Site: Distler Brickyard
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Five-Year Review Report

Third Five-Year Review Report
for
Distler Brickyard

West Point
Hardin County, Kentucky

September 2008

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9/26/08

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Third Five-Year Review Report
for
Distler Brickyard
U.S. Highways 31 & 60
West Point
Hardin County, Kentucky

List of Acronyms 3

Executive Summary 4

Five-Year Review Summary Form 8

1.0 Introduction 10

2.0 Site Chronology 12

3.0 Background 13

3.1 PHYSICAL CHARACTERISTICS 13
3.2 LAND AND RESOURCE USE 13
3.3 HISTORY OF CONTAMINATION 17
3.4 INITIAL RESPONSE 17
3.5 BASIS FOR TAKING ACTION 18

4.0 Remedial Actions 19

4.1 REMEDY SELECTION 19
4.2 REMEDY IMPLEMENTATION 21
4.3 OPERATION AND MAINTENANCE (O&M) 25

5.0 Progress Since the Last Five-Year Review 26

5.1 CONTINUED MONITORING 27
5.2 FUNDING 27
5.3 OVERSIGHT 27
5.4 RESULTS OF BIOREMEDIATION 27

6.0 Five-Year Review Process 29

6.1 ADMINISTRATIVE COMPONENTS 29
6.2 COMMUNITY INVOLVEMENT 29
6.3 DOCUMENT REVIEW 29
6.4 DATA REVIEW 31
6.5 SITE INSPECTION 34
6.6 INTERVIEWS 35

7.0 Technical Assessment 37

7.1 QUESTION A: IS THE REMEDY FUNCTIONING AS INTENDED BY THE DECISION DOCUMENTS? 37
7.2 QUESTION B: ARE THE EXPOSURE ASSUMPTIONS, TOXICITY DATA, CLEANUP LEVELS, AND REMEDIAL ACTION OBJECTIVES (RAOS) USED AT THE TIME OF REMEDY SELECTION STILL VALID? 37

7.3 QUESTION C: HAS ANY OTHER INFORMATION COME TO LIGHT THAT COULD CALL INTO QUESTION THE PROTECTIVENESS OF THE REMEDY? 38
7.4 TECHNICAL ASSESSMENT SUMMARY 39

8.0 Issues 40

9.0 Recommendations and Follow-up Actions 41

10.0 Protectiveness Statements 43

11.0 Next Review 44

Appendix A: List of Documents Reviewed .... A-Error! Bookmark not defined.

Appendix B: Press Notices .... B-Error! Bookmark not defined.

Appendix C: Sample Interview Questions .... C-Error! Bookmark not defined.

Appendix D: Site Inspection Checklist .... D-Error! Bookmark not defined.

Appendix E: Photographs from Distler Brickyard Site Inspection VisitE-Error! Bookmark not defined.

Appendix F: North Wind Report: Bioremediation of Chlorinated Solvents in Variably Saturated, Low Permeability Soils .... F-Error! Bookmark not defined.

Appendix G: Operation and Maintenance Manual .... G-Error! Bookmark not defined.

Appendix H: May 2007 Ground Water Sampling Results . H-Error! Bookmark not defined.

Tables

Table A: ESD Health-Based Ground Water COC MCLs 5
Table B: Allowable Soil Concentrations from ESD 5
Table 1: Chronology of Site Events 12
Figure 1: Location Map for the Distler Brickyard Superfund Site 15
Figure 2: Detailed Map of Distler Brickyard Superfund Site 16
Table 2: Contaminants of Concern in Soil and Ground Water 18
Table 3: ESD Health-Based Ground Water COC MCLs 20
Table 4: Allowable Soil Concentrations from ESD 21
Table 5: Progress on Recommendations from the 2003 FYR 26
Table 6: Previous and Current MCLs for Ground Water COCs 31
Table 7: 1995-1998 and 2007 Ground Water COC Sampling Data 32
Table 8: May 2007 Ground Water Sampling Contaminant Detection Results 33
Table 9: 1988 Cleanup Goals versus 2008 SSLs for Soil COCs 34
Table 10: Distler Brickyard Deed Documents 35
Table 11: 1988 Cleanup Goals versus 2008 SSLs for Soil COCs 38
Table 12: Current Issues for the Distler Brickyard Site 40
Table 13: Recommendations to Address Current Issues at Distler Brickyard Site 41

Figures

Figure 1: Location Map for the Distler Brickyard Superfund Site 15

Figure 2: Detailed Map of Distler Brickyard Superfund Site... 16

List of Acronyms

ARARs	Applicable or Relevant and Appropriate Requirements
ASC	Allowable Soil Concentrations
ATSDR	Agency for Toxic Substances and Disease Registry
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CGA	Coarse Grained Alluvium
COCs	Contaminants of Concern
DAF	Dilution Attenuation Factor
EPA	U.S. Environmental Protection Agency
ESD	Explanation of Significant Differences
FGA	Fine Grained Alluvium
IEUBK	Integrated Exposure-Uptake Biokinetic Model
INEEL	Idaho National Engineering and Environmental Laboratory
KDEP	Kentucky Department for Environmental Protection
KNREPC	Kentucky Natural Resources and Environmental Protection Cabinet
LTRA	Long-Term Remedial Action
MCL	Maximum Contaminant Level
mg/kg	milligrams per kilogram
µg/L	micrograms per liter
MW	Monitoring Well
NCP	National Contingency Plan
NPL	National Priorities List
NSF	National Science Foundation
O&M	Operation and Maintenance
OU	Operable unit
ppb	parts per billion
RD	Remedial Design
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SSLs	Soil Screening Levels
TBCs	To-Be-Considered Criteria
USGS	United States Geological Survey
VOCs	Volatile Organic Compounds

Executive Summary

Introduction

The remedy for the Distler Brickyard Site (the Site) in West Point, Kentucky included the excavation and removal of contaminated soil; disposal of contaminated soil at a permitted hazardous waste landfill; backfilling of the excavated areas with clean soil; grading; revegetation; extraction and on-site treatment of contaminated ground water and re-injection into the aquifer; ground water bioremediation; and Operation and Maintenance (O&M). The Commonwealth of Kentucky (the State) has been responsible for implementing O&M and Long-Term Remedial Action (LTRA) of the Site under a Superfund State Contract. The Site is approximately three acres in size and is a portion of a 70-acre farm. The triggering action for this Five-Year Review (FYR) was the signing of the previous FYR on September 29, 2003.

Remedial Action Objectives

On August 19, 1986 the U.S. Environmental Protection Agency (EPA) issued a Record of Decision (ROD) for the Site. The objectives in developing remedial actions (Remedial Action Objectives; RAOs) at the Site were as follows:

Surface Contamination

- control source;
- reduce concentration of contaminants;
- control potential migration of surface and subsurface contaminants resulting from contaminated soils;
- prevent or minimize surface erosion and consequent contaminant runoff, including environmental hazards associated with potential flooding of the Salt River, Ohio River, or both; and
- prevent, minimize, or eliminate the on-site potential for exposure by direct contact, the on-site potential for airborne releases, and the potential for contaminant migration by surface water pathways.

Ground Water Contamination

- manage contaminant migration;
- prevent increase in concentration of contaminants of concern (COCs);
- reduce concentrations of contaminants; and
- prevent or minimize further migration of contaminants (plume control).

In 1988, the ROD was modified by an Explanation of Significant Differences (ESD) for both the Distler Farm and Distler Brickyard Sites based on further soil studies conducted as part of the Remedial Design. To determine alternate cleanup levels, drinking water standards were utilized and a soil remediation study was prepared for the Site. Based on drinking water standards and the soil remediation study, EPA, with the concurrence of the State, changed the implementation of the remedies from what was originally outlined in the ROD to require excavation of soil and remediation of ground water to levels set by the following health-based criteria:

- Ground water will be remediated to the drinking water standards and the health-based Maximum Contaminant Levels (MCLs) in Table A.
- Soils will be excavated to the Allowable Soil Concentrations (ASCs) in Table B to ensure that no water leaching into the aquifer underlying the Site will exceed the health-based values given in Table A.

Table A: ESD Health-Based Ground Water COC MCLs

Contaminant of Concern	MCL in 1988 ESD (ppb)
Arsenic	50
Chromium	50
Lead	50
2-butanane	170
Trans-l, 2-dichloroethene	70
1,1,1-trichloroethane	200
Trichloroethylene	5
Benzene	5
Toluene	2,000
1,1-dichloroethylene	7
ppb=parts per billion	

Table B: Allowable Soil Concentrations from ESD

Contaminant of Concern	ASC in 1988 ESD (mg/kg)
Arsenic	208
Chromium	25,000
Lead	21,000
2-butanone	1.178
Trans-l, 2-dichloroethylene	11.966
1,1,1-trichloroethane	13.398
Trichloroethylene	0.716
Benzene	0.485
Toluene	803.880
1,1-dichloroethylene	1.471
mg/kg=milligrams per kilogram	

Technical Assessment

The remedy required in the ROD and ESD for this Site has been implemented. The decision documents established certain cleanup goals, some of which the remedy has attained: soils were excavated and removed from the Site; ground water was pumped, treated, and reinjected. In addition, attempts have been made to enhance natural attenuation of ground water COCs at the Site with some level of success (see pages 23-24). The Site seems to be in the process of being returned to use; the site inspection showed that the brick kilns and warehouse have been demolished. The Site was leased in 2007 for gas and oil exploration, though there are no current plans for wells on site. There have been changes in certain soil cleanup standards and ground water MCLs since the ESD was developed. Soil cleanup goals in the ESD were based on contaminants leaching into the ground water. Some of the original ASCs exceed current Region 4 Soil Screening Levels (SSLs). Ground water cleanup goals established in the ESD were appropriate relative to 2008 federal and Kentucky drinking water standards for all contaminants except arsenic, lead, and toluene.

The Site does not have institutional controls (ICs) restricting land and ground water use because ICs were not required in the ROD or the ESD. EPA should evaluate the Site to determine if ICs may be appropriate as ground water remediation has not been confirmed as complete; and the 2007 sampling event detected ground water contaminants that exceeded 2008 MCLs for certain compounds. EPA should also evaluate the possibility of land use restrictions as the original ASCs for chromium, trans-1,2-dichloroethylene, trichloroethylene, benzene, toluene, and 1,1-dichloroethylene were higher than current Region 4 SSLs, while ASCs for arsenic and 1,1,1-trichloroethane were less than current SSLs.

Ground water sampling has been inadequate since the 2003 FYR. The sampling events that did occur did not include all COCs. Consistent, scheduled ground water sampling events should be conducted to confirm current COC levels. Currently, no active ground water treatment is taking place. Confirmatory sampling previously recommended for the Site needs to be implemented to assess the completeness of the Site remedy.

Conclusion

The remedy at the Distler Brickyard Site protects human health and the environment in the short term because no one is consuming contaminated ground water and because contaminated soil was removed pursuant to site decision documents. In order for the Site to be protective in the long term, the following actions need to be taken:

- evaluate the Site to determine if ground water ICs would be appropriate until it is determined that ground water remediation is complete;
- evaluate the Site to determine if ICs would be appropriate to restrict land use to prevent future users or workers from coming into contact with soil contamination that may remain on site in surface or subsurface soils that exceed 2008 soil screening levels;
- perform ground water monitoring quarterly to verify COC levels and confirm completeness of remedy;

- continue ground water long-term remedial action or formally terminate remedial action using confirmatory sampling results; and
- secure unsecured wells.

Five-Year Review Summary Form

SITE IDENTIFICATION

Site name ***(from WasteLAN)*****: Distler Brickyard**

EPA ID ***(from WasteLAN)*****: KYD980602155**

Region: 4	**State: KY**	**City/County: Hardin County**

SITE STATUS

NPL status: ☒ Final ☐ Deleted ☐ Other (specify)

Remediation status (choose all that apply): ☐ Under Construction ☐ Operating ☒ Complete

Multiple OUs?* ☐ YES ☒ NO	**Construction completion date:** 01/11/1995

Has site been put into reuse? ☐ YES ☒ NO

REVIEW STATUS

Lead agency: ☒ EPA ☐ State ☐ Tribe ☐ Other Federal Agency

Author name: Kristin Winterson Sprinkle and Johnny Zimmerman-Ward (Reviewed by EPA)

Author title: Senior Associate and Associate	**Author affiliation: E^2 Inc.**

Review period**: October 2007 to August 2008

Date(s) of site inspection: November 14, 2007

Type of review:

☐ Post-SARA ☒ Pre-SARA ☐ NPL-Removal only
☐ Non-NPL Remedial Action Site ☐ NPL State/Tribe-lead
☐ Regional Discretion

Review number: ☐ 1 (first) ☐ 2 (second) ☒ 3 (third) ☐ Other (specify)

Triggering action:

☐ Actual RA Onsite Construction at OU# ☐ Actual RA Start at OU#
☐ Construction Completion ☒ Previous Five-Year Review Report
☐ Other (specify)

Triggering action date ***(from WasteLAN)*****:** 9/23/2003

Due date ***(five years after triggering action date)*****:** 09/23/2008

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* ["OU" refers to operable unit.]

** [Review period should correspond to the actual start and end dates of the Five-Year Review in WasteLAN.]

Five-Year Review Summary Form continued

Issues:
1) Ground water remediation has not been determined to be complete and the 2007 sampling event detected certain contaminants that exceed 2008 MCLs.
2) The ASCs established in the ESD for chromium, trans-1,2-dichloroethylene, trichloroethylene, benzene, toluene, and 1,1-dichloroethylene were higher than current Region 4 SSLs.
3) There are inadequate ground water sampling data.
4) Ground water cleanup goals have not been met for benzene and trichloroethylene and there is no active ground water remediation currently taking place.
5) There are unsecured ground water wells.
6) Pump houses and other structures are overgrown and collapsing.
7) Site documents are not available at local site repository.
8) Portions of the Site are overgrown.

Recommendations and Follow-up Actions:
1) Evaluate the Site to determine if ground water ICs may be appropriate.
2) Evaluate the Site to determine if ICs would be appropriate to restrict land use to prevent future users or workers from coming into contact with soil contamination that may remain on site in surface or subsurface soils that exceed 2008 soil screening levels.
3) Sample wells quarterly for all COCs as called for in the O&M plan and the 2003 FYR to verify contaminant cleanup.
4) Continue ground water long-term remedial action or formally terminate remedial action using confirmatory sampling results.
5) Secure unsecured ground water wells.
6) Properly abandon or repair pump houses and other structures.
7) Submit FYRs and other necessary site related documents to the local site repository.
8) Mow and maintain Site.

Protectiveness Statement(s):
The remedy at the Distler Brickyard Site protects human health and the environment in the short term because no one is consuming contaminated ground water and because contaminated soil was removed pursuant to site decision documents. In order for the Site to be protective in the long term, the following actions need to be taken:

- evaluate the Site to determine if ground water ICs would be appropriate until it is determined that ground water remediation is complete;
- evaluate the Site to determine if ICs would be appropriate to restrict land use to prevent future users or workers from coming into contact with soil contamination that may remain on site in surface or subsurface soils that exceed 2008 soil screening levels;
- perform ground water monitoring quarterly to verify COC levels and confirm completeness of remedy;
- continue ground water long-term remedial action or formally terminate remedial action using confirmatory sampling results; and
- secure unsecured wells.

Other Comments:
The brick kilns and warehouse have recently been demolished on the Site and the Site has been leased for gas and oil exploration. However, the lessee has indicated to EPA and the State that there are currently no plans to drill any wells on the Site.

Third Five-Year Review Report
for
Distler Brickyard Superfund Site

1.0 Introduction

The purpose of a Five-Year Review (FYR) is to evaluate the implementation and performance of a remedy in order to determine if the remedy will continue to be protective of human health and the environment. The methods, findings, and conclusions of FYRs are documented in FYR reports. In addition, FYR reports identify issues found during the review, if any, and document recommendations to address them.

The U.S. Environmental Protection Agency (EPA) prepares FYRs pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121 and the National Contingency Plan (NCP). CERCLA 121 states:

> "If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews."

EPA interpreted this requirement further in the NCP; 40 Code of Federal Regulations (CFR) Section 300.430(f)(4)(ii), which states:

> "If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such actions no less often than every five years after the initiation of the selected remedial action."

E^2 Inc., an EPA Region 4 contractor, conducted the FYR and prepared this report regarding the remedy implemented at the Distler Brickyard Site (the Site) in West Point, Hardin County, Kentucky. This FYR was conducted from October 2007 to August 2008. EPA and the Kentucky Department for Environmental Protection (KDEP) also supported the review of the Site. This report documents the results of that review.

This is the third FYR for the one Operable Unit (OU) at the Site. The triggering action for this policy review is the signature date of the previous FYR report on September 29, 2003. The two previous FYRs were conducted at the Site in September 1998 and September 2003 respectively. This review will be placed in the site files and the local repository for the Brickyard Site upon completion. The repository is located at the West Point City Hall, 509 Elm Street, West Point, Kentucky. This FYR is being conducted because contaminated ground water, which is being addressed in a Long-Term Remedial Action (LTRA), and contaminated soils have been left on site above levels that allow for unlimited use or unrestricted exposure. The next FYR will be required in September 2013.

2.0 Site Chronology

The following table lists the dates of important events for the Distler Brickyard Superfund Site.

Table 1: Chronology of Site Events

Event	Date
Kentucky officials discovered and inspected the Site	December 1976
EPA conducted emergency removal action at the Site	March-April 1982
EPA proposed Site for National Priorities List (NPL)	December 30, 1982
NPL listing was finalized	September 8, 1983
EPA began Remedial Investigation/Feasibility Study (RI/FS)	September 30, 1983
EPA began enforcement activities	December 1985
Proposed plan public meeting held	April 1986
RI/FS completed	August 1986
Record of Decision (ROD) signed	August, 19 1986
Remedial Design activities initiated	April 1987
Superfund-State Contract signed	September 28, 1988
Soil remediation began/Remedial construction started	September 1988
EPA issued Explanation of Significant Differences (ESD)	October 26, 1988
Ground water remedial action initiated	July 1989
Remedial action construction completed/LTRA started	September 1994
Interim Site Close-Out Report signed	January 11, 1995
United States Geological Survey (USGS) special monitoring services started	August 1995
Consent Decree issued	October 12, 1995
State-Lead-Fund-Financed Cooperative Agreement for LTRA signed	April 1, 1996
EPA issued first FYR	September 28, 1998
Technical support from EPA Las Vegas began	April 1999
Enhanced bioremediation pilot test conducted	October 2001-January 2002
Full-scale enhanced bioremediation construction conducted	April-May 2003
EPA issued second FYR	September 29, 2003
North Wind issued bioremediation report	April 2005
KDEP ground water sampling conducted	May 2007
Brick kilns and warehouse demolished	Summer 2007

3.0 Background

3.1 Physical Characteristics

The Distler Brickyard Site is located approximately 17 miles southwest of Louisville, just north of mile-marker 36 on the Dixie Highway, in the City of West Point in Hardin County, Kentucky (Figure 1). The Site is a portion of a 70-acre farm which is divided by Dixie Highway (U.S. Route 60/31 West), the western boundary of the Site. The Ohio River and Salt River confluence is approximately one mile northwest of the Site. Site elevations vary between 418 and 451 feet above sea level and portions of the 70-acre property are within the 10-year flood plain of the Ohio River. The property occupies county parcel number 136-00-00-027. The Dixie Highway runs north-south through the property. The portion of the property west of the Dixie Highway is undeveloped, while portions of the property east of the highway contain some improvements. An old county road bisects the eastern portion of the Site and Fort Hill Road, which leads to the top of Fort Hill, forming the northwestern boundary of the eastern portion of the Site. South of the Site is mostly undeveloped agricultural land and the town of West Point, Kentucky is north of the Site.

The three-acre Site contains the remains of five brick kilns, pump stations, and wells. The balance of the former waste storage facility is an open field covered with grass and shrubs, and the surrounding area is primarily forested. An Illinois Central Railroad track runs through the property parallel to the location of the former brick kilns. Several house foundations and an old barn are situated about 300 feet to the east of the railroad track. A dirt road runs from the area across the tracks to Dixie Highway. A chain-link fence with a gate at the dirt road parallels the highway and is the only barrier to the Site. Other boundaries of the Site are unsecured.

3.2 Land and Resource Use

The Site is an area of low lying grassland with a fair amount of forestation. Land in the area supports minimal agriculture and low density housing. The Site is situated in the Ohio River Valley; the river bank itself is approximately 0.2 miles northwest of the Site. The valley is narrow near the Site, but widens upstream. The great alluvial aquifer under the Ohio Valley is the principal natural resource of the region affected by the Site. Two distinct alluvial deposits form the aquifer. They are the Fine Grained Alluvium (FGA) and the Coarse Grained Alluvium (CGA), which overlie the Mississippian bedrock. The FGA mainly consists of silt and clay. Therefore, it is tight with low permeability. The CGA is directly below the FGA and is made up of sand and gravel. Therefore, it is significantly permeable.

The alluvial deposits in the Ohio Valley range from zero to 110 feet in thickness with varying degrees of productivity. Wells that encounter the CGA may yield as much as 1,000 gallons of water daily while those completed in the FGA may be negligibly productive. The Mississippian bedrock, consisting of limestone and shale, generally yields little or no water to wells.

Several domestic wells existed in the area when the Site was initially discovered and produced primarily from the CGA. Many of these wells have been abandoned over the years due to mechanical problems, availability of public water lines, or both. As part of the 2003 FYR, the State surveyed residences in the area and reported that the domestic wells previously sampled for site monitoring purposes were no longer available. Area homes now depend on public water supply.

The brick kilns and warehouse that were once on the Site have been demolished The Site was leased in 2007 by Pioneer Oil Company of Illinois for the purpose of exploration and exploitation of the oil and natural gas resources the property may contain. The lease is for three years or until hydrocarbons cease to be produced from the land. There are currently no plans to drill wells at the Site.

Figure 1: Location Map for the Distler Brickyard Superfund Site

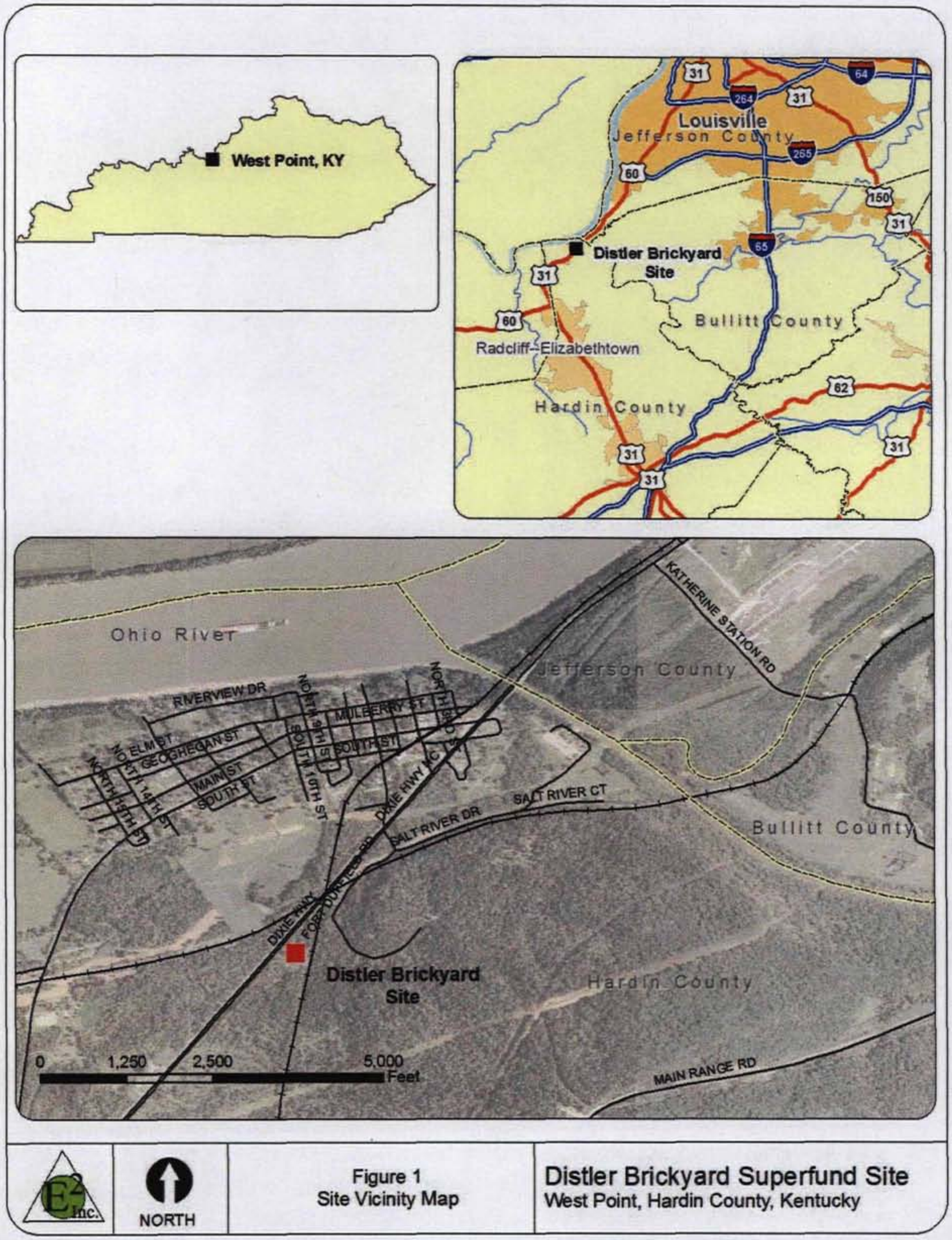
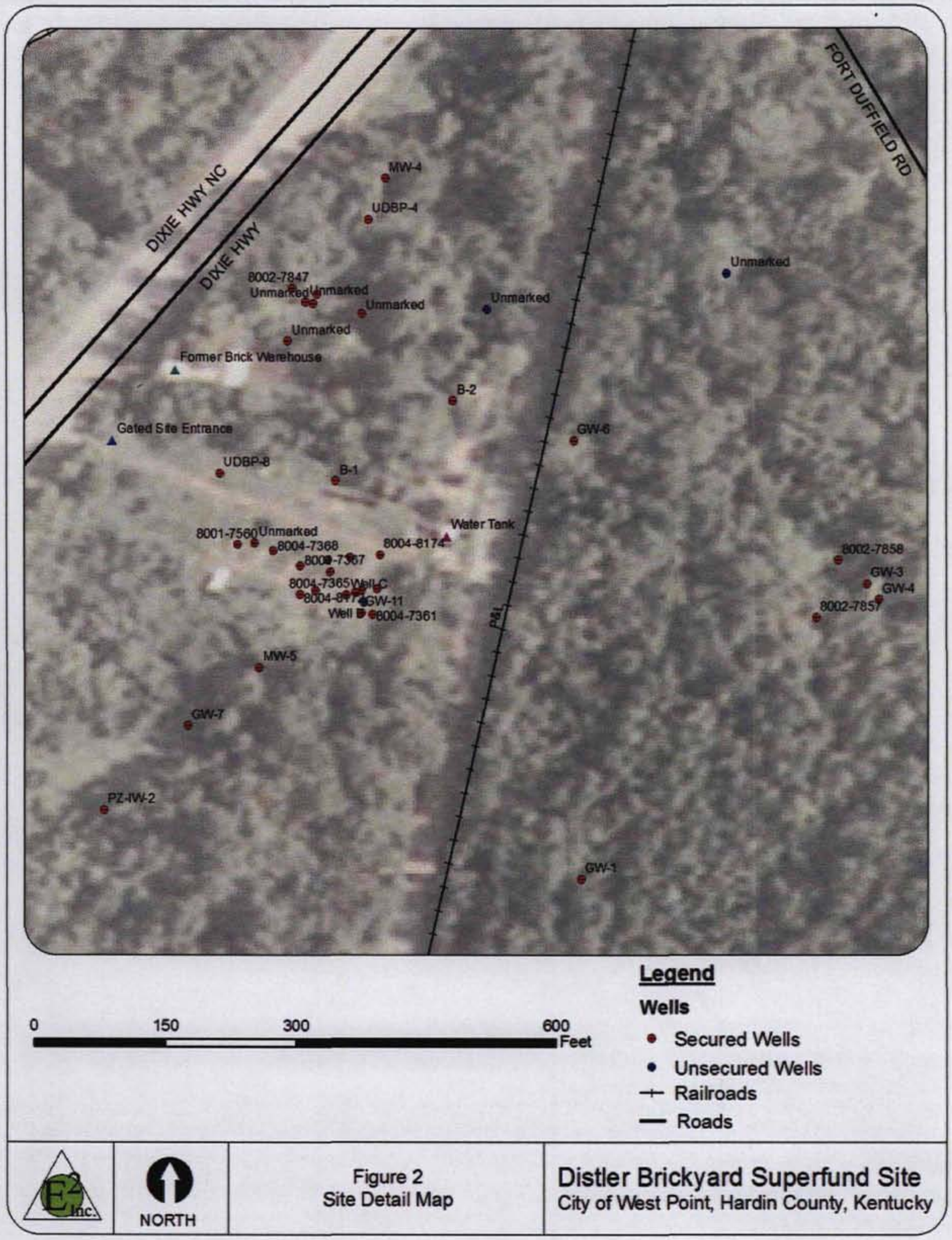


Figure 2: Detailed Map of Distler Brickyard Superfund Site



3.3 History of Contamination

The Site property was used as a brick manufacturing plant between 1950 and late 1976. Shortly after, Kentucky Liquid Recycling Inc., founded by Mr. Donald Distler, leased the property from the owner for use as a waste recycling and storage facility.

In late 1976, Mr. Distler attended a Kentucky Governor's Conference on the Environment and engaged in a general conversation with an employee of the Kentucky Bureau of Environmental Protection. During the conversation, Mr. Distler indicated that he was planning to build a hazardous waste incinerator in Kentucky and that he was already in business in the area collecting and storing hazardous waste. This led to a State investigation of Mr. Distler's activities and the discovery of the waste storage facility at the Brickyard location.

3.4 Initial Response

In early 1977, an enforcement action was initiated by the Kentucky Natural Resources and Environmental Protection Cabinet (KNREPC) against Mr. Distler. The Federal Bureau of Investigation, EPA, and KNREPC inspected the Site and found a significant number of drums containing waste stored on the property. Subsequently, approximately 30 of the drums were sampled and a restraining order was served to Mr. Distler prohibiting further use of the property for storage or disposal of industrial waste. A follow-up official visit to the property revealed that Mr. Distler did not immediately heed the order.

In August 1978, EPA reported the results of the initial field sampling and indicated that the sampled materials were toxic. KNREPC served an Order to Abate and Alleviate Operations on Mr. Distler in January 1979. This action prompted a partial removal of drummed wastes from the property and prevented further storage activities. Between January 1979 and December 1981, several additional orders were issued to Mr. Distler for further removal of waste from the facility. The orders were ignored. In December 1981, KNREPC requested EPA to initiate an emergency removal action at the property.

In March 1982, EPA removed approximately 2,300 drums of hazardous waste from the property. The drums were found to contain various liquids, sludge, and solids, which were sampled and described as toxic, corrosive, volatile, flammable, or a combination of these. Soils contaminated by leaking drums were also sampled and removed. Air quality monitoring and geophysical surveys to explore for buried drums were conducted. The results of these activities indicated no air quality problems, two possible areas of buried drums, and potential ground water contamination due to spills and leaking drums. Additional investigations were conducted in 1982 to confirm the nature of soil contamination and to delineate the extent of possible ground water contamination. Results of these investigations were used to support placing the Site on the National Priorities List (NPL) in 1983.

