FEASIBILITY EVALUATION

OF

ALTERNATIVE GREEN REMEDIATION APPLICATIONS

Willow Run Company Vehicle Operations

March 2010

INTRODUCTION

Toxicological & Environmental Associates, Inc. (TEA) reviewed the Motors Liquidation Company (MLC) site portfolio to determine if there are candidates for Alternative Green Remedial approaches, either solely or in combination with other remedies previously identified for those sites. Alternative Green Remedial approaches were defined in a memorandum submitted on October 2, 2009, entitled "Site Selection Criteria for the Identification of Candidate Sites for Alternative Green Remediation" and included, but were not limited to, phytoremediation, source area reduction of dense non-aqueous phase liquid (DNAPL), and various in-situ technologies. Eight sites from the MLC portfolio were identified for conceptual development. These eight sites included:

1. Former Delco Chassis Plant (Livonia)
2. Willow Run Company Vehicle Operations
3. GMPT Bay City
4. Danville Central Foundry
5. Stamping - Grand Rapids
6. Buick City
7. Former GM Delco Plant 5 (Kokomo)
8. Delphi - Moraine

In addition to these sites, GMPT Massena (New York), Buick City and others were targeted for feasibility evaluation of an emerging polychlorinated biphenyl (PCB) abatement technology for paints, soils, sediment, sludge, and light non-aqueous phase liquid (LNAPL) treatment for oils containing PCBs.

TEA prepared "Conceptual Design and Preliminary Cost" reports for these sites which were uploaded to the IDEA database in October 2009. Based on subsequent discussions among the remedial and planning team members, TEA evaluated these sites in further detail to assess the practical feasibility of incorporating alternative green technologies into remedial plans for those specific sites. Assessments of potential cost impacts were also evaluated during the current assignment.

The limited information and data available for TEA's "Conceptual Design and Preliminary Cost" reports were expanded to generate this document. The feasibility evaluations presented herein are based solely on data available on the IDEA database and telephone discussions with site project managers.

The objectives of this submittal are to evaluate practical, logistical, technical, regulatory, and financial issues related to these sites in which alternative green remedies may be considered within the course of proposed remediation schemes. Considered during the evaluations were implementability, effectiveness, cost, and green sustainable principles and practices. Estimates of capital costs, O&M costs, and monitoring costs were refined for the alternative green remedies proposed for each site. The results of the evaluation are presented succinctly using the following general outline:

I. Problem Statement
   - compounds/contaminants
   - media
   - saturated/unsaturated zones
   - landfill, etc.

II. Site Characteristics
   - Hydrogeology
     a. depth to groundwater
     b. groundwater flow direction
     c. hydraulic conductivity, groundwater velocity, etc.
   - Extent of contaminant plume
   - Potential receptors

III. Proposed Alternative Green Remedy
   - Purpose and objectives
   - Description of alternative green remedial technology
   - Sustainability
   - Analysis of Green and Sustainable Remediation
   - Monitoring program
   - Term of operation
   - Advantages and disadvantages

IV. Regulatory Outlook
   - Existing order
   - Regulatory agency
   - Potential obstacles

V. Green and Sustainable Remediation (GSR) Comparison

VI. Costs

- Capital/O&M/Monitoring
- Assumptions
- Potential savings

VII. Conclusions

Estimated costs for the proposed alternative green remedies proposed in this submittal were refined based on all information and data gathered by TEA to date. At this time, costs are not necessarily intended to modify overall remediation estimates necessary for these sites. These estimates are mostly intended for consideration during future planning and design of site remediation as proven, implementable, sustainable, and effective cost-saving measures.

Willow Run – CVO, Ypsilanti, MI
MLC #1342

I. Problem Statement

In May 2004, the presence of DNAPL was confirmed in two monitoring wells at the Company Vehicle Operations (CVO) site in Willow Run. The DNAPL contains high levels of trichloroethene (TCE) and PCBs (PCBs have been classified as a TSCA and RCRA hazardous waste). A sheet pile wall barrier was installed to ensure that DNAPL did not migrate into the adjacent pond. DNAPL removal continues behind the sheet pile wall. It is believed that the groundwater is starting to migrate around the sheet piling, transporting constituents into Tyler Pond at concentrations that exceed the Final Acute Value (FAV) Criterion.

Historical disposal practices have also resulted in other areas of elevated volatile organic compounds (VOCs), PCBs, and LNAPL resulting in a concern over site-wide groundwater migrating to Tyler Pond containing constituents of concern.

Currently proposed remedies include additional sheet pile to further contain DNAPL, continued pumping and disposal of DNAPL at a TSCA facility, possible expansion of pilot test of enhanced anaerobic biodegradation of dissolved phase contaminants, and installation and operation of a dual-phase extraction (DPE) system and water treatment system.

