COST AND PERFORMANCE REPORT

Molasses Injection at the Avco Lycoming Superfund Site,
Williamsport, Pennsylvania

March 2000

EPA
U.S. Environmental Protection Agency
Office of Solid Waste and Emergency Response
Technology Innovation Office

Molasses Injection at the Avco Lycoming Superfund Site,
Williamsport, Pennsylvania

Summary Information [1-6]

Site Name, Location	Avco Lycoming Superfund Site, Williamsport, Pennsylvania
EPA ID Number	PAD003053709
Mechanism(s)	Anaerobic Reductive Dechlorination (Cometabolic and Direct)
Technology	Electron Donor Addition (Molasses)
Configuration	Direct Injection
Technology Scale	Pilot and Full-scale
Media/Matrix Treated	Groundwater
Contaminants Targeted	TCE, DCE, VC, hexavalent chromium, cadmium
Period of Operation	Pilot study October 1995 to March 1996; Full-scale system ongoing, data available from January 1997 to July 1998

Site History/Source of Contamination [1,6,7,8]

The Avco Lycoming Superfund site (Lycoming) is a 28-acre facility located in Williamsport, Pennsylvania. Since 1929, various manufacturing companies have operated at the site, including a bicycle and sewing machine plant, a sandpaper plant, a tool and die shop, a silk plant, and an aircraft engine plant, that is currently operating at the site. Past waste handling practices, including disposal of wastes in a dry well and coolant well, spillage and dumping of wastes from metal plating areas, and storing sludge in a holding lagoon, resulted in soil and groundwater contamination at the site.

In the mid-1980's, the state identified the Lycoming site as the source of volatile organic compound (VOC) contamination in the local municipal water authority well field located 3,000 ft south of the site. Contaminants include trichloroethene (TCE) and trans-1,2-dichloroethene (DCE), and metals, including hexavalent chromium and cadmium. A pump and treat system was installed at the site in the late 1980's to remediate on-site and off-site groundwater contamination. The Lycoming site was placed on the National Priority List on February 21, 1990, and a Record of Decision (ROD) was issued for this site in June 1991 requiring pump and treat for the shallow groundwater beneath the facility property, followed by discharge to a nearby stream. Design of this system was suspended pending resolution of a permit for the discharge.

In May 1995, the potentially responsible party (PRP) proposed an alternative for remediating the shallow groundwater that involved using an in situ bioremediation system that included molasses injection and air sparging/soil vapor extraction (SVE). Pilot studies were conducted from October 1995 to June 1996. A

new ROD was issued in December 1996 replacing the pump and treat with an in situ remedy. A full-scale molasses injection system was installed and has been operating at the site since January 1997.

Although the air sparging/SVE system was pilot tested, and construction of a full-scale system begun in October 1997, construction was suspended in the Spring of 1998, due to higher than anticipated water levels at the site. The PRP is planning to submit a new proposal to EPA for remediation of the organic-contaminated groundwater at the site. Therefore, this case study focuses on the molasses injection technology.

Geology/Hydrogeology/Contaminant Characterization [1, 3]

Site geology consists of a sandy silt overburden overlying a fractured bedrock and a fractured limestone. The target area for the in situ treatment is the shallow overburden to approximately 25 ft below ground surface (bgs), and covers approximately two acres. The maximum concentrations measured in this area in late 1996 were TCE, 0.7 mg/L, hexavalent chromium, 3 mg/L, and cadmium, 0.8 mg/L.

Matrix Characteristics at Lycoming Superfund Site [1,3,8]

Parameter	Value
Soil Type	Sandy silt
Depth to Groundwater	10 to 15 ft bgs
Thickness of Aquifer	10 to 12 ft
Fraction of Organic Carbon	Not available
DNAPL Presence	Not identified
Hydraulic Conductivity	0.2 to 24 ft/day
Groundwater Velocity	0.02 to 2.3 ft/day

Technology Description [1,7,8]

Pilot Study. The molasses pilot study was conducted from November 1995 to June 1996. In the pilot study, an in situ reactive zone was created to reduce groundwater concentrations of hexavalent chromium and cadmium. Monitoring data showed that chromium concentrations were reduced from 7 mg/L to less than 0.05 mg/L in the test zone, and that the technology also created conditions needed to reductively dechlorinate the CAHs. For example, during the pilot study, redox conditions were shown to be strongly reducing, at less than -300mV. The air sparging/SVE pilot system took place from October 1995 to May 1996.

