ITLL Environmental, LLC

University of Colorado
1 Engineering Place
Campus Box 421
Boulder, CO 80309

August 25, 2004

Lisa Hennessy, P.E.

Cameron-Cole, LLC
5777 Central Ave.
Suite 100
Boulder, CO 80301

Dear Lisa Hennessy:

ITLL Environmental is dedicated to providing our clients with efficient, cost effective approaches to the challenges they face. We work hard to synthesize the many pieces of environmental problems providing a solution that is most suitable to the specific situation.

Our engineering team has reviewed several technologies that could be applied the situation at hand, and has developed several possible remedial strategies for contaminant removal. We will ensure that your guidelines and specifications are met and will work to deliver a solution that is compatible with your needs.

Attached you will find some of our preliminary thoughts on the ABC tetrachloroethene spill at the Mega Rail Yard, Anywhere USA. Additionally, there is information on the decision making process which ITLL uses in its remediation designs. Please take the time to review the following document. Any questions or concerns can be addressed to the project manager via email at gormanc@colorado.edu or by phone at (303) 829-3245.

Sincerely,

Craig Gorman
Project Manager
ITLL Environmental, LLC

Table of Contents

Scope of Work

ITLL Environmental has prepared the following proposal in response to a request for remedial services by Cameron-Cole, LLC on the behalf of ABC Chemicals. The work will be performed as a result of a request by AnyState Department of Environmental Quality (ADEQ) to complete the remediation of a railyard tetrachloroethene (PCE) spill in Anywhere, USA.

ITLL Environmental, LLC will be conducting an investigation to determine the most appropriate strategy to complete the remediation of the PCE spill. As part of this process, we will deliver a comprehensive assessment of several possible remedial technologies at our disposal. Each technology will be evaluated, based on total project cost, expediency, and site compatibility. In addition, we will include specific criteria that the client sees as high priorities. Once the most appropriate remedial strategy is chosen, we will present a preliminary remedial design to lower contaminant concentrations to acceptable levels, within federal regulations.

Project Background

Approximately thirteen years ago a release of the chemical tetrachloroethene (PCE) occurred between the Mainline Tracks 1 and 2 at the Mega Rail Yard, Anywhere, USA. A rail car, leased to ABC Chemicals, was transporting roughly 14,800 gallons of the PCE from its manufacturing plant in Somewhere Else Town, USA. The rail car was found to have a 26 inch crack on the underside of the tanker car. It is believed that the leak began somewhere in transit, therefore the exact amount of PCE released at the Mega site is unknown; however the contamination did appear to be limited to an area of 200 feet x 10 feet. Upon realization of the incident, the employees of Mega removed the pooled chemical from the surface and attempted to contain the PCE by covering the wetted ground with plastic and ballast. The Mega Railroad site is also contaminated from a previous release of diesel fuel.

Subsurface investigations have detected PCE and diesel fuel in the soil and groundwater. Daughter products of PCE including trichloroethene (TCE), dichloroethene (DCE), and vinyl chloride (VC) have also been identified at the site. Free phase diesel has been detected in the area which is now contaminated with PCE. However, no free phase PCE has been found. As a result of the local groundwater flow some of the dissolved diesel fuel has migrated below the west wing of the former depot. Figure 1 presents on a site map the concentration contours of volatile organic compounds (VOC), which include PCE and its daughter compounds.

