UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

Oba/
Sue

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MIAMISBURG
LOG E-02658
CODE 1272

SEP 2 8 2001

REPLY TO THE ATTENTION OF:

SR-6J

Mr. Richard B. Provencher, Director
Miamisburg Environmental Management Program
United States Department of Energy
P.O. Box 66
Miamisburg, Ohio 45343-0066

Re: U.S. DOE Mound Plant, Miamisburg, Ohio
Five-Year Review Report

Dear Mr. Provencher:

The U. S. Environmental Protection Agency (U. S. EPA) has reviewed the Five-Year Review Report dated September 27, 2001, developed by the United States Department of Energy for the subject site and concurs with the protectiveness statement. The report is hereby approved.

U. S. EPA appreciates the efforts of Ms. Sue Smiley and Mr. Mark Spivey, of your staff in conducting this review. Please feel free to contact me if you have any questions.

Sincerely,

Wm. E. Muno

William E. Muno, Director
Superfund Division

Department of Energy

Ohio Field Office
Miamisburg Environmental Management Project
P.O. Box 66
Miamisburg, Ohio 45343-0066

SEP 27 2001

Mr. William E. Muno, Director
US Environmental Protection Agency
Superfund Division (SRF-J)
77 W. Jackson Blvd.
Chicago, IL 60604

MB-0564-01

Dear Mr. Muno:

Enclosed please find the "CERCLA Five-Year Report for the Operable Unit 1 Remedy at the U.S. Department of Energy Miamisburg Environmental Management Project," dated September 27, 2001.

If you have any questions on the enclosed report, please contact Ms. Sue Smiley of my staff at (937) 865-3984.

Sincerely,

Richard B. Provencher
Director

Enclosure

cc w/enclosure:
Brian Nickel, Ohio EPA
Timothy Fischer, USEPA
P. Sandy Baker, BWXTO
Robert Rothman, DOE-MEMP

CERCLA Five-Year Review Report

for the

Operable Unit 1 Remedy

at the

U.S. Department of Energy

Miamisburg Environmental Management Project

September 27, 2001

Prepared by: ______________________________ Date: Sept. 27, 01

Robert Rothman, Remedial Project Manager
U.S. Department of Energy
Miamisburg Environmental Management Project

Executive Summary

The extraction and monitoring wells for the Operable Unit 1 (OU-1) remediation project were installed in 1996, and the installation of the air stripper and associated equipment was completed and operation started on February 18, 1997. This was done using a pump-and-treatment system, as per the Record of Decision, for the containment of the Volatile Organic Compound contamination plume. Since implementation and based upon the review of the systems performance data, the ongoing remedial actions are considered operational and functional. Also, based on information available at the time of this review, the remedy for OU-1 remains protective of human health and the environment.

I. Introduction

This review was conducted following CERCLA section 121(c), National Contingency Plan (NCP) section 300.430(f)(4)(ii), and OSWER Directive 9355.7-03B-P, *Comprehensive Five-Year Review Guidance*. The U.S. Department of Energy (DOE) Miamisburg Environmental Management Project (MEMP) conducted the review in accordance with the signed Federal Facility Agreement with the Ohio EPA and the U.S. EPA. This is the first review conducted for this site; the next review is anticipated in Summer of 2006. This is a statutory review. The purpose of this review is ensure the engineered or institutional measures being relied on to protect human health and the environment at this site continue to function and operate as intended such that no unacceptable exposures to residual contamination remaining at the site occur. All supporting documentation relied on in selecting the remedy for this site is contained in the Administrative Record located in the DOE-MEMP Public Reading Room.

This report contains seven (7) attachments. Attachment A includes the list of documents reviewed during preparation of this report. Attachment B contains site maps. Attachment C contains tables and figures documenting Remedy performance. Attachment D contains interview reports. Attachment E is the site inspection checklist for OU-1. Attachment F is the (draft) Cost and Performance Report for OU-1. Attachment G is a sample table from the FFA Monthly Report, documenting pounds of VOCs removed.

II. Site Chronology

The Mound Plant began a periodic water-sampling program for VOCs in 1984. Under the Environmental Restoration (ER) Program, a Remedial Investigation (RI) was started in 1987 and focused on groundwater contamination. Since 1986, VOCs have been detected and monitored in the groundwater in Operable Unit 1 (OU-1).

As a result of the VOC groundwater contamination found in OU-1, the Mound Plant was placed on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priority List, in 1989. As part of the Mound CERCLA process, a Federal Facility Agreement (FFA) was signed between the Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA) and Ohio EPA. The agreement required DOE to produce a Remedial Investigation/Feasibility Study (RI/FS) report, which is based on remedial investigative fieldwork. As a result of the remedial investigative process, which took approximately 3 years (1992-1995), DOE and the U.S. EPA and Ohio EPA signed a CERCLA Record of Decision (ROD) in 1995 selecting a remedy to control groundwater VOC contamination in OU-1, and in the adjacent Buried Valley Aquifer (BVA).

A remedial design was developed for the pump-and-treat system which consists of extraction and monitoring wells and an air stripper system. The extraction and monitoring wells for the OU-1 remediation project were installed in 1996, and the installation of the air stripper and associated equipment was completed and operation started on February 18, 1997. The first 180 days of operation was under a Treatability Test. Operation of the facility following the Treatability Test period has been conducted in accordance with the Authorization to Discharge. The effluent from the treatment facility is known as Outfall 003 (a CERCLA Authorization to Discharge outfall). The monitoring for VOC contamination in OU-1 is ongoing and part of the Mound Plant Environmental Monitoring Program. Based upon the pump-and-treat monitoring results, the system is fulfilling the criterion set forth by the ROD and the aforementioned ROD is considered to be fully implemented.

III. Background

OU-1, or Area B as it was originally called, occupies approximately 4 acres in the southwestern portion of the Mound Plant. It encompasses the historic landfill, the site sanitary landfill, the overflow sediment reduction pond, and the three plant water production wells situated in the Buried Valley Aquifer (BVA). A Remedial Investigation (RI) focused on groundwater contamination. Volatile Organic Compounds (VOCs) have been detected and monitored in the groundwater in Area B. The "groundwater contaminant plume" emanates southward from the OU-1 landfill area and travels toward the Mound Plant production wells. The primary contaminants of concern are cis-1,2-dichloroethene; trans-1,2-dichloroethene; tetrachloroethene;tetrachloromethane; 1,1,1-trichloroethane; trichloroethene; trichlorofluoromethane; chloroform, and vinyl chloride.

The OU-1 BVA is characterized by low-level (1 ppm) chlorinated solvent contamination of a shallow, wedge-shaped, anaerobic, highly permeable, sandy-gravel aquifer. This designated sole source aquifer provides drinking water for many cities along the Miami River, as well as the Mound Plant. The major contaminants of concern are PCE, TCE, and DCE. Meandering lenses of glacial till, fill, and sand and gravel sit above the water table and contain the same contaminants, generally in the range of 100 ppb but in some areas to levels as high as 7-25 ppm. Remediation of this area is further complicated by the location of an engineered landfill which is situated on the site.

An extended discussion of Area B history, including waste disposal and construction activities, is provided in the OU-1 Remedial Investigation Report, Section 1, March

1994.

IV. Remedial Actions

An initial (six-month) monitoring program was conducted to assess the hydraulic containment of the groundwater contamination plume within the western and southern compliance boundaries. This was accomplished by collecting water level data from 20 monitoring wells to evaluate the potentiometric surface and local hydraulic gradients in the OU-1 area. The initial pump-and-treatment capture zone monitoring and reports were performed by Terran Corporation.

Local hydraulic gradients are determined by conducting three point evaluations using monitoring wells that straddle the compliance boundary. Two sets of three monitoring wells are currently being utilized to determine if hydraulic containment is achieved; wells 0417, 0305 and 0410 are used to verify containment at the southern boundary, and wells 0422, 0423 and P003 are used to verify containment at the western boundary. The results of the monitoring show that the system is effectively capturing the contamination and are reported monthly in the FFA Monthly Report.

The VOC contaminants of concern (COC) have also been monitored monthly on both the influent and effluent of the pump-and-treat system. The rate at which the concentration of contaminants present in the influent is dropping shows that the pump-and-treatment system is operating effectively in the removal of the COCs from the groundwater. The effluent data demonstrates the effectiveness of the air stripper in removing the COCs from the water being treated and exhibits compliance with the CERCLA Authorization to Discharge at Outfall 003. Based upon the pump-and-treat monitoring results, the system is fulfilling the criteria set forth by the ROD. Graphs of the VOC concentration data are attached.

In consideration of the anticipated treatment time required for the conventional pump-and-treat system to remediate the site, which includes waiting for any contamination suspended in the unsaturated zone to naturally migrate to the BVA, an additional treatment system was installed to expedite the process. The pump-and-treat, on its own, would take more than an estimated 30 years to achieve completion.

The Innovative Treatment Remediation Demonstration (ITRD) group was contacted and asked to work with the Mound ER Program to review and evaluate applicable innovative remediation technologies and suggest enhancements to a site-selected baseline pump-and-treat system. The ITRD group is an advisory group composed of DOE, EPA, industry, and regulatory agency representatives.

Based on detailed engineering assessments and cost/performance evaluations, the ITRD group identified two technologies for application at the site. The two technologies are air sparging and soil vapor extraction (AS/SVE). It was initially estimated that clean up could be achieved in approximately three to five years, based upon simultaneous operation of these systems.

Construction of the full-scale system started in April 1997 and was completed in November 1997. The system consists of 23 air sparge and 17 vapor extraction wells divided into two zones that can be operated alternately. The soil vapor extraction system is designed to operate at a vacuum of up to 18 inches of mercury (at the intake to blowers) and a flow rate of approximately 500 standard cubic feet per minute (scfm). The sparging system is designed to operate at nominally 150 scfm. After initial trial operations, the system became operational on December 18, 1997. Graphs depicting the amount of COC removal since implementation are attached.

OU-1 data are reported on a monthly basis to the Department of Energy and the Environmental Protection Agency through a section in the FFA Monthly Report from BWXTO. Detailed data can be found in the OU-1 Annual Report; Pump & Treat, Air Sparge, and Soil Vapor Extraction System.

Based upon the review of the systems performance data, the ongoing remedial actions are considered operational and functional.

V. Five-Year Review Process

The scope of this five-year review included three elements - a site inspection, review of documentation, and personnel interviews. The USEPA's October 1999 draft guidance entitled "Comprehensive Five-Year Review Guidance" was followed, to the extent practicable. In late August 2001, the USEPA finalized the five-year review guidance, and a cursory review of the final guidance was performed by DOE-MEMP prior to issuing this five-year review report for Operable Unit 1. DOE-MEMP also reviewed DOE Headquarter's CERCLA Five-Year Review Guidance (Draft, September 2001) and "Sample" CERCLA Five-Year Review Report (dated April 15, 2001). The site inspection of Operable Unit 1 occurred on September 20, 2001. The inspection was led by Mr. Robert Rothman, Remedial Project Manager, DOE-MEMP, and Ms. Sue Smiley, Post Closure Stewardship Project Manager, DOE-MEMP. Inspection participants included Mr. Monte Williams, Environmental Restoration Project Manager, BWXTO, Mr. Mark Spivey, OU-1 Project Engineer, BWXTO, and Ms. Kathy Lee Fox, OEPA. Refer to Attachment E of this report for a copy of the site inspection checklist completed in the field by Ms. Smiley on September 20, 2001. A variety of documents were reviewed during the course of this five-year review, including the OU-1 Record of Decision and FFA Monthly Reports. Refer to Attachment A of this report for a complete list of all documents reviewed. This report intentionally does not duplicate information contained in other documents; rather, salient information is incorporated by reference. Ms. Smiley interviewed the following additional personnel: Mr. Richard Neff, Sierra Lobo Co., technical support contractor to DOE-MEMP, Mr. Ron Paulick, Environmental Compliance Group, BWXTO, and Mr. Mark Gilliat, Groundwater Hydrologist, BWXTO. Refer to Attachment D of this report for a summary of the interviews. This summary-level information only includes information that is not already reflected in the body of this report.

A copy of this five-year review report will be placed in the CERCLA Public Reading Room after concurrence is obtained from U.S. EPA. DOE will place a notice in the local Miamisburg newspaper when this report is available to the public.

VI. Assessment

The remediation systems in OU-1 are functioning as intended by the ROD and as designed. This is evidenced by the continued drop in the influent contaminant concentrations as well as declining concentrations at the boundary of compliance. Furthermore, data reported on a monthly basis indicates hydraulic containment of the area of concern. The clean-up criteria set forth by the ROD are still appropriate for the site, and no new information has come to light which would call into question the protectiveness of the implemented remedy.

VII. Deficiencies

There were no deficiencies identified during the course of the inspection of OU-1, or based upon interviews with BWXTO personnel responsible for the operation and oversight of the OU-1 Remedy, or based upon the review of documentation associated with the operation, maintenance and effectiveness of the OU-1 Remedy.

VIII. Recommendations and Follow-up Actions

Continue pump & treat operation at OU-1. Perform rebound test when criteria for same have been met.

IX. Protectiveness Statement

Based on the information available at the time of this review, the Remedy for OU-1 remains protective of human health and the environment.

X. Next Review

The next five-year review of the OU-1 Remedy will be performed in the Summer of 2006. Based upon the review of data acquired to-date, remediation efforts may succeed and be terminated prior to the next five-year review.

XI. Summary of Other Remedies

In addition to the OU-1 Remedy, Records of Decision (ROD) for land parcels that have been transferred to the DOE-designated Community Reuse Organization include institutional controls in the form of Deed Restrictions. An Operation & Maintenance ((&M) Plan is updated each time title to a land parcel is transferred. At this point in time, the O&M Plan is considered a draft "living" document that can, and should, be revised as successive land parcels transfer and the DOE and regulators make further refinements to the land transfer process itself. At the time of this five-year review of th OU-1 Remedy, the following three land parcels had been transferred:

Parcel D	Approx. 12.5 acres	Transferred in March 1999
Parcel H	Approx. 14.3 acres	Transferred in August 1999
parcel 4	Approx 95 acres	Transferred in May 2001

As stipulated in the O&M Plan, an annual review of the effectiveness of the institutional controls associated with transferred land parcels must be performed no later than June 13th of each year. The O&M Plan states that the inspection frequency may be reduced, upon transfer of the final land parcel. In no case, would the inspection frequency be more than every five years. On June 13, 2001, a report on the first annual review (covering Parcels D and H) was submitted to the regulators. On July 2, 2001, the Ohio EPA provided comments to the DOE, and on July 24, 2001, the USEPA provided comments. The DOE is evaluating these comments and may issue an addendum to at least part of the annual report. At a minimum, the comments will be addressed in the annual report prepared in early Summer 2002. The 2002 report will cover Parcels D, H and 3. Refer to Attachment A of this report for a citation of the June 13, 2001 report on Parcels D and H.

Attachment A

List of Documents Reviewed

List of Documents Reviewed

OU-1 Annual Report; Pump & Treat, Air Sparge, and Soil Vapor Extraction; System Start through December 1998, BWXTO, August 1999
December 1998 through December 1999, BWXTO, May 2000.

Draft Cost Performance Report, Air Sparge/Soil Vapor Extraction, Mound OU-1 Site, Innovative Treatment Remediation Demonstration US Department of Energy, January 2001.

Site Specific Health and Safety Plan for OU-1 Pump and Treatment System Operations and Maintenance, BWXTO.

Site Specific Health and Safety Plan for OU-1 Air Sparge/Soil Vapor Extraction Systems Operations and Maintenance, BWXTO.

MSDS files for chemical used/stored in Building 300 and Building 301.

Draft Comprehensive Five-Year Review Guidance, EPA 540R-98-050, Office of Emergency and Remedial Response, US Environmental Protection Agency, October 1999.

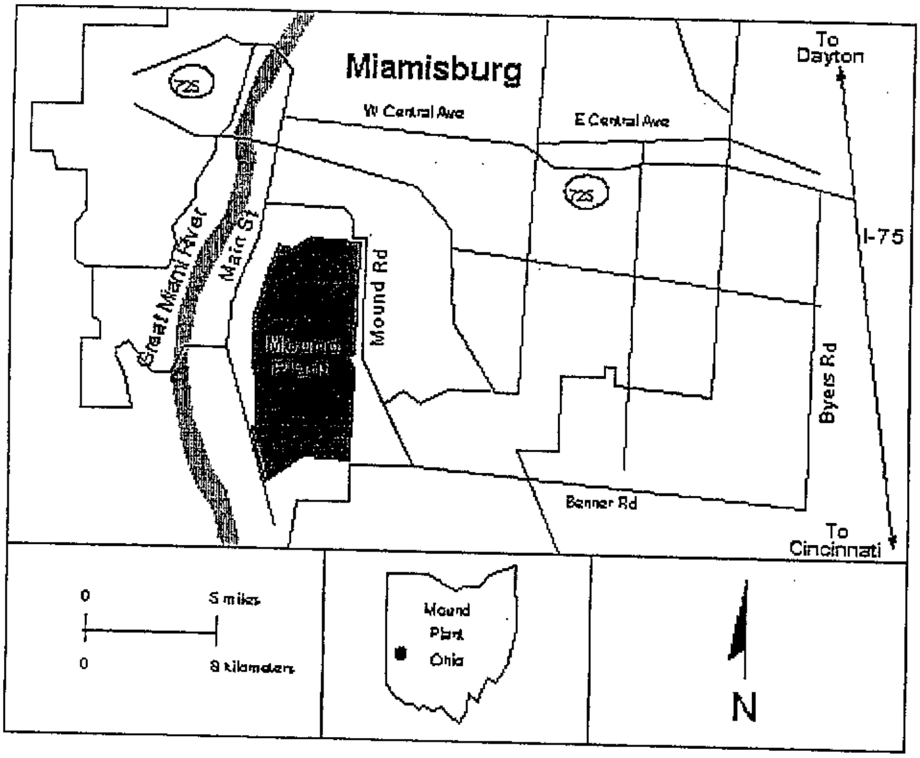
Operable Unit 1 Record of Decision, Mound Plant, Miamisburg, Ohio, US Department of Energy, June 1995.

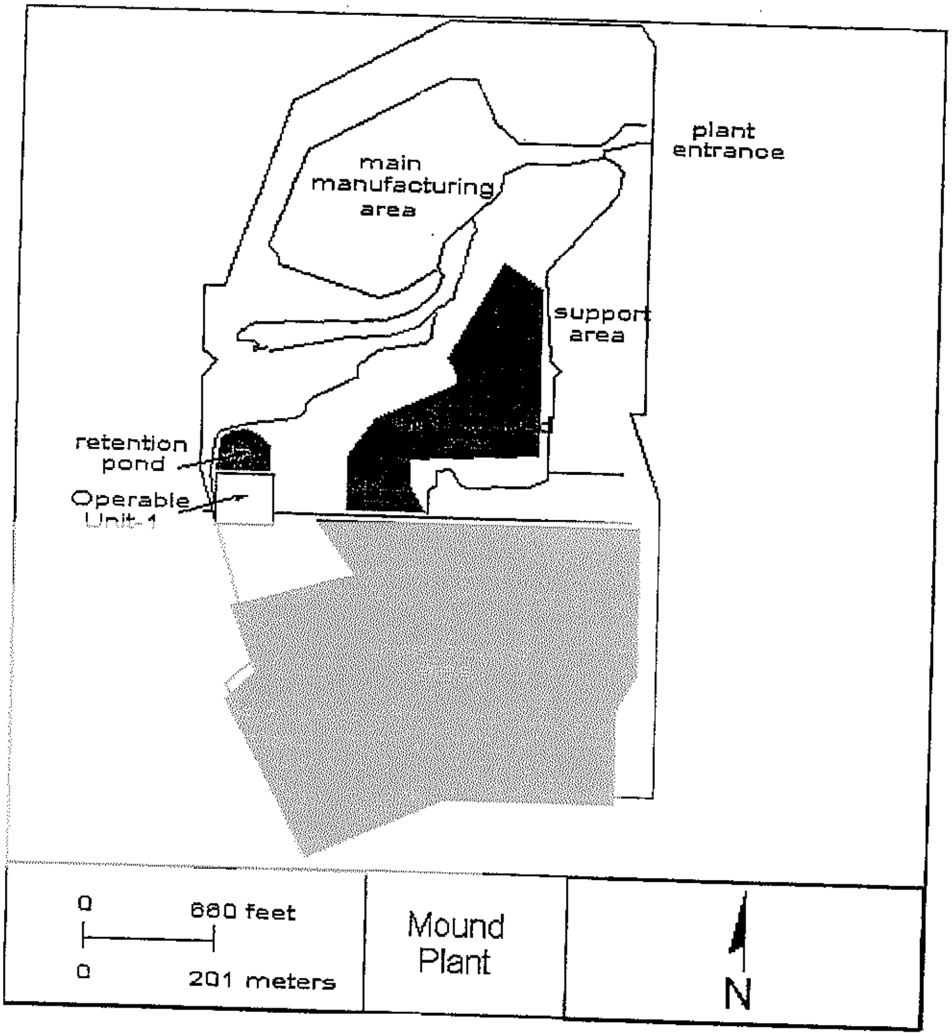
Environmental Restoration Monthly Progress Reports, U.S. Department of Energy.