3.5 Basis for Taking Action

The Remedial Investigation (RI) report, which was completed in 1986, confirmed soil and ground water contamination. The contaminants of concern (COCs) found in the ground water and the soil within the site boundaries are shown in Table 2.

Table 2: Contaminants of Concern in Soil and Ground Water

Contaminant of Concern	Media
Arsenic	Ground Water and Soil
Chromium	Ground Water and Soil
Lead	Ground Water and Soil
Benzene	Ground Water
Bis(2-ethylhexyl)phthalate	Ground Water and Soil
2-Butanone	Ground Water and Soil
1,1-Dichloroethene	Ground Water
Naphthalene	Ground Water and Soil
Toluene	Ground Water and Soil
Trans-1,2-dichloroethene	Ground Water
Trichloroethylene	Ground Water and Soil
1,1,1-Trichloroethane	Ground Water

Based on the RI results, EPA concluded that the COCs were confined to the Site, but that hydrogeologic information suggested that the contaminants were likely to migrate off site with time. Consequently, a Feasibility Study (FS) was conducted between 1985 and 1986 to determine necessary remedial measures.

An Agency for Toxic Substances and Disease Registry (ATSDR) November 22, 1988 Health Assessment of the Site found that the following potential human exposure pathways existed:

- ingestion, inhalation, and dermal contact with contaminated soils;
- ingestion, inhalation, and dermal contact with contaminated ground water;
- ingestion and dermal contact of contaminated sediments; and
- ingestion of contaminated biota.

4.0 Remedial Actions

A number of remedial action alternatives were considered for the Distler Brickyard Site and final remedy selection was made in the 1986 Record of Decision (ROD). An initial screening of applicable alternative technologies was performed to select those which best met the criteria specified in section 300.68 of the NCP. Following initial screening of technologies, potential remedial action alternatives were identified and analyzed. These alternatives were screened and the most promising were retained and further developed. Each of the remaining alternatives was evaluated based upon technical considerations, institutional issues, environmental issues, public health aspects, and cost.

4.1 Remedy Selection

A public meeting was held in April 1986, to discuss the findings of the Remedial Investigation/Feasibility Study (RI/FS) and to explain the proposed remedies for the Site. In August 1986, EPA published a ROD which reflected the results of the RI/FS and public comments. The objectives in developing remedial actions at the Site were as follows:

<u>Surface Contamination</u>

- control source;
- reduce concentration of contaminants;
- control potential migration of surface and subsurface contaminants resulting from contaminated soils;
- prevent or minimize surface erosion and consequent contaminant runoff, including environmental hazards associated with potential flooding of the Salt River, Ohio River, or both; and
- prevent, minimize, or eliminate the on-site potential for exposure by direct contact, the on-site potential for airborne releases, and the potential for contaminant migration by surface water pathways.

<u>Ground Water Contamination</u>

- manage contaminant migration;
- prevent increase in concentrations of COCs;
- reduce concentrations of contaminants; and
- prevent or minimize further migration of contaminants (plume control).

The ROD specified the following Remedial Action activities:

1. Excavation of contaminated soils to background levels, removal and off-site disposal of contaminated soil, back-filling with clean soil, re-grading and seeding for new grass.
2. Extraction and on-site treatment of contaminated ground water to background levels and reinjection into the aquifer.

3. Operation and Maintenance (O&M) of the ground water treatment system and upkeep of Site grounds.

The ROD was modified by a 1988 Explanation of Significant Differences (ESD) for both the Distler Farm and Distler Brickyard Sites based on further soil studies conducted as part of the Remedial Design. The ROD required, at the request of the State, remediation of soil and ground water to background levels. Background levels were defined as the minimum quantity detected by the analytical instrumentation. After determining the difficulty of attaining the required background levels, EPA assessed alternate cleanup levels that would still attain the same degree of health protection. To determine alternate cleanup levels, drinking water standards were utilized, and a soil remediation study was prepared for the Site. The study calculated soil concentrations that would ensure that water moving through the soil into the drinking water aquifer beneath the Site would not contain contaminant concentrations higher than health-based standards for drinking water. Based on drinking water standards and the soil remediation study, EPA, with the concurrence of the State, changed the implementation of the remedy from what was originally outlined in the ROD to require excavation of soil and remediation of ground water to levels set by the following health-based criteria:

- Ground water will be remediated to the drinking water standards and the health-based Maximum Contaminant Levels (MCLs) in Table 3.
- Soils will be excavated to the Allowable Soil Concentrations (ASCs) in Table 4 to ensure that no water leaching into the aquifer underlying the Sites will exceed the health-based values given in Table 3.

Table 3: ESD Health-Based Ground Water COC MCLs

Contaminant of Concern	**MCLs in 1988 ESD (ppb)**
Arsenic	50
Chromium	50
Lead	50
2-butanone	170
trans-l, 2-dichloroethene	70
1,1,1-trichloroethane	200
Trichloroethylene	5
Benzene	5
Toluene	2,000
1,1-dichloroethylene	7
ppb=parts per billion	

Table 4: Allowable Soil Concentrations from ESD

Contaminant of Concern	ASCs in 1988 ESD (mg/kg)
Arsenic	208
Chromium	25,000
Lead	21,000
2-butanone	1.178
Trans-l, 2-dichloroethylene	11.966
1,1,1-trichloroethane	13.398
Trichloroethylene	0.716
Benzene	0.485
Toluene	803.880
1,1-dichloroethylene	1.471
mg/kg=milligrams per kilogram	

4.2 Remedy Implementation

Remediation of contaminated soil was completed in late 1988, after a series of excavation and sampling events. After each round of excavation, samples from excavation pits and trenches were analyzed to determine current levels of contamination. This process continued until approximately six inches of native soil had been removed and the final laboratory analysis indicated that all contaminants were either at or below the levels established in the ESD. Analyses of samples were performed at the EPA Environmental Services Division laboratory in Athens, Georgia. Soil excavated from the Site was trucked to Emelle, Alabama for proper disposal at ChemWaste's facility. Clean soil was brought to the Site to backfill all excavated areas. Top soil was spread and seeds were sown to cultivate grass over the disturbed area of the Site.

Ground water remediation construction began in 1989 with the installation of six recovery wells, two injection wells, and a temporary water treatment facility. These were equipped as a pilot wastewater treatment system and utilized to provide ground water recovery data on the Site. The water recovery system was operated and tested for approximately three weeks.

Evaluation of test data from the pilot treatment system was completed in 1990. The results indicated that the aquifer affected by the Site consisted of two different stratigraphic units, the CGA and the FGA. Most of the contaminants at the Site were in the FGA, which exhibited low fluid flow rates and which was poorly connected to the highly productive CGA. Therefore, it was concluded that wells located in the CGA, like the pilot wells, would not clean up the ground water effectively.

Between 1991 and 1993, several additional field sampling activities and hydrogeologic studies were conducted in order to further characterize the FGA and to obtain data necessary for designing an appropriate set of water extraction wells. All existing data and technical reports on the Site were reevaluated. As a result of these efforts, clusters of wells installed in phases appeared to be appropriate for the ground water cleanup.

Final remedy construction resumed at the Site in August 1993, when four new recovery wells were installed in the FGA near the only existing FGA well. All five wells were developed, sampled, and tested for hydrologic data. The information obtained was used to design the system for ground water treatment. The system consisted of two carbon adsorption units, filters, meters, and flowlines. Installation of the treatment system in September 1994 concluded this phase of remedial construction.

Considering the complexity of the site's geology, EPA contracted with the United States Geological Survey (USGS) at the start of the LTRA to provide special monitoring services. The services, which began in August 1995, included collection of hydrologic data and ground water sampling. Results obtained by USGS were similar to those obtained by EPA. Furthermore, USGS observed that contaminant levels fluctuated in direct response to seasonal variation in ground water levels. Low contaminant concentrations were observed during wet periods with high ground water levels and high concentrations occurred during dry periods.

In spite of the fluctuations, it was clear that contaminants were being extracted from the ground water by the cleanup system. However, the contaminant extraction rate was low due to low water yield from the FGA in which the recovery wells were placed. The five wells pumping the ground water tested at the start of the LTRA yielded approximately 29 gallons of water per hour. Subsequently, the yield averaged approximately three gallons per hour.

In March 1994, USGS sampled six residential wells near the Site. The samples were analyzed at EPA's Athens, Georgia laboratory for metals and volatile organic compounds (VOCs). None of the wells exhibited site-related contamination. In addition, EPA and Kentucky project managers conducted another sampling of residential wells in the area in May 1998. The samples were analyzed by the State and no site related compounds were reported at unacceptable concentrations.

On the basis of the findings, the 1998 FYR concluded the following:

1. Four of the 10 COCs at the Site were below the cleanup goals. The other COCs remained at unacceptable concentrations. Therefore, at the time of the FYR, the cleanup was progressing and the project was maintaining its goal of protecting human health and the environment.
2. The persistent COCs at the Site were being recovered at extremely low rates. The prevailing flow rate for the system was significantly lower than expected which could have been a function of limited aquifer capacity, transmissivity, or possible clogging of the recovery wells by solids in the flow streams.
3. Results of private well sampling conducted in 1994 and 1998 indicated that the Site was not adversely impacting private well drinking water supplies in the area. Therefore, migration of contaminants beyond the boundaries of the Site did not appear to be an issue at the time of the FYR.

Pursuant to the conclusions, the FYR recommended the following:

1. Conduct a special evaluation of the LTRA to determine a more efficient contaminant recovery method.
2. Test, backwash, or recomplete existing wells as necessary.
3. Install and properly complete additional recovery wells.
4. Evaluate applicability of innovative contaminant recovery methods such as horizontal wells and french drains.

After completion of the FYR, studies were immediately initiated to determine methods of improving the effectiveness and speed of site cleanup based on these recommendations. EPA Region 4 expanded the scope of work for the existing contract with the USGS to provide a comprehensive evaluation of the cleanup progress from a geologic and hydrologic standpoint. The EPA Office of Research and Development in Las Vegas was also requested to provide on-site technical assistance by evaluating to-date site performance and determining appropriate technologies for enhancing contaminant recovery. The Las Vegas office then contracted with the Idaho National Engineering and Environmental Laboratory (INEEL) to assist on the Site. Since then, USGS and INEEL have conducted all technical work related to the Site.

Between 1995 and 1997, the USGS collected and analyzed several rounds of water samples from the Site and utilized the information to assess the performance of the LTRA. Four site monitoring wells were strategically selected in order to study the behavior and characteristics of the COCs under the prevailing geologic conditions at various locations over the study period. Trends in the chemical compositions of site contaminants were examined to determine the factors affecting their subsurface fate and transport mechanism. The study also included a review of existing reports on the Site and an extensive technical literature review to obtain an understanding of the Site and its condition.

The USGS presented the findings of the study to EPA and the State in an unpublished report in 1999. The conclusions of the study are summarized as follows:

1. Examination of spatial and temporal trends of VOCs at the Site indicated that residual hydrocarbon contaminants were trapped by capillary pressure in the subsurface, forming the sources of ground water contamination.
2. Chlorinated and aromatic hydrocarbon chemicals diffused from storage and were transported by advection and dispersion from the FGA to the CGA.
3. Bioremediation via anaerobic reductive dechlorination appeared to be actively removing the chlorinated solvents at the Site.
4. Effectiveness of the dechlorination process was curtailed by the difference in stratigraphy, geochemical environment, and source of recharge between the FGA and CGA. Conditions of the FGA were more suitable for the process than those of the CGA.
5. The potential for enhanced biodegradation of the contaminants (especially in the CGA) were recommended for further investigation using special monitoring data that were unavailable at the time of sampling.

6. The diffusion-dominated contaminant transport mechanism in the subsurface could have limited the ability of the ground water extraction wells to remove contaminants from the FGA. Hydraulic gradients generated by pumping are generally insufficient for removing residual contaminants in tight formations such as the FGA.
7. Effectiveness of the pump and treat system at the Site appeared to be hindered by the low permeability and poor yield of the FGA.
8. Given the evidence of biodegradation in the FGA, migration of more soluble, less chlorinated degradation products into the CGA, and the superior quality of CGA permeability, extraction wells completed in the CGA would have helped to clean the Site effectively and rapidly.

INEEL began its activities at the Site in 1998 with technical support from a private company, North Wind Environmental, Inc.. The activities included a review of the USGS study, further site characterization through the installation of new wells, ground water sampling, and soil gas monitoring. Information derived from these activities was used to confirm that some contaminant biodegradation processes were in effect at the Site which could be enhanced by an appropriately designed technology.

In 2000, North Wind recommended the application of an enhanced bioremediation process at the Site. The process was proposed to be a combination of hydraulic fracturing of the contaminated aquifer to improve permeability, and the injection of chitin to stimulate subsurface microbial activity. Chitin is a solid polymeric organic material. It consists of shrimp and crab shells and has been shown in laboratory research to be capable of stimulating the growth of indigenous organisms which can degrade contaminants such as those found at Distler Brickyard. EPA evaluated the proposal and then approved it with State concurrence. Although field use of hydraulic fracturing to improve tight formation permeability is common, the Distler Brickyard Site became the first location for field application of chitin to enhance bioremediation at a Superfund Site. The combined fracturing-chitin injection field test at the Site was proposed to the National Science Foundation (NSF) as an Innovative Technology by North Wind and the pilot project received an award of $100,000. The Phase 1 test was conducted from October 2001 to January 2002.

The material was deployed at the Site under pump pressure into the appropriate wells and mixed with sand as a slurry to create fractures in the formation and to prop the fractures. Based on field sampling data collected before and after the pilot test was conducted, North Wind reported that the technology was successfully applied at the Site and that the LTRA would benefit from a full-scale application of the process.

In view of the success of the pilot project, EPA and the State supported North Wind's proposal to the NSF for funding to implement the technology at the entire Site as a full scale project. In January 2003, North Wind received a $400,000 grant NSF for the project. In April 2003, North Wind initiated the construction phase of the project which primarily included the construction of new wells and the process of formation fracturing through selected site wells. Project construction was completed in May 2003, and the monitoring phase of the project as planned and undertaken by both North Wind and USGS was complete as of April 2005. LTRA was expected to be improved significantly with time as a result of the enhanced bioremediation process. The pump and treat system is no longer in service and North Wind has completed its involvement with the Site. In an April 2005 report (Appendix G), North Wind stated that the "technology continues to appear very promising for cleanup of this site."

4.3 Operation and Maintenance (O&M)

The ROD indicated that when the remedy was completed, O&M would be required to maintain the Site, including mowing and repairing erosion gullies which might occur in the restored areas. It recommended a one-year O&M period after all remediation was completed and the Site restored.

The 1994 Operation and Maintenance Manual (Appendix F) required the following:

- provide a clean effluent for discharge by operating and maintaining all equipment and instruments properly and in accordance with the procedures outlined in the manual;
- maintain accurate O&M records to evaluate system performance;
- maintain accurate sampling records (quarterly effluent and ground water sampling) to track data and to schedule laboratory analyses and delivery of laboratory bottles; and
- maintain accurate disposal records to track waste and to schedule pickups.

LTRA began at the Site in September 1994. Initially, an EPA contractor, Bechtel/ICF, provided the field services, including O&M of the ground water pump and treat system, periodic sampling of the ground water recovery wells, and reporting of site activities. Analytical results for the ground water samples were reported regularly to EPA. In early 1996, responsibility for the LTRA was assumed by the State under a Cooperative Agreement with EPA. Kentucky continues to lead the operation of the LTRA. O&M total operating costs for 30 years were estimated in the ROD at $4,443,000. O&M costs were only available for 2007 for this review period with a total of approximately $14,000.

5.0 Progress Since the Last Five-Year Review

The 2003 FYR included this Protectiveness statement:

> "The remedy implemented at the Distler Brickyard Site currently protects human health and the environment. Many of the COCs at the site have been reduced to acceptable concentration levels. Enhanced remedial measures have been taken to ensure that the remaining COCs are cleaned up rapidly. There are no technical or physical issues related to the site that are likely to reverse its current level of stability and protectiveness of human health and the environment."

The document recommended that monitoring should continue in light of the bioremediation enhancement efforts. EPA and the State were to ensure that USGS and North Wind were properly funded to continue providing technical assistance at the Site until all cleanup goals were met. The 2003 levels of EPA and State oversight of the LTRA were to be maintained to ensure that the project was evaluated regularly and its progress documented properly for the 2008 FYR.

Table 5 provides a summary of all the recommendations made in the 2003 FYR as well as followup actions taken to address the recommendations.

Table 5: Progress on Recommendations from the 2003 FYR

Section	Recommendations	Party Responsible	Milestone Date	Action Taken and Outcome	Date of Action
5.1	Monitoring should continue in light of bioremediation efforts.	State	None given	North Wind collected six quarterly ground water sampling rounds. Ground water sampling occurred in May 2007 by the State.	September 2003-November 2004 May 2007
5.2	EPA and the State should ensure that USGS and North Wind are properly funded to continue providing technical assistance to the Site until all cleanup goals are met.	EPA and State	None given	North Wind completed its project in April 2005, but cleanup goals have not been met for benzene and trichloroethylene.	Completed in April 2005
5.3	Current levels of EPA and State oversight of the LTRA should be maintained to ensure that the project is evaluated regularly and its progress documented properly for the next FYR.	EPA and State	None given	Progress of Site documented through April 2005 North Wind report and one ground water sampling event that occurred in 2007.	2003-2008

Section	Recommendations	Party Responsible	Milestone Date	Action Taken and Outcome	Date of Action
5.4	Determine the results of bioremediation.	North Wind, EPA, and State	2005	North Wind completed a study of the results of bioremediation at the Site. North Wind reported that the "technology continues to appear very promising for cleanup of this site."	April 2005

The following sections provide more information about the progress on the recommendations from the 2003 FYR.

5.1 Continued Monitoring

The State performed a ground water sampling event of eight wells at the Site in May of 2007. North Wind also performed sampling in its bioremediation area at 16 wells. Ten rounds of samples were collected between April 2003 and November 2004, including one baseline sampling round (April 2003), three monthly sampling rounds (May - July 2003), and six quarterly sampling rounds (September 2003 - November 2004).

5.2 Funding

North Wind completed a study of the results of bioremediation at the Site in April 2005. North Wind reported that the "technology continues to appear very promising for cleanup of this site." USGS and North Wind are no longer involved with the Site. North Wind was funded until its study was completed in April 2005.

5.3 Oversight

Year 2003 levels of EPA and State oversight of the LTRA should be maintained to ensure that the project is evaluated regularly and its progress documented properly for the 2008 FYR. In April 2005, North Wind completed the report "Bioremediation of Chlorinated Solvents, in Variably Saturated, Low Permeability Soils: Final Report." A ground water sampling event was conducted by the State in May of 2007.

5.4 Results of Bioremediation

In April 2005, North Wind completed a report evaluating the results of hydraulic fracturing for enhancing permeability of fine-textured soil and emplacement of chitin for stimulating bioremediation of chloroethenes at the Distler Brickyard Site (Appendix F).

Ten rounds of samples were collected between April 2003 and November 2004. Results of sampling indicated that chitin was a long-lived electron donor, and it was reasonable to expect that biodegradation of chloroethenes would be stimulated for at least 12 months after chitin injection. Prior to the chitin emplacement, the dominant chloroethene was cis-dichloroethene (DCE), followed by trichloroethylene and vinyl chloride. Ethene was also observed in the vicinity of the Phase 1 pilot test. Overall, the highest chloroethene concentrations were observed in the northern portion of the treatment cell. Baseline data from Monitoring Well 11 (MW-11) and MW-15 showed cis-DCE concentrations of 1,300 and 370 micrograms per liter (µg/L), respectively. For wells throughout the rest of the Site, cis-DCE concentrations dropped and ethene concentrations increased, making it the dominant compound. These trends demonstrate that biodegradation of cis-DCE to ethene was stimulated by the presence of chitin. These trends were observed sitewide throughout the duration of the test, with contaminant concentrations at most of the Site falling to near or below the MCLs within two months of chitin emplacement. VOC concentrations remained at or below MCLs in all of the Phase 1 pilot wells (Well-B, Well-C, RW-9, and RW-11). VOC concentrations in the northern portion of the treatment cell, where concentrations were initially greatest, remained above MCLs, but overall showed substantial reduction from baseline concentrations. Baseline sampling at these northern locations showed cis-DCE as the dominant compound, with no ethene detection. November 2004 data indicated that ethene is the dominant compound at MW-11 and MW-15, and is approximately equal to cis-DCE at FR-3 and FR-4. The trend of decreasing cis-DCE concentrations coupled with increasing ethene concentrations is evidence that biodegradation of cis-DCE and trichloroethylene occurred. Ground water monitoring data indicated that the presence of volatile fatty acids from chitin degradation continued to stimulate complete degradation of chloroethenes for over a year.

6.0 Five-Year Review Process

6.1 Administrative Components

E^2 Inc. conducted the third FYR for the Distler Brickyard Site with support from EPA Region 4. The FYR team included Femi Akindele, the Remedial Project Manager (RPM); Angela Miller, the EPA Community Involvement Coordinator (CIC); Wesley Turner and Kenneth Logsdon of KDEP; and Kristin Sprinkle and Johnny Zimmerman-Ward of E^2 Inc.. The team established that the FYR would require the following components:

- community notification;
- document review;
- data collection and review;
- site inspection;
- local interviews; and
- FYR report development and review.

6.2 Community Involvement

On October 31, 2007, a public notice was published in Radcliffe, Kentucky's *Sentinel Newspaper* announcing the commencement of the FYR process for the Distler Brickyard Site, providing the RPM's contact information, and inviting community participation (Appendix B). The FYR report will be made available to the public once it has been finalized. Copies will be placed in the designated public repository: West Point City Hall, 509 Elm St., West Point, Kentucky 40177. Upon completion of the 2008 FYR, a public notice will be placed in the *Sentinel Newspaper* to announce the availability of the final FYR report in the site document repository. No citizen comments or concerns regarding cleanup activities at the Site have been received from the public to date. On November 14, 2007, as part of the site inspection, E^2 Inc. staff visited the West Point City Hall and found one non-EPA document from 1996 summarizing the Site's remedial history, and one newspaper article on the Site, also from the late 1990s.

6.3 Document Review

This FYR included a review of relevant, site-related documents including the ROD, remedial action reports, and recent monitoring data. A complete list of the documents reviewed can be found in Appendix A.

ARARs Review

Section 121 (d)(2)(A) of CERCLA specifies that Superfund remedial actions must meet any federal standards, requirements, criteria, or limitations that are determined to be legally Applicable or Relevant and Appropriate Requirements (ARARs). ARARs are those standards, criteria or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA Site. To-Be-Considered criteria (TBCs) are non-promulgated advisories and guidance that are not legally binding, but should be considered in determining the necessary level of cleanup for protection of human health or the environment. While TBCs do not have the status of ARARs, EPA's approach to determining if a remedial action is protective of human health and the environment involves consideration of both TBCs and ARARs.

Location-specific ARARs are restrictions placed on the concentrations of hazardous substances or the conduct of activities solely on the basis of location (e.g., wetlands). Action-specific ARARs are technology- or activity-based requirements or limitations on actions taken with respect to hazardous wastes. These requirements are triggered by the particular remedial activities that are selected to accomplish a remedy. Chemical-specific ARARs are specific numerical quantity restrictions on individually listed contaminants in specific media. Examples of chemical-specific ARARs include the MCLs specified under the Safe Drinking Water Act as well as the ambient water quality criteria that are enumerated under the Clean Water Act. Because there are usually numerous contaminants of potential concern for any Site, various numerical quantity requirements can be ARARs. The final remedy selected for this Site was designed to meet or exceed all chemical-specific ARARs and meet location- and action-specific ARARs. Excavation of soils and pumping and treatment of the Site's ground water were selected to achieve these standards. The guidance also requires that state ARARs be met if they are more stringent than federal ARARs.

Ground Water ARARs

Ground water MCLs for 1,1,1-trichloroethene, trichloroethylene, benzene, and 1,1-dichloroethylene remain unchanged since the 1988 ESD (Table 6). However, ground water cleanup standards have become more stringent for arsenic, lead, and toluene. Current MCLs for chromium and trans-1,2-dichloroethene are less stringent than they were at the time of the 1988 ESD. There are no current federal or state MCLs for 2-butanone.

Table 6: Previous and Current MCLs for Ground Water COCs

Contaminant	1988 ESD MCLs (ppb)	2008 MCLs[1] (ppb)
Arsenic	50	10
Chromium	50	100
Lead[2]	50	15
2-butanone[3]	170	NA
Trans-l, 2-dichloroethene	70	100
1,1,1-trichloroethane	200	200
Trichloroethylene	5	5
Benzene	5	5
Toluene	2,000	1,000
1,1-dichloroethylene	7	7

ppb=parts per billion
NA=Not Available

1. Current MCLs are based on Federal (40 CFR 141-143) and Commonwealth of Kentucky Public Water Supply standards (401 KAR 8:250 and 8:420). Federal standards are based on National Primary and Secondary Drinking Water MCLs http://www.epa.gov/safewater/contaminants/index.html (accessed on 02/14/2008) and State standards are based on Kentucky State Public Water Inorganic and Volatile Organic Chemical MCLs http://www.lrc.state.ky.us/kar/401/008/250.htm and http://www.lrc.state.ky.us/kar/401/008/420.htm (accessed on 03/03/2008). For all the COCs listed in this table, federal and state MCLs are identical.
2. Lead is regulated by a treatment technique that requires systems to control the corrosiveness of their water. If more than 10 percent of tap water samples exceed the action level, water systems must take additional steps.
3. There are no current federal or state standards regulating 2-butanone in drinking water.

6.4 Data Review

Ground Water

Table 7 summarizes the laboratory results obtained from ground water monitoring since the startup of the LTRA through 1998, as well as the May 2007 COC sampling results. COC concentrations presented for 1995 through 1998 were the project area average for recovery wells sampled at each period. The May 2007 results are the maximum concentrations detected from the sampled wells. Compared to cleanup goals, chromium, 2-butanone, 1,1,1-trichloroethane, and toluene were consistently below the acceptable concentrations, whereas arsenic, lead, trans-1,2-dichloroethane, trichloroethylene, benzene and 1,1-dichlororethylene exceeded acceptable levels on several occasions.

Table 7: 1995-1998 and 2007 Ground Water COC Sampling Data

COC	Cleanup Goals (ppb)	Mar 95 (ppb)	Jun 95 (ppb)	Sep 95 (ppb)	Jun 96 (ppb)	Dec 96 (ppb)	Mar 97 (ppb)	Jun 97 (ppb)	Dec 97 (ppb)	Apr 98 (ppb)	May 07[1] (ppb)
Arsenic	50	ND	4	11	22	67	76	5	60	179	NT
Chromium	50	ND	ND	1	ND	7	ND	ND	10	17	NT
Lead	50	ND	9	5	122	29	8	ND	11	20	NT
2-Butanone	170	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trans-1,2-dichloroethene	70	374	187	306	4	8	1	ND	680	2	6.5
1,1,1-trichloroethane	200	2	ND	2	ND	4	ND	ND	6	ND	6.1
Trichloroethylene	5	1	ND	ND	1	18	3	ND	33	18	8.9
Benzene	5	4	ND	ND	ND	22	ND	ND	6	15	5.6
Toluene	2000	2	ND	2	137	ND	101	4	93	183	ND
1,1-dichloroethylene	7	188	70	154	ND	2	99	58	25	ND	ND

ppb=parts per billion
ND=not detected
NT=not tested

[1] May 2007 sampling results in this column are the maximum COC detected in all wells sampled.

May 2007 Sampling Data

The State sampled ground water from eight monitoring wells in May 2007 (Appendix H). Contaminants were not found in three of the wells, but contaminants were detected in the remaining five wells as summarized in Table 8. For COCs identified at the Site, 1,1,1-trichloroethane and trans-1,2-dichloroethane remained below cleanup goals. These two COCs were also below 2008 MCLs. However, benzene and trichloroethylene both were detected above cleanup goals, as well as 2008 MCLs. Although not identified as ground water COCs, vinyl chloride and cis-1,2-dichloroethene were both above their 2008 MCLs of 2 ppb and 70 ppb, respectively.

Table 8: May 2007 Ground Water Sampling Contaminant Detection Results

Well #	Contaminant	Detection Result (ppb)	Cleanup Goals (ppb)	2008[1] MCLs (ppb)
8004-8121	1,1-dichloroethane	15	NA	NA
	Benzene	5.6	5	5
	Cis-1,2-dichloroethene (cis-1,2-dichloroethylene)	590[a]	NA	70
	Trans-1,2-dichloroethene (trans-1,2-dichloroethylene)	6.5	70	100
	Vinyl chloride	45	NA	2
8004-7361	1,1-dichloroethane	5.4	NA	NA
	Cis-1,2-dichloroethene (cis-1,2-dichloroethylene)	18	NA	70
	Vinyl chloride	45	NA	2
8004-8172	Chloroethane	11	NA	NA
8004-7368	1,1,1-trichloroethane	6.1	200	200
	1,1-dichloroethane	7.5	NA	NA
	Cis-1,2-dichloroethene (cis-1,2-dichloroethylene)	7.5	NA	70
	Trichloroethylene	8.9	5	5
8001-7571	Trichloroethylene	6	5	5

ppb=parts per billion

a=estimated value

1. Current MCLs are based on Federal (40 CFR 141-143) and Commonwealth of Kentucky Public Water Supply standards (401 KAR 8:250 and 8:420). Federal standards are based on National Primary and Secondary Drinking Water Maximum Contamination Levels http://www.epa.gov/safewater/contaminants/index.html (accessed 02/14/2008) and state standards are based on Kentucky State Public Water Inorganic and Volatile Organic Chemical Maximum Contamination Levels http://www.lrc.state.ky.us/kar/401/008/250.htm and http://www.lrc.state.ky.us/kar/401/008/420.htm (accessed 03/03/2008). For all the COCs listed in this table, federal and state MCLs are identical.

NA=Not available. No MCLs were available for 1,1-dichloroethane or chloroethane in Federal (40 CFR 141-143) and Commonwealth of Kentucky Public Water Supply standards (401 KAR 8:250 and 8:420).

Soil

Soil Cleanup Levels

Soil cleanup goals established in the 1988 ESD (ASCs) were calculated with a view to ensuring that no soil contaminants leaching into the aquifer underlying the Site will exceed the ground water MCLs. However, EPA has since published Soil Screening Guidance to help standardize the evaluation and cleanup of contaminated soils at Superfund Sites based on the same assumption that no soil contaminants leaching into the aquifer underlying the Site will exceed the ground water MCLs (see http://www.epa.gov/region4/waste/ots/healtbul.htm). The Soil Screening Levels (SSLs) are compared to cleanup levels established in the 1988 ESD. SSLs applied at the Site are based on a Dilution Attenuation Factor (DAF) of 231, which is also used in the 1988 soil remediation study to support the ESD. Table 9 compares SSLs to the ASC cleanup goals. Compared to Region 4's SSLs, the original ASCs for chromium, trans-1,2-dichloroethylene, trichloroethylene, benzene, toluene, and 1,1-dichloroethylene are higher than SSLs, while ASCs for arsenic and 1,1,1-trichloroethane are less than SSLs. There are no SSLs for 2-butanone or lead.