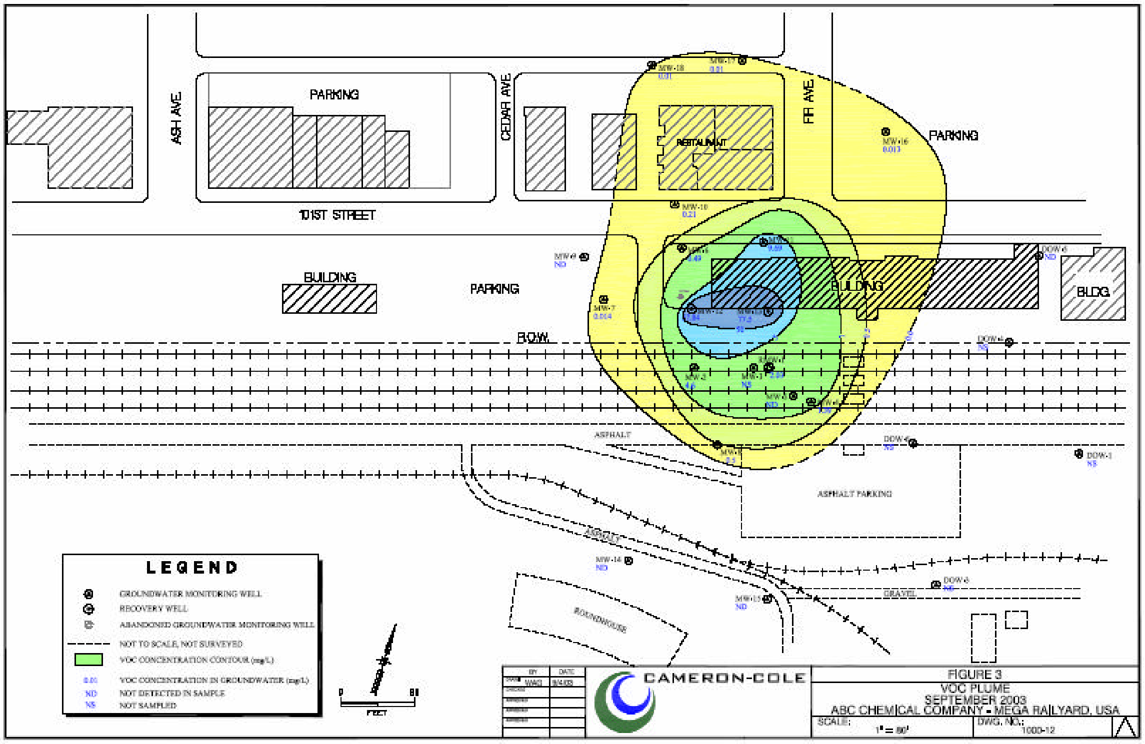

Figure 1 *Site map with the location of the VOC plume*

Two remediation systems have been previously installed at the Mega Rail Yard site. Ozone generators were placed in the basement of the west and central wings of the depot to treat any chemicals that may diffuse from the ground water into the building. A dual phase extraction pump coupled with a soil vapor extraction (SVE) system was also installed in November of 1989. The extracted soil vapor was not treated. This system was shut down in May, 1997 as a result of diminishing returns from the system.

ABC Chemical is interested in completing the remediation of the PCE spill at the Mega Rail Yard, which includes the above mentioned daughter products in a timely fashion. Ideally, the time period and cost of the remediation will not be negatively impacted as a result of the preexisting diesel plume on site.

Regulations

The United States Environmental Protection Agency (EPA) has an extensive database of acceptable maximum contaminant levels (MCL) for drinking water. Since there is the potential for onsite groundwater to be used as a drinking water source in the future, we will be using these guidelines as target clean up levels. State regulations will not be considered at present to protect the confidentiality of our client. Colorado State permitting and licensing regulations will be used for the assessment, and may be modified at the client’s request.

Potential Remedial Options

Permeable Reactive Barriers

Permeable reactive barriers (PRB's) are walls or regions of selectively permeable material that are installed across the local groundwater flow path. As groundwater passes through the wall, contaminants are removed by physical, chemical, or biological means. Their primary function is to contain a contaminant plume and remediate it over a long time period (http://www.frtr.gov/matrix2/section 4/4_46.htm.).

