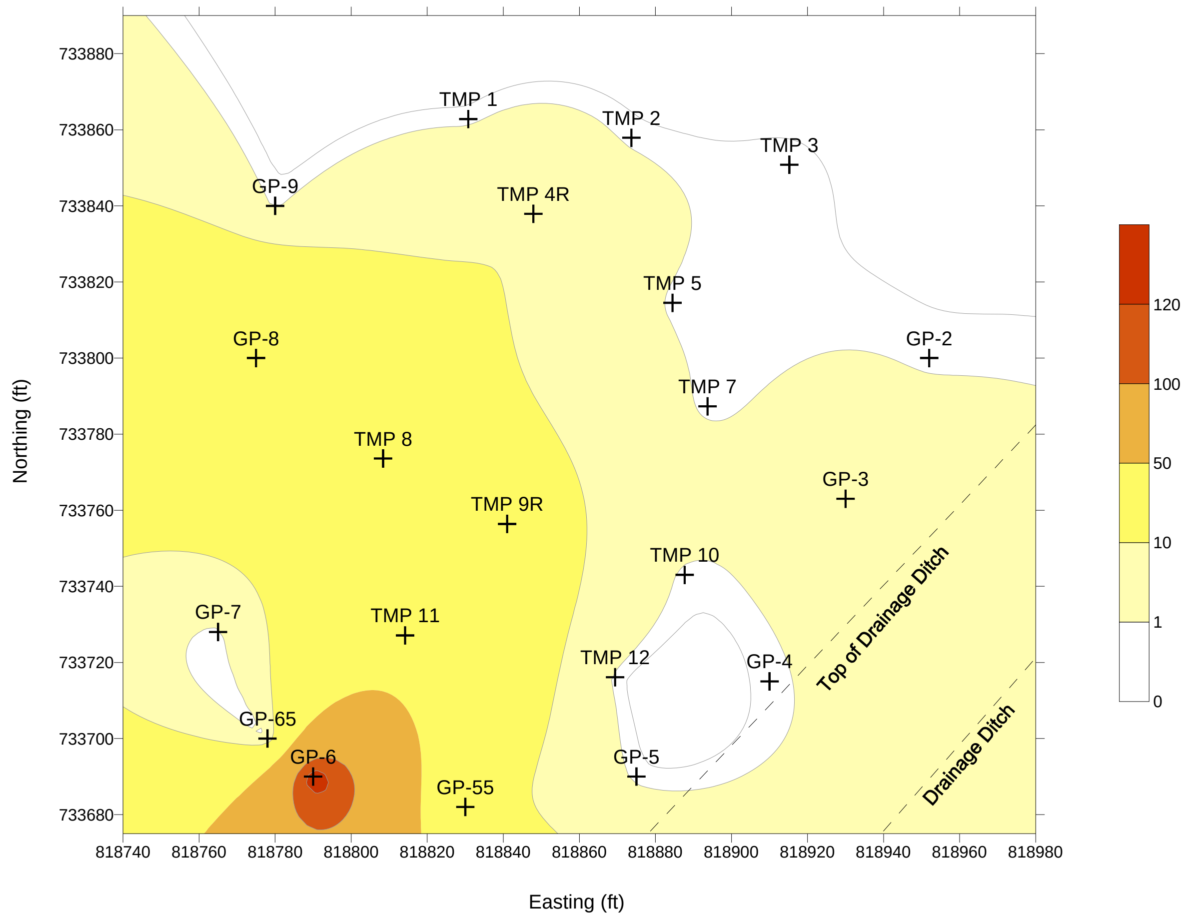
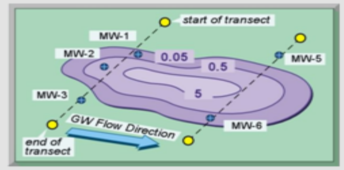


Figure 20. Naphthalene Contour Plot

Input Data and Grid

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



Site Location and I.D.: Hunter AAF
Description: Former Pumphouse #2

4. CHOOSE TRANSECT Transect 1

5. CHOOSE TIME PERIOD 1

6. ENTER TRANSECT DATA

6.1 Distance of Transect 1 from Source → 400 (ft)

6.2 ○ Darcy Velocity ◉ Hydraulic Conductivity

6.6 ◉ Sampling Interval ○ Mid Point of Sampling Interval

6.3 Hydraulic Conductivity Units: ft/d

6.4 Uniform Hydraulic Conductivity? No

6.5 Uniform Hydraulic Gradient? Yes → Hydraulic Gradient 1.00E-02 (ft/ft)

	Monitoring Point	Distance of Monitoring Point from Start of Transect (ft)	Sampling Interval (ft bgs) Top	Sampling Interval (ft bgs) Bottom	Plume Top (ft bgs)	Plume Bottom (ft bgs)	Hydraulic Conductivity (ft/d)	Concentration (ug/L) Constituent A Benzene	Concentration (ug/L) Constituent B
1	Start of Transect	0						0	0
2	End of Transect	400						0	0
3	GP 2	2	13	13.5	12.5	22.5	3.8	0.5	
4	GP 2	2	14	14.5	12.5	22.5	13	0.5	
5	GP 2	2	16	16.5	12.5	22.5	16	0.5	
6	GP 2	2	18	18.5	12.5	22.5	5.3	0.5	
7	GP 2	2	20	20.5	12.5	22.5	16	0.5	
8	GP 3	46	13	13.5	12.5	22.5	2.4	1	
9	GP 3	46	14	14.5	12.5	22.5	8.3	0.5	
10	GP 3	46	16	16.5	12.5	22.5	11	0.5	
11	GP 3	46	18	18.5	12.5	22.5	24	0.5	
12	GP 3	46	20	20.5	12.5	22.5	19	0.5	
13	GP 4	99	13	13.5	12.5	22.5	20	0.5	
14	GP 4	99	14	14.5	12.5	22.5	24	0.5	
15	GP 4	99	16	16.5	12.5	22.5	23	0.5	

7. CHOOSE GRID (OPTIONAL)

	Current Grid	Refine Grid By	Refined Grid
Number of rows	10	1	10
Number of columns	9	3	25

8. SELECT CONSTITUENT FOR CALCULATIONS ◉ Benzene ○ Constituent B

Next Step: Continue Data Input

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

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

Figure 21. Mass Flux Analysis of Benzene Data

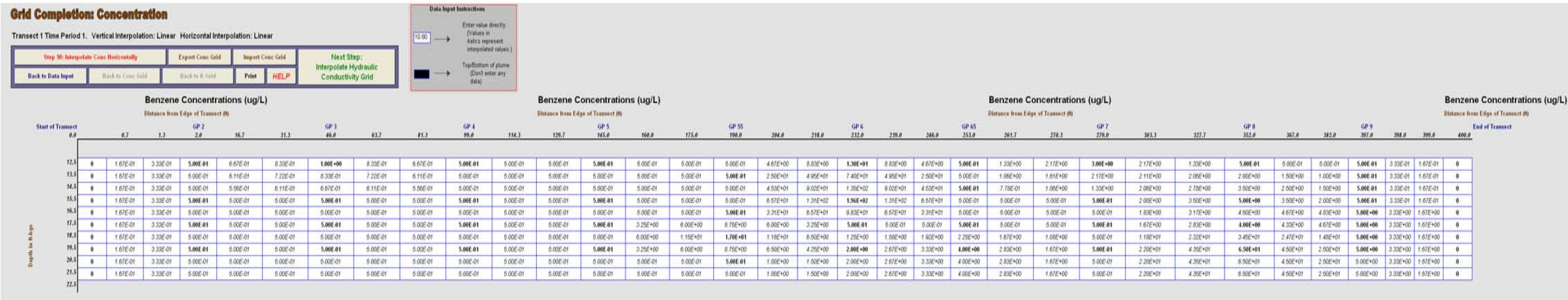
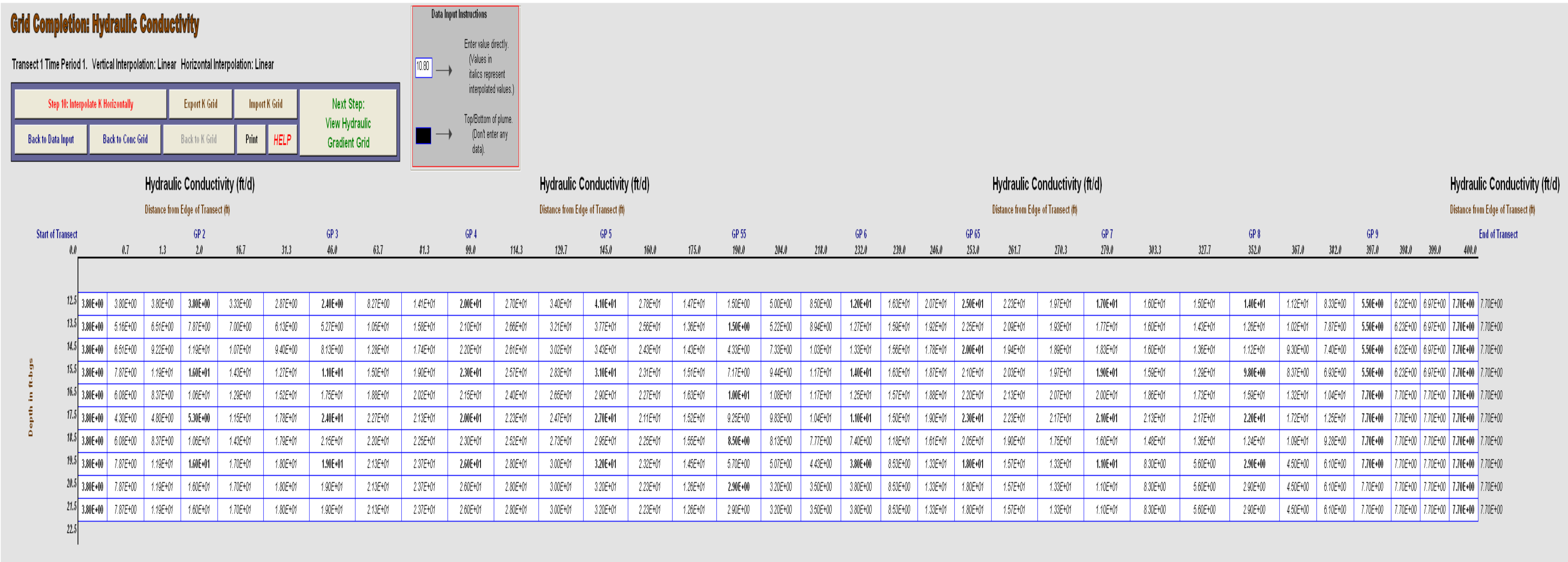


Figure 22. Interpolated Benzene Concentration Grid

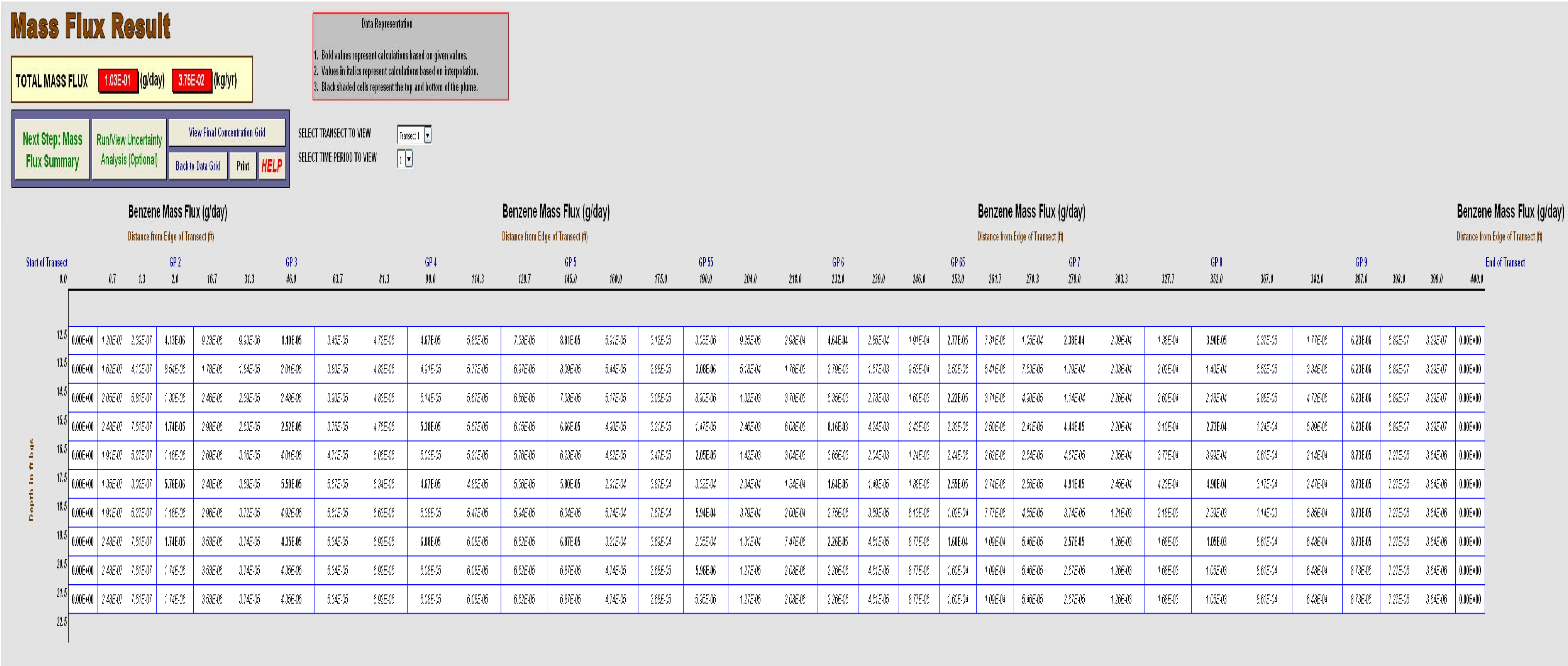


Depth in ft-bgs	Start of Transect 0.0	0.7	1.3	GP 2 2.0	16.7	31.3	GP 3 46.0	63.7	81.3	GP 4 99.0	114.3	129.7
12.5	3.80E+00	3.80E+00	3.80E+00	3.80E+00	3.33E+00	2.87E+00	2.40E+00	8.27E+00	1.41E+01	2.00E+01	2.70E+01	3.40E+01
13.5	3.80E+00	5.16E+00	6.51E+00	7.87E+00	7.00E+00	6.13E+00	5.27E+00	1.05E+01	1.58E+01	2.10E+01	2.66E+01	3.21E+01
14.5	3.80E+00	6.51E+00	9.22E+00	1.19E+01	1.07E+01	9.40E+00	8.13E+00	1.28E+01	1.74E+01	2.20E+01	2.61E+01	3.02E+01
15.5	3.80E+00	7.87E+00	1.19E+01	1.60E+01	1.43E+01	1.27E+01	1.10E+01	1.50E+01	1.90E+01	2.30E+01	2.57E+01	2.83E+01
16.5	3.80E+00	6.08E+00	8.37E+00	1.06E+01	1.29E+01	1.52E+01	1.75E+01	1.88E+01	2.02E+01	2.15E+01	2.40E+01	2.65E+01
17.5	3.80E+00	4.30E+00	4.80E+00	5.30E+00	1.15E+01	1.78E+01	2.40E+01	2.27E+01	2.13E+01	2.00E+01	2.23E+01	2.47E+01
18.5	3.80E+00	6.08E+00	8.37E+00	1.06E+01	1.43E+01	1.79E+01	2.15E+01	2.20E+01	2.25E+01	2.30E+01	2.52E+01	2.73E+01
19.5	3.80E+00	7.87E+00	1.19E+01	1.60E+01	1.70E+01	1.80E+01	1.90E+01	2.13E+01	2.37E+01	2.60E+01	2.80E+01	3.00E+01
20.5	3.80E+00	7.87E+00	1.19E+01	1.60E+01	1.70E+01	1.80E+01	1.90E+01	2.13E+01	2.37E+01	2.60E+01	2.80E+01	3.00E+01
21.5	3.80E+00	7.87E+00	1.19E+01	1.60E+01	1.70E+01	1.80E+01	1.90E+01	2.13E+01	2.37E+01	2.60E+01	2.80E+01	3.00E+01
22.5												

Depth in ft-bgs	GP 5 145.0	160.0	175.0	GP 55 190.0	204.0	218.0	GP 6 232.0	239.0	246.0	GP 65 253.0	261.7	270.3
12.5	4.10E+01	2.78E+01	1.47E+01	1.50E+00	5.00E+00	8.50E+00	1.20E+01	1.63E+01	2.07E+01	2.50E+01	2.23E+01	1.97E+01
13.5	3.77E+01	2.56E+01	1.36E+01	1.50E+00	5.22E+00	8.94E+00	1.27E+01	1.59E+01	1.92E+01	2.25E+01	2.09E+01	1.93E+01
14.5	3.43E+01	2.43E+01	1.43E+01	4.33E+00	7.33E+00	1.03E+01	1.33E+01	1.56E+01	1.78E+01	2.00E+01	1.94E+01	1.89E+01
15.5	3.10E+01	2.31E+01	1.51E+01	7.17E+00	9.44E+00	1.17E+01	1.40E+01	1.63E+01	1.87E+01	2.10E+01	2.03E+01	1.97E+01
16.5	2.90E+01	2.27E+01	1.63E+01	1.00E+01	1.08E+01	1.17E+01	1.25E+01	1.57E+01	1.88E+01	2.20E+01	2.13E+01	2.07E+01
17.5	2.70E+01	2.11E+01	1.52E+01	9.25E+00	9.83E+00	1.04E+01	1.10E+01	1.50E+01	1.90E+01	2.30E+01	2.23E+01	2.17E+01
18.5	2.95E+01	2.25E+01	1.55E+01	8.50E+00	8.13E+00	7.77E+00	7.40E+00	1.18E+01	1.61E+01	2.05E+01	1.90E+01	1.75E+01
19.5	3.20E+01	2.32E+01	1.45E+01	5.70E+00	5.07E+00	4.43E+00	3.80E+00	8.53E+00	1.33E+01	1.80E+01	1.57E+01	1.33E+01
20.5	3.20E+01	2.23E+01	1.26E+01	2.90E+00	3.20E+00	3.50E+00	3.80E+00	8.53E+00	1.33E+01	1.80E+01	1.57E+01	1.33E+01
21.5	3.20E+01	2.23E+01	1.26E+01	2.90E+00	3.20E+00	3.50E+00	3.80E+00	8.53E+00	1.33E+01	1.80E+01	1.57E+01	1.33E+01
22.5												

Depth in ft-bgs	GP 7 279.0	303.3	327.7	GP 8 352.0	367.0	382.0	GP 9 397.0	398.0	399.0	End of Transect 400.0	
12.5	1.70E+01	1.60E+01	1.50E+01	1.40E+01	1.12E+01	8.33E+00	5.50E+00	6.23E+00	6.97E+00	7.70E+00	7.70E+00
13.5	1.77E+01	1.60E+01	1.43E+01	1.26E+01	1.02E+01	7.87E+00	5.50E+00	6.23E+00	6.97E+00	7.70E+00	7.70E+00
14.5	1.83E+01	1.60E+01	1.36E+01	1.12E+01	9.30E+00	7.40E+00	5.50E+00	6.23E+00	6.97E+00	7.70E+00	7.70E+00
15.5	1.90E+01	1.59E+01	1.29E+01	9.80E+00	8.37E+00	6.93E+00	5.50E+00	6.23E+00	6.97E+00	7.70E+00	7.70E+00
16.5	2.00E+01	1.86E+01	1.73E+01	1.59E+01	1.32E+01	1.04E+01	7.70E+00	7.70E+00	7.70E+00	7.70E+00	7.70E+00
17.5	2.10E+01	2.13E+01	2.17E+01	2.20E+01	1.72E+01	1.25E+01	7.70E+00	7.70E+00	7.70E+00	7.70E+00	7.70E+00
18.5	1.60E+01	1.48E+01	1.36E+01	1.24E+01	1.09E+01	9.28E+00	7.70E+00	7.70E+00	7.70E+00	7.70E+00	7.70E+00
19.5	1.10E+01	8.30E+00	5.60E+00	2.90E+00	4.50E+00	6.10E+00	7.70E+00	7.70E+00	7.70E+00	7.70E+00	7.70E+00
20.5	1.10E+01	8.30E+00	5.60E+00	2.90E+00	4.50E+00	6.10E+00	7.70E+00	7.70E+00	7.70E+00	7.70E+00	7.70E+00
21.5	1.10E+01	8.30E+00	5.60E+00	2.90E+00	4.50E+00	6.10E+00	7.70E+00	7.70E+00	7.70E+00	7.70E+00	7.70E+00
22.5											

Figure 23. Interpolated Hydraulic Conductivity Grid



Depth in ft-bgs	Start of Transect 0.0	0.7	1.3	GP 2 2.0	16.7	31.3	GP 3 46.0	63.7	81.3	GP 4 99.0	114.3
12.5	**0.00E+00**	1.20E-07	2.39E-07	**4.13E-06**	9.23E-06	9.93E-06	**1.10E-05**	3.45E-05	4.72E-05	**4.67E-05**	5.86E-05
13.5	**0.00E+00**	1.62E-07	4.10E-07	8.54E-06	1.78E-05	1.84E-05	2.01E-05	3.80E-05	4.82E-05	4.91E-05	5.77E-05
14.5	**0.00E+00**	2.05E-07	5.81E-07	1.30E-05	2.46E-05	2.39E-05	2.48E-05	3.90E-05	4.83E-05	5.14E-05	5.67E-05
15.5	**0.00E+00**	2.48E-07	7.51E-07	**1.74E-05**	2.98E-05	2.63E-05	**2.52E-05**	3.75E-05	4.75E-05	**5.38E-05**	5.57E-05
16.5	**0.00E+00**	1.91E-07	5.27E-07	1.16E-05	2.69E-05	3.16E-05	4.01E-05	4.71E-05	5.05E-05	5.03E-05	5.21E-05
17.5	**0.00E+00**	1.35E-07	3.02E-07	**5.76E-06**	2.40E-05	3.69E-05	**5.50E-05**	5.67E-05	5.34E-05	**4.67E-05**	4.85E-05
18.5	**0.00E+00**	1.91E-07	5.27E-07	1.16E-05	2.96E-05	3.72E-05	4.92E-05	5.51E-05	5.63E-05	5.38E-05	5.47E-05
19.5	**0.00E+00**	2.48E-07	7.51E-07	**1.74E-05**	3.53E-05	3.74E-05	**4.35E-05**	5.34E-05	5.92E-05	**6.08E-05**	6.08E-05
20.5	**0.00E+00**	2.48E-07	7.51E-07	1.74E-05	3.53E-05	3.74E-05	4.35E-05	5.34E-05	5.92E-05	6.08E-05	6.08E-05
21.5	**0.00E+00**	2.48E-07	7.51E-07	1.74E-05	3.53E-05	3.74E-05	4.35E-05	5.34E-05	5.92E-05	6.08E-05	6.08E-05
22.5											

Depth in ft-bgs	129.7	GP 5 145.0	160.0	175.0	GP 55 190.0	204.0	218.0	GP 6 232.0	239.0	246.0	GP 65 253.0	261.7	270.3
12.5	7.38E-05	**8.81E-05**	5.91E-05	3.12E-05	3.08E-06	9.25E-05	2.98E-04	**4.64E-04**	2.86E-04	1.91E-04	**2.77E-05**	7.31E-05	1.05E-04
13.5	6.97E-05	8.09E-05	5.44E-05	2.88E-05	**3.08E-06**	5.18E-04	1.76E-03	2.79E-03	1.57E-03	9.53E-04	2.50E-05	5.41E-05	7.63E-05
14.5	6.56E-05	7.38E-05	5.17E-05	3.05E-05	8.90E-06	1.32E-03	3.70E-03	5.35E-03	2.78E-03	1.60E-03	**2.22E-05**	3.71E-05	4.90E-05
15.5	6.15E-05	**6.66E-05**	4.90E-05	3.21E-05	1.47E-05	2.46E-03	6.08E-03	**8.16E-03**	4.24E-03	2.43E-03	2.33E-05	2.50E-05	2.41E-05
16.5	5.76E-05	6.23E-05	4.82E-05	3.47E-05	**2.05E-05**	1.42E-03	3.04E-03	3.65E-03	2.04E-03	1.24E-03	2.44E-05	2.62E-05	2.54E-05
17.5	5.36E-05	**5.80E-05**	2.91E-04	3.87E-04	3.32E-04	2.34E-04	1.34E-04	**1.64E-05**	1.49E-05	1.88E-05	**2.55E-05**	2.74E-05	2.66E-05
18.5	5.94E-05	6.34E-05	5.74E-04	7.57E-04	**5.94E-04**	3.79E-04	2.00E-04	2.75E-05	3.69E-05	6.13E-05	1.02E-04	7.77E-05	4.65E-05
19.5	6.52E-05	**6.87E-05**	3.21E-04	3.69E-04	2.05E-04	1.31E-04	7.47E-05	**2.26E-05**	4.51E-05	8.77E-05	**1.60E-04**	1.09E-04	5.46E-05
20.5	6.52E-05	6.87E-05	4.74E-05	2.68E-05	**5.96E-06**	1.27E-05	2.08E-05	2.26E-05	4.51E-05	8.77E-05	1.60E-04	1.09E-04	5.46E-05
21.5	6.52E-05	6.87E-05	4.74E-05	2.68E-05	5.96E-06	1.27E-05	2.08E-05	2.26E-05	4.51E-05	8.77E-05	1.60E-04	1.09E-04	5.46E-05
22.5													

Depth in ft-bgs	GP 7 279.0	303.3	327.7	GP 8 352.0	367.0	382.0	GP 9 397.0	398.0	399.0	End of Transect 400.0
12.5	**2.38E-04**	2.39E-04	1.38E-04	**3.90E-05**	2.37E-05	1.77E-05	**6.23E-06**	5.89E-07	3.29E-07	**0.00E+00**
13.5	1.79E-04	2.33E-04	2.02E-04	1.40E-04	6.52E-05	3.34E-05	**6.23E-06**	5.89E-07	3.29E-07	**0.00E+00**
14.5	1.14E-04	2.26E-04	2.60E-04	2.18E-04	9.88E-05	4.72E-05	**6.23E-06**	5.89E-07	3.29E-07	**0.00E+00**
15.5	**4.44E-05**	2.20E-04	3.10E-04	**2.73E-04**	1.24E-04	5.89E-05	**6.23E-06**	5.89E-07	3.29E-07	**0.00E+00**
16.5	4.67E-05	2.35E-04	3.77E-04	3.99E-04	2.61E-04	2.14E-04	**8.73E-05**	7.27E-06	3.64E-06	**0.00E+00**
17.5	**4.91E-05**	2.45E-04	4.23E-04	**4.90E-04**	3.17E-04	2.47E-04	**8.73E-05**	7.27E-06	3.64E-06	**0.00E+00**
18.5	3.74E-05	1.21E-03	2.18E-03	2.39E-03	1.14E-03	5.85E-04	**8.73E-05**	7.27E-06	3.64E-06	**0.00E+00**
19.5	**2.57E-05**	1.26E-03	1.68E-03	**1.05E-03**	8.61E-04	6.48E-04	**8.73E-05**	7.27E-06	3.64E-06	**0.00E+00**
20.5	2.57E-05	1.26E-03	1.68E-03	1.05E-03	8.61E-04	6.48E-04	8.73E-05	7.27E-06	3.64E-06	**0.00E+00**
21.5	2.57E-05	1.26E-03	1.68E-03	1.05E-03	8.61E-04	6.48E-04	8.73E-05	7.27E-06	3.64E-06	**0.00E+00**
22.5										

Figure 24. Benzene Mass Flux Results

Tables

Table 1. Geologic Descriptions of Continuous Soil Cores (March/April 2007)

Boring Depth (ft)	Subsurface Features
Continuous Soil Core GP 3	
0-20	Fine Sand
Continuous Soil Core GP 6	
0-20	Fine Sand

Table 2. Sampling Locations and Types of Test Performed (March/April 2007)

Groundwater Monitoring Well or Direct-push Sampling Location	Physical Assessment			Water Quality Assessment	
	Depth-To-Water Measurement	Slug Testing	Constant Drawdown Aquifer Testing	Field Parameters[(c)]	Dissolved Petroleum Hydrocarbon Analysis
TMP 1	Yes		Yes	Yes	Yes
TMP 2	Yes		Yes	Yes	Yes
TMP 3	Yes		Yes	Yes	Yes
TMP 4R	Yes		Yes	Yes	Yes
TMP 5	Yes		Yes	Yes	Yes
TMP 7	Yes		Yes	Yes	Yes
TMP 8	Yes		Yes	Yes	Yes
TMP 9R	Yes		Yes	Yes	Yes
TMP 10	Yes		Yes	Yes	Yes
TMP 11	Yes		Yes	Yes	Yes
TMP 12	Yes		Yes	Yes	Yes
P2-MW28	Yes	Yes		Yes	Yes
GP 2[(a)]	Yes[(b)]		Yes		Yes
GP 3[(a)]	Yes[(b)]		Yes		Yes
GP 4[(a)]	Yes[(b)]		Yes		Yes
GP 5[(a)]	Yes[(b)]		Yes		Yes
GP 6[(a)]	Yes[(b)]		Yes		Yes
GP 7[a]	Yes[(b)]		Yes		Yes
GP 8[(a)]	Yes[(b)]		Yes		Yes
GP 9[(a)]	Yes[(b)]		Yes		Yes
GP 55[(a)]	Yes[(b)]		Yes		Yes
GP 65[(a)]	Yes[(b)]		Yes		Yes

(a) Water quality assessments and constant drawdown tests at direct-push locations were performed on 1 and 2-ft intervals from the phreatic surface (~13' bgs) to 20-22' bgs.
(b) Depth to water measurements are approximate and not intended for groundwater elevation calculations.
(c) Field parameters include: pH, electrical conductivity, temperature, dissolved oxygen, and oxidation reduction potential.

