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Technology Innovation

Optimization Review
Valley Park TCE Superfund Site

Valley Park, Missouri

OPTIMIZATION REVIEW

VALLEY PARK TCE SUPERFUND SITE
VALLEY PARK, MISSOURI



Report of the Optimization Review
Site Visit Conducted at the Valley Park TCE Superfund Site on
24 January 2013

Final
4 June 2013

EXECUTIVE SUMMARY

USEPA's definition of optimization is as follows:

"Efforts at any phase of the removal or remedial response to identify and implement actions that improve the action's effectiveness and cost-efficiency of that phase. Such actions may also improve the remedy's protectiveness and long-term implementation which may facilitate progress towards site completion. To identify these opportunities, regions may use a systematic site review by a team of independent technical experts, apply techniques or principles from green remediation or Triad, or apply other approaches to identify opportunities for greater efficiency and effectiveness. Contractors, states, tribes, the public, and PRPs are also encouraged to put forth opportunities for the Agency to consider."

An optimization evaluation considers the goals of the remedy, available site data, conceptual site model (CSM), remedy performance, protectiveness, cost-effectiveness, and closure strategy. A strong interest in sustainability has also developed in the private sector and within Federal, State, and Municipal governments. Consistent with this interest, optimization now routinely considers green remediation and environmental footprint reduction during optimization evaluations. An optimization evaluation includes reviewing site documents, interviewing site stakeholders, potentially visiting the site for one day, and compiling a report that includes recommendations in the following categories:

- Protectiveness
- Cost-effectiveness
- Technical improvement
- Site closure
- Environmental footprint reduction

The recommendations are intended to help the site team identify opportunities for improvements in these areas. In many cases, further analysis of a recommendation, beyond that provided in this report, may be needed prior to implementation of the recommendation. Note that the recommendations are based on an independent evaluation, and represent the opinions of the evaluation team. These recommendations do not constitute requirements for future action, but rather are provided for consideration by the Region and other site stakeholders. Also note that while the recommendations may provide some details to consider during implementation, the recommendations are not meant to replace other, more comprehensive, planning documents such as work plans, sampling plans, and quality assurance project plans.

Site-Specific Background

The Valley Park TCE Superfund is located in Valley Park, Missouri. The site is an area of mixed industrial, commercial, and residential land use on the floodplain of the Meramec River. Releases of chlorinated solvents at two primary sources (the Wainwright and Valley Technologies facilities) have created a composite plume containing various volatile organic compounds that has affected municipal and commercial production wells. The contamination has been found in a high permeability aquifer that is in communication with the Meramec River. The aquifer is overlain by approximately 20 feet of fine-grained materials.

Past remedial activities at the Valley Technologies facility have included soil excavation and off-site disposal, soil vapor extraction (SVE) system installation, and a ground water extraction and treatment system (GETS). The SVE system has not been in operation due to limited vapor recovery rates. The GETS has been in operation since 2007 and currently treats approximately 180 gallons/minute via air stripping. Treated water is discharged to a storm sewer. Persistent and high contaminant concentrations have been identified in a monitoring well (MW-56) within 90 feet of the extraction well. Ground water remediation activities have been implemented at the Wainwright facility but these activities are not the focus of this study.

Routine ground water monitoring includes nine wells surrounding the Valley Technologies site and three wells near the Wainwright facility. Sampling is done on a roughly annual basis. A more comprehensive sampling round was conducted in March 2011. Sub-slab sampling and indoor air sampling was conducted at residences and businesses near the source areas in 2012. Additional soil sampling was also conducted in 2012 on the Valley Technologies source area to determine if contaminated source materials remain and are causing the observed high concentrations in MW-56. No high concentrations were encountered in soils, though concentrations slightly over the soil cleanup goal of 66 ug/kg were found.

Summary of Conceptual Site Model

Contamination from both the Valley Technologies and Wainwright facilities has affected soil and ground water. Ground water contamination was largely drawn westward/southwestward by pumping of municipal and commercial wells to create the composite plume. High concentrations remain in ground water near the sources and are the result of ongoing flux of contaminants from remaining sources. In the case of the Valley Technologies site, the sources may be below/near the water table or under the Valley Technologies building. Continued dissolution of contaminants from these remaining sources perpetuates the high concentrations still observed in key monitoring wells. In the absence of the ongoing flux, the ground water plume should be significantly reduced in this high permeability aquifer due to remedial ground water extraction and continued pumping of commercial wells.

Summary of Findings

Based on a review of the information provided to the optimization review team, the Site visit conducted on 24 January 2013 and interviews with persons knowledgeable about the Site, the following are the key findings from this optimization evaluation:

- The optimization team found that the remediation and monitoring activities at the Valley Park site have generally been implemented in a very efficient manner. The air stripper was found to be operating efficiently, with modest maintenance requirements. The GETS has consistently achieved removal of TCE down to the detection limit (0.5 ug/L) while operating at the target flow rate of about 180 gpm. In addition to TCE, all of the other VOCs being monitored were consistently removed down to below detection limits by the stripper.
- The ground water extraction at the Valley Technologies site creates a capture zone that likely encompasses the entire plume. The extraction may actually be drawing PCE contamination from the Wainwright site toward the Valley Technologies site.
- For the first 3 quarters of 2012, the GETS was in operation every day except for March 19th , when the system was shut down at the request of the City of Valley Park due to high river stage on the Meramec River. No incidents of mechanical, electrical, software, or other equipment failures were documented in the quarterly reports from the first 3 quarters of 2012. Although there have been several GETS shut-down incidents in the past 5 years, these have almost always been due to high river stage events.

- The persistent concentrations in MW-56 strongly suggest that a source remains at the site, possibly below the water table or under the Valley Technologies building. The removal or control of the source is important for attaining site closure in a reasonable amount of time.
- The monitoring program may not be able to verify that the edges of the plume are being controlled and that migration is not occurring to the Meramec River. Monitoring of the impact from pumping at the Valley Technologies site on the Wainwright plume could possibly be improved.

Summary of Recommendations

For remedy optimization:
Recommendations are provided to improve remedy effectiveness, reduce cost, facilitate technical improvement, and assist with accelerating site closure. The recommendations in these areas are shown below.

The monitoring program should be expanded to better define the behavior of the plume, including defining the southern edge of the plume and the area between the two primary source areas. This would involve adding several existing wells and four new monitoring wells to the regularly sampled network. A consistent annual sampling frequency should be implemented, though some upgradient wells could be sampled biennially.

An opportunity for optimization of the air stripper was identified (i.e., optimizing the design of the air-stripper to reduce electrical power consumption, when the blower motor is nearing the end of its useful life). Recommendations were also identified for improving the level of maintenance for the GETS by performing routine maintenance activities on a more regular schedule, and documenting maintenance work in the quarterly reports. Specific maintenance / monitoring recommendations were provided for the extraction well pump, the blower, the PLC / electrical system, and the piping system.

The current low-flow sampling method should be replaced with a passive diffusion bag sampling method. This could substantially reduce the labor in the field for sampling, thereby reducing costs for monitoring.

Since the SVE system has been shut down indefinitely, it was suggested that the project team consider making the blower available to another superfund project. However, the optimization team also recognizes that it should be established, beyond a shadow of a doubt, that the project has nothing further to gain from the SVE system.

To improve the sustainability of remedial activities, a recommendation was provided regarding reducing electrical power consumption by turning down the heat in the building in the winter.

Additional characterization is recommended to locate the source of contamination that sustains the high concentrations in MW-56. This involves drilling of temporary borings and ground water sampling along several transects on the Valley Technologies property and possibly within the Valley Technologies building. These data would also be used to evaluate the appropriate methods for addressing the source of the contamination in MW-56.

Potential recommendations were also provided for follow-on in-situ treatment alternatives to hasten achievement of site close out. In-situ chemical oxidation using persulfate is suggested as one potential method. Regarding in-situ treatment alternatives, these recommendations would be contingent on additional characterization work.

The fact that the VOC concentrations in the extracted groundwater are low enough that off-gas treatment is not required, makes the air stripper a very cost effective solution for the GETS. Also, unlike many other sites with air strippers, the nature of the groundwater is such that it does not create fouling problems for the stripper

NOTICE

Work described herein was performed by US Army Corps of Engineers, Environmental and Munitions Center of Expertise (USACE EM CX) for the U.S. Environmental Protection Agency (USEPA). Work conducted by the USACE EM CX, including preparation of this report, was performed under Interagency Agreement DW96921926. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

PREFACE

This report was prepared as part of a national strategy to expand Superfund optimization practices from site assessment to site completion implemented by the United States Environmental Protection Agency (USEPA) Office of Superfund Remediation and Technology Innovation (OSRTI). The project contacts are as follows:

Organization	**Key Contact**	**Contact Information**
USEPA Office of Superfund Remediation and Technology Innovation (OSRTI)	Jennifer Edwards	US USEPA Headquarters, 1200 Pennsylvania Ave, NW, Mail Code 5204P, Washington DC 20460 Edwards.Jennifer@epamail.epa.gov 703-603-8762
US Army Corps of Engineers Environmental and Munitions Center of Expertise (Contractor to EPA)	Dave Becker	1616 Capitol Ave., Suite 9200, Omaha, NE 68102-9200 Dave.J.Becker@usace.army.mil 402-697-2655

LIST OF ACRONYMS

bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfm	cubic feet of air per minute
cm/sec	centimeter per second
CSM	conceptual site model
DCE	dichloroethene
EM CX	Environmental and Munitions Center of Expertise
EPA	Environmental Protection Agency
ESD	Explanation of Significant Differences
FS	Feasibility Study
ft	feet
ft/day	feet per day
GETS	Groundwater Extraction and Treatment System
gpm	gallons per minute
IC	Institutional control
ISCO	in-situ chemical oxidation
LTM	long-term monitoring
MCL	maximum contaminant level
MDNR	Missouri Department of Natural Resources
MIP	membrane interface probe
mg/L	milligrams per liter
MSDS	material safety data sheet
NAPL	non-aqueous phase liquid
NPDES	National Pollutant Discharge Elimination System
O&M	operations and maintenance
OMB	Office of Management and Budget
OSRTI	Office of Superfund Remediation and Technology Innovation
OSWER	Office of Solid Waste and Emergency Response
OU	operable unit
PCE	tetrachloroethene
PDB	passive diffusion bag
PLC	programmable logic controller
PRP	Potentially Responsible Party
P&T	pump and treat
QAPP	Quality Assurance Project Plan
QC	quality control
RAO	remedial action objective
RI	remedial investigation
ROD	Record of Decision
RSE	Remediation System Evaluation
SVE	soil vapor extraction
TCA	trichloroethane
TCE	trichloroethene
TIFSD	Technology Innovation and Field Services Division
ug/kg	micrograms per kilogram

ug/L	micrograms per liter
ug/m^3	micrograms per cubic meter
VC	vinyl chloride
VOA	volatile organic analysis
VOC	volatile organic compound
WOU	Wainwright Operable Unit
USACE	United States Army Corps of Engineers
US EPA	United States Environmental Protection Agency

TABLE OF CONTENTS

List of Tables

Figures (following text)

1.0 INTRODUCTION

1.1 PURPOSE

During fiscal years 2000 and 2001 independent Remediation System Evaluations (RSEs) were conducted at 20 operating pump and treat (P&T) sites (i.e., those sites with P&T systems funded and managed under Superfund by EPA, other federal agencies, and by the States). Due to the opportunities for system optimization that arose from those RSEs, U.S. Environmental Protection Agency (USEPA) Office of Superfund Remediation and Technology Innovation (OSRTI) has incorporated RSEs into a larger post-construction complete strategy for Fund-lead remedies as documented in OSWER Directive No. 9283.1-25, *Action Plan for Ground Water Remedy Optimization*. Concurrently, USEPA developed and applied the Triad Approach to optimize site characterization strategies, methods and technologies, including the increased use of conceptual site models (CSMs) as the basis for identifying project data gaps, and using those gaps to guide the development of site characterization objectives and work plans. USEPA has since expanded the reach of optimization to encompass reviews at the investigation stage of projects (such as for the BBM Site). USEPA's definition of optimization is as follows:

"Efforts at any phase of the removal or remedial response to identify and implement actions that improve the action's effectiveness and cost-efficiency at that phase. Such actions may also improve the remedy's protectiveness and long-term implementation which may facilitate progress towards site completion To identify these opportunities, regions may use a systematic site review by a team of independent technical experts, apply techniques or principles from green remediation or Triad, or apply other approaches to identify opportunities for greater efficiency and effectiveness. Contractors, states, tribes, the public, and PRPs are also encouraged to put forth opportunities for the Agency to consider." (OSWER Directive 9200.3-75, EPA National Strategy to Expand Superfund Optimization Practices from Site Assessment to Site Completion, September, 2012)

The Strategy also encourages other activities designed to facilitate better site characterization, remedy selection, and design and construction by applying various techniques and optimization lessons learned to improve a given project's scope, schedule and cost.

As stated in the definition, optimization refers to a "systematic site review", indicating that the site as a whole is often considered in the review. Optimization can be applied to a specific aspect of the remedy (e.g., focus on long-term monitoring [LTM] optimization or focus on one particular operable unit [OU]), but other site or remedy components are still considered to the degree that they affect the focus of the optimization. An optimization evaluation considers the goals of the remedy, available site data, CSM, remedy performance, protectiveness, cost-effectiveness, and closure strategy. A strong interest in sustainability has also developed in the private sector and within Federal, State, and Municipal governments. Consistent with this interest, OSRTI has developed a Green Remediation Primer (http://cluin.org/greenremediation/), and now routinely considers green remediation and environmental footprint reduction during optimization evaluations. The evaluation includes reviewing site documents, potentially visiting the site for one day, and compiling a report that includes recommendations in the following categories:

- Protectiveness
- Cost-effectiveness
- Technical improvement
- Site closure
- Environmental footprint reduction

The recommendations are intended to help the site team identify opportunities for improvements in these areas. In many cases, further analysis of a recommendation, beyond that provided in this report, may be needed prior to implementation of the recommendation. Note that the recommendations are based on an independent evaluation, and represent the opinions of the evaluation team. These recommendations do not constitute requirements for future action, but rather are provided for consideration by the Region and other site stakeholders. Also note that while the recommendations may provide some details to consider during implementation, the recommendations are not meant to replace other, more comprehensive, planning documents such as work plans, sampling plans, and quality assurance project plans.