Reactive barriers may be installed with a variety of media to treat specific contaminants. Zero-valent iron is effective at removing chlorinated VOC's and has been used as a medium in more than 50% of past PRB installations (EPA, 2002). The wall is installed beyond the down gradient extent of the current plume to allow contaminated groundwater to pass through. Electrons released during iron oxidation sequentially dechlorinate the contaminants passing through the wall. Funnel and gate techniques operate in a similar fashion employing walls with very low permeability to channel contaminated groundwater and non-aqueous phase liquids (NAPL) into a specific reactive region. Figure 2 illustrates a typical PRB installation.

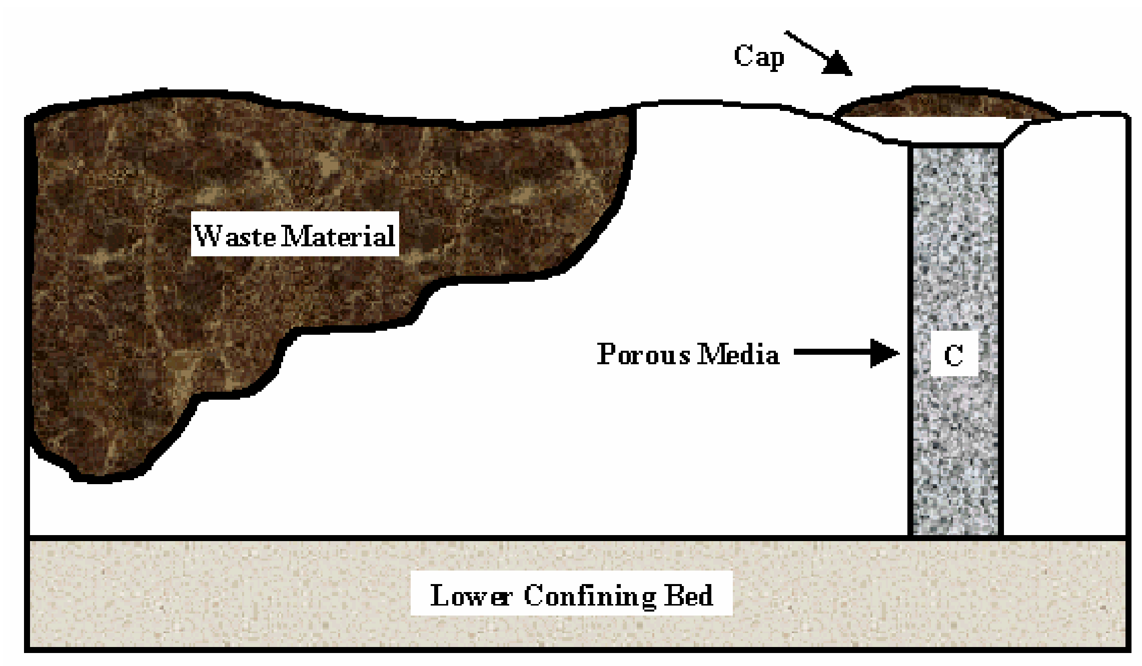

Figure 2 *Typical permeable reactive barrier design. Porous media may be equipped with zero-valent iron, microbes, or precipitating agents (http://www.frtr.gov/matrix2/section4/94p-3317.gif)*

Enhanced Biological Treatment

In-situ enhanced biological treatment utilizes the ability of an aquifer's natural microbial population to degrade chlorinated VOC's, either directly, by using the contaminants as electron acceptors/donors, or cometabolically, through generalized enzymatic activity. This reductive dechlorination occurs readily under aerobic and anaerobic conditions (http://www.frtr.gov/matrix2/section3/3_9.html). Substrates such as molasses or sugar are typically introduced into the aquifer to serve as a food source for microbes. The chemical environment is closely monitored to provide a highly reducing environment, where Fe^{+3}, SO_4^{-2}, and CO_2 serve as the primary electron acceptors (Suthersan 2002).