Table 9: 1988 Cleanup Goals versus 2008 SSLs for Soil COCs

Contaminants	Soil Cleanup Goals – 1988 ESD ASCs (mg/kg)	SSLs – DAF 231 (mg/kg)[1]
Arsenic	208	231
Chromium	25,000	462
Lead[2]	21,000	NA
2-butanone	1.178	NA
Trans-l, 2-dichloroethylene	11.966	6.93
1,1,1-trichloroethane	13.398	23.1
Trichloroethylene	0.716	0.693
Benzene	0.485	0.462
Toluene	803.880	138.6
1,1-dichloroethylene	1.471	0.693

NA=Not Available

mg/kg=milligrams per kilogram

1. Region 9's SSLs used in this table were published in 2004; see http://www.epa.gov/region09/waste/sfund/prg/files/04prgtable.pdf (accessed on 1/17/2008). SSLs are based on the assumption of soil contaminants migrating into ground water. The SSLs were developed using a DAF of 231 based on the soil remediation study supporting the 1988 ESD. This value was determined by multiplying the SSLs that assume no dilution or attenuation between the source and the receptor well (i.e., a DAF of 1) by the site-specific DAF of 231. See EPA's 1996 Soil Screening Guidance: User's Guide, Page 30, "Dilution Factor Model (http://www.epa.gov/superfund/health/conmedia/soil/pdfs/ssg496.pdf) for details on DAF (accessed on 1/17/2008).
2. EPA evaluates lead exposure by using blood-lead modeling, such as with the Integrated Exposure-Uptake Biokinetic Model (IEUBK).

Remediation of contaminated soil was accomplished in late 1988, with a series of excavation and sampling events. After each round of excavation, samples from excavation pits and trenches were analyzed to determine current levels of contamination. This process continued until approximately six inches of native soil had been removed and the final laboratory analysis indicated that all contaminants were either at or below the levels established in the ESD. As stated before, the original ASCs used during this removal action for chromium, trans-1,2-dichloroethylene, trichloroethylene, benzene, toluene, and 1,1-dichloroethylene were higher than current SSLs.

6.5 Site Inspection

The site inspection for this FYR was conducted on November 14, 2007 by KDEP representatives and FYR contractor staff, E^2 Inc. The EPA RPM also inspected the site on August 7, 2008. The purposes of the inspections were to take pictures and assess the condition of the Site, including all remaining structures, wells, and fences. In addition, E^2 Inc. staff conducted research at the Beaufort County Public Records office on November 14, 2007 to locate deed information pertaining to the Site. See Table 10.

Table 10: Distler Brickyard Deed Documents

Date	Type of Document	Description	Book #	Page #
1975	Deed	In January of 1975, Thomas A. Hoeppner purchased the property from the West Point Brick Company. The property was purchased for $61,500 and was conveyed free of encumbrances. The document contains a three-page survey map of the property.	271	184
2006	Quit Claim Deed	This deed transferred the property from Thomas A. Hoeppner to his Trust. Conveyance of the property to the Thomas A. Hoeppner Revocable Trust did not involve payment for the parcel, the fair market value of which was listed as $75,000. At this time the property was free and clear of all liens and encumbrances with the exception of two easements for communications companies.	1196	276
2007	Lease	The Thomas A. Hoeppner Revocable Trust leased the property to the Pioneer Oil Company of Illinois for the purpose of exploration and exploitation of the oil and natural gas resources the property may contain. The lease is for three years or until hydrocarbons cease to be produced from the land. Compensation includes an annual royalty and one eighth of the hydrocarbons captured. The Pioneer Oil Company has the right to use the water at the Site free of charge, but not the owner's ponds and wells. The owner may divide the land, but that will not change the lease's applicability to each subdivided parcel. The company is bound to comply with all environmental regulations.	1228	363

The entrance to the Site is along the Dixie Highway and is fenced and locked. It displays a rusty "No Trespassing" sign. The fence does not enclose the Site, but only extends a short distance beyond each side of the entrance, along the highway. The brick kilns have been demolished and a large portion of the property is littered with bricks and remnants of the warehouse and kilns. The pump buildings, which are each surrounded by fencing, are overgrown with brush. The buildings and fences are damaged or have collapsed. During the site inspection, most ground water monitoring wells were locked and appeared to be in good condition. There were a few wells with missing or malfunctioning locks that need to be secured. There was a wire across part of the Site that had fallen, or has been cut from the electric pole, as well as an electrical box lying on the ground. There were dilapidated buildings on site, as well as an unused water collection tank. Many of the wells near the North Wind's bioremediation area were surrounded by tall grasses. There was evidence of trespassing on the Site. The complete site inspection is included in Appendix C and site inspection photographs are included in Appendix D.

6.6 Interviews

As part of the FYR process, community phone interviews were conducted by Angela Miller, the site Community Involvement Coordinator (CIC). All individuals interviewed were notified that the FYR was being conducted at the Site and that the final report will be placed in the information repository located at the West Point City Hall, 509 Elm Street, West Point, Kentucky 40177, for the public to review.

Several interviews were conducted with staff at the West Point City Hall and city staff stated that they have not received any concerns or complaints about the cleanup of the Distler Brickyard Site. However, citizens have been commenting on how good the property looks. A copy of the final FYR report was requested by the Mayor of West Point. Sample interview questions are available in Appendix D.

7.0 Technical Assessment

7.1 Question A: Is the remedy functioning as intended by the decision documents?

The remedy at this Site was constructed and operated as required by the Superfund decision documents until approximately 2006. Soils were excavated and removed from the Site; ground water has been pumped, treated, and reinjected. The documents established certain cleanup goals, some of which the remedial activities at the Site have attained as discussed in this and previous FYR reports. Ground water sampling of eight monitoring wells was performed in May of 2007 by the Commonwealth of Kentucky. For COCs identified at the Site, 1,1,1-trichloroethane remained below cleanup goals, and trans-1,2 dichloroethane dropped well below cleanup goals since the 1995-1998 sampling. However, benzene and trichloroethylene both were detected above cleanup goals. Although not identified as ground water COCs, vinyl chloride and cis-1,2-dichloroethene were both above 2008 MCLs for at least one well.

In April 2003, North Wind initiated a test of an enhanced bioremediation technology to speed up ground water cleanup at the Site. The subsequent 2005 report of the field work indicated that the technology appeared very promising for cleanup of the Site. VOC concentrations remained at or below MCLs in all of the Phase I pilot tests and VOC concentrations in the northern portion of the chitin treatment cell (where concentrations were initially greatest) remained above MCLs, but overall showed substantial reduction from baseline concentrations. Ground water sampling since the completion of the 2005 study has been inadequate, with only one event in 2007 (which did not include all COCs). Consistent, scheduled ground water sampling events should be conducted to confirm current COC levels. Currently, no active ground water treatment is taking place. Confirmatory sampling previously recommended for the Site by the 2003 FYR needs to be implemented to assess the completeness of the Site remedy.

The Site does not have ICs restricting land and ground water use because ICs were not required in the ROD or the ESD. EPA should evaluate the Site to determine if ground water ICs may be appropriate as ground water remediation has not been confirmed as complete; and the 2007 sampling event detected ground water contaminants that exceeded 2008 MCLs for certain compounds.

7.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of remedy selection still valid?

The cleanup goals established in the ESD were appropriate relative to 2008 federal and state drinking water standards for all contaminants except arsenic, lead, and toluene. The goal for arsenic was 50 ppb versus the 2008 acceptable MCL of 10 ppb. The goal for lead was 50 ppb versus the 2008 acceptable MCL of 15 ppb. The goal for toluene was 2,000 ppb versus the 2008 acceptable MCL of 1,000 ppb.

The original ASCs for chromium, trans-1,2-dichloroethylene, trichloroethylene, benzene, toluene, and 1,1-dichloroethylene exceeded current EPA SSLs, while the standards for arsenic and 1,1,1-trichloroethane have become less stringent. There are no SSLs for 2-butanone or lead. The ASCs and SSLs are compared in Table 11.

Table 11: 1988 Cleanup Goals versus 2008 SSLs for Soil COCs

Contaminants	ASCs in 1988 ESD (mg/kg)	SSLs – DAF 231 (mg/kg)[1]
Arsenic	208	231
Chromium	25,000	462
Lead[2]	21,000	NA
2-butanone	1.178	NA
Trans-1, 2-dichloroethylene	11.966	6.93
1,1,1-trichloroethane	13.398	23.1
Trichloroethylene	0.716	0.693
Benzene	0.485	0.462
Toluene	803.880	138.6
1,1-dichloroethylene	1.471	0.693

mg/kg=milligrams per kilogram
NA=Not Available

1. Region 9's SSLs used in this table were published in 2004; see http://www.epa.gov/region09/waste/sfund/prg/files/04prgtable.pdf (accessed on 1/17/2008). SSLs are based on the assumption of soil contaminants migrating into ground water. The SSLs were developed using a DAF of 231 based on the soil remediation study supporting the 1988 ESD. This value was determined by multiplying the SSLs that assume no dilution or attenuation between the source and the receptor well (i.e., a DAF of 1) by the site-specific DAF of 231. See EPA's 1996 Soil Screening Guidance: User's Guide, Page 30, "Dilution Factor Model (http://www.epa.gov/superfund/health/conmedia/soil/pdfs/ssg496.pdf) for details on DAF (accessed on 1/17/2008).
2. EPA evaluates lead exposure by using blood-lead modeling, such as with the Integrated Exposure-Uptake Biokinetic Model (IEUBK).

Because several ASCs established in the 1988 ESD do not meet current SSLs, reuse of the Site could cause unacceptable exposure pathways. Although ICs were not required in the decision documents, it is recommended that EPA evaluate the possibility of land use restrictions as the original ASCs for chromium, trans-1,2-dichloroethylene, trichloroethylene, benzene, toluene, and 1,1-dichloroethylene were higher than current Region 4 SSLs, while ASCs for arsenic and 1,1,1-trichloroethane were less than current SSLs.

7.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

The Site has been leased for the purpose of exploration and exploitation of the oil and natural gas resources the property may contain. There has been recent construction activity at the Site as the brick kilns and warehouse have been demolished and their debris lay on the Site. During the May 2007 ground water sampling event, vinyl chloride and cis-1,2-dichloroethene, which were not considered as COCs in decision documents, were detected above MCLs in at least one well.

7.4 Technical Assessment Summary

The remedy required in the ROD and ESD for this Site has been implemented. The decision documents established certain cleanup goals, some of which the remedy has attained: soils were excavated and removed from the Site; ground water was pumped, treated, and reinjected. In addition, attempts have been made to enhance natural attenuation of ground water COCs at the Site with some level of success (see pages 23-24). The Site seems to be in the process of being returned to use; the site inspection showed that the brick kilns and warehouse have been demolished. The Site was leased in 2007 for gas and oil exploration, though there are no current plans for wells on site. There have been changes in certain soil cleanup standards and ground water MCLs since the ESD was developed. Soil cleanup goals in the ESD were based on contaminants leaching into the ground water. Some of the original ASCs exceed current Region 4 SSLs. Ground water cleanup goals established in the ESD were appropriate relative to 2008 federal and Kentucky drinking water standards for all contaminants except arsenic, lead, and toluene.

The Site does not have ICs restricting land and ground water use because ICs were not required in the ROD or the ESD. EPA should evaluate the Site to determine if ICs may be appropriate as ground water remediation has not been confirmed as complete; and the 2007 sampling event detected ground water contaminants that exceeded 2008 MCLs for certain compounds. EPA should also evaluate the possibility of land use restrictions as the original ASCs for chromium, trans-1,2-dichloroethylene, trichloroethylene, benzene, toluene, and 1,1-dichloroethylene were higher than current Region 4 SSLs, while ASCs for arsenic and 1,1,1-trichloroethane were less than current SSLs.

Ground water sampling has been inadequate since the 2003 FYR. The sampling events that did occur did not include all COCs. Consistent, scheduled ground water sampling events should be conducted to confirm current COC levels. Currently, no active ground water treatment is taking place. Confirmatory sampling previously recommended for the Site needs to be implemented to assess the completeness of the Site remedy.

8.0 Issues

Table 12 summarizes the current issues for the Distler Brickyard Site.

Table 12: Current Issues for the Distler Brickyard Site

Issue	Affects Current Protectiveness	Affects Future Protectiveness
Ground water remediation has not been determined to be complete and the 2007 sampling event detected certain contaminants that exceed 2008 MCLs.	No	Yes
The ASCs established in the ESD for chromium, trans-1,2-dichloroethylene, trichloroethylene, benzene, toluene, and 1,1-dichloroethylene were higher than current Region 4 SSLs.	No	Yes
There are inadequate ground water sampling data.	No	Yes
Ground water cleanup goals have not been met for benzene and trichloroethylene and there is no active ground water remediation currently taking place.	No	Yes
There are unsecured ground water wells.	No	Yes
Pump houses and other structures are overgrown and collapsing.	No	No
Site documents are not available at local site repository.	No	No
Portions of the Site are overgrown.	No	No

9.0 Recommendations and Follow-up Actions

Table 13 provides recommendations to address the current issues at the Distler Brickyard Site.

Table 13: Recommendations to Address Current Issues at Distler Brickyard Site

Issue	Recommendations/ Follow-Up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness?	
					Current	Future
Ground water remediation has not been determined to be complete and the 2007 sampling event detected certain contaminants that exceed 2008 MCLs.	Evaluate the Site to determine if ground water ICs may be appropriate.	EPA, KDEP	EPA	09/30/2009	No	Yes
The ASCs established in the ESD for chromium, trans-1,2-dichloroethylene, trichloroethylene, benzene, toluene, and 1,1-dichloroethylene were higher than current Region 4 SSLs.	Evaluate the Site to determine if ICs would be appropriate to restrict land use to prevent future users or workers from coming into contact with soil contamination that may remain on site in surface or subsurface soils that exceed 2008 soil screening levels.	EPA, KDEP	EPA	09/30/2009	No	Yes
There are inadequate ground water sampling data.	Sample wells quarterly for all COCs as called for in the O&M plan and the 2003 FYR to verify contaminant cleanup.	KDEP	EPA	09/30/2009	No	Yes
Ground water cleanup goals have not been met for benzene and trichloroethylene and there is no active ground water remediation currently taking place.	Continue ground water long-term remedial action or formally terminate remedial action using confirmatory sampling results.	KDEP	EPA	09/30/2009	No	Yes
There are unsecured ground water wells.	Secure unsecured ground water wells.	KDEP	EPA	09/30/2009	No	Yes
Pump houses and other structures are overgrown and collapsing.	Properly abandon or repair pump houses and other structures..	KDEP	EPA	09/30/2009	No	No
Site documents are	Submit FYRs and	EPA	EPA	12/31/2008	No	No

Issue	Recommendations/ Follow-Up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness?	
					Current	Future
not available at local site repository.	other necessary site related documents to the local site repository.					
Portions of the Site are overgrown.	Mow and maintain Site.	KDEP	EPA	09/30/2009	No	No

10.0 Protectiveness Statements

The remedy at the Distler Brickyard Site protects human health and the environment in the short term because no one is consuming contaminated ground water and because contaminated soil was removed pursuant to site decision documents. In order for the Site to be protective in the long term, the following actions need to be taken:

- evaluate the Site to determine if ground water ICs would be appropriate until it is determined that ground water remediation is complete;
- evaluate the Site to determine if ICs would be appropriate to restrict land use to prevent future users or workers from coming into contact with soil contamination that may remain on site in surface or subsurface soils that exceed 2008 soil screening levels;
- perform ground water monitoring quarterly to verify COC levels and confirm completeness of remedy;
- continue ground water long-term remedial action or formally terminate remedial action using confirmatory sampling results; and
- secure unsecured wells.

11.0 Next Review

This is a policy Site that requires ongoing FYRs as long as waste is left on site that does not allow for unrestricted use and unlimited exposure. The next FYR will be due within five years of the signature/approval date of this FYR, no later than September 2013.

Appendix A: List of Documents Reviewed

"Bioremediation of Chlorinated Solvents in Variably Saturated, Low Permeability Soils: Final Report," Submitted by: North Wind, Inc. Prepared for National Science Foundation Small Business Innovation Research Phase II Grant. March 2005.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Information System (CERCLIS) Site Information accessed from Web site http://cfpub.epa.gov/supercpad/cursites/csitinfo.cfm?id=0402127 December 2007 and February 2008.

EPA Superfund Explanation of Significant Differences: DISTLER BRICKYARD and DISTLER FARM, EPA ID" KYD980602155 and KYD980601975, OU 1, West Point, KY. EPA/ESD/R04-89/504. October 26, 1988.

EPA Superfund Record of Decision: DISTLER BRICKYARD, EPA ID: KYD980602155, OU 1, West Point, KY. EPA/ROD/R04-86/015. August 19, 1986.

"Feasibility Study of Remedial Alternatives, Dislter Brickyard Site," prepared by NUS Corporation. March 1986.

"Final Report, Site Assessment, Distler Brickyard, West Point, Kentucky," prepared by Weston for EPA. November 29, 1991.

"Five-Year Review Report, Distler Brickyard Site, Hardin County, Kentucky," September 1998.

"Groundwater Extraction and Treatment System Operation and Maintenance Manual, Distler Brickyard Oversight and Long-Term Remedial Action, Hardin County, Kentucky," prepared for Bechtel Environmental, Inc. Oak Ridge, Tennessee. Prepared by ICF Kaiser Environment and Energy Group. December 13, 1994.

"Health Assessment for Distler Brickyard NPL Site," prepared by the Agency for Toxic Substances and Disease Registry. November 22, 1988.

NPL Fact Sheet, available online at:
http://www.epa.gov/region4/waste/npl/nplky/distbrky.htm

"Remedial Investigation Report Volume II, Distler Brickyard Site," prepared by NUS Corporation. March 1986.

"Second Five-Year Review Report for Distler Brickyard Site, City of West Point, Hardin County, Kentucky," prepared by USEPA, Region 4 Atlanta, GA. September 2003.

Appendix B: Press Notices

U. S. Environmental Protection Agency, Region 4
Announces a Five-Year Review
for the Distler Brickyard Site,
West Point, Hardin County, Kentucky

The U.S. Environmental Protection Agency (EPA) is conducting a Five-Year Review of the remedy for soil and ground water contamination associated with the Distler Brickyard site (the site) in West Point, Hardin County, Kentucky. The three-acre site is located approximately seventeen miles southwest of Louisville and is part of a 70-acre farmland which is divided by Dixie Highway. The purpose of the Five-Year Review is to ensure that the selected cleanup actions effectively protect human health and the environment.

The site was a brick manufacturing plant between 1950 and 1976 and was later used as a hazardous waste storage facility. In 1982, EPA removed approximately 2,300 drums of hazardous waste containing various liquids, sludge, and solids considered to be toxic, volatile, and/or flammable. Spills and leaking drums contaminated soil and ground water at the site. In 1986, a Record of Decision was signed, selecting a remedy to address this contamination. The remedy included excavating contaminated soil for off-site disposal, along with back-filling with clean soil, re-grading and seeding for new grass, and treating ground water on-site. The remedy also required an operation and maintenance plan for treatment of the ground water system and site up keep.

The National Contingency Plan requires that remedial actions which result in any hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure be reviewed every five years to ensure protection of human health and the environment. The third of these Five-Year Reviews for this site will be completed in 2008.

EPA invites community participation in the Five-Year Review process.

The EPA is conducting a Five-Year Review to evaluate the results of soil removal and ground water monitoring to ensure that the site remains protective of human health and the environment. As part of the Five-Year Review process, EPA will be available to answer any questions about the site. Community members who have questions about the site, the Five-Year Review process, or who would like to participate in a community interview, are asked to contact the Remedial Project Manager:

Femi Akindele
U.S. EPA, Region 4
61 Forsyth St. (11th Floor)
Atlanta, GA 30303-8936
Phone: 404-562-8809
Akindele.femi@epa.gov

EPA plans to complete the Five-Year Review process by September 2008; comments are welcome during this time. More information about the site may be found at the West Point Repository or online at: http://cfpub.epa.gov/supercpad/cursites/csitinfo.cfm?id=0402127.

Appendix C: Sample Interview Questions

Interview Form for Distler Brickyard's Five-Year Review

Site Name: Distler Brickyard **EPA ID No.:** KYD980602155
Interviewer Name: ______________________ **Affiliation:** __________________
Subject's Name: ________________________ **Affiliation:** __________________
Subject's Contact Information: _____________________
Time: _________ **Date:** ____________________
Type of Interview (Circle one): In Person Phone Mail Other_________
Location of Interview: ____________________

Local Government

1. Are you aware of the former environmental issues at the Distler Brickyard site and of the cleanup that took place there?
2. What are your views about current site condition, problems, or related concerns?
3. What effect has this site had on the surrounding community?
4. Has the local government received any citizen complaints or inquiries regarding environmental issues at this site?
5. Are you aware of any changes to local laws that might affect the protectiveness of the remedy? Are you aware of any changes in projected land use at the site?
6. Do you feel well informed about the site's activities and progress? If not, what methods would you recommend EPA use to disseminate more information?
7. Do you have any comments, suggestions, or recommendations regarding the project?

Interview Form for Distler Brickyard's Five-Year Review

Site Name: Distler Brickyard **EPA ID No.:** KYD980602155
Interviewer Name: ______________________ **Affiliation:** __________________
Subject's Name: ________________________ **Affiliation:** __________________
Subject's Contact Information: ______________________________________
Time: ________ **Date:** ____________________
Type of Interview (Circle one): In Person Phone Mail Other__________
Location of Interview: ____________________

Affected Residents

1. Are you aware of the environmental issues at the Distler Brickyard Superfund site and what cleanup activities have occurred?
2. What are your views about current site conditions, problems, or related concerns?
3. What effect has this site had on the surrounding community, if any?
4. Should EPA do more to keep involved parties and surrounding neighbors informed of activities at the site? What methods would you recommend?
5. Do you have any comments, suggestions, or recommendations regarding the site's management or operations?

Appendix D: Site Inspection Checklist

FIVE-YEAR REVIEW SITE INSPECTION CHECKLIST

I. SITE INFORMATION

Site name: Distler Brickyard	**Date of inspection: 11/14/2007**
Location and Region: West Point, KY, Region 4	**EPA ID: KYD980602155**
Agency, office, or company leading the five-year review: EPA Region 4	**Weather/temperature: upper 60s, humid and overcast**

Remedy Includes: (Check all that apply)

☐ Landfill cover/containment
☐ Access controls
☐ Institutional controls
☒ Groundwater pump and treatment
☐ Surface water collection and treatment
☒ Other Contaminated soils were excavated and removed from the site and chitin was injected into the ground water to increase bioremediation of ground water contaminants.
☐ Monitored natural attenuation
☐ Groundwater containment
☐ Vertical barrier walls

Attachments: ☒ Inspection team roster attached ☐ Site map attached

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** _____ _____ mm/dd/yyyy
Name Title Date
Interviewed ☐ at site ☐ at office ☐ by phone Phone no. _____
Problems, suggestions; ☐ Report attached _____

2. **O&M staff** _____ _____ mm/dd/yyyy
Name Title Date
Interviewed ☐ at site ☐ at office ☐ by phone Phone no. _____
Problems, suggestions; ☐ Report attached _____

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.). Fill in all that apply.

Agency West Point City Hall
Contact Various Employees ______ ______ ______
Name Title Date Phone No.
Problems; suggestions; ☐ Report attached ______

Agency ______
Contact ______ ______ ______ ______
Name Title Date Phone No.
Problems; suggestions; ☐ Report attached ______

Agency ______
Contact ______ ______ ______ ______
Name Title Date Phone No.
Problems; suggestions; ☐ Report attached ______

Agency ______
Contact ______ ______ ______ ______
Name Title Date Phone No.
Problems; suggestions; ☐ Report attached ______

Agency ______
Contact ______Name ______ ______ ______
Title Date Phone No.
Problems; suggestions; ☐ Report attached ______

4. **Other interviews** (optional) ☐ Report attached

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**

☐ O&M manual	☐ Readily available	☐ Up to date	☒ N/A
☐ As-built drawings	☐ Readily available	☐ Up to date	☒ N/A
☐ Maintenance logs	☐ Readily available	☐ Up to date	☒ N/A

Remarks: ______

2. **Site-Specific Health and Safety Plan** ☐ Readily available ☐ Up to date ☒ N/A

☐ Contingency plan/emergency response plan ☐ Readily available ☐ Up to date ☒ N/A

Remarks: ______

3. **O&M and OSHA Training Records** ☐ Readily available ☐ Up to date ☒ N/A

Remarks: ______

4.	**Permits and Service Agreements**			
	☐ Air discharge permit	☐ Readily available	☐ Up to date	☒ N/A
	☐ Effluent discharge	☐ Readily available	☐ Up to date	☒ N/A
	☐ Waste disposal, POTW	☐ Readily available	☐ Up to date	☒ N/A
	☐ Other permits _____	☐ Readily available	☐ Up to date	☒ N/A
	Remarks: _____			
5.	**Gas Generation Records**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks: _____			
6.	**Settlement Monument Records**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks: _____			
7.	**Groundwater Monitoring Records**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks: _____			
8.	**Leachate Extraction Records**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks: _____			
9.	**Discharge Compliance Records**			
	☐ Air	☐ Readily available	☐ Up to date	☒ N/A
	☐ Water (effluent)	☐ Readily available	☐ Up to date	☒ N/A
	Remarks: _____			
10.	**Daily Access/Security Logs**	☐ Readily available	☐ Up to date	☒ N/A
	Remarks: _____			

IV. O&M COSTS

1. **O&M Organization**

☒ State in-house	☐ Contractor for State
☐ PRP in-house	☐ Contractor for PRP
☐ Federal Facility in-house	☐ Contractor for Federal Facility
☐	

2. **O&M Cost Records** – Requested from State of Kentucky

☐ Readily available ☐ Up to date

☐ Funding mechanism/agreement in place ☐ Unavailable

Original O&M cost estimate _____ ☐ Breakdown attached

Total annual cost by year for review period if available

From 02/28/2007 To 11/15/2007 $14,000 ☐ Breakdown attached
Date Date Total cost

From mm/dd/yyyy To mm/dd/yyyy _____ ☐ Breakdown attached
Date Date Total cost

From mm/dd/yyyy To mm/dd/yyyy _____ ☐ Breakdown attached
Date Date Total cost

From mm/dd/yyyy To mm/dd/yyyy _____ ☐ Breakdown attached
Date Date Total cost

From mm/dd/yyyy To mm/dd/yyyy _____ ☐ Breakdown attached
Date Date Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: _____

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☒ Gates secured ☐ N/A

Remarks: The gate and fence runs the width of the access road on Dixie Highway, the fence ends a few feet past the edge of the road.

B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☒ N/A

Remarks: There is an old no trespassing sign behind the entrance gate; the state of Kentucky prefers not to use no trespassing signs because they believe it encourages trespassing.

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented ☐ Yes ☐ No ☒ N/A

Site conditions imply ICs not being fully enforced ☐ Yes ☐ No ☒ N/A

Type of monitoring (e.g., self-reporting, drive by) _____

Frequency _____

Responsible party/agency

Contact _____	_____	mm/dd/yyyy	_____
Name	Title	Date	Phone no.

Reporting is up-to-date ☐ Yes ☐ No ☒ N/A

Reports are verified by the lead agency ☐ Yes ☐ No ☒ N/A

Specific requirements in deed or decision documents have been met ☐ Yes ☐ No ☒ N/A

Violations have been reported ☐ Yes ☐ No ☒ N/A

Other problems or suggestions: ☐ Report attached

2. **Adequacy** ☐ ICs are adequate ☐ ICs are inadequate ☐ N/A

Remarks: No ICs are in place at this time, however, they are likely necessary.

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ☐ No vandalism evident

Remarks: The site is obviously used for hunting as ATV trails are apparent on site.

2. **Land use changes on site** ☐ N/A

Remarks: The brick kilns and warehouse have been demolished; the current owner has plans to reuse the site.

3. **Land use changes off site** ☒ N/A

Remarks: _____

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

1. Roads damaged ☐ Location shown on site map ☒ Roads adequate ☐ N/A

Remarks: There is a path that vehicles are taking through the site, tracks are clearly visible.

B. Other Site Conditions

Remarks: There are tons of brick debris on site left over from the warehouse and kiln demolition. Many of the pump and treat buildings are still in place and should be dismantled, there are wires hanging down across the site near the railroad tracks. There is brush surrounding many of the wells and pump and treat areas. There appears to be a black tarry substance attached to the demolition debris that may need to be tested by state.

VII. LANDFILL COVERS ☐ Applicable ☒ N/A

A. Landfill Surface

1.	**Settlement** (Low spots)	☐ Location shown on site map	☐ Settlement not evident
	Arial extent _____		Depth _____
	Remarks: _____		
2.	**Cracks**	☐ Location shown on site map	☐ Cracking not evident
	Lengths _____	Widths _____	Depths _____
	Remarks: _____		
3.	**Erosion**	☐ Location shown on site map	☐ Erosion not evident
	Arial extent _____		Depth _____
	Remarks: _____		
4.	**Holes**	☐ Location shown on site map	☐ Holes not evident
	Arial extent _____		Depth _____
	Remarks: _____		
5.	**Vegetative Cover**	☐ Grass	☐ Cover properly established
	☐ No signs of stress	☐ Trees/Shrubs (indicate size and locations on a diagram)	
	Remarks: _____		
6.	**Alternative Cover** (armored rock, concrete, etc.)		☐ N/A
	Remarks: _____		
7.	**Bulges**	☐ Location shown on site map	☐ Bulges not evident
	Arial extent _____		Height _____
	Remarks: _____		
8.	**Wet Areas/Water Damage**	☐ Wet areas/water damage not evident	
	☐ Wet areas	☐ Location shown on site map	Arial extent _____
	☐ Ponding	☐ Location shown on site map	Arial extent _____
	☐ Seeps	☐ Location shown on site map	Arial extent _____
	☐ Soft subgrade	☐ Location shown on site map	Arial extent _____
	Remarks: _____		
9.	**Slope Instability**	☐ Slides	☐ Location shown on site map
	☐ No evidence of slope instability		
	Arial extent _____		
	Remarks: _____		
B. Benches	☐ Applicable	☒ N/A	
	(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)		
1.	**Flows Bypass Bench**	☐ Location shown on site map	☐ N/A or okay
	Remarks: _____		

2. **Bench Breached** ☐ Location shown on site map ☐ N/A or okay

Remarks: _____

3. **Bench Overtopped** ☐ Location shown on site map ☐ N/A or okay

Remarks: _____

C. Letdown Channels ☐ Applicable ☒ N/A

(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** (Low spots) ☐ Location shown on site map ☐ No evidence of settlement

Arial extent _____ Depth _____

Remarks: _____

2. **Material Degradation** ☐ Location shown on site map ☐ No evidence of degradation

Material type_____ Arial extent _____

Remarks: _____

3. **Erosion** ☐ Location shown on site map ☐ No evidence of erosion

Arial extent _____ Depth _____

Remarks: _____

4. **Undercutting** ☐ Location shown on site map ☐ No evidence of undercutting

Arial extent _____ Depth _____

Remarks: _____

5. **Obstructions** Type _____ ☐ No obstructions

☐ Location shown on site map Arial extent _____

Size _____

Remarks: _____

6. **Excessive Vegetative Growth** Type _____

☐ No evidence of excessive growth

☐ Vegetation in channels does not obstruct flow

☐ Location shown on site map Arial extent _____

Remarks: _____

D. Cover Penetrations ☐ Applicable ☒ N/A

1. **Gas Vents** ☐ Active ☐ Passive

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition

☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A

Remarks: _____

2. **Gas Monitoring Probes**

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A
Remarks: _____

3. **Monitoring Wells** (within surface area of landfill)

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A
Remarks: _____

4. **Extraction Wells Leachate**

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A
Remarks: _____

5. **Settlement Monuments** ☐ Located ☐ Routinely surveyed ☐ N/A

Remarks: _____

E. Gas Collection and Treatment ☐ Applicable ☒ N/A

1. **Gas Treatment Facilities**

☐ Flaring ☐ Thermal destruction ☐ Collection for reuse
☐ Good condition ☐ Needs Maintenance
Remarks: _____

2. **Gas Collection Wells, Manifolds and Piping**

☐ Good condition ☐ Needs Maintenance
Remarks: _____

3. **Gas Monitoring Facilities** (e.g., gas monitoring of adjacent homes or buildings)

☐ Good condition ☐ Needs Maintenance ☐ N/A
Remarks: _____

F. Cover Drainage Layer ☐ Applicable ☒ N/A

1. **Outlet Pipes Inspected** ☐ Functioning ☐ N/A

Remarks: _____

2. **Outlet Rock Inspected** ☐ Functioning ☐ N/A

Remarks: _____

G. Detention/Sedimentation Ponds ☐ Applicable ☒ N/A

1. **Siltation** Area extent _____ Depth _____ ☐ N/A

☐ Siltation not evident
Remarks: _____

2. **Erosion** Area extent _____ Depth _____
☐ Erosion not evident
Remarks: _____

3. **Outlet Works** ☐ Functioning ☐ N/A
Remarks: _____

4. **Dam** ☐ Functioning ☐ N/A
Remarks: _____

H. Retaining Walls ☐ Applicable ☒ N/A

1. **Deformations** ☐ Location shown on site map ☐ Deformation not evident
Horizontal displacement _____ Vertical displacement _____
Rotational displacement _____
Remarks: _____

2. **Degradation** ☐ Location shown on site map ☐ Degradation not evident
Remarks: _____

I. Perimeter Ditches/Off-Site Discharge ☐ Applicable ☒ N/A

1. **Siltation** ☐ Location shown on site map ☐ Siltation not evident
Area extent _____ Depth _____
Remarks: _____

2. **Vegetative Growth** ☐ Location shown on site map ☐ N/A
☐ Vegetation does not impede flow
Area extent _____ Type _____
Remarks: _____

3. **Erosion** ☐ Location shown on site map ☐ Erosion not evident
Area extent _____ Depth _____
Remarks: _____

4. **Discharge Structure** ☐ Functioning ☐ N/A
Remarks: _____

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

1. **Settlement** ☐ Location shown on site map ☐ Settlement not evident
Area extent _____ Depth _____
Remarks: _____

2. **Performance Monitoring** Type of monitoring _____

☐ Performance not monitored

Frequency _____ ☐ Evidence of breaching

Head differential _____

Remarks: _____

IX. GROUNDWATER/SURFACE WATER REMEDIES ☒ Applicable ☐ N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines ☒ Applicable ☐ N/A

1. **Pumps, Wellhead Plumbing, and Electrical**

☒ Good condition ☐ All required wells properly operating ☒ Needs Maintenance ☐ N/A

Remarks: Most wells found locked and rusted; pump and treat stations should be dismantled as they are no longer in use and are in disrepair.