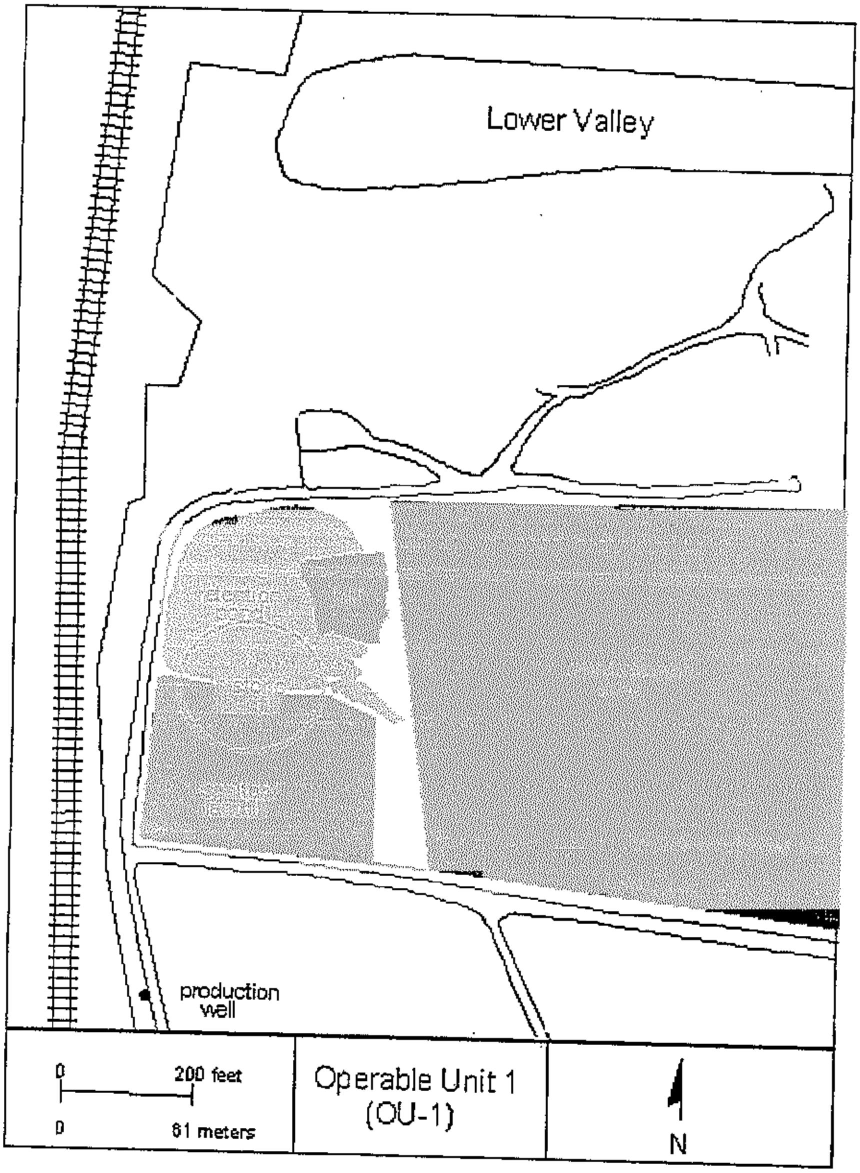
Annual Assessment of the Effectiveness Of Institutional Controls applied to the former Mound Site Property, US Department of Energy, Miamisburg Environmental Management Project, June 13, 2001.

Attachment B

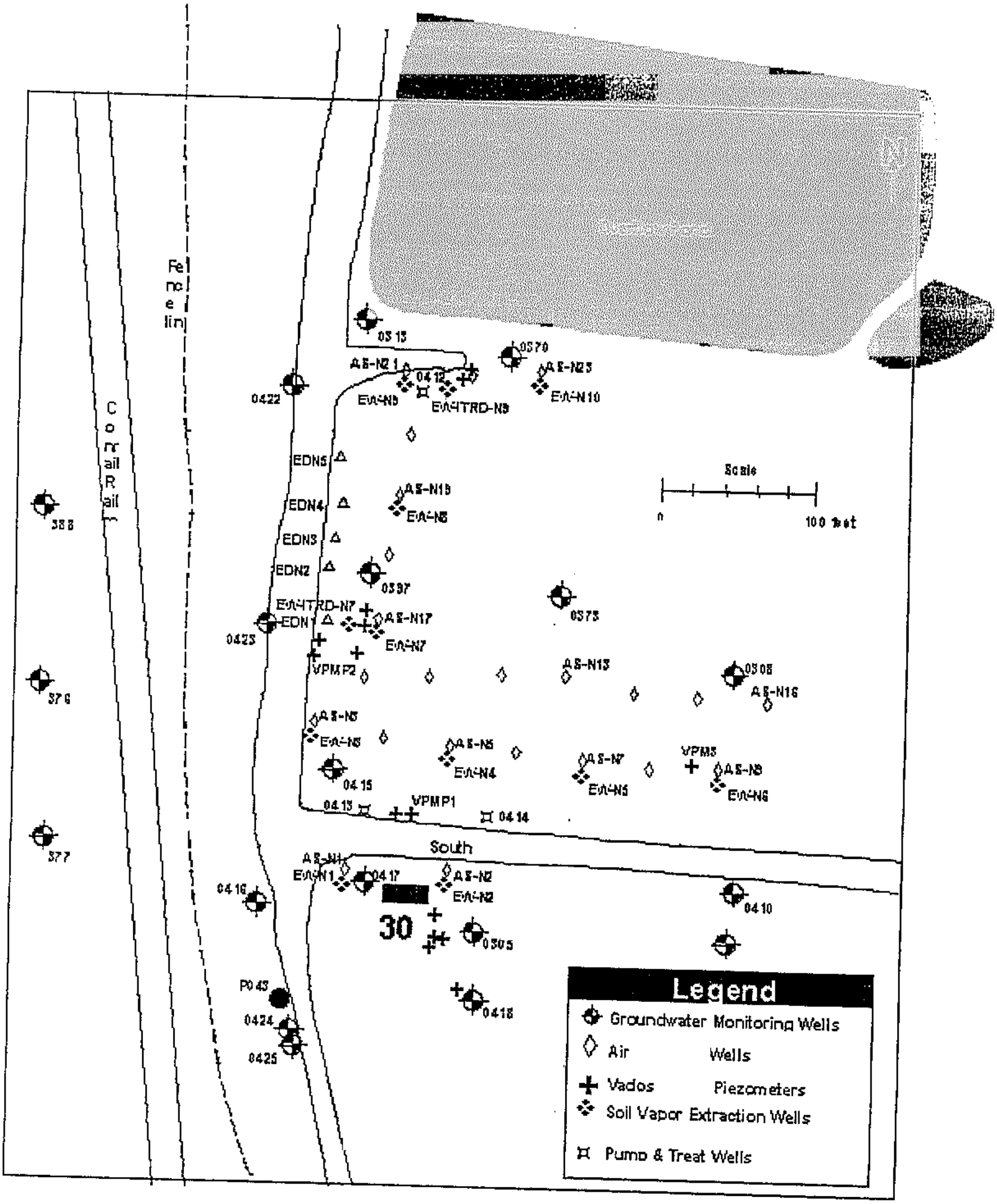
Site Maps


Miamisburg
725
W Central Ave
E Central Ave
725
To
Dayton
I-75
Great Miami River
Main St
Mound Rd
Mound
Plant
Byers Rd
Benner Rd
To
Cincinnati
0
5 miles
0
8 kilometers
Mound
Plant
Ohio
N

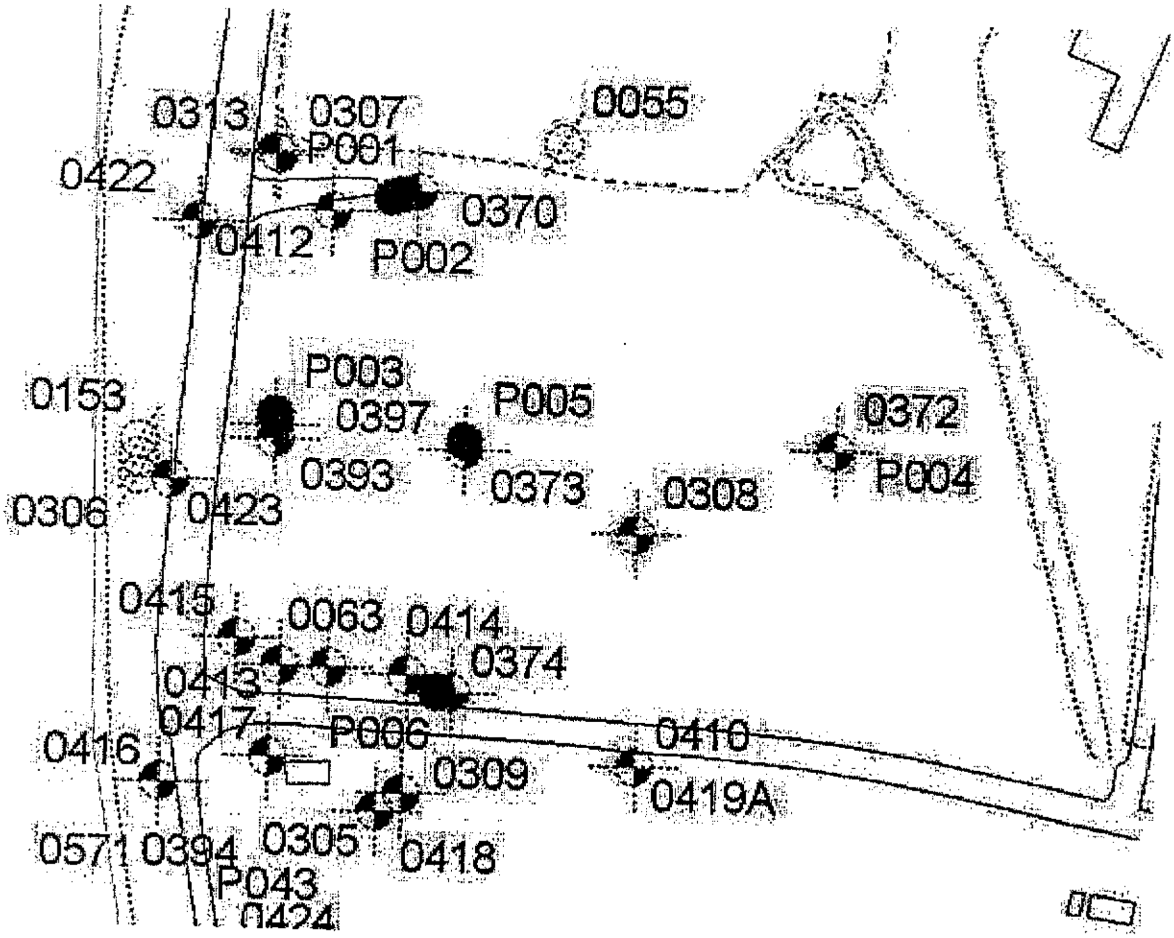

plant entrance
main manufacturing area
support area
retention pond
Operable Unit 1
0
660 feet
0
201 meters
Mound Plant
N



Operable Unit 1
(OU-1)