Full-scale System. The full-scale molasses injection system, a proprietary technology owned by ARCADIS Geraghty & Miller, was constructed in late 1996 and began operating in January 1997. As shown in Figure 1, the molasses injection system consists of 20 four-inch diameter injection wells, ranging in depth from 19 to 30 ft, completed in the overburden. Each well is connected to a 10 ft square treatment building by 3/4-inch diameter piping. Molasses is added two times each day at variable concentrations and rates based on the results from system monitoring. Figure 2 shows the monitoring wells network at the site. A programmable logic controller monitors and controls the feed rate and frequency of substrate addition. Table 1 summarizes the operating parameters for this system.

Figure 1: Molasses Injection System Used at Lycoming Superfund Site [2]

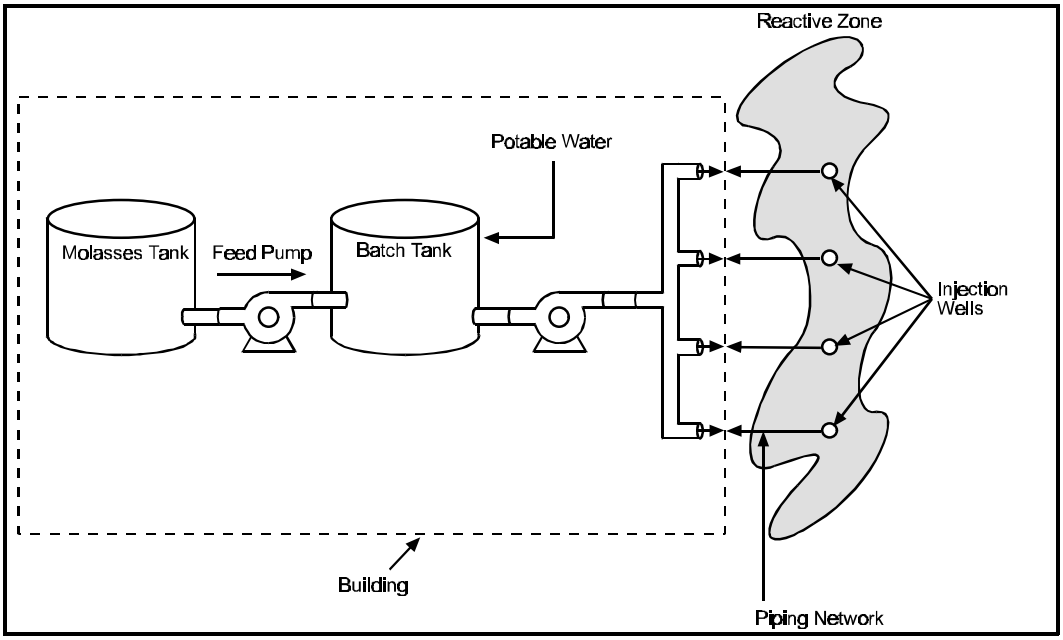


Figure 2: Monitoring Well Network at the Site [7]