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**

☐ Good condition ☐ Needs Maintenance

Remarks: _____

3. **Spare Parts and Equipment**

☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided

Remarks: There are many structures and various parts (e.g., piping) that are no longer in use or in disrepair and should be dismantled.

B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ☒ N/A

1. **Collection Structures, Pumps, and Electrical**

☐ Good condition ☐ Needs Maintenance

Remarks: _____

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances**

☐ Good condition ☐ Needs Maintenance

Remarks: _____

3. **Spare Parts and Equipment**

☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided

Remarks: _____

C. Treatment System ☒ Applicable ☐ N/A

1. **Treatment Train** (Check components that apply)

☐ Metals removal ☐ Oil/water separation ☒ Bioremediation

☐ Air stripping ☒ Carbon adsorbers

☐ Filters _____

☒ Additive (e.g., chelation agent, flocculent) Chitin

☐ Others _____

☐ Good condition ☐ Needs Maintenance

☐ Sampling ports properly marked and functional

☐ Sampling/maintenance log displayed and up to date

☐ Equipment properly identified

☐ Quantity of groundwater treated annually _____

☐ Quantity of surface water treated annually _____

Remarks: Recovery wells not marked or locked.

2. **Electrical Enclosures and Panels** (properly rated and functional)

☐ N/A ☐ Good condition ☒ Needs Maintenance

Remarks: Electrical lines found low lying across parts of site. Electrical boxes disassembled on ground.

3. **Tanks, Vaults, Storage Vessels**

☐ N/A ☐ Good condition ☐ Proper secondary containment ☐ Needs Maintenance

Remarks: Holding tank is no longer in use and should be dismantled.

4. **Discharge Structure and Appurtenances**

☒ N/A ☐ Good condition ☐ Needs Maintenance

Remarks: _____

5. **Treatment Building(s)**

☐ N/A ☐ Good condition (esp. roof and doorways) ☐ Needs repair

☐ Chemicals and equipment properly stored

Remarks: Pump and treat buildings are in disrepair and should be dismantled.

6. **Monitoring Wells** (pump and treatment remedy)

☒ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition

☒ All required wells located ☐ Needs Maintenance ☐ N/A

Remarks: Most wells were locked and rusted. Few were unlocked or uncovered completely.

D. Monitoring Data

1. **Monitoring Data**

☐ Is routinely submitted on time ☐ Is of acceptable quality

2. **Monitoring data suggests:**

☐ Groundwater plume is effectively contained ☐ Contaminant concentrations are declining

E. Monitored Natural Attenuation	
1.	**Monitoring Wells** (natural attenuation remedy) ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A Remarks: _____
X. OTHER REMEDIES	
If there are remedies applied at the site and not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.	
XI. OVERALL OBSERVATIONS	
A.	**Implementation of the Remedy**
	Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.). The remedy was designed to cleanup the soil and ground water contamination.
B.	**Adequacy of O&M**
	Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy. _____
C.	**Early Indicators of Potential Remedy Problems**
	Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future. The soil was cleaned up to older standards and may not meet present day MCLs.
D.	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. _____

Attachment: Site Inspection Team

Wesley Turner, Kentucky DEP
Ken Logsdon, Kentucky DEP
Amanda Knoff, E^2 Inc.
Kristin Sprinkle, E^2 Inc.
Johnny Zimmerman-Ward, E^2 Inc.

Appendix E: Photographs from Distler Brickyard Site Inspection Visit

Locked entrance gate of Distler Brickyard site on Dixie Highway at mile marker 36.

End of fence north of entrance where fence ends along Dixie Highway.

Debris, including bricks and concrete, from the brick kiln and warehouse demolition along Dixie Highway at the Distler Brickyard site.

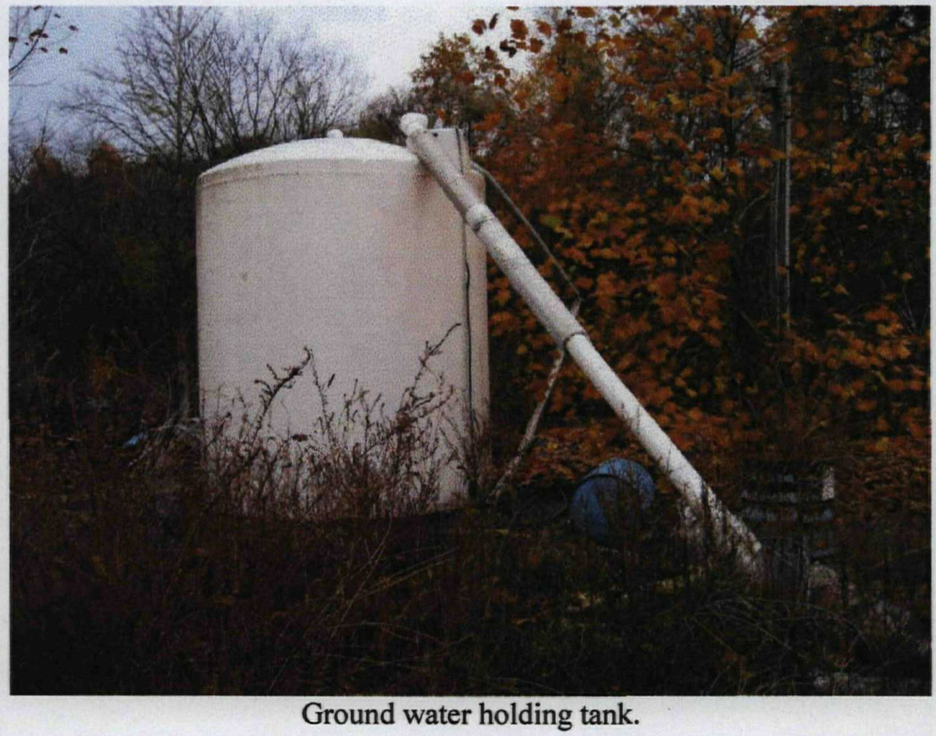
Remains of brick kiln demolitions.

Remnants of warehouse foundation and bridge over Dixie Highway.

USGS observation well UDBP-7.

Recovery well.

Fenced pump and treat system.

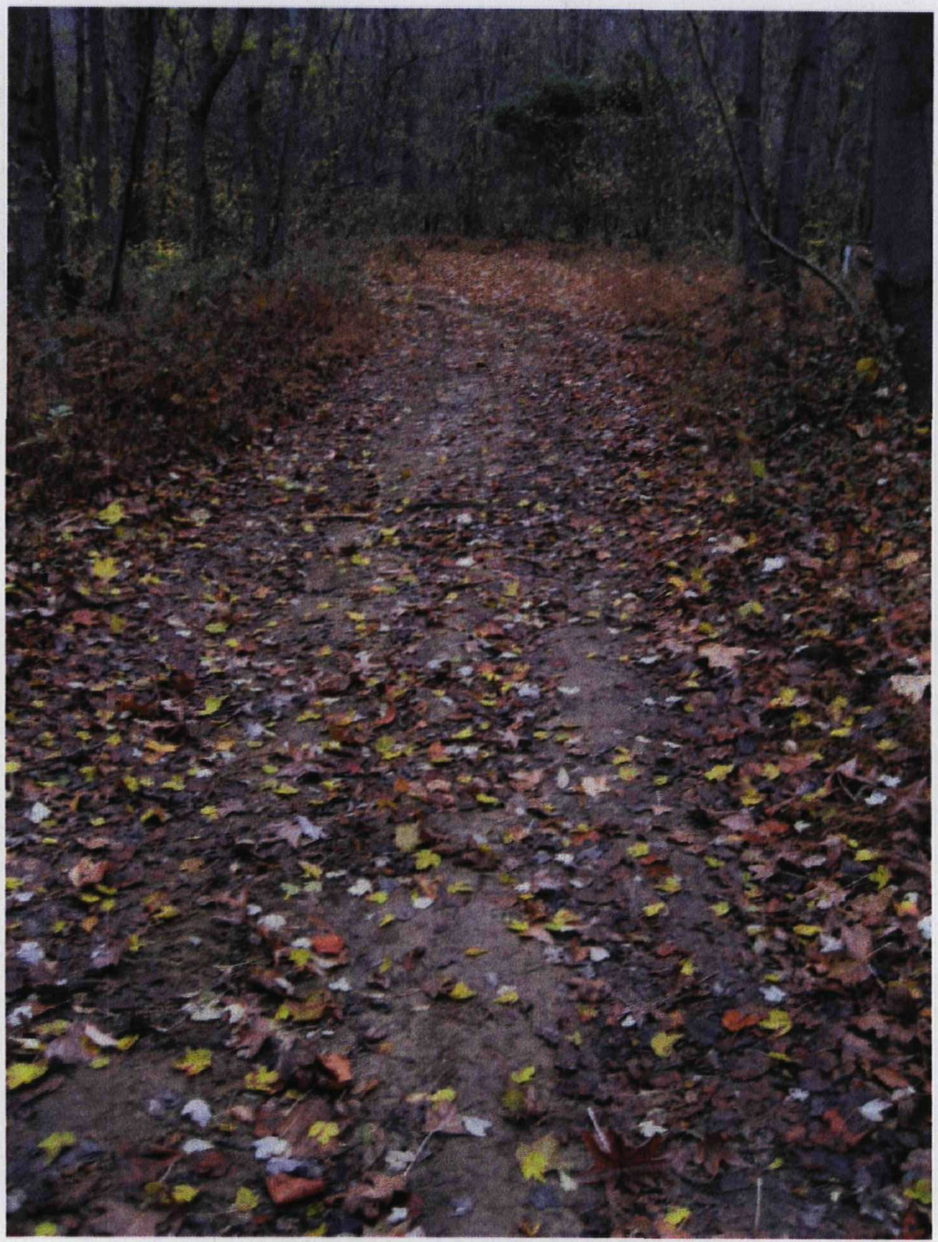


Ground water holding tank.

Well PZ-4.

Kentucky well #8004-7368.

Well UDBP-6.



Dirt road running through site.

Appendix F: North Wind Report: Bioremediation of Chlorinated Solvents in Variably Saturated, Low Permeability Soils

North Wind

April 19, 2005 NW-2005-118

M. Femi Akindele
Senior Project Manager
U.S. Environmental Protection Agency
61 Forsyth St., SW
Atlanta, GA 30303

Subject: Transmittal of *Bioremediation of Chlorinated Solvents in Variably Saturated, Low Permeability Soils: Final Report*

Dear Mr. Akindele:

We recently completed the project in which we evaluated the combination of hydraulic fracturing for enhancing permeability of fine-textured soil and emplacement of chitin for stimulating bioremediation of chloroethenes at the Distler Brickyard site in West Point, Kentucky. This project was funded in part by a National Science Foundation Small Business Innovation Research grant. A copy of the final report that we submitted to NSF is enclosed for your information.

I would like to thank you for your support of this project, and for making arrangements for analytical services at Athens.

I am curious about what you foresee as additional work that will be needed at Distler Brickyard. We would be interested in supporting you in additional work at that site, or at other sites.

Please contact me at 208-557-7878 or bstarr@northwind-inc.com (new email address) if you have any questions or comments.

Sincerely,

Robert C Starr

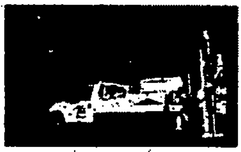
Robert C. Starr, Ph.D., P.E.
Consulting Hydrogeologist

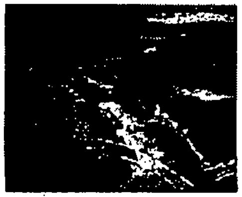
enclosure: as stated

cc: Aran Armstrong, Project Manager

North Wind, Inc. • P.O. Box 51174 • Idaho Falls, ID 83405 • Phone 208.528.8718 • www.nwindenv.com

NW-2005-021
Revision 0





Bioremediation of Chlorinated Solvents in Variably Saturated, Low Permeability Soils: Final Report

Patrick S. Lebow
Robert C. Starr

Submitted by:

North Wind, Inc.
P.O. Box 51174
Idaho Falls, ID 83405

March 2005

NW-2005-021
Rev. 0

Bioremediation of Chlorinated Solvents in Variably Saturated, Low Permeability Soils: Final Report

Patrick S. Lebow
Robert C. Starr

March 2005

North Wind, Inc.
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Idaho Falls, Idaho 83405-1174

Prepared for
National Science Foundation
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CONTENTS

ACRONYMS v

1. INTRODUCTION 1

2. TECHNICAL PROGRESS 2

2.1 Summary of the Research 2

2.1.1 Background 2
2.1.2 Objectives and Tasks 3
2.1.3 Field Activities 4
2.1.4 Laboratory Column Study 8
2.1.5 Conclusions 11

2.2 Problems and Resolutions 11

2.3 Problems Remaining or Unfulfilled Research Objectives 11

2.4 Unexpected or Serendipitous Results 11

3. COMMERCIALIZATION 25

FIGURES

2-1. Map of Distler Brickyard showing approximate distribution of SC-20, SC-40, and SC-80 grades of chitin. 13

2-2. Plan view of the fractures at the Distler Brickyard. Yellow areas indicate fractures filled with SC-80 chitin, orange areas indicate fractures filled with SC-40 chitin, and red areas indicate fractures filled with SC-20 chitin. 14

2-3. Cross-section view of fracture network at the Distler Brickyard viewed from the northeast. Yellow areas indicate fractures filled with SC-80 chitin, orange areas indicate fractures filled with SC-40 chitin, and red areas indicate fractures filled with SC-20 chitin. 14

2-4. Phase II monitoring and fracing locations. 15

2-5. VFAs at Well-B. 16

2-6. VFAs at MW-11. 16

2-7. VFAs at FR-4. 16

2-8. VFAs at MW-16. 16

2-9. Redox parameters at Well-B. 17

2-10. Redox parameters at MW-11. 17

2-11. Redox parameters at FR-4. 17

2-12. Redox parameters at MW-16. 17

2-13. VOCs at Well-B. 18

2-14. VOCs at MW-11. 18

2-15. VOCs at FR-4. 18

2-16. VOCs at MW-16. 18

2-17. Frac from SC-5 (vicinity of FR-8) collected May 2003. 19

2-18. Frac from SC-6 (vicinity of FR-10) collected May 2003. Note lack of staining and presence of non-degraded chitin. Note lack of staining and presence of non-degraded chitin. 19

2-19. Frac from SC-7 (vicinity of FR-3) collected Jan. 2004. 19

2-20. Frac from SC-15 (vicinity of FR-5) collected Jan. 2004. Note staining and lack of non-degraded chitin. Note relatively little staining and non-degraded chitin. 19

2-21. Typical fatty acid concentrations observed with different grades of chitin in the batch bottle experiments. A) SC-20; B) SC-40; C) SC-80. 21

2-22. Typical chloroethene profiles observed with different grades of chitin in the batch bottle experiments. A) SC-20; B) SC-40; C) SC-80. Arrows indicate spikes of 0.75 μL TCE. 22

2-23. Semi-batch column set up. 23

2-24. Typical fatty acids observed in the effluents of semi-batch columns containing three different grades of chitin at high (1:5) and low (1:15) and ratios with sand. Chitin grade and mass loading are indicated in the upper left of each plot. A) Column 8; B) Column 9; C) Column 3; D) Column 11; E) Column 12. 24

TABLES

2-1. Fracture slurry composition. 12

2-2. Coring locations in the treatment cell. 20

2-3. Comparative summary of performance of the different chitin grades tested in the batch bottle experiment, including average pH, average fatty acid concentrations, and average final ethene concentrations. Values listed are duplicate averages. 23

2-4. Comparative summary of performance of the different chitin grades tested in the semi-batch column experiment, including average pH, average fatty acid concentrations, and average final ethene concentrations. 23

ACRONYMS

ARD	anaerobic reductive dechlorination
DCE	dichloroethene
DNAPL	dense non-aqueous phase liquid
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ESTCP	Environmental Security Technology Certification Program
FFC	follow-on funding commitment
MCL	maximum contaminant level
MW	monitoring well
NSF	National Science Foundation
PCE	tetrachloroethene
RCRA	Resource Conservation and Recovery Act
SBIR	Small Business Innovative Research
TCE	trichloroethene
VC	vinyl chloride
VFA	volatile fatty acid
VOC	volatile organic compound

Bioremediation of Chlorinated Solvents in Variably Saturated, Low Permeability Soils: Final Report

1. INTRODUCTION

This document is the narrative portion of the final report for a project funded by a National Science Foundation (NSF) – Small Business Innovation Research (SBIR) Phase II grant. The technical report is presented in Section 2, and the commercialization report is presented in Section 3.

2. TECHNICAL PROGRESS

2.1 Summary of the Research

Chlorinated solvents are the most common class of ground water contaminants at hazardous waste sites in the United States. Remediating ground water contaminated by these compounds often presents unique obstacles related to their hydrophobicity and high density. In addition, remediation at sites with fine-grained, low permeability media is complicated by the difficulty in injecting and extracting fluids. Overcoming these obstacles often demands innovation and an interdisciplinary approach that integrates hydrology, geology, chemistry, microbiology, and economics. The research described in this report investigated an innovative approach for stimulating biodegradation in low permeability media. It combines hydraulic fracturing to both create permeable pathways in low permeability media and to emplace material that stimulates microbial biodegradation of contaminants. The material used is a long-lived form of organic carbon (chitin) that stimulates microorganisms that biodegrade trichloroethene (TCE) and other chloroethenes. This Phase II study included an evaluation of the effectiveness and duration of the biodegradation process under field conditions, and a laboratory evaluation of the effectiveness of various grades of chitin.

2.1.1 Background

The Distler Brickyard Superfund Site, located in Hardin County, Kentucky, has TCE and cis-dichloroethene (cis-DCE) in groundwater at concentrations that exceed the federal maximum contaminant level (MCL). These contaminants are located in low permeability, variably saturated sediments. Migration of contaminants from these sediments into the underlying aquifer following precipitation events contaminates the underlying aquifer that is used for water supply. Remediation at this site presents a number of challenges: (1) low-permeability of sediments makes conventional remedial techniques that use injection or extraction of fluids (either liquid or gas) difficult to implement; (2) the zone of contamination is variably saturated due to seasonal fluctuations in precipitation, which limits the effectiveness of remedial methods that rely on injection or extraction of water; and (3) available funding for remediation is limited. Pump-and-treat was previously used at the site but was ineffective in the low permeability sediments where the contaminants were located.

A Phase I test of the Bio-Frac™ process, an innovative technology for enhancing bioremediation in low permeability, variably saturated sediments, was successfully conducted from July 2001 to January 2002. The Bio-Frac™ process combines hydraulic fracturing for simultaneously creating fractures in low permeability media and emplacing a mixture of sand and solid organic carbon into the fractures in order to stimulate biodegradation of groundwater contaminants. Groundwater that flows through the fractures, which are preferential flow pathways, is in intimate contact with solid organic carbon that yields dissolved organic carbon stimulating microbial degradation of TCE and other chloroethenes. Chitin, a natural biopolymer produced by crustaceans, was used as the solid organic carbon material based on lab studies that showed it readily supports biodegradation of chloroethenes. The Phase I study showed that the Bio-Frac™ process is promising as a cost-effective technique for remediating chloroethenes in low permeability media.

The Bio-Frac™ process begins with hydraulic fracturing, in which a fracture is created in the subsurface by injecting liquid at a pressure that is sufficiently high to overcome the in situ stress and the tensile strength of the material. A fracture is initiated at a borehole and propagates radially outward, creating a more-or-less planar feature. The geometry (location and orientation) of the fracture in the immediate vicinity of the borehole is affected by the method used to initiate the fracture, but as the fracture propagates away from a borehole, it tends to become normal to the minor principal stress direction. The fluid used during fracturing is a mixture of water, sand, chitin, and a viscosity-increasing agent. These materials are carried into a hydraulic fracture as it is created. The sand creates a permeable pathway in the otherwise low permeability medium, which acts as a permeable groundwater flow pathway. Chitin is emplaced to provide a source of dissolved organic carbon that stimulates the biodegradation process. The viscosity enhancer improves the ability of the injected fluid to transport the solid sand and chitin particles.

After chitin is emplaced in the subsurface, it ferments and releases dissolved organic compounds, including volatile fatty acids (VFAs) that are readily utilized by microorganisms. Indigenous microorganisms (i.e., the bacteria Dehalococcoides ethenogenes) derive energy by coupling oxidation of organic carbon with reduction of inorganic species (oxygen, nitrate, ferric iron, sulfate), and when these species are depleted, by reducing the chloroethenes in a process known as anaerobic reductive dechlorination (ARD). In ARD, chlorine atoms are sequentially removed from chloroethene molecules in the sequence PCE➔TCE➔DCE➔VC➔ ethene, where PCE is tetrachloroethene (or perchloroethylene), TCE is trichloroethene, DCE is dichloroethene, and VC is vinyl chloride. ARD of TCE occurs only under strongly reducing conditions (i.e., sulfate reducing to methanogenic conditions). Microbial activity in subsurface environments is typically limited by low availability of organic carbon, and the persistence of aerobic or mildly reducing conditions is often an indication that labile organic carbon is poorly available. Hence, adding a supply of labile organic carbon frequently results in enhanced microbial activity, depletion of inorganic electron acceptors (oxygen, nitrate, ferric iron, sulfate), and development of strongly reducing conditions favorable for ARD. The approach of adding labile organic carbon to enhance biodegradation of chloroethenes has been applied at the field scale at numerous sites. The usual approach is to inject organic carbon as a solution, which then mixes with native groundwater during transport through the contaminated region. This approach is impractical in low permeability media due to the low injection rates that can be achieved. A second limitation is that organic carbon in aqueous form is consumed fairly rapidly, and thus reinjection is needed on a fairly frequent basis (e.g., bimonthly). Nonaqueous liquid (e.g., oils) and solid organic materials can be emplaced into the subsurface as a long-lived source of organic carbon, and hence much less frequent injections are needed to maintain biodegradation for long periods. Chitin is used in the Bio-Frac™ process based on previous laboratory evaluations of various long-lived organic materials that indicate that chitin has superior performance to other types of long-lived organic carbon sources.

2.1.2 Objectives and Tasks

Following the successful Phase I study, a Phase II study was undertaken with the overall goal of evaluating and improving the commercial viability of the technology by generating performance data at the field implementation scale. The two objectives included:

1. Evaluating the *effectiveness* of chitin-stimulated biodegradation of chloroethenes, and
2. Evaluating the *longevity* of chitin-stimulated biodegradation.

If the effectiveness and longevity are sufficient in a full-scale application, chitin-fracing will provide a cost-effective solution to the problem of remediating chloroethenes in low-permeability media. Furthermore, elucidating the controls on effectiveness and longevity should lead to improving the cost-effectiveness of the technology. Parallel field and laboratory studies were performed to meet these objectives.

The field effort involved scaling up the technology at the Distler Brickyard Superfund Site in Hardin County, Kentucky, where the Phase I project was conducted. The approach for the Phase II deployment was to create a biologically active zone in the contaminant source area, thus achieving complete ARD of chloroethene contaminants within this source and preventing downgradient migration of contaminants. To do this, additional fracing wells were installed in the source area near the Phase I fracing well (Well-B) to distribute chitin throughout most of the chlorinated solvent source area. Groundwater monitoring and analysis of soil cores over a nearly 2-year period were used to evaluate the efficiency and longevity of the process.

. The laboratory effort focused on investigating chloroethene degradation and chitin longevity with different grades of chitin and various chitin-loading conditions. Laboratory columns were constructed using three types of chitin blended with sand to mimic the material used in the hydraulic fracturing process. The columns were inoculated with a mixed microbial culture capable of completely dechlorinating TCE to ethene. TCE-spiked water was periodically injected into each column, and concentrations of various biogeochemically important constituents were determined in effluent samples. Information from the field and lab studies was used to optimize the Bio-Frac™ process in terms of chitin cost, longevity, and performance, which will help enhance commercial viability of the technology.

The field-based tasks included the following:

- *Task 1 – Chitin Fracing.* Creation of a network of chitin- and sand-filled fractures in the fine-textured, low permeability soils where dissolved chloroethene contaminants were present.
- *Task 2 – Groundwater Monitoring.* Groundwater samples were collected and analyzed to monitor the evolution of strongly reducing conditions needed for ARD of TCE to occur, to monitor production of dissolved labile organic carbon from the solid chitin emplaced into the subsurface, and to monitor biodegradation of chloroethenes.
- *Task 3 – Soil Coring.* Soil cores were collected on two occasions from the area where hydraulic fracturing was conducted to determine the location of chitin- and sand-filled fractures, and to assess the longevity of chitin in the subsurface.

The laboratory study addressed a single task, as follows:

- *Task 4 – Laboratory Column Study.* Lab columns were used to investigate chitin longevity and chloroethene degradation as a function of chitin grade and the ratio of chitin to sand. Chitin grade is of interest because the more refined grades of chitin are substantially more expensive than the least refined grade. The chitin:sand ratio is relevant because both chitin and sand must be injected during the hydraulic fracturing process. Chitin is injected to stimulate microbial activity, and sand is injected to provide permeable pathways in the subsurface.

Field activities are described in Section 3.1.3, and laboratory studies are discussed in Section 3.1.4.

2.1.3 Field Activities

Phase II field activities included three tasks:

1. Chitin-fracing,
2. Groundwater monitoring, and
3. Soil coring.

2.1.3.1 Task 1 - Fracture Emplacement and Mapping—The chitin-fracture network was created April 27 – May 2, 2003. Thirty-three individual hydraulic fractures were initiated from 10 boreholes, and 4,700 lb of chitin were injected into the subsurface. Details of the injection program are summarized in Table 2-1. Three different grades of chitin – SC-80 (the refined chitin used in the Phase I pilot test), SC-40 (a semi-refined chitin), and SC-20 (unrefined chitin) – were injected to compare the performance of the different grades (Figure 2-1). The chitin:sand mass ratio was varied to determine the optimum ratio that can be successfully injected.

Hydraulic fracture location and orientation were determined for 32 of the 33 fractures via tiltmeter surveys. Creating a fracture in the subsurface concurrently causes ground surface deflections that can be measured using a network of tiltmeters. Tiltmeter data indicate that the fractures propagated approximately 15 to 20 ft from the boreholes in which they were initiated. This finding indicates that a given volume of aquifer could be remediated via hydraulic fracturing using substantially fewer boreholes than techniques such as direct push, which affect a smaller radius from the point of injection. For example, about 550 direct push locations would be needed to treat a 1-acre site if the radius of influence was 5 ft, but only about 60 boreholes would be needed to implement a hydraulic fracturing approach if the radius of influence was 15 ft. The areal coverage of the fracture network was greater than 75%, and the fractures extended in the vertical dimension from bedrock to a few feet above the water table (approximate 25-ft depth) (Figures 2-2 and 2-3). Fracture orientation correlated with soil texture, with more horizontal propagation in finer textured soils (silt and clay) and more vertical propagation in coarser textured soils (sand).

2.1.3.2 Task 2 - Groundwater Monitoring—The groundwater monitoring task included installing eight new monitoring wells (MW-10, MW-11, MW-12, MW-13, MW-14, MW-15, MW-16, and MW-17), completing fracing boreholes as monitoring wells (FR-3, FR-4, FR-8, and FR-10), and sampling new and existing wells (Figure 2-4). Existing monitoring locations include the five wells from the *Phase I Pilot Test (Well B [Phase I fracing well], Well C*, RW-9, RW-11, and GW-11).

Ten rounds of samples were collected between April 2003 and November 2004, including one baseline sampling round (April 2003), three monthly sampling rounds (May - July 2003), and six quarterly sampling rounds (September 2003 – November 2004). Analytes included water levels, VFAs, redox indicators (dissolved oxygen, nitrate, ferrous iron, sulfate, and methane), and contaminants and degradation products (chloroethenes, ethene, chloroethanes, and ethane). Dissolved oxygen, nitrate, and ferrous iron were measured on-site, while the rest of the parameters were analyzed at fixed labs.

Substantial concentrations (>100 mg/L) of VFAs were distributed throughout the system almost immediately following chitin emplacement, clearly indicating that chitin rapidly releases labile organic carbon after emplacement (Figures 2-5 through 2-8). VFA concentrations were highest at MW-13, with hexanoate at 3,665 mg/L, acetate at 874 mg/L, and propionate at 215 mg/L one week after chitin emplacement. Hexanoate was the dominant VFA produced throughout the system, followed by acetate. These results are consistent with the laboratory study, which showed that hexanoate was the dominant VFA produced from SC-20 chitin. High concentrations of VFAs were observed almost immediately following chitin emplacement and persisted in the treatment cell for approximately 6 months. Peak VFA concentrations throughout the system were observed within 1 to 2 months following chitin emplacement. Within 6 months of chitin emplacement, VFA concentrations were significantly lower than immediately after chitin emplacement. One year after chitin emplacement, VFAs were depleted throughout most of the area. Higher concentrations of VFAs remained in portions of the treatment cell, with significant concentrations of butyrate observed in two of the downgradient locations (MW-16 and MW-17). VFA concentrations remained highest at MW-13 throughout the test, with measurable concentrations of formate and butyrate at this location 18 months following chitin emplacement. These data indicate that chitin is an effective slow-release electron donor, with VFAs from chitin degradation present in significant quantities for approximately 1 year after chitin emplacement. This demonstrates that chitin is a long-lived electron donor, and thus it is reasonable to expect that biodegradation of chloroethenes would be stimulated for at least 12 months after chitin injection.