The national optimization strategy includes a system for tracking consideration and implementation of the optimization recommendations and includes a provision for follow-up technical assistance from the optimization team as mutually agreed upon by the site management team and USEPA OSRTI.

1.2 PROJECT-SPECIFIC SCOPE

Following is scope of the optimization evaluation.

The Remediation System Evaluation (RSE) will evaluate the optimization opportunities for the OU2 (Valley Park proper) remedy as a whole. This will include the assessment of the existing GETS (including both subsurface and treatment performance and potential cost-efficiencies), the alternatives for treatment of contaminated soils left in place following previous soil excavation efforts (with an emphasis on possible actions near MW-56), and the monitoring program. The evaluation will also assess possible exit strategies for the site as a whole.

1.3 TEAM COMPOSITION

The optimization team consisted of the following individuals:

Table 1.

Name	Affiliation	Phone	Email
Jennifer Edwards	US EPA OSRTI	703-603-8762	Edwards.jennifer@epa.gov
Dave Becker	USACE EM CX	402-697-2655	dave.j.becker@usace.army.mil
Chuck Coyle	USACE EM CX	402-697-2578	

In addition, Chip Love from the EPA OSRTI, also participated in the optimization site visit.

1.4 DOCUMENTS REVIEWED

The following documents were reviewed. The reader is directed to these documents for additional site information that is not provided in this report.

- Record of Decision, OU2, 2001
- Second Five-Year Review Report, US EPA Region 7 and Missouri DNR, September 2008
- Explanation of Significant Differences, OU2, 2005
- Soil and Vapor Intrusion Sampling Report, TetraTech, October 2012
- Final Operations & Maintenance Manual, Volume 1, TMG, Revision November 2011
- Phase II remedial Investigation, Ecology & Environment, June 2001
- SVE Well Development and Replacement Report, Golder Associates, May 2007
- Remedial Design Investigation Soil Source Definition Study, Black & Veatch, February 2004
- Final Basis of Design Report, Black & Veatch, April 2005
- Preliminary Close-Out Report, US EPA, Region 7, September 2006
- Interim Remedial Action Report for the Groundwater Remediation, US EPA, Region 7, September 2008
- Quarterly Reports for 1st, 2nd , and 3rd Quarters, 2012, and others, TMG

1.5 QUALITY ASSURANCE

This optimization evaluation utilizes existing environmental data to interpret the conceptual site model, evaluate remedy performance, and make recommendations to improve the remedy. The quality of the existing hydrogeologic and chemical data is evaluated by the optimization team prior to using the data for these purposes. The evaluation for data quality includes a brief review of how the data were collected and managed (where practical, the site Quality Assurance Project Plan [QAPP] is considered), the consistency of the data with other site data, and the use of the data in the optimization evaluation. Data that are of suspect quality are either not used as part of the optimization evaluation or are used with the quality concerns noted. Where appropriate, this report provides recommendations made to improve data quality.

1.6 PERSONS CONTACTED

The following individuals associated with the site were present for the visit:

Table 2.

Name	Affiliation	Phone	Email Address
Hoai Tran	US EPA Region 7, Remedial Project Manager	913-551-7330	Tran.Hoai@epa.gov
Wane Roberts	Missouri Dept. of Natural Resources,	573-526-7309	Wane.Roberts@dnr.mo.gov
Jason Perez	Golder Associates, Site Operations Manager		

2.0 SITE BACKGROUND

2.1 LOCATION

The Valley Park TCE Superfund site is located in Valley Park, Missouri in the flood plain north of the Meramec River. The study area is located east of Missouri State Highway 141, generally south of Leonard Avenue, north of the Meramec River and west of 8th Street. See Figure 1 for the site vicinity. The area is relatively low-lying but is protected from flooding of the Meramec River by a levee along the northern bank of the river. This area has undergone significant flooding in the past.

The Valley Park TCE Superfund site has two primary source areas; the former Wainwright facility and the active Valley Technologies facility. This optimization study is limited to the Valley Technologies source area regarding treatment processes and source remediation. It does, however, address the composite plume created by releases at both sites.

2.2 SITE HISTORY

2.2.1 HISTORIC LAND USE AND OPERATIONS

The site consists of commingled plumes that have emanated from two facilities in Valley Park, the former Wainwright Industries and the current Valley Technologies. Valley Technologies occupies the northern half of the block bounded by Marshall Road to the south, St. Louis Avenue to the north, 5th St. to the west and 6th St. to the east. The manufacturing building is located on the eastern side of the parcel and parking has been located on the western portion. The former Wainwright Industries is located northwest of the intersection of 3rd St. and Benton St. and comprises a separate operable unit and is not directly discussed further.

Beginning in 1954, Valley Technologies operated two divisions in Valley Park, Missouri - Precision Forgings and Valley Heat Treat - until it began operating solely as Valley Technologies. Precision Forgings manufactured aluminum pressings, and Valley Heat Treat provided heat treatment services on metal parts. Valley Heat Treat utilized a degreaser that used the solvents 1,1,1-trichloroethane (TCA) and trichloroethene (TCE) through the years of operation. Wastes from the degreaser were placed in steel drums and stored on a gravel lot for pickup and disposal. An officer of Valley Technologies estimated that 150 gallons may have spilled over the years. In addition, several employees reported regular spillage of wastes from drums onto the gravel lot, burial of drums containing wastes, and cleaning solvents released directly onto the ground (EPA Five-Year Review Report, 2008).

The land use is primarily residential and commercial to the north, and east, and commercial and industrial land uses are generally found to the south and west. Residential properties are located just southwest of the site along Marshall Avenue. Two larger industrial operations, Reichhold Chemical and a beauty supply manufacturing plant are located west and southwest of the Valley Technologies site and have historically pumped significant amounts of shallow ground water. Former Valley Park municipal wells were located southwest and west of the source areas. These wells are no longer used. The City of Kirkwood has a municipal well field more than a mile east of the site.

2.2.2 CHRONOLOGY OF ENFORCEMENT AND REMEDIAL ACTIVITIES

Contamination was discovered in the Valley Park municipal wells in 1982. Well-head treatment by air stripping was conducted at these municipal wells until 1986 when Valley Park connected to the St. Louis County Water Company system and the municipal wells were taken out of service. Limited remedial investigation (RI) activities were conducted under State supervision in the mid-1980s and the site was listed on the National Priorities List in 1986. Further RI activities were conducted by Wainwright and a Remedial Investigation/Feasibility Study (RI/FS) report was issued in 1994, followed shortly by a Record of Decision (ROD) for the Wainwright Operable Unit (WOU). The remedial actions at the WOU are not discussed further.

Additional sampling conducted by the State in the mid-1990s represented the initiation of the investigation around the Valley Technologies facility and this area became the Operable Unit 2 (OU2). The State completed the RI/FS for OU2 in 2001and a ROD for OU2 was issue later in 2001. The ROD prescribed the following actions:

- On the Valley Technologies property, excavation of shallow soils to a depth of 16 feet or less and treatment using ex-situ soil vapor extraction (SVE).
- On the Valley Technologies property, in-situ SVE to remediate deep contaminated soils below 16 feet.
- Groundwater extraction and treatment using air stripping to hydraulically control the impacted groundwater and to achieve drinking water standards in the aquifer. The treated water will be reinjected downgradient to help in preventing migration of contaminants toward Kirkwood.
- An Institutional Control (IC) on the Valley Technologies property and on the area-wide plume to prohibit installation and operation of wells until the aquifer is clean.
- Groundwater monitoring to assess effectiveness of the soil and groundwater treatment systems.
- Installation of air emission controls on commercial wells using the contaminated aquifer.

Based on additional analysis, the requirement for air emission controls on the commercial wells was removed in an Explanation of Significant Difference (ESD) issued in 2005. The ESD also replaced the requirement for ex-situ soil vapor extraction for the excavated soils with off-site disposal, and allowed for the discharge of treated ground water to the storm sewer system.

Soil removal under the parking area west of the Valley Technologies plant building was conducted in 2006 and resulted in two primary excavations; one closer to the building and the other in the western portion of the current parking area extending southward to the alleyway bounding the Valley Technologies property. A total of approximately 5,000 cubic yards of soil were removed to depths of approximately 18-24 feet and transported for off-site disposal. The excavations were backfilled with “flowable” fill, a relatively weak concrete mix.

Following excavation, a ground water extraction well, a ground water treatment plant, an asphalt parking lot cap, and shallow and deep SVE wells were installed at the site. The ground water extraction and treatment system began operations in 2006 and is discussed further in subsequent sections. The SVE wells did not perform as anticipated. Based on the results of additional SVE well development and replacement activities and soil sampling, it was determined that the shallow soils (above approximately 18 feet) had a lower-than-expected air permeability, and the deeper SVE wells were screened in coarser materials that had been infiltrated by the flowable fill.

Based on observed persistent high (>2,000 micrograms/liter [ug/L]) ground water TCE concentrations in on-site monitoring well MW-56, additional investigations of soil contamination above the water table at the Valley Technologies site were conducted in 2012. The investigation included the use of a membrane-interface probe (MIP) and sampling of soils to depths as great as 28 feet in areas outside the previous excavation areas to assess the potential for additional contaminant mass to be present in these areas. Relatively low detections were observed, with the highest TCE concentration (less than 500 micrograms/kilogram [ug/kg]) found in the central part of the parking area in the unexcavated strip of soil. The highest concentrations were found below the depths of the previous excavation, in the depth range of water table fluctuations at the site. As part of the sampling effort, soil vapor samples were collected at and near the Valley Technologies site to assess vapor intrusion issues. These samples were collected from within buildings, in building crawl-spaces, and below building slabs.

2.3 POTENTIAL HUMAN AND ECOLOGICAL RECEPTORS

The site is located in a developed mixed-use area of residential, commercial, and industrial properties. The contamination was initially found to impact municipal drinking water supply wells and other municipal wells were threatened. However, based on the completion of the remedy at the Valley Technologies site, abandonment of the Valley Park municipal wells and connection to an alternate water source, and future implementation of institutional controls, there are no direct exposures to contaminated soil or ground water at the site. The atmospheric emissions from the OU2 treatment plant and the commercial users of contaminated ground water have been deemed to not pose a risk to the surrounding population (EPA,2005; Black & Veatch, 2005). The potential for exposure to subsurface contaminant vapors (vapor intrusion) is still being evaluated by EPA. In the absence of the operation of the site remedies, future contamination migration may impact off-site municipal wells or the Meramec River.

2.4 EXISTING DATA AND INFORMATION

2.4.1 SOURCES OF CONTAMINATION

Both the former Wainwright and active Valley Technologies facilities are considered the primary sources of soil and ground water contamination. The focus for the purpose of this report is on the Valley Technologies facility. The facility used a vapor degreaser that began operation from 1965. The solvent used in the degreaser unit was originally 1,1,1-TCA until 1993, when a switch to TCE was made (EPA, 2001). Drums of solvent were stored on the parking area west of the Valley Technologies building, and possible spills of solvent and the use of solvent for dust control have been alleged. Based on these accounts, the focus for source characterization has been on the parking area. The vapor degreaser unit was housed in the building and little information about its nature and operation was provided in the available reports.

2.4.2 GEOLOGY SETTING AND HYDROGEOLOGY

The Valley Park TCE Superfund site is located on the floodplain of the Meramec River and the site soils represent alluvial deposits. These deposits consist of silty clay materials (with some intervals of fine sands) from near the surface to a depth of approximately 20 feet. These materials are often moist with relatively low hydraulic conductivities of less than 1E-6 cm/sec (0.003 feet per day [ft/day]). Coarse materials, including sand to coarse gravels are found below the silty clay from a depth of about 20 feet to bedrock of the Burlington-Keokuk Limestones at depths of around 60 feet (Ecology & Environment, 2001). A geologic cross section is provided as Figure 2. The coarse materials represent a significant source of water for the surrounding area and have estimated hydraulic conductivities of over 300 feet/day

(0.1 cm/sec), with higher values (over 800 ft/day or over 0.25 cm/sec) near the Kirkwood municipal wells east of the site (Ecology and Environment, 2001).

Water levels in the OU2 study area are highly variable and apparently strongly tied to the stage in the Meramec River. Water levels have fluctuated approximately 12 feet at the site during the study period. For example, depths to water in monitoring well MW-56, at the Valley Technologies site varied from 18.6 feet to 32.15 feet in 2008 alone. This is significant for the success of both air sparging and deep soil vapor extraction at the Wainwright and Valley Technologies sites.

Recent ground water flow directions are difficult to discern as comprehensive data are limited. Based on the data for March 2011, the ground water gradient is generally to the east-northeast, with very flat gradients in the Valley Technologies area (approximately 0.0003 feet/foot [ft/ft]) with differences in elevation of only a few tenths of a foot. This is consistent with observations reported in the RI. Somewhat steeper gradients are found west of the Wainwright site where the gradient increases to approximately 0.0014 ft/ft. Flat gradients are consistent with the very high hydraulic conductivities determined for the shallow aquifer. Vertical gradients in the alluvial materials were found during the RI to be negligible.

The ground water flow has been influenced over time by pumping at the various commercial and municipal production wells. Based on the distribution of contaminants, flow directions have been toward the southwest where these wells have been historically active.

2.4.3 Soil Contamination

Soil sampling conducted during the RI indicated widespread soil contamination in the silty clay unit under the parking area at the Valley Technologies. Maximum soil concentrations included:

- vinyl chloride (VC) (83 micrograms ug/kg),
- trichloroethylene (96 ug/kg),
- cis-1,2-dichloroethylene (660 ug/kg),
- 1,1-dichloroethane (1,900 ug/kg),
- 1,1,1-trichloroethane (560 ug/kg),
- 1,1-dichloroethylene (1,600 ug/kg),
- ethylbenzene (40 ug/kg),
- toluene (110 ug/kg), and
- total xylenes (160 ug/kg)

Soil sampling following the excavation at the Valley Technologies found that most of the soil with TCE concentrations above the cleanup goals of 66 ug/kg had been removed. Concentrations in confirmatory samples from the excavations were below 250 ug/kg of TCE. The exception to this conclusion was an area near the alleyway. Soil TCE concentrations there exceeded 30,000 ug/kg.