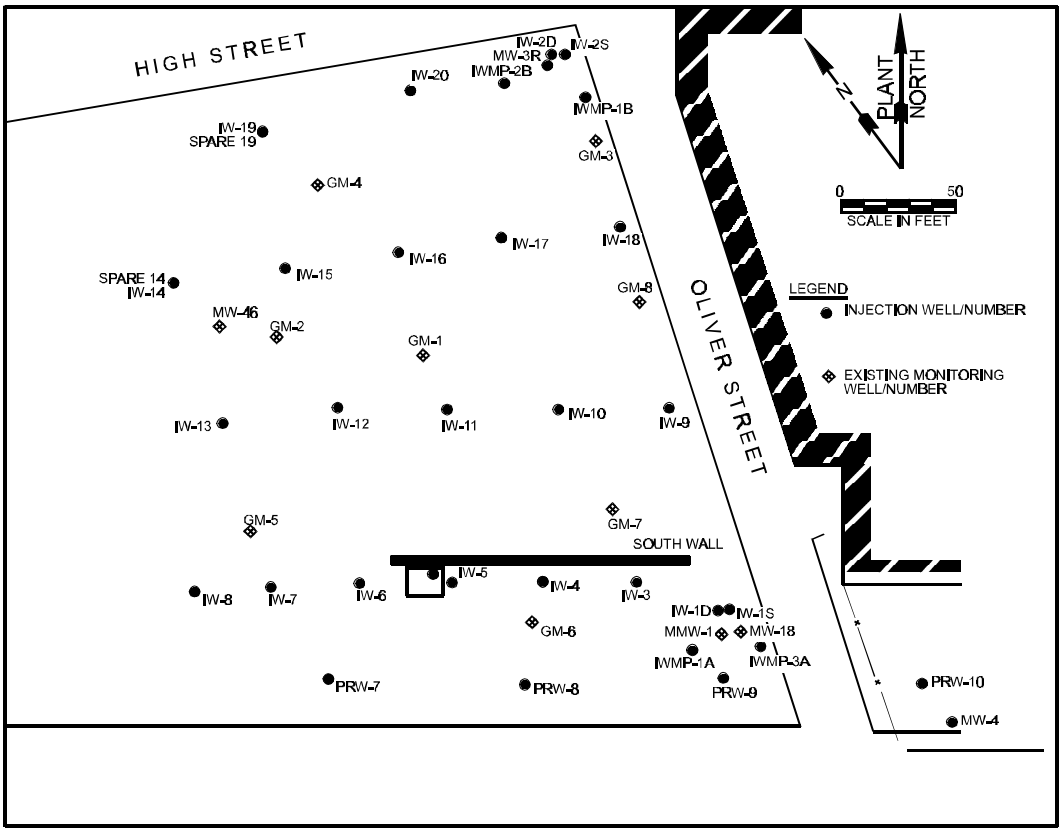


Table 1. Operating Parameters Used at Lycoming Superfund Site [1]

Operating Parameter	Value
Substrate (molasses) addition	Not provided
Redox potential	< -300mV

Technology Performance [7, 8]

The 1996 ROD specified the following cleanup goals for groundwater: TCE (5 ug/L), 1,2-DCE (70 ug/L), VC (2 ug/L), cadmium (3 ug/L), hexavalent chromium (32 ug/L0, and manganese (50 ug/L).

Groundwater monitoring data are available for January 1997 to July 1998. Samples were collected from 16 wells, (GM-1 through GM-8; MW-3R, 4, 18,and 46; and PRW-7, 8, 9, and 10), as shown on Figure 1. Figures 3 and 4 show the geochemical conditions of the groundwater in January 1997 and July 1998, respectively, using the following indicator parameters - redox potential, sulfide, and total organic carbon (TOC). The January 1997 results, collected prior to initiation of mollasses injections, were used as the baseline conditions. The data showed that anaerobic and reducing conditions were present only near two of the site monitoring wells (GM-3 and MW-18) located near the northeastern and southeastern corners of the site.

Data collected in July 1998 (Figure 4) show that the redox levels have decreased to anaerobic conditions in many of the wells that had previously indicated an aerobic environment, indicating that anaerobic and reducing conditions have been expanded to include a majority of the eastern portion of the treatment area. The presence of sulfide, the reduced product of sulfate, indicated that conditions were sufficient to promote reductive dechlorination of chlorinated aliphatic hydrocarbons. Concentrations of TOC also were increased in the treatment area. (DO data collected during the study were not collected using a flow-through cell. The PRP contractor reported that these data were believed to be significantly biased high, however, no additional information was provided).