Chitin injection affected redox conditions, generating strongly reducing conditions within 1 week of chitin emplacement. Prior to chitin emplacement, redox conditions at most of the site were iron-reducing, which are not sufficiently reducing for ARD to occur. Redox conditions in the vicinity of the Phase I test were more reducing than elsewhere due to the previous injection of chitin. The development of more strongly reducing conditions was indicated by increasing concentrations of ferrous iron, decreasing sulfate concentrations, and increasing methane concentration (Figures 2-9 through 2-12). The observed sulfate reducing to methanogenic conditions are favorable for ARD. By the end of the study (18 months after chitin emplacement), redox conditions were returning to baseline conditions.

Changes in contaminant concentrations illustrate the overall performance of the remedy. Prior to chitin emplacement, the dominant chloroethene was cis-DCE, followed by TCE and VC. Ethene was also observed in the vicinity of the Phase I pilot test. Overall, the highest chloroethene concentrations were observed in the northern portion of the treatment cell (MW-11, MW-15, FR-3, and FR-4). Baseline data from MW-11 and MW-15 showed cis-DCE concentrations of 1,300 and 370 μg/L, respectively. Throughout the rest of the site, cis-DCE concentrations were generally below 100 μg/L (Figures 2-13 through 2-16). One week after chitin emplacement, cis-DCE concentrations dropped and ethene concentrations increased, becoming the dominant compound. These trends demonstrate that biodegradation of cis-DCE to ethene was stimulated by the presence of chitin. These trends were observed sitewide throughout the duration of the test, with contaminant concentrations at most of the site falling to near or below the MCLs within 2 months of chitin emplacement. Volatile organic compound (VOC) concentrations remained at or below MCLs in all of the Phase I pilot test wells (Well-B, Well-C, RW-9, and RW-11). VOC concentrations in the northern portion of the treatment cell, where concentrations were initially greatest, remain above MCLs, but overall showed substantial reduction from baseline concentrations. Baseline sampling at these northern locations showed cis-DCE as the dominant compound, with ethene not detected. November 2004 data indicate that the ethene is the dominant compound at MW-11 and MW-15, and is approximately equal to cis-DCE at FR-3 and FR-4. Again, the trend of decreasing cis-DCE concentrations coupled with increasing ethene concentrations is clear evidence that biodegradation of cis-DCE and TCE occurred. The continued presence of ethene indicates that ARD is still occurring in this zone of the treatment area. Groundwater monitoring data indicate that the presence of VFAs from chitin degradation continued to stimulate complete degradation of chloroethenes for over 1 year. The technology continues to appear very promising for cleanup of this site and other chlorinated solvent contaminated sites.

2.1.3.3 Task 3 – Soil Coring—Two rounds of soil coring were performed to evaluate changes in chitin over time and to document the location of fractures for comparison to the inferred locations based on tiltmeter data. Soil cores were collected immediately after fracing and about 8 months after fracing (May 2003 and January 2004). Six locations were cored in May 2003 and 10 were cored in January 2004. At each location, samples were collected from ground surface to bedrock (typically 40 to 50 ft). Six locations cored in January, which were adjacent to the locations cored the previous May, were used to assess changes in chitin with time. The remaining locations were cored to document the location of chitin- and sand-filled fractures to validate the tiltmeter data interpretation methodology. Table 2-2 lists all of the coring locations in the treatment cell.

The physical appearance of chitin changed during the 8 months after emplacement. Chitin in fractures contained in soil cores collected in May 2003, soon after emplacement in May 2003, was visually unaltered from fresh material, and there was little to no evidence of staining. In contrast, chitin in fractures in core samples collected 8 months after emplacement adjacent to the initial samples was largely depleted, and there was substantial black staining of the sand. The black stain, which is thought to be iron sulfide (pyrite) precipitate, indicates that redox conditions were highly reducing (i.e., that sulfate had been reduced to sulfide and precipitated with ferrous iron). Figures 2-17 through 2-20 show chitin-filled fractures in various stages of decay.

The January 2004 coring event provided a more complete picture of chitin degradation in the subsurface over time. The appearance of chitin in the soil cores varied according to the location of the corehole. Core samples collected near FR-3 included fractures in which chitin was largely depleted and a substantial amount of black precipitate was present, suggesting that chitin degradation had produced strongly reducing conditions. Core samples collected near FR-10 did not intersect any fractures. Fractures in cores collected near FR-4 contained chitin that was less degraded than near FR-3, and less black precipitate was observed. Fractures in core samples collected near FR-4 typically contained relatively undegraded chitin and had little staining. Fractures in samples collected near FR-5 contained relatively unaltered chitin and little staining, although there was a strong odor associated with fermented chitin. These data indicated that the presence of degraded chitin was closely related to strongly reducing conditions.

Another objective of the January 2004 coring event was to verify the subsurface fracture model through coring. The coring locations around FR-5 were selected based on the fracture orientation modeled by the tiltmeter data. The fractures found in these cores were steeply dipping, which agreed with the orientation inferred from tiltmeter data (dip angle of approximately 80-85 degrees for all fractures at this location). Given the low likelihood of intersecting steeply dipping fractures with vertical boreholes, the observation of fractures with the predicted orientation in these samples provides a measure of confidence in the location and orientation of fractures inferred from tiltmeter data. A total of 22 fractures were observed during the coring event: 19 of the 22 fractures were within approximately 3 ft of the depth predicted based on the tiltmeter data. The greatest deviation from the modeled tiltmeter depth was approximately 8 ft. Overall, the fracture depths observed in the cores correlated well with the three-dimensional model of the fractures in the treatment area.

The results of the soil coring data lead to the following conclusions:

- Chitin degrades in the subsurface over time.
- At some locations, visual inspection of fractures indicates that chitin was largely degraded within 8 months of emplacement into the subsurface, but at other locations chitin was only slightly degraded after 8 months. The factors that cause chitin to degrade at different rates in different locations have not been elucidated. Based on observation of relatively fresh chitin in some locations 8 months after emplacement, it can be concluded that chitin will persist for at least 8 months in the subsurface at this site.
- Chitin degradation appears to correspond with development of strongly reducing conditions favorable for precipitation of sulfide minerals, and also favorable for biodegradation of chloroethenes, based on the apparent relationship between dark staining (thought to be sulfide mineral precipitation) and chitin degradation.
- The location and orientation of sand- and chitin-filled fractures observed in soil core samples corresponds well with the location and orientation inferred from tiltmeter data, which provide confidence in the ability to infer the geometry of the fracture network from tiltmeter data.

2.1.3.4 Summary of Field Results and Conclusions—Results from this field study confirm that chitin is a viable electron donor and carbon source for the remediation of chloroethenes. ARD was observed throughout the entire treatment cell. Furthermore, there seemed to be little difference in dechlorination performance between the three grades of chitin. The following conclusions can be drawn from the field study, with respect to chitin longevity, mass loading, and dechlorination performance:

- VFAs from chitin degradation persisted in the treatment cell for over 1 year following chitin emplacement.
- Various ratios of chitin:sand used in this study did not affect dechlorination performance in the field.
- Widespread dechlorination of TCE to ethene was observed.

2.1.4 Laboratory Column Study

The lab study included both a batch study and a semi-batch column study. Both approaches were used to evaluate the effect of chitin type (SC-20, SC-40, and SC-80) and chitin:sand ratio on production of VFAs and degradation of chloroethenes, including both the effectiveness of the process and the longevity of the chitin-enhanced biodegradation process.

2.1.4.1 Batch Study—Duplicate 160-mL serum bottles containing 100 mL anaerobic synthetic groundwater, 0.01 g limestone chips, 0.05 g chitin, and 0.75 µL TCE were prepared for each of three chitin grades. Limestone was added to buffer changes in pH caused by the production of VFAs. At time = 0, the bottles were inoculated with 5 mL of a dechlorinating microbial culture (5% vol/vol). The bottles were sealed with butyl rubber stoppers and aluminum crimp tops, incubated in the dark at room temperature, and monitored for 32 days. During this time, additional 0.75-µL aliquots of TCE were added periodically.

Aliquots were periodically removed and analyzed for VFAs, chloroethenes, and pH. The type and amount of VFAs produced varied between chitin grade. In the SC-20 vials, the predominant VFA was hexanoate, followed by acetate and propionate. In contrast, hexanoate was either a minor constituent or was absent in vials that contained the more refined grades of chitin. In the SC-40 and SC-80 vials, the predominant VFA was acetate, and propionate was present at lower concentrations (Figure 2-21).

Acetate is a good electron donor for reductive dechlorination, and its oxidation has been shown to support the complete dechlorination of PCE to ethene in the presence of syntrophic microorganisms. In previous experiments with chitin, acetate appeared to be the chitin fermentation product primarily responsible for observed dechlorination activity. More complex fatty acids (i.e., propionate, butyrate, and hexanoate) also have the potential to be excellent electron donors after they are further fermented to acetate and hydrogen.

Chitin fermentation products (i.e., VFAs) promoted dechlorination of TCE ultimately to ethene in all of the bottles. The greatest conversion of TCE to ethene was observed in the SC-80 treatments, followed by SC-20, and finally SC-40 (Figure 2-22). Higher ethene concentrations at later times indicate that the extent of dechlorination increased in the bottles with time. The lack of mass balance between the TCE injected in the bottles and the resulting products could be due to preferential sorption of TCE and DCE to the butyl rubber stoppers, or because of difficulties in sampling VC and ethene through the aqueous phase.

The pH remained slightly alkaline for each of the three chitin grades. The greatest change occurred with SC-80, the most refined grade, in which pH dropped from 7.6 to 7.3 over the month-long experiment. Presumably, the greater pH shift with the most refined grade indicates that the refining process removes material that contributes to alkalinity, such as carbonate shell fragments. No pH value was so extreme as to inhibit ARD.

The results of the batch study are summarized in Table 2-3. The SC-20 and SC-80 vials had similar production of VFAs in terms of total molar concentration, although the types produced differed, and similar production of ethene. The SC-40 vials produced about one-fifth as much VFAs and one-seventh as much ethene. These data suggest that SC-40 has inferior performance relative to either SC-20 or SC-80.

2.1.4.2 Column Study—The relatively slow reaction kinetics require residence times in a column on the order of days to weeks. To circumvent practical problems in column studies with continuous flow at the low flowrates that would be needed to produce residence times in this range, columns were operated in semi-batch mode. This mode involves periodically injecting fresh solution into a column and then stopping flow to allow biogeochemical processes to occur under quiescent conditions analogous to a batch study. After the quiescent incubation period, which was 2 to 20 days in this study, flow through the column is reestablished to simultaneously infuse the column with fresh solution and displace solution that has resided in the column throughout the incubation period. Samples of the column effluent are then collected for analysis. Semi-batch columns were packed with quartz sand, limestone, and one of three different grades of chitin: SC-20 (least refined); SC-40; or SC-80 (most refined). The columns were then inoculated with a microbial culture that can completely dechlorinate PCE and TCE to ethene. Each grade of chitin was evaluated at two different mass loading ratios: 1:15 or 1:5 (chitin:sand).

For each experiment, a stainless steel column containing sand, limestone, and chitin (i.e., chitin column) was connected in series with another stainless steel column containing sand, limestone, and dechlorinating cultures (i.e., dechlorinating column) (Figure 2-23). The chitin columns were packed with a mixture of quartz sand, limestone, and SC-20, SC-40, or SC-80 purified chitin. Limestone was added at a mass ratio of 1:5 with chitin to buffer changes in pH caused by the production of VFAs. The dechlorinating columns were packed with quartz sand and limestone and inoculated with the dechlorinating culture. Chitin fermented and produced VFAs in the chitin columns, and the solution in these columns was used as the feedstock for the dechlorinating columns. Dechlorination took place in the dechlorinating columns, which were inoculated with a dechlorinating microbial community.

As in the batch bottle experiment, fatty acid concentrations were observed to increase in all of the semi-batch columns by an elapsed time 4 to 5 days since chitin emplacement in the columns. Examples of typical fatty acid profiles for columns containing the three different grades of chitin at 1:5 and 1:15 mass loadings are shown in Figure 2-24. The type, profile shape, and magnitude of fatty acids generated were dependent primarily on chitin grade and secondarily on mass loading. For example, hexanoate was the dominant fatty acid in the SC-20 columns (average concentration = 43.0 mM) but exhibited significantly lower concentrations in the SC-40 columns (11.51 mM) and was extremely low in the SC-80 columns (0.48 mM). The production of hexanoate appears to be inversely proportional to chitin grade; hexanoate production decreases as the purity of chitin increases. Although the average acetate concentrations throughout the experiment were similar for the three grades of chitin in the first 40 days of the experiment (~15 mM), acetate dominated towards the end of the experiment in columns containing the more pure forms of chitin (SC-40 and SC-80). In the columns with higher mass loadings of chitin (1:5), a dramatic increase in fatty acid concentrations was observed when incubation times were increased after 40 days. In addition to hexanoate and acetate, propionate, isobutyrate, butyrate, isovalerate, and formate were also produced but at much lower concentrations (average concentration over the experiment generally < 2 mM). These fatty acids were especially elevated between days 7 – 15 in most columns.

Dechlorination activity was observed in all of the semi-batch columns. Figure 2-22 illustrates typical chloroethene profiles observed in the semi-batch columns for the different contaminant feed concentrations. The contaminant feed concentrations did not appear to significantly affect the magnitude of dechlorination products produced, indicating that the activity of the dechlorinating cultures was not limited by lack of available electron acceptor. The greatest average ethene production was observed in the SC-80 columns, followed by SC-20, and finally SC-40; however, the performance of SC-80 and SC-20 was within 9%. Although most of the columns exhibited some dechlorination activity of TCE to DCE and VC in the first 47 days of the experiment, significant ethene production was generally not observed until the incubation time was increased to at least 10 days. With longer incubation times (i.e., the elapsed time between sampling events), greater conversion to ethene was observed. Based on the trends of the chloroethene profiles, it is likely that if the experiment was allowed to continue with longer incubation times (e.g., 20 days), complete conversion of TCE, DCE, and VC to ethene would occur.

Table 2-4 summarizes the performance of the different chitin grades tested in the batch experiment in terms of average pH, average fatty acid concentrations, and final ethene concentrations. As in the batch experiment, the greatest pH decline occurred with SC-80. The total production of VFAs was similar in SC-20 and SC-80 columns, although the relative concentrations of VFAs varied between chitin grades. The final ethene concentration, which is a measure of the amount of complete chloroethene biodegradation that occurred, again was similar for SC-20 and SC-80 and substantially lower (about one-third as much) in the SC-40 column. Consistent with the batch study results, the column study results indicate that SC-40 has inferior performance relative to the other two grades, which have comparable performance. Given that the least refined grade (SC-20) is substantially less expensive than the most refined grade (SC-80), SC-20 should be utilized in field-scale implementation of this technology due to the similarities in performance.

Results from this laboratory study confirm that chitin is a viable electron donor and carbon source for the remediation of chloroethenes. The three grades of chitin tested all supported dechlorination activity in both bottle and column experiments. The following conclusions can be drawn from the laboratory study with respect to chitin longevity, mass loading, dechlorination performance, and effectiveness with different contaminant concentrations:

- In general, SC-80 exhibited the greatest longevity and highest fatty acid production, followed by SC-20, and finally SC-40.
- The ratio of chitin:sand (mass loading) did not appear to control the type and concentration of fatty acids as much as the grade of chitin used. When incubation times were increased, however, greater mass loading of chitin did extend the longevity of fatty acid production.
- The greatest conversion of chloroethenes to ethene was observed with SC-80, followed by SC-20, and finally SC-40. However, the performance of SC-20 and SC-80 was similar (within 9%). Since SC-20 performs nearly as well as SC-80 but is significantly less expensive, it would be the best option for use at the field scale.
- The chitin:sand ratio did not significantly affect chloroethene degradation.
- Initial contaminant concentrations did not substantially affect the magnitude of dechlorination products produced, indicating that chitin should support dechlorination in the field for the range of concentrations tested.

2.1.5 Conclusions

The field and lab studies support the following overall conclusions:

- A mixture of chitin and sand was readily injected into the fine-textured soil at the Distler Brickyard site using hydraulic fracturing.
- The geometry (location and orientation) of individual fractures was successfully inferred from tiltmeter data.
- Both the field and lab studies clearly demonstrate that chitin stimulates biodegradation of chloroethenes.
- Chitin fermentation produces VFAs that stimulate microbial activity.
- VFA production and the resulting enhanced microbial activity generate the strongly reducing geochemical conditions necessary for chloroethene biodegradation via ARD to take place.
- TCE was degraded sequentially to DCE, VC, and ethene in both the lab and field experiments. Hence, emplacing chitin into the subsurface is a very effective technique for stimulating biodegradation of chloroethenes.
- The field results indicate that chitin acted as a source of VFAs in the subsurface for 8 to 12 months.
- The lab results indicate that most refined (SC-80) and least refined (SC-20) grades of chitin have superior performance to the intermediate grade (SC-40).
- The performance of SC-80 and SC-20 are similar in terms of the molar concentrations of VFAs produced and the amount of chloroethene biodegradation that occurred.
- The mass loading of chitin (i.e., the chitin:sand ratio) had little effect on the concentrations of VFAs produced or the concentrations of chloroethene degradation products observed. This indicates that even at the lowest ratio used, there was sufficient chitin present to support biodegradation of the chloroethenes mass present. At the field scale, larger chitin:sand ratios would be selected to maximize the length of time in which VFAs are produced from chitin, and thereby stimulate biodegradation of chloroethenes.
- The field results indicate that the maximum chitin:sand ratio used, 0.36:1, could be successfully injected into the subsurface.
- The similar performance of the least refined and most refined chitin grades, coupled with the substantial cost differential between grades, indicates that the less expensive, least refined grade would be the appropriate selection for field-scale implementation.

2.2 Problems and Resolutions

No significant problems were encountered throughout the duration of the study.

2.3 Problems Remaining or Unfulfilled Research Objectives

All research objectives were met for this project.

2.4 Unexpected or Serendipitous Results

The project proceeded as expected.

Table 2-1. Fracture slurry composition.

Well ID	Sand Concentration (lb/gal)	Chitin Concentration (lb/gal)	Chitin Grade	Sand Injected (lb)	Chitin Injected (lb)	Chitin:Sand Ratio (lb:lb)	Slurry Volume (gal)
FR-1	2.1	0.5	SC-80	550	125	0.23:1	260
FR-2	2.1	0.5	SC-40	550	125	0.23:1	260
FR-3	2.1	0.5	SC-40	550	125	0.23:1	260
FR-4	2.1	0.5	SC-20	550	125	0.23:1	260
FR-5	2.1	0.5	SC-20	550	125	0.23:1	260
	2.1	0.6	SC-20	550	150	0.27:1	260
FR-6	2.1	0.6	SC-20	550	150	0.27:1	260
FR-7	2.1	0.6	SC-20	550	150	0.27:1	260
	2.1	0.7	SC-20	550	175	0.32:1	265
FR-8	2.1	0.7	SC-20	550	175	0.32:1	265
	2.1	0.8	SC-20	550	200	0.36:1	265
FR-9	2.1	0.8	SC-20	550	200	0.36:1	265
FR-10	2.1	0.8	SC-20	550	200	0.36:1	265
	2.2	0.3	SC-20	550	75	0.14:1	255
	2.2	0.4	SC-20	550	100	0.18:1	255

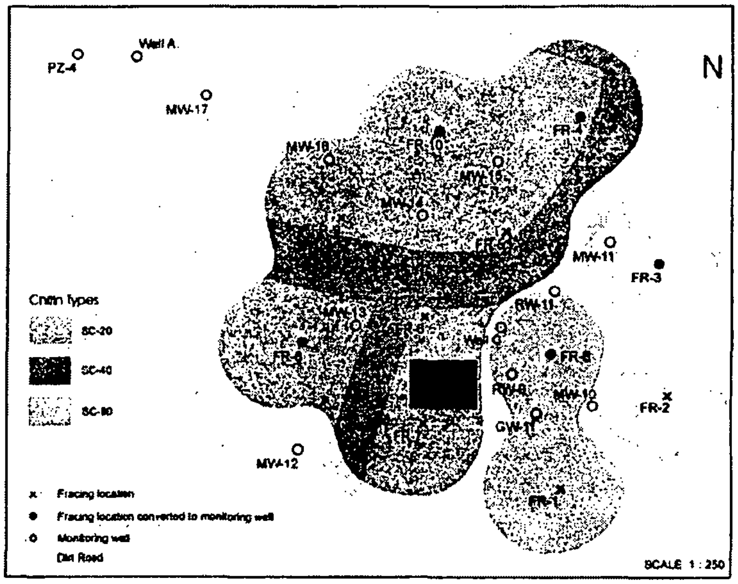

Figure 2-1. Map of Distler Brickyard showing approximate distribution of SC-20, SC-40, and SC-80 grades of chitin.

Figure 2-2. Plan view of the fractures at the Distler Brickyard. Yellow areas indicate fractures filled with SC-80 chitin, orange areas indicate fractures filled with SC-40 chitin, and red areas indicate fractures filled with SC-20 chitin.

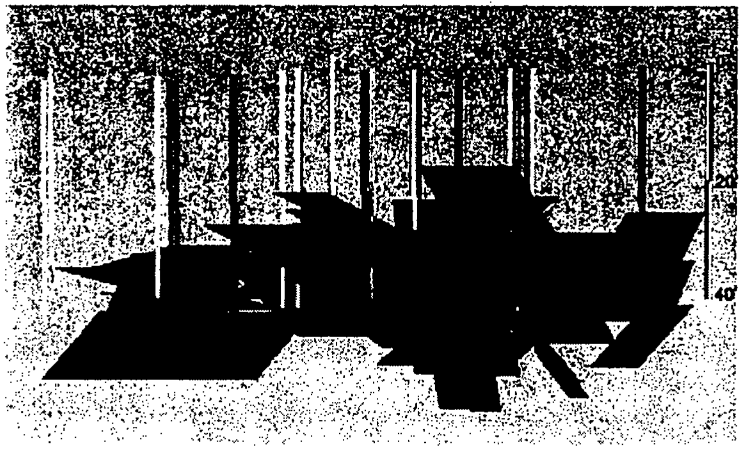

Figure 2-3. Cross-section view of fracture network at the Distler Brickyard viewed from the northeast. Yellow areas indicate fractures filled with SC-80 chitin, orange areas indicate fractures filled with SC-40 chitin, and red areas indicate fractures filled with SC-20 chitin.

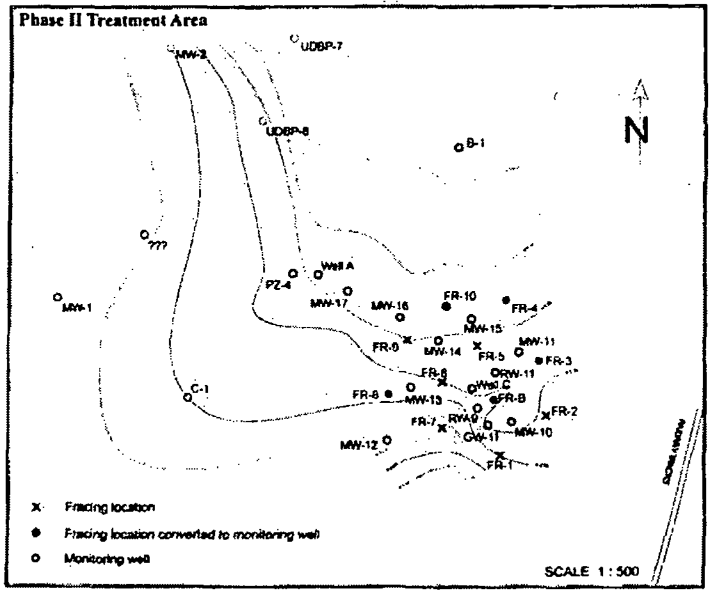

Figure 2-4. Phase II monitoring and fracing locations.

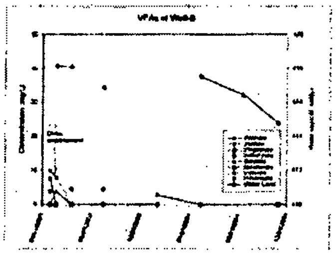

Figure 2-5. VFAs at Well-B.

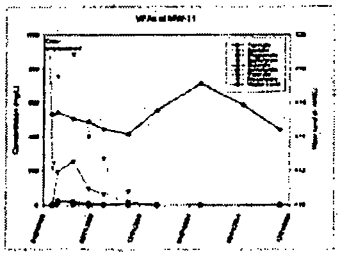

Figure 2-6. VFAs at MW-11.

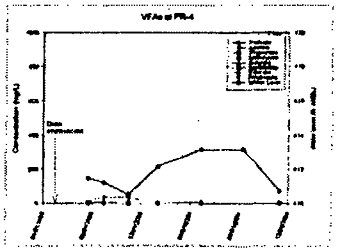

Figure 2-7. VFAs at FR-4.

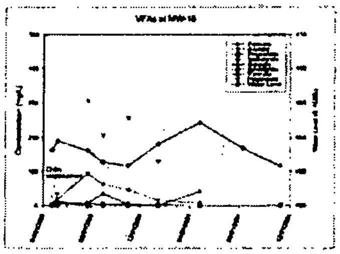

Figure 2-8. VFAs at MW-16.

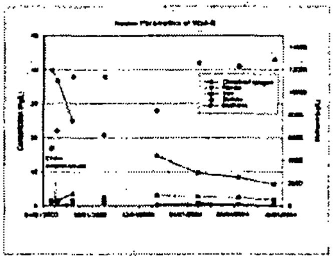

Figure 2-9. Redox parameters at Well-B.

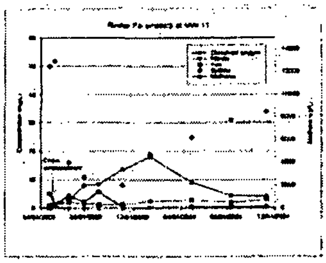

Figure 2-10. Redox parameters at MW-11.

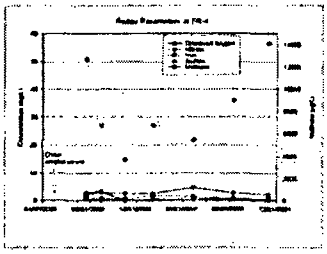

Figure 2-11. Redox parameters at FR-4.

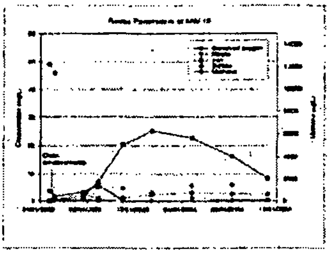

Figure 2-12. Redox parameters at MW-16.

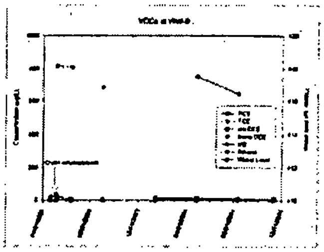

Figure 2-13. VOCs at Well-B.

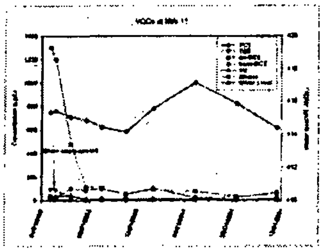

Figure 2-14. VOCs at MW-11.

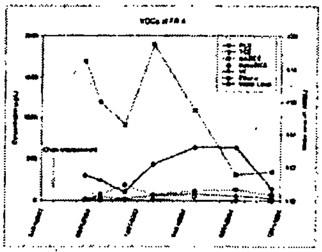

Figure 2-15. VOCs at FR-4.

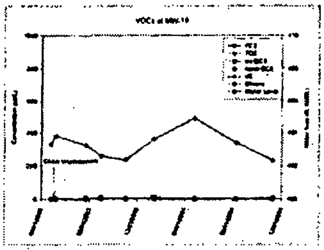

Figure 2-16. VOCs at MW-16.

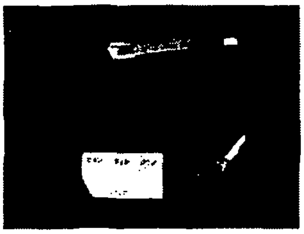

Figure 2-17. Frac from SC-5 (vicinity of FR-8) collected May 2003. Note lack of staining and presence of non-degraded chitin.

Figure 2-18. Frac from SC-6 (vicinity of FR-10) collected May 2003. Note lack of staining and presence of non-degraded chitin.

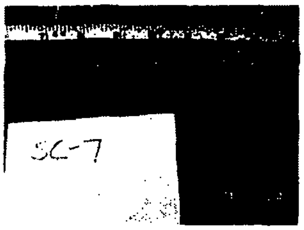

Figure 2-19. Frac from SC-7 (vicinity of FR-3) collected Jan. 2004. *Note staining and lack of non-degraded chitin.*

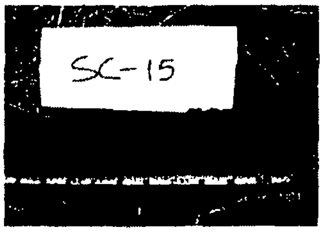

Figure 2-20. Frac from SC-15 (vicinity of FR-5) collected Jan. 2004. *Note relatively little staining and non-degraded chitin.*

Table 2-2. Coring locations in the treatment cell.

Coring Round	Borehole Location	Location of Core
May 2003	FR-3	2 ft to the north (SC-1)
		4 ft to the west (SC-3)
		4 ft to the south (SC-2)
	FR-8	2 ft to the north (SC-4)
		2 ft to the south (SC-5)
	FR-10	1.5 ft to the northwest (SC-6)
January 2004	FR-3	6 ft to the north (SC-7)
		6 ft to the west (SC-9)
		6 ft to the south (SC-8)
	FR-4	3 ft to the north (SC-13)
		3 ft to the northwest (SC-14)
	FR-5	2 ft to the northwest (SC-15)
		2 ft to the southeast (SC-16)
	FR-8	4 ft to the north (SC-11)
		4 ft to the south (SC-12)
	FR-10	4 ft to the north (SC-10)

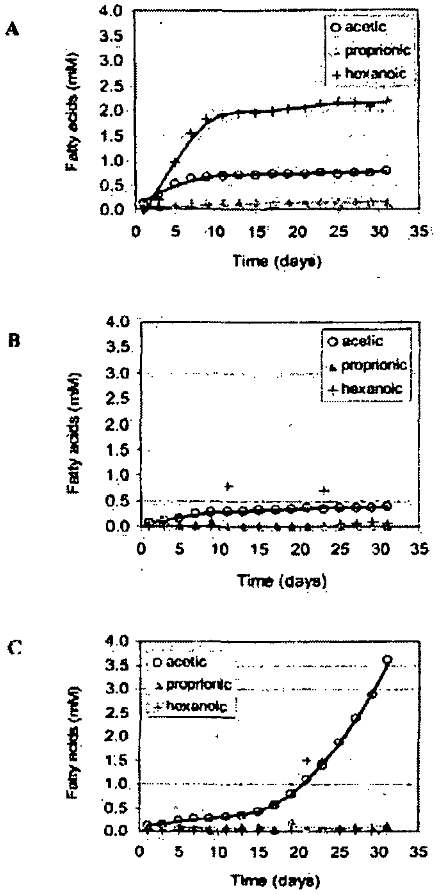

Figure 2-21. Typical fatty acid concentrations observed with different grades of chitin in the batch bottle experiments. A) SC-20; B) SC-40; C) SC-80.