Table 3. Slug Test Results (March/April 2007)

Monitoring Well	Well Screen (ft)	Hvorslev K (cm/s)	Hvorslev K (ft/d)	Bouwer and Rice K (cm/s)	Bouwer and Rice K (ft/d)
P2-MW28	8-18	7.05E-03	19.34	1.34E-03	3.60

Note:
The total depth of monitoring well P2-MW28 measured approximately 20 ft bgs, which did not correspond with the well completion specifications which reported a total depth of 18 ft bgs.

Table 4. Field Data and Results for Constant Drawdown Aquifer Testing in Monitoring Wells (March/April 2007)

Sampling Location*	Drawdown (ΔH) (ft BSWS**)	Volume purged (ml)	Time (min)	Time (sec)	Total Time (sec)	Q (ft3/s)	Q/ΔH ($ft^3/ft/s$)	K (cm/sec)	K (ft/d)
TMP 1	0.17	3000	2	8	128	8.3E-04	5.0E-03	5.6E-02	1.6E+02
TMP 2	0.25	3000	2	9	129	8.2E-04	3.3E-03	5.5E-02	1.6E+02
TMP 3	0.25	3000	2	1	121	8.8E-04	3.5E-03	4.9E-02	1.4E+02
TMP 4R	0.25	3000	3	8	188	5.6E-04	2.3E-03	2.1E-02	6.1E+01
TMP 5	0.25	2500	1	28	88	1.0E-03	4.0E-03	1.0E-01	2.9E+02
TMP 7	0.25	3000	2	44	164	6.5E-04	2.6E-03	7.9E-02	2.3E+02
TMP 8	0.25	3000	2	14	134	7.9E-04	3.2E-03	4.3E-02	1.2E+02
TMP 9R	0.25	3000	3	50	230	4.6E-04	1.8E-03	2.3E-02	6.6E+01
TMP 10	0.25	3000	2	15	135	7.8E-04	3.1E-03	5.3E-02	1.5E+02
TMP 11	0.25	1500	1	1	61	8.7E-04	3.5E-03	4.3E-02	1.2E+02
TMP 12	0.25	3000	2	55	175	6.1E-04	2.4E-03	5.8E-02	1.6E+02

* See Figure 3

** BSWS – Below estimated static water surface

Table 5. Depth-to-Groundwater and Groundwater Elevations for Monitoring Wells (March/April 2007)

Monitoring Well	Top of Casing Elevation (NGVD29) (ft)	Ground Surface Elevation (NGVD29) (ft)	NAD 27 Northing Coordinate (ft)	NAD 27 Easting Coordinate (ft)	DTW (m BTOC)	DTW (ft BTOC)	Groundwater Elevation (m)	Groundwater Elevation (ft)
TMP 1	39.12	38.40	733862.80	818830.80	4.19	13.76	7.73	25.36
TMP 2	39.84	39.00	733857.90	818873.70	4.42	14.48	7.73	25.36
TMP 3	39.53	38.80	733850.80	818915.20	4.33	14.19	7.72	25.34
TMP 4R	38.51	38.70	733837.90	818847.90	3.69	12.12	8.04	26.39
TMP 5	39.64	38.70	733814.50	818884.50	4.57	14.99	7.51	24.65
TMP 7	39.62	38.80	733787.30	818893.70	4.62	15.17	7.45	24.45
TMP 8	---	---	733773.60	818808.40	---	---	---	---
TMP 9R	38.03	38.40	733756.40	818841.00	3.65	11.99	7.94	26.04
TMP 10	39.43	38.60	733743.00	818887.70	4.42	14.50	7.60	24.93
TMP 11	38.70	37.80	733727.10	818814.20	4.25	13.95	7.54	24.75
TMP 12	39.71	38.70	733716.10	818869.40	4.55	14.93	7.55	24.78
P2-MW28	N/A	39.40	N/A	N/A	3.97	13.02	8.04	26.38

DTW - Depth-to-water
BTOC - Below top of casing
BGS - Below ground surface
N/A - Data not available
NAD 27 – North American Datum of 1927
NGVD29 – National Geodetic Vertical Datum of 1929
--- Unable to take a water level reading because casing was destroyed

Table 6. Water Quality Data for Monitoring Wells (March/April 2007)

Monitoring Well	Water Quality Data[(a)]				
	pH	**EC (mS)**	**Temperature (°C)**	**DO (mg/L)**	**ORP (mV)**
TMP 1	6.4	0.56	20.4	1.1	-50
TMP 2	6.7	0.40	20.0	0.8	-160
TMP 3	6.3	0.23	19.6	1.1	-4
TMP 4R	6.4	0.50	20.4	0.9	-163
TMP 5	6.2	0.32	20.3	1.2	-10
TMP 7	6.0	0.40	20.5	1.5	11
TMP 8	6.3	0.43	20.4	1.2	-9
TMP 9R	6.4	0.39	20.8	1.2	14
TMP 10	5.8	0.30	21.5	1.3	45
TMP 11	6.1	0.45	21.9	1.5	-13
TMP 12	6.3	0.30	22.0	1.7	51
P2-MW28	5.3	0.09	20.8	1.0	66

(a) All measurements were made with a Horiba U-22 meter.
EC = electrical conductivity
DO = dissolved oxygen
ORP = oxidation-reduction potential

Table 7. Chemical Concentration Data for Monitoring Wells (March/April 2007)

Monitoring Well	Concentration (μg/L)					
	Benzene	Toluene	Ethylbenzene	m/p-Xylene	o-Xylene	Naphthalene
TMP 1	342	1	98	12	5	<1
TMP 2	16	16	377	46	115	<1
TMP 2 DUP	<1	13	361	45	124	<1
TMP 3	<1	<1	2	1	<1	<1
TMP 3 REP	<1	<1	<1	1	<1	<1
TMP 4R	171	15	182	7	2	12
TMP 4R DUP	192	18	<1	8	5	20
TMP 5	<1	1	<1	<1	<1	<1
TMP 7	<1	4	<1	<1	<1	<1
TMP 8	23	4	11	<1	<1	8
TMP 9R	<1	8	4	1	<1	16
TMP 10	<1	1	<1	<1	<1	<1
TMP 11	2	3	1	1	2	43
TMP11 DUP	2	3	1	1	1	41
TMP 12	<1	1	<1	<1	<1	<1
TMP 12 REP	<1	1	<1	<1	1	<1
P2-MW28	<1	<1	2	<1	<1	<1

DUP - Duplicate sample
REP - Quality control sample (second analysis of same water sample)

Table 8. Chemical Concentration Data for Direct-Push Downgradient Transect Locations (March/April 2007)

Sampling Location*	Concentration (µg/L)					
	Benzene	Toluene	Ethylbenzene	m/p-Xylene	o-Xylene	Naphthalene
GP 2-13	<1	<1	9	2	<1	<1
GP 2-14	<1	<1	14	3	<1	<1
GP 2-16	<1	<1	3	<1	1	<1
GP 2-18	<1	1	<1	<1	<1	<1
GP 2-20	<1	1	<1	<1	<1	<1
GP 3-15	1	1	5	1	<1	<1
GP 3-15 REP	1	1	4	1	<1	<1
GP 3-16	<1	1	9	1	<1	2
GP 3-18	<1	<1	1	<1	<1	7
GP 3-20	<1	<1	1	<1	<1	<1
GP 3-22	<1	<1	1	<1	<1	<1
GP 4-15	<1	<1	1	<1	<1	<1
GP 4-16	<1	<1	<1	<1	<1	<1
GP 4-18	<1	<1	1	<1	<1	<1
GP 4-20	<1	0	<1	<1	<1	<1
GP 4-20 DUP	<1	0	<1	<1	<1	<1
GP 4-22	<1	<1	<1	<1	<1	<1
GP 5-15	<1	<1	<1	<1	<1	<1
GP 5-16	<1	<1	1	1	<1	<1
GP 5-18	<1	5	<1	<1	<1	<1
GP 5-18 DUP	<1	<1	<1	<1	<1	<1
GP 5-20	<1	<1	<1	<1	<1	<1
GP 5-22	<1	<1	<1	<1	<1	<1
GP 5-22 REP	<1	<1	<1	<1	<1	<1
GP 55-14	<1	6	<1	<1	<1	<1
GP 55-15	4	1	<1	<1	2	16
GP 55-17	<1	2	<1	<1	<1	<1
GP 55-19	16	4	19	6	<1	13
GP 55-19 REP	18	5	18	6	<1	9
GP 55-21	<1	<1	<1	<1	<1	<1
GP 6-13	13	2	25	2	<1	<1
GP 6-14	5	<1	4	<1	<1	<1
GP 6-14 DUP	<1	8	6	2	1	27
GP 6-16	196	7	306	43	20	132
GP 6-18	<1	<1	25	6	1	19
GP 6-20	2	2	3	<1	1	<1
GP 65-13	<1	13	<1	<1	<1	<1
GP 65-15	<1	<1	1	1	<1	<1
GP 65-16	<1	<1	<1	<1	<1	<1
GP 65-18	<1	<1	<1	<1	<1	<1
GP 65-18 DUP	<1	<1	<1	<1	<1	<1
GP 65-20	4	1	2	<1	<1	<1
GP 7-13	3	<1	4	<1	<1	<1
GP 7-14	2	1	2	4	<1	<1
GP 7-16	<1	<1	<1	<1	<1	<1
GP 7-18	<1	<1	<1	<1	<1	<1
GP 7-20	<1	<1	<1	2	<1	<1
GP 8-13	<1	<1	<1	<1	<1	<1

Sampling Location*	Concentration (µg/L)					
	Benzene	Toluene	Ethylbenzene	m/p-Xylene	o-Xylene	Naphthalene
GP 8-14	<1	<1	<1	<1	<1	<1
GP 8-16	5	<1	4	<1	<1	<1
GP 8-18	4	<1	<1	<1	<1	<1
GP 8-18 REP	<1	<1	<1	<1	<1	<1
GP 8-20	65	11	434	<1	7	40
GP 9-12/16	<1	<1	<1	<1	<1	<1
GP 9-16/20	5	<1	6	<1	<1	<1

See Figure 1
DUP = Duplicate sample, REP = Quality control sample (second analysis of same water sample)

Table 9. Water Quality Data for Direct-Push Downgradient Transect Locations (March/April 2007)

Monitoring Well	Water Quality Data[(a)]				
	pH	EC (mS)	Temperature (°C)	DO (mg/L)	ORP (mV)
GP 2-13	---	---	---	---	---
GP 2-14	---	---	---	---	---
GP 2-16	---	---	---	---	---
GP 2-18	5.6	0.06	22.5	1.0	24
GP 2-20	---	---	---	---	---
GP 3-15	---	---	---	---	---
GP 3-16	---	---	---	---	---
GP 3-18	5.9	0.23	22.3	1.0	-17
GP 3-20	5.7	0.10	22.5	0.9	28
GP 3-22	---	---	---	---	---
GP 4-15	---	---	---	---	---
GP 4-16	6.2	0.41	21.6	0.8	-7
GP 4-18	6.1	0.25	22.3	0.9	19
GP 4-20	6.0	0.11	23.1	1.0	59
GP 4-22	6.1	0.04	23.3	0.9	46
GP 5-15	---	---	---	---	---
GP 5-16	6.2	0.56	23.0	1.0	-9
GP 5-18	6.0	0.50	23.1	0.9	13
GP 5-20	5.5	0.21	23.8	1.0	90
GP 5-22	5.8	0.04	23.7	0.8	77
GP 6-13	---	---	---	---	---
GP 6-14	---	---	---	---	---
GP 6-16	6.4	0.64	25.4	1.1	-60
GP 6-18	5.2	0.18	25.0	1.1	22
GP 6-20	5.5	0.04	25.1	0.9	84
GP 7-13	---	---	---	---	---
GP 7-14	6.0	0.56	23.0	1.8	-21
GP 7-16	5.8	0.29	23.1	1.2	5
GP 7-18	5.8	0.12	22.5	0.8	21
GP 7-20	5.8	0.04	22.3	0.7	110
GP 8-13	---	---	---	---	---
GP 8-14	6.5	0.42	18.8	1.0	-20
GP 8-16	6.4	0.22	20.6	1.0	-35
GP 8-18	6.2	0.12	21.3	1.7	-7
GP 8-20	---	---	---	---	---
GP 9-12/16	6.0	0.28	22.3	1.0	-30
GP 9-16/20	5.9	0.13	22.1	1.2	19
GP 55-14	---	---	---	---	---
GP 55-15	6.2	0.28	22.4	2.7	12
GP 55-17	6.5	0.26	22.3	1.5	-47

Monitoring Well	Water Quality Data[a]				
	pH	EC (mS)	Temperature (°C)	DO (mg/L)	ORP (mV)
GP 55-19	5.8	0.31	23.0	1.3	24
GP 55-21	5.9	0.06	23.5	1.0	35
GP 65-13	---	---	---	---	---
GP 65-15	5.9	0.64	22.1	1.0	-39
GP 65-16	5.9	0.30	21.8	0.9	-3
GP 65-18	5.5	0.09	22.0	0.9	78
GP 65-20	5.6	0.03	22.4	0.8	78

(a) All measurements were made with a Horiba U-22 meter.
--- No water quality data taken
EC = electrical conductivity
DO = dissolved oxygen
ORP = oxidation-reduction potential

Table 10. Field Data and Results for Constant Drawdown Aquifer Testing in Direct-Push Downgradient Transect Locations (March/April 2007)

Sampling Location*	Drawdown (ΔH) (ft BSWS**)	Volume purged (ml)	Time (min)	Time (sec)	Total Time (sec)	Q (ft3/s)	Q/ΔH (ft^3/ft/s)	K (ft/sec)	K (cm/sec)	K (ft/d)
GP 2-13	0.67	60	2	0	120	1.8E-05	2.6E-05	4.4E-05	1.3E-03	3.8E+00
GP 2-14	1.00	150	1	0	60	8.8E-05	8.8E-05	1.5E-04	4.4E-03	1.3E+01
GP 2-16	1.00	190	1	0	60	1.1E-04	1.1E-04	1.8E-04	5.6E-03	1.6E+01
GP 2-18	3.00	280	1	30	90	1.1E-04	3.7E-05	6.0E-05	1.8E-03	5.2E+00
GP 2-20	3.00	170	3	0	180	3.3E-05	1.1E-05	1.8E-05	5.6E-04	1.6E+00
GP 3-15	0.58	50	3	0	180	9.8E-06	1.7E-05	2.8E-05	8.4E-04	2.4E+00
GP 3-16	1.50	220	1	30	90	8.6E-05	5.8E-05	9.5E-05	2.9E-03	8.2E+00
GP 3-18	3.00	300	0	45	45	2.4E-04	7.8E-05	1.3E-04	3.9E-03	1.1E+01
GP 3-20	1.00	210	0	45	45	1.6E-04	1.6E-04	2.7E-04	8.3E-03	2.3E+01
GP 3-22	1.00	220	1	0	60	1.3E-04	1.3E-04	2.1E-04	6.5E-03	1.8E+01
GP 4-15	0.50	180	1	30	90	7.1E-05	1.4E-04	2.3E-04	7.1E-03	2.0E+01
GP 4-16	1.50	320	0	45	45	2.5E-04	1.7E-04	2.8E-04	8.4E-03	2.4E+01
GP 4-18	1.50	300	0	45	45	2.4E-04	1.6E-04	2.6E-04	7.9E-03	2.2E+01
GP 4-20	1.50	260	0	45	45	2.0E-04	1.4E-04	2.2E-04	6.8E-03	1.9E+01
GP 4-22	1.50	340	0	45	45	2.7E-04	1.8E-04	2.9E-04	8.9E-03	2.5E+01
GP 5-15	0.50	240	1	0	60	1.4E-04	2.8E-04	4.6E-04	1.4E-02	4.0E+01
GP 5-16	1.00	250	0	30	30	2.9E-04	2.9E-04	4.8E-04	1.5E-02	4.2E+01
GP 5-18	1.00	270	0	45	45	2.1E-04	2.1E-04	3.5E-04	1.1E-02	3.0E+01
GP 5-20	1.00	240	0	45	45	1.9E-04	1.9E-04	3.1E-04	9.4E-03	2.7E+01
GP 5-22	1.00	280	0	45	45	2.2E-04	2.2E-04	3.6E-04	1.1E-02	3.1E+01
GP 6-13	0.25	120	3	30	210	2.0E-05	8.1E-05	1.3E-04	4.0E-03	1.1E+01
GP 6-14	0.75	140	1	30	90	5.5E-05	7.3E-05	1.2E-04	3.7E-03	1.0E+01
GP 6-16	1.67	280	1	0	60	1.6E-04	9.9E-05	1.6E-04	5.0E-03	1.4E+01
GP 6-18	2.00	250	1	0	60	1.5E-04	7.4E-05	1.2E-04	3.7E-03	1.0E+01
GP 6-20	2.00	180	2	0	120	5.3E-05	2.6E-05	4.4E-05	1.3E-03	3.8E+00
GP 7-13	0.50	300	3	0	180	5.9E-05	1.2E-04	1.9E-04	5.9E-03	1.7E+01
GP 7-14	1.00	340	2	0	120	1.0E-04	1.0E-04	1.6E-04	5.0E-03	1.4E+01
GP 7-16	1.50	340	1	0	60	2.0E-04	1.3E-04	2.2E-04	6.7E-03	1.9E+01

Sampling Location*	Drawdown (ΔH) (ft BSWS**)	Volume purged (ml)	Time (min)	Time (sec)	Total Time (sec)	Q (ft3/s)	Q/ΔH ($ft^3/ft/s$)	K (ft/sec)	K (cm/sec)	K (ft/d)
GP 7-18	1.50	370	1	0	60	2.2E-04	1.5E-04	2.4E-04	7.3E-03	2.1E+01
GP 7-20	2.50	310	1	0	60	1.8E-04	7.3E-05	1.2E-04	3.7E-03	1.0E+01
GP 8-13	0.50	250	3	0	180	4.9E-05	9.8E-05	1.6E-04	4.9E-03	1.4E+01
GP 8-14	1.50	310	2	0	120	9.1E-05	6.1E-05	1.0E-04	3.0E-03	8.6E+00
GP 8-16	2.00	230	1	0	60	1.4E-04	6.8E-05	1.1E-04	3.4E-03	9.6E+00
GP 8-18	1.50	390	1	0	60	2.3E-04	1.5E-04	2.5E-04	7.7E-03	2.2E+01
GP 8-20	7.83	270	1	0	60	1.6E-04	2.0E-05	3.3E-05	1.0E-03	2.9E+00
GP 9-12/16	0.75	1000	2	35	155	2.3E-04	3.0E-04	6.2E-05	1.9E-03	5.4E+00
GP 9-16/20	1.00	3000	4	10	250	4.2E-04	4.2E-04	8.7E-05	2.7E-03	7.5E+00
GP 55-14	0.42	55	3	0	180	1.1E-05	2.6E-05	4.3E-05	1.3E-03	3.7E+00
GP 55-15	1.33	235	2	0	120	6.9E-05	5.2E-05	8.5E-05	2.6E-03	7.4E+00
GP 55-17	3.00	360	1	0	60	2.1E-04	7.1E-05	1.2E-04	3.5E-03	1.0E+01
GP 55-19	3.00	300	1	0	60	1.8E-04	5.9E-05	9.7E-05	2.9E-03	8.4E+00
GP 55-21	3.50	120	1	0	60	7.1E-05	2.0E-05	3.3E-05	1.0E-03	2.9E+00
GP 65-13	0.92	270	1	0	60	1.6E-04	1.7E-04	2.8E-04	8.7E-03	2.5E+01
GP 65-15	1.00	240	1	0	60	1.4E-04	1.4E-04	2.3E-04	7.1E-03	2.0E+01
GP 65-16	1.00	200	1	0	60	1.2E-04	1.2E-04	1.9E-04	5.9E-03	1.7E+01
GP 65-18	2.00	270	0	30	30	3.2E-04	1.6E-04	2.6E-04	8.0E-03	2.3E+01
GP 65-20	1.50	310	1	0	60	1.8E-04	1.2E-04	2.0E-04	6.1E-03	1.7E+01

* See Figure 2

** BSWS – Below estimated static water surface

Table 11. Monitoring Well Chemical Concentration Data Comparison

Sample Location	Benzene		Toluene		Ethylbenzene		Total Xylenes		Naphthalene	
	ASU (Mar/Apr '07)	HunterAAF (July '05)	ASU (Mar/Apr '07)	HunterAAF (July '05)	ASU (Mar/Apr '07)	Hunter AAF (July '05)	ASU (Mar/Apr '07)	Hunter AAF (July '05)	ASU (Mar/Apr '07)	Hunter AAF (July '05)
	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
TMP 1	340	37.3	<1	6.9	100	193	17	9.8	<1	12.5
TMP 2	20	519	20	137	380	257	161	296	<1	147
TMP 2 DUP	<1	519	10	137	360	257	169	296	<1	147
TMP 3	<1	0.37 J	<1	3.2	<1	1.2	1	1 U	<1	0.45 J
TMP 3 REP	<1	0.37 J	<1	3.2	<1	1.2	1	1 U	<1	0.45 J
TMP 4R	170	1730	10	267	180	635	9	714	10	23.2
TMP 4R DUP	190	1730	20	267	<1	635	13	714	20	23.2
TMP 5	<1	11.3	<1	7	<1	39.9	<1	17.7	<1	1.6
TMP 7	<1	0.35 J	<1	3.3	<1	0.26 J	1	1U	<1	N/A
TMP 8	20	1.6	<1	3	10	1.5	<1	1.2 U	10	0.74 J
TMP 9R	<1	92.6	10	5.5	<1	76.4	1	7.5	20	6.1
TMP 10	<1	1 U	<1	4.8	<1	0.3 J	<1	1 U	<1	N/A
TMP 11	<1	1.2	<1	5.3	<1	1 U	2	1 U	40	N/A
TMP11 DUP	<1	1.2	<1	5.3	<1	1 U	2	1 U	40	N/A
TMP 12	<1	5.4	<1	3.7	<1	0.62 J	<1	1 U	<1	1.3
TMP 12 REP	<1	5.4	<1	3.7	<1	0.62 J	1	1 U	<1	1.3
P2-MW28	<1	N/A	<1	N/A	<1	N/A	<1	N/A	<1	N/A

N/A – No Data Available
Dup – Duplicate Sample
REP – Quality Control Sample (second analysis of same sample)

Draft Final

Data Analysis Report for
Ft. Lewis, Washington – Area 3

Critical Evaluation of the State of
In Situ Thermal Treatment Technologies
for DNAPL Source Zone Treatment

Prepared for:

Environmental Security Technology Certification Program
Arlington, VA

Prepared by:

Arizona State University
Battelle

January 2008

The vendors and products, including the equipment, system components, and other materials identified in this report, are primarily for information purposes only. Although some of these vendors and products may have been used in the past, mention in this report does not constitute a recommendation for using these vendors or products.

Contents

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Acronyms and Abbreviations

DELCD	dry electrolytic conductivity detector
ERH	electrical resistance heating
ESTCP	Environmental Security Technology Certification Program
FID	flame-ionization detector
ft	feet
GC	gas chromatography
kg	kilogram
PID	photo-ionization detector
USACE	U.S. Army Corps of Engineers
VOA	volatile organic analysis
yr	year

1. Introduction

The post-treatment field investigation of Ft. Lewis, Washington – Area 3 (Area 3), under the Environmental Security Technology Certification Program (ESTCP) project CU-0314, *Critical Evaluation of State of the In-Situ Thermal Treatment Technologies*, was performed June 6, 2006 to September 25, 2007. Consistent with the objectives set forth in the CU-0314 Demonstration Plan, field investigations at this site focused on the collection of data to determine dissolved groundwater concentrations and the mass discharge immediately downgradient from the remediated source zone.

The investigation at Area 3 was different than the other field investigations performed under CU-0314; this was the only investigation that spanned the complete treatment cycle of an in-situ thermal remedial application. Since the electrical resistance heating (ERH) application at Area 3 was undergoing installation when field investigations for CU-0314 began, it was decided that pre-, active-, and post-treatment groundwater samples would be collected from existing upgradient, treatment zone, and downgradient groundwater monitoring wells. This monitoring approach provided a comprehensive set of data that allowed for pre- versus post-treatment groundwater data analysis, the ability to assess treatment temperature and groundwater concentration versus time and location, and with existing hydraulic conductivity information generated by the contractor, the ability to calculate a mass discharge from the treatment zone immediately following the application.

2. Field InvestigationS

In accordance with the approved generic demonstration plan for this project, the following site-specific activities were conducted:

1. Collection of groundwater samples from 5 upgradient, 8 treatment-zone, and 4 downgradient groundwater monitoring wells (see Figure 1) for analysis of dissolved chlorinated and petroleum hydrocarbon concentrations. Samples were collected and analyzed for the pre-, during-, and post-treatment thermal time periods.

    a. Table 1 identifies the groundwater monitoring wells from which samples were collected. Groundwater was collected by United States Army Corps of Engineers (USACE) personnel for analysis and stored in volatile organic analysis (VOA) vials preserved hydrochloric acid. Samples were packaged and shipped to Arizona State University where they were analyzed for dissolved chlorinated and petroleum hydrocarbon concentrations by heated-headspace analysis and gas chromatography (GC) using a photo-ionization detector (PID), a flame-ionization detector (FID), and a dry electrolytic conductivity detector (DELCD). Chemical concentration data can be found in Table 2. During the post-treatment sample analysis, 1,1-dichloroethene (DCE), was detected. Therefore, 1,1-DCE analysis was then performed on the pre- and during treatment samples, but it was not detected. All non-detect samples are listed as less than the detection limit.

All monitoring well chemical concentration data has associated sampling temperature data. Temperature data is based on either in-situ thermocouple measurements (for wells within the treatment zone) or field measurements of purge water (for wells outside of treatment zone). Table 3 presents the monitoring well sampling temperature data. An average treatment zone groundwater temperature was calculated from thermocouple data and can be found in Table 4 and Figure 2.

The dissolved chemical concentration data and average treatment zone temperature were plotted against time for each monitoring well. Figures 3 through 19 represent these data parameters.

Using the dissolved TCE groundwater concentration data and hydraulic conductivity measurements made by USACE personnel/contractors for monitoring wells around Area 3, a TCE mass flux calculation was performed[1]. Hydraulic conductivity measurements ranged from 38 to 120 ft/day with an average of 65 ft/day. This range of hydraulic conductivity values was used when determining the mass flux. Ft. Lewis also has a variable hydraulic gradients based on the time of year. A range of hydraulic gradient values was found based on groundwater elevation data recorded throughout 2006-2007. This range of measurements was used in determining the mass flux to provide a reasonable range of values based on the seasonal variations. Table 5 presents the mass flux discharge numbers. The mass flux results for TCE are estimated to be 1.42E-01 to 1.57E+00 kg/yr.

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[1] The Mass Flux Toolkit Version 1.0 was used to calculate the mass flux. The Mass Flux Toolkit is a freeware program developed by Groundwater Services, Inc. and others under a contract funded by ESTCP.