As of July 1998, concentrations of TCE, DCE, and hexavalent chromium have been reduced to below than their cleanup goals in many of the monitoring wells at the site. Concentrations of hexavalent chromium been reduced by more than 99% from 1,950 ug/L to 10 ug/L. Figure 5 presents the results of analyses for TCE, DCE, and VC between January 1997 and July 1998 for monitoring well GM-7, which is located near the South Wall and within an area that was converted from aerobic to anaerobic during the first 18 months of treatment. As shown on Figure 5, the concentration of TCE was reduced by 90% from 67 ug/L to 6.7 ug/L. The concentration of DCE initially increased from 7 ug/L to 100 ug/L after 10 months of treatment, indicating the successful dechlorination of TCE, then decreased to 19 ug/L by July 1998. Similarly, the initial concentration of VC increased from below the detection limit of <1 ug/L to 5 ug/L after 10 months of treatment, then decreased to below the detection limit by July 1998.

While specific information about the analytical methods or data quality were not provided in the available references, no exceptions to the quality assurance/quality control (QA/QC) protocols were noted.

Figure 3: Distribution of Groundwater Indicator Parameters, Baseline Conditions, January 1997 [28]

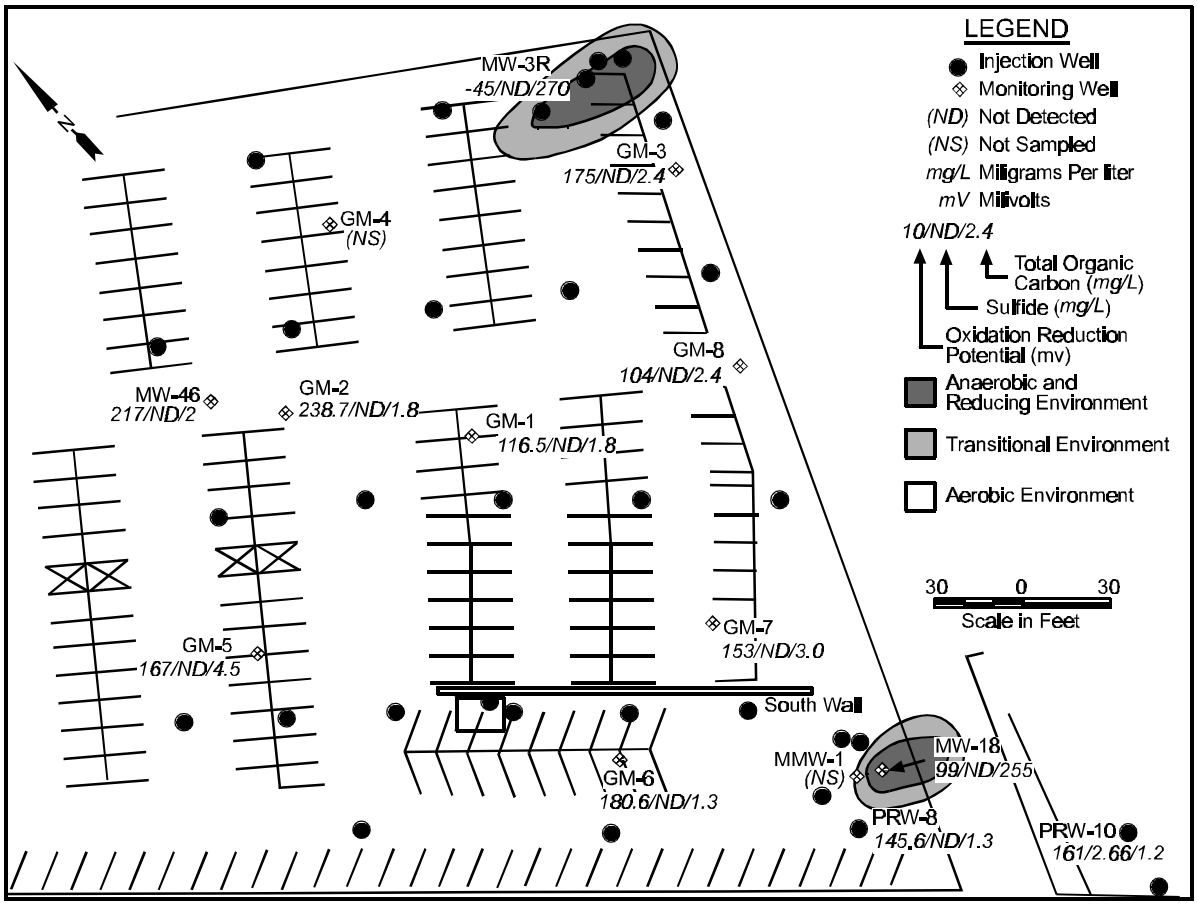


Figure 4: Distribution of Groundwater Indicator Parameters, Reactive Zone Established, July 1998 [8]