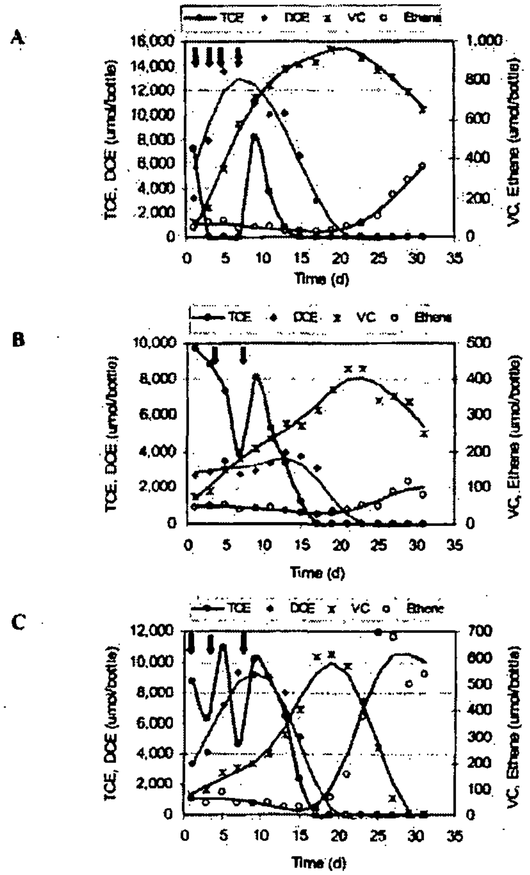

Figure 2-22. Typical chloroethene profiles observed with different grades of chitin in the batch bottle experiments. A) SC-20; B) SC-40; C) SC-80. Arrows indicate spikes of 0.75 µL TCE.

Table 2-3. Comparative summary of performance of the different chitin grades tested in the batch bottle experiment, including average pH, average fatty acid concentrations, and average final ethene concentrations. Values listed are duplicate averages.

	SC-20	SC-40	SC-80
Average pH	7.69	7.57	7.48
Average acetate (mM)	0.65	0.28	1.50
Average hexanoate (mM)	1.53	0.06	0.19
Average propionate (mM)	0.12	0.02	0.09
Sum of VFAs (mM)	2.30	0.36	1.75
Average final ethene (umol/bottle)	228	39	308

Table 2-4. Comparative summary of performance of the different chitin grades tested in the semi-batch column experiment, including average pH, average fatty acid concentrations, and average final ethene concentrations.

	SC-20	SC-40	SC-80
Average pH	7.40	7.18	6.14
Average acetic acid (mM)	11.9	9.6	62.0
Average hexanoic acid (mM)	43.0	11.5	0.5
Average propionic acid (mM)	1.3	1.7	1.6
Sum of VFAs (mM)	46.2	22.8	64.1
Average final ethene (nmol/L)	107	33	117

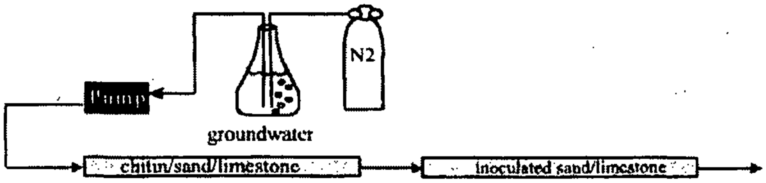

Figure 2-23. Semi-batch column set up.

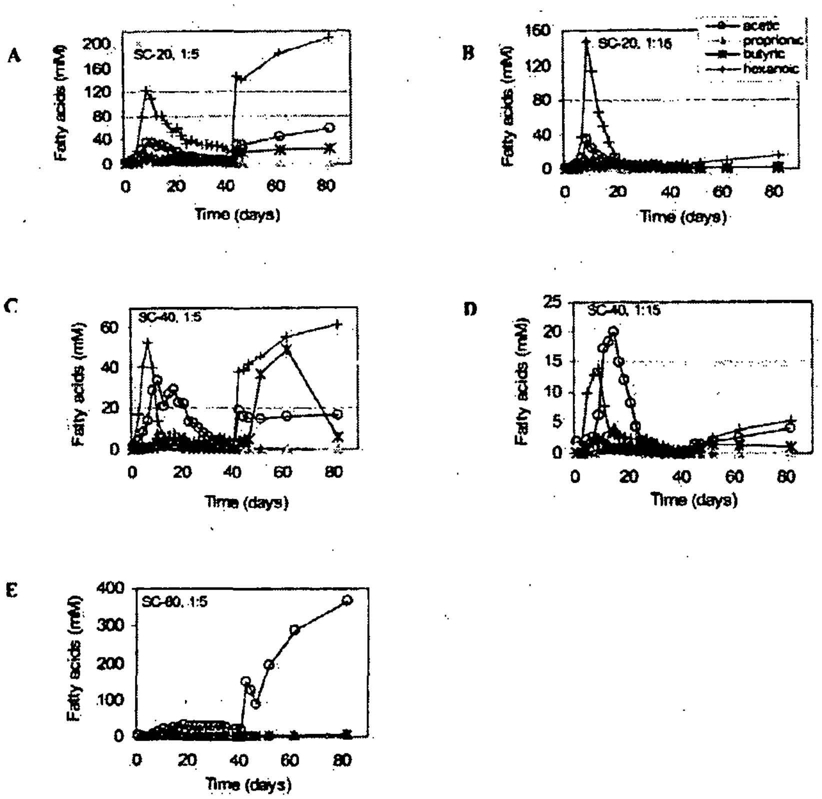

Figure 2-24. Typical fatty acids observed in the effluents of semi-batch columns containing three different grades of chitin at high (1:5) and low (1:15) and ratios with sand. Chitin grade and mass loading are indicated in the upper left of each plot: A) Column 8; B) Column 9; C) Column 3; D) Column 11; E) Column 12.

3. COMMERCIALIZATION

3.1 Part I: Company Data

SBIR Award Number: DMI-0239859
Name of Company: North Wind, Inc. (formerly North Wind Environmental)
Company Address: PO Box 51174 Idaho Falls, ID 83405
Telephone Number: 208-528-8718
Fax Number: 208-528-8714
Email: bstarr@nwindenv.com

Name and Title of the person preparing the report:
Robert C. Starr, Consulting Hydrogeologist.

3.2 Part 2: Follow-On Funding Commitment(s) (FFC)

Was the original FFC exercised? *Not applicable.* If yes, provide the following information:

Date:
Amount:
Source:

If no, provide explanation. Possible reasons for not exercising a FFC include the following:

- Technical objectives not met.
- Technology by-passed in market place.
- Technology not economically viable.
- Other (Explain)—*There was no commitment for follow-on funding from third parties. North Wind intends to fund marketing and proposal preparation activities as an on-going overhead expense following completion of the NSF SBIR Phase II project.*

3.3 Part 3: Were you awarded a Phase IIB supplement? If yes, describe the commercialization activities related to this supplement.

A Phase IIB supplement was not requested.

Two organizations were interested in funding application of this technology at their sites, and the funding from these organizations would have provided the basis for a Phase IIB proposal. The first, a Fortune 500 company, decided to delay making a commitment to fund application of the Low Permeability Aquifer Restoration™ process until after the deadline for submitting a Phase IIB proposal. The second organization, the Department of Defense (DoD), was interested in applying the Low Permeability Aquifer Restoration™ process for remediating contaminated groundwater at an operating military installation. This application would have been jointly funded by the Navy and the Environmental

Security Technology Certification Program (ESTCP). A proposal was submitted to ESTCP in August. Upon notification that the ESTCP proposal was successful, partial matching funds would have been requested through a Phase IIB proposal to NSF. In late October 2004, the ESTCP declined to fund the project. As a result of neither of our potential partners being able to commit funding for deployment, we did not submit a proposal for Phase IIB funding in November 2004. In February 2005, well after the deadline for submitting a request for Phase IIB funding had passed, ESTCP indicated its interest in receiving a revised proposal. A revised proposal will be submitted in 2005.

3.4 Part 4: List any products and/or processes currently in the marketplace, or patents resulting from the SBIR project.

The process of enhancing remediation of fine-grained media by creating hydraulic fractures and emplacing solid electron donor (e.g., chitin) has been entitled the Low Permeability Aquifer Restoration™ process. Trademark protection for this name has been obtained. The Low Permeability Aquifer Restoration™ process is being actively marketed by North Wind, and the results of the NSF-SBIR-Phase II study are instrumental in this marketing effort. Completing the Phase II study and presenting the results at technical conferences will assist this marketing effort.

Two patent applications have been submitted for different aspects of this technology. The first, U.S. Patent Application 10/817,163 (April 1, 2004), applies to the technique of using hydraulic fracturing to place treatment agents into the subsurface. The second, U.S. Patent Application 10/409,635 (April 7, 2003), applies to the use of shell (the chitin source material) as an electron donor for enhancing microbial degradation.

3.5 Part 5: Please furnish the revenues received from the commercialization of this SBIR project, include: Sales, Manufacturing, Product Licensing, Royalties, Consulting, Contracts, Other.

As of December 2004, the Low Permeability Aquifer Restoration™ process has yet to be used on a commercial project. Hence, no revenue has been generated from commercialization to date. However, we fully expect to generate revenue from the Low Permeability Aquifer Restoration™ process by applying it for full-scale remediation of contaminated sites. North Wind is preparing a proposal for applying the technology at a DoD site.

3.6 Part 6: Company Employment and Revenue Data.

	Start of SBIR Grant (1/15/03)	Current (3/31/05)
Number of employees		
Revenue (Total $'s)		
Percent of Revenue from SBIRs (from all agencies)		

3.7 Part 7: Briefly describe the company's efforts to commercialize technology resulting from this SBIR award.

3.7.1 Customer Base

The base of potential customers for the LPA Restoration™ technology is large. The technology is designed to remediate chloroethenes and other chlorinated solvents in low-permeability media, such as fine-textured soil. Chloroethenes and similar compounds are the most common class of groundwater contaminants at hazardous waste sites in the United States. In a list of the 25 most frequently detected contaminants at such sites, the Agency for Toxic Substances and Disease Registry found that 10 of the top 20 were chlorinated solvents or their degradation products, including two of the top three. The same survey found that the most common contaminant, TCE, is present at more than 40% of National Priority List sites. This survey clearly indicates that the types of contaminants that can be remediated by the LPA Restoration™ process are present at numerous sites across the United States. A similar situation exists in other industrialized countries.

A recent review prepared by the Environmental Protection Agency (EPA) (*Cleaning Up the Nation's Waste Sites: Markets and Technology Trends*. US EPA, Office of Solid Waste and Emergency Response, EPA-542-R-04-015, September 2004) indicates that there are about 169,000 hazardous waste sites (excluding 125,000 underground storage tank sites) in the United States that will require remediation. This same review estimates that about 46,000 of these sites have dense, non-aqueous phase liquids (DNAPLs) present. While there is not a one-to-one correlation between chlorinated solvents and DNAPLs, there is a strong correlation, indicating that there are probably tens of thousands of sites where chlorinated solvents are present as DNAPLs. This review reports that VOCs, which include chlorinated solvents, are present at 78% of Superfund sites, 67% of Resource Conservation and Recovery Act (RCRA) Corrective Action sites, 64% of DoD sites, and 38% of U.S. Department of Energy (DOE) sites, and that groundwater is contaminated at approximately 60-80% of these sites. This again suggests that there are at least tens of thousands of sites where groundwater is contaminated with chlorinated solvents that can be remediated using the LPA Restoration™ approach.

Low permeability media are present beneath many, if not most, hazardous waste sites. Low permeability media are the result of alluvial, lacustrine, marine, and eolian deposition, as well as in situ weathering of many rock types. Broad areas of the nation are underlain by low permeability media at relatively shallow depths. Our cities and industrial / commercial areas are often located in areas where low permeability media are present, particularly in river valleys and along the seacoasts. In fact, it is the norm rather than the exception that low permeability media are present in the shallow subsurface. Given the common occurrence of chlorinated solvents at hazardous waste sites and the prevalence of low permeability media, it is reasonable to conclude that the combination of chlorinated solvent contamination and low permeability media is relatively common. Hence, we believe that there are numerous - tens of thousands – of sites in the United States where the LPA Restoration™ technology is applicable.

The customer base includes both Federal sites and private sector sites. In the Federal sector, the primary agencies responsible for remediating contaminated sites are the EPA, DOE, and DoD. In the private sector, numerous types of industries are commonly associated with groundwater contaminated with chlorinated solvents, including the following:

- Electronics and electrical equipment manufacturing,
- Transportation equipment manufacturing,

- Metal products manufacturing,
- Solvent manufacturing, distribution, packaging, and recycling,
- Organic chemical manufacturing, distribution, packaging, and recycling,
- Equipment maintenance,
- Dry-cleaning,
- Instrument manufacturing, and
- Departments of Defense and Energy maintenance and training activities (excerpted from EPA 2004, *Cleaning Up the Nation's Waste Sites: Markets and Technology Trends*).

This document also estimates that there are about 150,000 state and private hazardous waste sites that will require remediation, excluding underground storage tank sites. Again, it is reasonable to conclude that chlorinated solvents are common contaminants at these sites and that low permeability media are present at many of these sites. Hence, we expect that the private sector market for LPA Restoration™ technology is in the tens of thousands of sites.

3.7.2 Marketing and Sales Strategies

Our marketing strategy includes (a) presenting the results of the research at technical conferences, (b) publishing in the technical literature, (c) promotion via exhibitor booths at technical conferences, (d) direct mail, (e) e-mail announcements, (f) publication on our external website, and (g) presentations to clients. As part of our activities for implementing this strategy, North Wind is a sponsor of the Battelle On Site and In Situ Remediation Conference series, which is the premier conference in this arena.

Our sales strategy is to focus primarily on the Federal sector to capitalize upon North Wind's 8(a) status, and secondarily on the private sector. The Federal sector is primarily EPA, DOE, and DoD; these organizations are responsible for most of the Federal contaminated sites. North Wind routinely provides technical assistance to EPA remedial project managers through the Superfund Technical Support Center in Las Vegas, and has worked with members of EPA's Superfund/RCRA Groundwater Forum. We will promote the LPA Restoration™ technology to EPA personnel through these relationships. In addition, the Distler site where the research was conducted is a Superfund site, and EPA Region 4 personnel have been involved with this project. Their involvement will facilitate acceptance of the technology within EPA. North Wind has on-going relationships at four DOE sites (Idaho National Laboratory, Hanford, Sandia-NM, and Oak Ridge), and again we will promote the technology where appropriate to environmental restoration personnel at these and other DOE sites. Finally, North Wind has contract vehicles in place with the U.S. Army Corps of Engineers and with the Air Force Center for Environmental Excellence that will enable projects at DoD sites. In addition, we have an established relationship with the U.S. Navy through providing services at the Seal Beach and North Island sites in California, and by submitting a proposal for applying the LPA Restoration™ process at Naval Air Station North Island, near San Diego. We intend to market the technology to EPA, DOE, and DoD for sites where it is appropriate.

We have recently (November 2004) provided information to the U.S. Army Corps of Engineers – Sacramento District regarding the potential application of the Low Permeability Aquifer Restoration™ process at the Ogden Depot in Utah. We expect to propose use of the Low Permeability Aquifer Restoration™ process at other sites as opportunities become available.

With respect to the private sector, we have discussed application of the LPA Restoration™ technology with a Fortune 500 company that has multiple sites that require remediation. This company is interested in applying the technology at several sites. We have been told that decisions regarding the availability of funding for these projects will be made during mid-2005.

Finally, we expect that our partners will actively seek out opportunities to apply this technology, primarily in the private sector. We have a long standing relationship with JRW Technologies, who is a supplier of chitin and other remediation amendments. JRW Technologies has made a commitment to publicize the success of this research project and to market the technology for remediating subsurface contamination. JRW Technologies would clearly benefit from this technology being successful in the marketplace due to increased sales of chitin. North Wind has established a strategic alliance with FracRite Environmental, a company that applies oil-field technology for solving environmental problems. Frac Rite Environmental developed the technology for emplacing chitin into hydraulic fractures and applied in both Phases I and II of this research. Based on Frac Rite Environmental's participation in this research, they have developed (at no cost to this project) improved tools and techniques for creating fractures in the subsurface. This clearly demonstrates that Frac Rite Environmental believes that there is a viable commercial market for this technology. Frac Rite Environmental will benefit from the commercial success of the Low Permeability Aquifer Restoration™ process by being the sole provider of the emplacement technology, and hence we expect that Frac Rite Environmental will actively market the LPA Restoration™ Technology.

North Wind, Frac Rite Environmental, and Adventus (a manufacturer of remediation amendment products) have entered into a tri-party agreement to promote the use of the FracRite process for emplacing a variety of remediation amendments into the subsurface. This agreement will allow us to apply a variety of amendments, including both chitin and Adventus's proprietary materials, to facilitate remediation of a wide range of contaminants.

3.7.3 Market Readiness / Market Window of Opportunity

The LPA Restoration™ process is ready for full-scale deployment. The marketplace is ready for such technologies. The conventional approach for remediating groundwater contaminated with chlorinated solvents is pump-and-treat, which is widely recognized as being effective for containment, but not remediation, if a contaminant source such as DNAPL remains in the subsurface. Alternative technologies for remediating contaminated low permeability media include excavation and above ground treatment or re-disposal and thermal treatment such as electric resistance heating or steam flushing. Excavation is feasible only to relatively shallow depths and typically above the water table. Excavated contaminated soils require further treatment that requires expenditure of energy and reagents to destroy the contaminants, or simply transfers contaminants to another medium (activated carbon or the atmosphere). Thermal methods can remove large masses of chlorinated solvent from the subsurface; however, they are not completely effective and the contaminants that are removed from the subsurface must be further treated or transferred to another medium. Thermal methods consume very large amounts of energy and the presence of above ground infrastructure precludes use of large areas during the remediation phase.

The LPA Restoration™ process offers a promising alternative to the conventional approaches for remediating low permeability media contaminated with chlorinated solvents. It offers in situ treatment that destroys contaminants, which eliminates trans-media-transfer and the requirement for subsequent above ground treatment. The in situ process reduces risks to workers and the public because hazardous materials are destroyed in situ, which eliminates the potential for personnel exposure. The passive nature of the process leads to low operating and maintenance cost. The lack of above ground infrastructure allows routine use of the site. These benefits are similar to those of in situ permeable reactive barriers, which have become widely accepted during the last decade for remediating permeable media. We anticipate that these benefits of the LPA Restoration™ technology will lead to rapid acceptance by clients.

As mentioned earlier, the market is now ready for the LPA Restoration™ technology to be accepted. We believe that the window of opportunity is on the order of 10 to 20 years, based on our assumption that most sites will have a remedial measure in place before 2025. We do not believe that a 'dark horse' technology will be introduced that is better suited than the LPA Restoration™ technology for remediating low permeability media. Hence, we believe that the LPA Restoration™ technology has a bright future in the next decades. In particular, we do not believe that there is a brief window of opportunity for applying this technology.

3.7.4 Product Life Cycle Financing Strategy

The strategy for financing the entire product life cycle is straightforward. Although funding provided by NSF has been essential to developing the technology and proving it at the field scale, we do not anticipate that substantial additional outside financing will be required to achieve success in the marketplace. The costs needed to achieve commercial success of the LPA Restoration™ process are primarily for marketing and proposal preparation.

The cost of publicizing and marketing the technology is an overhead expense, and will be borne by North Wind, Frac Rite Environmental, and JRW Technologies.

The costs of implementing the technology for remediating contaminated sites will be borne by the site responsible parties. We expect to win contracts to remediate contaminated sites through a competitive bid process. The cost of preparing proposals is a routine overhead expense in the consulting industry. We anticipate continuing to use North Wind's overhead funds to prepare proposals for applying this technology.

Capital costs for implementing the technology are minor. The majority of the equipment needed for creating fractures in the subsurface and then emplacing chitin or other amendments is readily available from subcontractors, and hence capital is not needed for acquiring this equipment. Costs of subcontracts for creating fractures and emplacing chitin will be passed on to the client. The specialty fracturing tools have already been developed and produced by Frac Rite Environmental, and hence capital is not needed for this infrastructure.

In summary, we do not anticipate that additional financing from third parties will be needed to achieve commercial success with the LPA Restoration™ process.

Appendix G: Operation and Maintenance Manual

REVIEW DRAFT

GROUNDWATER EXTRACTION AND TREATMENT SYSTEM OPERATION AND MAINTENANCE MANUAL

DISTLER BRICKYARD
OVERSIGHT AND LONG-TERM REMEDIAL ACTION
Hardin County, Kentucky

Prepared for

BECHTEL ENVIRONMENTAL, INC.
Oak Ridge, Tennessee

USEPA Work Assignment No. 04-4R31
ICF Kaiser Project No. 31274-004-14

Prepared by

ICF KAISER
ENVIRONMENT AND ENERGY GROUP
Pittsburgh, Pennsylvania 15222

December 13, 1994

TABLE OF CONTENTS

Section *Page*

1.0 INTRODUCTION 1-1
  1.1 OPERATOR RESPONSIBILITIES 1-1
  1.2 TREATMENT TYPE AND EFFLUENT LIMITATIONS 1-1

2.0 OPERATIONS AND CONTROLS 2-1
  2.1 PROCESS DESCRIPTION AND OPERATIONS 2-1
    2.1.1 Groundwater Recovery System 2-1
    2.1.2 Groundwater Treatment System 2-7
      2.1.2.1 Filtration 2-9
      2.1.2.2 Carbon Adsorption 2-9
      2.1.2.3 Flow Measuring Device 2-11
    2.1.3 Effluent Discharge System 2-12
  2.2 COMMON OPERATING PROBLEMS AND CORRECTIVE ACTIONS . 2-12
    2.2.1 Groundwater Recovery System 2-12
      2.2.1.1 Groundwater Extraction Pumps 2-13
      2.2.1.2 Air Compressor 2-13
      2.2.1.3 Pipe Insulation (Heat Tracing Tape) 2-14
      2.2.1.4 Electrical Tank Heaters (De-icers) 2-14
      2.2.1.5 Sump Pump 2-14
    2.2.2 Groundwater Treatment System 2-14
      2.2.2.1 Filtration 2-15
      2.2.2.2 Carbon Adsorption 2-15
      2.2.2.3 Flow Measuring Device 2-16
    2.2.3 Trouble-shooting Guidelines 2-16
  2.3 START-UP OPERATIONS 2-19
  2.4 EMERGENCY RESPONSE 2-19

3.0 SAMPLING AND ANALYSIS 3-1
  3.1 PURPOSE 3-1
  3.2 SAMPLING PROGRAM 3-1
    3.2.1 Effluent Quality Monitoring 3-2
    3.2.2 System Operation Monitoring 3-5
    3.2.3 Raw Groundwater Quality Monitoring 3-6

4.0 SAMPLE DOCUMENTATION, PACKAGING AND SHIPMENT 4-1
  4.1 SAMPLE LOG SHEET 4-1
  4.2 TRAFFIC REPORTS (TR) 4-1
  4.3 SAS PACKING LIST 4-2
  4.4 CHAIN-OF-CUSTODY (COC) 4-2
  4.5 SAMPLE PACKAGING PROCEDURE 4-2
  4.6 SHIPMENT 4-3

TABLE OF CONTENTS (Continued)

Section *Page*

5.0 MAINTENANCE 5-1
  5.1 CORRECTIVE MAINTENANCE 5-1
  5.2 PREVENTIVE MAINTENANCE 5-1
    5.2.1 Routine Inspection 5-1
    5.2.2 Lubrication 5-5
  5.3 EQUIPMENT LIST 5-5
  5.4 SPECIAL TOOLS AND INSTRUMENTS 5-5
  5.5 EQUIPMENT INVENTORY 5-5

6.0 OFF-SITE DISPOSAL PROCEDURE 6-1
  6.1 WASTE CHARACTERIZATION SAMPLING 6-1
  6.2 WASTE PACKAGING 6-1
  6.3 TRANSPORTATION 6-2
    6.3.1 Filters 6-2
    6.3.2 Tank Sludge 6-2
  6.4 DOCUMENTATION 6-3

List of Figures

Figure *Page*

Figure 2-1 Groundwater Remediation System Layout 2-2
Figure 2-2 Extraction Well Construction Diagram 2-3
Figure 2-3 Piping and Instrumentation Diagram of Control Panel 2-5
Figure 2-4 Holding Tank Construction Diagram 2-6
Figure 2-5 Groundwater Treatment Process Flow Diagrams 2-8
Figure 2-6 Lead Lag Arrangement for Carbon Filters 2-10

List of Tables

Table *Page*

1-1 Summary of Detected Analytes in Groundwater from the Accumulation Tank and Respective MCLs 1-3

2-1 Trouble-shooting Guide 2-17

3-1 Sampling Requirements 3-3
3-2 Recommended Sampling Schedule 3-4

5-1 Minimum Log Book Records Required 5-2
6-2 Recommended Inspection Checklist and Schedule 5-3

TABLE OF CONTENTS (Continued)

Section *Page*

5-3 Equipment/Material List and Nameplate Data 5-6
5-4 Special Tools and Instruments List 5-8

Appendices

Appendix A Ejector Pump Manuals
Appendix B Air Compressor Manual
Appendix C Heat Tracing Tape Manual
Appendix D Tank and Berm Manual
Appendix E Tank De-Icer Manual
Appendix F Sump Pump Manual
Appendix G Cartridge Filter and Carbon Filter Manuals
Appendix H Flow Meter Manual
Appendix I Sample Log Sheet Example
Appendix J Organic and Inorganic Traffic Reports Form Instructions and Example Reports
Appendix K SAS Packing List Instructions and Example
Appendix L Chain-Of-Custody Form
Appendix M Sample Tag Instructions and Example

1.0 INTRODUCTION

This manual is to be used as a guide to properly operate and maintain the groundwater remediation system at the Distler Brickyard Site. In addition, a sampling program, residual material and disposal procedures are provided.

1.1 OPERATOR RESPONSIBILITIES

The operator's responsibilities are as follows:

1. To provide a clean effluent for discharge by operating and maintaining all equipment and instruments properly and in accordance with the procedures outlined in this manual;
2. To maintain accurate operation and maintenance (O&M) records to evaluate system performance;
3. To maintain accurate sampling records to track data and to schedule laboratory analyses and delivery of laboratory bottles; and
4. To maintain accurate disposal records to track waste and to schedule pick-ups.

1.2 TREATMENT TYPE AND EFFLUENT LIMITATIONS

Physical applications are employed to remove chemicals of concern (COC) from the groundwater at this site. The treatment system is designed for greater than 99% removal of volatile and semi-volatile organic compounds and metals at an average design flow rate of one (1.0) gallon per minute (gpm) and a maximum design flow rate of five (5.0) gpm, continuously. The treatment system, at a minimum, will remove COCs from the raw groundwater to Record of Decision (ROD) concentration levels or to Drinking Water Standards, whichever is more stringent, to satisfy the United States

Environmental Protection Agency (USEPA) Underground Injection Control (UIC) discharge guidelines. Table 1-1 provides the designed raw groundwater COC data and the required effluent limitations.

TABLE 1-1

SUMMARY OF DETECTED ANALYTES IN GROUNDWATER FROM THE ACCUMULATION TANK AND RESPECTIVE MCLs
Distler Brickyard

		Sample Number	DB-ST-GW-0001	DB-ST-GW-0001D (2)
Parameter	MCL (1)	Sample Date	(12/6/93)	(12/6/93)
METALS: MG/L (3)				
Arsenic	0.05		0.0023	0.0021
Barium	2		0.1	0.1
Lead	0.015 (4)		0.0031	0.002
Zinc	— (5)		0.03	0.03
VOLATILEORGANIC COMPOUNDS: (MG/L)				
Chloroethane	—		0.057	0.059
1,1-Dichlorethane	—		0.115	0.004
Total 1,2-Dichloroethene	0.07 (6)		0.141	0.141
Toluene	1		0.548	0.591
Trichloroethene	0.005		0.009	0.01
Xylenes	10		0.316	0.331
SEMI-VOLATILEORGANIC COMPOUNDS: (MG/L)				
Bis(2-ethylhexyl)phthalate	—		0.063	0.044
Di(n-butyl)phthalate	—		0.072	0.078
1,4-Dimethylphenol	—		0.023	0.024
2-Methylphenol	—		0.018	0.018
INORGANICS: (MG/L) (DISSOLVED)				
Calcium	—		90.0	
Magnesium	—		37.6	
Manganese	—		0.78	
Iron	—		2.6	
Sodium	—		39.0	
Total Hardness	—		424	
TSS			75.2	
TDS			540	

Notes:

Accumulation tank groundwater samples were analyzed by Microbac using SW-846 methodology.

(1) "MCL" indicates maximum contaminant level.
(2) "D" indicates duplicate samples.
(3) "MG/L" indicates milligrams per liter.
(4) Lead does not have an MCL but has an action level of 0.015 mg/l. Refer to 40 CFR Section 141, Subpart I for source water treatment requirements.
(5) "—" indicates does not have an MCL.
(6) The MCL is 0.07 MG/L for cis 1,2-dichloroethene and 0.10 MG/L for trans 1,2-dichloroethene.

2.0 OPERATIONS AND CONTROLS

This section includes a brief description of each process or instrument and provides the operation standards under normal conditions. In addition, a list of major components and procedures for start-up operations are provided. To aid the operator with common operating problems, a trouble-shooting guideline is provided outlining corrective action procedures for the more common problems. Emergency operations and failsafe features are also discussed.

2.1 PROCESS DESCRIPTION AND OPERATIONS

The groundwater remediation system at this site consists of three separate segments which are (1) groundwater recovery (2) groundwater treatment, and (3) effluent discharge, and are discussed separately. Refer to Figure 2-1 for the layout of the groundwater remediation system.

2.1.1 Groundwater Recovery System

The groundwater recovery system consists of five extraction wells; RW-7, RW-9, RW-10, RW-11, and RW-12, each installed with a low flow pneumatic-type submersible pump. Refer to Figure 2-2 for construction details of the extraction wells. The pneumatic pump operates cyclically in two phases: (1) fill/vent cycle and (2) empty/discharge cycle. The pump chamber fills by gravity and is emptied by compressed air. The cycles are regulated by a timer system located on the control panel in the compressor house. By optimizing the cycle durations, the maximum chamber volume may be achieved to pump as much fluid as possible per cycle. Refer to the manufacturer's manuals provided in Appendix A for procedures on how to adjust the timer to the optimal settings.

The pump's flow rate is regulated by a level sensing device which automatically shuts down and restarts the pump at low and high water levels, respectively. The level sensing device is controlled by compressed air supplied through a bubbler line. The pump should shut off when the level gauge on the control panel indicates less than 3" water column (WC) and should restart when the level gauge indicates 10" WC.

Features on the control panel include: (1) ejector pressure and (2) control pressure. The ejector pressure is the pressure required to empty the pump chamber and lift the well fluid to ground surface (total head). The ejector pressure should be set a value equal to 1 psi for every 2 ft of pump submergence below the ground surface plus 15 psi. The control pressure measures the supplied air flow from the air compressor to all the components which operate by compressed air. It should be set at 70% of the ejector pressure, but not higher than 90%. Refer to Figure 2-3 for piping and instrumentation diagram of control panel.