Figures

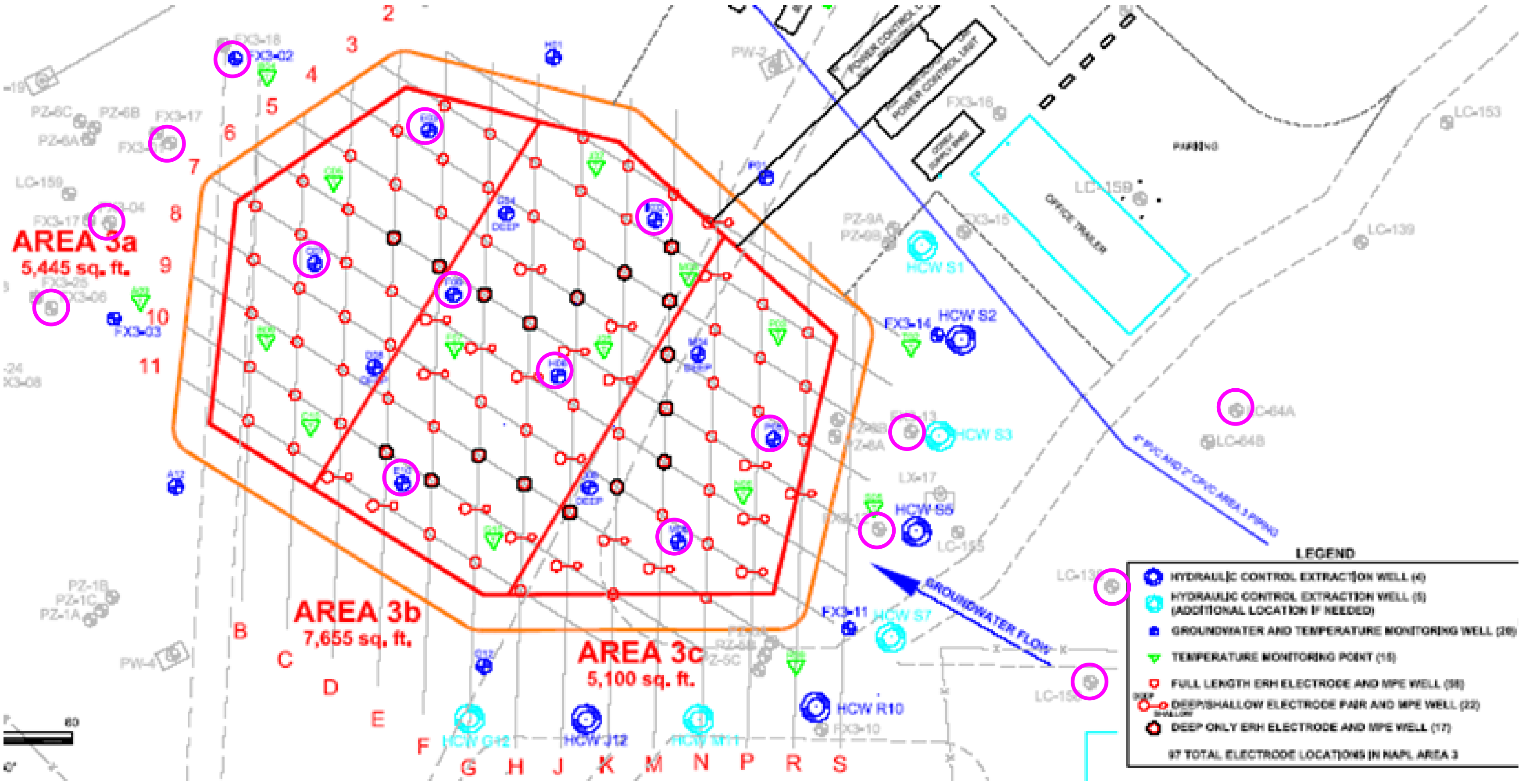

Figure 1. Site Map

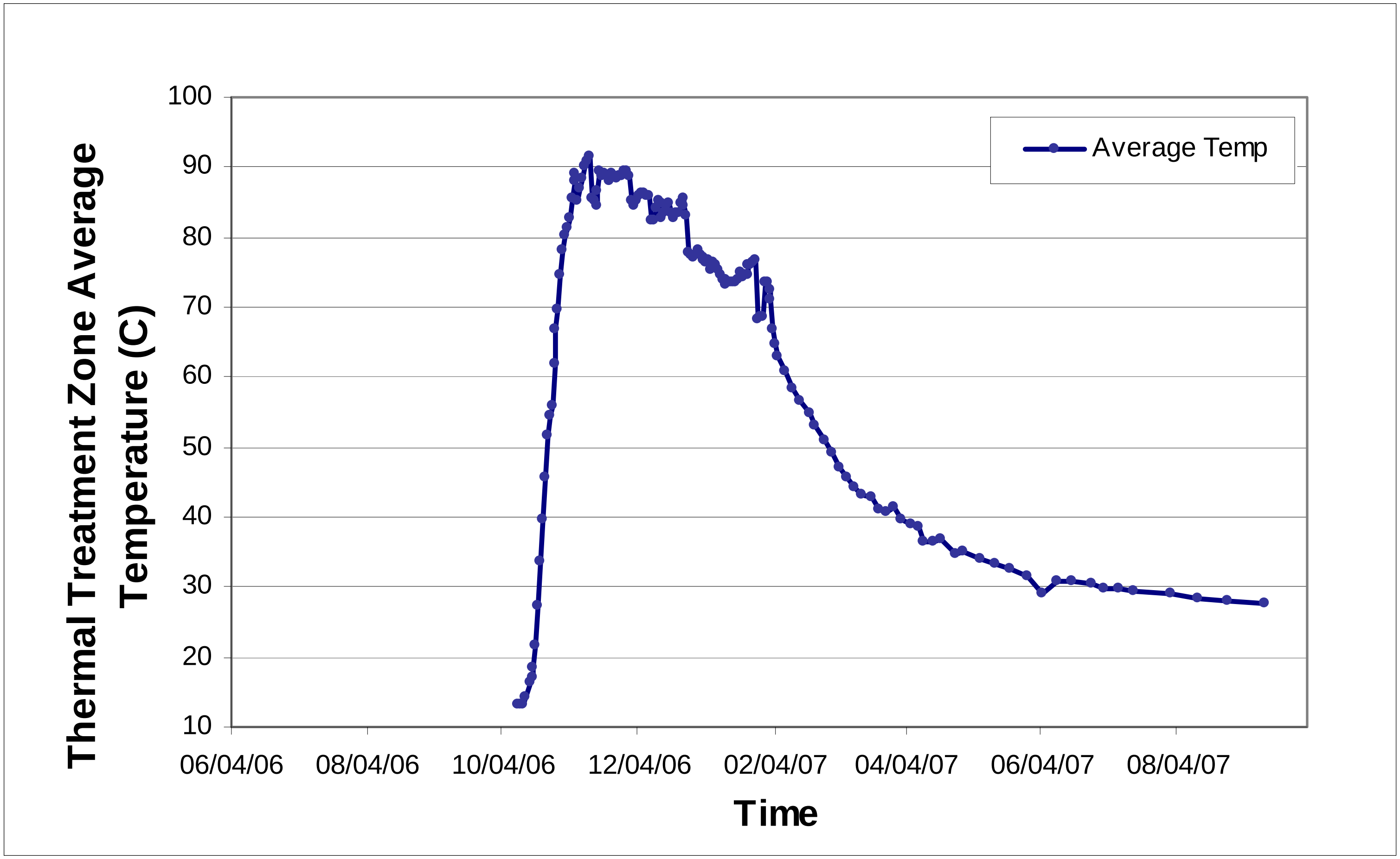

Figure 2. Average Groundwater Temperature (within ERH Treatment Zone)