2.4.4 Soil Vapor Contamination

No data about on-site soil gas concentrations could be found, even for the brief testing/operation of the SVE system at the Valley Technologies site. Vapor concentrations up to 44 micrograms/cubic meter (ug/m^3) of 1,1,1-TCA, 75 ug/m^3 tetrachloroethene (PCE), and 25 ug/m^3 TCE were found in samples obtained in 2012 for analysis of the vapor intrusion pathway. These samples were generally taken sub-slab, although elevated values of PCE (to 69 ug/m^3) were found in a basement. The report on the investigation provided a preliminary comparison to Regional Screening Levels for residential exposure at a excess cancer-risk level of 1E-5 and no indoor air sample exceeded these standards for TCE or PCE, though the levels did exceed the 1E-6 risk threshold.

2.4.5 GROUNDWATER CONTAMINATION

Since the start-up of the ground water remedy at the Valley Technologies site, volatile organic compound (VOC) concentrations were detected above Maximum Contaminant Levels (MCLs) at on-site wells MW-55 and -56 as well as off-site deep wells MW-3C, MW-6C, MW-10C, MW-17C, MW-51, and MW-57. High concentrations of contaminants were also found at the Wainwright site in monitoring well MW-BBC. Low detections near or just above the MCLs were found in the shallow wells near the Wainwright site. The VOCs detected above MCLs generally were TCE, PCE, cis-1,2DCE, and vinyl chloride. Maximum concentrations were observed in MW-56 at the Valley Technologies site where the maximum concentrations were: TCE – 2,110 ug/L and cis-1,2DCE – 2,640 ug/L, both in February 2010. Maximum concentrations were observed in MW-BBC at the Wainwright facility where the maximum concentrations were: PCE – 416 ug/L, TCE - 2,150 ug/L and cis-1,2DCE - 1,800 ug/L, all in April 2008. PCE is much more common near the Wainwright site. The most comprehensive recent ground water sampling event occurred in March 2011. Figures 3 and 4 present contours of PCE and TCE, respectively from that round. The ground water plume is defined to the north and east, but has not recently been defined to the south and west. Presumably, the contamination does not extend west of the inactive Valley Park municipal wells or south of the Meramec River.

2.4.6 SURFACE WATER CONTAMINATION

Sampling of surface water of the Meramec River was conducted as part of the RI (Ecology & Environment, 2001). No site contaminants were detected. Site contaminants were detected in 2000 in surface water outfall samples emanating from the Reichhold and Megas Beauty facilities. Site contaminants were identified in the discharge from these outfalls, though the concentrations were generally below relevant ecological and human health criteria, with the exception of PCE.

2.4.7 SEDIMENTS

No sampling results for sediments of the Meramec River were identified in site documents.

3.0 DESCRIPTION OF PLANNED OR EXISTING REMEDIES

3.1 REMEDY AND REMEDY COMPONENTS

3.1.1 OU2 SOIL

The remedy for the site included soil excavation and SVE for soils. Excavation and off-site disposal of shallow soils, backfilling with clean soil, and installation of an asphalt cap were completed in 2006. The excavation removed approximately 5000 cubic yards of contaminated soils on the Valley Technologies property to a depth between 18-24 feet. Two primary excavations were completed; one closer to the building and the other in the western portion of the current parking area extending southward to the alleyway bounding the Valley Technologies property. A strip of soil, approximately oriented north-south, remained between the two excavation areas. Figure 5 shows the excavation limits. Contaminated soils remain on site between the bottom of excavation and the water table, which ranges from 22-30 feet depending on river stages, and in an area along the alley south of the property. Excavation was limited laterally by structural considerations for the building and for utilities in the alleyway. This residual contaminated soil was to be addressed by the SVE system. Installation and testing of the SVE system was completed in summer of 2006. Unfortunately, the SVE was never able to extract a sufficient flow-rate of air out of the vadose zone soils. Upon startup, the SVE system was only able to extract a minimal airflow rate, while the design estimated flow rate was 180 cubic feet of air per minute (cfm). Extensive testing was conducted to determine if there were any mechanical or installation deficiencies causing the problem; but none were found. EPA performed some core sampling in June of 2012 to test the permeability of the area to be treated by the SVE system and found the shallow formation not to be conducive for SVE. According to the 2008 Interim Remedial Action Report for the Groundwater Remediation, the “flowable” fill material that was used to backfill the excavation is believed to have contributed to reducing the permeability of the underlying coarser soils. The flowable fill consisted of a sand, weak cement / bentonite mix, and was used to avoid difficulties with compaction during winter conditions. Thus, all SVE operations have been indefinitely suspended.

3.1.2 OU2 GROUND WATER

Installation and testing of the ground water extraction and treatment system (GETS) was completed in summer of 2006, with the Operational and Functional phase starting in August 2006. The GETS includes one extraction well located in the treatment plant and employs a low profile air stripper (Carbonair Model STAT-400 with six trays) to remove VOCs from the extracted groundwater. Bag filters are used to remove particulates before the water enters the air stripper. A chemical feed system is used to feed anti-scalant chemical into the water. After it passes thru the air stripper, the water is discharged to a storm sewer that conveys the treated water to the river. Figure 6 provides a process flow diagram of the treatment system.

The GETS is equipped with an electrical control system and a dial-out alarm to notify the operators if the system has shut down. The control system includes a programmable logic controller (PLC) unit that receives input from various sources (e.g., high-level alarm in the sump of the stripper) to allow for automatic shutdown of the system if an alarm condition is detected. A software system allows the Contractor to monitor the status of the system from a remote location via a computer.

3.2 REMEDIAL ACTION OBJECTIVES AND STANDARDS

Two remedial action objectives (RAOs) were specified in the ROD: 1) Restore the contaminated aquifer for unrestricted use in Valley Park, and remove the risk of future contamination at Kirkwood wells by achieving safe drinking water standards. 2) Remediate contaminated soil sources identified at the Valley Technologies' property to eliminate their contribution to groundwater contamination.

The remedy generally appears to be functioning to provide for containment of the source area groundwater contamination as discussed below; however, groundwater contamination levels in the source area on Valley Technologies' property remain above ground water cleanup goals. In addition, soil contamination levels were decreased by at least 97 percent. However, soil contamination levels remain above cleanup standards, and the SVE system is not functioning to remove this contamination.

Upon startup, the SVE system was drawing minimal air flow when the design estimated flow rate was 180 cubic feet per minute (cfm). Extensive testing was conducted to determine if there was a mechanical and/or installation error causing the problem; none were found.

The soil cleanup standard, as specified in the OU2 ROD to achieve the objective of protecting the groundwater, is 66 ug/kg for TCE. This soil cleanup standard was based on preventing contaminant levels in groundwater from reaching drinking water standards. The soil excavation was obviously very effective for the locations where it could be implemented. However, the soil contamination levels in some areas are still high (up to 38,000 ug/kg of TCE in the alley source area, based on Figure 10 from the 2008 Five Year Review (Map of Soil Concentration after the Excavation for OU2)).

Treated groundwater from the air stripper on the Valley Technologies' property must comply with the National Pollution Discharge Elimination System (NPDES) permit. The effluent limit for TCE, the primary contaminant, in the discharge from the air stripper is 5 ug/L. The pH of the effluent is to be maintained at or above 6.0 standard units.

3.3 PERFORMANCE MONITORING PROGRAM

Monitoring wells have been installed to monitor the plumes from both the Wainwright and Valley Technologies sites and to assess remedy performance. A number of on-site monitoring wells were impacted by the past remedial activities at the Valley Technologies site, and the current monitoring well network includes nine relatively recent wells installed to depths of 55 to 65 feet, with one well (MW-51 installed to 43 feet). The sixteen monitoring wells in the western portion of the OU2 study area include both shallow (depths to approximately 32-42 feet) and deep (depths to approximately 46 to 62 feet) points that have been installed before and during the RI.

The monitoring network (MW-51 through -59) around the Valley Technologies site has been sampled approximately twelve times for VOCs during the past five years. Recent sampling has been done roughly semi-annually to annually. The monitoring wells in the network near the Wainwright facility were sampled up to 5 times during roughly the same period, though some wells were sampled only once in the past five years. Wells MW-BBC, -5C, and -17C have been sampled more frequently than the other wells near the Wainwright facility and these are sampled approximately annually. The most comprehensive sampling round during the review period occurred in March 2011 when most of the wells near both sites were sampled. A larger network of monitoring wells was installed during the RI. A number of these wells were abandoned (e.g., MW-7B), and the condition of several wells is not known, including wells MW-7C, -8B and -8C near the Meramec River southwest of the site along the Highway 141 bridge, and

MW-1C at the far west end of the study area. These wells likely were covered during levee construction (H.Tran and Wane Roberts, personal communications, May 2013).

Sampling is conducted using a peristaltic pump or an electric submersible pump capable of achieving low flow rates. Field parameters (pH, temperature, and specific conductance) are monitored via sensors in a flow-through cell and sampling into volatile organic analysis (VOA) vials. Sampling is conducted by the Missouri Department of Natural Resources (MDNR). Site samples are analyzed for VOCs by EPA Method 8260B at the MDNR Lab. Wells in the MW-51 through -59 series were sampled for semi-volatile organics in August 2012, and select wells in the vicinity of the Valley Technologies source area were sampled for 1,4-dioxane on several occasions in 2008. Analytical data are managed electronically in a database. Data from early 2008 through 2012 were provided electronically for the optimization study for the Valley Technologies monitoring wells and for the period 2006 to 2011 for the Wainwright area monitoring wells.

4.0 CONCEPTUAL SITE MODEL

This section discusses the optimization team's interpretation of existing characterization and remedy operation data to explain how historic events and site characteristics have led to current conditions. This conceptual site model (CSM) may differ from that described in other site documents. The CSM is important to the development of recommendations for the acceleration of the attainment of cleanup at this site, given the persistent ground water concentrations observed at the Valley Technologies and Wainwright sites.

4.1 CSM OVERVIEW

The contamination fate and transport is strongly affected by the hydrogeology of the site. The releases of non-aqueous phase liquids (NAPL; i.e., degreasing solvents) and/or dissolved VOCs at the Valley Technologies site impacted the unsaturated fine-grained soils under the site over an unspecified period of time, but probably beginning in the 1960s. Contamination, present as dissolved contaminants or as NAPL, were transported to the coarse-grained sands and gravels that host the primary aquifer. The dissolved contamination was transported to some extent under natural gradient or, more commonly under induced gradients from the pumping of both commercial and municipal production wells, all of which were impacted. Persistent contaminant concentrations at the Valley Technologies and Wainwright source areas suggest that source materials of some kind remain at both sites. Current operation of the GETS at the Valley Technologies site is capturing ground water contamination but may be pulling contamination from the Wainwright site eastward. The fate of the plume to the south and west of the commercial production wells is not clear.

4.2 CSM DETAILS AND EXPLANATION

The effectiveness of the source remediation at the Wainwright facility was not assessed, so the conceptual model for the contribution to ground water contamination from that source is not detailed. Difficulties in maintaining remedial pumping and treatment at the facility are acknowledged. The available data from the Valley Technologies suggest that soil contamination still exists at the south edge of the parking area where excavation was limited. The ground water contamination that persists in on-site monitoring well MW-56, despite effective ground water extraction, is likely originating from other source(s). The focus at the Valley Technologies site has been the soil above the water table, particularly in the fine-grained materials, and for releases outside of the manufacturing building. The source(s) that maintain the ground water contamination at MW-56 may not be located in these materials.

The composite contaminant plume that extends south-southwest of the Wainwright facility and west of the Valley Technologies site should quickly dissipate via remedial and commercial pumping if mass flux feeding the plume is completely terminated. The high hydraulic conductivity materials that host the plume allow effective flushing and do not have strata that would retain mass by sorption or past diffusion. The consistent pumping of the extraction well at the Valley Technologies site should readily contain any mass continuing to be released from sources there. The current lack of effective containment of mass flux at the Wainwright facility is perpetuating the composite plume, and some of that mass is now potentially being drawn toward the Valley Technologies site.

Note that the higher concentrations are found in the deeper portions of the alluvial aquifer where paired shallow and deep wells were installed in the western portion of the composite plume. This suggests that there is significant vertical recharge that "buries" the plume under clean recharged water at the water table, that the hydraulic conductivities are higher at depth such that flow preferentially is drawn to depth possibly enhanced by pumping (although this is inconsistent with the negligible vertical gradients), or that (some) remaining sources may be found in the deeper portions of the aquifer.

The detections of the breakdown products, cis-1,2DCE and vinyl chloride, of the reductive dechlorination of TCE and PCE at the site suggest that degradation of site contaminants is occurring to some extent. The presence of 1,1-DCE also suggests that hydrolysis of 1,1,1-TCA is also occurring. These destructive processes have not been fully characterized at the site, but may contribute to the dissipation of the plume over time.

The plume is not fully defined to the south and southwest of the current monitoring network. The fate of the plume in these areas is not clear. The plume may discharge to the Meramec River, or may be fully captured by the commercial wells.

Recent investigations conducted by EPA, their contractor, and MDNR regarding vapor intrusion for nearby residences and businesses have shown that detectible but low concentrations of site contaminants can be found in living and working areas. The risks are being evaluated by EPA.

4.3 DATA GAPS

Data gaps are discussed in the above location-specific discussions. Again, data gaps for the Wainwright site are not identified here, but it would seem imperative that additional characterization of the contaminant source at the Wainwright be conducted to improve the remedial response at that site. The data gaps that are most relevant to significant improvement of the ground water remedy at the Valley Technologies site are provided below:

- The full definition of the high VOC ground water concentrations in the vicinity of MW-56, particularly as it will indicate the likely location of on-going sources of contamination at the Valley Technologies site.
- The evaluation of the potential for contamination under the Valley Technologies building.
- The impact of the remaining mass along the southern edge of the site along the alleyway.