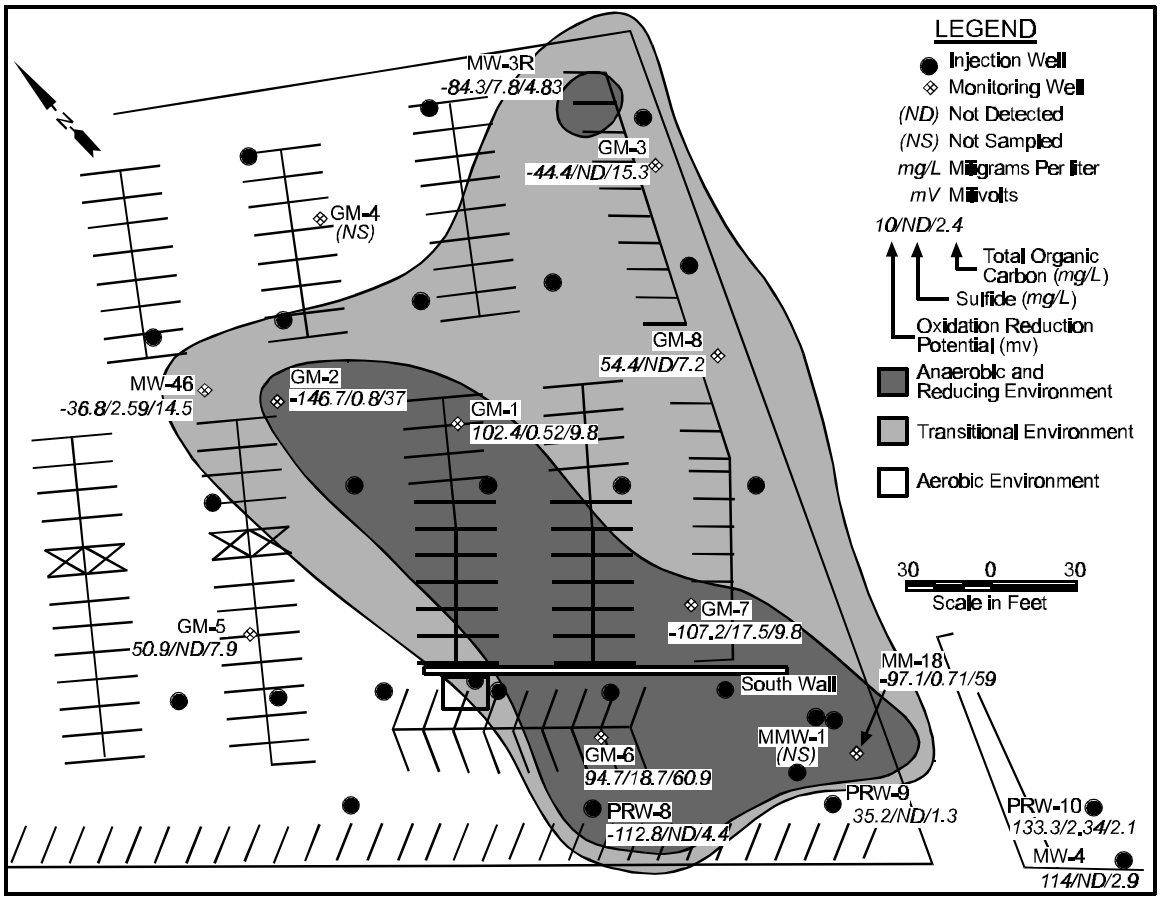
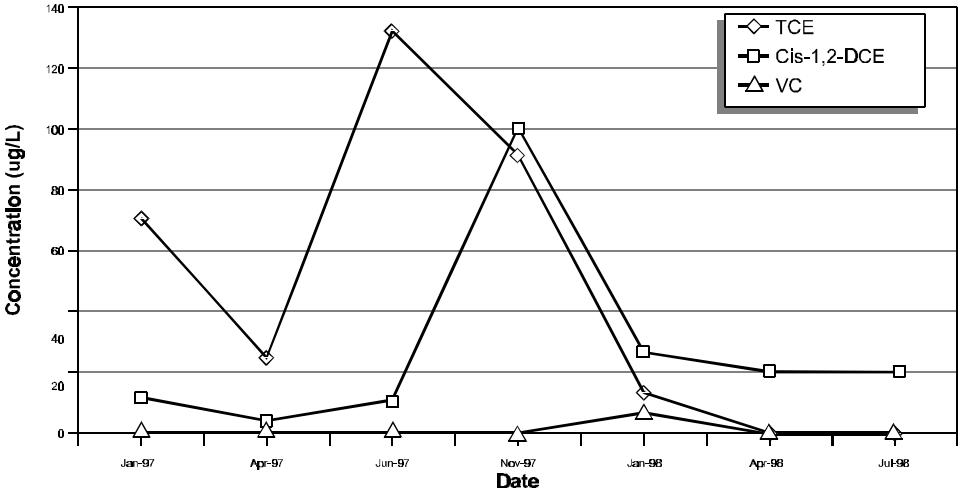