Bioremediation techniques are passive and require a significant amount of time to sufficiently reduce the concentration of contaminants in the aquifer. They are inexpensive in relation to other more aggressive technologies. In-situ bioremediation techniques can also be implemented unobtrusively, leaving virtually no footprint on the remediation site. The timeframe for remediation can also be abbreviated with the addition of subsurface amendments such as hydrogen releasing compounds, substrate introduction to act as a food source for microbes, or an electron donor such as powdered elemental iron (Fe^{0}). A typical pathway for the reductive dechlorination of PCE is shown in Figure 3.

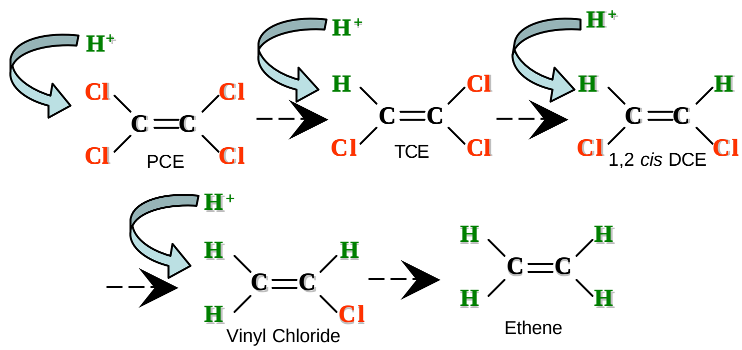

Figure 3 *Schematic of the reductive dechlorination of PCE to ethene*

Chemical Oxidation

Chemical oxidation is an aggressive in-situ treatment strategy that could be employed on site to rapidly mineralize the contaminant plume. During this process, hydrogen peroxide, permanganate, or ozone are introduced to oxidize the contaminants (Suthersan 2002).

This is an expedient technology, the reaction kinetics are quite fast, and therefore treatment times can magnitude less than biological techniques. It is also less disruptive to surface structures and topography than several ex-situ techniques. Due to the high cost of oxidizing agents, chemical oxidation is more expensive that biological techniques, but less expensive than other aggressive technologies, because the operating and maintenance costs associated with longer duration projects can be very large. Safety is the primary consideration when using this technology. Since oxidation is a highly exothermic reaction, the potential for greatly increased subsurface temperatures and pressures exists. Strong oxidants are corrosive and exposure by direct dermal contact is a safety concern. According to an authoritative text by Suthersan (2002), oxidative pathways include epoxide formation, which are highly unstable compounds, so there are undoubtedly explosion risks if meticulous chemical procedures are not followed.

Air Sparge / Soil Vapor Extraction

Air sparging (AS) is a process in which air is injected below the water table using a system of wells. As the air rises through the aquifer, volatile organic compounds volatilize into the bubbles and are subsequently removed.

Typically AS systems are used in combination with a series of vapor extraction wells, commonly referred to as a soil vapor extraction system (SVE). A vacuum is applied to the extraction wells and the contaminated vapors are then processed, typically with granular activated carbon, and released to the atmosphere. A schematic of an AS/SVE system is shown in Figure 4 below.