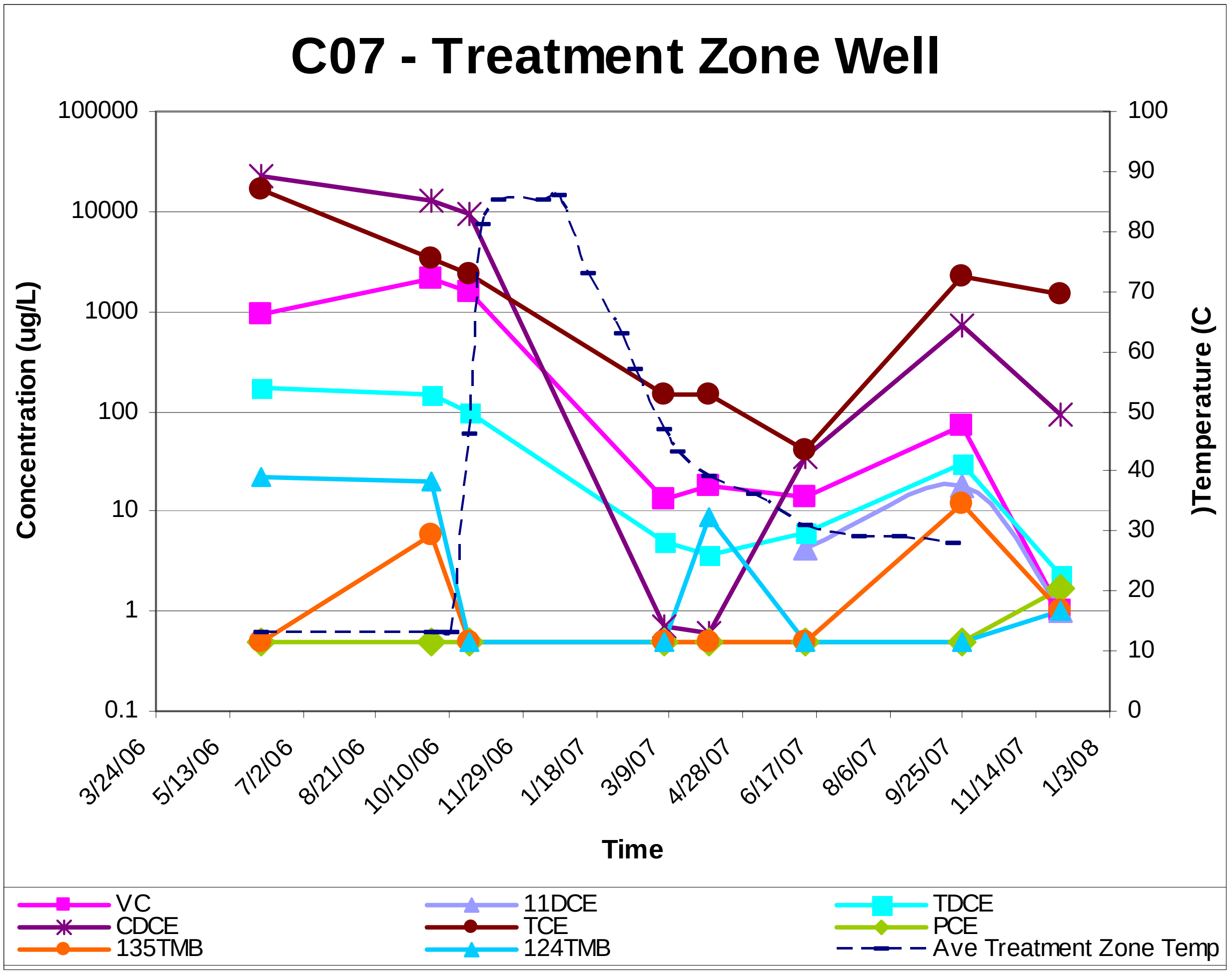

Figure 3. Monitoring Well C07 Data

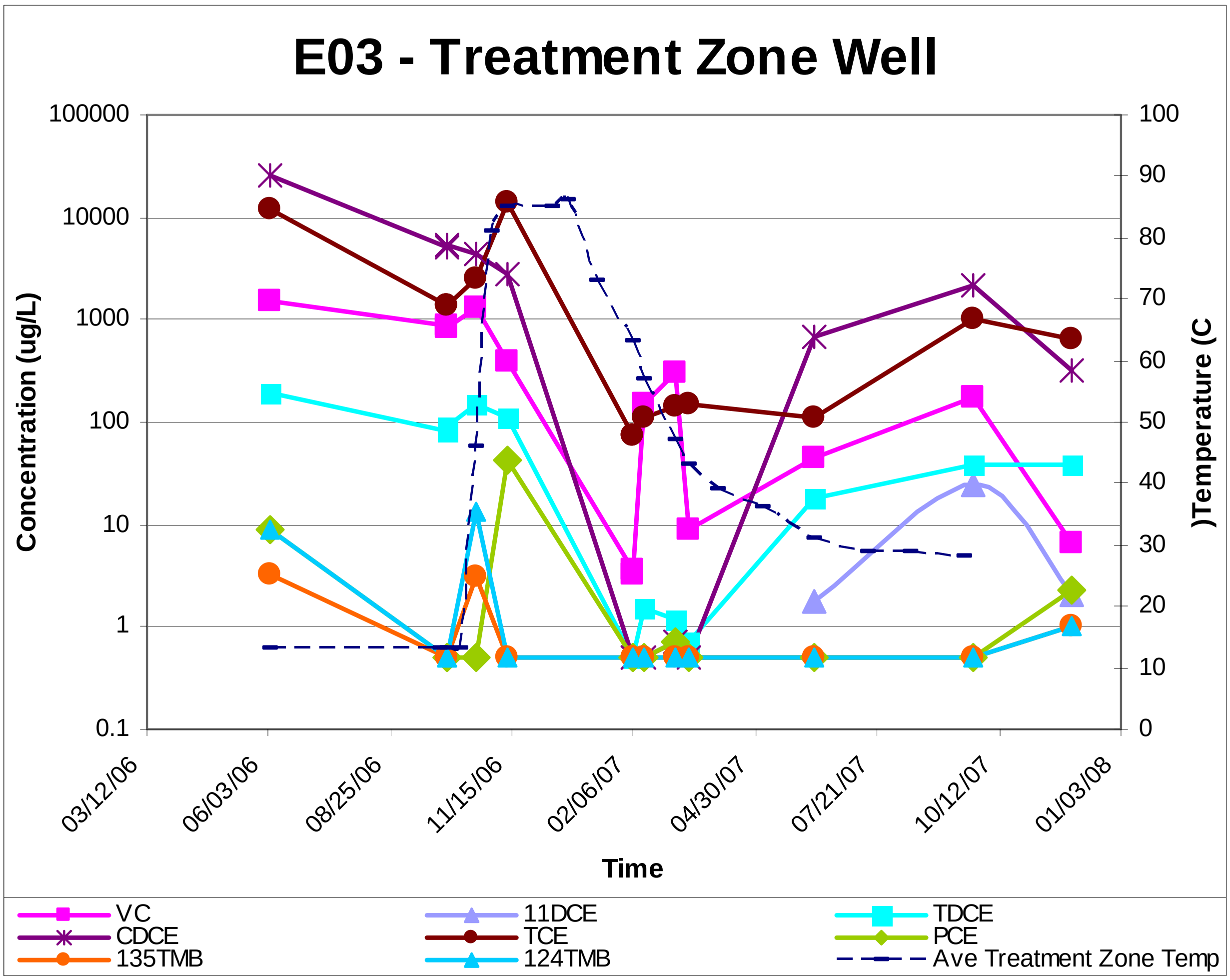

Figure 4. Monitoring Well E03 Data

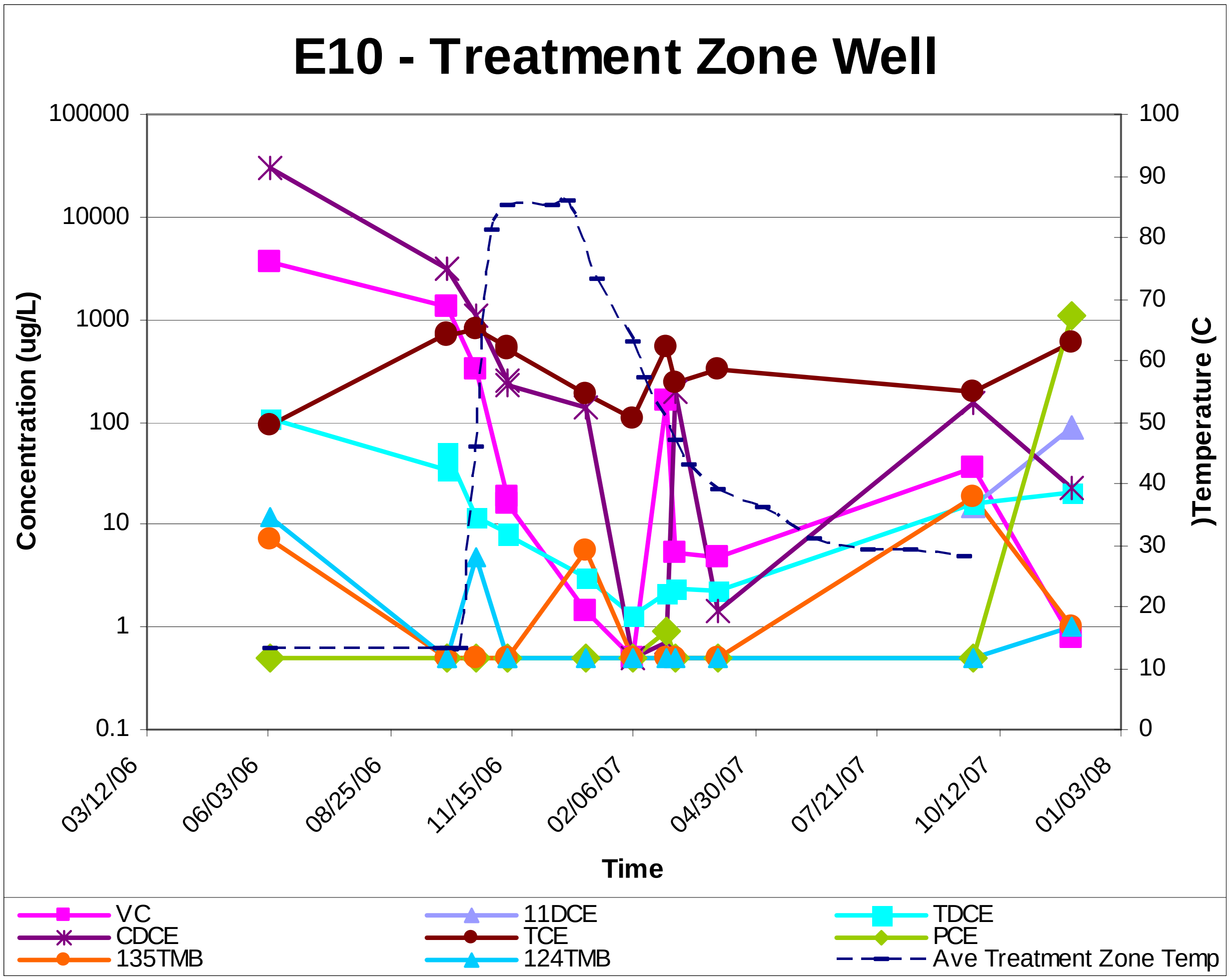

Figure 5. Monitoring Well E10 Data

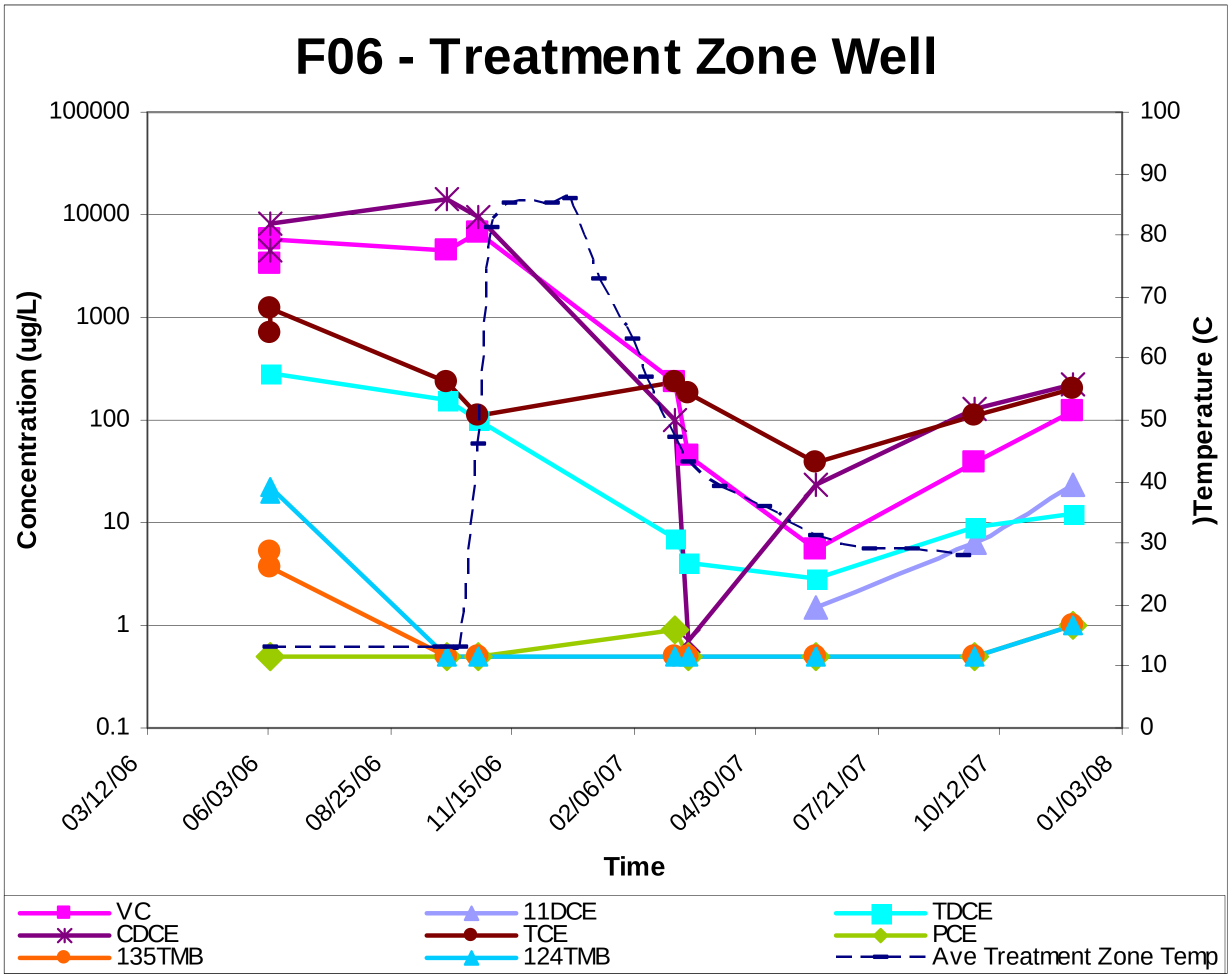

Figure 6. Monitoring Well F06 Data

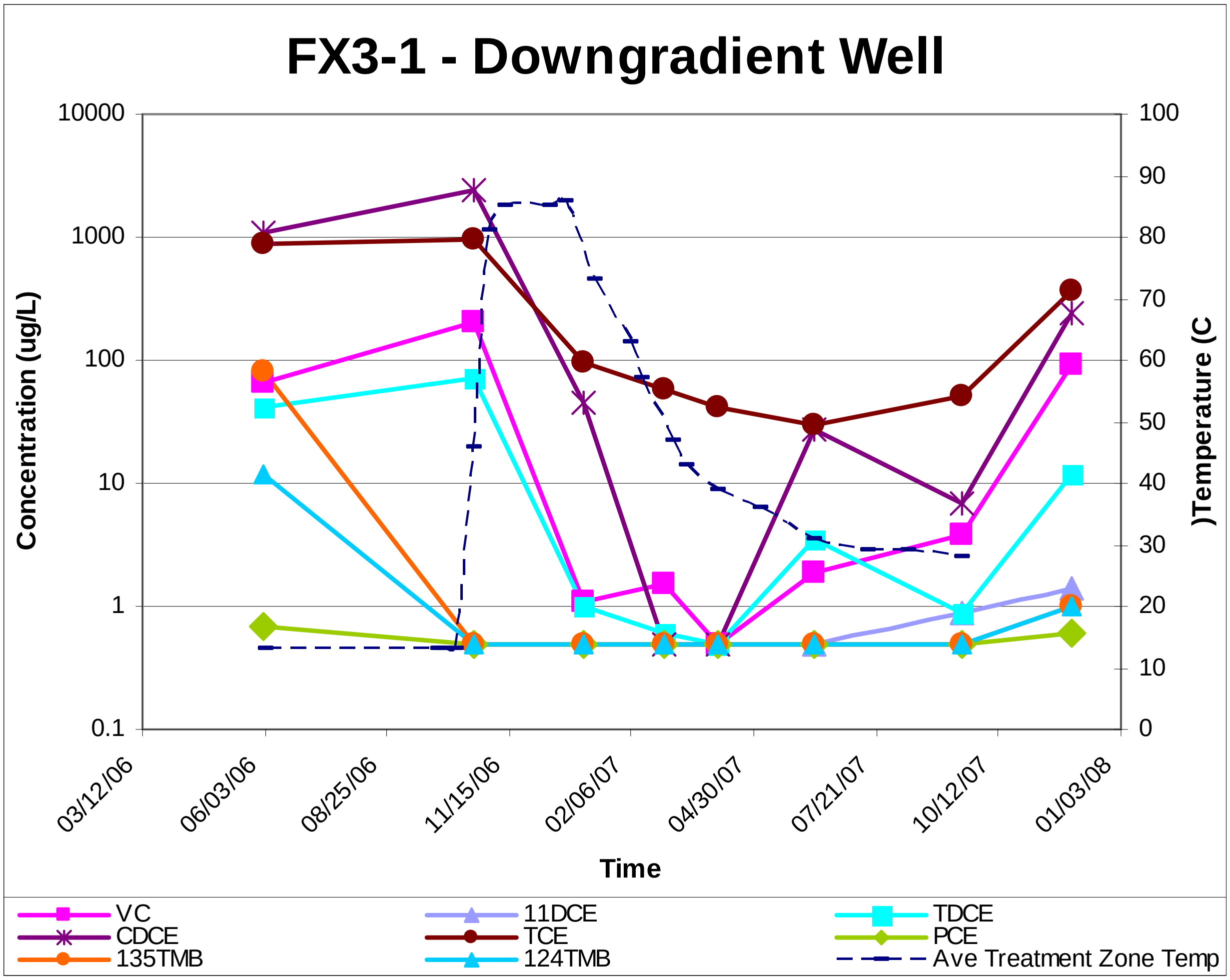

Figure 7. Monitoring Well FX3-1 Data

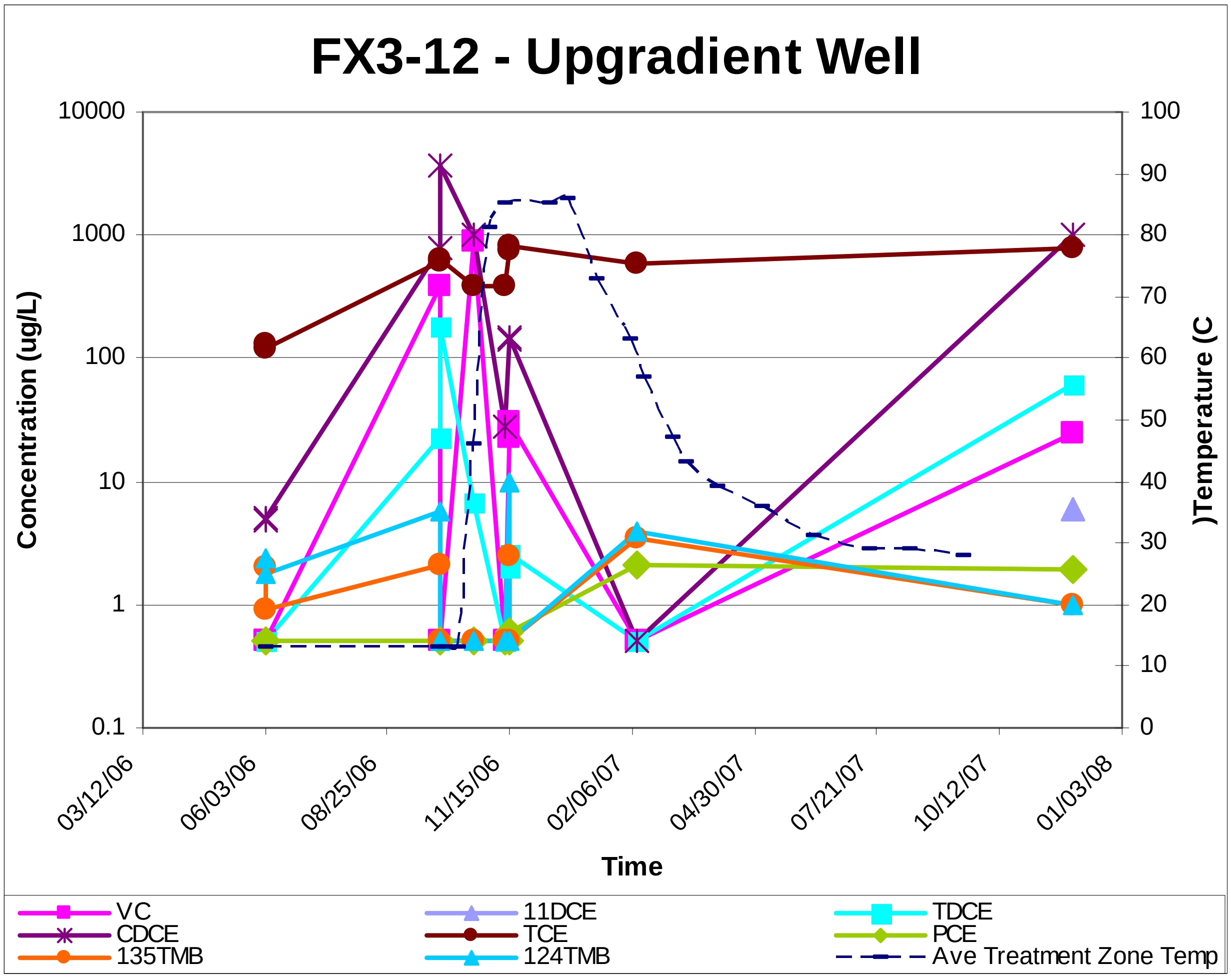

Figure 8. Monitoring Well FX3-12 Data

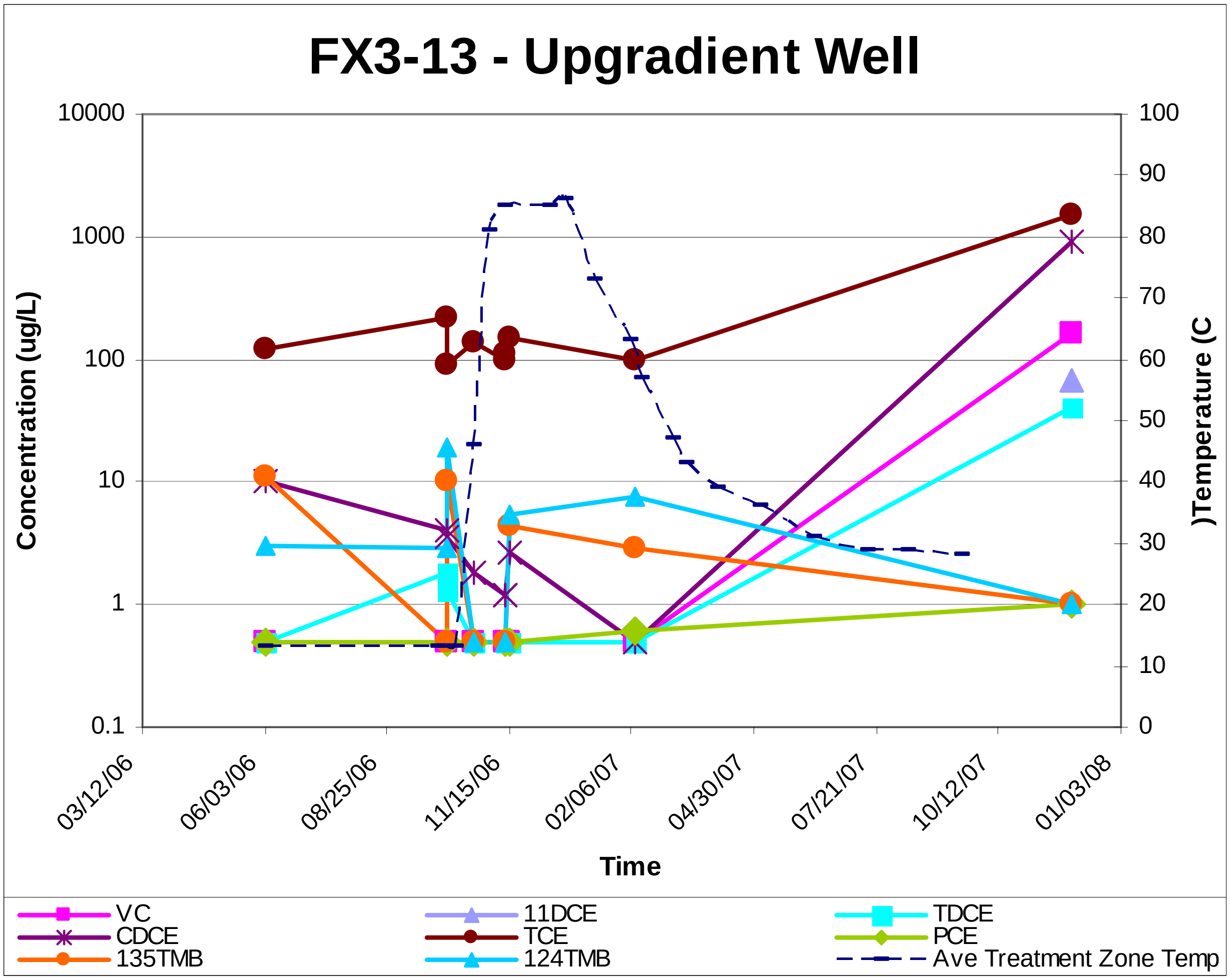

Figure 9. Monitoring Well FX3-13 Data

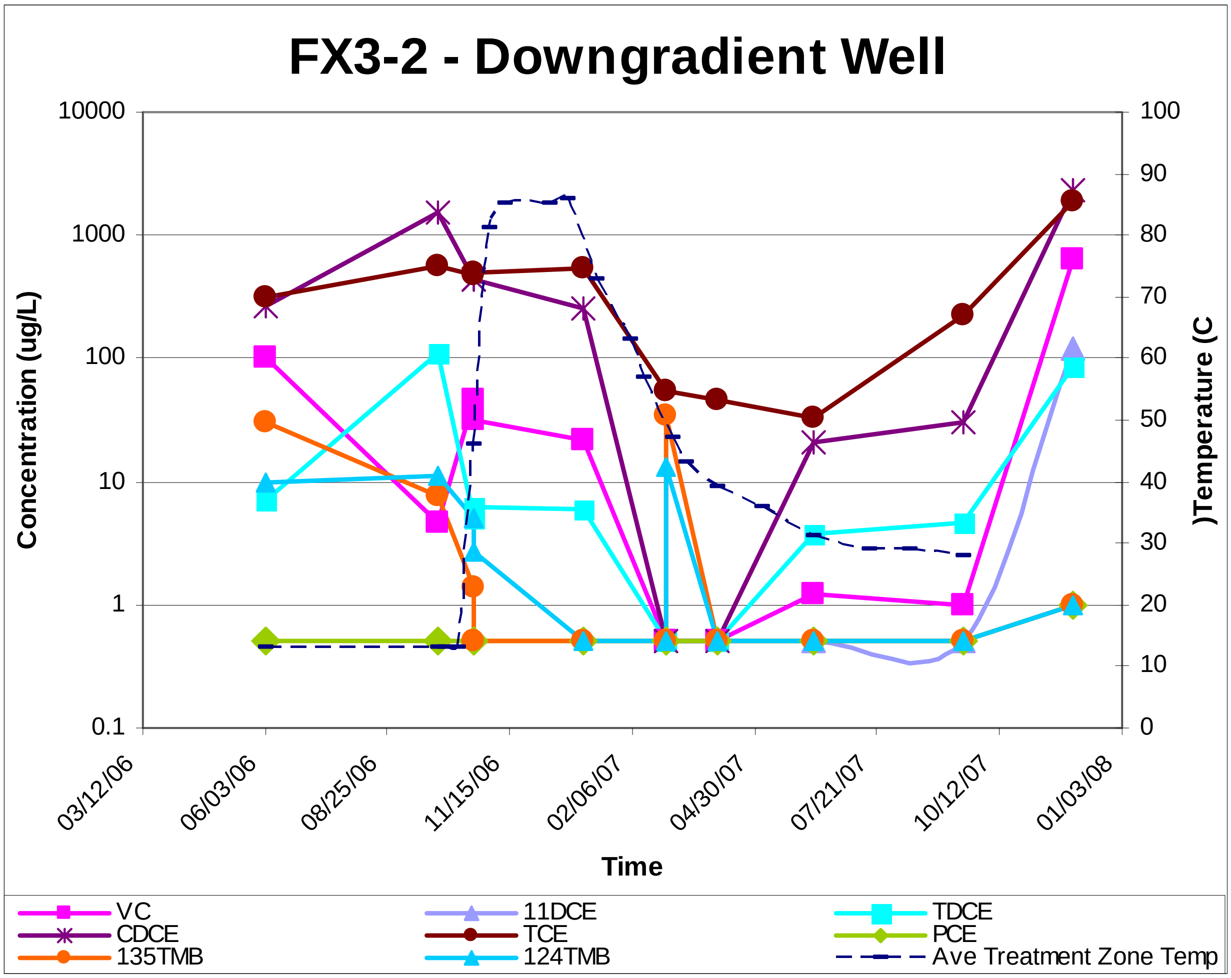

Figure 10. Monitoring Well FX3-2 Data

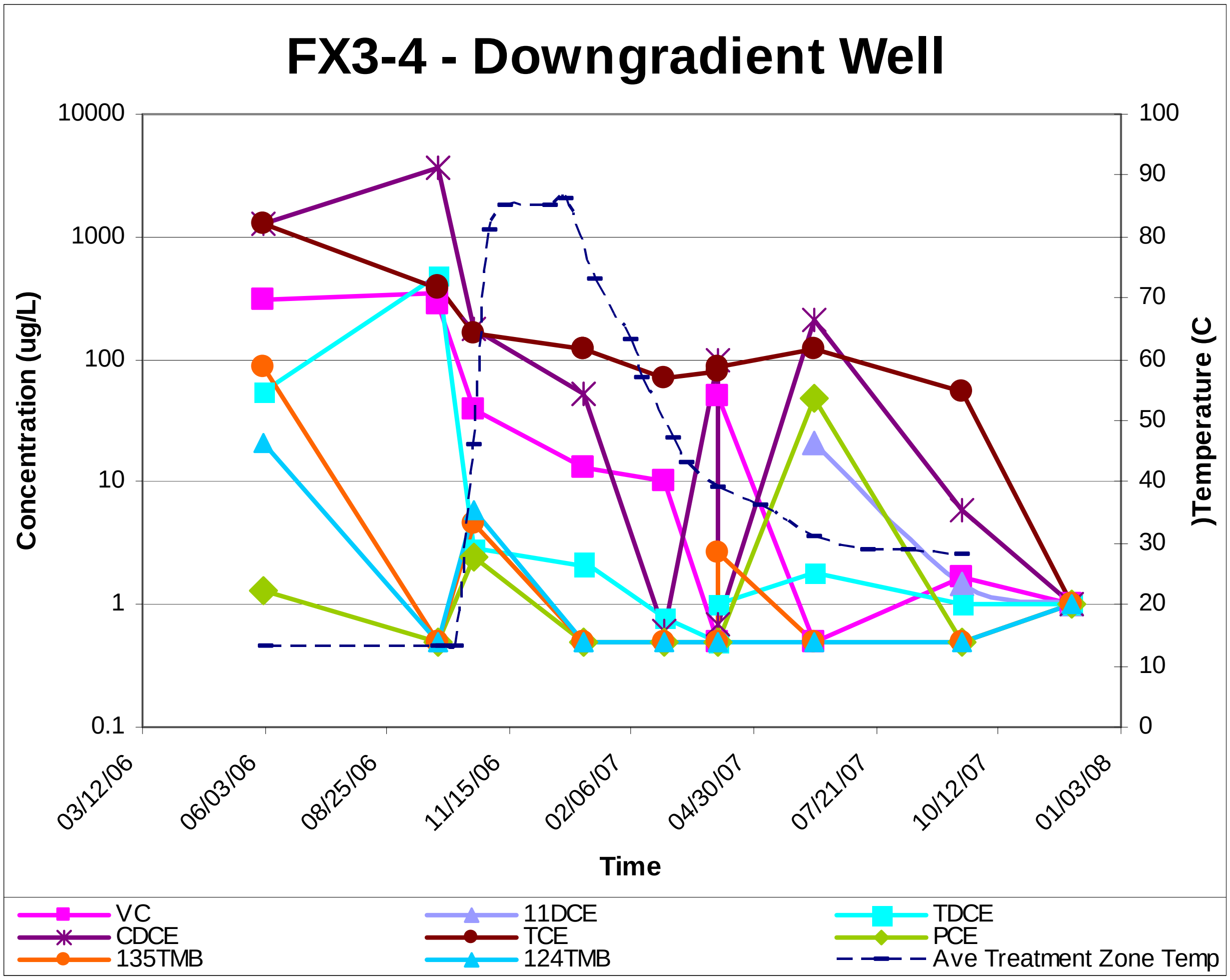

Figure 11. Monitoring Well FX3-4 Data

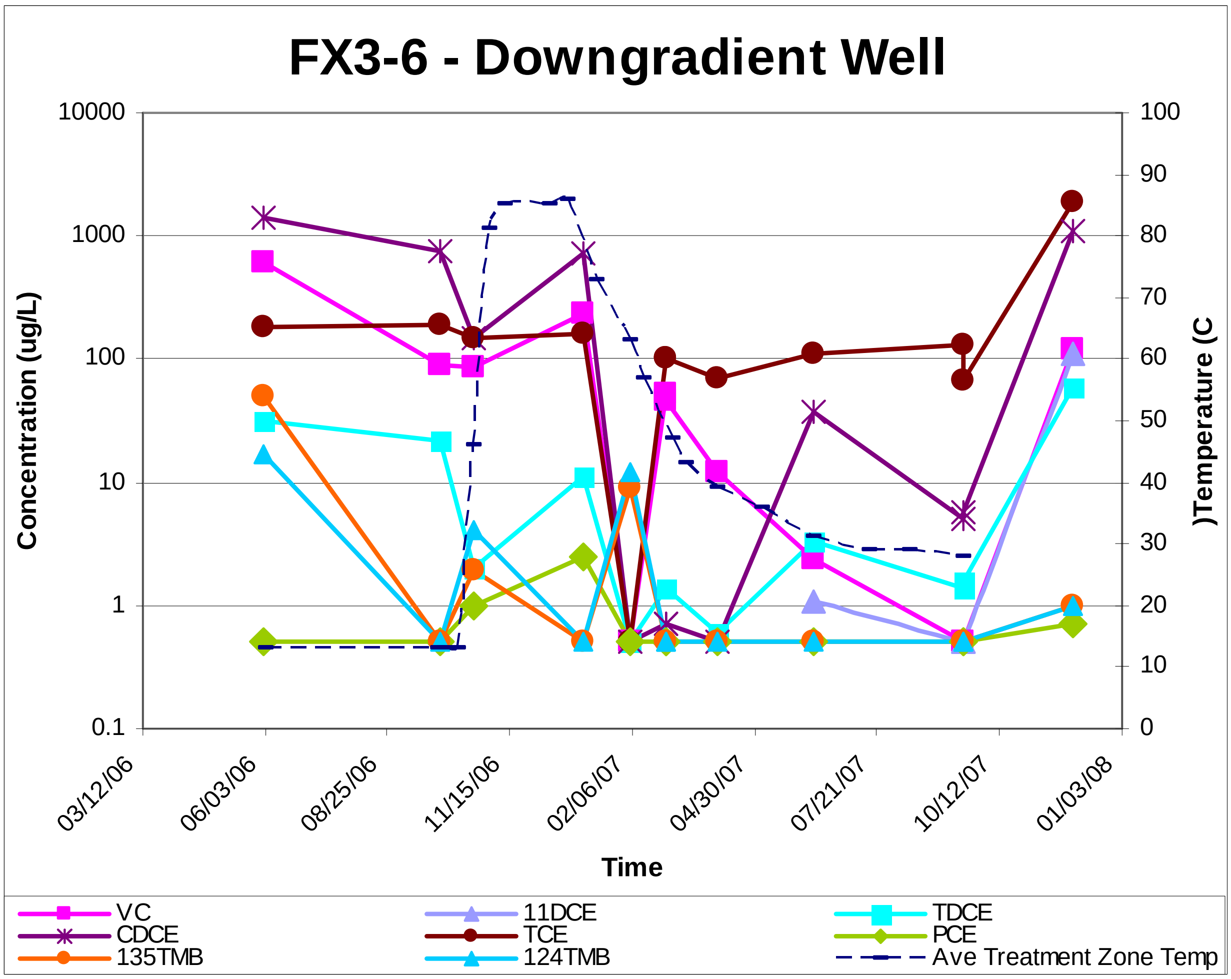

Figure 12. Monitoring Well FX3-6 Data

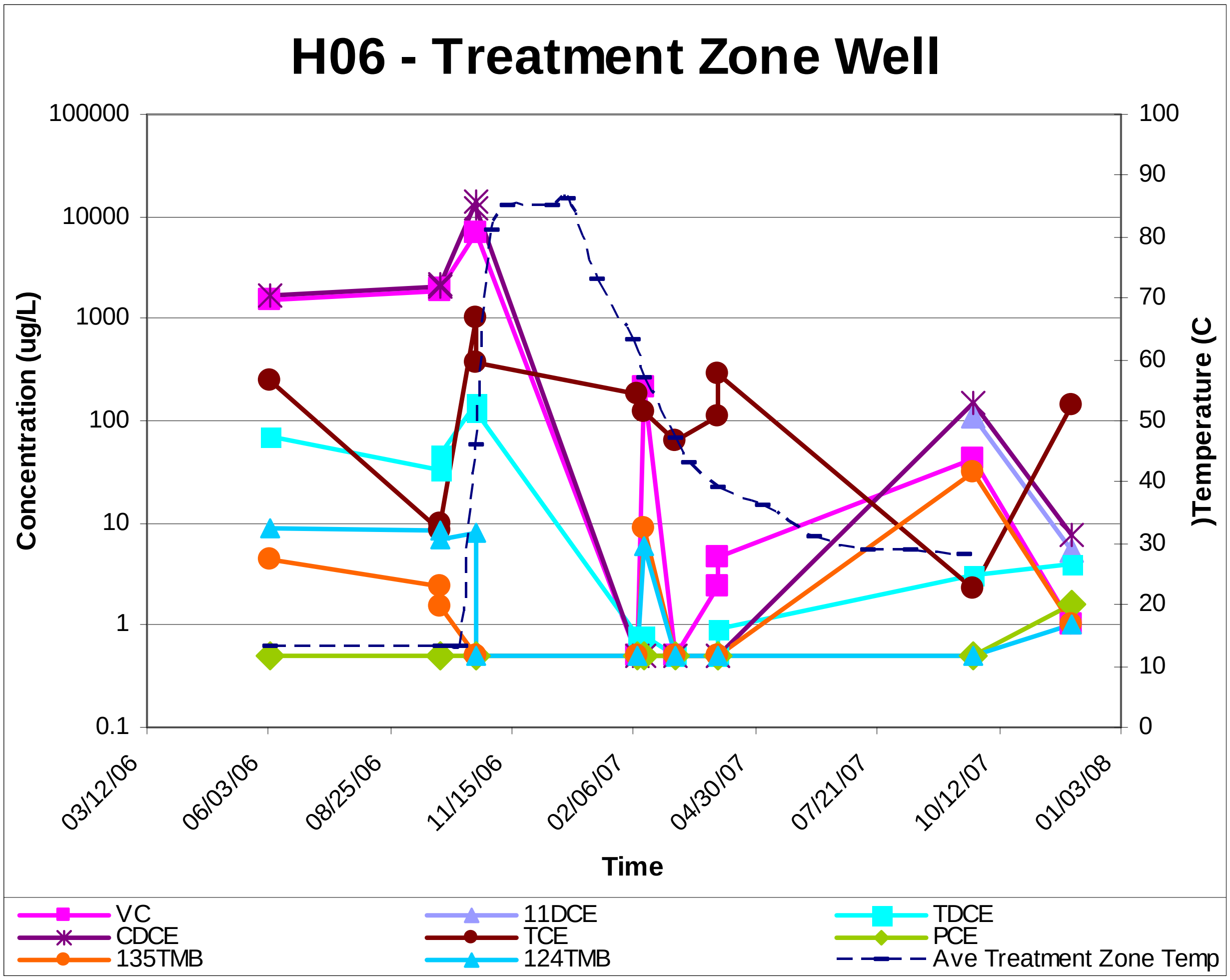

Figure 13. Monitoring Well H06 Data

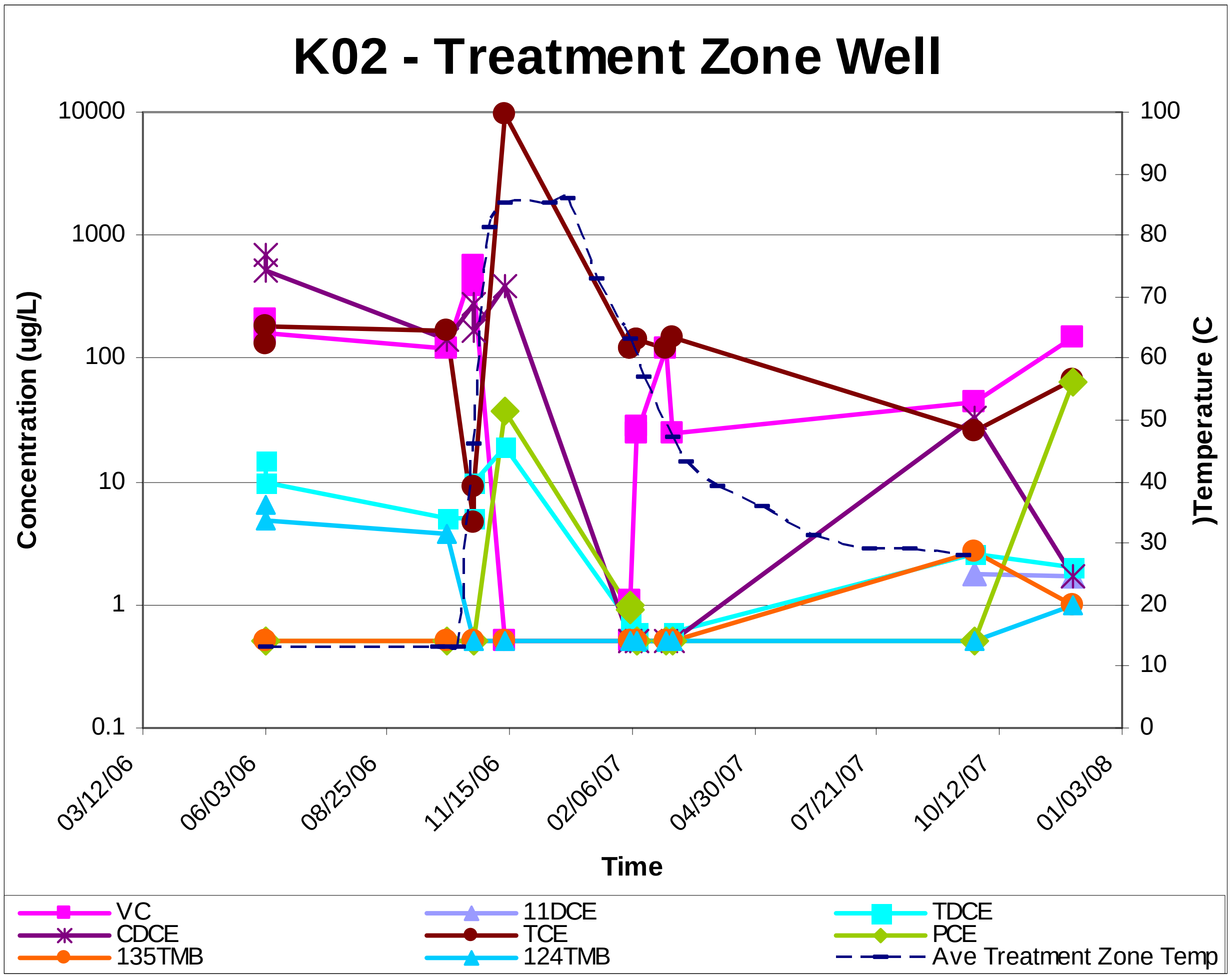

Figure 14. Monitoring Well K02 Data

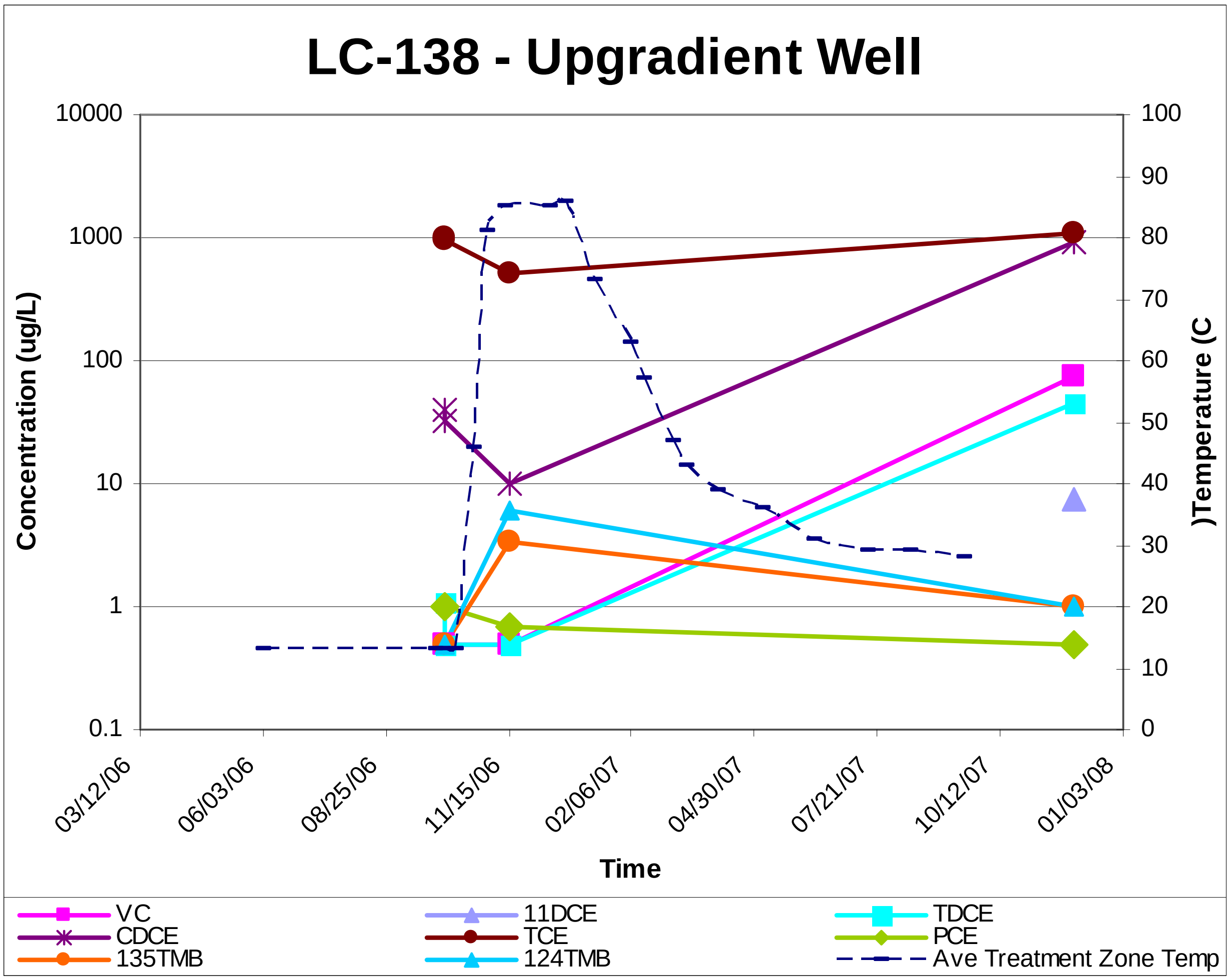

Figure 15. Monitoring Well LC-138 Data

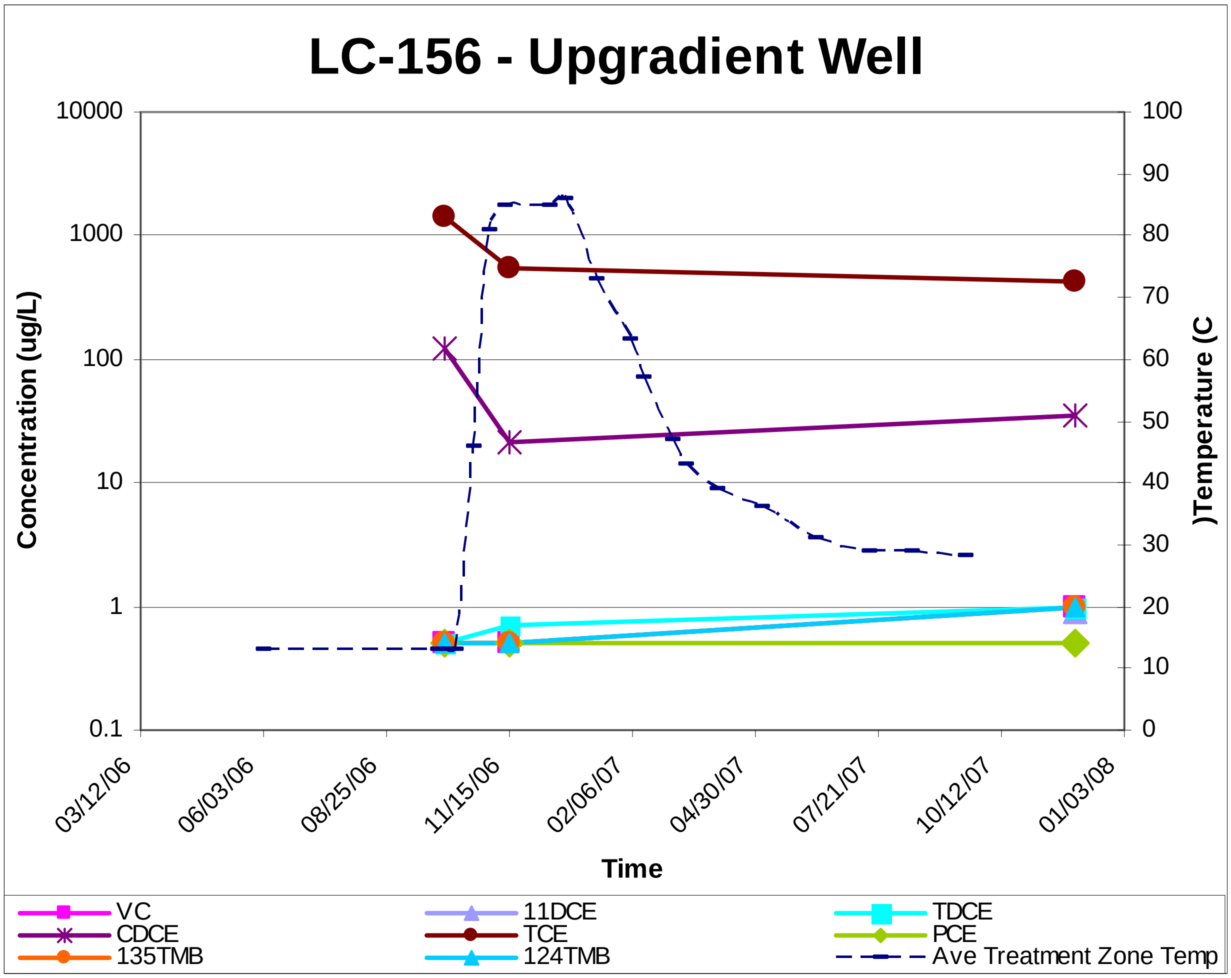

Figure 16. Monitoring Well LC-156 Data

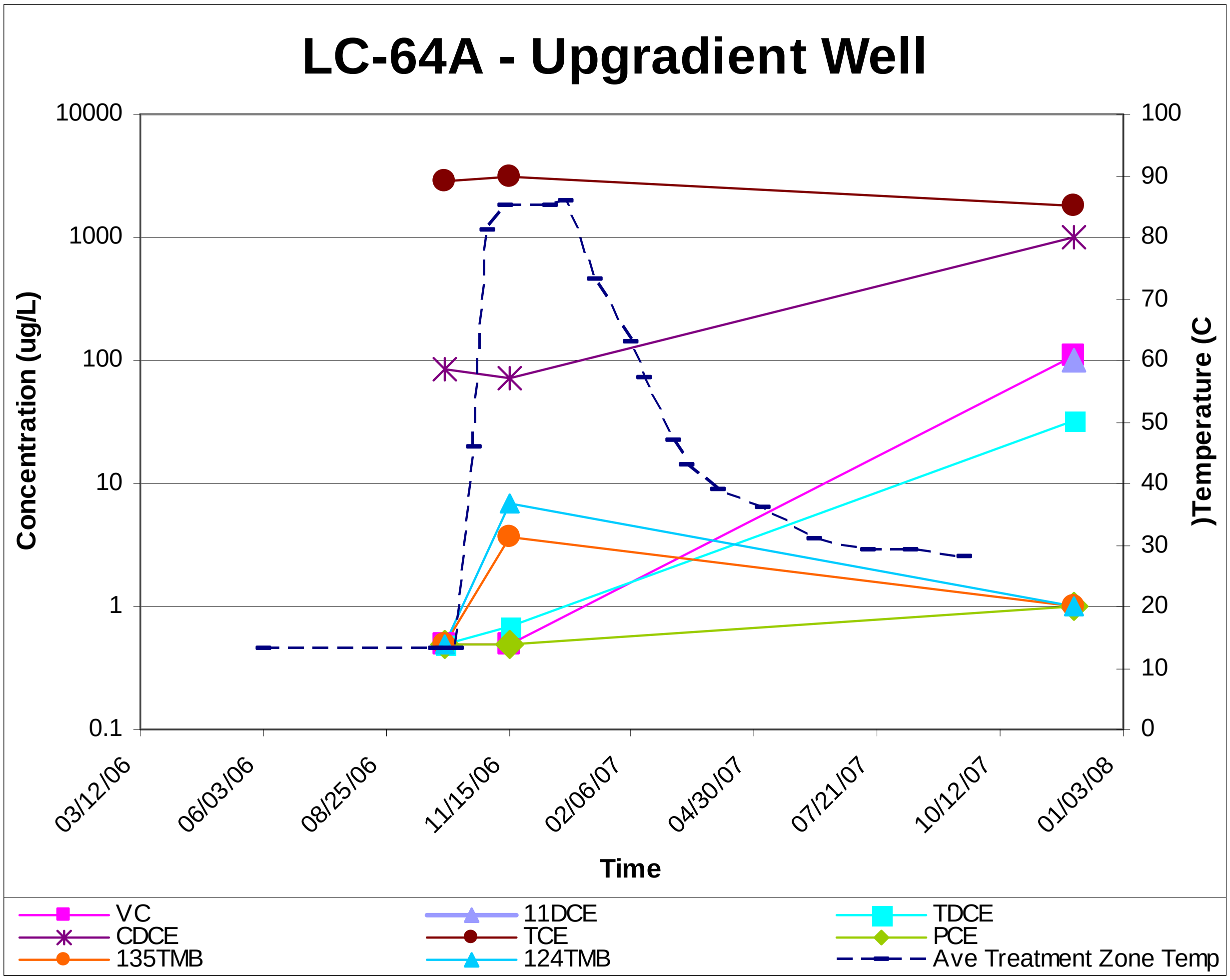

Figure 17. Monitoring Well LC-64A Data

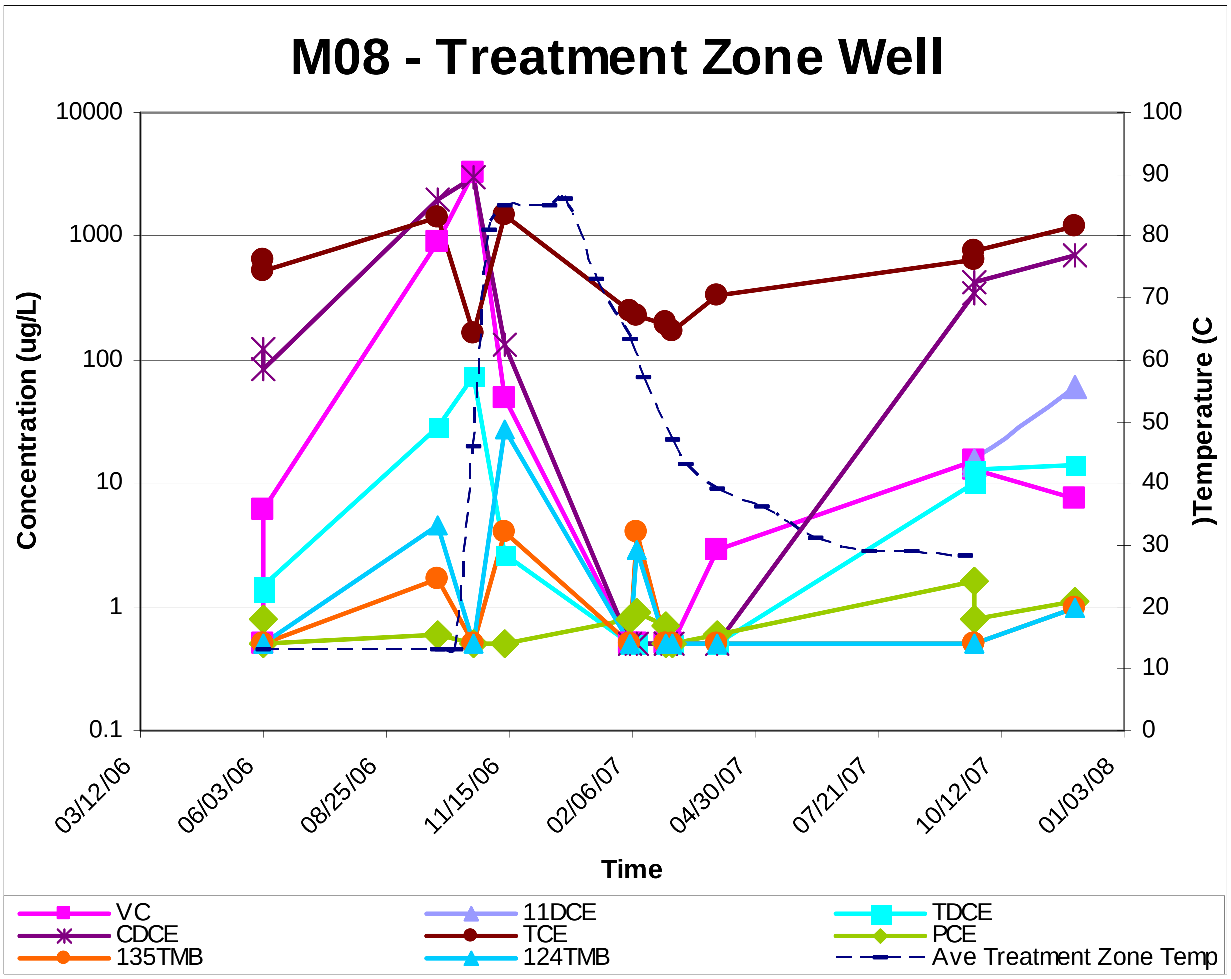

Figure 18. Monitoring Well M08 Data

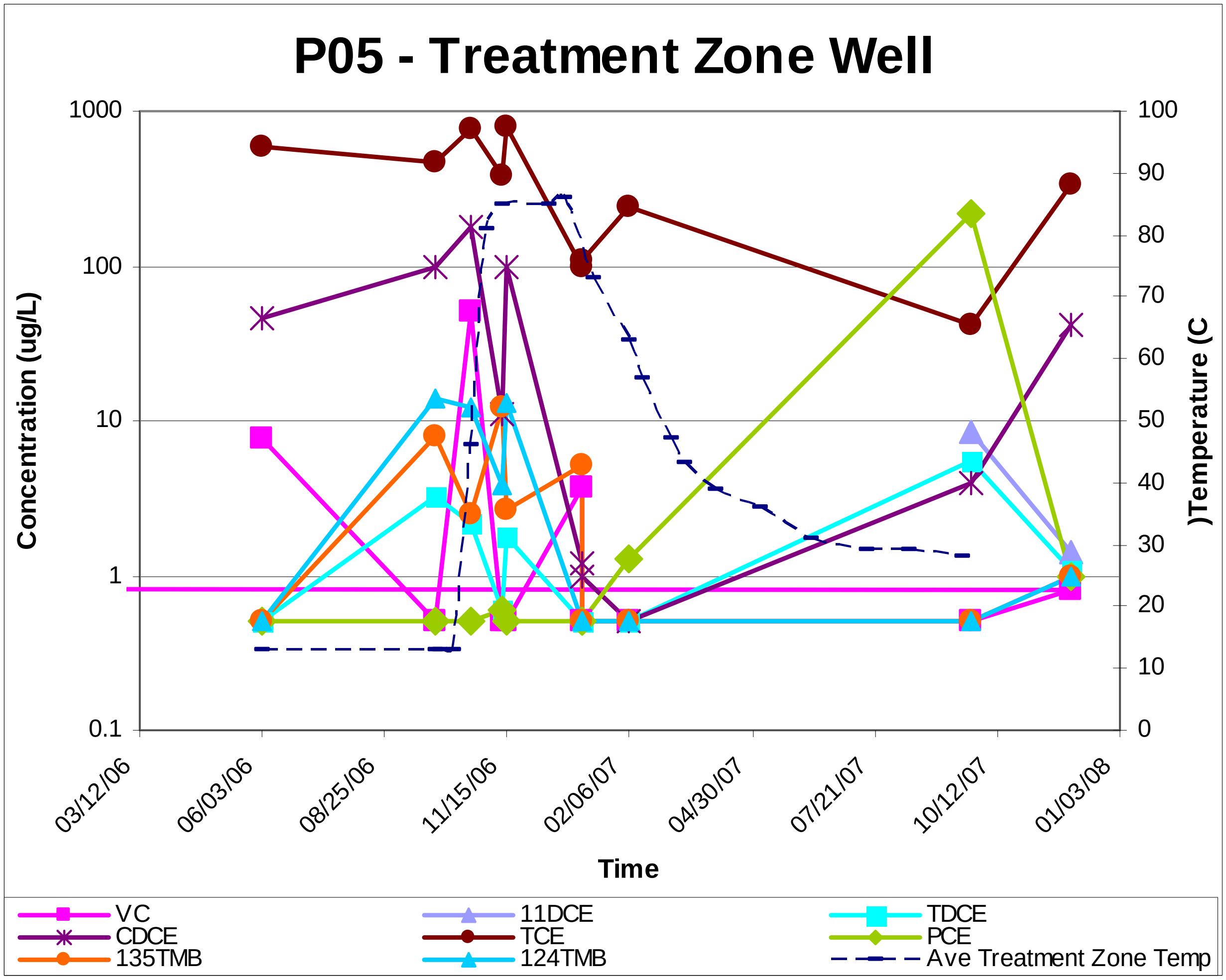

Figure 19. Monitoring Well P05 Data

Tables

Table 1. Groundwater Sampling Locations

Groundwater Monitoring Well or Direct Push Sampling Location	Water Quality Assessment Chlorinated Solvent and Petroleum Hydrocarbon Analysis
C07	Yes
E03	Yes
E10	Yes
F06	Yes
FX3-1	Yes
FX3-12	Yes
FX3-13	Yes
FX3-2	Yes
FX3-4	Yes
FX3-5	Yes
H06	Yes
K02	Yes
LC-138	Yes
LC-156	Yes
LC-64A	Yes
M08	Yes
P05	Yes

Table 2. Groundwater Monitoring Well Analytical Data

Monitoring Well	Date Analyzed	Concentration (µg/L)							
		Vinyl Chloride	*1,1 DCE*	*trans-1,2 DCE*	*cis-1,2 DCE*	*TCE*	*PCE*	*1,3,5 TMB*	*1,2,4 TMB*
C07	6/4/06	950	N/A	170	22000	17000	<1	<1	22
C07	6/4/06	790	N/A	160	20000	16000	<1	<1	15
C07	9/28/06	2100	N/A	150	13000	3300	<1	6	20
C07	10/23/06	1600	N/A	100	9600	2300	<1	<1	<1
C07	3/6/07	13	N/A	5	<1	150	<1	<1	<1
C07	4/5/07	18	N/A	4	<1	150	<1	<1	9
C07 DUP	4/5/07	17	N/A	4	<1	130	150	<1	<1
C07	6/9/07	14	4	6	35	40	<1	<1	<1
C07	9/25/07	72	18	30	720	2200	<1	12	<1
C07	12/1/07	<1	<1	2	93	1500	2	<1	<1
E03	6/4/06	1500	N/A	190	25000	12000	9	3	9
E03	10/2/06	870	N/A	82	5100	1400	<1	<1	<1
E03	10/2/06	850	N/A	91	5300	1400	<1	<1	<1
E03	10/23/06	1300	N/A	150	4500	2500	<1	3	13
E03	11/13/06	390	N/A	110	2800	14000	43	<1	<1
E03	2/5/07	4	N/A	<1	<1	74	<1	<1	<1
E03 DUP	2/5/07	3	N/A	<1	<1	74	<1	<1	<1
E03	2/14/07	150	N/A	2	<1	110	<1	<1	<1
E03	3/6/07	310	N/A	1	<1	140	<1	<1	<1
E03	3/15/07	9	N/A	<1	<1	150	<1	<1	<1
E03	6/9/07	45	2	18	670	110	<1	<1	<1
E03	9/25/07	170	24	38	2200	1000	<1	<1	<1
E03	12/1/07	7	2	39	320	650	2	<1	<1
E10	6/4/06	3600	N/A	110	30000	92	<1	7	12
E10	10/2/06	1300	N/A	34	3200	720	<1	<1	<1
E10 REP	10/2/06	1300	N/A	50	3100	700	<1	<1	<1
E10	10/23/06	320	N/A	12	1100	790	<1	<1	5
E10	11/13/06	19	N/A	8	250	530	<1	<1	<1
E10 DUP	11/13/06	16	N/A	8	230	500	<1	<1	<1
E10	1/5/07	1	N/A	3	140	190	<1	6	<1
E10	2/5/07	<1	N/A	1	<1	110	<1	<1	<1
E10	3/1/07	160	N/A	2	<1	530	<1	<1	<1
E10	3/6/07	5	N/A	2	200	240	<1	<1	<1

Table 2 Continued. Groundwater Monitoring Well Analytical Data

Monitoring Well	Date Analyzed	Concentration (µg/L)							
		Vinyl Chloride	*1,1-DCE*	*trans-1,2-DCE*	*cis-1,2-DCE*	*TCE*	*PCE*	*1,3,5-TMB*	*1,2,4-TMB*
E10	4/5/07	5	N/A	2	1	330	<1	<1	<1
E10	9/25/07	36	15	16	150	200	<1	19	<1
E10	12/1/07	1	87	21	23	610	1100	<1	<1
F06	6/4/06	3400	N/A	280	4600	710	<1	5	19
F06 REP	6/4/06	5800	N/A	280	8000	1200	<1	4	22
F06	10/2/06	4400	N/A	160	14000	240	<1	<1	<1
F06	10/23/06	6700	N/A	100	9600	110	<1	<1	<1
F06	3/6/07	230	N/A	7	100	240	<1	<1	<1
F06	3/15/07	44	N/A	4	<1	180	<1	<1	<1
F06	6/9/07	6	2	3	24	39	<1	<1	<1
F06	9/25/07	39	6	9	130	110	<1	<1	<1
F06	11/30/07	120	24	12	220	200	<1	<1	<1
FX3-1	6/3/06	67	N/A	41	1100	880	<1	81	12
FX3-1	10/23/06	200	N/A	73	2400	950	<1	<1	<1
FX3-1	1/5/07	1	N/A	1	46	96	<1	<1	<1
FX3-1	3/1/07	2	N/A	<1	<1	57	<1	<1	<1
FX3-1	4/5/07	0	N/A	<1	<1	41	<1	<1	<1
FX3-1	6/9/07	2	<1	4	27	30	<1	<1	<1
FX3-1	9/18/07	4	<1	<1	7	52	<1	<1	<1
FX3-1	12/1/07	91	1	12	240	360	1	<1	<1
FX3-12	6/4/06	<1	N/A	<1	5	130	<1	2	2
FX3-12 DUP	6/4/06	<1	N/A	<1	5	120	<1	<1	2
FX3-12	9/29/06	390	N/A	23	800	610	<1	2	6
FX3-12	9/29/06	<1	N/A	180	3700	630	<1	<1	<1
FX3-12	10/23/06	900	N/A	7	1000	390	<1	<1	<1
FX3-12	11/13/06	<1	N/A	<1	28	390	<1	<1	<1
FX3-12	11/16/06	23	N/A	2	140	750	<1	3	10