Figure 5: Analytical Results for Well GM-7 at Lycoming Superfund Site [8] (January 1997 to July 1998)



Technology Cost [3,8]

ARCADIS Geraghty & Miller, Inc. reported project costs for the full-scale molasses injection system at the Lycoming site to be about $220,000 for construction and about $50,000 per year for operation and maintenance. The cost for the pilot study at this site, including preparation of a work plan, was about $145,000.

Summary Observations and Lessons Learned [1, 3]

The use of molasses injection was shown to create an anaerobic reactive zone within an 18-month period, with concentrations of TCE, DCE, and hexavalent chromium reduced to below the cleanup goals in many of the wells.

This was one of the earliest full-scale applications of this technology at a Superfund site. According to ARCADIS Geraghty & Miller, this technology was shown to save substantial resources when compared to pump and treat.

The pilot study demonstrated the ability of the technology to create strongly reducing redox conditions and to reduce concentrations of chlorinated aliphatic hydrocarbons and hexavalent chromium. The results of the pilot study were used in the design and operation of the technology on a full-scale basis at the site.

Contact Information

EPA RPM:
Eugene Dennis
U.S. EPA Region 3
1650 Arch Street (3HS21)
Philadelphia, PA 19103-2029
(215) 814- 3202
E-mail: dennis.eugene@epa.gov

PRP Contractor:

Daniel L. Jacobs
ARCADIS Geraghty & Miller, Inc.
3000 Cabot Boulevard, West, Suite 3004
Langhorne, PA 19047
Telephone: (215) 752-6840
Fax: (215) 752-6879
E-mail: djacobs@gmgw.com

References:

1. Nyer, Evan, Frank Lenzo, and Jeffery Burdick, ARCADIS Geraghty & Miller, Inc. 1998. In Situ Reactive Zones: Dehalogenation of Chlorinated Hydrocarbons. Groundwater Monitoring Review. Spring.

2. ARCADIS Geraghty & Miller, Inc. Slides (2A and 2B) on Case Studies for Natural and Enhanced Reductive Dechlorination for Groundwater Remediation. Not Dated.

3. ARCADIS Geraghty & Miller, Inc. Enhanced Reductive Dechlorination Through Reactive Zones (Site 2 - Metal Manufacturing and Plating Site). Not Dated.

4. U.S. EPA. 1990. NPL Site Narrative at Listing. Avco Lycoming (Williamsport Division). February 21.

5. U.S. EPA. 1991. Record of Decision (ROD) Abstract. ROD Number: EPA/ROD/R03-91/112. In Situ Metals Treatment; Williamsport, PA. June 28.

6. U.S. EPA. 1998. General Site Information. Avco Lycoming (Williamsport Division). February.

7. Eugene Dennis, U.S. EPA RPM. 1999. Comments on Draft Case Study Report. January 27.

8. Fax Transmittal from Dan Jacobs, ARCADIS Geraghty & Miller, to Dawn Carroll, U.S. EPA. 1999. Comments on Draft Case Study Report. February 9.