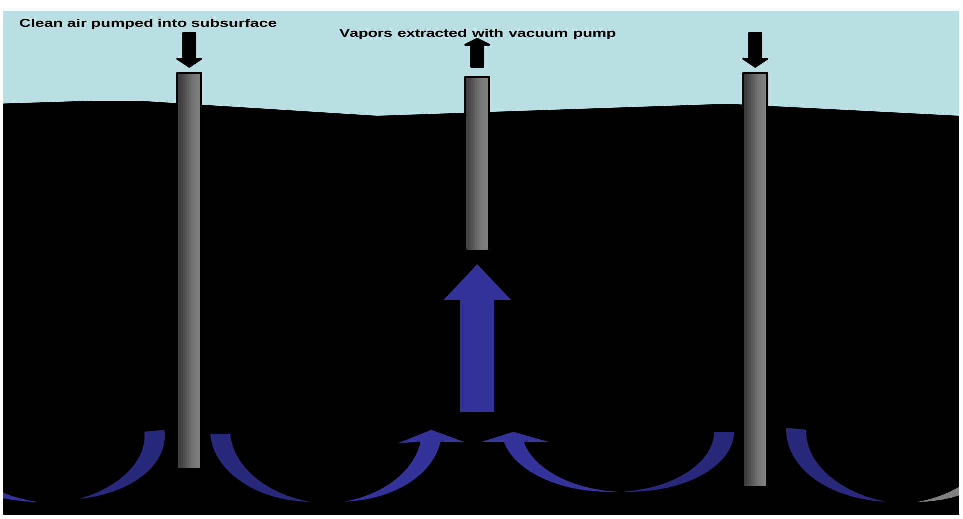

Figure 4 *Typical AS/SVE system*

Remedial Technology Selection Process

Prior to the selection of the remedial strategy at the Mega Rail Yard there will be an extensive review of all previously collected data. From this information ITLL Environmental will perform an in-depth assessment of each of the feasible alternatives in order to choose the technology that best suits the needs of ABC Chemical and Cameron-Cole. The technology that is ultimately selected for the final design will have the best combination of elements to suit the needs of our clients. Among the criteria to be used in the selection process are cost, time, technical reliability, and the impact and public perception of the process.

Deliverables

The deliverables that will be provided to Cameron-Cole and ABC Chemical along with their dates of delivery are listed in Table 1.

Table 1 *Project deliverables*

Deliverable	Date
Proposal Presentation	September 16, 2003
Proposal Submission	September 18, 2003
Preliminary Alternatives Assessment	October 30, 2003
Design Presentation	December 9, 2003
Preliminary Design Report	December 11, 2003

The Preliminary Alternatives Assessment Report will contain background information on the site, analysis of possible remediation techniques and systems, and a recommendation for the remediation system based upon a weighted design matrix.

The Preliminary Design Report will contain a Final Alternatives Assessment based on feedback from Cameron-Cole and ABC Chemical to determine the remediation system selected for the detailed design. This report will include detailed design calculations of the remediation system, including costs for construction, operation, and maintenance.

Schedule

The schedule of tasks necessary to complete the Preliminary Design Report is listed in Table 2, along with the scheduled completion date of each task.

***Table 2** Project Schedule*

Task	Completion Date
Proposal Presentation	September 16, 2003
Proposal Submission	September 18, 2003
Alternatives Assessment Research	October 10, 2003
Decision Matrix Development	October 17, 2003
Preliminary Alternatives Assessment Report	October 30, 2003
Preliminary Design Development	November 14, 2003
Cost Estimates	December 5, 2003
Preliminary Design Report	December 11, 2003

Cost and Budget

The costs and budget for each phase of the design process is shown below. Table 3 is the cost for the Alternatives Assessment phase of the project; Table 4 shows the cost of the design phase of the project and Table 5 shows the project totals for the ABC Chemical remediation.

***Table 3** Hours and cost for the Alternative Assessment*

Deliverable: Alternatives Assessment Date of Completion: 28-Oct, 2003			
Position	***Hours***	***Billable Rate, (per hr.)***	***Extended Total***
Project Manager/Project Engineer	14	$80.00	$1,120.00
Junior Engineer/Estimator	161	$40.00	$6,440.00
CAD Operator	0	$30.00	$0.00
	Total Hrs: 175		Total Billable: $7,560.00

***Table 4** Hours and cost for the Design Phase*

Deliverable: Final Design Presentation and Report Submission Date of Completion: 09-Dec, 2003			
Position	***Hours***	***Billable Rate, (per hr.)***	***Extended Total***
Project Manager/Project Engineer	32	$80.00	$2,560.00
Junior Engineer/Estimator	243	$40.00	$9,720.00
CAD Operator	10	$30.00	$300.00
	Total Hrs: 285		Total Billable: $12,580.00