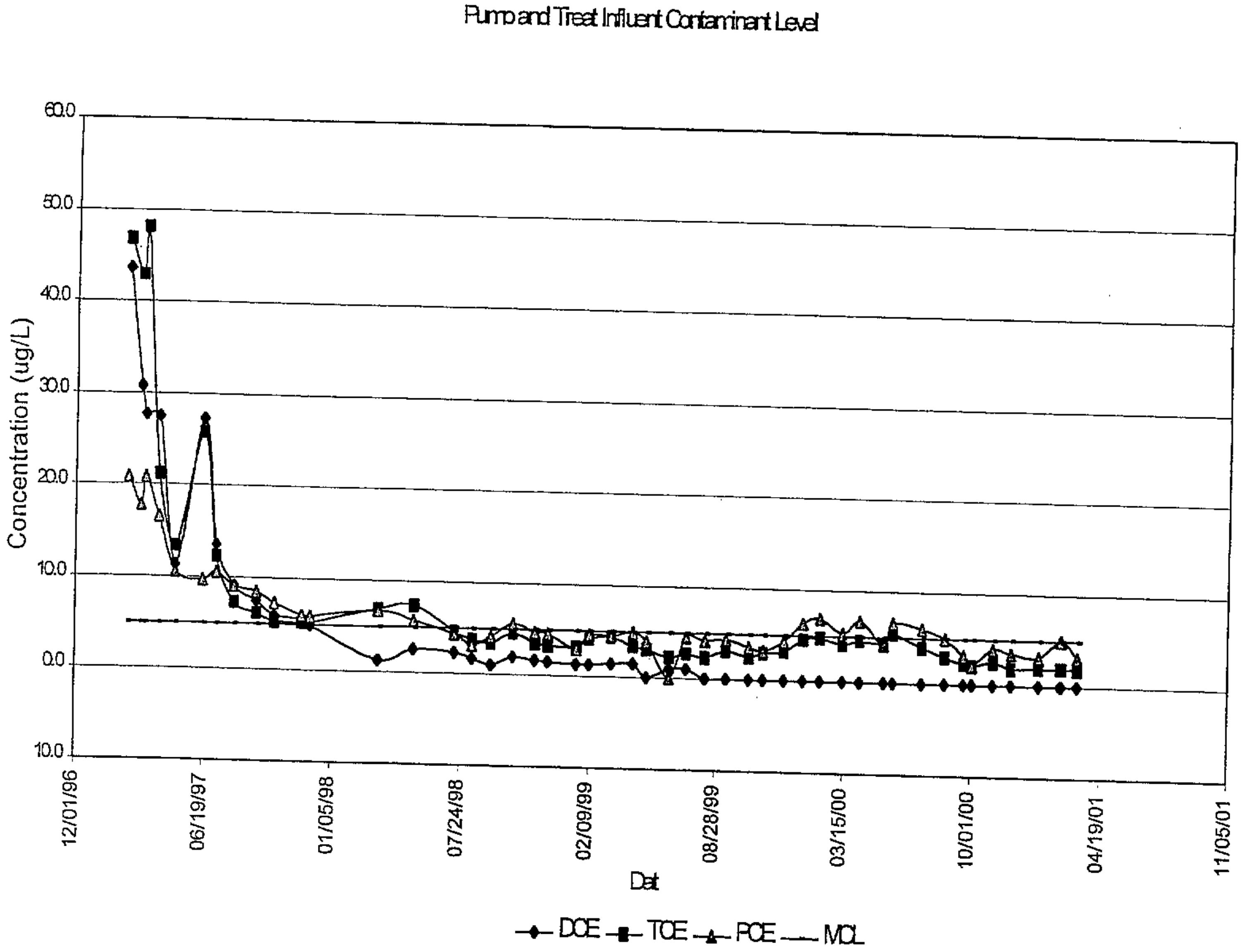
SVE/AS Well Locations



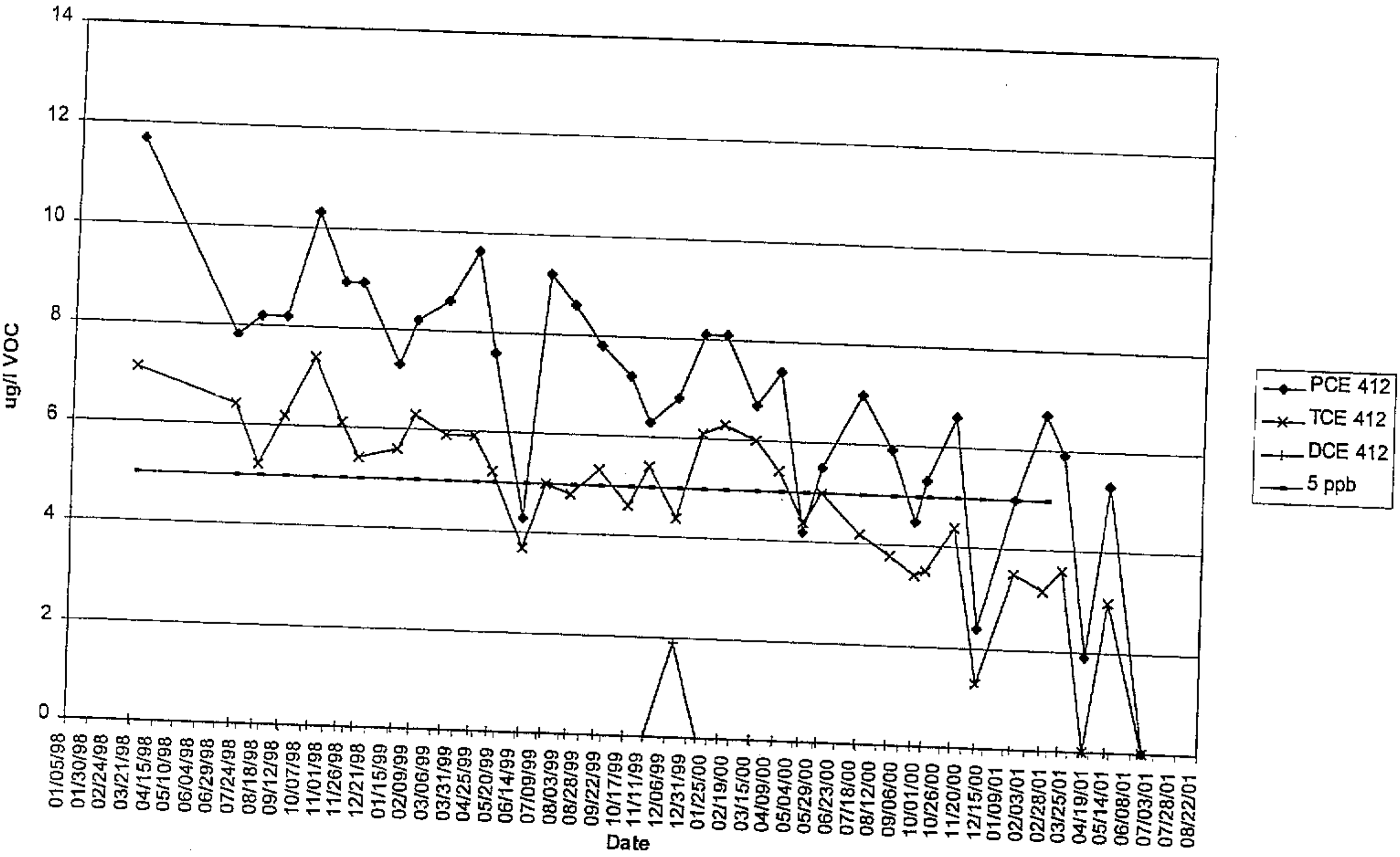
Monitoring/Extraction Well Locations

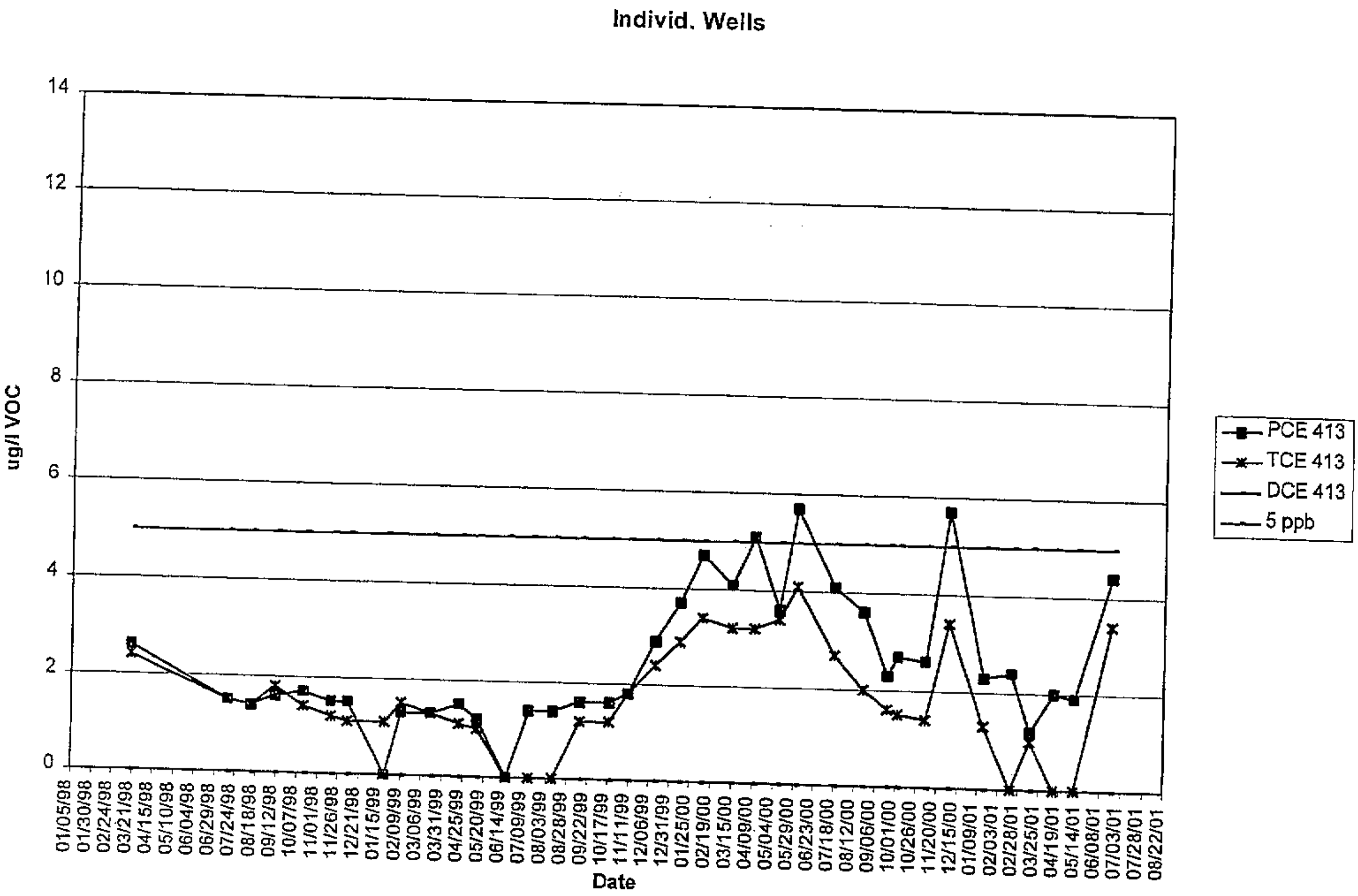
Attachment C

Tables, Figures
Documenting Remedy Performance


Pump and Treat Influent Contaminant Level
60.0
50.0
40.0
30.0
20.0
10.0
0.0
10.0
Concentration (ug/L)
12/01/96
06/19/97
01/05/98
07/24/98
02/09/99
08/28/99
03/15/00
10/01/00
04/19/01
11/05/01
Dat
DCE
TCE
PCE
MCL

Individ. Wells




Individ. Wells
ug/l VOC
0
2
4
6
8
10
12
14
Date
01/05/98
01/30/98
02/24/98
03/21/98
04/15/98
05/10/98
06/04/98
06/29/98
07/24/98
08/18/98
09/12/98
10/07/98
11/01/98
11/26/98
12/21/98
01/15/99
02/09/99
03/06/99
03/31/99
04/25/99
05/20/99
06/14/99
07/09/99
08/03/99
08/28/99
09/22/99
10/17/99
11/11/99
12/06/99
12/31/99
01/25/00
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03/15/00
04/09/00
05/04/00
05/29/00
06/23/00
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08/12/00
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03/25/01
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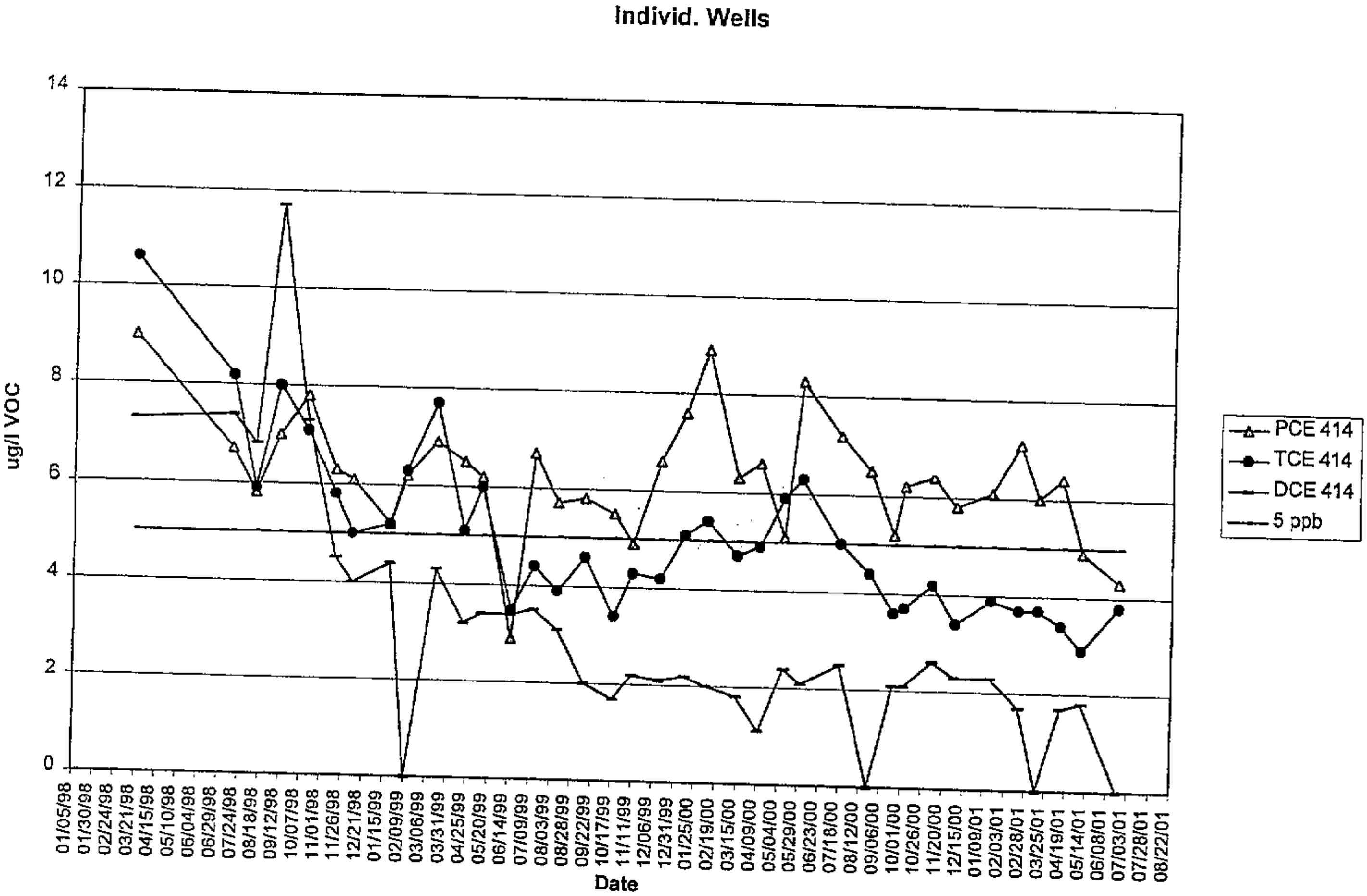
PCE 413
TCE 413
DCE 413
5 ppb


Individ. Wells
ug/l VOC
14
12
10
8
6
4
2
0
01/05/98
01/30/98
02/24/98
03/21/98
04/15/98
05/10/98
06/04/98
06/29/98
07/24/98
08/18/98
09/12/98
10/07/98
11/01/98
11/26/98
12/21/98
01/15/99
02/09/99
03/06/99
03/31/99
04/25/99
05/20/99
06/14/99
07/09/99
08/03/99
08/28/99
09/22/99
10/17/99
11/11/99
12/06/99
12/31/99
01/25/00
02/19/00
03/15/00
04/09/00
05/04/00
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06/23/00
07/18/00
08/12/00
09/06/00
10/01/00
10/26/00
11/20/00
12/15/00
01/09/01
02/03/01
02/28/01
03/25/01
04/19/01
05/14/01
06/08/01
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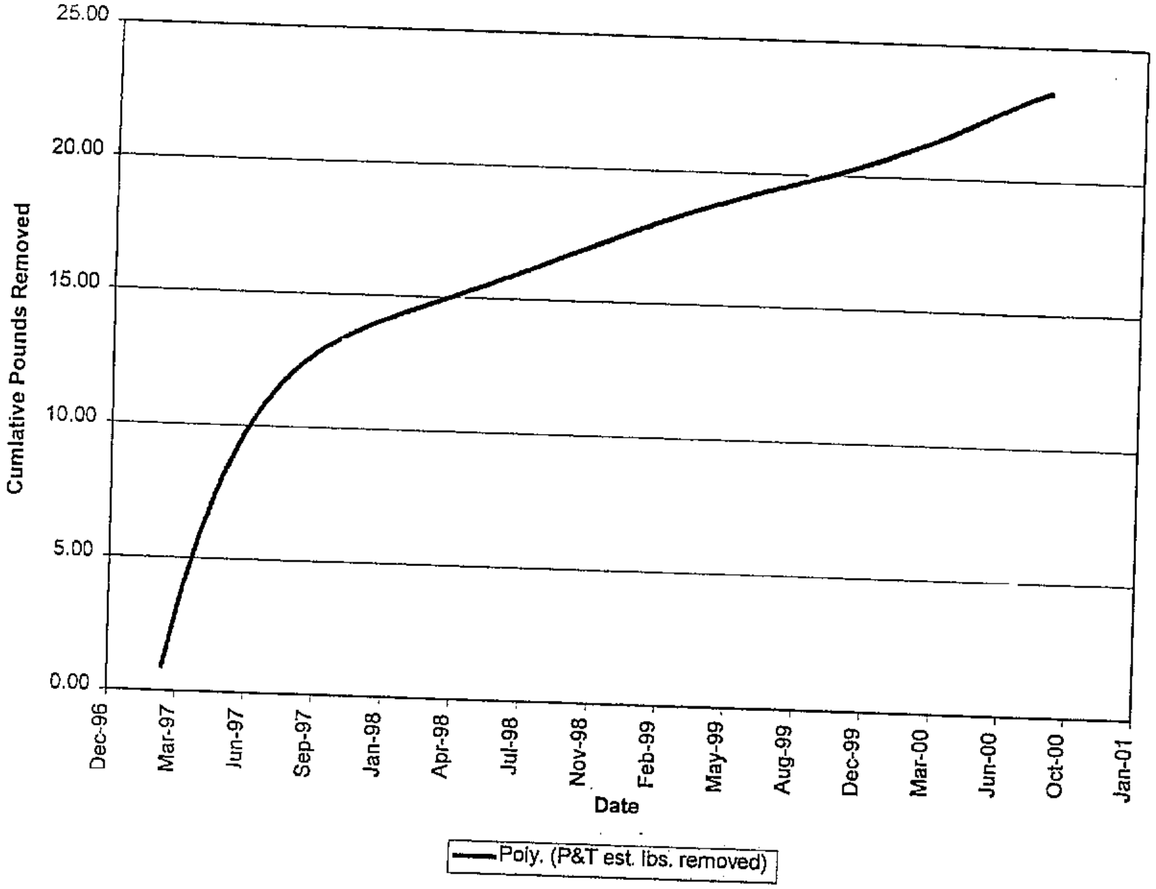
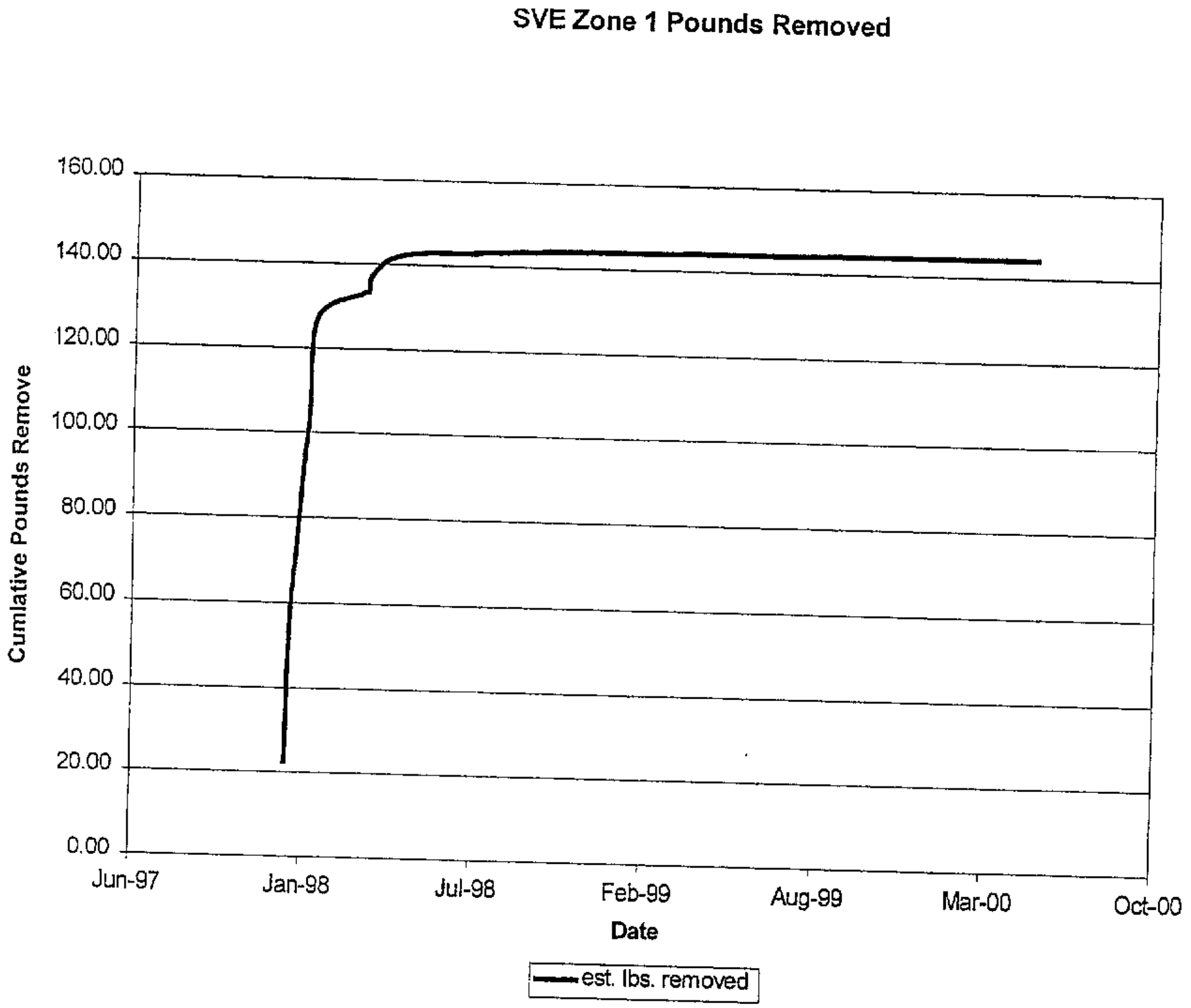
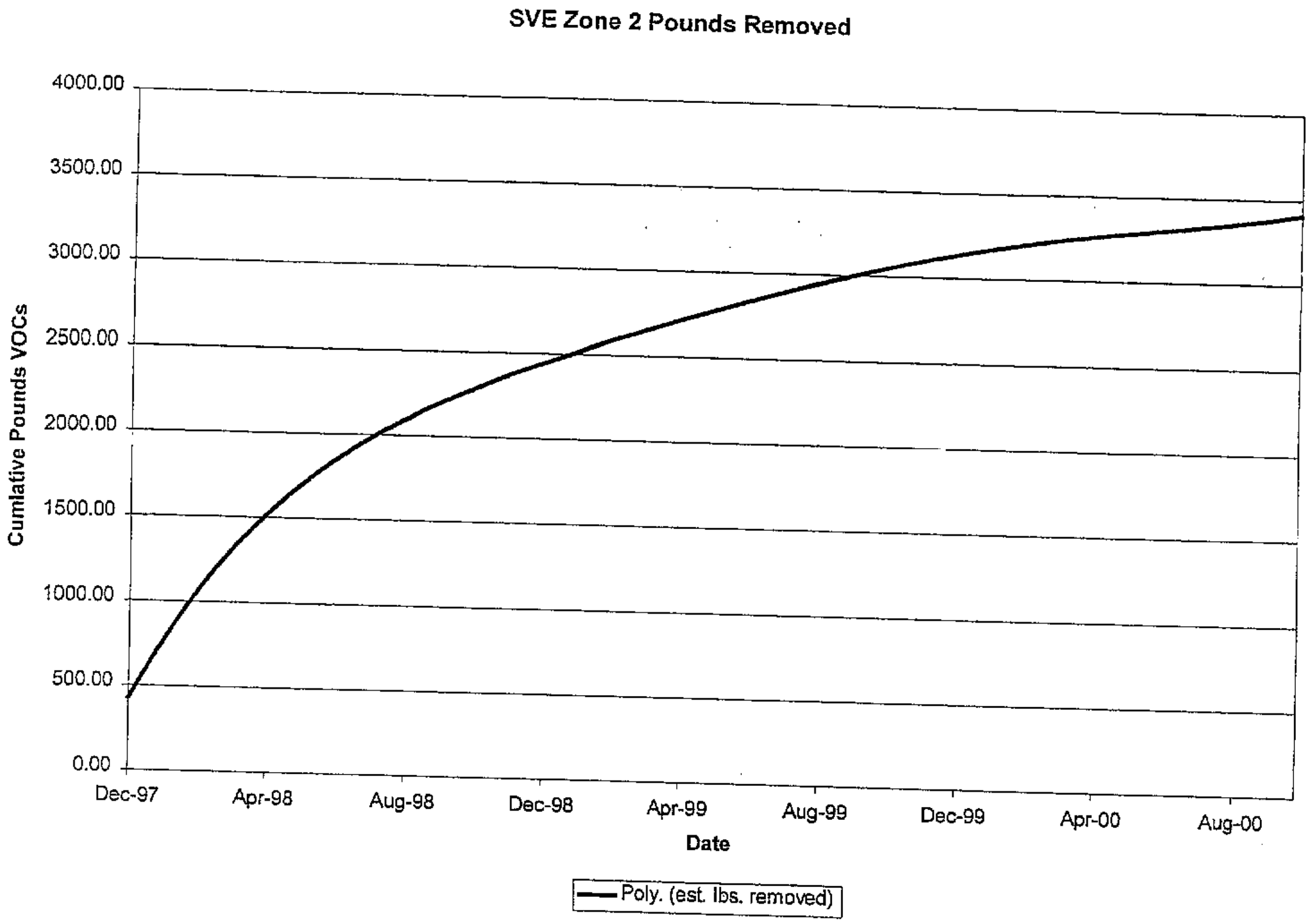
07/28/01
08/22/01
Date
PCE 414
TCE 414
DCE 414
5 ppb

P&T Pounds Removed





SVE Zone 1 Pounds Removed


SVE Zone 2 Pounds Removed
Cumlative Pounds VOCs
4000.00
3500.00
3000.00
2500.00
2000.00
1500.00
1000.00
500.00
0.00
Dec-97
Apr-98
Aug-98
Dec-98
Apr-99
Aug-99
Dec-99
Apr-00
Aug-00
Date
Poly. (est. lbs. removed)

Attachment D

Interview Reports

Interview – Mark Gilliat, BWXTO
Hydrogeologist

Conducted by: Sue Smiley
DOE-MEMP 9/20/01

clarified roles of Mark Spivey VS Mark Gilliat.