FX3-12 DUP	11/16/06	30	N/A	3	150	810	<1	<1	<1
FX3-12	2/9/07	<1	N/A	<1	<1	590	2	4	4
FX3-12	12/1/07	25	6	61	1000	780	2	<1	<1
FX3-13	6/4/06	<1	N/A	<1	10	120	<1	11	3

Table 2 Continued. Groundwater Monitoring Well Analytical Data

Monitoring Well	Date Analyzed	Concentration (µg/L)							
		Vinyl Chloride	*1,1-DCE*	*trans-1,2-DCE*	*cis-1,2-DCE*	*TCE*	*PCE*	*1,3,5-TMB*	*1,2,4-TMB*
FX3-13	10/4/06	<1	N/A	2	4	220	<1	<1	3
FX3-13	10/4/06	<1	N/A	1	4	92	<1	10	19
FX3-13	10/23/06	<1	N/A	<1	2	140	<1	<1	<1
FX3-13	11/13/06	<1	N/A	<1	1	100	<1	<1	<1
FX3-13 REP	11/13/06	<1	N/A	<1	1	110	<1	<1	<1
FX3-13	11/16/06	<1	N/A	<1	3	150	<1	4	5
FX3-13	2/9/07	<1	N/A	<1	<1	98	<1	3	8
FX3-13	12/1/07	160	66	41	920	1500	<1	<1	<1
FX3-13 DUP	12/1/07	3	1	3	130	1200	3	<1	<1
FX3-2	6/4/06	100	N/A	7	270	320	<1	30	10
FX3-2	9/28/06	5	N/A	110	1500	570	<1	8	11
FX3-2	10/23/06	46	N/A	5	440	470	<1	1	5
FX3-2 DUP	10/23/06	32	N/A	6	440	500	<1	<1	3
FX3-2	1/5/07	22	N/A	6	250	530	<1	<1	<1
FX3-2	3/1/07	<1	N/A	<1	<1	55	<1	<1	<1
FX3-2 REP	3/1/07	<1	N/A	<1	<1	55	<1	35	13
FX3-2	4/5/07	<1	N/A	<1	<1	46	<1	<1	<1
FX3-2	6/9/07	1	<1	4	21	33	<1	<1	<1
FX3-2	9/18/07	1	<1	5	30	220	<1	<1	<1
FX3-2	12/1/07	650	120	87	2300	1900	<1	<1	<1
FX3-4	6/3/06	310	N/A	55	1300	1300	1	88	21
FX3-4	9/29/06	340	N/A	480	3600	380	<1	<1	<1
FX3-4 REP	9/29/06	280	N/A	480	3600	390	<1	<1	<1
FX3-4	10/23/06	39	N/A	3	180	160	2	5	6
FX3-4	1/5/07	13	N/A	2	52	120	<1	<1	<1
FX3-4 REP	1/5/07	13	N/A	2	53	120	<1	<1	<1
FX3-4	3/1/07	10	N/A	<1	<1	70	<1	<1	<1
FX3-4	4/5/07	<1	N/A	<1	100	80	<1	<1	<1
FX3-4 REP	4/5/07	50	N/A	1	<1	87	<1	3	<1
FX3-4	6/9/07	<1	21	2	210	120	48	<1	<1
FX3-4	9/18/07	2	2	1	6	55	<1	<1	<1

Table 2 Continued. Groundwater Monitoring Well Analytical Data

Monitoring Well	Date Analyzed	Concentration (µg/L)							
		Vinyl Chloride	*1,1-DCE*	*trans-1,2-DCE*	*cis-1,2-DCE*	*TCE*	*PCE*	*1,3,5-TMB*	*1,2,4-TMB*
FX3-4	12/1/07	<1	<1	<1	<1	<1	<1	<1	<1
FX3-6	6/3/06	600	N/A	32	1400	180	<1	51	17
FX3-6	9/29/06	91	N/A	22	740	190	<1	<1	<1
FX3-6	10/23/06	87	N/A	2	150	150	1	2	4
FX3-6	1/5/07	230	N/A	11	710	160	3	<1	<1
FX3-6	2/5/07	<1	N/A	<1	<1	<1	<1	9	12
FX3-6	3/1/07	52	N/A	1	<1	100	<1	<1	<1
FX3-6 DUP	3/1/07	47	N/A	1	<1	100	<1	<1	<1
FX3-6	4/5/07	12	N/A	<1	<1	71	<1	<1	<1
FX3-6	6/9/07	2	1	3	37	110	<1	<1	<1
FX3-6	9/18/07	<1	<1	1	5	130	<1	<1	<1
FX3-6 DUP	9/18/07	<1	<1	2	6	68	<1	<1	<1
FX3-6	12/1/07	120	110	59	1100	1900	1	<1	<1
H06	6/4/06	1500	N/A	72	1700	250	<1	4	9
H06	9/28/06	1900	N/A	33	2100	9	<1	2	8
H06 DUP	9/28/06	2000	N/A	46	2200	10	<1	2	7
H06	10/23/06	6800	N/A	150	14000	1000	<1	<1	8
H06 DUP	10/23/06	7000	N/A	120	12000	380	<1	<1	<1
H06	2/9/07	<1	N/A	<1	<1	180	<1	<1	<1
H06	2/14/07	210	N/A	<1	<1	120	<1	9	6
H06	3/6/07	<1	N/A	<1	<1	63	<1	<1	<1
H06	4/4/07	2	N/A	<1	<1	110	<1	<1	<1
H06 DUP	4/4/07	5	N/A	<1	<1	290	<1	<1	<1
H06	9/25/07	43	110	3	150	2	<1	32	<1
H06	11/30/07	<1	5	4	8	140	2	<1	<1
K02	6/4/06	210	N/A	15	680	130	<1	<1	6
K02 REP	6/4/06	160	N/A	10	510	180	<1	<1	5
K02	10/4/06	120	N/A	5	140	170	<1	<1	4
K02	10/23/06	560	N/A	5	280	5	<1	<1	<1
K02	10/23/06	380	N/A	10	170	9	<1	<1	<1
K02	11/13/06	<1	N/A	19	390	9500	38	<1	<1

Table 2 Continued. Groundwater Monitoring Well Analytical Data

Monitoring Well	Date Analyzed	Concentration (µg/L)							
		Vinyl Chloride	*1,1-DCE*	*trans-1,2-DCE*	*cis-1,2-DCE*	*TCE*	*PCE*	*1,3,5-TMB*	*1,2,4-TMB*
K02	2/5/07	<1	N/A	<1	<1	120	<1	<1	<1
K02 DUP	2/5/07	1	N/A	<1	<1	120	1	<1	<1
K02	2/9/07	28	N/A	<1	<1	140	<1	<1	<1
K02 DUP	2/9/07	25	N/A	<1	<1	140	<1	<1	<1
K02	3/1/07	120	N/A	<1	<1	120	<1	<1	<1
K02	3/6/07	25	N/A	<1	<1	150	<1	<1	<1
K02	9/25/07	44	2	3	33	26	<1	3	<1
K02	11/30/07	150	2	2	2	66	65	<1	<1
LC-138	10/4/06	<1	N/A	1	39	1000	1	<1	<1
LC-138 DUP	10/4/06	<1	N/A	<1	32	970	1	<1	<1
LC-138	11/16/06	<1	N/A	<1	10	520	<1	3	6
LC-138	12/1/07	75	8	46	930	1100	1	<1	<1
LC-156	10/4/06	<1	N/A	<1	120	1400	<1	<1	<1
LC-156	11/16/06	<1	N/A	<1	21	550	<1	<1	<1
LC-156	11/30/07	<1	1	1	35	430	1	<1	<1
LC-64A	10/4/06	<1	N/A	<1	84	2900	<1	<1	<1
LC-64A	11/16/06	<1	N/A	<1	73	3100	<1	4	7
LC-64A	12/1/07	110	100	32	990	1800	<1	<1	<1
M08	6/4/06	<1	N/A	1	120	640	<1	<1	<1
M08 DUP	6/4/06	6	N/A	2	85	530	<1	<1	<1
M08	9/28/06	890	N/A	29	2000	1400	<1	2	5
M08	10/23/06	3300	N/A	73	3000	160	<1	<1	<1
M08	11/13/06	49	N/A	3	130	1500	<1	4	27
M08	2/5/07	<1	N/A	<1	<1	250	<1	<1	<1
M08	2/9/07	<1	N/A	<1	<1	230	<1	4	3
M08	3/1/07	<1	N/A	<1	<1	190	<1	<1	<1
M08 DUP	3/1/07	<1	N/A	<1	<1	200	<1	<1	<1
M08	3/6/07	<1	N/A	<1	<1	170	<1	<1	<1
M08	4/4/07	3	N/A	<1	<1	330	<1	<1	<1
M08	9/25/07	15	14	10	340	650	2	<1	<1
M08 DUP	9/25/07	13	15	13	420	760	<1	<1	<1