The extraction pump system is powered by compressed air which is supplied by an on-site air compressor. The air compressor is a two-stage heavy duty unit with an integral 80-gallon-capacity air tank and a 5 HP electric motor. The compressor should be on continuously unless it is shut off by the electromagnetic switch in the holding tank. The maximum (max) operating pressure is 175 psi, and the minimum (min) operating pressure is 145 psi. The pressure switch control automatically stops and starts the motor which drives the compressor at the max and min pressures, respectively. At maximum operating pressure, the compressor delivers air at 17.1 cubic feet per minute (CFM). Refer to Appendix B for the Air Compressor Manual.

The discharge lines are manifolded together inside secondary casing and wrapped with heat tracing tape and insulation to prevent freezing. The tracing tape does not have a built-in thermostat, therefore, it is the operator's responsibility to manually switch the heat on during cold winter weather. The minimum start-up temperature is 40°F. Manufacturer's information is provided in Appendix C. Carbon steel piping is used as secondary casing in the area where piping must cross a gravel roadway.

The extracted groundwater is discharged to a 6,500-gallon holding tank prior to treatment. The tank stands approximately 12 feet high and is constructed of polyethylene. Refer to Figure 2-4 for construction details of the holding tank. Manufacturer's information is provided in Appendix D.

The holding tank normally operates with 14 to 17 inches of water in the tank leaving sufficient space to operate the extraction system for approximately one week without discharging the tank. A lined fiberglass modular 8,000-gallon secondary containment berm is installed around the tank. A high level float switch is installed at the top of the tank to turn the air compressor off if the water level within the tank rises to the top.

Two submersible electric heaters (de-icers) are installed in the tank to prevent stored groundwater from freezing during cold winter weather. The heating device is a copper element with a built-in thermostat and maintains the water temperature around 40°F. The heating element will not operate until the water temperature drops below 40°F. The heater will shut-off automatically when removed from water. The manufacturer's manual is provided in Appendix E. In addition, a 3-inch vent is installed at the top of the tank to prevent excess pressure build-up. The potential for tank leakage due to fractures/cracks from freezing or pressure build-up are therefore reduced significantly with the installation of these two features.

A submersible centrifugal (sump) pump is installed about 1-foot above the bottom of the tank to prevent disturbing deposited solids, and a strainer is attached to the pump's intake to prevent clogging. An automatic control switch is installed with the pump to automatically switch on and off at pre-set water levels above the pump intake. The on level is set at approximately 11.5 inches and the off level is set at approximately 15.5 inches above the pump intake. The maximum delivery capacity for this pump at 6 feet of total dynamic head is 5.0 gpm. Refer to the manufacturer's manual provided in Appendix F for more details.

Stored groundwater exits the tank through 1-inch PVC piping leading from the pump to the treatment building. A check valve is installed in the line to prevent backflow of water from the treatment system into the tank.

2.1.2 Groundwater Treatment System

The groundwater treatment system consists of three processes (1) filtration, (2) carbon adsorption, and (3) effluent flow metering. Refer to Figure 2-5 for flow diagram of treatment system. Filtration in this system is employed as a pretreatment step to reduce operational problems with the carbon filters downstream. Carbon adsorption is the primary treatment processes used to remove chemicals in the groundwater. Effluent flow measurements are necessary for monitoring the total flow through the treatment system. A brief description of each process and its operation are provided below in the order of groundwater flow through the treatment system.

2.1.2.1 Filtration

The type of filtration unit installed at this system is a cartridge filter. It is designed to remove suspended solids greater than 3 μm in size at a maximum flow rate of 20 gpm. The maximum operating pressure is 175 psi. However, for low flow applications, filter pressure should be less than 20 psi when operating. As turbid groundwater passes through the cartridge filter, the larger suspended solids are retained inside the membrane. A noticeable increase in pressure will register at the pressure gauge as solids accumulate in the membrane. When the pressure increase in the cartridge filter is greater than about 15 psi, the spent cartridge filter should be changed with a fresh cartridge filter. Refer to Appendix G for the manufacturer's manual.

2.1.2.2 Carbon Adsorption

The two carbon filters installed in this system are liquid phase adsorbers charged with 95 pounds (lbs.) of 1240 virgin granular activated carbon. Granular activated carbon is most commonly used as an adsorbent due to its unique internal pore structure which gives it a large surface area to which dissolved compounds are adhered. Adsorption occurs when the attractive forces at the carbon surface overcome the attractive forces of the dissolved molecules in liquid. As the liquid passes through the carbon filter, dissolved compounds are adsorbed to the carbon surface. Once the bed does not have room for any more compounds, it is said to be exhausted. Exhaustion usually begins at the top of the filter and proceeds downward. The breakthrough point occurs when chemicals of concern begin to appear in the effluent at low concentrations. Maximum efficiency is obtained if a carbon filter is used until it is fully saturated (i.e., when the levels of the constituent of concern in the effluent reaches the cleanup level).

The two carbon filters at this facility are arranged in series to provide sufficient liquid contact time with the carbon, and to obtain a more efficient usage of carbon by operating in a lead/lag mode. While operating in a lead/lag mode, the lead unit becomes thoroughly saturated before replacement and the lag unit is expected to collect the breakthrough from the lead unit. Replacement of the lead unit will occur before effluent parameters have reached but not exceeded effluent standards. At that time, the lead unit will be disconnected, and the lag unit will be connected to the lead position. A fresh unit will then be reconnected in lag position. Refer to Figure 2-6 for lead lag arrangements.

When carbon unit C-1 is in lead position, the ball valves at units C-1 should remain closed, while the ball valve at unit C-2 should remain open. When carbon unit C-2 is in lead position, the ball valves at both units (C-1 and C-2) should also remain closed. In addition, in order to make C-2 the lead unit, supplemental tubing is required to re-route the flow. Prior to starting up C-2 in lead position, make sure that any quick couples not connected to any tubing are closed (capped off) to prevent flow leakage.

According to the carbon vendor, breakthrough from the first unit is expected to occur following treatment of 125,000 to 150,000 gallons of groundwater. The system will be monitored through sampling and analysis to determine actual replacement needs which will vary based on operating flow rate and duration of operation.

The maximum operating flow rate for the carbon filters is 5.0 gpm at a maximum operating pressure of 12 psig. It should be noted, however, that as the flow rate increases, the liquid contact time decreases, carbon usage rate increases and removal efficiencies decrease. Refer to Appendix G for the manufacturer's manual.

2.1.2.3 Flow Measuring Device

The flow measuring device installed in this system is a turbine flowmeter which is typical of meters used by water companies to measure domestic potable water flows. The meter is mechanically driven by fluid continuously flowing through the measuring chamber. The action of continuously filling and discharging the measuring chamber causes a disc inside the chamber to wobble which in turn results in the rotation of a spindle and drive magnet. The movement is sensed through the meter wall by an electronic sensor which converts each magnet rotation to an equivalent fixed volume of fluid. The rotational velocity of the spindle and drive magnet is proportional to the velocity of the water. To prevent the chamber from plugging, a screen at the intake is supplied. Refer to Appendix H for manufacturer's manual.

Total flow measurements are read directly at the meter. To determine daily flows and average flow rates, simple calculations need to be performed. Daily flows are estimated by subtracting the last recorded total from the most recent total and then dividing by the number of days between recordings. Measurements should be recorded at approximately the same time of day for increased accuracy.

$$\text{Daily Average Flow (gpd)} = \frac{\text{Today's Flow Measurement} - \text{Last Recorded Measurement}}{\text{Number of Days Between Measurements}}$$

The average flow rate is calculated by dividing the daily flow by a conversion factor of 1,440 minutes/day.

$$\text{Average system Flowrate (gpm)} = \frac{\text{Daily Flow (gpd)}}{1{,}440\ m/d}$$

2.1.3 Effluent Discharge System

The effluent discharge system consists of one injection well. The effluent discharge flow rate to the injection well is controlled by the treatment system pressure upstream and flow is regulated by a globe valve in discharge/re-injection line.

2.2 COMMON OPERATING PROBLEMS AND CORRECTIVE ACTIONS

Some common problems that may occur during process operations of the remediation system are presented in this section including instructions on identifying, monitoring, and correcting these problems. As a quick reference, trouble-shooting guidelines are also provided.

2.2.1 Groundwater Recovery System

Most of the common problems that may occur in the recovery system will be due to equipment failure. Therefore, equipment problems and corrective actions are presented in the order of flow through the system. Refer to Section 2.2.3 for quick reference to trouble-shooting problems.

2.2.1.1 Groundwater Extraction Pumps

The most common problems that occur with these pumps are (1) plugged or broken bubbler line, (2) broken air supply line, (3) malfunctioning valves (vent, intake or check), and (4) obstructed discharge lines. A well level indicating 0 inches WC may mean that the bubbler line is broken and a well level reading greater than 60 inches WC may indicate that the bubbler line is plugged. Refer to the manufacturer's manual provided in Appendix A for more details on how to identify and correct bubbler problems.

If air hissing sounds are heard at the supply line during the empty cycle, or a gurgling sound is heard at the well near the depth of the water table, then the air supply line may be broken and needs replacing.

If air hissing sounds are heard at the vent valve and the bubbler gauge indicates a pressure greater than 0 psi, then the vent valve may be malfunctioning and needs to be replaced.

If the pump is cycling properly but is not pumping water, then either (1) the intake valve is worn or obstructed, (2) the check valve is worn or obstructed, or (3) the discharge line is obstructed. Depending on the problem, either remove the obstruction or replace the part.

To completely understand the extraction system, the manufacturer's manual should be read and referred to as problems occur. Problem solving flowcharts are provided in the extraction pump manuals. The supplier is Ejector Systems, Inc. They can be reached directly at 1-800-OIL-LEAK for difficult trouble-shooting problems.

2.2.1.2 Air Compressor

A few of the common problems with air compressors are (1) malfunctioning valves, (2) restricted air intake, (3) leaks, (4) dirty air filters, (5) blown pressure switch diaphragm, and (6) pulley misaligned. Some of the typical symptoms of these problems are (1) insufficient pressures at point of use, (2) air blowing out of inlet, (3) high oil consumption, and (4) vibrations. Refer to the manufacturer's manual provided in Appendix B for more details. In addition, a copy of the manufacturer's trouble-shooting guidelines are provided in Section 2.2.3.

2.2.1.3 Pipe Insulation (Heat Tracing Tape)

Loss of heat and potential fire hazards are the major concerns. A loss of heat may be due to (1) a break in the circuit, (2) a power outage, or (3) physical damage. Refer to manufacturer's manual provided in Appendix C for repair details. A specific splice kit (WinterGard H621) should be used to make the necessary repairs. Physical damage to heat tracing may cause fires at this site. Therefore, the tracing tape and insulation should be inspected frequently for damage.

2.2.1.4 Electrical Tank Heaters (De-icers)

A loss of heat and impurity build-up around the heating elements are the major concerns with the heaters. It may be caused by (1) break in circuit, (2) power outage, or (3) worn copper element. Repair or replace parts depending on the problem. It is very important that impurities such as mud, lime, and/or iron do not build up around the heating element. A ground fault circuit interrupter should be used to prevent overheating of the circuit and potential electric shock. An excess build-up can cause the heating element to melt or burst sending an electric current directly into the water. Refer to the manufacturer's manual provided in Appendix C for further details.

2.2.1.5 Sump Pump

Typical problems that may occur are (1) continuous operation (will not shut-off), (2) operates but does not discharge liquid, (3) does not deliver rated capacity, and (4) cycles continuously. There are several causes for each of the problems. Refer to the manufacturer's manual provided in Appendix F for detailed guidelines for trouble-shooting problems. A copy of the guidelines is provided in Section 2.2.3.

2.2.2 Groundwater Treatment System

The common operating problems and corrective actions for each process in the treatment system are provided in the order of flow through the system. Refer to Section 2.2.3 for quick reference to trouble-shooting problems.

2.2.2.1 Filtration

The most common operation problems that may occur with cartridge-type filters are (1) increase head loss, and (2) leaks. Increased head losses are due to clogged or spent (over-filled) cartridges. A sharp increase in carbon filter pressure (exceeding 12 to 15 psi) or sharp decrease in flow through downstream process are indications that the cartridge is clogged or spent. In any case, the spent cartridge should be replaced with a fresh one. To open the filter housing at the top, a hex-nut wrench is required. Once the top is opened, the cartridge should simply pull out.

Leaks are generally due to poor or loose connections or a worn seal gasket. For leaks that are not visible, a general indication that a leak is present is a loss in filter pressure. To locate the leak, use soapy water in suspected areas and look for bubbles. Depending on the cause of leak, either tighten loose connections or replace the seal gasket.

2.2.2.2 Carbon Adsorption

Common operating problems that may occur with carbon adsorption are (1) channelling, (2) increased head loss, and (3) desorption. Channelling through filter media may be a direct effect of flow rate or may be caused by solids accumulation within the bed. To prevent channelling, the inflow should cover the entire bed surface. The carbon media is most susceptible at start-up when establishing proper flow rate. A good indication that channelling may have occurred is an increase in filtration rate (reduced contact time) and/or a decrease in removal efficiency (early breakthrough).

An increase in head loss may be due to an increase in flow rate or to solids accumulation. An increase in operating pressure of more than 5 psi is an indication of increased head loss. If influent flow exceeds the maximum design flow rate of 5 gpm, then adjustments are required to reduce flow rate through the system. A stop watch should be used to time flow into a graduated bucket to check the influent flow rate. As a double check, measure the rise in water level inside the 6,500-gallon tank to calculate combined flow rate from wells. Compare these values with metered data.

If the increase in operating pressure is not due to an increase in influent flow rate but is due to solids build-up, then backflushing of the carbon filters is required. Backflushing is performed by introducing clean or treated water through the outlet fitting at a flow rate not to exceed 5 gpm. When the effluent is clear, normally within two bed volumes, backflushing is considered complete. In stubborn cases, the top few inches of absorbent and solids may be removed and discarded. This will involve removing the lid from the carbon drum to scrape off the solids build-up. The top layer of carbon should be raked smooth before replacing the drum cover. The cartridge in the filter assembly should also be replaced.

Desorption may occur when there is a sudden drop in concentrations of contaminants in the raw groundwater and the filter media is near saturation, or when a more strongly adsorbable chemical appears in the influent. An indication that desorption may have occurred is when the effluent concentrations are higher than influent concentrations. If desorption should occur, the treatment system should be shut-down for further analyses to determine if an unknown chemical is present in the groundwater.

2.2.2.3 Flow Measuring Device

The most common operation problem with the turbine flow meter is unreliable measurements either due to (1) jammed meter chamber, (2) restrictions in inlet/outlet tubing, (3) malfunctioning pumps, or (4) cold weather. No registered change in total flow is an indication that an obstruction has jammed the clearance between the rotating disc and chamber or has created restrictions in inlet or outlet tubing. Remove obstruction as soon as it is detected.

A sharp drop or increase in totalized flow (erratic readings) may indicate a malfunctioning pump or may be due to cold winter weather. Refer to Section 2.1.1 for pump controls. If erratic readings are due to cold weather, employ a heater to increase the building temperature.

2.2.3 Trouble-shooting Guidelines

Table 2-1 presents diagnostic procedures to identify common operating problems and the corrective actions to amend the problems for each process in the remediation system.

2.3 START-UP OPERATIONS

Refer to manufacturer's manuals provided in Appendices A through H for proper start-up procedures on all system equipment. Before starting the compressor, check the oil level in the compressor crank case and add oil if required. Check pressure switch start/stop control according to directions provided in manufacturer's manual. Refer to manufacturer's manual for further equipment start-up procedures (Appendix B).

Open the air supply valve between the air source and the controller. Check all air lines and flow lines for restrictions and make the necessary adjustments at the control panel as described in the manufacturer's manual for total fluids operation prior to filling the groundwater storage tank. Refer to both manuals provided in Appendix A for start-up procedures.

Prior to filling the storage tank to minimum capacity, check the sump pump for obstructions. Then check the pump on/off level switch according to directions provided in the manufacturer's manual provided in Appendix F.

Prior to initiating flow through the treatment system, make sure that all valves that should be open are opened and that pressure gauges read zero psi. When flow is started, check the flow rate by discharging into a gradiated 5-gallon bucket and timing the flow with a stop watch. Compare values with the flow meter value.

2.4 EMERGENCY RESPONSE

The emergency operations that this manual deals with are spills, overflows, and inadequately treated groundwater. Raw or inadequately treated groundwater may escape the remediation system due to system upsets or spills. The potential for upsets or spills to occur are relatively low since provisions (failsafe features) were installed to prevent such conditions. If either conditions should occur, the Project Operations Engineer, Project Manager and USEPA should be informed of the situation immediately. Give as much of the following information as possible when reporting spills, overflow, or inadequate treatment:

- Name of Facility/Project
- Time and Date Situation Began
- Estimated Volume and Strength of Overflow/Spill
- Circumstances of Conditions
- Corrective Action Taken
- Request for Assistance, if needed.

The phone number for the Project Operation Engineer (presently Lisa Frich of ICF Kaiser) is (412) 497-2313; Project Manager (presently Jim Krueger of ICF Kaiser) (412) 497-2386; and USEPA Project Manager (Femi Akindele) (404) 347-7791, extension 4113.

The failsafe features installed to prevent spills, overflow and inadequately treated groundwater are presented below:

- A submersible centrifugal (sump) pump is installed approximately 1-ft. above the bottom of the tank and operates when the water level in the tank reaches approximately 16 inches.

- Sufficient capacity is provided in the holding tank to allow the extraction well pumps to operate for approximately one week without discharge from the holding tank.

- The holding tank is equipped with a high level electromagnetic switch to shut off the compressor when the water level approaches the top of the tank.

- The holding tank is surrounded by a 2.5 ft. high, 8,800-gallon capacity, containment berm constructed of fiberglass and lined with a flexible polyethylene liner.

3.0 SAMPLING AND ANALYSIS

Provided in this section is a sampling program which details the sampling procedures and frequency for sample collection. In addition, the number and types of sample bottles required for sampling and type of preservative required, if necessary, are provided.

3.1 PURPOSE

A sampling program is required for the three following purposes: (1) monitor effluent quality, (2) monitor system operation, and (3) monitor groundwater quality. Effluent quality monitoring is required to ensure that USEPA UIC discharge guidelines are being satisfied. System operation monitoring is required to identify carbon replacement frequency and to characterize waste such as tank solids and carbon media for disposal. Groundwater quality monitoring is required to evaluate the status of groundwater remediation. In addition, the combined sampling data provides information to evaluate plant efficiencies and operations, to predict potential problems, and to select appropriate corrective actions.

3.2 SAMPLING PROGRAM

In general, sampling for all three purposes will follow the sampling guidelines provided below, but will vary in three elements: (1) sampling location, (2) sampling frequency, and (3) types of analyses.

General Guidelines for Sampling

1. A single sample, referred to as a "grab" sample, will be collected at a sampling port at the indicated sampling frequency for the specified monitoring event. A bailer should be used to sample the raw groundwater from the extraction wells.

2. Fill sample bottles completely to the rim. For water samples, place an open sample bottle beneath the port's discharge outlet, and open the port by turning the valve completely to the right. Close the port by turning the valve completely to the left. When capping bottles, eliminate any air bubbles trapped in sample.

3. Care should be taken to prevent cross-contaminating samples by using clean sampling equipment between each sampling location or by using disposable sampling equipment.

4. Samples for shipment should be prepared to prevent decomposition. To deter the decomposition process, a preservative and/or refrigeration at 4°C may be required. Table 3-1 presents sampling collection details such as the type of preservative, maximum holding time, bottle size and number required for each analysis.

5. Quality control (QC) samples should also be collected to identify potential areas of concern in field and laboratory practices. Table 3-2 presents the recommended sampling schedule for each monitoring program. Included in the schedule are the required QC samples such as duplicates (D), field blanks (FB), trip blanks (TB), equipment blanks (EB), and lab QC samples.

6. Labels identifying samples should be attached to bottles either prior to sample collection or before packing for shipment. At a minimum, the following information is required; sample matrix, sample ID number, parameter for analyses, date collected, and time collected. A corresponding log sheet should be kept of the sampling event. Section 4.0 provides details on sample documentation, packaging and shipment.

3.2.1 Effluent Quality Monitoring

Effluent samples will be collected from the sampling port following the lag carbon unit. This sample should be representative of the discharge to the re-injection well. Refer to Figure 2-6 for sampling port location depending upon lead/lag arrangement. Once per quarter, water samples will be

TABLE 3-2

RECOMMENDED SAMPLING SCHEDULE
Distler Brickyard

Monitoring Event	Matrix	Analysis	Number of Samples	Number of QC Samples				Frequency
				D	FB	TB	EB	
Effluent Quality	Treated Groundwater	TCL Volatile Organics	1	1	1	1		Quarterly
		TCL Semi-volatile Organics	1	1	1			Quarterly
		TAL Metals	1	1	1			Quarterly
	Tank Solids and Carbon Canister[b]	Ignitability	1	1	1			Field determined
		Corrosivity	1	1	1			Field determined
		Reactivity	1	1	1			Field determined
		TCLP Organics and Metals	1	1	1			Field determined
Raw Groundwater	Water	TCL Volatile Organics	5[a]	1	1	1	1	Quarterly
		TCL Semi-volatile Organics	5	1	1		1	Quarterly
		TAL Metals	5	1	1		1	Quarterly

[a] One sample will be collected from each of the five extraction wells.

[b] One sample of the initial spent carbon canister must be assessed for each parameter.

D = Duplicate
FB = Field Blank
TB = Trip Blank
EB = Equipment Blank

collected for analysis of TCL organics (excluding PCBs and pesticides) and TAL metals. In addition, the following QC samples will be collected for each analysis; duplicate, field blank, trip blank (VOAs only), and lab QC samples. Refer to Table 3-2 for the recommended sampling schedule.

3.2.2 System Operation Monitoring

During system start-up, samples will be collected from the sampling port following the lag carbon unit after the system has stabilized. Samples will be analyzed for VOCs to confirm that the system is providing adequate treatment.

The carbon adsorption supplier has determined that approximately 120,000 gallons of groundwater will flow through the system before breakthrough from the first carbon unit is expected to occur. This determination was based on raw groundwater data previously collected. It is anticipated that the lighter, more soluble chloroethane compounds will break through before the heaver, less soluble xylene compounds. When the total flow through the system reaches approximately 110,000 gallons, samples will be collected weekly from the lead unit influent and effluent sampling ports, and analyzed for VOCs with a 24- to 48-hour turnaround time. Once chloroethane breakthrough is observed, the sampling frequency should increase to every two to three days with a 24- to 48-hour turnaround time. Once the effluent chloroethane concentration is approximately equal to the influent chloroethane concentration, the lead carbon unit should be replaced with the lag carbon unit. The lag carbon unit should be replaced with a fresh unit. The lag carbon unit and quarterly effluent monitoring results will ensure that effluent quality is maintained between break through and exhaustion of the lead carbon unit. This sampling scheme will only be conducted once, and will be used to determine the frequency of carbon replacement.

To characterize carbon for disposal, a one-time residual sample of the carbon needs to be collected from the top 6 inches and analyzed for RCRA characteristics (ignitability, corrosivity, reactivity, and toxicity). Samples may be collected using a plastic hand shovel or trowel.

To characterize tank sediment for disposal, solid samples need to be collected from the bottom of the tank each time for RCRA characteristics. Samples may be collected using an Eckman dredge.

In addition to sampling for chemical analyses, QC samples need to be collected during each sampling event for each matrix analysis. Refer to Table 3-2 for the recommended sampling schedule.

3.2.3 Raw Groundwater Quality Monitoring

Raw groundwater samples will be collected from the five extraction wells. Quarterly (every 3 months) sampling will be performed with analyses for TCL organics and TAL metals. Refer to Table 3-2 for the recommended sampling schedule.

5.0 MAINTENANCE

In this section, a maintenance program and schedule are provided. A good maintenance program includes both corrective and preventive measures. Corrective maintenance involves the necessary repair work to get a piece of equipment back in operation. Preventive maintenance involves the necessary work to minimize equipment failure. Preventive maintenance is usually scheduled at convenient intervals based on corrective measures and vendor recommendations.

5.1 CORRECTIVE MAINTENANCE

The diagnostic and corrective measures provided in the troubleshooting guide (Section 2.2.3) are a significant part of maintaining an operable system. Since the frequency to perform certain maintenance items vary, depending on equipment and system operations, a log book should be maintained on-site for weekly entries of operating controls to predict when corrective measures should be executed. Table 5-1 lists the minimal operating controls that should be recorded weekly in a field log book, and organized according to systems.

In addition, any repair work performed, parts replaced, or modifications made to the system should be recorded.

5.2 PREVENTIVE MAINTENANCE

Routine inspection and lubrication of mechanical equipment are also a significant part of maintaining an operable system. These measures are scheduled at appropriate intervals.

5.2.1 Routine Inspection

Table 5-2 provides a scheduled checklist of inspection items for each system. However, schedule is subject to change based on frequency of corrective measures. In addition, manufacturer's manuals should be reviewed for their suggested maintenance care.

TABLE 5-1

MINIMUM LOG BOOK RECORDS REQUIRED
Distler Brickyard

System	Controls**
Groundwater Recovery	control pressure ejector pressure fill time empty time well level gauge reading extraction pump flow rates* water level in holding tank solids level in holding tank
Groundwater Treatment	pre-filter pressure carbon filter pressures total flow daily average flow*
Effluent Discharge	water level in discharge well

* Method and calculations should be provided in log book.
** All system control readings shall be noted weekly.

TABLE 5-2

RECOMMENDED INSPECTION CHECKLIST AND SCHEDULE
Distler Brickyard

System	Item	Schedule
Groundwater Recovery	Pressure gauges at control panel. Make sure pressures are at vendor recommended pressures.	Weekly
	Visually check all air lines, water lines and fittings in the system, which includes compressor, for leaks and for restrictions.	Monthly
	Compressor v-belt for tightness and air filter, cylinder head, motor, fan blades, intercooler and tank for dust. Refer to manufacturer manuals for detail.	Weekly
	Air tank for moisture. Drain water by opening the drain cock at the bottom of the receiver. Refer to manufacturer manual for details.	Weekly
	Compressor oil level. Add as required. Refer to manufacturer manual for details.	Weekly
	Pipe insulation (heat tape) for physical damage.	Monthly
	Copper element of electrical tank heaters (de-icers) for wear and/or impurities build-up.	Monthly
	Tank and berm condition for leaks; especially around tank fittings.	Semi-annually
	Electromagnetic Switch.	Quarterly (every 3 months)
	Sump pump intake and discharge line for obstructions.	Monthly
	Sump pump seals and bearings. Replace if either one is worn. Refer to manufacturer's manual for details.	Annually

TABLE 5-2 (Continued)

System	Item	Schedule
Groundwater Treatment	Pressure gauges in-line. Make sure pressures are at vendor recommended pressures.	Weekly
	Piping and fittings for leaks and for obstructions.	Weekly
	Flow rates (influent, system and effluent). Use stop watch and graduated bucket to compare with meter flow reading.	Monthly
	Ball valve operations. Open and close manually. Check for tight or loose operations.	Monthly
Effluent Discharge	Globe valve operation. Open and close manually. Check for tight or loose operations.	Monthly
General	Measure voltage at control panel at electric-powered motors of compressor and sump pump, and at heat trace tape circuits.	Monthly

5.2.2 Lubrication

Proper lubrication is usually the most important consideration in obtaining maximum service life of equipment. Oil changes must be maintained and recorded. Sample the oil to determine when changes are needed. If oil appears brown/black, then the oil requires changing. If the oil appears milky, then the seals may require repair/replacement.

The only piece of equipment in this remediation system that requires the oil level to be checked and changed at scheduled frequency is the pump of the air compressor. The recommended scheduled oil change for the compressor's pump is every 90 days or 500 operating hours, whichever comes first; and the recommended lubricant is a single viscosity, 30W, non-detergent, compressor oil.

5.3 EQUIPMENT LIST

Table 5-3 lists the equipment and materials used in the groundwater remediation system. Available nameplate data is also provided for ordering replacement parts for the equipment.

5.4 SPECIAL TOOLS AND INSTRUMENTS

Table 5-4 lists the tools and instruments required to perform maintenance and repair work.

5.5 EQUIPMENT INVENTORY

At a minimum, 10 cartridges, 1 Cansorb C-5 canister, a cooler and a set of bottles for next sampling events should be kept in inventory on-site.

6.0 OFF-SITE DISPOSAL PROCEDURE

Those materials on-site that require off-site disposal include: (1) spent cartridges, (2) spent carbon filters and (3) sediment accumulation in the tank. The procedure to dispose of these materials involves: (1) waste characterization sampling, (2) waste packaging, (3) transportation of waste to off-site disposal facility, and (4) documentation.

6.1 WASTE CHARACTERIZATION SAMPLING

The wastes to be disposed needs to be characterized to determine the disposal facility that will accept it (waste.) Refer to Sections 3.0 and 4.0 for wastes that require sampling, sampling procedures, required analyses, and sample documentation.

6.2 WASTE PACKAGING

Pre-transport requirements of generated wastes include: (1) packaging, (2) labeling, (3) marking, (4) placarding, and (5) accumulation time. Supplemental packaging is required for spent filter cartridges. The spent carbon canisters may be transported without repackaging. A vacuum truck can be used to pump and haul the tank sediment offsite. Since filter cartridges will exhaust frequently temporarily store cartridges in a 55-gallon double-lined drum on-site until filled and off-site disposal is arranged. Drums may be double-lined with heavy-duty plastic garbage bags. Cartridges may then be disposed off-site in sealed drums. No further packaging is required, as long as drum is double-lined.

Each drum and carbon filter should be labelled with diamond-shaped label indicating degrees of hazards (based on waste characterization results), and marked with the following words and information prior to transport.

> Hazardous Waste - Federal Law Prohibits Improper Disposal. If found, contact the nearest police or public safety authority or the U.S. Environmental Protection Agency.
>
> Generator's Name and Address ______________________________.
>
> Manifest Documentation Number ______________________________.

The appropriate placards based on waste characterization results should be supplied by the transporter.

Disposal of cartridges should be scheduled at the same time as carbon filters are scheduled for disposal. Therefore, drums that are completely filled with cartridges need to be stored at a temporary collection area. However, the maximum holding period for accumulation is 90 days. Therefore, each drum stored in collection area should be visibly marked with start date of accumulation.

6.3 TRANSPORTATION

6.3.1 Filters

Transportation and disposal of both spent cartridges and spent carbon filters will be handled by Tigg Corporation. Typically, filters disposed by Tigg are incinerated at a licensed hazardous waste disposal facility. For disposal of the first spent filters, a sample of the residual carbon and any data that may be indicative of the waste are required. The disposal facility will perform the waste characterization analysis.

When carbon filters are exhausted, call Tigg Corp. (412/463-5300) and arrange for disposal of filters. Inform them of the number and size of drums to be disposed of and that a fresh carbon filter (Comsorb C-5) is needed. To order fresh filter, Tigg will need:

- Purchase Order Number,
- Ship to address, and
- Bill to address.

6.3.2 Tank Sludge

Disposal of tank sediment should be infrequent. After the sediment has been characterized, a disposal facility needs to be selected that will accept the waste. It is anticipated that even though the sediment may be characterized as non-hazardous, for liability purposes, the waste will be disposed at a licensed hazardous waste facility.

Depending upon the disposal facility selected, transportation of the wastes will be arranged either through the facility or transported by a small local trucking firm that is licensed to transport hazardous waste.