Spivey = systems engineer for OU1.
responsible for day-to-day operations & maintenance of OU1.
able to "tweak" system (isolate wells, valves)

Gilliat = hydrogeologist for MEMP
monitors impact of OU1 operations on the groundwater
The Pump & Treat is a containment system
The SVE is very effective at removing VOCs from the vadose zone
Air Sparging is always accompanied by an SVE system (although SVE can operate w/o air sparging system)

Mark Gilliat's primary role, in terms of OU1, is to ensure hydraulic containment is maintained. He monitors groundwater wells, primarily those down-gradient of OU1, to show that the 3 extraction wells have reversed the flow of water (i.e., system [OU1] is providing capture).

Mark also monitors VOCs in wells surrounding OU1

☆ Mark's data becomes more important when its time to do rebound test.

<u>Interview:</u> Ron Paulick, BWXTO
Environmental Compliance Group

Conducted by: Sue Smiley, DOE-MEMP
9/25/01

EC group collects data from the OU1 effluent, combined extraction wells influent and the 3 capture wells.

Discharge Outfall 003 is <u>not</u> an NPDES Outfall. 003 is a "CERCLA Authorization to Discharge". It does not expire, unlike the NPDES Permit.

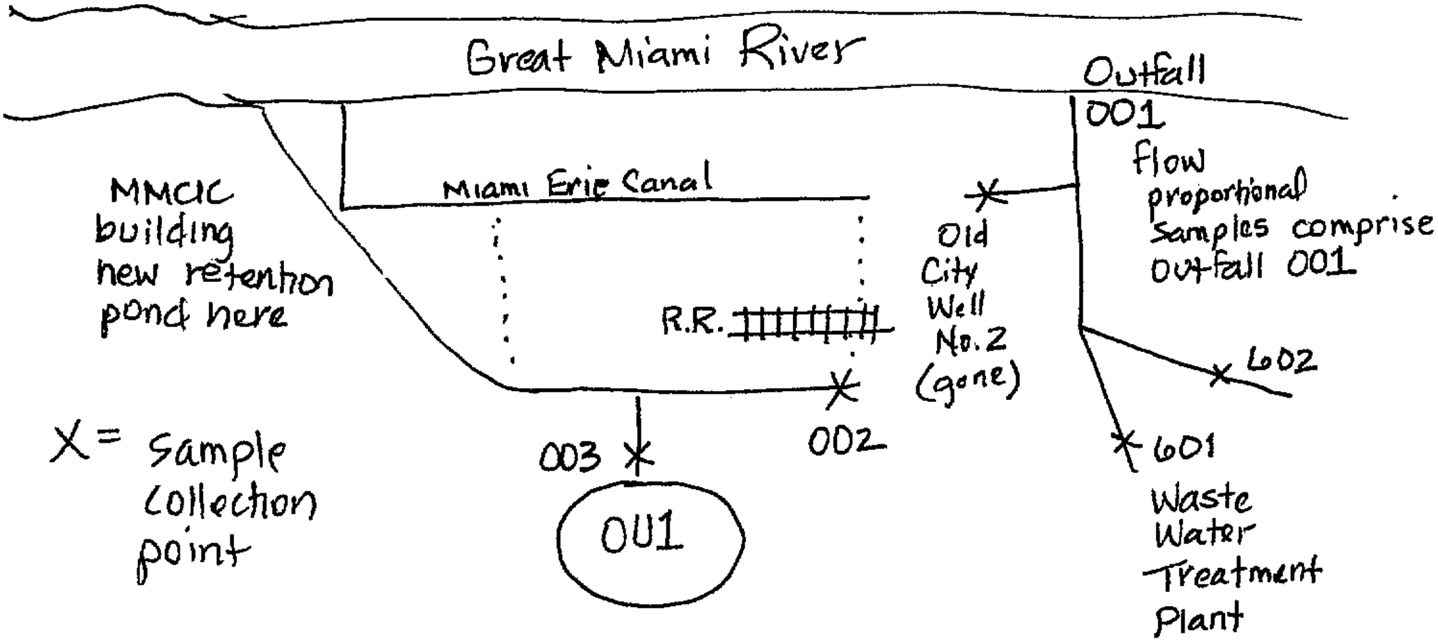
Monthly monitoring report on 003 submitted to Ohio EPA, separate from NPDES report.

003 effluent is continuous. EC group monitors for VOCs. There are 10 listed VOCs of interest. Sampling results for 003 have always been "non-detect". Also monitor 003 for biotoxicity, metals, dissolved solids -- similar to NPDES outfalls.

Reviewed CY2000 Annual Site Environmental Report (ASER) for description of anomalous sampling data from OU1 extraction wells which was caused by old City of Miamisburg "well No. 2" in Miami-Erie Canal.

Due to valve failure in City's well, MEMP's three extraction wells for OU1 began detecting tri halomethanes (extraction wells would detect earlier than Mound's production wells).

City corrected problem. Sampling data now normal for MEMP's 3 extraction wells for OU1.



Outfalls 001, 002 = NPDES permitted

Outfall 003 = CERCLA Authorization to Discharge for OU-1.

Refer to CY2000 ASER for accurate drawing of three outfalls.

Interview: Dick Neff, Sierra Lobo Co.

Conducted by: Sue Smiley, DOE-MEMP
9/24/01

Discussed directed Air Sparging approx. 2 months ago when found isolated number of hits ("hot" soil).

Discussed criteria for rebound test (note: was consistent w/ discussion during 9/20/01 site inspection with Mark Spivey, BWXTO, and Kathy Lee Fox, OEPA).

Discussed Nov. 1990 reconnaissance magnetic survey of MEMP, Areas 2, 6, 7, C. Area 2 is Operable Unit 1. Crushed, empty thorium drums evident. Survey pre-dates the OU1 ROD.

Discussed compliance boundary for OU1 - the three extraction wells (i.e., compliance boundary not based on contaminant levels in soil).

"South Plume" is from VOCs. The source of VOCs is not the historic landfill.

Attachment E

Site Inspection Checklist

Please note that "O&M" is referred to throughout this checklist. At sites where Long-Term Response Actions are in progress, O&M activities may be referred to as "system operations" since these sites are not considered to be in the O&M phase while being remediated under the Superfund program.

Five-Year Review Site Inspection Checklist (Template)

(Working document for site inspection. Information may be completed by hand and attached to the Five-Year Review report as supporting documentation of site status. "N/A" refers to "not applicable.")

I. SITE INFORMATION

Site name: DOE-MEMP Operable Unit 1	**Date of inspection:** 9/20/01
Location and Region: Miamisburg, OH	**EPA ID:** OH6890008984
Agency, office, or company leading the five-year review: U.S. Dept. of Energy	**Weather/temperature:** cloudy 60°F

Remedy Includes: (Check all that apply)

Landfill cover/containment
Access controls
Institutional controls
[✓ Groundwater pump and treatment]
Surface water collection and treatment
Other Augmented by AirSparging/Soil Vapor Extraction

Monitored natural attenuation
Groundwater containment
Vertical barrier walls

Attachments: Inspection team roster attached see below Site map attached see 5-yr report

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** Mark Spivey (Name) OU1 Project Engineer (Title) 9/20/01 (Date)
Interviewed [✓ at site] [✓ at office] by phone Phone no. 865-3709
Problems, suggestions; Report attached

2. **O&M staff** N/A (Name) (Title) (Date)
Interviewed at site at office by phone Phone no.
Problems, suggestions; Report attached

Roster

Sue Smiley, DOE-MEMP
Rob Rothman, DOE-MEMP
Monte Williams, BWXTO
Mark Spivey, BWXTO
Kathy Lee Fox, OEPA

Prepared by:
Susan L. Smiley
Post-Closure Stewardship
Project Manager
DOE-MEMP
9/20/01

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 Ohio EPA
Contact Kathy Lee Fox Groundwater Hydrologist 9/20/01
Name Title Date Phone no.
Problems; suggestions; Report attached (937) 285-6441

Agency Ohio EPA
Contact Brian Nickel, Project Mgr, (937) 285-6468
Name Title MEMP Group Date Phone no.
Problems; suggestions; Report attached

Agency USEPA Region 5
Contact Tim Fischer Remedial Project Manager
Name Title Date Phone no.
Problems; suggestions; Report attached (312) 886-5787

Agency Ohio Dept. of Health
Contact Celeste Lipp Health Physicist (614) 728-0395
Name Title Date Phone no.
Problems; suggestions; Report attached

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

Ron Paulick, Environmental Compliance Group, BWXTO
Mark Gilliat, Groundwater Hydrologist, BWXTO
Dick Neff, Sierra Lobo Co., DOE-MEMP Technical Support Contractor

Above 3 individuals interviewed after completing site inspection. Interviews were consistent with information gathered during site inspection and document reviews (e.g., ROD, FFA Monthly Reports). Inspection, interview and document review findings to be consolidated in 5-year report. This inspection checklist will be an attachment to the report.

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

1. **O&M Documents**

at OU1 site → O&M manual [✓ Readily available] [✓ Up to date] N/A
As-built drawings ← in Project Engineer's office [✓ Readily available] [✓ Up to date] N/A
at OU1 site → Maintenance logs [✓ Readily available] [✓ Up to date] N/A
Remarks

2. **Site-Specific Health and Safety Plan** onsite [✓ Readily available] [✓ Up to date] N/A
Contingency plan/emergency response plan [✓ Readily available] [✓ Up to date] N/A
Remarks General MEMP site Emerg. Response procedures manual covers OU1

3. **O&M and OSHA Training Records** [✓ Readily available] [✓ Up to date] N/A
Remarks Project Engineer maintains copy. Copies also maintained by BWXTO Medical Dept.

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 Be sure to interview Ron Paulick, BWXTO, re. CERCLA Authorization to Discharge Outfall #003

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 Maintained in Mark Spivey's office

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 Ron Paulick responsible for. Reports for Discharge 003 submitted to regulators separate from NPDES reporting.

10. **Daily Access/Security Logs** [✓ Readily available] at OU1 [✓ Up to date] N/A
Remarks Mon-Thurs, OU1 inspected twice a day. Automatic dialer notifies personnel during non-work hours if system shuts down.

IV. O&M COSTS

1. **O&M Organization**

State in-house
PRP in-house
Federal Facility in-house
Contractor for State
Contractor for PRP
[✓ Contractor for Federal Facility]
Other BWXTO does O&M in-house; has subcontract w/ Terran for maintenance. 24-hr response, per contract.

2. **O&M Cost Records**

Readily available Up to date
Funding mechanism/agreement in place
Original O&M cost estimate__________ Breakdown attached

include ITRD Cost Performance Report in 5-Year Report

Total annual cost by year for review period if available

From______ (Date) To______ (Date) ______ (Total cost) Breakdown attached
From______ (Date) To______ (Date) ______ (Total cost) Breakdown attached
From______ (Date) To______ (Date) ______ (Total cost) Breakdown attached
From______ (Date) To______ (Date) ______ (Total cost) Breakdown attached
From______ (Date) To______ (Date) ______ (Total cost) Breakdown attached

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

Describe costs and reasons: See CPR

V. ACCESS AND INSTITUTIONAL CONTROLS Applicable N/A

A. Fencing

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

Remarks MEMP site perimeter fence protects OU1. No health risk if site worker walks over OU1.

B. Other Access Restrictions

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

Remarks "DOE property" signs on fences. Locks on Buildings 300 & 301 where OU1 mechanics are housed.

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 Mon-Thurs. checks done twice daily
Responsible party/agency BWXTO
Contact Mark Spivey (or staff)
Name Title Date Phone no.
Ron Pavlick (or staff)

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

Building Manager signs are outdated on Bldgs 300/301. Need to update so all MEMP employees know who to call if see something amiss at OU1

2. **Adequacy** [✓ ICs are adequate] ICs are inadequate N/A
Remarks

D. General

1. **Vandalism/trespassing** Location shown on site map [✓ No vandalism evident]
Remarks Varmints try to access Bldgs 300/301, but no damage. Weed-trimming has done minimal damage to exterior of 300/301. No health, safety or operation impact though

2. **Land use changes on site** [✓ N/A]
Remarks

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

N/A

B. Other Site Conditions

Remarks

VII. LANDFILL COVERS Applicable N/A

A. Landfill Surface

1. **Settlement** (Low spots) Location shown on site map Settlement not evident
Areal 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
Areal extent Depth
Remarks

4. **Holes** Location shown on site map Holes not evident
Areal 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
Areal extent Height
Remarks

N/A

8. Wet Areas/Water Damage — Wet areas/water damage not evident
Wet areas — Location shown on site map — Areal extent________
Ponding — Location shown on site map — Areal extent________
Seeps — Location shown on site map — Areal extent________
Soft subgrade — Location shown on site map — Areal extent________
Remarks________

9. **Slope Instability** — Slides — Location shown on site map — No evidence of slope instability
Areal 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** — Location shown on site map — No evidence of settlement
Areal extent________ Depth________
Remarks________

2. **Material Degradation** — Location shown on site map — No evidence of degradation
Material type________ Areal extent________
Remarks________

3. **Erosion** — Location shown on site map — No evidence of erosion
Areal extent________ Depth________
Remarks________

N/A

4. **Undercutting** Location shown on site map No evidence of undercutting
Areal extent______________ Depth__________
Remarks____

5. **Obstructions** Type______________________ No obstructions
Location shown on site map Areal 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 Areal 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. **Leachate Extraction Wells**
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____

N/A

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** Areal extent______________ Depth__________ N/A
Siltation not evident
Remarks______________________________

2. **Erosion** Areal extent______________ Depth__________
Erosion not evident
Remarks______________________________

3. **Outlet Works** Functioning N/A
Remarks______________________________

4. **Dam** Functioning N/A
Remarks______________________________

N/A

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
Areal extent__________ Depth__________
Remarks__________

2. **Vegetative Growth** Location shown on site map N/A
Vegetation does not impede flow
Areal extent__________ Type__________
Remarks__________

3. **Erosion** Location shown on site map Erosion not evident
Areal 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
Areal 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

OK

Applicable N/A

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

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

Remarks 2001 Annual Report and FFA Monthly Reports discuss

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

Good condition Needs Maintenance

Remarks Header system for P&T is in Bldg 300. Everything else is underground.

3. **Spare Parts and Equipment**

[✓ Readily available] Good condition Requires upgrade Needs to be provided

Remarks stored in Sealand container behind Bldgs 300/301. Can get other spare parts in < 48 hr.

B. Surface Water Collection Structures, Pumps, and Pipelines

Applicable N/A

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

Good condition Needs Maintenance

Remarks concrete drainage control system borders OU1. Part of stormwater control program.

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

Good condition Needs Maintenance

Remarks N/A

3. **Spare Parts and Equipment**

Readily available Good condition Requires upgrade Needs to be provided

Remarks N/A

Extraction Well 414 did have cycling problem for short time. Problem fixed promptly. Due to failed sensor. There was no migration of contaminants. Well 414 is close to edge of BVA ∴ can draw well down till cycles off. Are maintaining containment. No increases in wells past point of compliance

Next month's FFA Report will discuss above.

Reviewed the following documents in Bldgs 300/301:
O&M Manual
Log Book
Health & Safety Plan
MSDSs
PPE also available at bldg entrances.

C. Treatment System Applicable N/A

1. **Treatment Train** (Check components that apply)
Metals removal Oil/water separation Bioremediation
[✓ Air stripping] Carbon adsorbers
[✓ Filters] Intake Air
[✓ Additive] (e.g., chelation agent, flocculent) Drewsperse 752
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] ~100 gal/min. (Cited in FFA Monthly Reports)
Quantity of surface water treated annually N/A
Remarks

2. **Electrical Enclosures and Panels** (properly rated and functional)
N/A [✓ Good condition] Needs Maintenance
Remarks

3. **~~Tanks~~, Vaults, Storage Vessels**
[✓ N/A] Good condition Proper secondary containment Needs Maintenance
Remarks

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

6. **Monitoring Wells** (pump and treatment remedy)
Properly secured/[✓ locked] Functioning Routinely sampled [✓ Good condition]
All required wells located Needs Maintenance N/A
Remarks Drewsperse stored properly

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]

D. Monitored Natural Attenuation N/A

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 SVE/AS = augmentation of Pump & Treat Remedy

If there are remedies applied at the site which are 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.).

Remedy is effective

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.

O&M is adequate

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.

N/A

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

Air Sparging / Soil Vapor Extraction is "optimization" of the Remedy (i.e., pump & treat)

Attachment F

Cost and Performance Report (draft)

DRAFT
COST AND PERFORMANCE REPORT

Air Sparge/Soil Vapor Extraction
Mound OU-1 Site
Miamisburg, Ohio

Innovative Treatment
Remediation Demonstration
U.S. Department of Energy

January 2001

CONTENTS

LIST OF FIGURES

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LIST OF ACRONYMS

AS	*air sparge*
Atm	*atmosphere*
cfm	*cubic feet per minute*
cm/sec	*centimeters per second*
COC	*contaminant of concern*
DCE	*dichloroethene*
DOE	*Department of Energy*
EPA	*Environmental Protection Agency*
ER	*Environmental Restoration*
g/mol	*grams per mole*
GAC	*granulated activated carbon*
GC	*gas chromatograph*
ITRD	*Innovative Treatment Remediation Demonstration*
L/mol	*liters per mole*
lbs/hr	*pounds per hour*
mg/L	*milligrams per liter*
MSL	*mean sea level*
µL/L	*micrograms per gram*
µg/L	*micrograms per liter*
PCE	*tetrachloroethene (perchlorotehene)*
ppbm	*parts per billion mass*
ppmv	*parts per million volume*
RCRA	*Resource Conservation and Recovery Act*
scfm	*standard cubic feet per minute*
SVE	*soil vapor extraction*
TCE	*trichloroethene*
v/v	*volume per volume*
VOC	*volatile organic compound*

FOREWORD

The Department of Energy (DOE) is working to accelerate the acceptance and application of innovative technologies that improve the way the nation manages its environmental remediation problems. The DOE Office of Environmental Restoration (EM-40) established the Innovative Treatment Remediation Demonstration (ITRD) Program to help accelerate the adoption and implementation of new and innovative soil and ground water remediation technologies. Developed as a public-private partnership in cooperation with Clean Sites Inc., the U.S. Environmental Protection Agency (EPA) Technology Innovation Office, and Sandia National Laboratories, the ITRD Program attempts to reduce many of the classic barriers to the use of new technologies by involving government, industry, and regulatory agencies in the assessment, implementation, and validation of innovative technologies.

The ITRD Program is an operational testing and evaluation program that assists DOE facilities in identifying and evaluating innovative technologies that can remediate their sites in the most cost-effective and responsible manner. The technologies considered for evaluation lack the cost and performance information that would otherwise permit their full consideration as remedial alternatives. The technologies have often shown promise in bench- or small-scale applications but have limited pilot or full-scale operational performance data.

Funding is provided through the ITRD Program to assist participating site managers in identifying, evaluating, implementing, and monitoring innovative technologies. The program provides technical assistance to the participating DOE sites by coordinating DOE, EPA, industry, and regulatory participation in each project; providing funds for site-specific treatability and pilot studies for optimizing full-scale operating parameters; coordinating technology performance monitoring; and by developing cost and performance reports on the technology applications.

An ITRD Project was initiated in 1995 with the DOE Mound Facility in Miamisburg, Ohio at the OU-1 Site, a three acre capped landfill. The site is characterized by chlorinated volatile organic compound contamination of ground water in a shallow, high permeability, sandy-gravel, sole source aquifer overlain by volatile organic compound contaminated low permeability glacial till and compacted fill. Advisory groups composed of DOE, EPA, industry, and state and federal regulatory representatives worked with the site Environmental Restoration (ER) Program to review and evaluate approximately 20 potentially applicable innovative remediation technologies that could enhance the cost or performance of the proposed baseline pump-and-treat system. Participants involved in the assessment and evaluation of this technology included Ohio Environmental Protection Agency (OEPA), U.S. EPA National Risk Management Research Laboratory, U.S. EPA Region V, U.S. EPA Superfund Innovative Technology Evaluation (SITE), U.S. EPA Technology Innovation Office, U.S. DOE Office of Environmental Restoration (EM-40), U.S. DOE Ohio Field Office, Sandia National Laboratories, Babcock and Wilcox of Ohio, ICI Americas, Inc., Occidental Chemical, Clean Sites, Inc., and EG&G Mound Applied Technologies.