Table 2 Continued. Groundwater Monitoring Well Analytical Data

Monitoring Well	Date Analyzed	Concentration (µg/L)							
		Vinyl Chloride	*1,1-DCE*	*trans-1,2-DCE*	*cis-1,2-DCE*	*TCE*	*PCE*	*1,3,5-TMB*	*1,2,4-TMB*
M08	12/1/07	8	59	14	690	1200	1	<1	<1
P05	6/4/06	<1	N/A	<1	46	580	<1	<1	<1
P05	9/28/06	51	N/A	3	100	470	<1	8	14
P05	10/23/06	<1	N/A	2	180	770	<1	3	12
P05	11/13/06	<1	N/A	<1	11	380	<1	12	4
P05	11/16/06	4	N/A	2	100	790	<1	3	13
P05	1/5/07	<1	N/A	<1	1	97	<1	5	<1
P05 DUP	1/5/07	<1	N/A	<1	1	110	<1	<1	<1
P05	2/5/07	<1	N/A	<1	<1	240	1	<1	<1
P05	9/25/07	<1	8	6	170	700	220	7	<1
P05	12/1/07	<1	1	1	42	330	<1	<1	<1
TB 01	6/4/06	1	N/A	2	2	3	3	4	9
TB 01	6/4/06	26	N/A	2	2	2	2	3	8
TB 02	6/4/06	<1	N/A	<1	<1	<1	<1	<1	2
TB 03	6/4/06	<1	N/A	<1	<1	<1	<1	<1	2
TB 01	10/2/06	<1	N/A	<1	<1	<1	<1	<1	<1
TB 02	10/4/06	<1	N/A	<1	<1	<1	<1	<1	<1
TB01	10/23/06	<1	N/A	<1	<1	<1	<1	5	9
TB01	11/13/06	<1	N/A	<1	<1	<1	<1	5	17
TB01	11/16/06	<1	N/A	<1	<1	<1	<1	<1	25
TB	1/5/07	<1	N/A	<1	<1	<1	<1	<1	<1
TB	1/5/07	<1	N/A	<1	<1	<1	<1	<1	<1
TB01	2/9/07	<1	N/A	<1	<1	<1	<1	<1	<1
TB02	2/9/07	<1	N/A	<1	<1	<1	<1	9	9
TB	2/14/07	<1	N/A	<1	<1	<1	<1	<1	<1
TB01	3/1/07	<1	N/A	<1	<1	<1	<1	<1	<1
TB	3/6/07	<1	N/A	<1	<1	<1	<1	<1	<1
TB	3/6/07	<1	N/A	<1	<1	<1	<1	<1	<1
TB	3/15/07	<1	N/A	<1	<1	<1	<1	<1	<1
TB	4/4/07	<1	N/A	<1	<1	<1	<1	<1	<1
TB	4/5/07	<1	N/A	<1	<1	<1	<1	<1	<1

Table 2 Continued. Groundwater Monitoring Well Analytical Data

Monitoring Well	Date Analyzed	Concentration (µg/L)							
		Vinyl Chloride	*1,1-DCE*	*trans-1,2-DCE*	*cis-1,2-DCE*	*TCE*	*PCE*	*1,3,5-TMB*	*1,2,4-TMB*
TB	9/18/07	<1	<1	<1	<1	<1	<1	<1	<1
TB01	9/25/07	<1	<1	<1	<1	<1	<1	<1	<1
TB02	9/25/07	<1	<1	<1	<1	<1	<1	<1	<1
TB	12/1/07	73	36	13	470	430	<1	<1	<1

Notes:

Pre-treatment concentration data
During treatment concentration data
Post-treatment concentration data

DUP - Duplicate sample, REP - Quality control sample (second analysis of same water sample), N/A - Contaminant not analyzed for
Non-detect parameters are reported as less than the detection limit (<1 µg/L), TB - Trip blank
DCE – Dichloroethene, TCE – Trichloroethene, TMB – Trimethylbenzene, PCE - Tetrachloroethene

Table 3. Groundwater Monitoring Well Water Temperatures

Monitoring Well	Date Analyzed	Pre-treatment Temperature (ºC)
C07	6/4/06	13
C07	6/4/06	13
C07	9/28/06	13
E03	6/4/06	13
E03	10/2/06	13
E03	10/2/06	13
E10	6/4/06	11
E10	10/2/06	11
E10 REP	10/2/06	11
F06	6/4/06	13
F06 REP	6/4/06	13
F06	10/2/06	13
FX3-1	6/3/06	14*
FX3-12	6/4/06	14*
FX2-12 DUP	6/4/06	14*
FX3-12	9/29/06	14*
FX3-12	9/29/06	14*
FX3-13	6/4/06	14*
FX3-13	10/4/06	14*
FX3-13	10/4/06	14*
FX3-2	6/4/06	14*
FX3-2	9/28/06	15
FX3-4	6/3/06	14*
FX3-4	9/29/06	14
FX3-4 REP	9/29/06	14
FX3-6	6/3/06	14*
FX3-6	9/29/06	15
H06	6/4/06	15
H06	9/28/06	15
H06 DUP	9/28/06	15
K02	6/4/06	12
K02 REP	6/4/06	12
K02	10/4/06	12
LC-138	10/4/06	14*
LC-138 DUP	10/4/06	14*
LC-156	10/4/06	14*
LC-64A	10/4/06	14*
M08	6/4/06	14
M08	9/28/06	15
M08 DUP	6/4/06	14
P05	6/4/06	13
P05	9/28/06	13
TB 01	6/4/06	--
TB 01	6/4/06	--
TB 02	6/4/06	--
TB 03	6/4/06	--
TB 01	10/2/06	--
TB 02	10/4/06	--

Monitoring Well	Date Analyzed	During Treatment Temperature (ºC)
C07	10/23/06	47
E03	10/23/06	45
E03	11/13/06	71
E10	10/23/06	37
E10	11/13/06	92
E10 DUP	11/13/06	92
E10	1/5/07	51
F06	10/23/06	50
FX3-1	10/23/06	14
FX3-1	1/5/07	18
FX3-12	10/23/06	14*
FX3-12	11/13/06	14*
FX3-12	11/16/06	14*
FX3-12 DUP	11/16/06	14*
FX3-13	10/23/06	14*
FX3-13	11/13/06	14*
FX3-13 REP	11/13/06	14*
FX3-13	11/16/06	14*
FX3-2	10/23/06	13
FX3-2 DUP	10/23/06	13
FX3-2	1/5/07	12
FX3-4	10/23/06	13
FX3-4	1/5/07	14*
FX3-4 REP	1/5/07	14*
FX3-6	10/23/06	14
FX3-6	1/5/07	16
H06	10/23/06	66
H06 DUP	10/23/06	66
K02	10/23/06	51
K02	10/23/06	51
K02	11/13/06	80
LC-138	11/16/06	14*
LC-156	11/16/06	14*
LC64A	11/16/06	14*
M08	10/23/06	40
M08	11/13/06	79
P05	10/23/06	30
P05	11/13/06	79
P05	11/16/06	80
P05	1/5/07	57
P05 DUP	1/5/07	57
TB01	10/23/06	--
TB01	11/13/06	--
TB01	11/16/06	--
TB	1/5/07	--
TB	1/5/07	--

Note:
-- No temperature data taken

* Temperature data estimated based on background temperature because wells were not in the treatment zone

Table 3. Groundwater Monitoring Well Water Temperatures (Continued)

Monitoring Well	Date Analyzed	Post-Treatment Temperature (ºC)
C07	3/6/07	76
C07	4/5/07	70
C07 DUP	4/5/07	70
C07	6/9/07	58
C07	9/25/07	43
E03	2/5/07	66
E03 DUP	2/5/07	66
E03	2/14/07	61
E03	3/6/07	53
E03	3/15/07	49
E03	6/9/07	37
E03	9/25/07	33
E10	2/5/07	75
E10	3/1/07	44
E10	3/6/07	57
E10	4/5/07	46
E10	9/25/07	40
F06	3/6/07	75
F06	3/15/07	67
F06	6/9/07	35
F06	9/25/07	36
FX3-1	3/1/07	11
FX3-1	4/5/07	11
FX3-1	6/9/07	14*
FX3-1	9/18/07	14*
FX3-12	2/9/07	14*
FX3-13	2/9/07	14*
FX3-2	3/1/07	9
FX3-2 REP	3/1/07	9
FX3-2	4/5/07	10
FX3-2	6/9/07	14*
FX3-2	9/18/07	14*
FX3-4	3/1/07	15
FX3-4	4/5/07	14
FX3-4 REP	4/5/07	14
FX3-4	6/9/07	14*
FX3-4	9/18/07	14*
FX3-6	2/5/07	14*
FX3-6	3/1/07	22
FX3-6 DUP	3/1/07	22
FX3-6	4/5/07	19
FX3-6	6/9/07	14*
FX3-6	9/18/07	14*
FX3-6 DUP	9/18/07	14*
H06	2/9/07	67
H06	2/14/07	58
H06	3/6/07	47
H06	4/4/07	39
H06 DUP	4/4/07	39
H06	9/25/07	20

Monitoring Well	Date Analyzed	Post-Treatment Temperature (ºC)
K02	2/5/07	42
K02 DUP	2/5/07	42
K02	2/9/07	37
K02 DUP	2/9/07	37
K02	3/1/07	27
K02	3/6/07	26
K02	9/25/07	20
M08	2/5/07	53
M08	2/9/07	51
M08	3/1/07	34
M08 DUP	3/1/07	34
M08	3/6/07	32
M08	4/4/07	22
M08	9/25/07	14
M08 DUP	9/25/07	14
P05	2/5/07	12
P05	9/25/07	14
TB01	2/9/07	--
TB02	2/9/07	--
TB	2/14/07	--
TB01	3/1/07	--
TB	3/6/07	--
TB	3/6/07	--
TB	3/15/07	--
TB	4/4/07	--
TB	4/5/07	--
TB	9/18/07	--
TB01	9/25/07	--
TB02	9/25/07	--

Note:
-- No temperature data taken
* Temperature data estimated based on background temperature because wells were not in the treatment zone

Table 4. Groundwater Treatment Zone Average Water Temperature

Date	Temperature (C)
6/4/06	13
9/28/06	13
10/2/06	13
10/11/06	13
10/23/06	46
11/2/06	81
11/13/06	85
12/13/06	85
12/24/06	86
1/13/07	73
2/5/07	63
2/14/07	57
3/6/07	47
3/15/07	43
4/5/07	39
5/5/07	36
6/9/07	31
7/16/07	29
8/13/07	29
9/18/07	28

Table 5. Mass Flux Analysis

Hydraulic conductivity (ft/day)	Hydraulic Gradient (ft/ft)	Hydraulic Conductivity and Gradient Measurements	Discharge (kg/yr)
38	0.0012	Low hydraulic conductivity and gradient	1.42E-01
38	0.0027	Low hydraulic conductivity and average gradient	3.20E-01
65	0.0027	Average hydraulic conductivity and gradient	5.47E-01
65	0.0034	Average hydraulic conductivity and middle of average and high gradient	6.89E-01
120	0.0042	High hydraulic conductivity and gradient	1.57E+00

Appendix E

Quality Assurance Project Plan
(see electronic attachment)

APPENDIX E

QUALITY ASSURANCE PROJECT PLAN
(Reproduced here from the Demonstration Plan)

E1.0 Purpose and Scope of Plan

This Quality Assurance Project Plan (QAPP) establishes the quality assurance guidelines to be utilized during this project. This QAPP has been developed to address the DoD requirements for precision, accuracy, representativeness, completeness, and comparability of data collected and generated during this demonstration. The QAPP also provides the quality assurance requirements for data handling, manipulation, and reporting. It has been designed to ensure the quality of the data gathered and generated, as well as the conclusions and recommendations reached from the use of the data.

E2.0 Quality Assurance Responsibilities

Dr. Paul C. Johnson will be responsible for ensuring that the data collection activities conform to this QAPP. ASU will conduct the analysis of groundwater samples in the field with a laboratory-quality GC (SRI Model 3610C or equivalent). The ASU field laboratory will establish data quality objectives similar to those outlined below.

The quality assurance activities incorporated in the project will be used to maintain the accuracy and the precision of the system demonstration and the field analytical techniques. These activities include frequent equipment calibration, field blank samples (for shipment to the analytical laboratory), and field laboratory sample blanks. The quality assurance activities are designed to trigger corrective action activities and diagnose potential sources of error.

ASU will be responsible for summarizing the laboratory data and for data reduction and technology evaluation. Dr. Paul Johnson will be responsible for reviewing analytical data, identifying any deviations from the established protocols and data quality objectives, and then deciding how the data will be used, and what corrections, if any, need to be made to the field analytical procedures.

E3.0 Project Objectives

The objectives of this demonstration are summarized below:

Performance Criteria	Description	Primary or Secondary
Data set collected provides useful supplemental post-treatment data on water quality and mass discharge	Data set to include aquifer characterization data and contaminant concentration along a transect perpendicular to groundwater flow.	Primary

This QAPP focuses on the in-field data collection activities.

E4.0 Experimental Measurements

The following section describes measurements to be made during this project; these are divided into categories focused on water quality changes and system hydraulic measurements.

E4.1 Groundwater Quality Measurement

Groundwater will be assessed for dissolved oxygen and concentrations of chemicals of interest (site-specific).

General Water Quality Parameters: General water quality parameters pH, electrical conductivity (EC), temperature, dissolved oxygen (DO), and oxidation reduction potential (ORP) will be measured using a flow-through system composed of a meter (Horiba U-22 or similar), a flow-through cell, and a variable-speed slow-flow peristaltic pump. Water quality measurements will be monitored until a stable reading is obtained and until a sufficient volume of water from the well or groundwater sampling point is purged (volume will vary depending on the depth of the depth-discrete sample).

Dissolved Oxygen: In lieu of more detailed general water quality assessments, DO concentrations will be measured using a flow-through system composed of a DO meter (YSI Model 550A Oxygen Probe or similar), a flow-through cell, and a variable-speed slow-flow peristaltic pump. DO concentrations will be monitored until a stable reading is obtained and until a sufficient volume of water from the well or groundwater sampling point is purged (volume will vary depending on the depth of the depth-discrete sample).

Dissolved Chemicals of Interest: Groundwater samples will be collected using the low-flow variable-speed peristaltic pump discussed above. After water quality parameters have been collected and an appropriate volume of water has been purged from the sampling interval, a sample will be collected in a 40-mL VOA vial with a septa-lined cap. Groundwater samples will be analyzed in the field for concentrations of chemicals of interest. Samples measured in the field will be analyzed using a headspace GC method. The GC used will be an SRI Series 8610C or similar equipped with a FID, PID, and/or an DELCD detectors. The GC will be calibrated to known dissolved concentrations of these analytes.

E4.2 System Hydraulics Measurements

The following measurements relate to better understanding the groundwater flow system at the time of sampling:

<u>Depth to groundwater:</u> The depth to groundwater will be measured with a standard electronic interface probe. For example, typical devices are comprised of an electronic sensor attached to the end of a 50- to 200-ft measuring tape marked with 0.01-ft increments.

<u>Aquifer Characterization Tests:</u> Specific capacity pump tests will be conducted as follows: a) an interface probe will locate the static water level in a small-diameter Geoprobe drive rod, b) tubing will be lowered so that the tubing intake is located a known distance below the static water level, c) a peristaltic pump will be operated at full speed with the hope that the pump rate is faster than the recharge rate to the well, so that the draw-down becomes the depth to the tubing intake, d) the flow rate is measured by the standard bucket-and-stopwatch approach, and e) the data is analyzed to determine hydraulic conductivity.

Slug tests will be conducted in conventional wells using a data logging pressure transducer and a slug capable of displacing about 2-ft of water. The slug is either lowered into, or pulled out of the well, and the water level response is monitored until it stabilizes at the pre-test level. The data is then analyzed by standard slug-test analysis methods.

Laboratory permeameter tests will be conducted using the constant-head technique whereby the flow through a vertical column is measured under conditions of a constant pre-set hydraulic head. The flow is measured by recording the time it takes to fill a 2-L volumetric flask and then the hydraulic conductivity is determined from the known column geometry, pre-set head, and measured flowrate.

E4.3 Sample Collection Techniques

Groundwater samples will be collected in a manner consistent with site conditions.

In most cases, groundwater samples will be collected using a variable-speed low-flow peristaltic pump and collected in a 40-mL VOA vial with a septa-lined cap. Analyses will be conducted in the field within 24-hours. In some cases it may be necessary to collect samples using bailers or down-hole pumps.

All sample collection devices will be cleaned and prepared in accordance to applicable USEPA procedures prior to each use.

E4.4 Sample Identification Procedures

Each sample will be identified with a unique sample number coded to correlate to the sampling location and depth assigned by the sample collector at the time of collection. This code will be logged onto a master field data sheet indicating who collected the sample, where the sample was collected, and the date of sample collection.

Each sample will be logged in the Project Record Book (see section on Documentation) with the information recorded on the sample container label and a brief sample description. Any samples being shipped off-site for analysis will be logged on a chain-of-custody log sheet to be sent with the samples to document sample receipt.

E5.0 Data Quality Parameters

Precision will be based on the relative percent difference (RPD) of duplicate analysis of samples. Accuracy will be determined by the percentage of analyte recovered (percent recovery [%R]) from sample of known concentration. Laboratory QC will consist of analytical duplicates conducted for 10% of the total samples submitted for analysis. One laboratory control sample will be included for each 20 samples to ensure that the analytical equipment is operating properly. Laboratory controls will consist of standards of known concentrations. The calculation for each of these quantitative objectives is described in the following sections.

Accuracy: The percent accuracy is calculated from the general equation:

$$\%\ \text{Accuracy} = \frac{100\left(X - X_a\right)}{X_a} \qquad \text{(B-1)}$$

where X is the parameter measured
X_a is the parameter's known value

The accuracy claimed by each field instrument manufacturer will be compared with the percent accuracy as measured from standard samples. If the percent accuracy is less than the required accuracy then corrective action will be initiated.

Precision: Precision for the field laboratory analytical procedures will be assessed by the analytical laboratory on an on-going basis. ASU (Dr. Johnson) will review all analytical data to ensure that any questions concerning data validity are addressed at the earliest time possible.

Completeness: Percent completeness is defined by the general equation:

$$\%\ \text{Completeness} = 100\,\frac{D_o}{D_S} \qquad \text{(B-2)}$$

where D_o = quantity of data obtained
D_s = quantity of data scheduled to be obtained

Completeness in meeting the scheduled data recovery objectives will increase throughout the project as the experience base in equipment operation characteristics increases. The completeness objective for operations during this study is 90% for each test parameter.

E6.0 Calibration Checks, Quality Control Checks, and Corrective Actions

All GC-FID/PID/DELCD analyses will be conducted on a dedicated SRI Instruments Model 8610C gas chromatograph using a DB-1 type capillary column. The instrument will be calibrated each day at at least three different concentrations spanning the concentration range of interest (e.g. 10, 100, 1000 µg/L for dissolved concentrations of chemicals of interest). In addition, at least one calibration sample is re-analyzed approximately two – to four-times during the day to detect any instrument drift. If area counts from successive calibration analyses consistently deviate by more than 20%, or if retention times vary by more than 0.20 minutes, then the following routine checks are made to the equipment: a) leaking septum and b) change in gas flows. If these prove not to be the source of error, then a new standard is made and analyzed. If necessary, recalibration over the entire concentration range is repeated. Reporting levels will be established based on the calibration results. Based on experience with this instrument, reporting levels of about 1 – 5 µg/L are possible for typical chemicals of interest in groundwater.

Water quality meters are calibrated according to the manufacturer's specification.

YSI DO meters are calibrated in air, at ambient temperature, according to the manufacturer's specification.

The specific nature of all corrective actions and the operating limits that would trigger the need for corrective action for all aspects of the remediation system and analytical operations are to numerous to anticipate here. Most corrective actions will be empirical in nature as the following specific examples show.

<u>Problem</u>	<u>Corrective Action</u>
Analysis of standard sample indicated field GC accuracy has drifted outside established limits (calibration check every 20 samples).	Perform replicate standard analysis. Verify instrument parameters Recalibrate instrument.
<u>Problem</u>	<u>Corrective Action</u>
DO/WQ meter does not calibrate properly, or is providing suspect data.	Recalibrate and re-test Replace membrane as applicable, recalibrate, and retest

E7.0 Documentation and Record-Keeping

E7.1 Quality Assurance Reports

A chronological record of all field work associated with the project will be maintained in the Project Record Book. The record book will be used to record all activities and relevant observations during the field sampling events.

E7.2 Data Format

A summary of the sampling results for each sampling event will be produced within 30 days of the sampling event. The data will be presented with the following data fields:

- Sampling date
- Sampling time
- Location designation
- Position of sampling location relative to known location
- DO
- Temperature
- Chemical concentration(s)
- Relevant notes for the collection and analysis of that sample

E7.3 Data Storage

All data and reports will be archived in both paper and electronic format. All electronic files will be backed-up on compact disks (CDs) at one-month intervals (minimum). All paper files (e.g., field log books) will be copied and archived in a project-specific file.

APPENDIX F

Uncertainty Analysis
for Mass Discharge Calculations

Interpolation Error Results

INSTRUCTIONS
1. The table below shows all concentration and, if applicable, non-uniform conductivity/Darcy velocity and gradient input data.
2. During the uncertainty analysis, each of the points in the table are removed one at a time and the mass flux calculated without that point using the interpolation scheme specified in the Data Input section (note that

Site Location and I.D.: Air Force Plant 4
Description: Building 181

Next Step: Mass Flux Summary | Back to Mass Flux Result | Print | Back to Data Input | HELP

SELECT TRANSECT TO VIEW: Transect 1
SELECT TIME PERIOD TO VIEW: 1

TCE Interpolation Methods

Hydraulic Conductivity: 1) Vertical: Linear 2) Horizontal: Linear
Concentration: 1) Vertical: Linear 2) Horizontal: Linear
Hydraulic Gradient: 1) Vertical: Linear 2) Horizontal: Linear

Total Mass Flux Including All Points 1.06E+01 *(g/day)*

	End of Transect	Top of Sampling Interval	Bottom of Sampling Interval	Parameter Examined	Parameter Value Removed For Analysis	Parameter Units	RESULTS: Total Mass Flux Excluding Selected Point and Interpolating (g/day)	RESULTS: Contribution of Selected Point to Total Mass Flux (%)
1	Start of Transect			Conductivity	5.00E-03	ft/d	1.06E+01	0.0
2	GP5	29.0	34.0	Conductivity	5.00E-03	ft/d	1.07E+01	-1.5
3	GP6	29.0	31.0	Conductivity	5.00E-03	ft/d	1.09E+01	-2.8
4	GP6	31.0	31.5	Conductivity	2.57E+01	ft/d	9.98E+00	5.5
5	GP6	32.0	32.2	Conductivity	2.57E+01	ft/d	1.06E+01	0.0
6	GP6	33.0	33.5	Conductivity	2.57E+01	ft/d	1.06E+01	0.0
7	GP6	29.0	34.0	Conductivity	2.01E+01	ft/d	1.06E+01	0.0
8	GP11	29.0	31.0	Conductivity	5.00E-03	ft/d	1.14E+01	-7.7
9	GP11	31.0	35.0	Conductivity	3.98E+01	ft/d	8.64E+00	18.2
10	GP4	29.0	30.0	Conductivity	5.00E-03	ft/d	1.19E+01	-12.4
11	GP4	30.0	30.5	Conductivity	5.40E+01	ft/d	5.98E+00	43.3
12	GP4	31.0	31.5	Conductivity	5.00E-02	ft/d	1.06E+01	0.0
13	GP4	32.0	32.5	Conductivity	5.00E-03	ft/d	1.06E+01	0.0
14	GP4	33.0	33.5	Conductivity	5.40E+01	ft/d	1.06E+01	0.0
15	GP4	34.0	34.5	Conductivity	5.00E-03	ft/d	1.06E+01	0.0
16	*GP4*	*29.0*	*34.5*	*Conductivity*	*5.00E-03*	*ft/d*	1.06E+01	0.0
17	*GP7*	*29.0*	*31.0*	*Conductivity*	*5.00E-03*	*ft/d*	1.23E+01	-16.4
18	*GP7*	*31.0*	*31.5*	*Conductivity*	*1.66E+02*	*ft/d*	7.09E+00	32.8
19	*GP7*	*32.0*	*32.5*	*Conductivity*	*5.00E-03*	*ft/d*	1.06E+01	0.0
20	*GP7*	*33.0*	*33.5*	*Conductivity*	*1.66E+02*	*ft/d*	1.06E+01	0.0
21	*GP7*	*33.8*	*34.3*	*Conductivity*	*4.68E+02*	*ft/d*	1.06E+01	0.0
22	*GP7*	*29.0*	*34.3*	*Conductivity*	*5.00E-03*	*ft/d*	1.06E+01	0.0
23	*GP3*	*29.0*	*32.0*	*Conductivity*	*5.00E-03*	*ft/d*	1.06E+01	-0.3
24	*GP3*	*32.0*	*32.5*	*Conductivity*	*3.50E+01*	*ft/d*	1.05E+01	0.2
25	*GP3*	*33.0*	*33.5*	*Conductivity*	*5.01E+01*	*ft/d*	1.06E+01	0.0
26	*GP3*	*33.5*	*34.0*	*Conductivity*	*2.64E+01*	*ft/d*	1.06E+01	0.0
27	*GP3*	*29.0*	*34.0*	*Conductivity*	*5.00E-03*	*ft/d*	1.06E+01	0.0
28	*GP8*	*29*	*33.5*	*Conductivity*	*5.00E-03*	*ft/d*	1.06E+01	0.0
29	*End of Transect*			*Conductivity*	*5.00E-03*	*ft/d*	1.06E+01	0.0
30	*Start of Transect*			*Concentration*	*0.00E+00*	*ug/L*	1.06E+01	0.0
31	*GP5*	*29*	*34*	*Concentration*	*1.20E+03*	*ug/L*	1.05E+01	0.7
32	*GP6*	*29*	*31*	*Concentration*		*ug/L*	1.06E+01	0.0
33	*GP6*	*31*	*31.5*	*Concentration*	*7.10E+02*	*ug/L*	1.13E+01	-7.3
34	*GP6*	*32*	*32.2*	*Concentration*	*5.60E+02*	*ug/L*	1.06E+01	0.0
35	*GP6*	*33*	*33.5*	*Concentration*	*1.75E+03*	*ug/L*	1.06E+01	0.0
36	*GP6*	*29*	*34*	*Concentration*	*3.90E+03*	*ug/L*	1.06E+01	0.0
37	*GP11*	*29*	*31*	*Concentration*		*ug/L*	1.06E+01	0.0
38	*GP11*	*31*	*35*	*Concentration*	*2.90E+03*	*ug/L*	1.02E+01	3.8
39	*GP4*	*29*	*30*	*Concentration*		*ug/L*	1.06E+01	0.0
40	*GP4*	*30*	*30.5*	*Concentration*	*4.70E+03*	*ug/L*	5.34E+00	49.5
41	*GP4*	*31*	*31.5*	*Concentration*	*1.50E+03*	*ug/L*	1.06E+01	0.0
42	*GP4*	*32*	*32.5*	*Concentration*		*ug/L*	1.06E+01	0.0
43	*GP4*	*33*	*33.5*	*Concentration*	*5.40E+03*	*ug/L*	1.06E+01	0.0
44	*GP4*	*34*	*34.5*	*Concentration*		*ug/L*	1.06E+01	0.0
45	*GP4*	*29*	*34.5*	*Concentration*	*2.40E+03*	*ug/L*	1.06E+01	0.0
46	*GP7*	*29*	*31*	*Concentration*		*ug/L*	1.06E+01	0.0
47	*GP7*	*31*	*31.5*	*Concentration*	*1.00E+02*	*ug/L*	2.04E+01	-93.0
48	*GP7*	*32*	*32.5*	*Concentration*	*1.10E+02*	*ug/L*	1.06E+01	0.0
49	*GP7*	*33*	*33.5*	*Concentration*	*5.20E+01*	*ug/L*	1.06E+01	0.0
50	*GP7*	*33.8*	*34.3*	*Concentration*	*3.80E+01*	*ug/L*	1.06E+01	0.0
51	*GP7*	*29*	*34.3*	*Concentration*		*ug/L*	1.06E+01	0.0
52	*GP3*	*29*	*32*	*Concentration*		*ug/L*	1.06E+01	0.0
53	*GP3*	*32*	*32.5*	*Concentration*	*4.30E+01*	*ug/L*	1.06E+01	-0.3
54	*GP3*	*33*	*33.5*	*Concentration*	*3.80E+01*	*ug/L*	1.06E+01	0.0
55	*GP3*	*33.5*	*34*	*Concentration*	*5.10E+01*	*ug/L*	1.06E+01	0.0
56	*GP3*	*29*	*34*	*Concentration*	*4.00E+01*	*ug/L*	1.06E+01	0.0
57	*GP8*	*29*	*33.5*	*Concentration*	*3.30E+01*	*ug/L*	1.06E+01	0.0
58	*End of Transect*			*Concentration*	*0.00E+00*	*ug/L*	1.06E+01	0.0