4.4 IMPLICATIONS FOR REMEDIAL STRATEGY

The CSM and indicated data gaps have the following significant implications for the success of the remedy:

- By locating the source of contaminant mass flux sustaining the plume, a strategy for removal or efficient and cost-effective control of the source can be developed.
- With the complete removal or control of the source(s), the plume footprint could be rapidly reduced or even eliminated outside of small area(s) near the sources. This would restore a significant resource and reduce future costs and risks.

5.0 FINDINGS

5.1 GENERAL FINDINGS

The observations provided below are not intended to imply a deficiency in the work of the system designers, system operators, or site managers but are offered as constructive suggestions in the best interest of the EPA and the public. These observations have the benefit of being formulated based upon operational data unavailable to the original designers. Furthermore, it is likely that site conditions and equipment performance become better understood as the remedy progresses. Finally, the general knowledge of groundwater remediation has changed over time.

5.2 SUBSURFACE PERFORMANCE AND RESPONSE

5.2.1 EXTRACTION WELL CAPTURE ZONE

There are several lines of evidence that may be used to assess the adequacy of capture by a ground water extraction well (EPA, 2008; A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems, EPA600/R-08/003). The effectiveness of the current ground water extraction program at the Valley Technologies site was primarily assessed by computing a simple, theoretical capture zone based on reported hydraulic conductivities and observed gradients. The equation used is:

$$\text{Width} = Q/(Kib)$$

where Q is the pumping rate, K is the hydraulic conductivity, i is the inferred natural gradient, and b is the saturated thickness of the aquifer (assuming little change due to pumping)

Using a hydraulic conductivity of 310 ft/day, a gradient of 0.00021 ft/ft, a steady-state pumping rate for the extraction well of 180 gal/min (~35,000 cu ft/day), and an aquifer thickness of 25 feet, a capture zone width greater than 21,000 feet was computed. Even if the hydraulic conductivity was 895 and the gradient was 0.001 (very conservative values), the capture zone width would be approximately 1600 feet (measured generally north to south perpendicular to the natural ground water flow direction and upgradient of the site); still greater than the mapped width of the plume.

An assessment of flow to the extraction well was also attempted based on the creation of a piezometric surface map. Unfortunately, because the hydraulic conductivity is so large, the gradient so flat, and the monitoring network not overly dense, the inferred flow could not be deduced from the map.

The other component of the assessment was the analysis of the response of the contaminant concentrations to pumping. The TCE and 1,2-cisDCE concentrations in MW-51, located downgradient of the Valley Technologies site, are not increasing and are relatively low and the concentrations in MW-58, even farther downgradient, have declined to non-detectable levels since the extraction system began operation. MW-57, located upgradient of the extraction well appears to show an increasing trend for PCE concentrations, as does the influent to the treatment system, suggesting that the Wainwright PCE plume is being pulled eastward by the extraction at the Valley Technologies site. Concentration trends for PCE, TCE, and cis-1,2DCE in key wells are illustrated on Figure 7a, b, and c, respectively.

Overall, it appears the ground water extraction remedy at the Valley Technologies site is having the desired impact on the plume emanating from the site, but may be drawing contamination from the Wainwright portion of the plume.

The performance of the ground water extraction remedy at the Wainwright facility was not analyzed for this optimization study. However, since the extraction well at the Wainwright facility is reportedly not operating to its design flow, the mass from the Wainwright source area, as represented by MW-BBC, may not be captured/controlled, and may be migrating eastward and potentially southward toward the Valley Technologies site and the commercial production wells, respectively. Without full control of this mass flux, substantial progress toward closure is significantly inhibited.

5.2.2 EFFECTIVENESS OF SOURCE REMEDIATION

The past soil remediation actions at the Valley Technologies have been very effective at removing contamination from the environment and provided good progress toward site closure. However, the relatively large (in the ppm range) and stable concentrations of TCE and cis-1,2DCE in MW-56 at the Valley Technologies site clearly suggest a persistent release of mass to the ground water system, likely in the immediate vicinity of MW-56 or somewhere just to the east of that well. The ground water flow direction at MW-56 is likely strongly westward toward the extraction well and the source would have to lie along a limited set of flow lines east of the extraction well. Given that significant contaminant mass was removed to depths of 18 to 24 feet with the past soil excavation, and subsequent sampling in areas adjacent to the excavations failed to find substantial soil contamination above about 20 feet (except along the alleyway), it seems unlikely that additional mass above the high water table elevation exists under the asphalt-capped parking area. This means that the residual contamination sustaining the contamination in MW-56 must either reside below this depth or under the Valley Technologies building. A modest correlation between water table elevation and the concentration in MW-56 suggests that remaining mass may be concentrated near the high water table elevations.

The known remaining mass along the alleyway south of the parking area may also be yielding mass to the water table, particularly, during times of high water table elevations. The plume associated with this area would not be identifiable with the current monitoring network as there is no monitoring well between the alleyway and the extraction well.

Again, although an evaluation of the remedial activities at the Wainwright facility was not conducted, the relatively high and stable concentrations of TCE and PCE in on-site monitoring well MW-BBC suggest that source mass likely also remains at that site. Without removal of the source or the containment of the mass flux from the source, it would appear that it will be very difficult to reduce the plume footprint and attain real progress toward site closure.

If the source mass(es) can be removed or controlled, the composite plume has a high likelihood of relatively rapid remediation. Coarse-grained aquifers such as the one underlying this site have excellent chances of remediation if source mass flux is greatly reduced (National Research Council, 1994, Alternatives for Ground Water Cleanup).

5.2.3 EFFECTIVENESS OF THE GROUND WATER MONITORING PROGRAM

The typical goals for long-term ground water monitoring at a site with active remediation are to:

1) verify that the remedial actions are contributing to progress toward site closure
2) verify that the ground water plume is not escaping/expanding laterally (or vertically)
3) verify that no unacceptable exposures occur

To achieve objective 1, sampling is typically conducted from monitoring wells located in the plume, often near the source and along the plume centerline. To achieve objective 2, sampling is typically conducted from monitoring wells located just beyond the "edge" of the plume. Finally, to achieve objective 3, sampling in conducted at the point of potential exposure (e.g., a production well) or at a "sentinel" well located upgradient (along a flow line) of the potential exposure point.

At the Valley Park TCE site, these objectives are only partially being met. Though monitoring is somewhat regularly conducted within the plume itself, the boundary of the plume is not consistently defined by monitoring, particularly west and south of the Wainwright facility. Only one round of sampling during the past five years has defined the plume to the west. The plume near the Valley Technologies site is bounded to the north and east, but not to the south. If the Meramec River is a potential exposure point, there are no monitoring points that would act as sentinel wells for the river. MW-10C, located near one of the commercial production wells, was only sampled once in the 2006-2012 timeframe. At least two monitoring wells north of the Meramec River and south of the existing network would be needed to provide plume definition. Even monitoring of the plume interior for assessment of the interaction between the two primary source areas is limited in extent. Additional wells north-northwest and south-southeast of MW-57 would be needed to adequately assess migration of the bulk of the composite contaminant plume toward the Valley Technologies extraction well.

Ground water levels appear to only be obtained at the time of sampling. Fluctuations in the water table appear to be significant, and likely at least vary seasonally, but these fluctuations are not well defined.

5.3 COMPONENT PERFORMANCE

The GETS has consistently achieved removal of TCE down to the detection limit (0.5 ug/L) while operating at the target flow rate of about 180 gallons/minute (gpm). In addition to TCE, all of the other VOCs being monitored were consistently removed down to below detection limits by the stripper.

For the first 3 quarters of 2012, the GETS was in operation every day except for March 19th , when the system was shut down at the request of the City of Valley Park due to high river stage on the Meramec River. The GETS flow-rate ranged from 179.75 to 181.24 gpm, during the first 3 quarters of 2012. No incidents of mechanical, electrical, software, or other equipment failures were documented in the quarterly reports from the first 3 quarters of 2012.

Over the past 5 years, the GETS had to be shut down on many occasions due to high water levels in the Meramec River (e.g., 19 Nov 2009, 17 May 2010, 11 Oct 2010, 17 Nov 2010). The City of Valley Park is required to close the flood gates to the Meramec River when the river level reaches 11 feet, and when this occurs, the GETS has to be shut down. One notable incident of an equipment failure was identified in the OU2 Sampling Report from Aug 2010. According to the report, the air stripper was shut down because the blower was "locked up".

Just past the point where the extraction well head comes up thru the floor, a short section of piping (approx. 3 feet) was replaced during fall of 2012, because it began to leak due to corrosion. The corroded section was replaced with stainless steel. Some external surface corrosion was also present on other sections of the influent piping, between the floor and the stripper. External surface corrosion was also evident on the backflow preventer, and the bag filter casings. The external corrosion is due to primarily to condensation on the piping, and is less of a concern than the internal corrosion which is believed to be the primary cause of the leak thru the sidewall of the section of piping that had to be replaced. The groundwater appears to be moderately corrosive, and careful monitoring of the steel piping should be performed going forward.

The type of chemical being used to control fouling of the air stripper is called Analytix AN-100 NP. According the Material Safety Data Sheet (MSDS), the active ingredient is "carboxylated polymer", and the chemical is classified as a "Scale Inhibitor/Dispersant". Consumption of the chemical is modest, approximately 2-3 gallons per month, according to the Contractor representative. The chemical is metered into the influent piping downstream from the backflow preventer, before the water flows thru the bag filters.

Acid cleaning of the air stripper was performed about 2 years ago using a product called Analytix AN-750, a hydrochloric acid solution. The solution was recirculated thru the stripper for about 3 hours. This is believed to be the only time that acid cleaning has been performed since the GETS has been in operation. When the air pressure in the sump reaches about 42 inches of water, this serves as a trigger for the need to perform acid cleaning. The normal operating pressure in the sump is about 38 inches of water. Some of the newer low-profile air strippers are designed with relatively small, sliding trays that can be removed from the body of the stripper, by a single operator, so that they can be cleaned by soaking in a tub filled with an acid solution. However, this particular air stripper was constructed with relatively large, heavy trays that would probably require some type of hoist to be removed. The lower trays cannot be accessed without removing the overlying trays. Due to the construction of the stripper, the acid-cleaning procedure appears to be the most expeditious means of cleaning the unit.

The float-switches in the sump had to be replaced recently. Three of the floats were torn from the rubber flaps. All four rubber flaps were replaced and the floats reattached. Unlike the newer models of Carbonair strippers, the Valley Park stripper did not come equipped with a sump access hatch. In order to gain access to the floats, without having to disassemble the stripper (and remove the 6 overlying trays), a new access hatch had to be welded onto the side of the sump.

The bag filters continue to successfully remove particulates before the air stripper. The bag filters are changed out monthly, as they become saturated with iron and particulate material. The gravity-flow, discharge from the stripper sump to the storm sewer continues to operate without problems. To the best of our knowledge, the electronics control system continues to function effectively in managing GETS and alerting the operations and maintenance (O&M) contractor when shutdown incidents have occurred.

Various ideas for reducing the costs for operation of the GETS facility were considered by the Optimization Team. At some sites it has been possible to eliminate on-site treatment by sending contaminated groundwater to municipal wastewater treatment plant. This would require routing the water to a sanitary sewerline. However, sewerlines often leak, so this would create a risk of recontamination of the subsurface due to exfiltration from the sewerline. Also, municipal wastewater treatment plants often charge a fee for receipt of discharge from industrial wastewater generators, and are not really designed to accommodate treatment of chlorinated VOCs.

In some instances, cost savings can be achieved by operating air strippers at a lower air-to-water ratio. However, the motor for the GETS blower does not have a variable frequency drive, so it would not be possible to reduce power consumption by reducing the air-to-water ratio (at least not unless the motor were to be replaced). Also, low-profile air strippers are much more limited than tower strippers in regard to their ability to be operated at reduced air-to-water ratios. Over the last year, the GETS air stripper has usually operated within an air-to-water ratio range of about 40 to 55. Low-profile air strippers often operate at a much higher air-to-water. The fact that the system if functioning effectively at a relatively low air-to-water ratio, indicates that the blower is not significantly oversized for the current stripper configuration.

5.4 REGULATORY COMPLIANCE

The GETS has consistently achieved removal of TCE and other VOCs present in the influent to below the detection limit. The effluent also continues to meet the criteria of the NPDES discharge permit (e.g., the pH of the effluent has consistently been above a pH of 6.0 units). The pH of the effluent from the stripper ranges from about 7.8 to 8.6 units.

In two sampling events (as indicated in the 2008 Five-Year Review), ambient air emissions from the exhaust stack have documented that site contaminants were below detection levels and risk-based standards. No stack sampling data from after the 2008 Five-Year Review could be located. However, since the VOC levels in the influent have generally remained stable, the Optimization Team has no reason to believe that air emissions would have changed in a significant way since the previous sampling events. The only influent VOC that appears to have significantly increased is PCE. PCE levels have increased from a range of 6 to 8 ug/L in 2008, to a range of 7.7 to 19.7 in 2010 / 2011. The PCE concentrations are graphically shown in Figure 7d. Total influent VOC levels have varied from a range of 62 to 68 ug/L in 2008, to a range of 63 to 81 in 2010 / 2011 (this excludes the data from the 17 August 2010 sampling event, in which the total VOC level of 35 ug/L appears to be an outlier). Refer to Table 3 for measured influent concentrations. Assuming a flow rate of 180 gpm, this equates to the following influent VOC extraction rates: 0.13 to 0.15 lb per day in 2008, to a range of 0.14 to 0.17 lb per day 2010 / 2011 (this excludes the data from the 17 August 2010 sampling event, in which the influent VOC extraction rate of 0.076 lb per day appears to be an outlier).

Table 3. GETS Influent Ground Water Concentrations

CONTAMINANT	**2006 Base-Line**	**JAN 2008**	**FEB 2008**	**APR 2008**	**FEB 2010**	**AUG 2010**	**JUN 2011**
1,1 DICHLOROETHANE	4	2	2	2	1.9	2.1	2.7
1,2 DICHLOROETHANE	ND	ND	ND	ND	ND	ND	ND
1,1 DICHLOROETHENE	14	15	10	10	10.4	5.4	10.9
CIS-1,2 DICHLOROETHENE	5	12	12	14	11.9	6.6	16.2
TRANS-1,2 DICHLOROETHENE	ND	ND	ND	ND	ND	ND	ND
PERCHLOROETHENE	2	8	8	6	16.3	7.7	19.7
1,1,1 TRICHLOROETHANE	2	4	4	3	2.4	1.2	3.0
TRICHLOROETHENE	22	27	26	29	20.4	11.9	28.6
VINYL CHLORIDE	ND	ND	ND	ND	ND	ND	ND
TOTAL	49	68	62	64	63.3	34.9	80.8

All concentrations are shown in ug/L.