II. Site Characteristics

The Willow Run Company Vehicle Operations (CVO) facility is a site at which GM previously stored, processed, and maintained GM-owned vehicles. It encompasses 22 acres. Of concern is the man-made Tyler Pond on the northern edge of the site. Historical operations included waste dumping and general filling along the edges of Tyler Pond, particularly in the vicinity of the area now called PAOC 18 at which a significant quantity of DNAPL has been located in the subsurface.

The majority of the property is now paved or covered by structures. The paved areas and building roofs drain to the storm water sewer system, which flows into Tyler Pond through a series of outfalls. Surface water runoff from much of the surrounding area also flows to Willow Run Creek and Tyler Pond.

The general overburden at the Site consists of four basic units, proceeding downward from land surface:

- Surficial fill unit - 0 to 11.5 ft thick;
- Upper sand unit – 8 to 15 ft thick;
- Lacustrine clay unit – 50 to 85 ft thick; and
- Lower sand unit – 8 to 28 ft thick.

The upper sand unit contains limited groundwater that is typically encountered in unconfined conditions at very shallow depths (i.e., 8 to 10 feet). The horizontal hydraulic gradient of groundwater in the upper sand unit is relatively flat. Hydraulic conductivities range from 2.52 x 10^{-5} centimeters per second (cm/s) to1.21 x 10^{-2} cm/s. MDEQ does not consider the upper sand unit at CVO to be in an aquifer (i.e., groundwater not in an aquifer).

III. Proposed Alternative Green Remedy

Purpose and Objectives

The purpose of the remedial solution proposed herein is to provide an alternative green remedy for some portion of the site's environmental issues that will reduce the overall costs for meeting the long-term requirements. This objective can most readily be met by reducing the costs associated with the long-term extraction and treatment of groundwater.

Description of Technology

The two primary environmental issues at Willow Run – CVO are the presence of DNAPL adjacent to Tyler Pond (PAOC 18) and the site-wide groundwater plume discharging to the surface water of Tyler Pond (PAOC 19). The proposed alternative green remedy incorporates the use of emulsified zero-valent iron (EZVI) to destroy the DNAPL in situ and the planting of an *ENGINEERED_PHYTOREMEDIATION*℠ buffer strip along the perimeter of the site to hydraulically control the contaminated groundwater. Both EZVI and *ENGINEERED_PHYTOREMEDIATION*℠ would work very effectively in conjunction with the current in situ bioremediation/monitored natural attenuation remedy existing at the site.

Previous investigations have delineated an irregular-shaped area of DNAPL in PAOC 18, approximately 165-ft long by 60-ft wide. The DNAPL in this area has been measured to have a thickness up to 1.2 ft lying on top of the clay at approximately 15 to 20 ft bgs. Within this area,

EZVI could be injected into the 2-ft to 3-ft interval above the clay at 50% to 100% pore space saturation (where a measurable thickness of DNAPL has been observed). Above this, it would be injected at 10% pore space saturation. The estimated volume of EZVI required to treat this area is 50,000 gallons. Proper injection sequence of EZVI may eliminate the need for additional sheet pile wall to contain the DNAPL.

In addition to the EZVI, an *ENGINEERED_PHYTOREMEDIATION*℠ buffer strip would be planted along the northern boundary along Tyler Pond and along the southern boundary along Tyler Road. Phreatophytic trees such as willows or poplars would be planted using *TreeWell*® units to inhibit the migration of contaminants in groundwater to Tyler Pond and off-site to the south. Five hundred *TreeWell*® units would be installed at 20-ft spacing over 2.5 acres, approximately 2,000 ft by 50 ft.

Description of Monitoring Program

The monitoring requirements for the phytoremediation remedy consist of a standard groundwater monitoring program (hydraulics and groundwater quality) with semi-annual assessments of tree health during the initial five years of implementation.

Although trees use water during the initial growing season, full hydraulic effects of the trees are expected 3 to 5 years after planting. Although early stages of contaminant reduction are often observed within the first two growing seasons, concentration trends of site contaminants due to phytoremediation are typically more demonstrable and quantifiable between years three and ten of the monitoring program.

Term of Operation

The phytoremediation system would be designed, implemented, and maintained to operate in perpetuity. Once regulatory objectives are achieved, the phytoremediation system can be left in place or easily removed using inexpensive methods. Tree waste from phytoremediation systems can be reused, destroyed, or transported to a construction waste landfill for disposal.

EZVI begins destroying DNAPL immediately and with significant measurable reductions of contaminants within six months.

Advantages and Disadvantages

Advantages

EZVI

- No on-going maintenance requirements;
- Has been proven to destroy DNAPL;
- No disposal costs;
- Non-hazardous material;
- Also supplies carbon for biological degradation of chlorinated solvents; and
- Does not require on-site activation for chemical reaction.