						RESULTS	
End of Transect	Top of Sampling Interval	Bottom of Sampling Interval	Parameter Examined	Parameter Value Removed For Analysis	Parameter Units	Total Mass Flux Excluding Selected Point and Interpolating (g/day)	Contribution of Selected Point to Total Mass Flux (%)

Interpolation Error Results

INSTRUCTIONS
1. The table below shows all concentration and, if applicable, non-uniform conductivity/Darcy velocity and gradient input data.
2. During the uncertainty analysis, each of the points in the table are removed one at a time and the mass flux calculated without that point using the interpolation scheme specified in the Data Input section (note that

Site Location and I.D.: Air Force Plant 4
Description: Building 181

Next Step: Mass Flux Summary

Back to Mass Flux Result | Print | Back to Data Input | HELP

SELECT TRANSECT TO VIEW: Transect 1

SELECT TIME PERIOD TO VIEW: 1

TCE Interpolation Methods

Hydraulic Conductivity: 1) Vertical: Linear 2) Horizontal: Linear
Concentration: 1) Vertical: Linear 2) Horizontal: Linear
Hydraulic Gradient: 1) Vertical: Linear 2) Horizontal: Linear

Total Mass Flux Including All Points 2.99E+01 *(g/day)*

							RESULTS	
	End of Transect	Top of Sampling Interval	Bottom of Sampling Interval	Parameter Examined	Parameter Value Removed For Analysis	Parameter Units	Total Mass Flux Excluding Selected Point and Interpolating (g/day)	Contribution of Selected Point to Total Mass Flux (%)
1	Start of Transect			Conductivity	5.00E-03	ft/d	2.99E+01	0.0
2	GP5	29.0	34.0	Conductivity	5.00E-03	ft/d	3.00E+01	-0.4
3	MW-11	30.0	36.0	Conductivity	1.19E+01	ft/d	2.97E+01	0.6
4	GP6	29.0	31.0	Conductivity	5.00E-03	ft/d	3.01E+01	-0.8
5	GP6	31.0	31.5	Conductivity	2.57E+01	ft/d	2.95E+01	1.3
6	GP6	32.0	32.2	Conductivity	2.57E+01	ft/d	2.99E+01	0.0
7	GP6	33.0	33.5	Conductivity	2.57E+01	ft/d	2.99E+01	0.0
8	GP6	29.0	34.0	Conductivity	2.01E+01	ft/d	2.99E+01	0.0
9	GP11	29.0	31.0	Conductivity	5.00E-03	ft/d	3.08E+01	-3.2
10	GP11	31.0	35.0	Conductivity	3.98E+01	ft/d	2.80E+01	6.4
11	GP4	29.0	30.0	Conductivity	5.00E-03	ft/d	3.05E+01	-2.1
12	GP4	30.0	30.5	Conductivity	5.40E+01	ft/d	2.55E+01	14.6
13	GP4	31.0	31.5	Conductivity	5.00E-02	ft/d	2.99E+01	0.0
14	GP4	32.0	32.5	Conductivity	5.00E-03	ft/d	2.99E+01	0.0
15	GP4	33.0	33.5	Conductivity	5.40E+01	ft/d	2.99E+01	0.0
16	*GP4*	*34.0*	*34.5*	*Conductivity*	*5.00E-03*	*ft/d*	2.99E+01	0.0
17	*GP4*	*29.0*	*34.5*	*Conductivity*	*5.00E-03*	*ft/d*	2.99E+01	0.0
18	*MW-12*	*29.0*	*34.0*	*Conductivity*	*9.62E+02*	*ft/d*	9.42E+00	68.5
19	*GP7*	*29.0*	*31.0*	*Conductivity*	*5.00E-03*	*ft/d*	3.00E+01	-0.5
20	*GP7*	*31.0*	*31.5*	*Conductivity*	*1.66E+02*	*ft/d*	2.96E+01	0.9
21	*GP7*	*32.0*	*32.5*	*Conductivity*	*5.00E-03*	*ft/d*	2.99E+01	0.0
22	*GP7*	*33.0*	*33.5*	*Conductivity*	*1.66E+02*	*ft/d*	2.99E+01	0.0
23	*GP7*	*33.8*	*34.3*	*Conductivity*	*4.68E+02*	*ft/d*	2.99E+01	0.0
24	*GP7*	*29.0*	*34.3*	*Conductivity*	*5.00E-03*	*ft/d*	2.99E+01	0.0
25	*GP3*	*29.0*	*32.0*	*Conductivity*	*5.00E-03*	*ft/d*	2.99E+01	-0.1
26	*GP3*	*32.0*	*32.5*	*Conductivity*	*3.50E+01*	*ft/d*	2.99E+01	0.1
27	*GP3*	*33.0*	*33.5*	*Conductivity*	*5.01E+01*	*ft/d*	2.99E+01	0.0
28	*GP3*	*33.5*	*34*	*Conductivity*	*2.64E+01*	*ft/d*	2.99E+01	0.0
29	*GP3*	*29*	*34*	*Conductivity*	*5.00E-03*	*ft/d*	2.99E+01	0.0
30	*MW-7*	*29*	*34.5*	*Conductivity*	*1.19E+02*	*ft/d*	2.99E+01	-0.1
31	*GP8*	*29*	*33.5*	*Conductivity*	*5.00E-03*	*ft/d*	2.99E+01	-0.1
32	*End of Transect*			*Conductivity*	*5.00E-03*	*ft/d*	2.99E+01	0.0
33	*Start of Transect*			*Concentration*	*0.00E+00*	*ug/L*	2.99E+01	0.0
34	*GP5*	*29*	*34*	*Concentration*	*1.20E+03*	*ug/L*	2.99E+01	0.1
35	*MW-11*	*30*	*36*	*Concentration*	*1.75E+03*	*ug/L*	2.96E+01	1.0
36	*GP6*	*29*	*31*	*Concentration*		*ug/L*	2.99E+01	0.0
37	*GP6*	*31*	*31.5*	*Concentration*	*7.10E+02*	*ug/L*	3.04E+01	-1.8
38	*GP6*	*32*	*32.2*	*Concentration*	*5.60E+02*	*ug/L*	2.99E+01	0.0
39	*GP6*	*33*	*33.5*	*Concentration*	*1.75E+03*	*ug/L*	2.99E+01	0.0
40	*GP6*	*29*	*34*	*Concentration*	*3.90E+03*	*ug/L*	2.99E+01	0.0
41	*GP11*	*29*	*31*	*Concentration*		*ug/L*	2.99E+01	0.0
42	*GP11*	*31*	*35*	*Concentration*	*2.90E+03*	*ug/L*	2.96E+01	0.8
43	*GP4*	*29*	*30*	*Concentration*		*ug/L*	2.99E+01	0.0
44	*GP4*	*30*	*30.5*	*Concentration*	*4.70E+03*	*ug/L*	1.36E+01	54.6
45	*GP4*	*31*	*31.5*	*Concentration*	*1.50E+03*	*ug/L*	2.99E+01	0.0
46	*GP4*	*32*	*32.5*	*Concentration*		*ug/L*	2.99E+01	0.0
47	*GP4*	*33*	*33.5*	*Concentration*	*5.40E+03*	*ug/L*	2.99E+01	0.0
48	*GP4*	*34*	*34.5*	*Concentration*		*ug/L*	2.99E+01	0.0
49	*GP4*	*29*	*34.5*	*Concentration*	*2.40E+03*	*ug/L*	2.99E+01	0.0
50	*MW-12*	*29*	*34*	*Concentration*	*1.30E+02*	*ug/L*	6.27E+01	-110.0
51	*GP7*	*29*	*31*	*Concentration*		*ug/L*	2.99E+01	0.0
52	*GP7*	*31*	*31.5*	*Concentration*	*1.00E+02*	*ug/L*	2.99E+01	0.1
53	*GP7*	*32*	*32.5*	*Concentration*	*1.10E+02*	*ug/L*	2.99E+01	0.0
54	*GP7*	*33*	*33.5*	*Concentration*	*5.20E+01*	*ug/L*	2.99E+01	0.0
55	*GP7*	*33.8*	*34.3*	*Concentration*	*3.80E+01*	*ug/L*	2.99E+01	0.0
56	*GP7*	*29*	*34.3*	*Concentration*		*ug/L*	2.99E+01	0.0
57	*GP3*	*29*	*32*	*Concentration*		*ug/L*	2.99E+01	0.0
58	*GP3*	*32*	*32.5*	*Concentration*	*4.30E+01*	*ug/L*	3.00E+01	-0.2
59	*GP3*	*33*	*33.5*	*Concentration*	*3.80E+01*	*ug/L*	2.99E+01	0.0
60	*GP3*	*33.5*	*34*	*Concentration*	*5.10E+01*	*ug/L*	2.99E+01	0.0
61	*GP3*	*29*	*34*	*Concentration*	*4.00E+01*	*ug/L*	2.99E+01	0.0
62	*MW-7*	*29*	*34.5*	*Concentration*	*1.40E+02*	*ug/L*	2.97E+01	0.6
63	*GP8*	*29*	*33.5*	*Concentration*	*3.30E+01*	*ug/L*	2.99E+01	0.0
64	*End of Transect*			*Concentration*	*0.00E+00*	*ug/L*	2.99E+01	0.0

						RESULTS	
End of Transect	Top of Sampling Interval	Bottom of Sampling Interval	Parameter Examined	Parameter Value Removed For Analysis	Parameter Units	Total Mass Flux Excluding Selected Point and Interpolating (g/day)	Contribution of Selected Point to Total Mass Flux (%)

Interpolation Error Results

INSTRUCTIONS
1. The table below shows all concentration and, if applicable, non-uniform conductivity/Darcy velocity and gradient input data.
2. During the uncertainty analysis, each of the points in the table are removed one at a time and the mass flux calculated without that point using the interpolation scheme specified in the Data Input section (note that

Site Location and I.D.: CAMP LEJEUNE
Description: SITE 89 - DIRECT PUSH SAMPLING

Next Step: Mass Flux Summary | Back to Mass Flux Result | Print | Back to Data Input | HELP

SELECT TRANSECT TO VIEW: Transect 1
SELECT TIME PERIOD TO VIEW: 1

TCE Interpolation Methods

Hydraulic Conductivity: 1) Vertical: Linear 2) Horizontal: Linear
Concentration: 1) Vertical: Linear 2) Horizontal: Linear
Hydraulic Gradient: Nearest Neighbor

Total Mass Flux Including All Points 9.10E+01 *(g/day)*

							RESULTS	
	End of Transect	Top of Sampling Interval	Bottom of Sampling Interval	Parameter Examined	Parameter Value Removed For Analysis	Parameter Units	Total Mass Flux Excluding Selected Point and Interpolating (g/day)	Contribution of Selected Point to Total Mass Flux (%)
1	Start of Transect			Conductivity	1.67E+00	ft/d	9.11E+01	-0.1
2	GP 6	9.0	9.5	Conductivity	1.67E+00	ft/d	1.31E+02	-44.3
3	GP 6	13.0	13.5	Conductivity	1.67E+00	ft/d	9.10E+01	0.0
4	GP 6	17.0	17.5	Conductivity	1.88E+01	ft/d	8.30E+01	8.8
5	GP 6	17.0	17.5	Conductivity	7.89E+00	ft/d	9.13E+01	-0.4
6	GP 6	21.0	21.5	Conductivity	4.23E+01	ft/d	8.77E+01	3.6
7	GP 6	21.0	21.5	Conductivity	9.45E-01	ft/d	9.10E+01	0.0
8	GP 6	23.0	23.5	Conductivity	9.17E-01	ft/d	9.09E+01	0.1
9	GP 6	25.0	25.5	Conductivity	8.02E-01	ft/d	9.01E+01	1.0
10	GP 6	29.0	29.5	Conductivity	1.31E-01	ft/d	9.24E+01	-1.5
11	GP 6	29.0	29.5	Conductivity	1.72E+00	ft/d	9.10E+01	0.0
12	GP 6	33.0	33.5	Conductivity	1.72E+00	ft/d	9.10E+01	0.0
13	GP 6	37.0	37.5	Conductivity	5.96E-01	ft/d	9.10E+01	0.0
14	GP 5	11.0	11.5	Conductivity	6.48E-01	ft/d	9.10E+01	0.0
15	GP 5	13.0	13.5	Conductivity	8.77E-01	ft/d	9.10E+01	0.0
16	*GP 5*	*17.0*	*17.5*	*Conductivity*	*1.04E+00*	*ft/d*	9.10E+01	0.0
17	*GP 5*	*21.0*	*21.5*	*Conductivity*	*2.75E-01*	*ft/d*	9.10E+01	0.0
18	*GP 5*	*25.0*	*25.5*	*Conductivity*	*1.28E+00*	*ft/d*	9.02E+01	0.9
19	*GP 5*	*25.0*	*25.5*	*Conductivity*	*5.96E-01*	*ft/d*	9.13E+01	-0.4
20	*GP 5*	*29.0*	*29.5*	*Conductivity*	*1.38E+00*	*ft/d*	9.10E+01	0.0
21	*GP 5*	*33.0*	*33.5*	*Conductivity*	*1.11E+00*	*ft/d*	9.10E+01	0.0
22	*GP 5*	*37.0*	*37.5*	*Conductivity*	*1.11E+00*	*ft/d*	9.10E+01	0.0
23	*GP 2*	*3.0*	*3.5*	*Conductivity*	*9.36E-01*	*ft/d*	9.10E+01	0.0
24	*GP 2*	*9.0*	*9.5*	*Conductivity*	*2.43E+00*	*ft/d*	9.10E+01	0.0
25	*GP 2*	*13.0*	*13.5*	*Conductivity*	*8.10E-02*	*ft/d*	9.10E+01	0.0
26	*GP 2*	*17.0*	*17.5*	*Conductivity*	*5.20E-02*	*ft/d*	9.10E+01	0.0
27	*GP 2*	*21.0*	*21.5*	*Conductivity*	*6.95E+00*	*ft/d*	8.17E+01	10.3
28	*GP 2*	*25*	*25.5*	*Conductivity*	*4.54E-01*	*ft/d*	9.20E+01	-1.1
29	*GP 2*	*29*	*29.5*	*Conductivity*	*4.54E-01*	*ft/d*	9.10E+01	0.0
30	*GP 2*	*33*	*33.5*	*Conductivity*	*1.70E-01*	*ft/d*	9.10E+01	0.0
31	*GP 2*	*33*	*33.5*	*Conductivity*	*3.79E-01*	*ft/d*	9.10E+01	0.0
32	*GP 2*	*37*	*37.5*	*Conductivity*	*8.15E-01*	*ft/d*	9.11E+01	-0.1
33	*GP 1*	*9*	*9.5*	*Conductivity*	*2.75E+01*	*ft/d*	9.10E+01	0.0
34	*GP 1*	*15*	*15.5*	*Conductivity*	*3.07E+00*	*ft/d*	9.10E+01	0.0
35	*GP 1*	*15*	*15.5*	*Conductivity*	*3.07E+00*	*ft/d*	9.10E+01	0.0
36	*GP 1*	*19*	*19.5*	*Conductivity*	*5.20E-02*	*ft/d*	9.11E+01	-0.1
37	*GP 1*	*23*	*23.5*	*Conductivity*	*2.99E+00*	*ft/d*	9.20E+01	-1.1
38	*GP 1*	*27*	*27.5*	*Conductivity*	*3.93E+00*	*ft/d*	7.75E+01	14.8
39	*GP 1*	*31*	*31.5*	*Conductivity*	*2.13E-01*	*ft/d*	9.70E+01	-6.6
40	*GP 1*	*35*	*35.5*	*Conductivity*	*2.56E-01*	*ft/d*	9.13E+01	-0.3
41	*GP 1*	*35*	*35.5*	*Conductivity*	*9.11E-01*	*ft/d*	9.14E+01	-0.4
42	*GP 1*	*39*	*39.5*	*Conductivity*	*1.93E+00*	*ft/d*	9.11E+01	-0.1
43	*GP 3*	*39*	*39.5*	*Conductivity*	*4.05E+00*	*ft/d*	9.10E+01	0.0
44	*GP 3*	*6*	*6.5*	*Conductivity*	*4.05E+00*	*ft/d*	9.10E+01	0.0
45	*GP 3*	*17*	*17.5*	*Conductivity*	*2.00E+00*	*ft/d*	9.10E+01	0.0
46	*GP 3*	*21*	*21.5*	*Conductivity*	*3.21E-01*	*ft/d*	9.11E+01	-0.1
47	*GP 3*	*25*	*25.5*	*Conductivity*	*1.93E-01*	*ft/d*	1.09E+02	-19.2
48	*GP 3*	*25*	*25.5*	*Conductivity*	*2.62E-01*	*ft/d*	9.10E+01	0.0
49	*GP 3*	*29*	*29.5*	*Conductivity*	*2.44E+00*	*ft/d*	8.26E+01	9.2
50	*GP 3*	*33*	*33.5*	*Conductivity*	*8.46E-01*	*ft/d*	9.12E+01	-0.2
51	*GP 3*	*37*	*37.5*	*Conductivity*	*1.69E-01*	*ft/d*	9.14E+01	-0.4
52	*GP 4*	*3*	*3.5*	*Conductivity*	*1.69E-01*	*ft/d*	9.10E+01	0.0
53	*GP 4*	*6*	*6.5*	*Conductivity*	*7.28E-01*	*ft/d*	9.10E+01	0.0
54	*GP 4*	*9*	*9.5*	*Conductivity*	*1.75E+00*	*ft/d*	9.10E+01	0.0
55	*GP 4*	*13*	*13.5*	*Conductivity*	*2.03E+00*	*ft/d*	9.10E+01	0.0
56	*GP 4*	*17*	*17.5*	*Conductivity*	*3.42E+00*	*ft/d*	8.24E+01	9.5
57	*GP 4*	*17*	*17.5*	*Conductivity*	*9.17E-01*	*ft/d*	9.43E+01	-3.6
58	*GP 4*	*21*	*21.5*	*Conductivity*	*3.03E+00*	*ft/d*	8.95E+01	1.7
59	*GP 4*	*25*	*25.5*	*Conductivity*	*3.03E+00*	*ft/d*	9.10E+01	0.0
60	*GP 4*	*29*	*29.5*	*Conductivity*	*2.19E-01*	*ft/d*	9.19E+01	-1.0
61	*GP 4*	*33*	*33.5*	*Conductivity*	*2.19E-01*	*ft/d*	9.10E+01	0.0
62	*GP 4*	*37*	*37.5*	*Conductivity*	*8.53E-01*	*ft/d*	9.10E+01	0.0
63	*GP 7*	*8*	*12*	*Conductivity*	*1.30E+00*	*ft/d*	9.09E+01	0.1
64	*GP 7*	*8*	*12*	*Conductivity*	*1.12E+00*	*ft/d*	9.10E+01	0.0
65	*GP 7*	*12*	*16*	*Conductivity*	*1.12E+00*	*ft/d*	9.10E+01	0.0
66	*GP 7*	*16*	*20*	*Conductivity*	*1.01E+00*	*ft/d*	9.10E+01	0.0
67	*GP 7*	*20*	*24*	*Conductivity*	*2.80E+00*	*ft/d*	9.10E+01	0.0

	End of Transect	Top of Sampling Interval	Bottom of Sampling Interval	Parameter Examined	Parameter Value Removed For Analysis	Parameter Units	RESULTS Total Mass Flux Excluding Selected Point and Interpolating (g/day)	RESULTS Contribution of Selected Point to Total Mass Flux (%)
68	End of Transect			Conductivity	2.80E+00	ft/d	9.10E+01	0.0
69	Start of Transect			Concentration	0.00E+00	ug/L	9.12E+01	-0.2
70	GP 6	9	9.5	Concentration	7.60E+04	ug/L	8.99E+01	1.2
71	GP 6	13	13.5	Concentration	7.40E+04	ug/L	9.10E+01	0.0
72	GP 6	17	17.5	Concentration	4.40E+04	ug/L	9.01E+01	1.0
73	GP 6	17	17.5	Concentration	6.60E+02	ug/L	9.41E+01	-3.4
74	GP 6	21	21.5	Concentration	3.80E+02	ug/L	9.16E+01	-0.7
75	GP 6	21	21.5	Concentration	1.00E+00	ug/L	9.60E+01	-5.5
76	GP 6	23	23.5	Concentration	1.50E+05	ug/L	8.90E+01	2.2
77	GP 6	25	25.5	Concentration	1.60E+05	ug/L	8.96E+01	1.6
78	GP 6	29	29.5	Concentration	5.80E+04	ug/L	9.26E+01	-1.7
79	GP 6	29	29.5	Concentration	4.50E+02	ug/L	9.44E+01	-3.7
80	GP 6	33	33.5	Concentration	4.60E+02	ug/L	9.10E+01	0.0
81	GP 6	37	37.5	Concentration	6.60E+02	ug/L	9.34E+01	-2.7
82	GP 5	11	11.5	Concentration	2.00E+04	ug/L	8.79E+01	3.4
83	GP 5	13	13.5	Concentration	8.70E+02	ug/L	9.25E+01	-1.7
84	GP 5	17	17.5	Concentration	6.40E+01	ug/L	9.12E+01	-0.2
85	GP 5	21	21.5	Concentration	2.90E+02	ug/L	9.10E+01	0.1
86	GP 5	25	25.5	Concentration	8.50E+01	ug/L	9.11E+01	-0.1
87	GP 5	25	25.5	Concentration	1.10E+03	ug/L	9.10E+01	0.1
88	GP 5	29	29.5	Concentration	5.80E+02	ug/L	9.10E+01	0.0
89	GP 5	33	33.5	Concentration	1.20E+02	ug/L	9.10E+01	0.0
90	GP 5	37	37.5	Concentration	1.30E+02	ug/L	9.10E+01	0.0
91	GP 2	3	3.5	Concentration	4.90E+01	ug/L	9.10E+01	0.0
92	GP 2	9	9.5	Concentration	6.40E+01	ug/L	9.10E+01	0.0
93	GP 2	13	13.5	Concentration	2.90E+02	ug/L	9.10E+01	0.0
94	GP 2	17	17.5	Concentration	7.50E+02	ug/L	9.10E+01	0.0
95	GP 2	21	21.5	Concentration	1.20E+03	ug/L	9.08E+01	0.2
96	GP 2	25	25.5	Concentration	6.20E+02	ug/L	9.10E+01	0.0
97	GP 2	29	29.5	Concentration	5.40E+02	ug/L	9.10E+01	0.0
98	GP 2	33	33.5	Concentration	6.20E+02	ug/L	9.10E+01	0.0
99	GP 2	33	33.5	Concentration	6.80E+01	ug/L	9.10E+01	0.0
100	GP 2	37	37.5	Concentration	3.00E+00	ug/L	9.10E+01	0.0
101	GP 1	9	9.5	Concentration	2.00E+01	ug/L	9.10E+01	0.0
102	GP 1	15	15.5	Concentration	7.20E+01	ug/L	9.10E+01	0.0
103	GP 1	15	15.5	Concentration	1.10E+02	ug/L	9.10E+01	0.0
104	GP 1	19	19.5	Concentration	7.30E+02	ug/L	9.10E+01	0.0
105	GP 1	23	23.5	Concentration	5.80E+01	ug/L	1.10E+02	-21.4
106	GP 1	27	27.5	Concentration	1.80E+05	ug/L	7.91E+01	13.0
107	GP 1	31	31.5	Concentration	1.50E+05	ug/L	9.01E+01	1.0
108	GP 1	35	35.5	Concentration	4.20E+04	ug/L	9.25E+01	-1.6
109	GP 1	35	35.5	Concentration	4.40E+03	ug/L	9.13E+01	-0.4
110	GP 1	39	39.5	Concentration	1.20E+03	ug/L	9.10E+01	0.0
111	GP 3	39	39.5	Concentration	1.10E+02	ug/L	9.11E+01	-0.1
112	GP 3	6	6.5	Concentration	2.70E+01	ug/L	9.10E+01	0.0
113	GP 3	17	17.5	Concentration	3.00E+01	ug/L	9.10E+01	0.0
114	GP 3	21	21.5	Concentration	4.20E+02	ug/L	9.10E+01	0.0
115	GP 3	25	25.5	Concentration	1.10E+05	ug/L	8.97E+01	1.4
116	GP 3	25	25.5	Concentration	1.10E+05	ug/L	9.10E+01	0.0
117	GP 3	29	29.5	Concentration	9.40E+04	ug/L	9.11E+01	-0.1
118	GP 3	33	33.5	Concentration	7.90E+04	ug/L	8.98E+01	1.3
119	GP 3	37	37.5	Concentration	2.80E+04	ug/L	9.12E+01	-0.2
120	GP 4	3	3.5	Concentration	2.70E+04	ug/L	9.10E+01	0.0
121	GP 4	6	6.5	Concentration	1.70E+02	ug/L	9.15E+01	-0.5
122	GP 4	9	9.5	Concentration	5.10E+02	ug/L	9.10E+01	0.0
123	GP 4	13	13.5	Concentration	1.90E+02	ug/L	9.10E+01	0.0
124	GP 4	17	17.5	Concentration	1.20E+05	ug/L	8.91E+01	2.1
125	GP 4	17	17.5	Concentration	9.40E+04	ug/L	9.05E+01	0.5
126	GP 4	21	21.5	Concentration	3.80E+03	ug/L	9.42E+01	-3.6
127	GP 4	25	25.5	Concentration	3.60E+03	ug/L	9.10E+01	0.0
128	GP 4	29	29.5	Concentration	2.30E+03	ug/L	9.10E+01	0.0
129	GP 4	33	33.5	Concentration	5.70E+02	ug/L	9.10E+01	0.0
130	GP 4	37	37.5	Concentration	2.10E+03	ug/L	9.10E+01	0.0
131	GP 7	8	12	Concentration	5.20E+03	ug/L	9.10E+01	0.1
132	GP 7	8	12	Concentration	1.80E+03	ug/L	9.10E+01	0.0
133	GP 7	12	16	Concentration	1.80E+03	ug/L	9.10E+01	0.0
134	GP 7	16	20	Concentration	1.40E+02	ug/L	9.10E+01	0.0
135	GP 7	20	24	Concentration	3.20E+01	ug/L	9.10E+01	0.0
136	End of Transect			Concentration	0.00E+00	ug/L	9.13E+01	-0.3

Interpolation Error Results

INSTRUCTIONS
1. The table below shows all concentration and, if applicable, non-uniform conductivity/Darcy velocity and gradient input data.
2. During the uncertainty analysis, each of the points in the table are removed one at a time and the mass flux calculated without that point using the interpolation scheme specified in the Data Input section (note that

Site Location and I.D.: Ft. Lewis NAPL Area 3
Description:

Next Step: Mass Flux Summary | Back to Mass Flux Result | Print | Back to Data Input | HELP

SELECT TRANSECT TO VIEW: Transect 1
SELECT TIME PERIOD TO VIEW: 2

TCE Interpolation Methods

Hydraulic Conductivity: Uniform
Concentration: 1) Vertical: Linear 2) Horizontal: Linear
Hydraulic Gradient: Uniform

Total Mass Flux Including All Points 4.31E+00 *(g/day)*

	End of Transect	Top of Sampling Interval	Bottom of Sampling Interval	Parameter Examined	Parameter Value Removed For Analysis	Parameter Units	RESULTS: Total Mass Flux Excluding Selected Point and Interpolating (g/day)	RESULTS: Contribution of Selected Point to Total Mass Flux (%)
1	Start of Transect			Concentration	0.00E+00	ug/L	0.00E+00	100.0
2	FX3-06	9.0	40.0	Concentration	1.30E+02	ug/L	0.00E+00	100.0
3	FX3-04	9.0	40.0	Concentration	5.50E+01	ug/L	0.00E+00	100.0
4	FX3-01	9.0	40.0	Concentration	5.20E+01	ug/L	0.00E+00	100.0
5	FX3-02	9.0	40.0	Concentration	2.20E+02	ug/L	0.00E+00	100.0
6	End of Transect			Concentration	0.00E+00	ug/L	0.00E+00	100.0

Interpolation Error Results

Site Location and I.D.: Ft. Lewis NAPL Area 3
Description:

INSTRUCTIONS
1. The table below shows all concentration and, if applicable, non-uniform conductivity/Darcy velocity and gradient input data.
2. During the uncertainty analysis, each of the points in the table are removed one at a time and the mass flux calculated without that point using the interpolation scheme specified in the Data Input section (note that

Next Step: Mass Flux Summary | Back to Mass Flux Result | Print | Back to Data Input | HELP