Table 5 *Total cost for the Remedial Design*

Project Totals:		
Title/Position	**Hours**	**Rate**
Project Manager/Project Engineer:	46	$80.00
Junior Engineer/Estimator:	404	$40.00
CAD Operator:	10	$30.00

Grand total:	$20,140.00

ITLL Remediation Team

Our remediation team is composed of four University of Colorado Environmental Engineering students who have dedicated their academic pursuits to understanding remediation science and addressing the complexities of environmental problems. Our individual backgrounds are diverse, so we invite you to read through each member's vitae in the appendix. Over the past few years our individual team members have worked side-by-side on similar projects, having many opportunities to focus interdisciplinary backgrounds. Through these common projects we have developed a well-defined group dynamic yielding the experience to solve complex engineering problems.

Personnel

Mr. Craig Gorman

Mr. Gorman is a Graduate Student studying Environmental Engineering at the University of Colorado at Boulder. He received his Bachelors of Science degree in Environmental Science and received a minor in geology from the State University of New York in December of 1999. Prior to attending graduate school, Mr. Gorman was a field engineer for Hepworth-Pawlak Geotechnical in Silverthorne, Colorado.

Mr. Duane Herring

Mr. Herring is pursuing graduate study in Environmental Engineering at the University of Colorado at Boulder. He holds a Bachelor of Science from the State University of New York in Environmental and Forest Biology. Mr. Herring's academic focus is in pollutant fate/transport in ground and surface water systems, and bioremediation technologies.

Mr. Patrick Niedermeyer

Mr. Niedermeyer is a senior in Civil Engineer, with a focus on Water Resources. He has taken courses in aquatic chemistry, and environmental sampling through which he received his HAZWOPR certification. Mr. Niedermeyer is currently enrolled in applied microbiology, economics, and groundwater hydraulics and pollutant transport.

Mr. Andrew Vann
Andrew Vann is a senior studying for a B.S. in Environmental Engineering, following the Applied Ecology track. He has taken courses in environmental sampling, water chemistry and ecology, and is currently taking courses in microbiology and environmental modeling. Mr. Vann has experience designing and installing an air sparge/soil vapor extraction system.

In House Quality Control and Assurance

In order to provide a design that will stand up to the ITLL reputation, we have implemented a series of in house checks and balances to assure a high quality final product. Case studies of similarly contaminated sites will be evaluated in order to prepare our engineers for nuances that may be particular to the given technology. Each calculation used in the final design will be meticulously performed by a staff engineer and then reevaluated by the project engineer. Our remediation team has developed a close professional relationship where the ideas and expertise of each member are integrated to develop a design that reflects the insight of the entire staff.

Summary

ITLL Environmental is equipped to supply the technical resources and guidance in order to properly remediate the ABC Chemical PCE spill. We are prepared to review all existing data in order to provide a well-informed, fact based solution for the removal of PCE and its subsequent daughter products from the Mega Rail Yard site. Our team of engineers will create a final design that will reflect the specific need of both our client (cost, time, and overall effectiveness) and the site (hydrogeology, structures, and exposure pathways). ITLL Environmental looks forward to the opportunity of working with you toward this common goal.

References

"Analysis of Selected Enhancements for Soil Vapor Extraction" United States EPA Document. EPA-542-R-97-007 http://www.epa.gov/swertio1/download/remed/sveenhmt.pdf

Suthersan, Suthan S. 2001. Natural and Enhanced Remediation Systems. Lewis Publishing Inc.

Federal Remediation Technology Roundtable Website Remediation Technology Screening Matrix. http://www.frtr.gov/matrix2/section 4/4_46.htm.

United States Environmental Protection Agency Website. IRIS Database. http://www.epa.gov/iris.htm

Appendices