ENGINEERED_PHYTOREMEDIATION℠

The principal advantage of the phytoremediation system is its simplicity and low operation and maintenance costs. Once the tree growth is established, there is very little to do to maintain the system. Advantages associated with phytoremediation systems include the following:

- Reduced long-term cost of ownership due to:
  a. No external energy inputs required during operation;
  b. No operation requirements;
  c. Low maintenance requirements;
- Pumping capacity is spread out over many natural pumping units;
- Effectiveness of technology has been demonstrated at many environmental sites under various conditions by numerous regulatory agencies;
- In addition to creating desired hydraulic effects, can effectively reduce contamination in situ;
- Utilizes standard groundwater monitoring programs; and
- Eliminates monitoring of permitted discharges.

Disadvantages

EZVI

- Requires special injection equipment and techniques to achieve large radius of influence.

ENGINEERED_PHYTOREMEDIATION℠

- The cover area can be so great that the property cannot be used for anything else until remediation is successful;
- Average of 3- to 5-year lag time until full hydraulic effects of trees likely to be observed;
- Does not eliminate groundwater monitoring downgradient outside barrier wall; and
- More trees will need to be planted to compensate for the limited growing season.

IV. Regulatory Outlook

MDEQ currently is the lead agency for the Site. There is no formal agreement with MDEQ or other agency regarding the investigation and remediation of the Site. GM currently is performing investigation and remediation work at the Site on a voluntary basis. If and when a formal agreement with MDEQ or other agency is developed, then the proposed investigation and remediation work at the Site and related timeframes may change.

Although not presently under active evaluation by MDEQ or other agencies, potential natural resource damage claims may be brought with respect to Tyler Pond, Willow Run Creek and additional downstream water bodies.

V. GSR Comparison

	Proposed Remedy	Alternative
Technology	Pump and dispose DNAPL & Dual-phase extraction of groundwater	EZVI treatment of DNAPL & Phytoremediation of groundwater
Energy Inputs		
Materials	High – manufacturing of pumps, piping, and treatment chemicals	Low – growing trees, manufacturing of root sleeve and boot, fertilizer, EZVI
Installation	Moderate	Moderate
O&M	High – electricity to run system	Low
Waste Generation	Waste from treatment process Discharge of treated water to sewer	None other than vegetative matter
Effectiveness	Effective	Effective
CO2 sequestration	None	Sequesters carbon in trees
Land and Ecosystem Impacts	Neutral compared to existing system in place	Positive impact on ecosystem
Air Emissions	Depends upon power source Possible air emissions from DPE system and incineration of DNAPL	No emissions, positive effect on ambient air quality
Maintenance	High – requires constant O&M	Low – Once established, system is essentially self-sustaining
Risk Reduction	Risk reduction only through containment of contaminants	Risk reduction through containment and destruction of contaminants
Site Reuse	Possible, maybe constrained by DPE system	Possible, trees provide natural habitat if left in place or may be removed if site redeveloped
Water usage	Does not require additional water inputs	Engineered phytoremediation system does not require additional water inputs
Natural Processes Utilization	Does not use natural processes	Utilizes all natural processes
Renewable Resources	Not renewable	Trees are renewable, vegetable oil is renewable

Reduction/destruction of contaminant mass	Does not reduce contaminants other than in extracted water transferred to other media. Incineration destroys contaminant but may generate other byproducts	Potential to stimulate in situ degradation of contaminants. EZVI destroys CVOC in situ with no hazardous by-products

VI. Costs

Capital Costs

The estimated capital cost for the course of action recommended here is $2,000,000, broken out as follows.

- EZVI for DNAPL destruction $1,500,000
- Plant 500 *ENGINEERED_PHYTOREMEDIATION*℠ trees $500,000

O&M/Monitoring Costs

There would still be monitoring required for the groundwater ($50,000/yr through 2032). Costs associated with other PAOCS (23 and 24) remain the same.

Potential Savings

The estimated cost savings would be approximately $3,000,000.

VII. Conclusions

The two primary environmental issues at Willow Run – CVO are the presence of DNAPL adjacent to Tyler Pond (PAOC 18) and the site-wide groundwater plume discharging to the surface water of Tyler Pond (PAOC 19). The proposed alternative green remedy incorporates the use of EZVI to destroy the DNAPL in situ and the planting of an *ENGINEERED_PHYTOREMEDIATION*℠ buffer strip along the perimeter of the site to hydraulically control the contaminated groundwater. Both EZVI and *ENGINEERED_PHYTOREMEDIATION*℠ will work very effectively in conjunction with the current in-situ bioremediation/monitored natural attenuation remedy existing at the site.

1. Our recommendation would be to:

    a. Inject approximately 50,000 gal of EZVI for DNAPL destruction ($1,500,000); and

    b. Plant 500 trees for hydraulic control ($500,000).

2. Assuming that on-going monitoring of the groundwater ($50,000/yr through 2032), and costs associated with other PAOCS (23 and 24) remain the same; the estimated cost savings would be approximately $3,000,000 (which includes elimination of $2.5 million proposed for a dual-phased extraction system for dissolved phase constituent migration to Tyler Pond.)