5.5 COMPONENTS OR PROCESSES THAT ACCOUNT FOR MAJORITY OF ANNUAL COSTS

The costs for the operation and maintenance (O&M) of the GETS are summarized in the quarterly reports provided by the operating contractor. The most recent costs (for 9/1/2011 through 6/30/2012) estimated on an annual basis included:

Utilities:	$18,000
Labor:	$72,000
Sampling and Analytical	$10,000 (estimated as discussed below)
Repair	$ 1,000
Project Management and Reporting	unknown
Total	$101,000 per year

The sampling costs were not explicitly given but were estimated assuming 12 wells sampled once per year, two and one half days in the field for two sampling crew members ($1000/day per person labor, equipment, vehicles), $150/sample for VOCs, 10% quality control (QC) samples, two influent and two effluent samples per year, and two person-days (at $800/day) for data validation and data entry QC. Even if project management and reporting add another 30-40%, the O&M costs are modest compared to other similar sites.

6.0 RECOMMENDATIONS

Several recommendations are provided in this section related to remedy effectiveness, cost control, technical improvement, and site closure strategy. Note that while the recommendations provide some details to consider during implementation, the recommendations are not meant to replace other, more comprehensive, planning documents such as work plans, sampling plans, and quality assurance project plans.

Cost estimates provided herein have levels of certainty comparable to those done for CERCLA Feasibility Studies (-30%/+50%), and these cost estimates have been prepared in a manner generally consistent with EPA 540-R-00-002, *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study*, July, 2000. The costs presented do not include potential costs associated with community or public relations activities that may be conducted prior to field activities. The cost impacts of these recommendations are summarized in Table 4.

Sections 4.0 and 5.0 of this report highlighted several data gaps in the CSM and questioned the effectiveness of the existing remedies to control the source areas and fully contribute to aquifer restoration. The recommendations related to improving effectiveness in Section 6.1 are focused on addressing the identified data gaps, but do not represent all of the information that may be needed to complete the CSM and appropriately modify the remedies. The recommendations in Section 6.1 do not discuss improving the ability of the existing remedies to restore groundwater because these recommendations are presented in Section 6.4 where various remedial strategies are considered for moving forward. Section 6.4 presents considerations for a remedial strategy at the site once the CSM is improved based on information collected from the recommended follow-up characterization activities. The use of alternate remedies, such as in-situ chemical oxidation (ISCO), may merit a ROD Amendment or ESD.

6.1 RECOMMENDATIONS TO IMPROVE EFFECTIVENESS

The primary improvement that could impact the effectiveness of the current remedy is to improve the monitoring program. This improvement would improve the project team's ability to make site decisions about the operation of the long-term remedial actions. There are three primary recommendations for the improvements to the monitoring network (and the objective that would be met as shown in section 5.3.2):

1) Add two monitoring wells along the southern edge of the study area to assess the plume extent (verify stability of plume edge and assess protection of the Meramec River as an exposure location)
2) Sample additional wells on the Wainwright (western) portion of the ground water plume on a routine basis, including MW-2B, MW-3C, MW-4C, MW-AAC to verify the western extent of the plume (to assess stability of the plume edge and the response to remedial actions)
3) Add two additional monitoring wells between the two primary source areas, one well north-northwest of MW-57 (between MW-57 and MW-53, on a line between Wainwright and Valley Technologies) and the other south-southeast of MW-57 (to assess impact of remediation, i.e., pumping at the Valley Technologies site on the western portion of the plume). This would be important if ground water extraction/treatment is not reinstituted to design levels at the Wainwright facility.

Most wells, including those new and existing wells recommended for addition above, should be sampled annually, based on the relative consistency in the sampling results, provided there is not a substantial change in pumping or boundary conditions (e.g., major or long-lasting flooding). Some wells could be sampled less often, biennially perhaps, where little change would be expected, including at MW-52, -53, -54, and even MW-2B. Monitoring well locations, including proposed additional wells, are shown on Figure 8.

Water level measurements should be taken in all available monitoring wells at least semi-annually. Spring and fall measurement would be best to assess seasonal fluctuations.

An additional four monitoring wells (60 ft deep) may cost approximately $60,000 plus work plans and reports for a total of perhaps $85,000. The sampling of an additional four existing wells and four new wells on an annual basis would add perhaps $2000 for analysis, QC, and reporting. If the recommendations for changes in the sampling method are not adopted, the labor cost for sampling would also increase by another $3500 (for a total impact of an additional $5,500 on the sampling and analysis costs).

6.2 RECOMMENDATIONS TO REDUCE COSTS

6.2.1 REVISIT AIR STRIPPER DESIGN FOR OPTIMIZATION

The air stripper is a Carbonair Model STAT-400 with 6 trays. The unit is designed to treat a maximum water flow rate of up to 360 gpm. The system currently operates at 180 gpm. All of the contaminants of concern being treated by the strippers have relatively high Henry’s constants (i.e., easily strippable), and are being removed down to below detection limits. This suggests that the unit could probably achieve adequate performance with fewer than 6 trays. If the number of trays were reduced, this would reduce the pressure drop that has to be overcome by the blower, would probably allow the system to be retrofitted with a smaller blower motor (i.e., a blower motor with a lower horse-power rating), and would reduce the electrical power consumption. It is recommended that Carbonair technical representative be provided with the influent contaminants / concentrations, and requested to model the stripper performance with fewer than 6 trays. The technical representative should also be able to provide recommendations for retrofitting the GETS with a smaller blower motor, as appropriate for operation with fewer trays.

It is recommended that a Carbonair technical representative be contacted at the earliest opportunity to perform the contaminant removal modeling for operation of the stripper with fewer trays. Reduction of the number of trays, and replacement of the blower motor with a smaller unit could be deferred until the blower motor has to be replaced, or is believed to be nearing the end of its useful life. A cost savings for this recommendation has not been provided, because the capability of the stripper to function effectively with fewer trays must first be verified. Also, it is not anticipated that the blower motor will be replaced with a smaller, more energy-efficient, unit until it is nearing the end of its useful life.

6.2.2 MODIFY SAMPLING PROCEDURES FOR MONITORING WELLS

Currently, the monitoring wells are sampled with low-flow sampling methodology. Given that the contaminants at the site are primarily VOCs, the use of passive sampling methods, such as passive diffusion bag (PDB) samplers may significantly reduce the labor costs for sampling at the site while maintaining high data quality. PDB samplers have been proven to provide comparable to superior data quality for the appropriate contaminants, and are applicable to the Valley Park TCE site contaminants of concern. The PDB samplers involve the placement of polyethylene bags filled with deionized water into the screened interval of monitoring wells for a period of time (typically two weeks or more). During this time, the diffusion of contaminants from the ground water flowing naturally through the well screen into the bag causes the concentrations in the bag to equilibrate with the ground water concentrations. The bags are retrieved following the placement period and the water is decanted into standard VOA vials for shipment for standard lab analysis. The placement and retrieval of the bags are very quick as is the transfer of the water to the bottles. This could reduce labor for sampling significantly (by 50-70%) relative to low-flow sampling. It also avoids the need to manage waste water from the purging process. The potential annual savings at the Valley Park site would be around $3,000/year for the current well network. The savings from PDB samplers relative to annual low-flow sampling for the expanded network recommended above would be over $5,000 per year.

Since the low-flow sampling represents a physical composite of water drawn from various portions of the screened interval and the PDB samples may reflect a more depth-specific concentration, the first application of PDBs in a monitoring well typically involves a vertical profile using two or more PDB samplers in the same well. Subsequent samples are obtained from depths that represent a depth that most appropriately meets the project goals (usually within the zone with the highest concentrations). The first round with PDB samplers is often conducted in parallel with use of low-flow sampling for comparability purposes. Though the PDB profiling would have little impact on labor costs, it would temporarily increase analytical costs, as would the parallel sampling by both PDB and low-flow methods. The extra costs would be relatively quickly (within a year or two) recouped following transition to PDB methods.

Note that some site contaminants that are not driving the remediation at the site, including 1,4-dioxane and methyl-tert-butyl ether are not recovered by PDB samplers, though other passive/no purge samplers can quickly obtain samples for these compounds if the project team wishes to sample select wells for these compounds. Alternatives for obtaining these samples include the Snap sampler and the Hydrasleeve sampler. In the experience of the optimization team, the Hydrasleeve sampler has been successful in sampling for 1,4-dioxane at a Superfund site in Arizona.

6.3 RECOMMENDATIONS FOR TECHNICAL IMPROVEMENT

6.3.1 INCREASE THE LEVEL OF MAINTENANCE FOR THE GETS

Based on a review of the quarterly monitoring reports the level of maintenance / monitoring at the GETS could be improved. There are some preventative maintenance / monitoring activities that are apparently not being performed. The following paragraphs provide descriptions of recommended maintenance and monitoring activities that may provide early warning of mechanical, electrical, or software problems; and, in turn, will minimize down-time of the GETS going forward. Preventative maintenance work may require some additional labor, but it usually pays for itself by preventing costly, wide-scale damage to equipment resulting from neglect of regular maintenance. Though it did not appear that the following activities were being performed, they may be performed but just not documented in the quarterly monitoring reports. It is recommended that the operators maintain a log of maintenance activities, and that maintenance activities be recorded and attached to the quarterly reports. Inspections, observations and any required corrective measures should be documented in the maintenance log and attached to the quarterly reports.

6.3.2 PERIODIC INSPECTION OF THE EXTRACTION WELL PUMP AND MOTOR

Extraction well pumps are prone to malfunctions due to mineral encrustation, iron deposition, and biofouling. Periodically, the extraction well pump should be pulled out of the well for cleaning and inspection. Checking the current-draw of the pump motor is also recommended to determine if the amperage level is within manufacturer specifications, or if the motor requires repair or replacement. Regular inspection and maintenance of other mechanical parts is also recommended (e.g., lubrication of bearings, replacement of worn seals), in accordance with manufacturer's instructions Recommend that the extraction well pump be pulled out of the well for cleaning and inspection on an annual basis.

6.3.3 PERIODIC MONITORING OF THE BLOWER AND MOTOR

Monitoring the current-draw of a motor can provide an early warning that the motor may be nearing the end of its life. Checking the current-draw of the blower motor is recommended to determine if the amperage level is within manufacturer specifications, or if the motor requires, repair or replacement. Regular inspection and maintenance of other mechanical parts is also recommended (e.g., lubrication of bearings, replacement of worn seals), in accordance with manufacturer's instructions. Recommend that the current-draw of the blower motor be measured on an annual basis.

6.3.4 PERIODIC TESTING OF PLC SYSTEM INTERLOCKS AND ELECTRICAL CONNECTIONS

PLC system interlocks can fail due to faulty electrical connections, and other problems that may develop over time. Periodically, the PLC system interlocks should be tested to ensure that the automatic GETS shutdown control systems are working properly. Cleaning and inspection of all probes / switches, simulation of all shutdown conditions included in the design should be done to verify functionality, and testing of the dial-out alarm system. Any faulty components should be replaced or repaired. Electrical inspection should include the condition of the control panel, wiring, relays, PLC, and switches for wear & tear; and repair / replacement of any faulty components. Recommend that the PLC system interlocks and electrical connections be tested at least every 2 years.

6.3.5 MONITOR PIPING FOR LEAKS

The fact that one section of the influent piping has already had to be replaced should serve as a warning that corrosion is occurring in the steel piping. The groundwater appears to be moderately corrosive, and careful monitoring of the steel piping, and bag filter casings, should be performed going forward. It is recommended that the steel piping that conveys groundwater thru the GETS be carefully inspected for leaks during each weekly monitoring event. Any faulty sections of piping should be replaced as soon as possible after leaks have been detected.

6.3.6 PERIODIC DISASSEMBLY, CLEANING AND INSPECTION OF THE AIR STRIPPER

The Carbonair low-profile air stripper that was installed at the GETS cannot be properly cleaned and inspected unless it is disassembled. While disassembly of this type of air stripper is not an easy task, it should still be performed periodically. Disassembly of the stripper should be performed to determine if internal fouling, sediment buildup, or corrosion problems are developing. It is also possible that the gaskets may need to be replaced, since they are believed to be the original gaskets, and are probably beginning to harden or crack. Recommend that the air stripper be disassembled, cleaned and inspected about every 2-4 years.

Assuming that the additional work described in section 6.3 takes one person an additional 2 days per year at a cost of $1000/day, the total additional cost would be $2,000/year or $40,000 over 20 years.

6.3.7 Consider Making the SVE Blower and Appurtenances Available to Another Superfund Project

Since the SVE system operations have been indefinitely suspended, the project team should consider making the SVE blower and appurtenances available to another EPA project. The optimization team recognizes that there are conditions under which re-starting the SVE system could still be warranted; in which case, this recommendation would be withdrawn until the SVE system is permanently shut down. Also, prior to permanent shut down, the optimization team believes that it would probably be worthwhile to determine if the system can be operated when the water table (and river level) is down at seasonal lows. If the drought conditions that have occurred in the Midwest during the summer of 2012 continue into the future, this could be an opportunity to try re-starting the deep SVE system, to determine if increased air-flow rates, and significant mass removal can be achieved while the water table is at a multi-year low.

The blower is believed to be in very good condition since it was only used for a very short time period. Provided the equipment was purchased by EPA, there could be a benefit to the Superfund program by having the SVE equipment transferred to another EPA site where it could be put to productive use.