Based on this technology review the Mound Facility selected two complementary technologies for pilot scale implementation. The technologies selected were air sparging of the aquifer through 23 air injection wells, and soil vapor extraction through 12 extraction wells and five French drains. The purpose of this Cost and Performance Report is to document these activities, present summary data, and provide evaluation results on the cost and performance of this air sparge/soil vapor extraction system.

1. SUMMARY

From mid December 1997 through mid May 2000, the Innovative Treatment Remediation Demonstration (ITRD) Program conducted a treatment technology study at the Mound Plant Operable Unit 1 (OU-1) Site to remediate chlorinated volatile organic compounds (VOCs) in the landfill vadose (unsaturated) and saturated zones. The treatment system evaluated was a combination of air sparge and soil vapor extraction technologies. The OU-1 Site is characterized by VOC contamination of a 15 to 20 foot thick saturated zone composed of glacial outwash materials, primarily gravel and sandy gravel, and an unsaturated zone, ranging from 24 to 31 feet thick, composed of glacial till and artificial fill. The primary objectives of this study were to 1) evaluate the effectiveness of combining air sparge and soil vapor extraction technologies for the removal of chlorinated VOCs from water and soil matrices simultaneously, and 2) obtain operating and performance data to evaluate the design, operation, and cost of a full-scale system. During the operational period of this study, the emphasis was on reducing contaminants to a specific regulatory level.

The OU-1 Site initial total chlorinated contaminant concentrations in groundwater ranged from 10 to 1200 g/L (ppbm), with an average of 101 g/L. The total chlorinated contaminant concentrations of the unsaturated zone generally ranged from 0.001 to 14.4 L/L. (ppmv). However, one well had a total VOC concentration of 8619 L/L.

The air sparge/soil vapor extraction system consisted of ten valved extraction wells with various screen intervals, five valved French drains, and twenty-three air injection wells. The valves on the extraction wells and French drains allowed operators to adjust airflow for individual well optimization. Air was pumped into the aquifer through the injection wells, and removed as soil vapor from the extraction wells and French drains. VOC concentrations were monitored at the extraction manifold by an automated onsite gas chromatograph to optimize system performance.

This report covers system operations from start-up on December 16, 1997 through to May 30, 2000. During this period, the air sparge system was operational from December 18, 1997 through February 4, 1998. The air sparge system was shut down after seven weeks operation due to fouling of the well screens. The soil vapor extraction system, however, was operational for the entire time except for short maintenance periods. The soil vapor extraction system removed soil gas at rates ranging from 475 to 625 scfm during the evaluation period. As of May 30, 2000 3,433 lbs of VOCs had been removed from the OU-1 Site by the vapor extraction system, and the total VOC concentration in the unsaturated zone decreased from 618.1 μL/L (ppmv) to 4.54 μL/L (ppmv).

The total cost for the full scale AS/SVE system was $1,439,039, with $116,773 (8.11%) representing pilot testing, $221,591 (15.40%) representing design costs, $398,000 (27.66%) representing construction costs, $517,958 (35.99%) representing operating costs, and $184,717 (12.84%) representing sampling and analysis costs. Based on these figures the system costs were $420 per pound of contaminant removed as of May 2000. If system performance is maintained, the site is anticipated to meet regulatory cleanup levels by December 2002.

2. SITE INFORMATION

Identifying Information

Facility: Mound Plant
Location: Miamisburg, Ohio
OU/SWMU: OU-1 Site
Regulatory Driver: CERCLA
Type of Action: ITRD Technology Demonstration
Technology: Air sparge/soil vapor extraction
Period of operation: December 1997 to May 2000
Treatment volume: 46,000 cubic yards

Site Background

The Mound Plant is a government owned and contractor operated facility occupying a 306-acre site within the city of Miamisburg, Montgomery County, Ohio. The site is approximately 10 miles south-southwest of Dayton and 45 miles north of Cincinnati. The plant site is bordered on the north by the city of Miamisburg, on the south by the township of Miami, to the south and east by arterial roads, and to the west by railroad tracks (Figure 1). The Mound Facility is situated on an escarpment with topographic elevation ranging from 900 feet MSL, on the east boundary, to 725 feet MSL, along the north, south, and west boundaries. Montgomery County has two distinguishing climatic elements, temperature and precipitation. Precipitation is abundant, with significant amounts occurring year-round. Overall, the county can be described as having warm summers and cold winters.

The OU-1 Site occupies approximately three acres on the western edge of the developed portion of the facility (Figure 2). The operable unit is composed of four sub-units: the historic landfill, the site sanitary landfill, the overflow pond, and three plant production water wells (Figure 3). The OU-1 site sanitary landfill area slopes steeply and is covered with soil and native vegetation.

Site History

The Mound Plant, currently owned by the U S Department of Energy, was first occupied in 1948 under the auspices of the Atomic Energy Commission. The site has had three contractors - Monsanto Research Corporation (1948-1988), EG&G Mound Applied technologies (1988-1997), and Babcock & Wilcox Technologies of Ohio (BWXTO), the present contractor. BWXTO will oversee closure activities and final cleanup of the Mound Plant prior to conversion of the facility to private ownership.

On November 21, 1989, the Mound Plant was placed on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List (NPL) under Section 120 of CERCLA. The Mound Plant site was divided into Operable Units (OUs) to facilitate site investigation and remediation under the environmental restoration program.

The historic landfill in Operable Unit 1 (OU-1) was used between 1948 and 1974 for disposal of general trash, and liquid wastes from Mound Plant operations. Much of the waste was relocated and encapsulated in the site sanitary landfill in 1977. The sanitary landfill was constructed partially within and adjacent to the location of the historic landfill. Both disposal sites have a long history of dumping, burning, moving, reworking, and burying of various plant wastes.

Mound Plant personnel began a periodic water sampling program for volatile organic compounds (VOCs) in 1984. A Phase 1 Preliminary Assessment/Site Inspection was completed in 1986 as part of an Environmental Restoration (ER) Program. The water sampling program and Phase 1 Investigation results indicate the presence of VOCs in both the soil vadose zone and groundwater of OU-1.

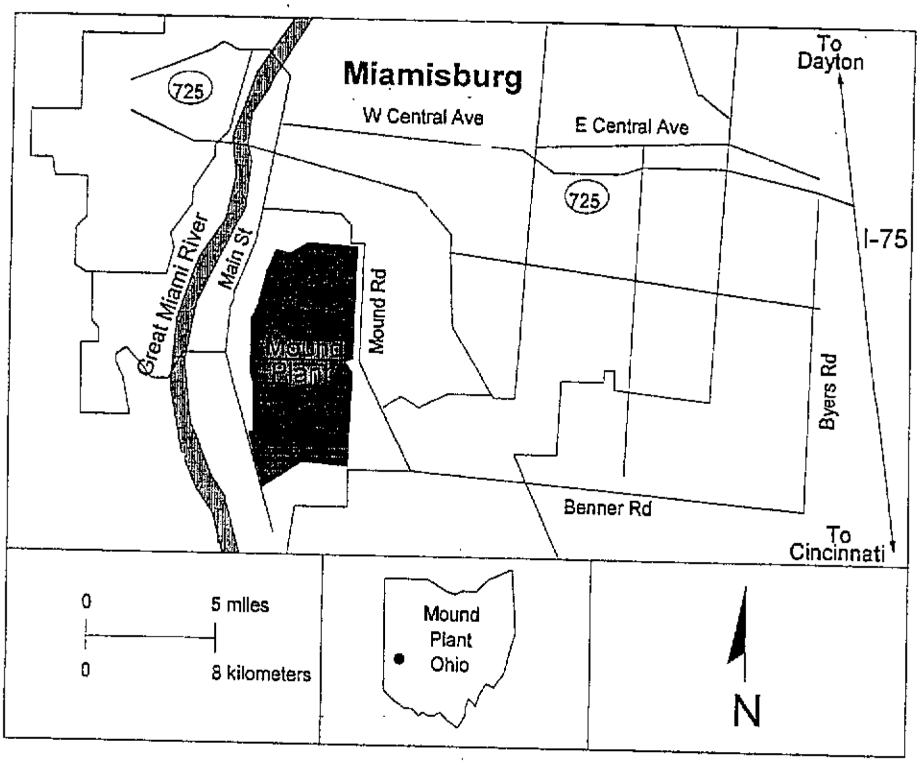


Figure 1. Local and regional setting of the Mound Plant.

Figure 2. Location of Operable Unit-1 (OU-1) at Mound Plant.

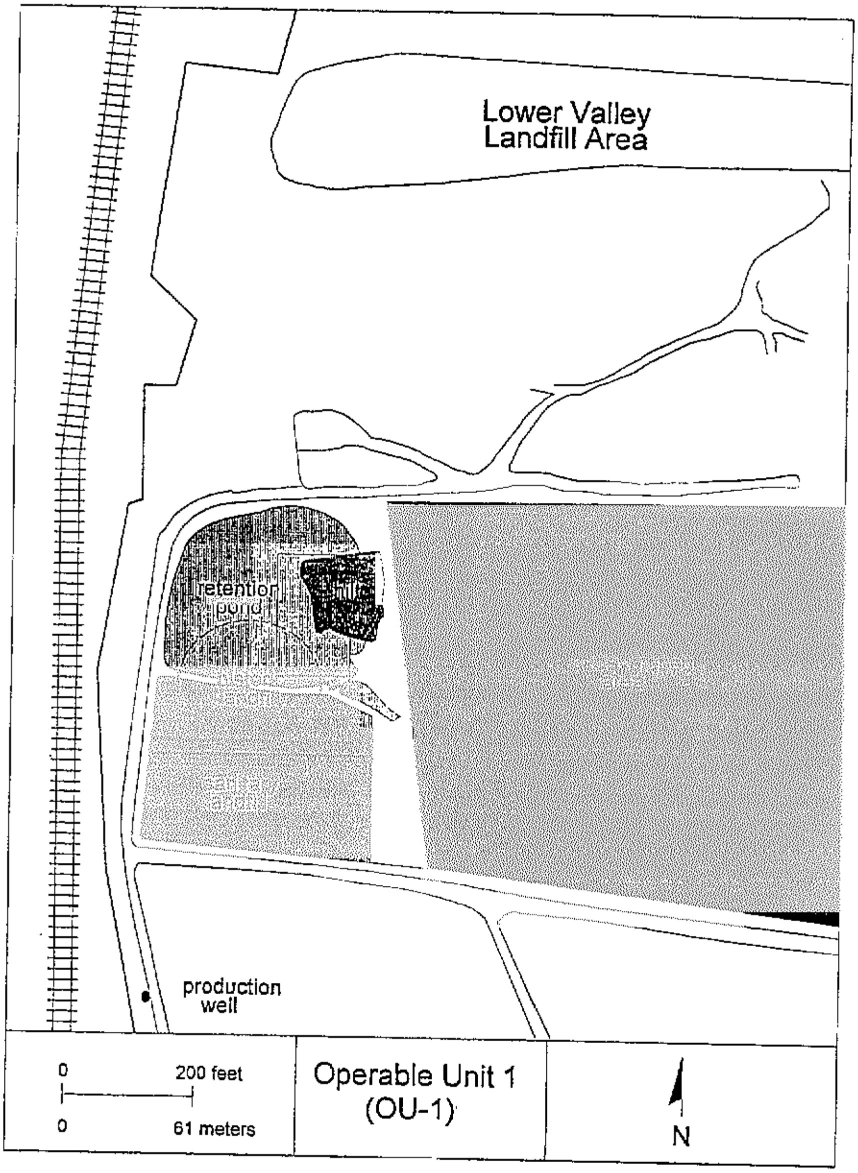


Figure 3. Mound Plant Operable Unit 1 Site.

Contaminant Inventory

The VOC contamination was primarily restricted to depths less than 20 feet below grade. The primary VOCs detected in vadose zone soil samples were *cis*-1,2-dichloroethene (DCE), trichloroethene (TCE), toluene, tetrachloroethene (PCE), ethylbenzene, and xylenes. Analysis of soil samples indicated VOC soil concentrations generally less than 10 L/L (ppmv) with a median concentration of 3.21 L/L (ppmv). However, a peak concentration of 8619 L/L was found in one area.

Dissolved VOCs detected in the groundwater at levels above the established regulatory limits included vinyl chloride, trichloromethane, DCE, TCE, and PCE. The aqueous concentrations of individual VOCs were generally less than 1 g/L (ppbm) with seasonal variability bringing a maximum concentration of 7 g/L in some areas. The dissolved VOCs in the groundwater appear to be sourced by the vadose zone VOC contamination.

Site Contacts

Site management is provided by the DOE Miamisburg Environmental Management Project Office (MEMP). The BWXTO Mound OU-1 Environmental Restoration Project Manager is Monte Williams [(937) 865-4543]. The technical contacts for the Mound Air Sparge/Soil Vapor Extraction Project are Dr. Gary Brown, the ITRD technical coordinator at Sandia National Laboratories [(505) 845-8312]; or Mark Spivey, the BWXTO Mound OU-1 Project Engineer [(937) 865-3709].

3. MATRIX AND CONTAMINANT DESCRIPTION

Site Geology/Hydrology

Based on analysis of soil borings, details of well construction, and environmental studies the OU-1 site is located on a buried bedrock shelf that drops off to the west, north, and south. The surface of the bedrock is a pre-glacial erosional surface that is weathered, but grades rapidly into competent material. The bedrock material is overlain by 15 to 20 feet of glacial outwash materials, primarily gravel and sandy gravel. A surficial deposit ranging from 24 to 31 feet thick, composed of glacial till and artificial fill, caps the site. The fill and glacial till are texturally silty clay to sandy clay.

The principal groundwater aquifer, the Buried Valley Aquifer, is contained in the outwash materials above the bedrock. Only the western portion of the site sanitary landfill overlies the aquifer. The portion of the Buried Valley Aquifer immediately adjacent to OU-1 varies from 0 to 40 feet thick and is relatively free of fine-grained till layers within the outwash. In the main part of the aquifer, to the west of OU-1, gradients are nearly flat with flow from the east and north. Flow is governed by the interrelationships among recharge, river stage, and pumping of the Mound Plant production wells.

The waste materials and contaminated soils within OU-1 are partially isolated from the hydrologic environment, because much of the surface is engineered to provide rapid runoff. The water table is at or below the bedrock interface, leaving most unconsolidated contaminated materials in the unsaturated zone. However, during periods of high seasonal groundwater or enhanced recharge some contaminated soils are exposed to circulating waters. The hydrogeologic setting is shown in Figure 4.

Figure 4. OU-1 geologic setting.

Nature and Extent of Contamination

The primary contaminant group that the air sparge/soil vapor extraction technology was designed to treat, in this application, was chlorinated VOCs in the Mound OU-1 vadose zone and the Buried Valley Aquifer

Soil

Contaminants of concern (COCs) detected in OU-1 Site subsurface vadose zone included benzene, *cis*-1,2-dichloroethene (DCE), dichloromethane, ethylbenzene, tetrachloroethene (PCE), toluene, trichloroethene (TCE), and xylenes. The vadose zone areal extent of contamination is restricted to the area of past disposal activity and occurs at a depth less than 20 feet. The only discernable pattern for all compounds detected in the soil analyses appear directly related to activities in and around the site sanitary landfill. There appears to be no major source of contamination, but rather a random pattern of dispersed contamination caused by reworking and transporting of materials. The contaminant concentrations found in extraction wells prior to treatment within the vadose zone treatment area are summarized in Table 1.

Groundwater

Contaminants of concern detected in OU-1 Site groundwater included *cis*-1,2-dichloroethene (DCE), tetrachloroethene (PCE), toluene, trichloroethene (TCE), trichloromethane, and vinyl chloride. Contaminant concentration was generally less than 1 g/L and appears to vary seasonally. There is no consistent trend in groundwater VOC concentration with time or depth. The data show no discernible pattern or point source of contamination. However, the source of contamination to the aquifer appears to be the VOCs resident in the site vadose zone. The vadose zone contaminants are mobilized by dissolution in precipitation recharge, and by seasonal variations in the groundwater table. The concentrations prior to treatment within the groundwater treatment area are summarized in Table 2.

Table 1. Pretreatment detectable concentrations of contaminants in soil vadose zone.

Contaminant	Soil Concentration (μL/L) *	
	Maximum	Average (n=10)
benzene	16.0	4.4
cis-1,2- dichloroethene	3700.0	286.6
dichloromethane	28.0	2.9
ethylbenzene	4.2	0.4
tetrachloroethene	75.0	5.7
toluene	2000.0	201.7
trichloroethene	2800.0	252.5
xylenes (*ortho and para*)	12.0	1.3

* Summa Analysis Method TO-14 Quanterra 11/11/97

Table 2. Pretreatment concentration of contaminants in groundwater.

Contaminant	Groundwater Concentration (μg/L) *	
	Maximum	Average (n=21)
cis 1,2-dichloroethene	640	36.30
tetrachloroethene	270	33.90
toluene		
trichloroethene	210	22.20
trichloromethane	130	7.90
vinyl chloride	4.5	0.96

* Operable Unit 1 Remedial Investigation Report 5/94

Matrix Description and Characteristics

The aquifer material consists of glacial outwash materials, primarily gravel and sandy gravel. The outwash material, being the most permeable, has a hydraulic conductivity averaging nearly 70 x 10^{-5} cm/sec. The unsaturated zone is composed of glacial till and artificial fill. The fill and glacial till are texturally silty clay to sandy clay and are classified under the Unified Soil Classification System as CL-ML, SC-SM, and CH. For these soils, the hydraulic conductivities in the horizontal direction range from 7 x 10^{-3} to 9 x 10^{-5} cm/sec, while the estimated vertical hydraulic conductivities range from 1 x 10^{-6} to 1 x 10^{-5} cm/sec.

4. TECHNOLOGY DESCRIPTION

Air sparge (AS) and soil vapor extraction (SVE) systems rely on mass transfer of VOC contaminants from the dissolved-, sorbed-, and non-aqueous-phases to a gas phase that is extracted under negative pressure in the subsurface by the soil vapor extraction system. This mass transfer occurs, in accordance with the partitioning laws and vapor densities of the individual contaminant constituents, under a pressure gradient from the deep subsurface, created by the air sparge system, to a negative pressure in the vadose zone, created by the soil vapor extraction system.

Air Sparge/Soil Vapor Extraction Technology Description

Air Sparge

The air sparge system operates by injecting air through conventionally constructed wells into the aquifer. The air enters the aquifer from the well at 15 cfm by passing through a diffuser screen as 50 μm diameter bubbles. The dissolved-phase and any non-aqueous- and sorbed-phase contamination below the water table will partition into the injected bubbles and be carried up to the vadose zone. In the vadose zone, the gas-phase contaminants mix with the soil gas.

Soil Vapor Extraction

The soil vapor extraction system consists of conventionally constructed extraction wells screened above the water table. These wells are connected via manifold to a vacuum pump that creates negative pressures in the vadose zone. Contaminants, present as non-aqueous- and sorbed phase, are volatilized and mix with any existing soil gas and gas-phase contaminants from the air sparge system. The combined contaminated soil gas is extracted via the soil vapor extraction wells, and transported to the offgas treatment system by a system manifold.

A unique attribute of the vapor extraction system is the use of a relatively high vacuum for extraction to remove volatile organics from a relatively low permeability soil. The vacuum system operates at approximately 13 inches of mercury against a soil permeability of 1 x 10^{-6} cm/sec, producing a flow rate of 500 scfm. General system design parameters are based on two pilot studies conducted at Mound OU-1. The results of the pilot studies are documented in Radian Corporation and Groundwater Technology reports (1,2). The AS and SVE well design details are shown in Figure 5.

Technology Advantages

The treatment of VOC-contaminated soils and ground water using air sparge/soil vapor extraction technology offers the following advantages:

- aqueous and vapor phase contaminants are removed simultaneously,
- relatively rapid rate of treatment for large volume of contaminated soil,
- low installation and operating cost,
- high reliability and low maintenance, and
- minimum residuals to other environmental compartments produced.