6.4 DOCUMENTATION

A Manifest OMB Control Number 2050-0039 on EPA Form 8700-22, and EPA Form 8700-2AA, if necessary, needs to be prepared each time of shipment. Manifests may be acquired from the State where the waste is disposed. If that state will not supply the Manifest, then acquire a Manifest from the State of Kentucky or from another source.

McCoy & McCoy Laboratories, Inc.
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Madisonville KY 270-821-7375
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NREPC/Division of Waste Mgnt
Attn: Ken Logsdon
14 Reilly Road
Frankfort KY 40601

Batch # :	07051026
Received:	05/10/2007
Reported:	05/17/2007
Client:	KY3875
Page:	1 of 36

Analysis Report

COUNTY: Hardin
FACILITY: Distler Brickyard
I.D. # AI 51824
SECTION: Main
SENT BY: KL BRANCH SFB

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2007 MAY 23 P 3:29
KY. DIV. OF WASTE MGMT.
SUPERFUND BRANCH

NREPC/Division of Waste Mgnt
Attn: Ken Logsdon
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Batch # : 07051026
Received: 05/10/2007
Reported: 05/17/2007
Client: KY3875
Page: 18 of 36

Analysis Report

AF23519 TRIP BLANK Distler Brickyard Collected: 8/2/2005

Test Description	Analyzed	By	Method	Result	Units	Report Limit	Note
1,1,1,2-Tetrachloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1,1-Trichloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1,2,2-Tetrachloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1,2-Trichloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1-Dichloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1-Dichloroethene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1-Dichloropropene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2,3-Trichlorobenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2,3-Trichloropropane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2,4-Trimethylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dibromo-3-Chloropropane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dibromoethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dichloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dichloropropane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,3,5-Trimethylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,3-Dichloropropane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,4-Dioxane	05/14/2007	FAM	SW 8260 B	10 U	ug/l	10	
1-Chlorobutane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2,2-Dichloropropane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2,2-Dichloropropane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Butanone	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Chloro-1,3-Butadiene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-chloroethylvinyl ether	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Chlorotoluene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Hexanone	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
4-Chlorotoluene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
4-Methyl-2-Pentanone	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acetone	05/14/2007	FAM	SW 8260 B	8.9	ug/l	5	
Acetonitrile	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acrolein	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acrylonitrile	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Allyl Chloride	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Benzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromobenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromodichloromethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromoform	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromomethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Carbon Disulfide	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Carbon Tetrachloride	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloroacetonitrile	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	

H-3

NREPC/Division of Waste Mgnt
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Client: KY3875
Page: 19 of 36

Analysis Report

AF23519 TRIP BLANK Distler Brickyard Collected: 8/2/2005

Test Description	Analyzed	By	Method	Result	Units	Report Limit	Note
Chlorobenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloroform	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloromethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
cis-1,2-Dichloroethene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
cis-1,3-Dichloropropene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Dibromochloromethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Dibromomethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Dichlorodifluoromethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Ethyl Methacrylate	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Ethylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Iodomethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Isobutyl Alcohol	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
m,p-Xylene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methacrylonitrile	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methyl Methacrylate	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methylene Chloride	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methyl-tert-Butylether	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
n-Butylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
n-Propylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
o-Xylene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Pentachloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
p-Isopropyltoluene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Propionitrile	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
sec-Butylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Styrene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
tert-Butylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Tetrachloroethene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Tetrahydrofuran	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Toluene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
trans-1,2-Dichloroethene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
trans-1,3-Dichloropropene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
trans-1,4-Dichloro-2-butene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Trichloroethene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Trichlorofluoromethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Vinyl Acetate	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Vinyl Chloride	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	

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Analysis Report

AF23520 8004 - 8173 Distler Brickyard Collected: 5/9/2007

Test Description	Analyzed	By	Method	Result	Units	Report Limit	Note
1,1,1,2-Tetrachloroethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1,1-Trichloroethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1,2,2-Tetrachloroethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1,2-Trichloroethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1-Dichloroethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1-Dichloroethene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1-Dichloropropene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2,3-Trichlorobenzene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2,3-Trichloropropane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2,4-Trimethylbenzene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dibromo-3-Chloropropane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dibromoethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dichloroethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dichloropropane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,3,5-Trimethylbenzene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,3-Dichloropropane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,4-Dioxane	05/15/2007	FAM	SW 8260 B	10 U	ug/l	10	
1-Chlorobutane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
2,2-Dichloropropane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
2,2-Dichloropropane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Butanone	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Chloro-1,3-Butadiene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-chloroethylvinyl ether	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Chlorotoluene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Hexanone	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
4-Chlorotoluene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
4-Methyl-2-Pentanone	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acetone	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acetonitrile	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acrolein	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acrylonitrile	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Allyl Chloride	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Benzene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromobenzene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromodichloromethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromoform	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromomethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Carbon Disulfide	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Carbon Tetrachloride	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloroacetonitrile	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	

ACCREDITED IN ACCORDANCE WITH nela

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Received: 05/10/2007
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Client: KY3875
Page: 21 of 36

Analysis Report

AF23520 8004 - 8173 Distler Brickyard Collected: 5/9/2007

Test Description	Analyzed	By	Method	Result	Units	Report Limit	Note
Chlorobenzene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloroethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloroform	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloromethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
cis-1,2-Dichloroethene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
cis-1,3-Dichloropropene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Dibromochloromethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Dibromomethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Dichlorodifluoromethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Ethyl Methacrylate	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Ethylbenzene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Iodomethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Isobutyl Alcohol	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
m,p-Xylene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methacrylonitrile	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methyl Methacrylate	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methylene Chloride	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methyl-tert-Butylether	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
n-Butylbenzene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
n-Propylbenzene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
o-Xylene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Pentachloroethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
p-Isopropyltoluene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Propionitrile	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
sec-Butylbenzene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Styrene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
tert-Butylbenzene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Tetrachloroethene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Tetrahydrofuran	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Toluene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
trans-1,2-Dichloroethene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
trans-1,3-Dichloropropene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
trans-1,4-Dichloro-2-butene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Trichloroethene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Trichlorofluoromethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Vinyl Acetate	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Vinyl Chloride	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	

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Received: 05/10/2007
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Client: KY3875
Page: 22 of 36

Analysis Report

AF23521 8004 - 8121 Distler Brickyard Collected: 5/9/2007

Test Description	Analyzed	By	Method	Result	Units	Report Limit	Note
1,1,1,2-Tetrachloroethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1,1-Trichloroethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1,2,2-Tetrachloroethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1,2-Trichloroethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1-Dichloroethane	05/15/2007	FAM	SW 8260 B	15	ug/l	5	
1,1-Dichloroethene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1-Dichloropropene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2,3-Trichlorobenzene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2,3-Trichloropropane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2,4-Trimethylbenzene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dibromo-3-Chloropropane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dibromoethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dichloroethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dichloropropane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,3,5-Trimethylbenzene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,3-Dichloropropane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,4-Dioxane	05/15/2007	FAM	SW 8260 B	10 U	ug/l	10	
1-Chlorobutane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
2,2-Dichloropropane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
2,2-Dichloropropane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Butanone	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Chloro-1,3-Butadiene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-chloroethylvinyl ether	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Chlorotoluene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Hexanone	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
4-Chlorotoluene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
4-Methyl-2-Pentanone	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acetone	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acetonitrile	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acrolein	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acrylonitrile	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Allyl Chloride	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Benzene	05/15/2007	FAM	SW 8260 B	5.6	ug/l	5	
Bromobenzene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromodichloromethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromoform	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromomethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Carbon Disulfide	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Carbon Tetrachloride	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloroacetonitrile	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	

H-7

NREPC/Division of Waste Mgnt
Attn: Ken Logsdon
14 Reilly Road
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Batch # : 07051026
Received: 05/10/2007
Reported: 05/17/2007
Client: KY3875
Page: 23 of 36

Analysis Report

AF23521 8004 - 8121 Distler Brickyard Collected: 5/9/2007

Test Description	Analyzed	By	Method	Result	Units	Report Limit	Note
Chlorobenzene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloroethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloroform	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloromethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
cis-1,2-Dichloroethene	05/15/2007	FAM	SW 8260 B	590 j	ug/l	5	
cis-1,3-Dichloropropene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Dibromochloromethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Dibromomethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Dichlorodifluoromethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Ethyl Methacrylate	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Ethylbenzene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Iodomethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Isobutyl Alcohol	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
m,p-Xylene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methacrylonitrile	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methyl Methacrylate	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methylene Chloride	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methyl-tert-Butylether	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
n-Butylbenzene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
n-Propylbenzene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
o-Xylene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Pentachloroethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
p-Isopropyltoluene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Propionitrile	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
sec-Butylbenzene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Styrene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
tert-Butylbenzene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Tetrachloroethene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Tetrahydrofuran	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Toluene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
trans-1,2-Dichloroethene	05/15/2007	FAM	SW 8260 B	6.5	ug/l	5	
trans-1,3-Dichloropropene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
trans-1,4-Dichloro-2-butene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Trichloroethene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Trichlorofluoromethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Vinyl Acetate	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Vinyl Chloride	05/15/2007	FAM	SW 8260 B	45	ug/l	5	

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Attn: Ken Logsdon
14 Reilly Road
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Batch # : 07051026
Received: 05/10/2007
Reported: 05/17/2007
Client: KY3875
Page: 24 of 36

Analysis Report

AF23522 8004 - 7361 Distler Brickyard Collected: 5/9/2007

Test Description	Analyzed	By	Method	Result	Units	Report Limit	Note
1,1,1,2-Tetrachloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1,1-Trichloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1,2,2-Tetrachloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1,2-Trichloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1-Dichloroethane	05/14/2007	FAM	SW 8260 B	5.4	ug/l	5	
1,1-Dichloroethene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1-Dichloropropene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2,3-Trichlorobenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2,3-Trichloropropane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2,4-Trimethylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dibromo-3-Chloropropane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dibromoethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dichloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dichloropropane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,3,5-Trimethylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,3-Dichloropropane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,4-Dioxane	05/14/2007	FAM	SW 8260 B	10 U	ug/l	10	
1-Chlorobutane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2,2-Dichloropropane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2,2-Dichloropropane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Butanone	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Chloro-1,3-Butadiene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-chloroethylvinyl ether	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Chlorotoluene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Hexanone	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
4-Chlorotoluene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
4-Methyl-2-Pentanone	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acetone	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acetonitrile	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acrolein	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acrylonitrile	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Allyl Chloride	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Benzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromobenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromodichloromethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromoform	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromomethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Carbon Disulfide	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Carbon Tetrachloride	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloroacetonitrile	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	

NREPC/Division of Waste Mgnt
Attn: Ken Logsdon
14 Reilly Road
Frankfort KY 40601

Batch # : 07051026
Received: 05/10/2007
Reported: 05/17/2007
Client: KY3875
Page: 25 of 36

Analysis Report

AF23522 8004 - 7361 Distler Brickyard Collected: 5/9/2007

Test Description	Analyzed	By	Method	Result	Units	Report Limit	Note
Chlorobenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloroform	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloromethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
cis-1,2-Dichloroethene	05/14/2007	FAM	SW 8260 B	18	ug/l	5	
cis-1,3-Dichloropropene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Dibromochloromethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Dibromomethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Dichlorodifluoromethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Ethyl Methacrylate	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Ethylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Iodomethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Isobutyl Alcohol	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
m,p-Xylene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methacrylonitrile	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methyl Methacrylate	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methylene Chloride	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methyl-tert-Butylether	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
n-Butylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
n-Propylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
o-Xylene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Pentachloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
p-Isopropyltoluene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Propionitrile	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
sec-Butylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Styrene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
tert-Butylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Tetrachloroethene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Tetrahydrofuran	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Toluene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
trans-1,2-Dichloroethene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
trans-1,3-Dichloropropene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
trans-1,4-Dichloro-2-butene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Trichloroethene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Trichlorofluoromethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Vinyl Acetate	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Vinyl Chloride	05/14/2007	FAM	SW 8260 B	7.3	ug/l	5	

NREPC/Division of Waste Mgnt
Attn: Ken Logsdon
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Frankfort KY 40601

Batch # : 07051026
Received: 05/10/2007
Reported: 05/17/2007
Client: KY3875

Analysis Report

AF23523 8004 - 8172 Distler Brickyard Collected: 5/9/2007

Test Description	Analyzed	By	Method	Result	Units	Report Limit	Note
1,1,1,2-Tetrachloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1,1-Trichloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1,2,2-Tetrachloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1,2-Trichloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1-Dichloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1-Dichloroethene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1-Dichloropropene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2,3-Trichlorobenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2,3-Trichloropropane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2,4-Trimethylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dibromo-3-Chloropropane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dibromoethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dichloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dichloropropane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,3,5-Trimethylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,3-Dichloropropane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,4-Dioxane	05/14/2007	FAM	SW 8260 B	10 U	ug/l	10	
1-Chlorobutane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2,2-Dichloropropane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2,2-Dichloropropane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Butanone	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Chloro-1,3-Butadiene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-chloroethylvinyl ether	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Chlorotoluene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Hexanone	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
4-Chlorotoluene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
4-Methyl-2-Pentanone	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acetone	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acetonitrile	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acrolein	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acrylonitrile	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Allyl Chloride	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Benzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromobenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromodichloromethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromoform	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromomethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Carbon Disulfide	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Carbon Tetrachloride	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloroacetonitrile	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	

NREPC/Division of Waste Mgnt
Attn: Ken Logsdon
14 Reilly Road
Frankfort KY 40601

Batch # : 07051026
Received: 05/10/2007
Reported: 05/17/2007
Client: KY3875
Page: 27 of 36

Analysis Report

AF23523 8004 - 8172 Distler Brickyard Collected: 5/9/2007

Test Description	Analyzed	By	Method	Result	Units	Report Limit	Note
Chlorobenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloroethane	05/14/2007	FAM	SW 8260 B	11	ug/l	5	
Chloroform	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloromethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
cis-1,2-Dichloroethene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
cis-1,3-Dichloropropene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Dibromochloromethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Dibromomethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Dichlorodifluoromethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Ethyl Methacrylate	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Ethylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Iodomethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Isobutyl Alcohol	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
m,p-Xylene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methacrylonitrile	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methyl Methacrylate	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methylene Chloride	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methyl-tert-Butylether	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
n-Butylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
n-Propylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
o-Xylene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Pentachloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
p-Isopropyltoluene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Propionitrile	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
sec-Butylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Styrene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
tert-Butylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Tetrachloroethene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Tetrahydrofuran	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Toluene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
trans-1,2-Dichloroethene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
trans-1,3-Dichloropropene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
trans-1,4-Dichloro-2-butene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Trichloroethene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Trichlorofluoromethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Vinyl Acetate	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Vinyl Chloride	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	

NREPC/Division of Waste Mgnt
Attn: Ken Logsdon
14 Reilly Road
Frankfort KY 40601

Batch # : 07051026
Received: 05/10/2007
Reported: 05/17/2007
Client: KY3875
Page: 28 of 36

Analysis Report

AF23524 8004 - 7368 Distler Brickyard Collected: 5/9/2007

Test Description	Analyzed	By	Method	Result	Units	Report Limit	Note
1,1,1,2-Tetrachloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1,1-Trichloroethane	05/14/2007	FAM	SW 8260 B	6.1	ug/l	5	
1,1,2,2-Tetrachloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1,2-Trichloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1-Dichloroethane	05/14/2007	FAM	SW 8260 B	7.5	ug/l	5	
1,1-Dichloroethene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1-Dichloropropene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2,3-Trichlorobenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2,3-Trichloropropane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2,4-Trimethylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dibromo-3-Chloropropane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dibromoethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dichloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dichloropropane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,3,5-Trimethylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,3-Dichloropropane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,4-Dioxane	05/14/2007	FAM	SW 8260 B	10 U	ug/l	10	
1-Chlorobutane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2,2-Dichloropropane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2,2-Dichloropropane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Butanone	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Chloro-1,3-Butadiene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-chloroethylvinyl ether	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Chlorotoluene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Hexanone	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
4-Chlorotoluene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
4-Methyl-2-Pentanone	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acetone	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acetonitrile	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acrolein	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acrylonitrile	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Allyl Chloride	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Benzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromobenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromodichloromethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromoform	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromomethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Carbon Disulfide	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Carbon Tetrachloride	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloroacetonitrile	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	

H-13

NREPC/Division of Waste Mgnt
Attn: Ken Logsdon
14 Reilly Road
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Batch # : 07051026
Received: 05/10/2007
Reported: 05/17/2007
Client: KY3875
Page: 29 of 36

Analysis Report

AF23524 8004 - 7368 Distler Brickyard Collected: 5/9/2007

Test Description	Analyzed	By	Method	Result	Units	Report Limit	Note
Chlorobenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloroform	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloromethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
cis-1,2-Dichloroethene	05/14/2007	FAM	SW 8260 B	7.5	ug/l	5	
cis-1,3-Dichloropropene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Dibromochloromethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Dibromomethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Dichlorodifluoromethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Ethyl Methacrylate	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Ethylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Iodomethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Isobutyl Alcohol	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
m,p-Xylene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methacrylonitrile	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methyl Methacrylate	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methylene Chloride	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methyl-tert-Butylether	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
n-Butylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
n-Propylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
o-Xylene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Pentachloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
p-Isopropyltoluene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Propionitrile	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
sec-Butylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Styrene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
tert-Butylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Tetrachloroethene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Tetrahydrofuran	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Toluene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
trans-1,2-Dichloroethene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
trans-1,3-Dichloropropene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
trans-1,4-Dichloro-2-butene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Trichloroethene	05/14/2007	FAM	SW 8260 B	8.9	ug/l	5	
Trichlorofluoromethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Vinyl Acetate	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Vinyl Chloride	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	

NREPC/Division of Waste Mgnt
Attn: Ken Logsdon
14 Reilly Road
Frankfort KY 40601

Batch # : 07051026
Received: 05/10/2007
Reported: 05/17/2007
Client: KY3875
Page: 30 of 36

Analysis Report

AF23525 8001 - 7571 Distler Brickyard Collected: 5/9/2007

Test Description	Analyzed	By	Method	Result	Units	Report Limit	Note
1,1,1,2-Tetrachloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1,1-Trichloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1,2,2-Tetrachloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1,2-Trichloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1-Dichloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1-Dichloroethene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1-Dichloropropene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2,3-Trichlorobenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2,3-Trichloropropane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2,4-Trimethylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dibromo-3-Chloropropane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dibromoethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dichloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dichloropropane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,3,5-Trimethylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,3-Dichloropropane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,4-Dioxane	05/14/2007	FAM	SW 8260 B	10 U	ug/l	10	
1-Chlorobutane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2,2-Dichloropropane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2,2-Dichloropropane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Butanone	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Chloro-1,3-Butadiene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-chloroethylvinyl ether	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Chlorotoluene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Hexanone	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
4-Chlorotoluene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
4-Methyl-2-Pentanone	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acetone	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acetonitrile	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acrolein	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acrylonitrile	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Allyl Chloride	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Benzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromobenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromodichloromethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromoform	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromomethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Carbon Disulfide	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Carbon Tetrachloride	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloroacetonitrile	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	

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Attn: Ken Logsdon
14 Reilly Road
Frankfort KY 40601

Batch # : 07051026
Received: 05/10/2007
Reported: 05/17/2007
Client: KY3875
Page: 31 of 36

Analysis Report

AF23525 8001 - 7571 Distler Brickyard Collected: 5/9/2007

Test Description	Analyzed	By	Method	Result	Units	Report Limit	Note
Chlorobenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloroform	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloromethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
cis-1,2-Dichloroethene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
cis-1,3-Dichloropropene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Dibromochloromethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Dibromomethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Dichlorodifluoromethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Ethyl Methacrylate	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Ethylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Iodomethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Isobutyl Alcohol	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
m,p-Xylene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methacrylonitrile	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methyl Methacrylate	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methylene Chloride	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methyl-tert-Butylether	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
n-Butylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
n-Propylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
o-Xylene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Pentachloroethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
p-Isopropyltoluene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Propionitrile	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
sec-Butylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Styrene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
tert-Butylbenzene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Tetrachloroethene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Tetrahydrofuran	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Toluene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
trans-1,2-Dichloroethene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
trans-1,3-Dichloropropene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
trans-1,4-Dichloro-2-butene	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Trichloroethene	05/14/2007	FAM	SW 8260 B	6.0	ug/l	5	
Trichlorofluoromethane	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Vinyl Acetate	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	
Vinyl Chloride	05/14/2007	FAM	SW 8260 B	5 U	ug/l	5	

NREPC/Division of Waste Mgnt
Attn: Ken Logsdon
14 Reilly Road
Frankfort KY 40601

Batch # : 07051026
Received: 05/10/2007
Reported: 05/17/2007
Client: KY3875
Page: 32 of 36

Analysis Report

AF23526 B - 2 Distler Brickyard Collected: 5/9/2007

Test Description	Analyzed	By	Method	Result	Units	Report Limit	Note
1,1,1,2-Tetrachloroethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1,1-Trichloroethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1,2,2-Tetrachloroethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1,2-Trichloroethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1-Dichloroethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1-Dichloroethene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1-Dichloropropene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2,3-Trichlorobenzene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2,3-Trichloropropane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2,4-Trimethylbenzene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dibromo-3-Chloropropane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dibromoethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dichloroethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dichloropropane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,3,5-Trimethylbenzene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,3-Dichloropropane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,4-Dioxane	05/15/2007	FAM	SW 8260 B	10 U	ug/l	10	
1-Chlorobutane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
2,2-Dichloropropane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
2,2-Dichloropropane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Butanone	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Chloro-1,3-Butadiene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-chloroethylvinyl ether	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Chlorotoluene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Hexanone	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
4-Chlorotoluene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
4-Methyl-2-Pentanone	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acetone	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acetonitrile	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acrolein	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acrylonitrile	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Allyl Chloride	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Benzene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromobenzene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromodichloromethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromoform	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromomethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Carbon Disulfide	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Carbon Tetrachloride	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloroacetonitrile	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	

NREPC/Division of Waste Mgnt
Attn: Ken Logsdon
14 Reilly Road
Frankfort KY 40601

Batch # : 07051026
Received: 05/10/2007
Reported: 05/17/2007
Client: KY3875
Page: 33 of 36

Analysis Report

AF23526 B - 2 Distler Brickyard Collected: 5/9/2007

Test Description	Analyzed	By	Method	Result	Units	Report Limit	Note
Chlorobenzene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloroethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloroform	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloromethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
cis-1,2-Dichloroethene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
cis-1,3-Dichloropropene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Dibromochloromethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Dibromomethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Dichlorodifluoromethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Ethyl Methacrylate	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Ethylbenzene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Iodomethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Isobutyl Alcohol	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
m,p-Xylene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methacrylonitrile	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methyl Methacrylate	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methylene Chloride	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methyl-tert-Butylether	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
n-Butylbenzene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
n-Propylbenzene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
o-Xylene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Pentachloroethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
p-Isopropyltoluene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Propionitrile	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
sec-Butylbenzene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Styrene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
tert-Butylbenzene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Tetrachloroethene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Tetrahydrofuran	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Toluene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
trans-1,2-Dichloroethene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
trans-1,3-Dichloropropene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
trans-1,4-Dichloro-2-butene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Trichloroethene	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Trichlorofluoromethane	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Vinyl Acetate	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	
Vinyl Chloride	05/15/2007	FAM	SW 8260 B	5 U	ug/l	5	

NREPC/Division of Waste Mgnt
Attn: Ken Logsdon
14 Reilly Road
Frankfort KY 40601

Batch # : 07051026
Received: 05/10/2007
Reported: 05/17/2007
Client: KY3875
Page: 34 of 36

Analysis Report

AF23527 8002 - 7851 Distler Brickyard Collected: 5/9/2007

Test Description	Analyzed	By	Method	Result	Units	Report Limit	Note
1,1,1,2-Tetrachloroethane	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1,1-Trichloroethane	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1,2,2-Tetrachloroethane	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1,2-Trichloroethane	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1-Dichloroethane	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1-Dichloroethene	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,1-Dichloropropene	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2,3-Trichlorobenzene	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2,3-Trichloropropane	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2,4-Trimethylbenzene	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dibromo-3-Chloropropane	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dibromoethane	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dichloroethane	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,2-Dichloropropane	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,3,5-Trimethylbenzene	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,3-Dichloropropane	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
1,4-Dioxane	05/16/2007	FAM	SW 8260 B	10 U	ug/l	10	
1-Chlorobutane	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
2,2-Dichloropropane	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
2,2-Dichloropropane	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Butanone	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Chloro-1,3-Butadiene	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-chloroethylvinyl ether	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Chlorotoluene	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
2-Hexanone	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
4-Chlorotoluene	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
4-Methyl-2-Pentanone	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acetone	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acetonitrile	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acrolein	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Acrylonitrile	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Allyl Chloride	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Benzene	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromobenzene	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromodichloromethane	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromoform	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Bromomethane	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Carbon Disulfide	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Carbon Tetrachloride	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloroacetonitrile	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	

ACCREDITED IN ACCORDANCE WITH nela

McCoy & McCoy Laboratories, Inc.
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Madisonville, KY 42431
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NREPC/Division of Waste Mgnt
Attn: Ken Logsdon
14 Reilly Road
Frankfort KY 40601

Batch # : 07051026
Received: 05/10/2007
Reported: 05/17/2007
Client: KY3875
Page: 35 of 36

Analysis Report

AF23527 8002 - 7851 Distler Brickyard Collected: 5/9/2007

Test Description	Analyzed	By	Method	Result	Units	Report Limit	Note
Chlorobenzene	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloroethane	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloroform	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Chloromethane	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
cis-1,2-Dichloroethene	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
cis-1,3-Dichloropropene	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Dibromochloromethane	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Dibromomethane	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Dichlorodifluoromethane	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Ethyl Methacrylate	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Ethylbenzene	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Iodomethane	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Isobutyl Alcohol	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
m,p-Xylene	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methacrylonitrile	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methyl Methacrylate	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methylene Chloride	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Methyl-tert-Butylether	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
n-Butylbenzene	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
n-Propylbenzene	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
o-Xylene	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Pentachloroethane	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
p-Isopropyltoluene	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Propionitrile	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
sec-Butylbenzene	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Styrene	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
tert-Butylbenzene	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Tetrachloroethene	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Tetrahydrofuran	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Toluene	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
trans-1,2-Dichloroethene	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
trans-1,3-Dichloropropene	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
trans-1,4-Dichloro-2-butene	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Trichloroethene	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Trichlorofluoromethane	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Vinyl Acetate	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	
Vinyl Chloride	05/16/2007	FAM	SW 8260 B	5 U	ug/l	5	

NREPC/Division of Waste Mgnt
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Batch # : 07051026
Received: 05/10/2007
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Client: KY3875
Page: 36 of 36

Analysis Report

Sample Qualifier Legend
U - Non-detected at the reported detect limit.
j - Estimated value

Submitted By:
Syd Tate, Data Reviewer

The analyses reported above have been determined by protocols that meet or exceed the requirements of NELAC. Methods listed with an "*" are not part of this accreditation. Call Syd Tate at 270-821-7375 for any questions concerning this analysis report.

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5510 Fern Valley Rd.
Suite 104 Promenade Pavilion
Louisville, KY 40228
502.961.0001

SHADED AREA FOR LAB USE ONLY — **CHAIN OF CUSTODY and ANALYTICAL REQUEST** — **Please print legibly.**

Client: Ken Logsdon
DWM
14 ReillyRd, Frankfort
Ky 40601
Phone/Email: 564-6716

Bill To: ←
Phone/Email Kenneth.Logsdon@Ky.gov

Send Results to: ←
Kenneth logsdon
@ e-mail address
Phone/Email:

Compliance Monitoring (check one)? Yes ___ No ___
Samples Chlorinated (check one)? Yes ✓ No ___
TCE?

PO#

PWS ID#

STATE

Batch# C705102G

Project Name Distler Brickyard

Collected by (Signature): Ken Logsdon, Nathan Hancock

MMLI Quote # (if applicable)

Sample ID#	COLLECTION DATE	COLLECTION TIME (24 hr)	SAMPLE DESCRIPTION Composite samples indicate begin time, end time and temp (°C) at end time	SAMPLE ANALYSIS REQUESTED Method ID if known (I.e. 8260B, 6010B/7470A...)	SAMPLE REMARKS (i.e. composite, grab, field readings, corrosive...)	Field Data pH S.U.	Field Data Temp °C	# OF CONTAINERS	MATRIX CODE (See Lower Left)	PRESERVATIVE CODE (See Lower Left)
23519	8-2-05	1400	Trip Blank	VOC	EXPEDITED ANALYSIS			1	GW	HA
23520	5-9-07	5:25 pm	8004-8173	VOC				3	GW	HA
23521	5-9-07	5:30 pm	8004-8121	VOC				3	GW	HA
23522	5-9-07	5:35 pm	8004-7361	VOC				3	GW	HA
23523	5-9-07	5:40 pm	8004-8172	VOC				3	GW	HA
23524	5-9-07	5:50 pm	8004-7368	VOC				3	GW	HA
23525	5-9-07	6:00 pm	8001-7571	VOC				3	GW	HA
23526	5-9-07	6:10 pm	B-2	VOC				3	GW	HA
23527	5-9-07	6:10 pm	8002-7851	VOC				3	GW	AH

1. Expedited services not available for all services, please call. 2. Samples received unannounced with less than 48 hours holding time remaining may be subject to additional surcharges. 3. Lab reserves the right to return unused portions of samples to client.

Relinquished by: (Signature)	Received By: (Signature)	DATE	TIME (24 hr)
Ken Logsdon, DWM	R. [illegible]	5-10-07	1425
Relinquished by: (Signature)	Received by: (Signature)	DATE	TIME (24 hr)
Relinquished by: (Signature)	Received for MMLI by:	DATE	TIME (24 hr)

CONDITIONS UPON RECEIPT (CHECK ONE)
✓ Iced wet/Blue ___ °C Temp
___ Ambient ___ °C Temp ___ N/A

	YES	NO	N/A
Custody seals present/intact?			
Broken containers?		✓	
COC agree with sample Labels?	✓		
Correct containers for testing?	✓		
Headspace issues acceptable?	✓		
Holding time(s) acceptable?	✓		
Preservative pH's acceptable?	✓		
Was pH left unadjusted?	✓		
All samples listed on COC received?	✓		
Samples properly preserved?	✓		
Client's sample documents received?	✓		
COC been relinquished?	✓		
Are tests listed for each sample?	✓		

Method of Shipment (circle one): US Postal UPS FedEx MMLI [✓ Client]
Date Shipped:
Airbill#:
Logged in by: [illegible] **Location:** LEX
LAB NOTES
Follow up action required: YES ___ NO ___
Client informed on: ___/___/___
Client Rep:
By:
Reviewed by:
Date: 05/14/07

MATRIX CODES:
DW – Drinking Water
SW – Solid Waste
SO – Soil/Solid
SL – Sludge
GW – Ground Water
WW – Waste Water
OL – Oil
SU – Surface Water

PRESERVATIVE CODES:
NI – Nitric acid (HNO_3)
HA – Hydrochloric Acid (HCl)
SH – Sodium Hydroxide (NaOH)
ST – Sodium Thiosulfate
ZN – Zinc acetate
SA – Sulfuric Acid (H_2SO_4)
4C – 4°C
AA – Ascorbic Acid
NO – No preservative
SS – Sodium sulfite