6.4 Considerations for Gaining Site Close Out

6.4.1 Additional Characterization of Remaining Contaminant Sources

The primary recommendations for progressing toward site closure involve identification and remediation of additional source materials on the Valley Technologies site itself. The persistent concentrations in MW-56 suggest an on-going release, perhaps under and near the water table. The TCE concentrations near MW-56 are around 1000 ug/L and the influent TCE concentrations are near 25-28 ug/L, indicating a roughly 35-40X dilution. Assuming that all of the mass coming into the extraction well is from a source area affecting MW-56, and assuming roughly radial flow, this would suggest that the mass is coming into the well in flowlines over $360^o/40$ or roughly $10\text{-}20^o$ arc. This means that, at most, the contamination is migrating along a 15- to 30-foot-wide zone at MW-56 (90 feet from the extraction well; width = distance * $\tan 10^o$). Thus, finding the source may be quite difficult. The goal will be to work upgradient (assuming westward flow toward the extraction well) from known contamination to determine the source.

It is recommended that several ground water sampling transects be conducted to the east-northeast of the treatment plant building and within the Valley Technologies building (if possible). These profiles should consist of 4-5 sampling points separated laterally by as little as 10 feet that obtain grab samples for either on-site or expedited off-site analysis. Samples should be obtained from at least two depths; one near the low water table (say, 28-30 feet below ground surface [bgs]), and other sample 20 feet below that (to be within the MW-56 screened interval). The profiles should be conducted along north-northwest to south-southeast lines; one extending north and south from MW-56, another parallel to the west side of the Valley Technologies building, and another within the Valley Technologies building (if possible). If contamination substantially over the cleanup goals is found under the building, another line on the east side of the Valley Technologies building would be needed to confirm the extent of the contamination. Soil samples should be obtained above the water table for any boreholes within the Valley Technologies building and the location of the profile in the building should be based, to the extent possible, on the locations of equipment and piping for past vapor degreasing activities (and possibly floor drain locations). New monitoring wells would be installed in select boreholes to provide the ability to monitor the high concentrations and to possibly be used to facilitate future treatment.

An additional sampling profile of 3-4 points should be considered along the southern side of the treatment plant building to assess the contribution to the ground water plume from contamination remaining under the alleyway. Boreholes on this profile should be spaced about 10 feet apart and also drilled to similar depths as those on the north-south profiles described above. Suggested transect locations are shown on Figure 9.

Based on the results of the additional characterization, targeted remediation should be considered. If the source appears to be within the ground water under the parking area (i.e., there is no high ground water concentrations under the Valley Technologies building), the remediation would likely focus on remaining sources within the saturated zone under past excavations. If the sources appear to be primarily under the Valley Technologies building, then soil and/or ground water remediation options may need to be considered.

The costs for four transects of 5 points to 40 feet would be approximately $40,000 assuming $50/foot drilling and oversight. Analytical costs would be approximately $10,000 for roughly 60 samples. Work plan and report preparation would add perhaps $30,000 for a total of approximately $80,000 for the work. Any additional monitoring wells would be added to the monitoring program. Assuming an additional five monitoring wells are installed, this would add approximately $1,250/year for sampling and an additional $750/year for reporting for a total of $2,000/year.

6.4.2 POTENTIAL REMEDIATION STRATEGIES FOR REMAINING SOURCES

For ground water contamination, in-situ treatment may be necessary in order to achieve cleanup goals in a reasonable timeframe for hot spot areas such as MW-56. The Optimization team favors the use of chemical oxidation for treatment of hot spot areas such as MW-56. Electron donor injection can also be effective for in-situ treatment of some chlorinated solvents, but this introduces the risk of drawing electron donor into the GETS. If electron donor were to be drawn into the influent, this would result in accumulation of biomass on the interior surfaces of the piping, bag filters, and air stripper. This, in turn would create, continuous maintenance problems in order to try to keep the equipment from becoming clogged due to biofouling.

The Optimization team favors the use of a type of oxidant that would be effective against both chloroethenes and chloroethanes since both categories of contaminants are present above groundwater cleanup goals at the site. Persulfate is an example of one type of oxidant with demonstrated effectiveness for chloroethanes. Persulfate is typically injected in the form of a liquid solution. Persulfate is often activated using either heat or by increasing the pH to create basic conditions. Ferrous iron can also enhance persulfate effectiveness.

Technologies are also being developed to emplace persulfate in the form of a solid that would gradually dissolve into groundwater. Oxidants can be mixed into a semi-soluble wax matrix which, as it dissolves, gradually releases the oxidants into groundwater. These oxidant “candles” can be hung in wells, or emplaced in direct contact with the formation during drilling, or with direct-push rigs.

Alternatively, persulfate solutions (with appropriate activation) could be injected east of the suspected source area. The injected oxidant would be drawn westward through the targeted zone by the extraction well. A sub-stream of treated water could be used for the persulfate solution. This stream could represent less than 20% of the treated water. Alkaline activation by the addition of a base and/or the addition of a source of ferrous iron could be accomplished with the addition of limited chemical feed equipment and piping at the plant. The injection of the persulfate solution would be best conducted by a series of vertical wells with appropriate screened interval or a horizontal well set at an appropriate depth.

Unreacted persulfate or the sulfate produced during reactions would generally not be detrimental to the site treatment equipment, though verification that no discharge standard would be violated and that objectionable precipitation of calcium sulfate would not occur may be necessary. Note that the natural oxidant demand would need to be determined to estimate dosages. Samples for determining this demand should be collected during the additional characterization described above.

Treatment of any remaining source materials near or above the water table is more problematic. For example, if contaminated soil is encountered under the Valley Technologies building, excavation is not feasible. Vapor extraction may be very difficult in the fine-grained materials if these materials are moist. Mass flux from the fine-grained materials to water table could be managed by vapor extraction from the coarse materials below them, at least when the water table is relatively low (deeper than, say, 22 feet bgs). The vapor extraction rates would not need to be high to capture the mass flux, and passive vapor extraction may even be feasible as there is likely a significant diurnal pressure differential between the atmosphere and the unsaturated coarse (and air permeable) materials. This would also be a potential strategy for soils along the alley way. Vapor extraction wells would be required in the alleyway and appropriate traffic-rated well vaults would be needed. Eventually, the diffusion or leaching of mass from the fine-grained soils would presumably result in a low mass flux such that natural processes (both destructive and dispersive) would be adequate to manage the site.

Costs for implementing such a remedial strategy using in-situ chemical oxidation and soil vapor extraction have not been estimated as the dosages, configurations, target volumes, etc. have not been determined.

6.4.3 OTHER SOURCES AT THE VALLEY PARK TCE SITE

Although the focus of this optimization report is the Valley Technologies portion of the site (OU2), the ground water plume represents contribution from multiple sources.   As stated in section 5, if the flux from these sources can be effectively controlled near the sources, the greater ground water plume should be remediated relatively rapidly based on the experience at other sites with plumes in high hydraulic conductivity aquifers. The current extraction at the Valley Technologies site, along with extraction by commercial ground water users, most likely would capture much of the plume. The optimization team believes it is imperative to establish effective control of the source area at the Wainwright site. Adequate control is not apparent based on the increasing to relatively stable contaminant concentrations in MW-17C, although the variation in concentrations in MW-17C may be due to initiation of pumping at Valley Technologies and changes in nearby commercial ground water use.

6.5 RECOMMENDATIONS RELATED TO ENVIRONMENTAL FOOTPRINT REDUCTION

The temperature setting could be reduced to decrease costs for wintertime heating of the GETS treatment building. Alternatively, a programmable thermostat could be installed to decrease costs for wintertime heating of the GETS treatment building. The building has two Berko wall- mounted electrical heaters. The temperature in the treatment building is maintained at a constant level of 70 degrees F during the winter. The treatment plant operates unattended the majority of the time. A programmable thermostat would allow the temperature to be maintained at a lower level most of the time, and reduce electrical utility costs. The thermostat could be programmed to increase the temperature before the weekly inspection and quarterly monitoring events.

The simplest way to implement this recommendation would be to reduce the temperature setting for the heaters. No costs would be incurred to implement this recommendation. Based on the following calculator, reducing the temperature setting of a facility about the size of a single family home, that uses electrical heaters, by 10 degrees F, a cost savings of about $740 per year could be achieved. The operators could turn the heat back up to 70 degree F during the weekly inspection and quarterly monitoring events, and then turn it back down again when they leave. The calculator is shown at this website: http://www.mge.com/home/saving/thermostat.htm

Alternatively, a programmable thermostat could be installed. Costs would be incurred for purchase and installation of a programmable thermostat, but it is expected that the costs would be recovered within one year or less.

6.6 SUGGESTED APPROACH TO IMPLEMENTING RECOMMENDATIONS

The recommendations provided above are generally independent of each other. The modifications to the monitoring network and sampling methodology could be implemented regardless of the other recommendations. The recommendations for changes in the treatment plant operations and maintenance and climate settings can also be implemented no matter if other recommendations are adopted, with the exception of the removal of the SVE equipment. The SVE equipment would remain if the additional source characterization would suggest vadose zone contamination remains in soils that are amenable to SVE. Any implementation of the recommendation for in-situ chemical oxidation of on-going contaminant sources will depend on the implementation of the recommendations for further characterization of the ground water contamination on the Valley Technologies site. Some of the maintenance recommendations for the air stripper may be slightly affected by the method of implementation of any in-situ chemical oxidation if mineral precipitation may be increased by the recirculation of oxidant solution.

Table 4. Summary of Recommendations

Recommendation	Reason	Additional Capital Costs ($)	Estimated Change in Annual Costs ($)	Estimated Change in Life-Cycle Costs ($)*	Estimated Change in Life-Cycle Costs ($)**
6.1 Modification to the Ground Water Monitoring Program	Better verify remedy performance and potential exposures	$85,000	$2,000 or $5,500 if the recommendation in 6.2.2 is not adopted	$125,000 or $195,000 if recommendation in 6.2.2 is not adopted	$121,828 or $186,278 if recommendation in 6.2.2 is not adopted.
6.2.1 Revisit Air Stripper Design	Reduce operating cost and energy footprint	Not determined pending feasibility determination	Not determined pending feasibility determination	Not determined pending feasibility determination	Not determined pending feasibility determination
6.2.2 Modify Sampling Methods to Include PDBs	Reduce costs while maintaining data quality	$4,600 for side-by-side comparison of methods	($3,000) or ($5,000) if the recommendation in 6.1 is not adopted	($55,400) or ($95,600) if the recommendation in 6.1 is not adopted	($50,642) or ($87.471) if the recommendation in 6.1 is not adopted
6.3.1 Increase Level of Maintenance for the GETS	Improve remedy reliability and effectiveness	None	$4,000 for all recommendations in section 6.3	$80,000 for all recommendations in section 6.3	$73,657 for all recommendations in section 6.3
6.3.2 Periodic Inspection of Extraction Well Pump & Motor	Improve remedy reliability and effectiveness	None	See 6.3.1	See 6.3.1	See 6.3.1
6.3.3 Periodic Monitoring of Blower & Motor	Improve remedy reliability and effectiveness	None	See 6.3.1	See 6.3.1	See 6.3.1
6.3.4 Periodic Testing of PLC System Interlocks & Connections	Improve remedy reliability and effectiveness	None	See 6.3.1	See 6.3.1	See 6.3.1
6.3.5 Monitor Piping for Leaks	Improve remedy reliability and effectiveness	None	See 6.3.1	See 6.3.1	See 6.3.1
6.3.6 Periodic Disassembly & Cleaning of Air Stripper	Improve remedy reliability and effectiveness	None	See 6.3.1	See 6.3.1	See 6.3.1
6.3.7 Consider Making SVE Equipment Available to Other Project	Recoup value of investment and to be sustainable	None	See 6.3.1	See 6.3.1	See 6.3.1

6.4.1 Additional Characterization of Remaining Sources	Shorten time to attainment of goals	$80,000	$2,000 for sampling additional monitoring wells	($1,000,000) assuming avoiding 10 years of operations. less the $80,000 characterization costs and $40,000 in additional sampling costs for **a net savings of ($880,000)**. Does not include remediation costs	**($767.219) less the undermined remediation costs.** This accounts for the discounted future savings for operations starting in 10 years and discounted value of added sampling costs.
6.4.2 Remediate Remaining Sources	Shorten time to attainment of goals	Not determined	Not determined	See 6.4.1 above	See 6.4.1 above
6.5 Reduce Temperature in the Treatment Building	Reduce both cost and environmental footprint	$500	($740)	($14,300)	($13,126)

Numbers in parentheses are reductions in cost
*Non-discounted costs/savings over a life cycle of 20 years
**Discounted cost/savings over 20 years using a 0.8% discount rate per OMB Circular A-94, Appendix C. Dec. 2012

FIGURES

Figure 1. Site Vicinity.