SELECT TRANSECT TO VIEW Transect 1
SELECT TIME PERIOD TO VIEW 2

TCE Interpolation Methods

Hydraulic Conductivity: Uniform
Concentration: 1) Vertical: Linear 2) Horizontal: Linear
Hydraulic Gradient: Uniform

Total Mass Flux Including All Points **3.90E-01** *(g/day)*

	End of Transect	Top of Sampling Interval	Bottom of Sampling Interval	Parameter Examined	Parameter Value Removed For Analysis	Parameter Units	RESULTS: Total Mass Flux Excluding Selected Point and Interpolating (g/day)	RESULTS: Contribution of Selected Point to Total Mass Flux (%)
1	Start of Transect			Concentration	0.00E+00	ug/L	0.00E+00	100.0
2	FX3-06	9.0	40.0	Concentration	1.30E+02	ug/L	0.00E+00	100.0
3	FX3-04	9.0	40.0	Concentration	5.50E+01	ug/L	0.00E+00	100.0
4	FX3-01	9.0	40.0	Concentration	5.20E+01	ug/L	0.00E+00	100.0
5	FX3-02	9.0	40.0	Concentration	2.20E+02	ug/L	0.00E+00	100.0
6	End of Transect			Concentration	0.00E+00	ug/L	0.00E+00	100.0

Interpolation Error Results

Site Location and I.D.: Ft. Lewis NAPL Area 3
Description:

INSTRUCTIONS
1. The table below shows all concentration and, if applicable, non-uniform conductivity/Darcy velocity and gradient input data.
2. During the uncertainty analysis, each of the points in the table are removed one at a time and the mass flux calculated without that point using the interpolation scheme specified in the Data Input section (note that

Next Step: Mass Flux Summary | Back to Mass Flux Result | Print | Back to Data Input | HELP

SELECT TRANSECT TO VIEW: Transect 1
SELECT TIME PERIOD TO VIEW: 2

TCE Interpolation Methods

Hydraulic Conductivity: Uniform
Concentration: 1) Vertical: Linear 2) Horizontal: Linear
Hydraulic Gradient: Uniform

Total Mass Flux Including All Points 1.50E+00 *(g/day)*

	End of Transect	Top of Sampling Interval	Bottom of Sampling Interval	Parameter Examined	Parameter Value Removed For Analysis	Parameter Units	RESULTS: Total Mass Flux Excluding Selected Point and Interpolating (g/day)	RESULTS: Contribution of Selected Point to Total Mass Flux (%)
1	Start of Transect			Concentration	0.00E+00	ug/L	1.70E+00	-13.4
2	FX3-06	9.0	40.0	Concentration	1.30E+02	ug/L	1.14E+00	24.0
3	FX3-04	9.0	40.0	Concentration	5.50E+01	ug/L	1.64E+00	-9.7
4	FX3-01	9.0	40.0	Concentration	5.20E+01	ug/L	1.80E+00	-20.3
5	FX3-02	9.0	40.0	Concentration	2.20E+02	ug/L	9.39E-01	37.4
6	End of Transect			Concentration	0.00E+00	ug/L	1.81E+00	-20.7

Interpolation Error Results

INSTRUCTIONS
1. The table below shows all concentration and, if applicable, non-uniform conductivity/Darcy velocity and gradient input data.
2. During the uncertainty analysis, each of the points in the table are removed one at a time and the mass flux calculated without that point using the interpolation scheme specified in the Data Input section (note that

Site Location and I.D.: Hunter AAF
Description: Former Pumphouse #2

Next Step: Mass Flux Summary | Back to Mass Flux Result | Print | Back to Data Input | HELP

SELECT TRANSECT TO VIEW: Transcect 1
SELECT TIME PERIOD TO VIEW: 1

Benzene Interpolation Methods

Hydraulic Conductivity: 1) Vertical: Linear 2) Horizontal: Linear
Concentration: 1) Vertical: Linear 2) Horizontal: Linear
Hydraulic Gradient: Nearest Neighbor

Total Mass Flux Including All Points 1.03E-01 *(g/day)*

	End of Transect	Top of Sampling Interval	Bottom of Sampling Interval	Parameter Examined	Parameter Value Removed For Analysis	Parameter Units	RESULTS: Total Mass Flux Excluding Selected Point and Interpolating (g/day)	RESULTS: Contribution of Selected Point to Total Mass Flux (%)
1	Start of Transect			Conductivity	3.80E+00	ft/d	1.03E-01	0.0
2	GP 2	13.0	13.5	Conductivity	3.80E+00	ft/d	1.03E-01	-0.1
3	GP 2	14.0	14.5	Conductivity	1.30E+01	ft/d	1.03E-01	0.0
4	GP 2	16.0	16.5	Conductivity	1.60E+01	ft/d	1.03E-01	0.1
5	GP 2	18.0	18.5	Conductivity	5.30E+00	ft/d	1.03E-01	-0.1
6	GP 2	20.0	20.5	Conductivity	1.60E+01	ft/d	1.03E-01	0.1
7	GP 3	13.0	13.5	Conductivity	2.40E+00	ft/d	1.03E-01	-0.2
8	GP 3	14.0	14.5	Conductivity	8.30E+00	ft/d	1.03E-01	0.0
9	GP 3	16.0	16.5	Conductivity	1.10E+01	ft/d	1.03E-01	-0.1
10	GP 3	18.0	18.5	Conductivity	2.40E+01	ft/d	1.03E-01	0.1
11	GP 3	20.0	20.5	Conductivity	1.90E+01	ft/d	1.03E-01	-0.1
12	GP 4	13.0	13.5	Conductivity	2.00E+01	ft/d	1.03E-01	0.0
13	GP 4	14.0	14.5	Conductivity	2.40E+01	ft/d	1.03E-01	0.0
14	GP 4	16.0	16.5	Conductivity	2.30E+01	ft/d	1.03E-01	0.1
15	GP 4	18.0	18.5	Conductivity	2.00E+01	ft/d	1.03E-01	-0.1
16	GP 4	20.0	20.5	Conductivity	2.60E+01	ft/d	1.03E-01	0.1
17	GP 5	13.0	13.5	Conductivity	4.10E+01	ft/d	1.03E-01	0.1
18	GP 5	14.0	14.5	Conductivity	4.30E+01	ft/d	1.03E-01	0.0
19	GP 5	16.0	16.5	Conductivity	3.10E+01	ft/d	1.03E-01	0.0
20	GP 5	18.0	18.5	Conductivity	2.70E+01	ft/d	1.03E-01	-0.2
21	GP 5	20.0	20.5	Conductivity	3.20E+01	ft/d	1.02E-01	0.3
22	GP 55	14.0	14.5	Conductivity	1.50E+00	ft/d	1.06E-01	-3.7
23	GP 55	15.0	15.5	Conductivity	7.50E+00	ft/d	1.03E-01	0.0
24	GP 55	17.0	17.5	Conductivity	1.00E+01	ft/d	1.00E-01	2.2
25	GP 55	19.0	19.5	Conductivity	8.50E+00	ft/d	1.02E-01	0.5
26	GP 55	21.0	21.5	Conductivity	2.90E+00	ft/d	1.03E-01	-0.3
27	GP 6	13.0	13.5	Conductivity	1.20E+01	ft/d	1.04E-01	-1.3
28	GP 6	14	14.5	Conductivity	1.10E+01	ft/d	1.03E-01	0.0
29	GP 6	16	16.5	Conductivity	1.40E+01	ft/d	9.68E-02	5.7
30	GP 6	18	18.5	Conductivity	1.10E+01	ft/d	1.02E-01	0.7
31	GP 6	20	20.5	Conductivity	3.80E+00	ft/d	1.03E-01	-0.6
32	GP 65	13	13.5	Conductivity	2.50E+01	ft/d	1.02E-01	0.3
33	GP 65	15	15.5	Conductivity	2.00E+01	ft/d	1.04E-01	-1.2
34	GP 65	16	16.5	Conductivity	1.70E+01	ft/d	1.03E-01	0.0
35	GP 65	18	18.5	Conductivity	2.30E+01	ft/d	1.02E-01	0.5
36	GP 65	20	20.5	Conductivity	1.80E+01	ft/d	1.03E-01	-0.3
37	GP 7	13	13.5	Conductivity	1.70E+01	ft/d	1.03E-01	-0.1
38	GP 7	14	14.5	Conductivity	1.40E+01	ft/d	1.03E-01	0.0
39	GP 7	16	16.5	Conductivity	1.90E+01	ft/d	1.03E-01	0.0
40	GP 7	18	18.5	Conductivity	2.10E+01	ft/d	1.02E-01	0.5
41	GP 7	20	20.5	Conductivity	1.10E+01	ft/d	1.10E-01	-6.6
42	GP 8	13	13.5	Conductivity	1.40E+01	ft/d	1.02E-01	0.2
43	GP 8	14	14.5	Conductivity	8.80E+00	ft/d	1.03E-01	0.0
44	GP 8	16	16.5	Conductivity	9.80E+00	ft/d	1.04E-01	-1.2
45	GP 8	18	18.5	Conductivity	2.20E+01	ft/d	9.80E-02	4.5
46	GP 8	20	20.5	Conductivity	2.90E+00	ft/d	1.51E-01	-47.1
47	GP 9	12	16	Conductivity	5.50E+00	ft/d	1.03E-01	-0.1
48	GP 9	16	20	Conductivity	7.70E+00	ft/d	1.01E-01	1.3
49	End of Transect			Conductivity	7.70E+00	ft/d	1.03E-01	0.0
50	Start of Transect			Concentration	0.00E+00	ug/L	1.03E-01	0.0
51	GP 2	13	13.5	Concentration	5.00E-01	ug/L	1.03E-01	0.0
52	GP 2	14	14.5	Concentration	5.00E-01	ug/L	1.03E-01	0.0
53	GP 2	16	16.5	Concentration	5.00E-01	ug/L	1.03E-01	0.0
54	GP 2	18	18.5	Concentration	5.00E-01	ug/L	1.03E-01	0.0
55	GP 2	20	20.5	Concentration	5.00E-01	ug/L	1.03E-01	0.0
56	GP 3	13	13.5	Concentration	1.00E+00	ug/L	1.03E-01	0.1
57	GP 3	14	14.5	Concentration	5.00E-01	ug/L	1.03E-01	0.0
58	GP 3	16	16.5	Concentration	5.00E-01	ug/L	1.03E-01	-0.1
59	GP 3	18	18.5	Concentration	5.00E-01	ug/L	1.03E-01	0.0
60	GP 3	20	20.5	Concentration	5.00E-01	ug/L	1.03E-01	0.0
61	GP 4	13	13.5	Concentration	5.00E-01	ug/L	1.03E-01	0.0
62	GP 4	14	14.5	Concentration	5.00E-01	ug/L	1.03E-01	0.0
63	GP 4	16	16.5	Concentration	5.00E-01	ug/L	1.03E-01	0.0
64	GP 4	18	18.5	Concentration	5.00E-01	ug/L	1.03E-01	0.0
65	GP 4	20	20.5	Concentration	5.00E-01	ug/L	1.03E-01	0.0
66	GP 5	13	13.5	Concentration	5.00E-01	ug/L	1.03E-01	0.0
67	GP 5	14	14.5	Concentration	5.00E-01	ug/L	1.03E-01	0.0

							RESULTS	
	End of Transect	**Top of Sampling Interval**	**Bottom of Sampling Interval**	**Parameter Examined**	**Parameter Value Removed For Analysis**	**Parameter Units**	**Total Mass Flux Excluding Selected Point and Interpolating (g/day)**	**Contribution of Selected Point to Total Mass Flux (%)**
68	GP 5	16	16.5	Concentration	5.00E-01	ug/L	1.03E-01	0.0
69	GP 5	18	18.5	Concentration	5.00E-01	ug/L	1.03E-01	0.0
70	GP 5	20	20.5	Concentration	5.00E-01	ug/L	1.03E-01	0.0
71	GP 55	14	14.5	Concentration	5.00E-01	ug/L	1.03E-01	0.0
72	GP 55	15	15.5	Concentration	4.00E+00	ug/L	1.03E-01	0.0
73	GP 55	17	17.5	Concentration	5.00E-01	ug/L	1.06E-01	-3.6
74	GP 55	19	19.5	Concentration	1.70E+01	ug/L	9.81E-02	4.4
75	GP 55	21	21.5	Concentration	5.00E-01	ug/L	1.07E-01	-3.9
76	GP 6	13	13.5	Concentration	1.30E+01	ug/L	1.40E-01	-36.4
77	GP 6	14	14.5	Concentration	5.00E+00	ug/L	1.03E-01	0.0
78	GP 6	16	16.5	Concentration	1.96E+02	ug/L	4.87E-02	52.6
79	GP 6	18	18.5	Concentration	5.00E-01	ug/L	1.23E-01	-19.5
80	GP 6	20	20.5	Concentration	2.00E+00	ug/L	1.02E-01	0.3
81	GP 65	13	13.5	Concentration	5.00E-01	ug/L	1.03E-01	0.0
82	GP 65	15	15.5	Concentration	5.00E-01	ug/L	1.03E-01	0.0
83	GP 65	16	16.5	Concentration	5.00E-01	ug/L	1.03E-01	0.0
84	GP 65	18	18.5	Concentration	5.00E-01	ug/L	1.03E-01	-0.7
85	GP 65	20	20.5	Concentration	4.00E+00	ug/L	1.01E-01	1.2
86	GP 7	13	13.5	Concentration	3.00E+00	ug/L	1.02E-01	1.2
87	GP 7	14	14.5	Concentration	2.00E+00	ug/L	1.03E-01	0.0
88	GP 7	16	16.5	Concentration	5.00E-01	ug/L	1.03E-01	-0.6
89	GP 7	18	18.5	Concentration	5.00E-01	ug/L	1.03E-01	0.0
90	GP 7	20	20.5	Concentration	5.00E-01	ug/L	1.03E-01	0.0
91	GP 8	13	13.5	Concentration	5.00E-01	ug/L	1.05E-01	-1.9
92	GP 8	14	14.5	Concentration	5.00E-01	ug/L	1.03E-01	0.0
93	GP 8	16	16.5	Concentration	5.00E+00	ug/L	1.01E-01	1.2
94	GP 8	18	18.5	Concentration	4.00E+00	ug/L	1.20E-01	-17.3
95	GP 8	20	20.5	Concentration	6.50E+01	ug/L	8.12E-02	20.9
96	GP 9	12	16	Concentration	5.00E-01	ug/L	1.04E-01	-0.9
97	GP 9	16	20	Concentration	5.00E+00	ug/L	1.01E-01	1.5
98	End of Transect			Concentration	0.00E+00	ug/L	1.03E-01	-0.1

Interpolation Error Results

INSTRUCTIONS
1. The table below shows all concentration and, if applicable, non-uniform conductivity/Darcy velocity and gradient input data.
2. During the uncertainty analysis, each of the points in the table are removed one at a time and the mass flux calculated without that point using the interpolation scheme specified in the Data Input section (note that

Site Location and I.D.: NAS Alameda
Description: Site 5

Next Step: Mass Flux Summary | Back to Mass Flux Result | Print | Back to Data Input | HELP

SELECT TRANSECT TO VIEW: Transect 1
SELECT TIME PERIOD TO VIEW: 1

TCE Interpolation Methods

Hydraulic Conductivity: 1) Vertical: Linear 2) Horizontal: Linear
Concentration: 1) Vertical: Linear 2) Horizontal: Linear
Hydraulic Gradient: 1) Vertical: Linear 2) Horizontal: Linear

Total Mass Flux Including All Points 1.79E-01 *(g/day)*

	End of Transect	Top of Sampling Interval	Bottom of Sampling Interval	Parameter Examined	Parameter Value Removed For Analysis	Parameter Units	RESULTS: Total Mass Flux Excluding Selected Point and Interpolating (g/day)	RESULTS: Contribution of Selected Point to Total Mass Flux (%)
1	Start of Transect			Conductivity	1.90E+01	ft/d	1.80E-01	-0.8
2	GP 1	7.0	7.5	Conductivity	1.90E+01	ft/d	1.83E-01	-2.8
3	GP 1	10.0	10.5	Conductivity	6.60E+00	ft/d	1.72E-01	3.8
4	GP 1	13.0	13.5	Conductivity	3.10E+00	ft/d	1.86E-01	-4.4
5	GP 1	16.0	16.5	Conductivity	6.40E-02	ft/d	1.87E-01	-4.9
6	GP 1	19.0	19.5	Conductivity	1.10E+00	ft/d	1.86E-01	-4.2
7	GP 1	21.0	21.5	Conductivity	5.10E-01	ft/d	1.86E-01	-4.2
8	GP 2	7.0	7.5	Conductivity	1.60E+01	ft/d	1.81E-01	-1.4
9	GP 2	10.0	10.5	Conductivity	1.40E+00	ft/d	2.55E-01	-42.8
10	GP 2	13.0	13.5	Conductivity	1.20E+01	ft/d	1.56E-01	12.5
11	GP 2	17.0	17.5	Conductivity	5.10E-01	ft/d	1.94E-01	-8.6
12	GP 2	19.0	19.5	Conductivity	8.40E+00	ft/d	1.86E-01	-4.0
13	GP 2	21.0	21.5	Conductivity	2.70E-01	ft/d	1.89E-01	-5.7
14	GP 3	6.5	7.0	Conductivity	1.60E+01	ft/d	1.86E-01	-4.2
15	GP 3	9.5	10.0	Conductivity	9.60E+00	ft/d	1.60E-01	10.2
16	GP 3	12.5	13.0	Conductivity	1.40E+00	ft/d	1.99E-01	-11.2
17	GP 3	15.5	16.0	Conductivity	1.80E+00	ft/d	1.84E-01	-3.2
18	GP 3	20.5	21.0	Conductivity	2.50E-01	ft/d	1.87E-01	-4.5
19	GP 4	6.5	7.0	Conductivity	1.50E+01	ft/d	1.77E-01	0.6
20	GP 4	9.5	10.0	Conductivity	4.30E+00	ft/d	1.91E-01	-6.9
21	GP 4	12.5	13.0	Conductivity	4.50E+00	ft/d	1.81E-01	-1.4
22	GP 4	15.5	16.0	Conductivity	6.90E-01	ft/d	1.88E-01	-5.4
23	GP 4	18.5	19.0	Conductivity	2.10E+00	ft/d	1.86E-01	-4.1
24	GP 4	20.5	21.0	Conductivity	5.10E-01	ft/d	1.86E-01	-4.2
25	GP 5	6.5	7.0	Conductivity	9.30E+00	ft/d	1.85E-01	-3.8
26	GP 5	9.5	10.0	Conductivity	5.20E+00	ft/d	1.86E-01	-4.2
27	GP 5	12.5	13.0	Conductivity	1.10E+00	ft/d	1.90E-01	-6.4
28	GP 5	15.5	16	Conductivity	1.50E+00	ft/d	1.87E-01	-4.7
29	GP 5	18.5	19	Conductivity	4.40E+00	ft/d	1.86E-01	-4.2
30	GP 5	20.5	21	Conductivity	4.00E-01	ft/d	1.86E-01	-4.2
31	GP 6	6.5	7	Conductivity	4.70E+01	ft/d	1.80E-01	-0.8
32	GP 6	10.5	11	Conductivity	4.60E-01	ft/d	1.89E-01	-6.1
33	GP 6	12.5	13	Conductivity	4.00E+00	ft/d	1.85E-01	-3.8
34	GP 6	18.5	19	Conductivity	7.00E+00	ft/d	1.85E-01	-3.6
35	GP 6	20.5	21	Conductivity	5.00E-01	ft/d	1.86E-01	-4.2
36	GP 8	7	7.5	Conductivity	1.30E+01	ft/d	1.85E-01	-3.9
37	GP 8	9.5	10	Conductivity	1.60E+00	ft/d	1.87E-01	-4.8
38	GP 8	12.5	13	Conductivity	1.90E+01	ft/d	1.75E-01	1.8
39	GP 8	18.5	19	Conductivity	5.60E-01	ft/d	1.89E-01	-5.8
40	GP 8	20.5	21	Conductivity	9.70E-01	ft/d	1.86E-01	-4.2
41	End of Transect			Conductivity	9.70E-01	ft/d	1.88E-01	-5.2
42	Start of Transect			Concentration	0.00E+00	ug/L	2.07E-01	-16.2
43	GP 1	7	7.5	Concentration	8.00E+00	ug/L	1.83E-01	-2.8
44	GP 1	10	10.5	Concentration	3.40E+01	ug/L	1.70E-01	4.9
45	GP 1	13	13.5	Concentration	1.35E+01	ug/L	1.89E-01	-5.7
46	GP 1	16	16.5	Concentration	1.00E+00	ug/L	1.90E-01	-6.3
47	GP 1	19	19.5	Concentration	0.00E+00	ug/L	1.86E-01	-4.3
48	GP 1	21	21.5	Concentration	0.00E+00	ug/L	1.86E-01	-4.2
49	GP 2	7	7.5	Concentration	1.40E+01	ug/L	1.81E-01	-1.4
50	GP 2	10	10.5	Concentration	4.90E+01	ug/L	1.62E-01	9.4
51	GP 2	13	13.5	Concentration	1.15E+01	ug/L	2.14E-01	-19.9
52	GP 2	17	17.5	Concentration	0.00E+00	ug/L	1.88E-01	-5.6
53	GP 2	19	19.5	Concentration	0.00E+00	ug/L	1.87E-01	-5.0
54	GP 2	21	21.5	Concentration	2.00E+00	ug/L	1.86E-01	-4.1
55	GP 3	6.5	7	Concentration	0.00E+00	ug/L	1.86E-01	-4.2
56	GP 3	9.5	10	Concentration	1.60E+01	ug/L	1.93E-01	-8.0
57	GP 3	12.5	13	Concentration	2.10E+01	ug/L	1.79E-01	-0.4
58	GP 3	15.5	16	Concentration	4.00E+00	ug/L	1.95E-01	-9.2
59	GP 3	20.5	21	Concentration	0.00E+00	ug/L	1.88E-01	-5.3
60	GP 4	6.5	7	Concentration	9.00E+00	ug/L	1.75E-01	1.9
61	GP 4	9.5	10	Concentration	1.00E+00	ug/L	1.97E-01	-10.3
62	GP 4	12.5	13	Concentration	1.80E+01	ug/L	1.76E-01	1.6
63	GP 4	15.5	16	Concentration	0.00E+00	ug/L	1.89E-01	-5.7
64	GP 4	18.5	19	Concentration	0.00E+00	ug/L	1.86E-01	-4.2
65	GP 4	20.5	21	Concentration	0.00E+00	ug/L	1.86E-01	-4.2
66	GP 5	6.5	7	Concentration	1.00E+00	ug/L	1.86E-01	-4.2
67	GP 5	9.5	10	Concentration	1.00E+00	ug/L	1.92E-01	-7.5

	End of Transect	Top of Sampling Interval	Bottom of Sampling Interval	Parameter Examined	Parameter Value Removed For Analysis	Parameter Units	RESULTS: Total Mass Flux Excluding Selected Point and Interpolating (g/day)	RESULTS: Contribution of Selected Point to Total Mass Flux (%)
68	GP 5	12.5	13	Concentration	1.60E+01	ug/L	1.79E-01	-0.5
69	GP 5	15.5	16	Concentration	0.00E+00	ug/L	1.90E-01	-6.3
70	GP 5	18.5	19	Concentration	0.00E+00	ug/L	1.86E-01	-4.2
71	GP 5	20.5	21	Concentration	0.00E+00	ug/L	1.86E-01	-4.2
72	GP 6	6.5	7	Concentration	1.00E+00	ug/L	1.81E-01	-1.5
73	GP 6	10.5	11	Concentration	0.00E+00	ug/L	1.87E-01	-4.5
74	GP 6	12.5	13	Concentration	0.00E+00	ug/L	1.86E-01	-4.2
75	GP 6	18.5	19	Concentration	0.00E+00	ug/L	1.86E-01	-4.2
76	GP 6	20.5	21	Concentration	0.00E+00	ug/L	1.86E-01	-4.2
77	GP 8	7	7.5	Concentration	1.00E+00	ug/L	1.86E-01	-4.2
78	GP 8	9.5	10	Concentration	1.00E+00	ug/L	1.87E-01	-4.9
79	GP 8	12.5	13	Concentration	7.00E+00	ug/L	1.73E-01	2.9
80	GP 8	18.5	19	Concentration	0.00E+00	ug/L	1.93E-01	-7.9
81	GP 8	20.5	21	Concentration	0.00E+00	ug/L	1.86E-01	-4.2
82	End of Transect			Concentration	0.00E+00	ug/L	1.89E-01	-5.6
83	Start of Transect			Gradient	1.09E-01	ft/ft	1.87E-01	-4.5
84	GP 1	7	7.5	Gradient	1.09E-01	ft/ft	1.83E-01	-2.8
85	GP 1	10	10.5	Gradient	1.09E-01	ft/ft	1.86E-01	-4.2
86	GP 1	13	13.5	Gradient	1.09E-01	ft/ft	1.96E-01	-9.8
87	GP 1	16	16.5	Gradient	3.92E-01	ft/ft	1.85E-01	-3.6
88	GP 1	19	19.5	Gradient	3.92E-01	ft/ft	1.86E-01	-4.2
89	GP 1	21	21.5	Gradient	3.92E-01	ft/ft	1.86E-01	-4.2
90	GP 2	7	7.5	Gradient	1.09E-01	ft/ft	1.81E-01	-1.4
91	GP 2	10	10.5	Gradient	1.09E-01	ft/ft	1.86E-01	-4.2
92	GP 2	13	13.5	Gradient	1.09E-01	ft/ft	2.03E-01	-13.5
93	GP 2	17	17.5	Gradient	3.92E-01	ft/ft	1.85E-01	-3.6
94	GP 2	19	19.5	Gradient	3.92E-01	ft/ft	1.86E-01	-4.2
95	GP 2	21	21.5	Gradient	3.92E-01	ft/ft	1.86E-01	-4.2
96	GP 3	6.5	7	Gradient	1.09E-01	ft/ft	1.86E-01	-4.2
97	GP 3	9.5	10	Gradient	1.09E-01	ft/ft	1.86E-01	-4.2
98	GP 3	12.5	13	Gradient	1.09E-01	ft/ft	1.97E-01	-10.5
99	GP 3	15.5	16	Gradient	3.92E-01	ft/ft	1.84E-01	-2.8
100	GP 3	20.5	21	Gradient	3.92E-01	ft/ft	1.86E-01	-4.2
101	GP 4	6.5	7	Gradient	1.09E-01	ft/ft	1.86E-01	-4.2
102	GP 4	9.5	10	Gradient	1.09E-01	ft/ft	1.86E-01	-4.2
103	GP 4	12.5	13	Gradient	1.09E-01	ft/ft	1.95E-01	-9.4
104	GP 4	15.5	16	Gradient	3.92E-01	ft/ft	1.85E-01	-3.8
105	GP 4	18.5	19	Gradient	3.92E-01	ft/ft	1.86E-01	-4.2
106	GP 4	20.5	21	Gradient	3.92E-01	ft/ft	1.86E-01	-4.2
107	GP 5	6.5	7	Gradient	1.09E-01	ft/ft	1.86E-01	-4.2
108	GP 5	9.5	10	Gradient	1.09E-01	ft/ft	1.86E-01	-4.2
109	GP 5	12.5	13	Gradient	1.09E-01	ft/ft	1.90E-01	-6.5
110	GP 5	15.5	16	Gradient	3.92E-01	ft/ft	1.86E-01	-4.0
111	GP 5	18.5	19	Gradient	3.92E-01	ft/ft	1.86E-01	-4.2
112	GP 5	20.5	21	Gradient	3.92E-01	ft/ft	1.86E-01	-4.2
113	GP 6	6.5	7	Gradient	1.09E-01	ft/ft	1.86E-01	-4.2
114	GP 6	10.5	11	Gradient	1.09E-01	ft/ft	1.86E-01	-4.2
115	GP 6	12.5	13	Gradient	1.09E-01	ft/ft	1.90E-01	-6.4
116	GP 6	18.5	19	Gradient	3.92E-01	ft/ft	1.85E-01	-3.8
117	GP 6	20.5	21	Gradient	3.92E-01	ft/ft	1.86E-01	-4.2
118	GP 8	7	7.5	Gradient	1.03E-02	ft/ft	1.86E-01	-4.2
119	GP 8	9.5	10	Gradient	1.03E-02	ft/ft	1.86E-01	-4.2
120	GP 8	12.5	13	Gradient	1.03E-02	ft/ft	2.01E-01	-12.3
121	GP 8	18.5	19	Gradient	3.92E-01	ft/ft	1.84E-01	-2.9
122	GP 8	20.5	21	Gradient	3.92E-01	ft/ft	1.86E-01	-4.2
123	End of Transect			Gradient	3.92E-01	ft/ft	1.84E-01	-3.3