Technology Limitations

The treatment of VOC-contaminated soils and ground water using air sparge/soil vapor extraction technology offers the following limitations:

- off gas treatment is required,
- air sparge has a limited area of influence due to lack of horizontal driving force,
- contaminant extraction is limited by soil permeability, channeling, and water content, and
- is favorable only to contaminants with vapor pressure greater than 0.001 atm and Henry's Law Constant less than 0.01.

Mound AirSparge/Soil Vapor Extraction System Description

Based on the engineering cost and performance estimates of air sparging and soil vapor extraction systems, a pilot-scale remediation system test was performed at the OU-1 Site. A high vacuum extraction pilot test was performed within the OU-1 Site by Radian International (1), and an air sparge/soil vapor extraction pilot test was completed by Groundwater Technology, Inc. (2). The test data indicated that the AS/SVE technology could be applied to the OU-1 Site. Specifically, the test showed that vapor extraction from the unsaturated sand and gravel deposit at a flow rate of 50 cfm per well with a radius of influence of approximately 35 feet was possible. Sparging of the saturated sand and gravel at a flow rate of 20 cfm per well with a radius of influence of approximately 20 feet was also possible.

The top of the extraction well screens were located at an average depth of approximately 15 feet with an average screen length of 13.5 feet (exempting screens located within the till) in a zone of relatively high hydraulic conductivity. An airflow rate of between 475 and 625 scfm was sustained for each zone throughout the remediation period. The AS injection wells were placed in the aquifer at various depths based upon bedrock.

The soil vapor extraction system is segregated into two zones. The south zone, Zone 1, includes six wells in the southern portion of the site. The west zone, Zone 2, includes six SVE wells and five French drain vents in the western portion of the site. Table 3 shows the zone assignment, screen length and geologic strata of each well.

SVE wells were located within the areas of identified contamination without impingement on the landfill cell. Total airflow from the west SVE wells was anticipated to be 300 scfm under 13 inches of mercury. The south subsystem airflow performance was similar to the west subsystem. The AS injection and the SVE extraction well locations are shown in Figure 6.

All of the SVE wells in each zone intersect a main manifold that enters Treatment Building 301. The manifolds are connected in series with a water knockout tank, two flow through carbon beds, SVE pumps, and an atmospheric exhaust. A strategy of pulsed treatment was developed to alternate between the two zones, so the system is capable of independent operation of either the west or the south zones for variable time periods. The pulsed approach provides a greater degree of flexibility in actual system operation, allowing withdrawal rates from individual wells to be adjusted or fine tuned based on recovered VOC concentrations.

Figure 5. AS/SVE well design details.

Table 3. Extraction Well Details.

Extraction Well	Depth to Screen (feet)	Screen Length	Geologic Strata
Zone 1			
EW-N1	17	2	till
EW-N2	10	15	non-till
EW-N3	18	3	Till
EW-N4	10	22	non-till
EW-N5	22.5	2.5	Clay
EW-N6	24	10	non-till
Zone 2			
EW-N7	10	10	non-till
EW-N8	10	10	non-till
EW-N9	15.5	15	non-till
EW-N10	17	12.5	non-till
ITRD-N7			
ITRD-N9			
ED-N1	NA	5	base of French drain
ED-N2	NA	5	base of French drain
ED-N3	NA	5	base of French drain
ED-N4	NA	5	base of French drain
ED-N5	NA	5	base of French drain

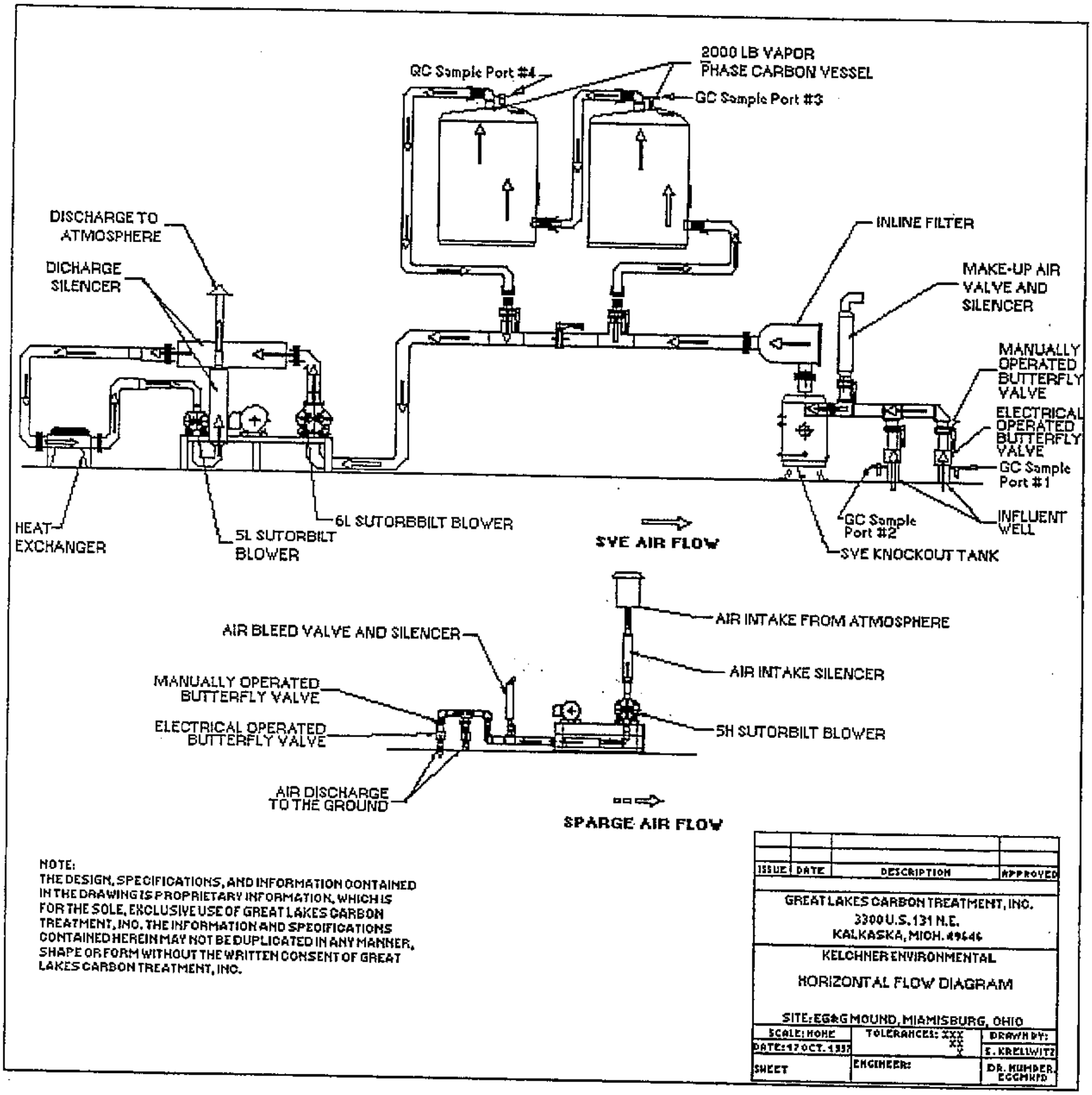
Figure 6. OU-1 Air sparge and vapor extraction well locations.

The offgas treatment system consists of a water knockout tank, and two granulated activated carbon (GAC) beds connected in series. The treatment system removes both water and volatile organics before discharge to the atmosphere. The water collected in the knockout tank is directed to an air stripper system that operates in conjunction with the previously installed baseline pump-and-treat system. A diagrammatic representation of the AS/SVE injection, extraction, and treatment system components is presented in Figure 7.

Key Design Criteria

The air sparge/soil vapor extraction system was designed to meet three main objectives:

- reduce the soil contamination in the west zone to acceptable regulatory levels within three to five years,
- reduce the groundwater contamination to acceptable regulatory levels within three to five years,
- and reach deminimis atmospheric release levels.



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ISSUE	DATE	DESCRIPTION	APPROVED

GREAT LAKES CARBON TREATMENT, INC.
3300 U.S. 131 N.E.
KALKASKA, MICH. 49646

KELCHNER ENVIRONMENTAL
HORIZONTAL FLOW DIAGRAM
SITE: EG&G MOUND, MIAMISBURG, OHIO

SCALE: NONE
DATE: 17 OCT. 1997
SHEET
TOLERANCES: XXX XX X
ENGINEER:
DRAWN BY: S. KRELLWITZ
DR. NUMBER: EGGMKFD

Figure 7. Diagrammatic representation of the AS/SVE injection, extraction, and treatment system components.

Operating Parameters

The major operating parameters needed to assess the performance and cost of the AS/SVE were considered to be airflow rate, contaminant removal, granular activated carbon renewal, and well redevelopment. Operating parameters were adjusted slightly during the study to optimize operating conditions for the AS/SVE system. The general operating parameters for the system are summarized in Table 4.

Table 4. Operating parameters affecting treatment cost or performance.

Parameter	Value or Specification
Optimal airflow from extraction wells	540 scfm
Effluent monitoring	bi-weekly
Frequency of GAC renewal	upon VOC breakthrough
Frequency of redevelopment of extraction well	annually
Frequency of redevelopment of injection well	annually

5. AIR SPARGE/SOIL VAPOR EXTRACTION SYSTEM PERFORMANCE

The air sparge/soil vapor extraction project at the OU-1 Site was conducted to assess the applicability of combined AS/SVE to accelerate the removal of the chlorinated contaminants of concern from the site unsaturated and saturated zones. The information gathered in this project was used to determine the cost and performance of the combined AS/SVE system at the OU-1 Site.

Demonstration Objectives and Approach

The objectives of the air sparge/soil vapor extraction project were as follows:

1. Remove chlorinated VOCs from the groundwater and soil unsaturated zone at the OU-1 Site,
2. Determine the suitability and effectiveness of this technology for site soil and ground water, and estimate the time period needed to meet cleanup objectives,
3. Evaluate the AS/SVE design configuration, determine hydraulic parameters, such as flow rates, residence times, flowpaths, and treatment levels,
4. Determine optimal operating parameters and conditions for treatment, and
5. Collect sufficient cost data to support cost estimates for site cleanup.

Performance Evaluation Criteria

The performance criteria considered in evaluating the AS/SVE system included:

- system run time,
- contaminant removal rates and the total mass reduction,
- fate of chlorinated solvent compounds, and
- ultimate achievable remediation levels of groundwater and soil contaminants.

The evaluation data were collected by a monitoring program that included: quarterly summa canister sampling and certified laboratory analysis for VOCs, weekly automated sampling and analysis by onsite gas chromatograph, daily operational parameter monitoring and recording, and system maintenance logs, as required.

Performance Summary

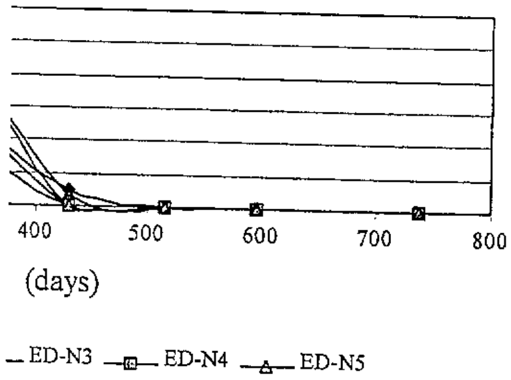
Unsaturated Zone Individual Extraction Well Soil Vapor Extraction Performance

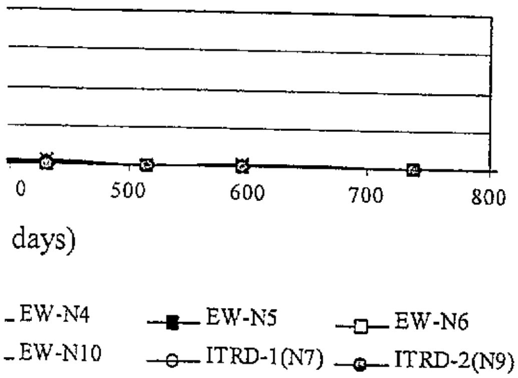
The OU-1 Site initial total chlorinated contaminant concentrations levels encountered at the different extraction wells within the unsaturated zone generally ranged from 0.001 to 14.4 L/L (ppmv). However, one well, EW-N7, had a total VOC concentration of 8619 L/L. Contaminant concentration data were collected for individual extraction wells on a quarterly basis to assess the performance of the SVE system on specific pockets of contamination.

Data from the quarterly extraction well sample analyses indicate a reduction in contaminant concentration in all wells. The concentrations of the six primary contaminants found in the extraction well soil gas samples, benzene, *cis* 1,2 dichloroethene, dichloromethane, toluene, tetrachloroethene, and trichloroethene, show a marked decrease over the 17674 hours of soil vapor extraction. Contaminant reduction ranged from 34.8 % to 100 %, and was commonly greater than 80% for the entire contaminant suite and well field. Table 5 shows the contaminant reduction numbers for all soil vapor extraction wells for the principal contaminants. The contaminant removal rates are suggestive of a first order logarithmic reduction, as most contaminant was removed in the first 155 days. Figures 8 through 13 illustrate the removal rate of benzene, *cis* 1,2 dichloroethene, dichloromethane, tetrachloroethene, and trichloroethene, respectively.

Table 5. Extraction well contaminant reduction percentage.

Well	Contaminant Reduction (%)					
	benzene	*cis* 1,2 dichloroethene	dichloromethane	tetrachloroethene	toluene	toluene
EW-N1	50.0	48.2	100.0		90.6	90.6
EW-N2	100.0	98.8		100.0	100.0	100.0
EW-N3	100.0		100.0			
EW-N4		83.2	100.0	96.4	100.0	100.0
EW-N5	81.1	80.7	100.0		40.1	40.1
EW-N6	66.7	90.3	100.0	87.5	100.0	100.0
EW-N7	87.8	100.0	100.0	100.0	100.0	100.0
ITRD-1(N7)			100.0			
EW-N8		99.5	100.0	100.0	100.0	100.0
EW-N9		99.9	100.0	100.0	100.0	100.0
ITRD-2(N9)				89.0		
EW-N10		98.7	100.0	100.0	100.0	100.0


400
500
600
700
800
(days)
ED-N3
ED-N4
ED-N5


0
500
600
700
800
days)
EW-N4
EW-N5
EW-N6
EW-N10
ITRD-1(N7)
ITRD-2(N9)

c.

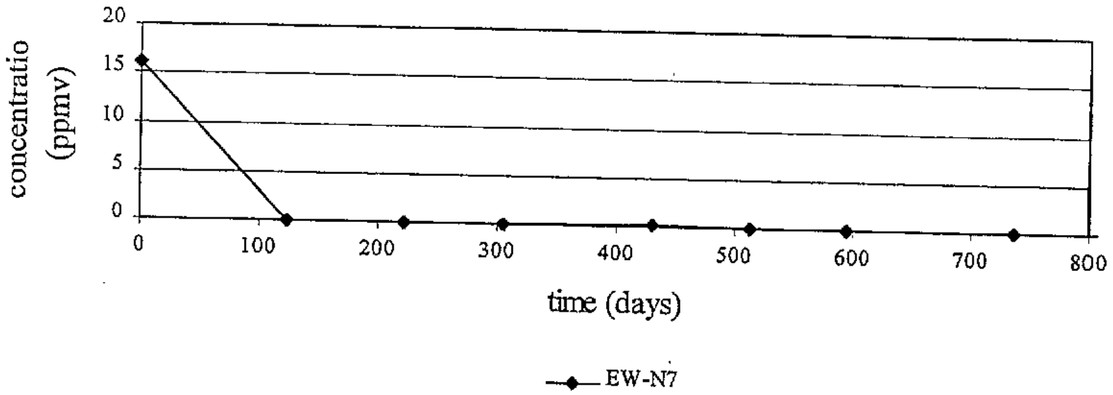
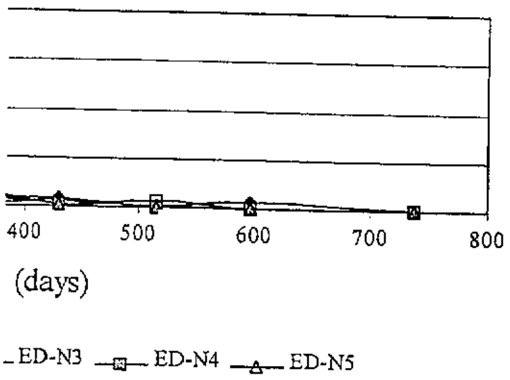
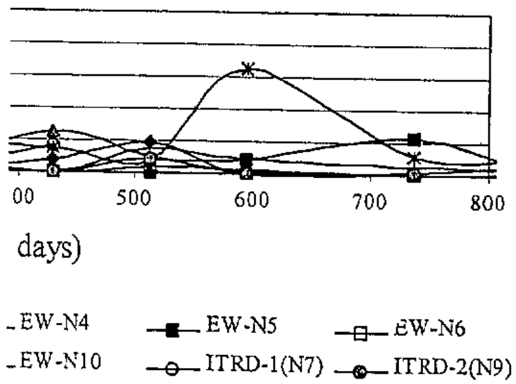


Figure 8. Extraction well monitoring data for bezene, a.) french drains, b.) extraction wells including EW-N7 after 125 days, c.) extraction well EW-N7.


400
500
600
700
800
(days)
ED-N3
ED-N4
ED-N5


00
500
600
700
800
days)
EW-N4
EW-N5
EW-N6
EW-N10
ITRD-1(N7)
ITRD-2(N9)

c.

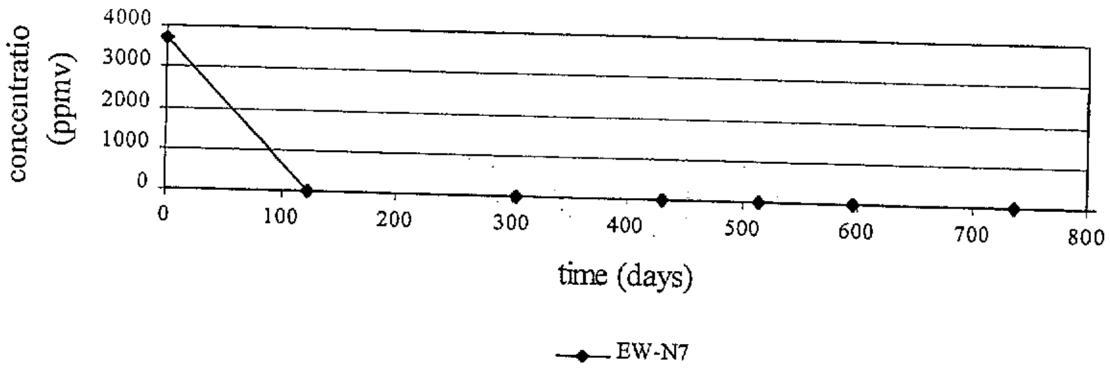
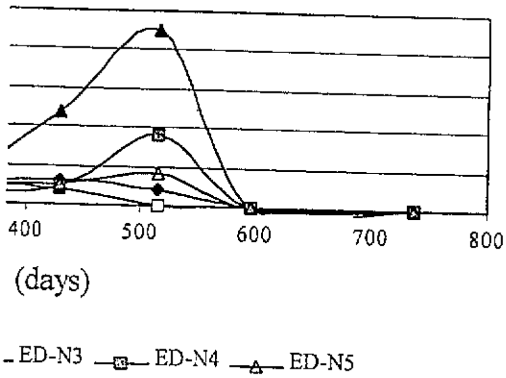
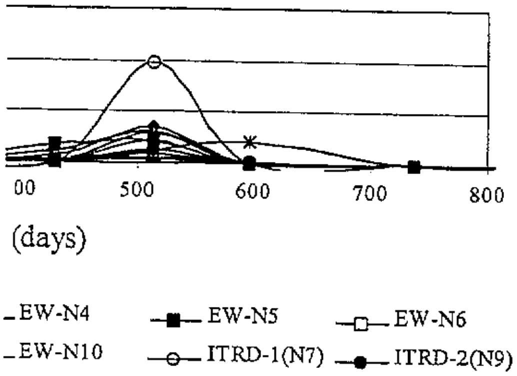


Figure 9. Extraction well monitoring data for *cis* 1,2-dichloroethene, a.) french drains, b.) extraction wells including EW-N7 after 125 days, c.) extraction well EW-N7.