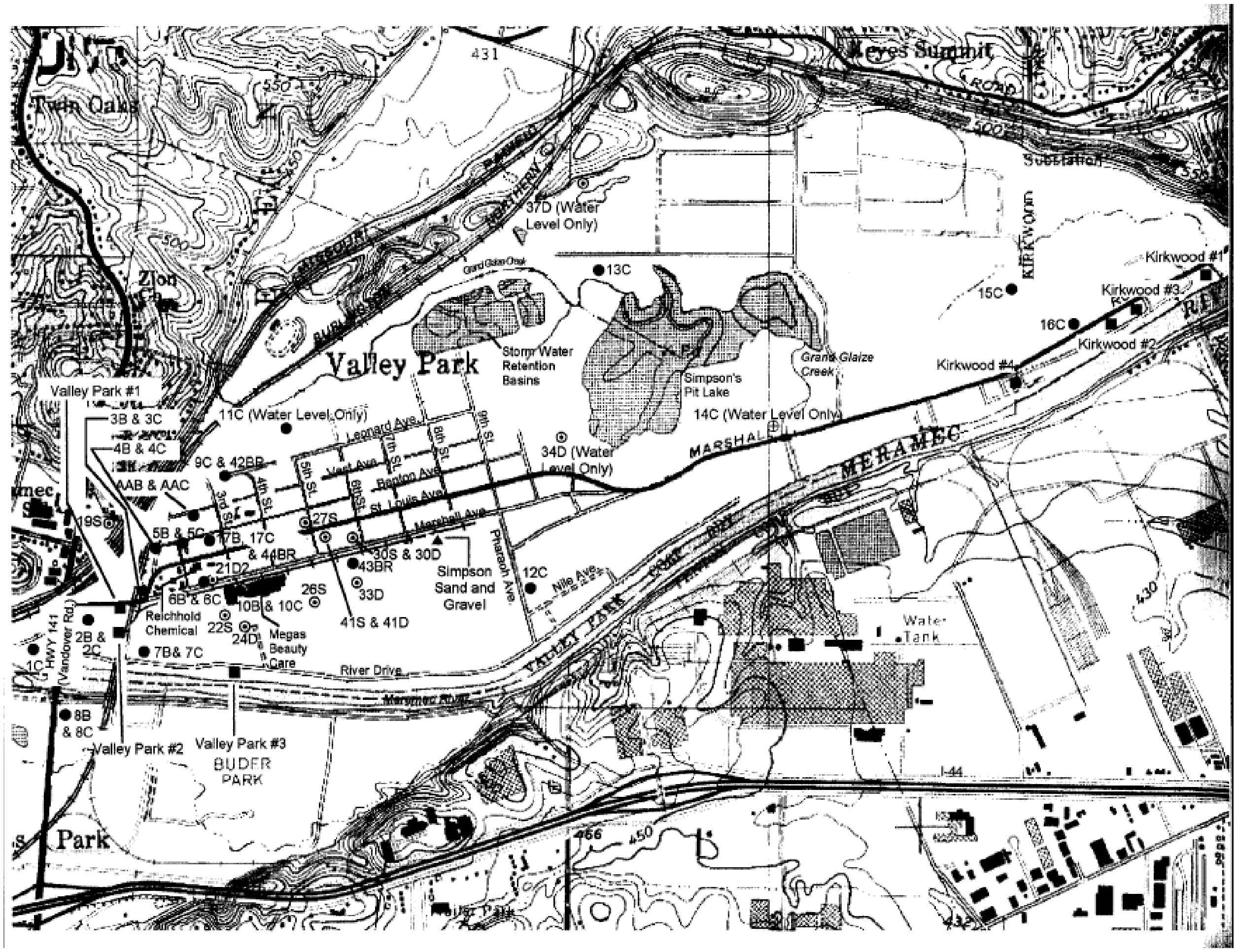

Figure 2. Generalized Geologic Cross Section.

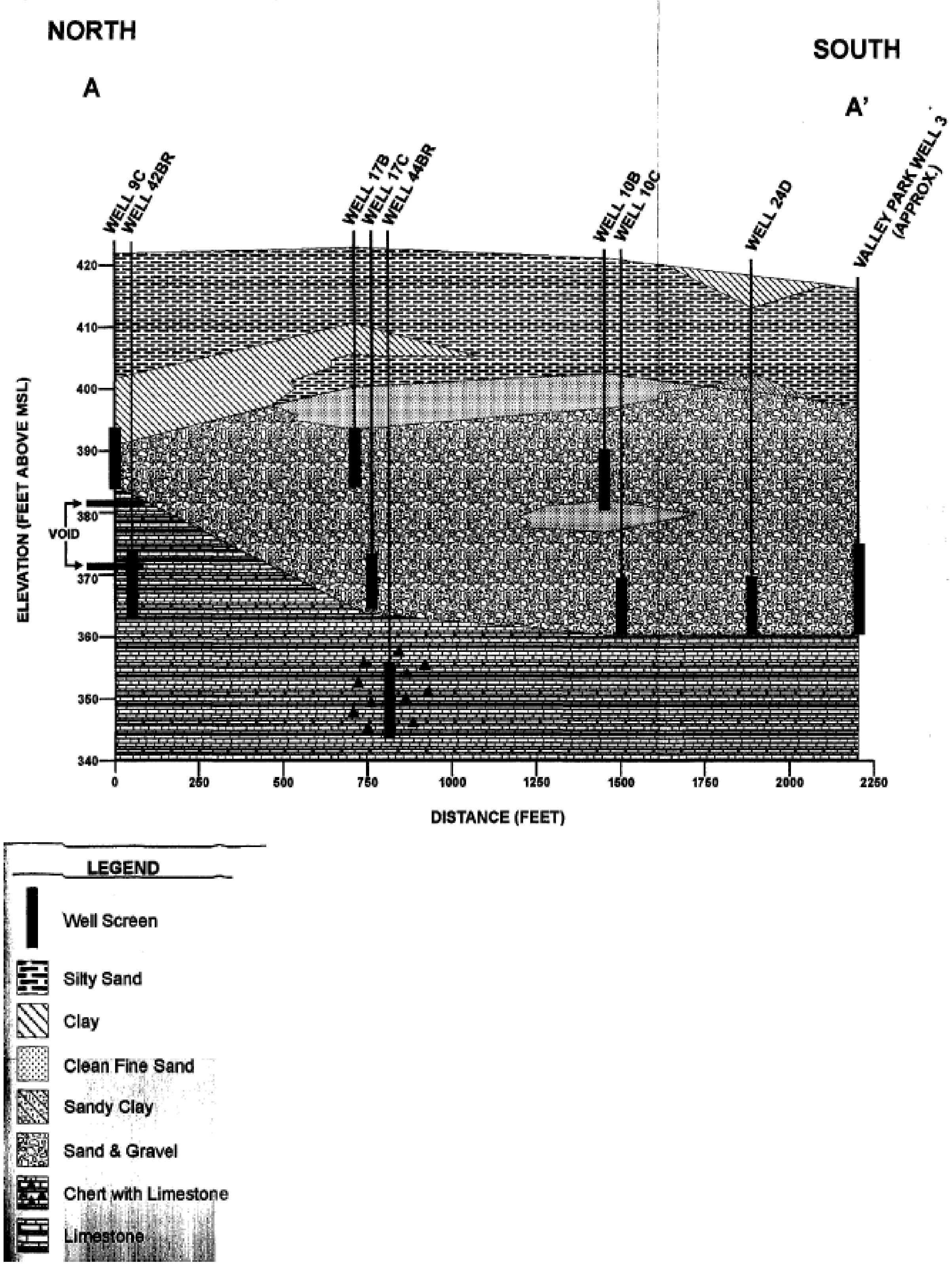

Figure 3. Tetrachloroethylene Plume (2011)

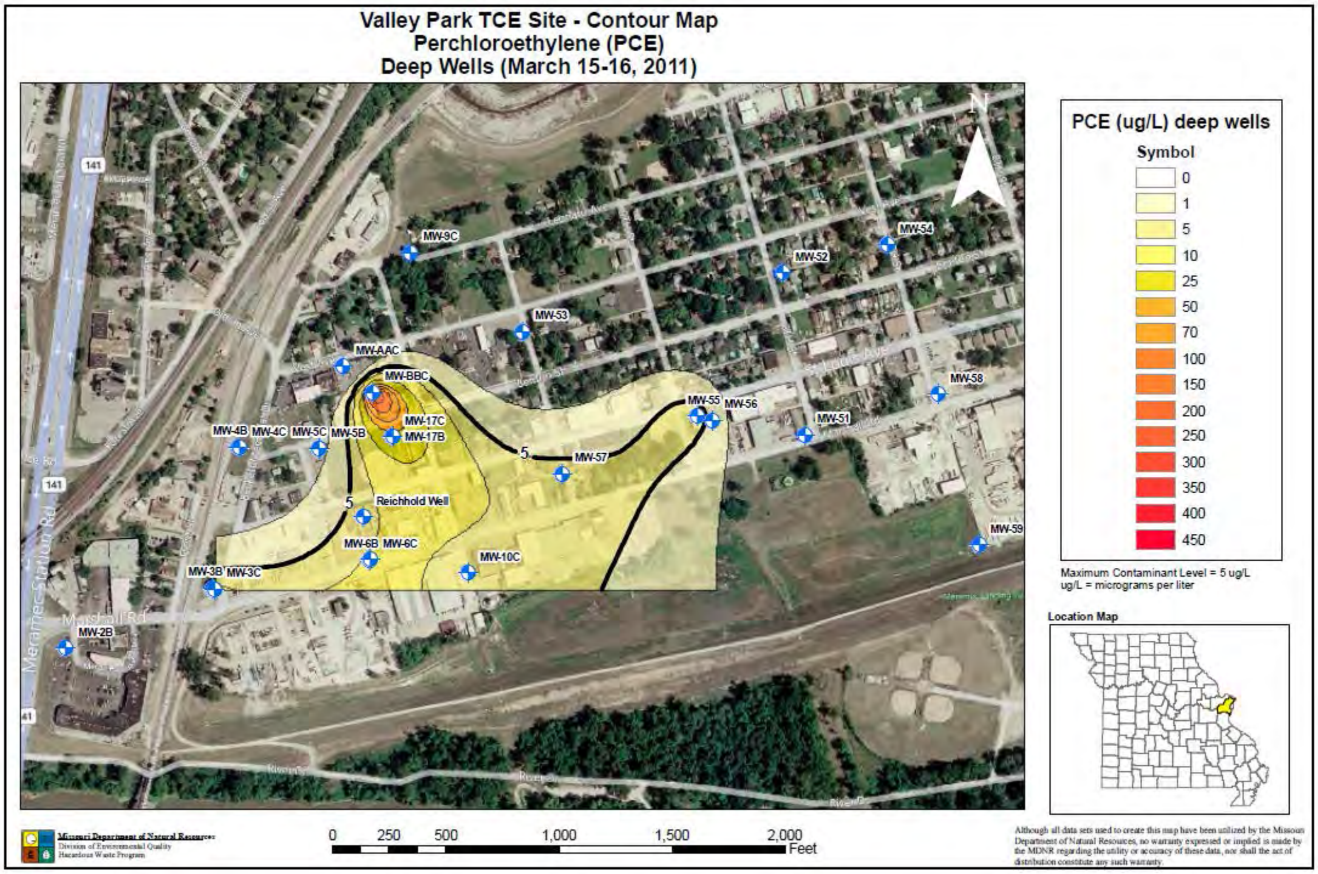

Figure 4. Trichloroethylene Plume (2011)