400
500
600
700
800
(days)
ED-N3
ED-N4
ED-N5


00
500
600
700
800
(days)
EW-N4
EW-N5
EW-N6
EW-N10
ITRD-1(N7)
ITRD-2(N9)

c.

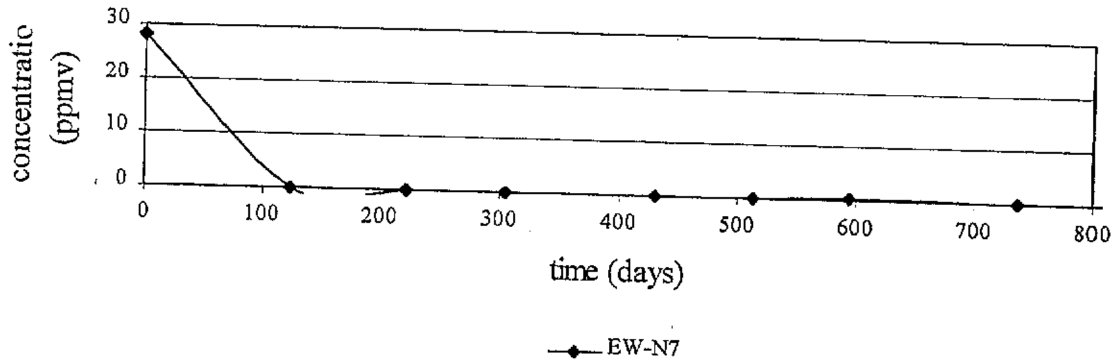


Figure 10. Extraction well monitoring data for dichloromethane, a.) french drains, b.) extraction wells including EW-N7 after 125 days, c.) extraction well EW-N7.

a.

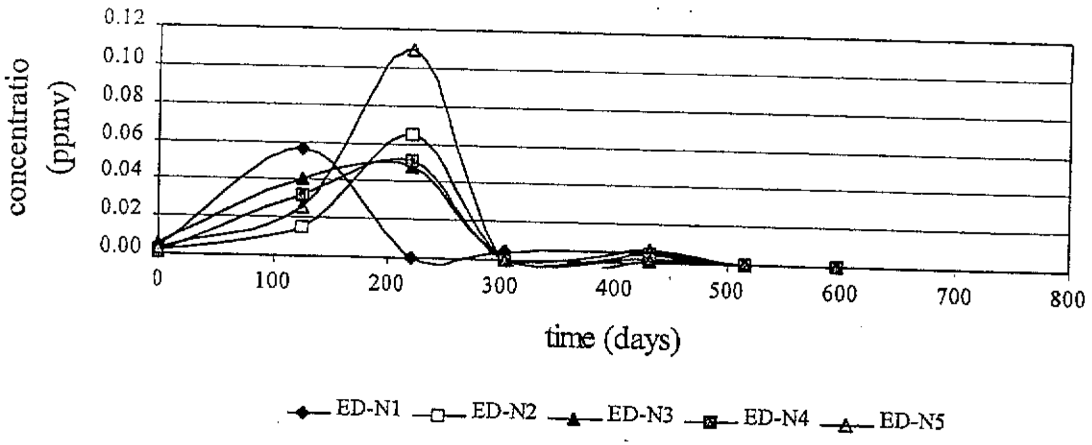
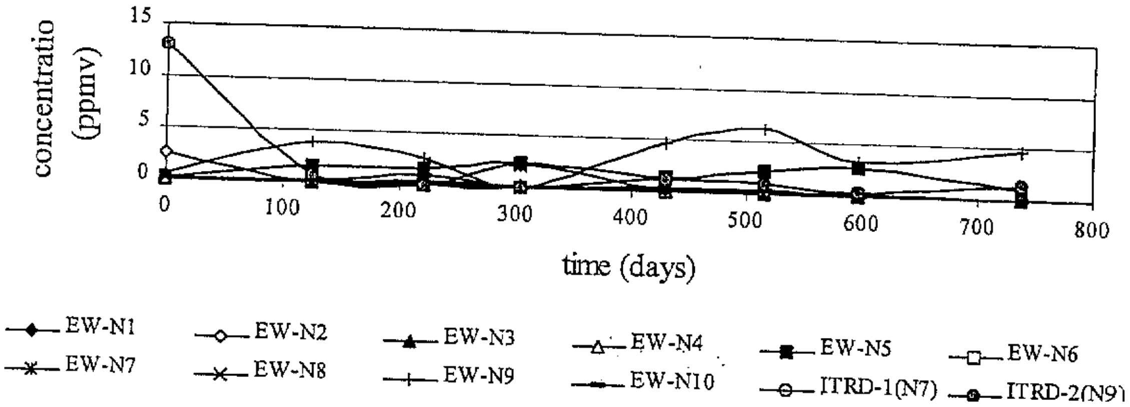
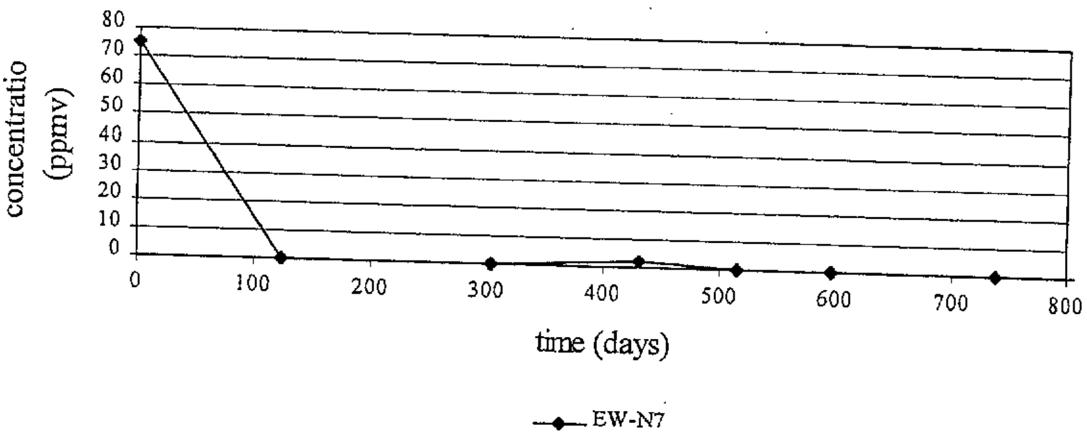


Figure 11. Extraction well monitoring data for tetrachloroethene, a.) french drains, b.) extraction wells including EW-N7 after 125 days, c.) extraction well EW-N7.

b.

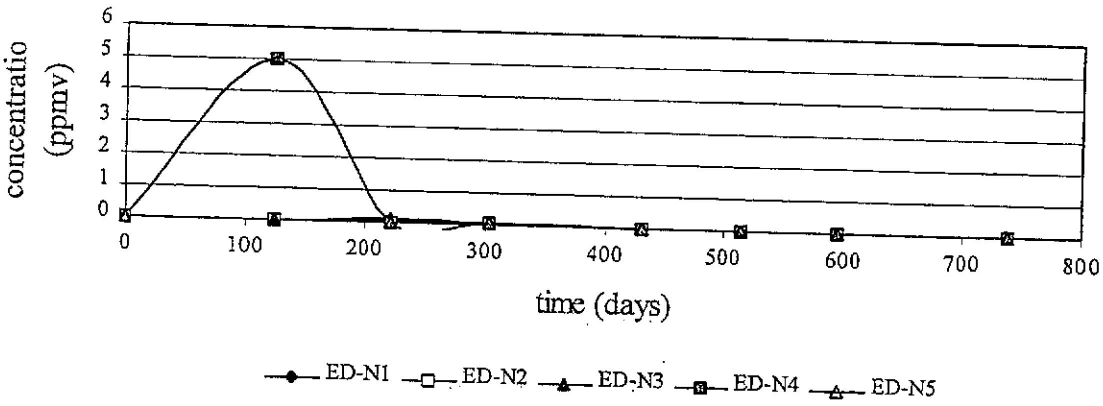

concentratio (ppmv)
15
10
5
0
0
100
200
300
400
500
600
700
800
time (days)
EW-N1
EW-N2
EW-N3
EW-N4
EW-N5
EW-N6
EW-N7
EW-N8
EW-N9
EW-N10
ITRD-1(N7)
ITRD-2(N9)

c.

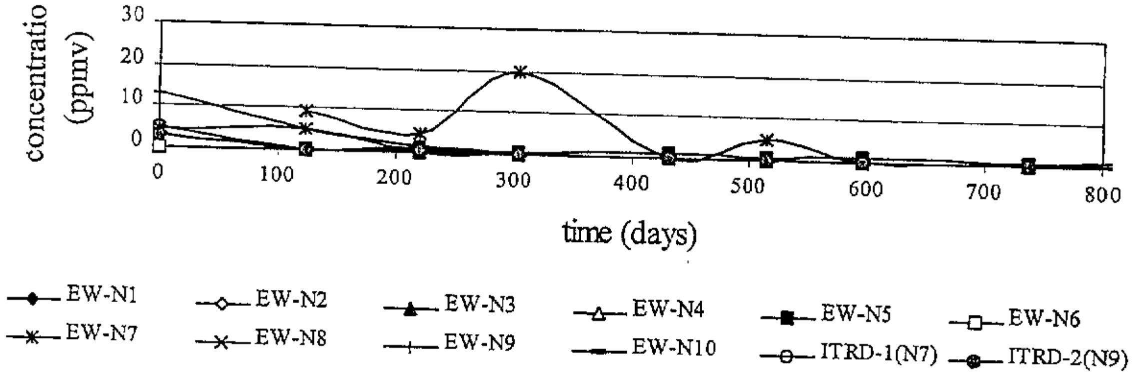


80
70
60
50
40
30
20
10
0
concentratio (ppmv)
0
100
200
300
400
500
600
700
800
time (days)
EW-N7

a.


concentratio (ppmv)
0
1
2
3
4
5
6
0
100
200
300
400
500
600
700
800
time (days)
ED-N1
ED-N2
ED-N3
ED-N4
ED-N5

b.


concentratio
(ppmv)
30
20
10
0
0
100
200
300
400
500
600
700
800
time (days)
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EW-N3
EW-N4
EW-N5
EW-N6
EW-N7
EW-N8
EW-N9
EW-N10
ITRD-1(N7)
ITRD-2(N9)

c.

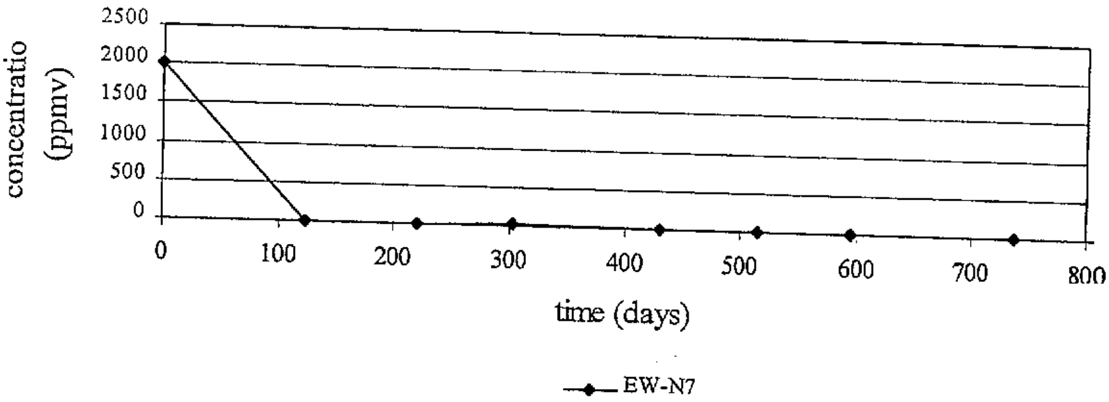
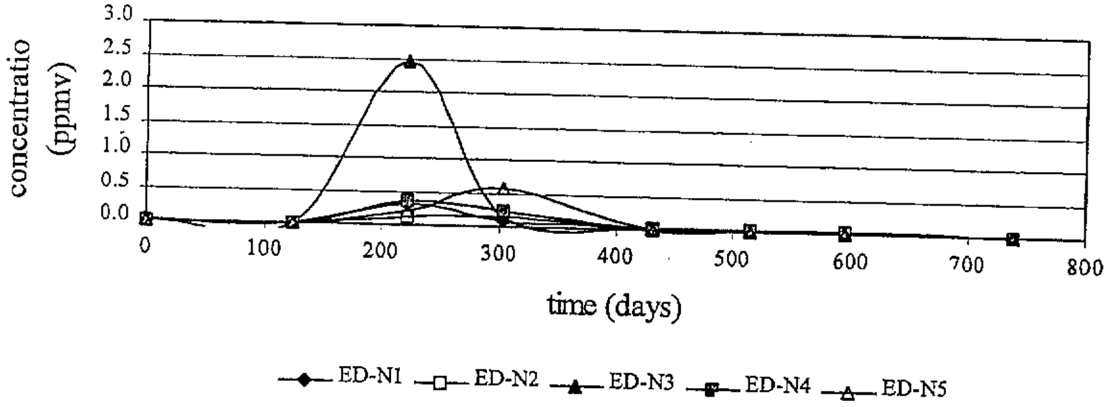
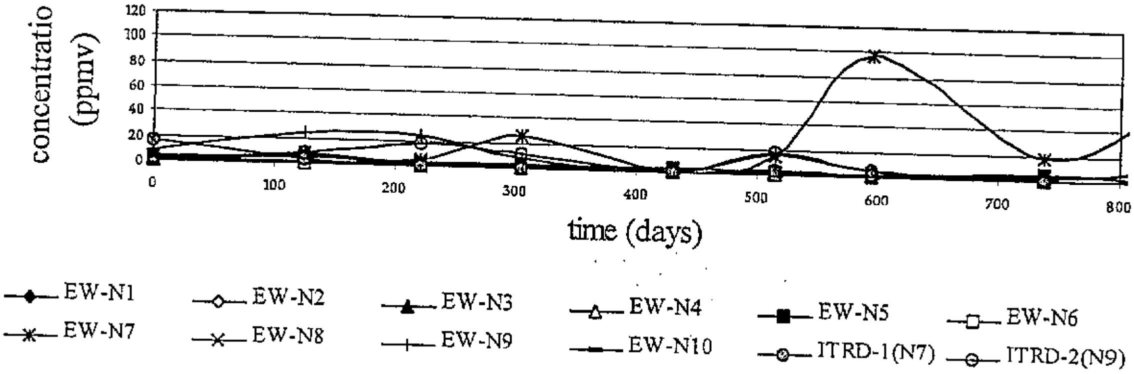


Figure 12. Extraction well monitoring data for toluene, a.) french drains, b.) extraction wells including EW-N7 after 125 days, c.) extraction well EW-N7.

a.


concentratio
(ppmv)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
100
200
300
400
500
600
700
800
time (days)
ED-N1
ED-N2
ED-N3
ED-N4
ED-N5

b.


concentratio (ppmv)
120
100
80
60
40
20
0
0
100
200
300
400
500
600
700
800
time (days)
EW-N1
EW-N2
EW-N3
EW-N4
EW-N5
EW-N6
EW-N7
EW-N8
EW-N9
EW-N10
ITRD-1(N7)
ITRD-2(N9)

c.

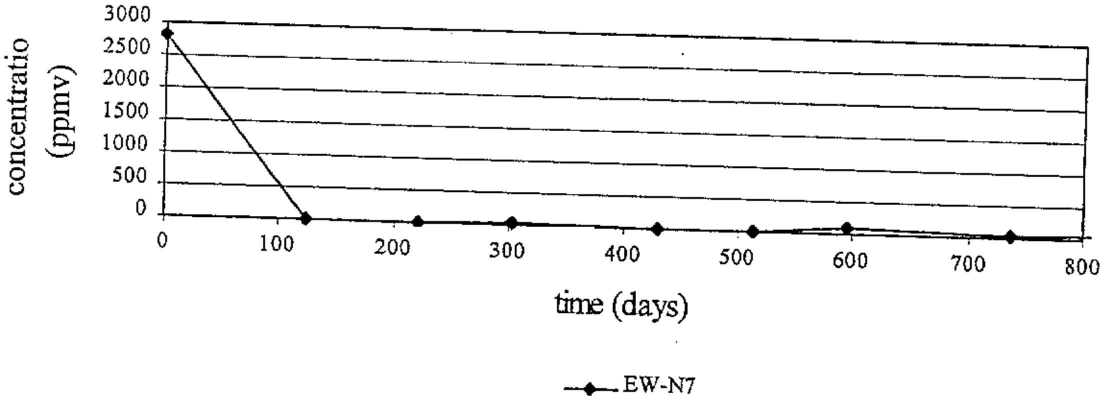


Figure 13. Extraction well monitoring data for trichloroethene, a.) french drains, b.) extraction wells including EW-N7 after 125 days, c.) extraction well EW-N7.

Unsaturated Zone Soil Vapor Extraction Performance

To establish a contaminant removal rate for the entire site, contaminant concentrations of the influent and effluent vapors were measured on a regular basis. A combination of Summa canister grab samples, and automated gas sampling and analysis equipment was used to measure the concentrations of volatile organic compounds at the extraction headers of Zone 1 and Zone 2. SVE extraction flow rates were measured by a standard pitot and read manually on a quasi-daily basis.

Tables 6 and 7 show the contaminant specific analytical results for Zone 1 and Zone 2, respectively. The concentrations of the six primary VOCs from Zone 1 over time are illustrated in Figure 14 and Zone 2 in Figures 15 and 16. The results of the grab samples for both Zones 1 and 2 show power function declines of the VOCs. Curve fit equations were matched to the data by Table Curve 2D (Ver 4, SPSS, Inc.). The bestfit equation for each compound was used to estimate contaminant concentration between sampling events. Tables 7 and 8 show the equations and correlation factors for the curve fits for each of the VOCs where sufficient evaluation data are available.

Early time concentrations fall very steeply and the curve fit lines may not be representative of the actual concentrations in the first 50 hours before the first sample was obtained on December 18, 1997. Therefore, mass removal estimates have been made starting from the first sample date. To estimate the total mass of each contaminant extracted from the soils, the flow rate from each manifold is used with the concentration data as follows:

M_{VOC} is the mass of the contaminant removed (lbs), C_{VOC} is the concentration of the contaminant (ppmv, v/v), MW_{VOC} is the molecular weight of the VOC (g/mol), $MV_{T,P}$ is the molar volume of the vapor at a specific temperature and pressure (24.5 L/mol at 25C and 1 atm), V is the volumetric flow rate in the extraction manifold (std ft^3/min), t is the time interval (min), and 3.74E-6 is for unit conversions.

From time zero to the operating time of 178 hours the system ran on six-hour intervals. The system was switched to four-hour intervals from hour 178 to 552, and to a two-hour interval from hour 552 to 2422. These changes were made to keep automatic shutdowns from occurring when large amounts of water were being extracted from the French drains soon after rainfall events. The system was changed to one hour on Zone 1 and 3 hours on Zone 2 from hour 2422 to 3453. From hour 3453 to date the system was set to only extract from Zone 2.

The early time periods in a SVE system provide much more mass removal than in the later periods due, principally, to the diffusion limitation condition in later time periods where VOCs must move from within dead end pore spaces to the locations experiencing active ventilation. At the time of shutdown on May 7,1998, the Zone 1 mass removal rate was approximately 0.04 lb/hr. The mass removal rate for Zone 2 was approximately 0.17 lb/hr as of October 15, 1998, giving an estimated mass removal of 4.08 lbs/day, which is below the deminimis regulatory emission level for air of 10 lb/day. The deminimus level was reached in July 1998. At that time, the extracted soil vapor was routed to bypass the carbon tanks and vent to the atmosphere. Subsequent fouling and breakdown of the extraction pumps caused by water and carbonate contamination required that the carbon tanks be brought back on line in August, 1998. As of May 30, 2000, the Zone 2 mass removal rate was 0.04 lb/hr, giving an estimated mass removal of 0.96 lb/day. It is estimated from grab sample and onsite GC contaminant concentration analysis, and measured flow rates that from December 18, 1997 through May 30, 2000 the SVE system extracted a total of 3433 pounds of volatile organics from the unsaturated zone. Zones 1 and 2 contributed 146.75 pounds and 3286.6 pounds of volatile organics, respectively. Table 10 shows the estimated total mass of individual VOCs removed between December 18, 1997 and May 30, 2000 by the system.