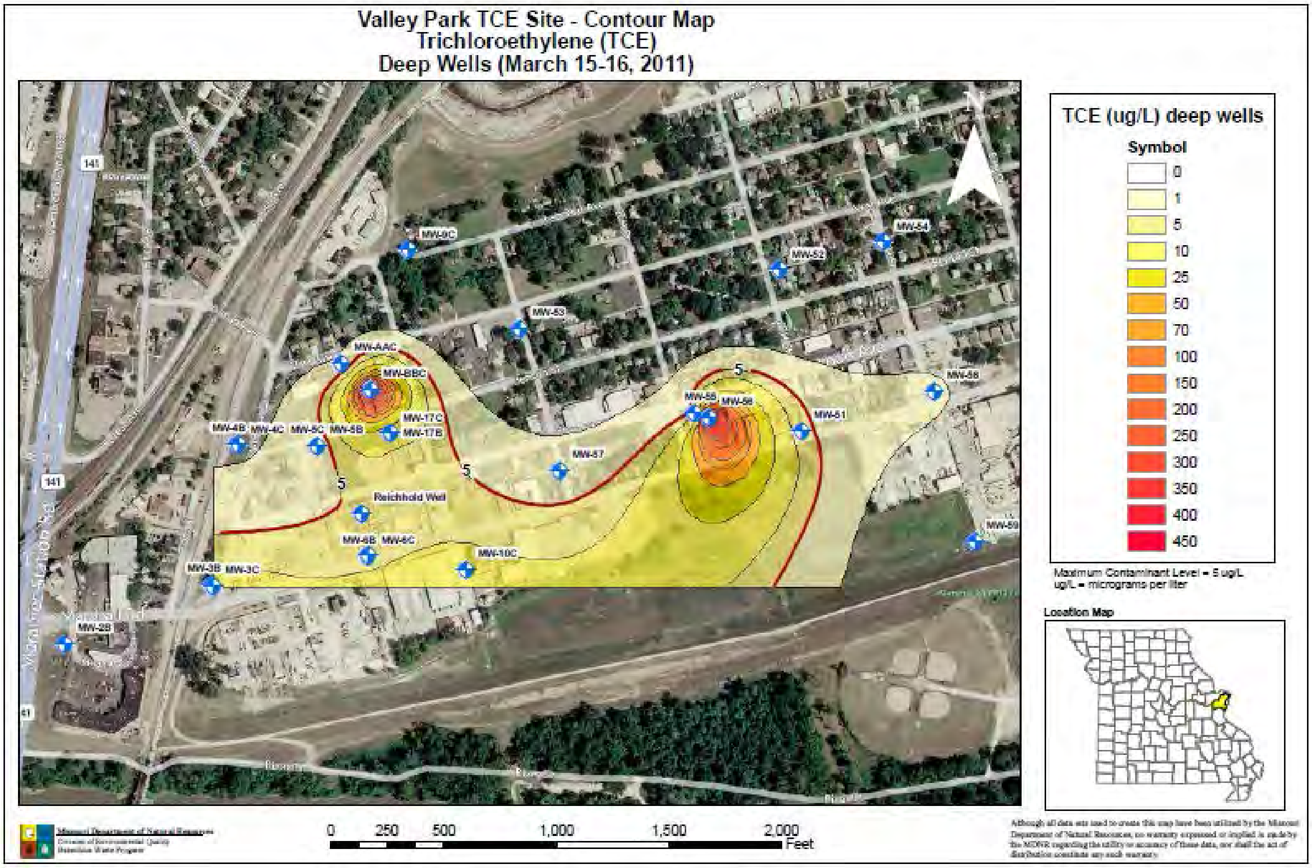

Figure 5. Limits of 2006 Soil Excavation

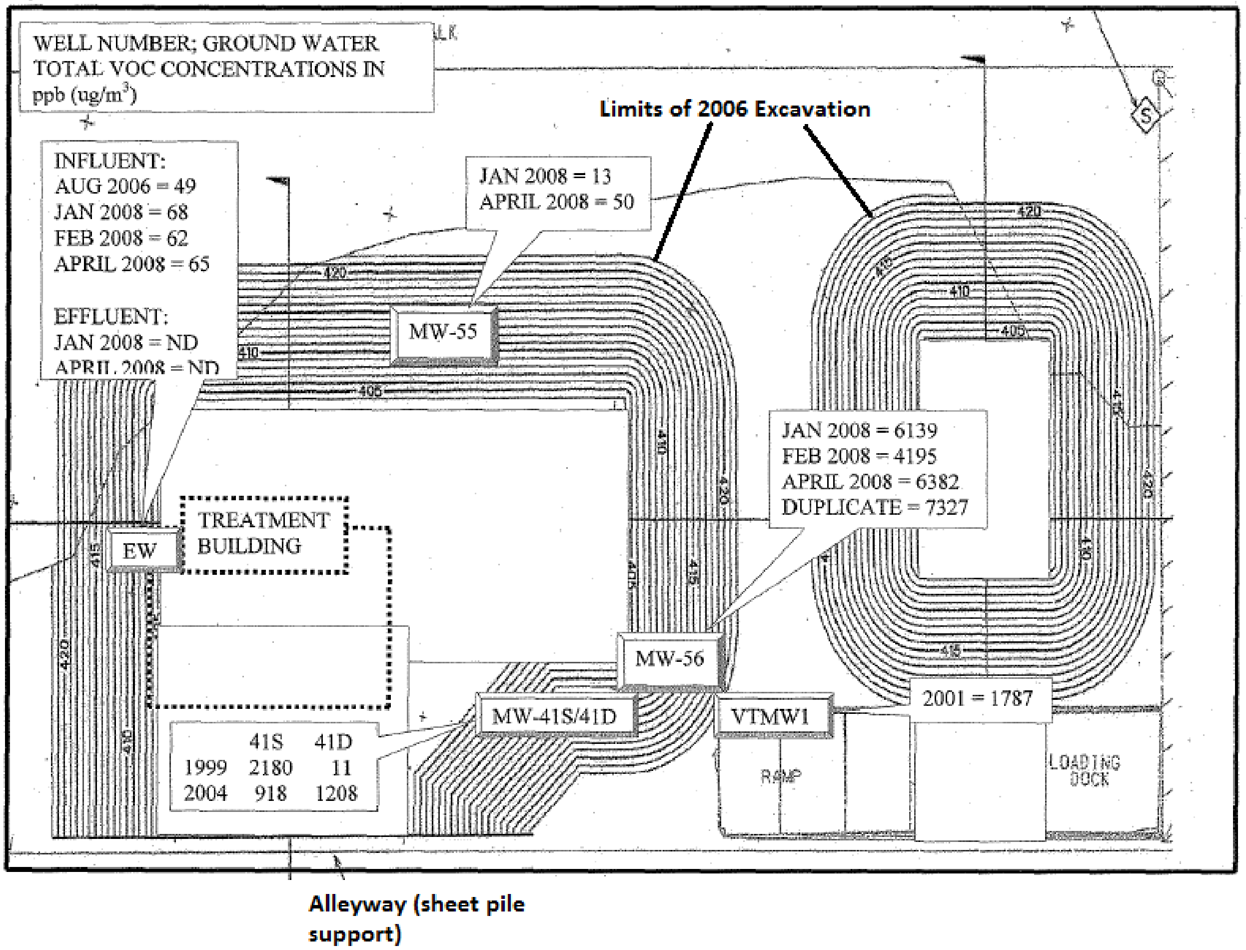

Figure 6. Process Plan.

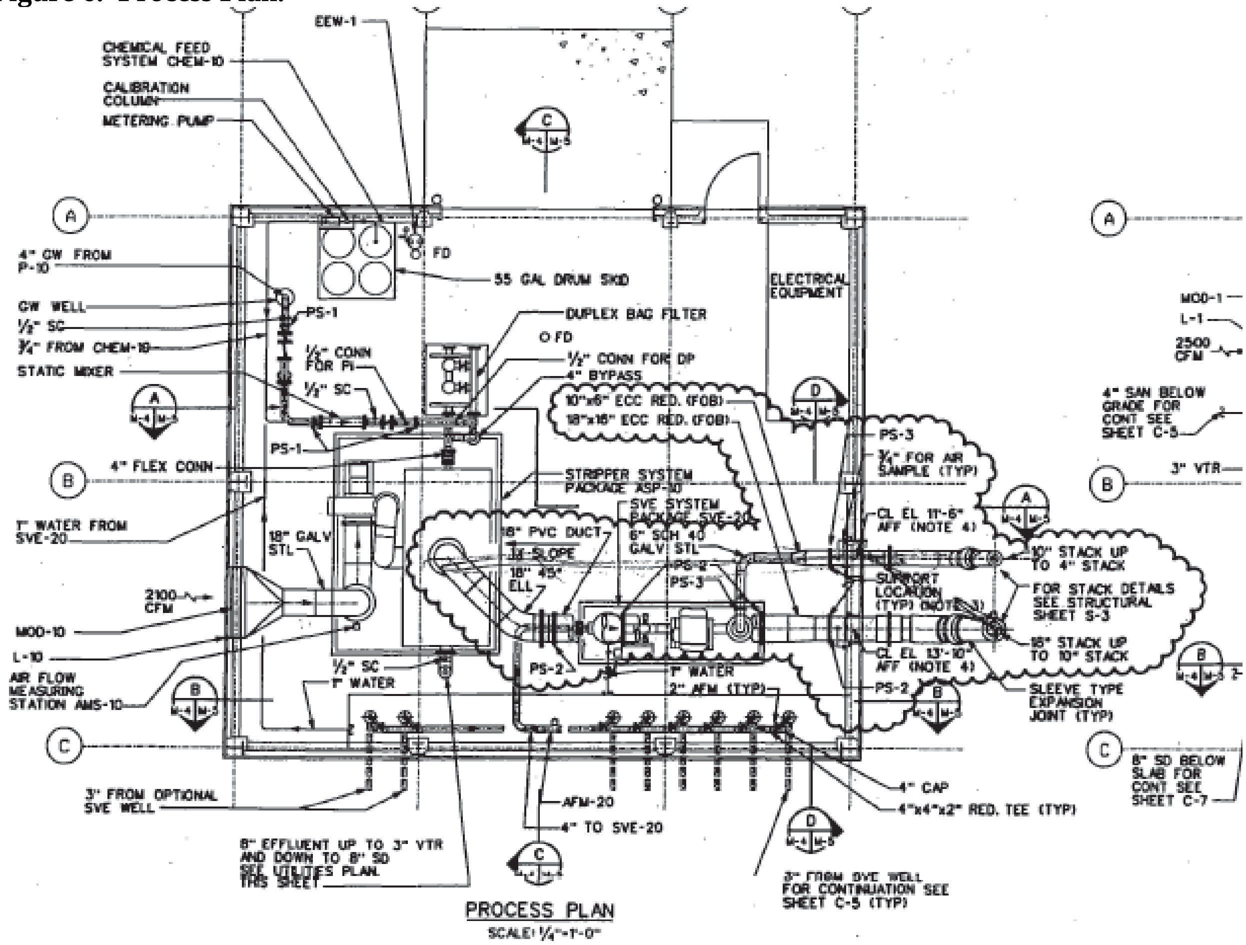

Figure 7. Concentrations of PCE, TCE, and cis-1,2DCE in Key Monitoring Wells and PCE Concentrations in System Influent

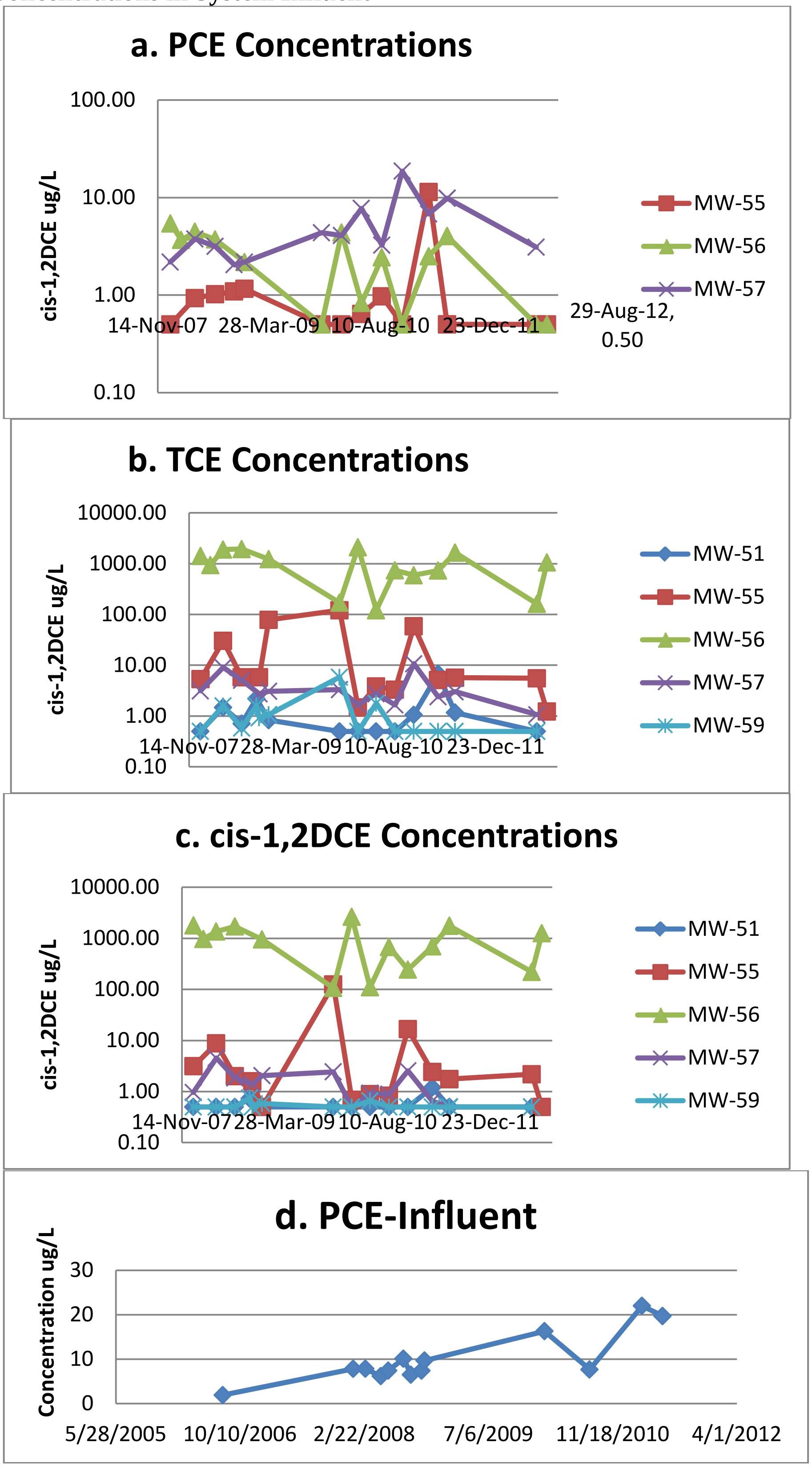

Figure 8. Proposed Locations of Additional Monitoring Wells

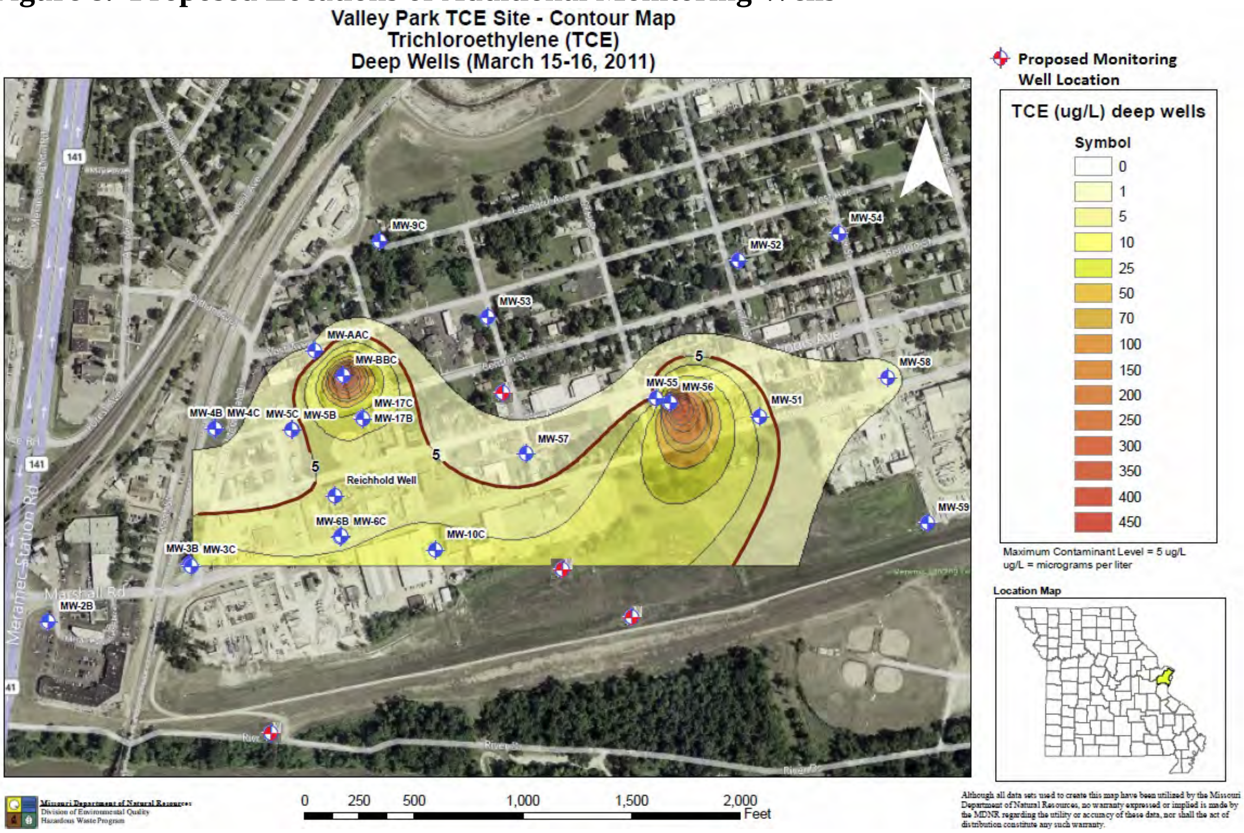

Figure 9. Suggested Ground Water Sampling Transects on Valley Technologies Site