Table 6. Zone 1 Contaminant Concentration Data

Date	Source	Run Time (hours)	Contaminant Concentration (ppmv)					
			benzene	*cis* 1,2-dichloroethene	dichloromethane	tetrachloroethene	toluene	trichloroethene
18-Dec-97	Summa	13	0.580	33.000	0.250	8.300	42.000	16.000
22-Dec-97	Summa	56.5	0.220	11.000	0.240	6.100	28.000	8.600
29-Dec-97	Summa	137.5	0.091	4.300	0.160	5.400	19.000	4.600
05-Jan-98	Summa	172.5	0.056	3.200	0.130	5.200	17.000	3.900
12-Jan-98	Summa	255.5	0.026	2.400	0.064	3.500	8.800	2.200
19-Jan-98	Summa	333.5	0.017	1.300	0.015	1.800	3.200	1.600
12-Mar-98	Summa	786.25	0.0056	0.770		0.430	0.062	0.930
19-Mar-98	GC	795.8					5.160	
20-Mar-98	GC	808.3					4.960	3.980
25-Mar-98	Summa	863.75	0.0067	0.750		0.410	0.053	0.930
13-Apr-98	GC	953.8						2.570
22-May-98	Summa	1095.8		0.16		0.26	0.048	0.300
21-Jul-98	GC	1109.8		0.158		0.216	0.016	0.366
21-Jul-98	Summa	1109.8	0.002	0.12		0.18	0.036	0.270
15-Oct-98	Summa	1194.8	0.003	0.2		0.32	0.044	0.430
15-Oct-98	GC	1194.8	0.006	0.161	0.012	0.27	0.057	0.385
17-Feb-99	GC	1204.2	0.003	0.159		0.175	0.014	0.237
11-May-99	GC	1228.1		0.084		0.102	0.011	0.229
12-Jan-00	GC	1284.5	0.001	0.094		0.148		0.187
12-Jan-00	Summa	1284.5	0.002	0.15		0.19	0.028	0.220
03-May-00	Summa	1291.6		0.071		0.11	0.002	0.130
03-May-00	GC	1291.6		0.045		0.046		0.105
11-May-00	GC	1291.7						

Table 7. Zone 2 Contaminant Concentration Data

Date	Source	Run Time (hours)	Contaminant Concentration (ppmv)					
			benzene	*cis* 1,2-dichloroethene	dichloromethane	tetrachloroethene	toluene	trichloroethene
18-Dec-97	Summa	28.00	2.300	130.000	1.600	10.000	220.000	130.000
19-Jan-98	Summa	351.00	0.540	17.000	0.680	3.300	41.000	50.000
25-Mar-98	Summa	886.25	0.170	8.700		2.000	26.000	36.000
02-Apr-98	GC	1030.25		9.440		0.820	20.400	31.883
13-Apr-98	GC	1155.25		11.990			14.210	19.943
21-Apr-98	GC	1296.25		5.200			7.960	21.094
22-May-98	Summa	1910.22		3.300		0.680	9.900	13.000
24-Jun-98	Summa	2687.81	0.120	4.000	0.160	0.700	12.000	15.000
23-Jul-98	Summa	3327.36	0.037	2.600	0.027	0.580	8.200	9.500
20-Aug-98	GC	3974.59		1.777			3.365	7.509
21-Sep-98	GC	4658.53		1.888			5.068	6.327
05-Oct-98	GC	4989.97		1.713			3.927	6.567
25-Nov-98	Summa	5755.03		1.900		0.560	3.700	8.200
09-Dec-98	Summa	6086.21	0.022	1.900	0.043	0.430	2.600	6.900
18-Dec-98	Summa	6305.46		1.700		0.460	2.600	7.100
30-Dec-98	GC	6575.44		1.857		0.194	2.348	1.145
28-Jan-99	GC	7238.75		2.110	0.06	0.404	4.852	13.688
15-Feb-99	GC	7677.75		1.701	0.062	0.214	3.175	11.826
31-Mar-99	GC L BC	8188.15						1.944
31-Mar-99	Summa	8188.15		1.100	0.043	0.260	0.940	4.300
05-Apr-99	Summa	8308.15		1.100	0.041	0.250	1.100	4.800
28-Apr-99	GC T BC	8853.34	0.009	0.874	0.054	0.183	1.135	7.607

Table 7. Zone 2 Contaminant Concentration Data continued

Date	Source	Run Time (hours)	Contaminant Concentration (ppmv)					
			benzene	*cis* 1,2-dichloroethene	dichloromethane	tetrachloroethene	toluene	trichloroethene
13-May-99	GC T BC	9179.06	0.009	0.841	0.052	0.212	1.301	7.491
24-Jun-99	GC T BC	9823.71	0.003	0.782	0.017	0.119	0.829	6.601
29-Jul-99	GC T BC	10620.00	0.015	0.926		0.103	0.606	7.620
30-Aug-99	GC T BC	11386.62	0.002	0.928	0.018	0.191	0.764	7.266
30-Sep-99	GC T BC	12086.32		0.802		0.151	0.505	6.680
28-Oct-99	GC T BC	12757.01		0.638		0.079	0.278	4.543
24-Nov-99	GC T BC	13404.89		0.634	0.011	0.063	0.208	4.417
20-Dec-99	GC T BC	14005.91		0.594		0.057	0.113	4.086
10-Jan-00	GC T BC	14476.49		0.540		0.067	0.045	3.817
10-Jan-00	Summa	14476.49	0.003	0.780	0.020	0.150	0.100	3.300
31-Jan-00	GC T BC	14966.23		0.186		0.004	0.010	1.355
24-Feb-00	GC T BC	15537.59		0.450		0.028		3.192
27-Mar-00	GC T BC	16278.11		0.099				0.839
24-Apr-00	GC T BC	16896.49		0.474		0.035		3.473
30-May-00	GC T BC	17673.63	0.003	0.687		0.022	0.010	3.619

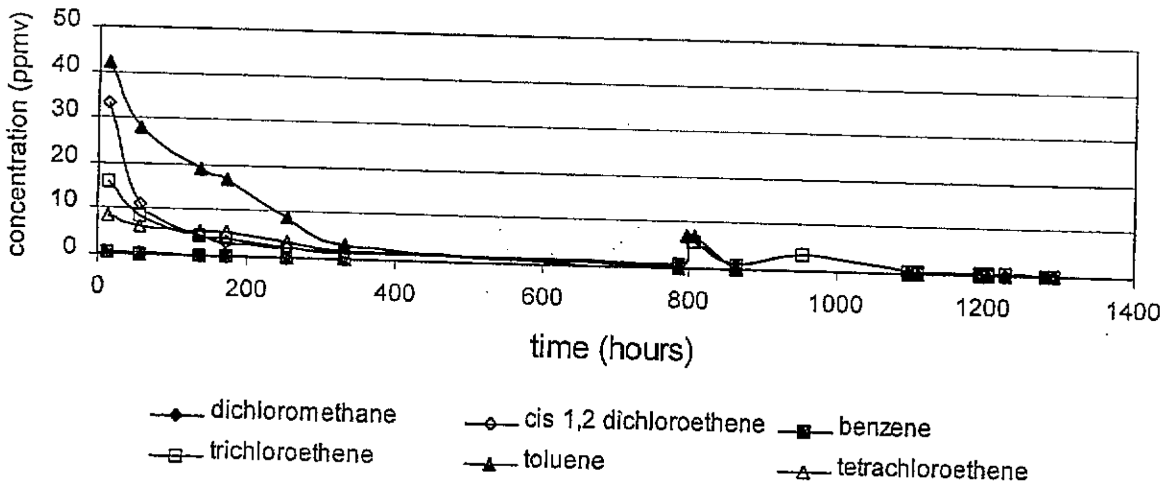
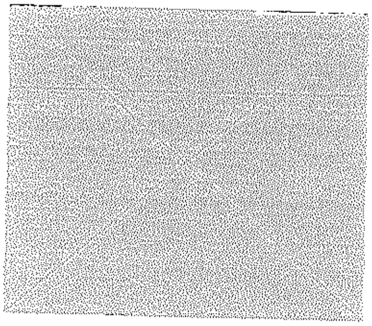
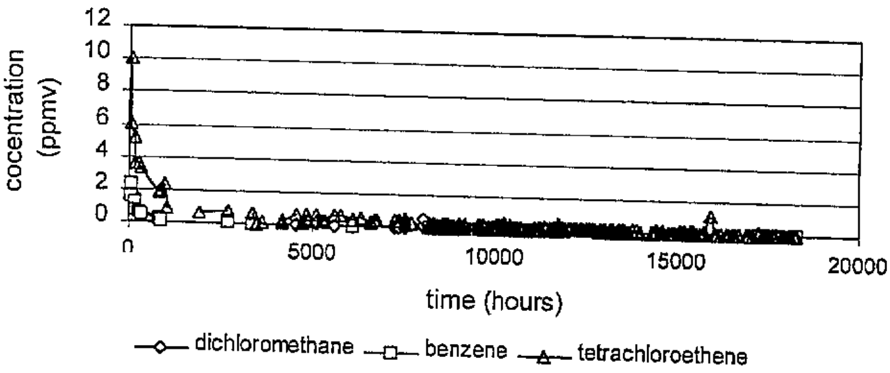


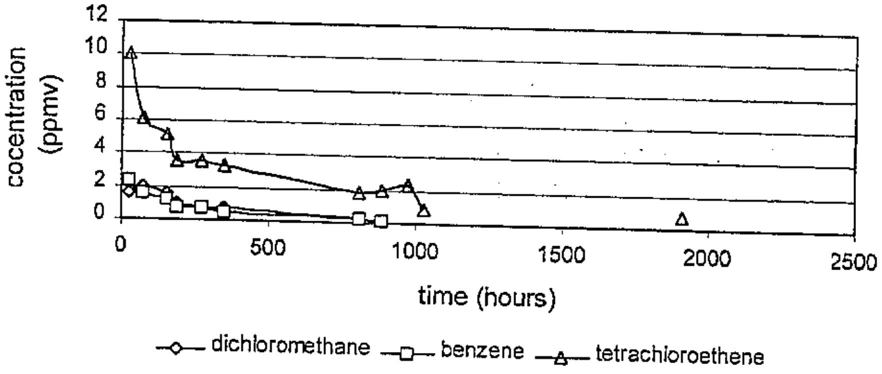
Figure 14. Zone 1 contaminant concentration data.



a.


12
10
8
6
4
2
0
cocentration (ppmv)
0
5000
10000
15000
20000
time (hours)
dichloromethane
benzene
tetrachloroethene

b.


12
10
8
6
4
2
0
cocentration (ppmv)
0
500
1000
1500
2000
2500
time (hours)
dichloromethane
benzene
tetrachloroethene

c.

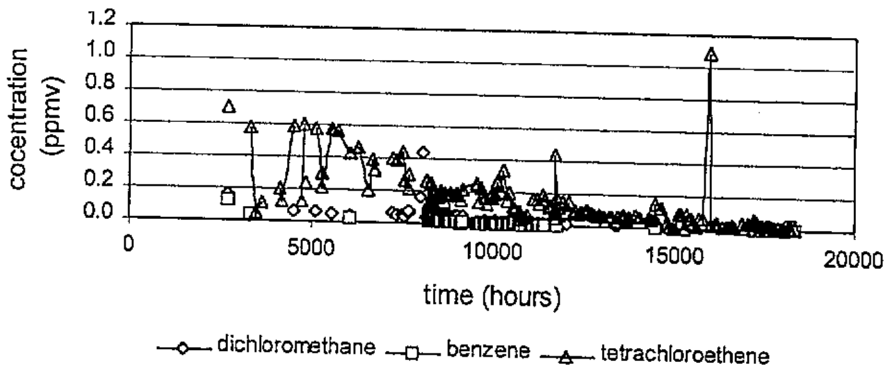
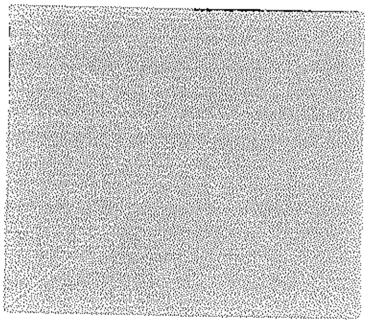
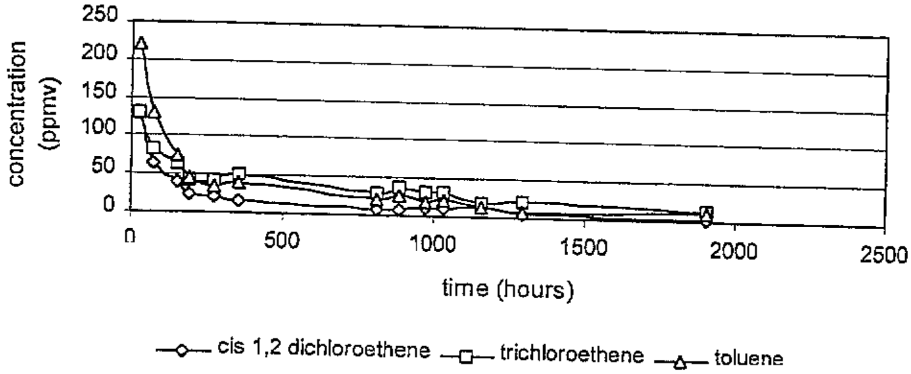


Figure 15. Zone 2 benzene, dichloromethane, and tetrachloroethene concentration data, a.) 0 to 18000 hours, b.) 0 to 2500 hours, and c.) 2500 to 18000 hours.



b.


250
200
150
100
50
0
concentration (ppmv)
0
500
1000
1500
2000
2500
time (hours)
cis 1,2 dichloroethene
trichloroethene
toluene

c.

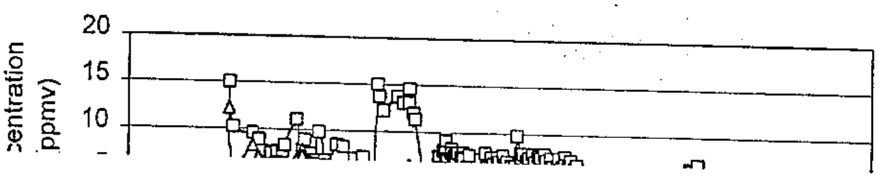


Table 8. Zone 1 Curve Fits and Correlation Factors for VOC Extraction Time History.

Contaminant	$y = a + bx^c$			Correlation (r^2)
	a	b	c	
benzene	-0.0046	27.7755	-1.1817	0.993
cis 1,2-dichlorethene	-0.3504	648.6003	-1.0031	0.996
dichloromethane	-0.0719	2.5430	-0.5125	0.912
tetrachloroethene	-83.6993	98.2605	-0.0222	0.960
toluene	-45.0769	129.344	-0.1496	0.966
trichloroethene	-2.4793	52.2583	-0.4025	0.948

Table 9. Zone 2 Curve Fits and Correlation Factors for VOC Extraction Time History

Contaminant	$y = a + bx^c$			Correlation (r^2)
	a	b	c	
benzene	-0.1216	13.5694	-0.5046	0.980
cis 1,2-dichlorethene	-0.6008	1666.3968	-0.7632	0.995
dichloromethane	-0.5566	5.7169	-0.2478	0.893
tetrachloroethene	-0.6464	46.3103	-0.4387	0.973
toluene	-3.5518	2042.1395	-0.6595	0.989
trichloroethene	-5.3955	555.4642	-0.4248	0.952

Table 10. VOC Mass Removed (lbs).

Contaminant	Total Mass Removed (lbs)		
	Zone 1	Zone 2	Zone 1 + Zone 2
benzene	0.29	8.99	9.28
cis 1,2-dichloroethene	24.71	360.26	384.97
dichloromethane	0.43	10.17	10.60
tetrachloroethene	31.60	152.89	184.49
toluene	50.04	721.15	771.19
trichloroethene	26.70	1876.16	1902.86
other VOCs	12.98	156.98	169.96
Total	**146.75**	**3286.6**	**3433.35**

A summary of the performance of the soil vapor extraction system is provided in Table 11, relative to stated performance measures and project objectives. Overall, the system met most of the identified system performance objectives.

Table 11. Soil vapor extraction system performance summary.

Performance Measures	Values/ Results
system run time	17674 hours of 21465 total hours available (82%)
contaminant removal rates and the total mass reduction	exponential removal rates for contaminants of concern and greater than 3400 lbs removed in 29 months
fate of chlorinated solvent compounds	deminimis requirement for direct exhaust to the atmosphere achieved
ultimate achievable remediation levels of groundwater and soil contaminants	total contaminants reduced by 1 to 3 orders of magnitude at present removal rate remediation goals will be attained by December 2002

Saturated Zone Air Sparge Performance

The air sparge airflow rate for both Zone 1 and Zone 2 initially increased over a ten day period. However, after the initial increase in flow rate, a significant decline was noted as the total flow rate decreased from a peak of 310 cfm to less than 150 cfm in both zones. A steady increase in delivery pressure was also noted as the flow rates decreased. On February 4, 1998 after 40 days of operation and with the system flow rate at approximately 50% of the initial value and the

[redacted]

pressure nearly double the start-up value, the system was shut down and an investigation initiated to determine the cause of system performance decline. Potential causes investigated for the decline in performance included microbial biofouling and inorganic iron or carbonate precipitate fouling of the 50 µm diameter well screens. Groundwater analysis reports indicated iron concentrations in the 1 ppmm range which essentially eliminated microbial iron oxidation and inorganic iron precipitation as a fouling mechanism, because such low iron concentrations would not be capable of producing enough precipitable mass to plug the well screens. However, the analysis reported alkalinity concentrations ranging from 200 to 300 ppmm which suggests that carbonate precipitation may have caused the screen fouling. Because no direct analysis of the fouling substance was possible, any remedy selected must be capable of eliminating the most probable fouling candidates, that is, aerobic microbial growth or carbonate precipitation.

A commercial product produced by Johnson Screens specifically to treat fouled well screens was selected as a treatment method to redevelop the wells. The treatment product was designed to eliminate fouling caused by iron precipitation, carbonate buildup, and microbial biofouling. The treatment is added to the wells as a granular enhancer compound, followed by granular acid, and the addition of water. After addition of the treatment compounds, the system was surged and allowed to set for 96 hours after which the treatment solution was pumped from the wells. The treatment for three air sparge wells, AS-N19, AS-N20, and AS-N21, began on August 26, 1998, and was completed at close of business on August 28. Prior to treatment the wells showed flow rates of 0, 0 and 12 cfm respectively, and 47, 27, and 39 cfm after treatment. Treatment of the remaining air sparge wells in Zone 2 was completed in mid October 1998.

Before the air sparge system was scheduled for operation, a tracer test to determine connectivity and capture efficiency of the air sparge/soil vapor extraction system, and to establish contaminant containment within site boundaries with air injection was proposed. A tracer test plan was developed that included the injection of 10 lbs of Halon 1211 into the Zone 2 AS manifold with subsequent extraction, measurement and monitoring of Halon 1211 concentration at the Zone 2 soil vapor extraction manifold.

In May 1999 the tracer test was conducted at the OU-1 Site. The test indicated a strong subsurface pneumatic connection between the air sparge system and the soil vapor extraction system. Based on Halon 1211 air sparge injection and vapor extraction manifold arrival times, the apparent velocity of Halon 1211 through the system was calculated to be 2.3 cm/sec which indicates that injected air is rapidly migrating into the SVE uptake wells through well formed pathways. The tracer test also indicated that offsite migration induced by the air sparge system was possibly greater than anticipated. The analysis of three offsite well groundwater samples obtained three hours after injection indicated the presence of significant amounts of Halon. Integration of Halon mass measured in the three wells over 60 hours produced a total mass of approximately 2.5 lbs of Halon 1211 in the offsite wells or 25% of the total mass injected.

Based on the tracer test results, it was decided by the Technical Advisory Group that the air sparge system at the OU-1 Site would not be operated as planned, because of the high probability of increased contaminant movement offsite induced by air injection into the aquifer. However, it was decided that the air sparge system would be utilized in a limited manner to assist in the removal of high contaminant concentrations in isolated areas where the pump-and-treat system

[redacted]
was ineffective.

[redacted]6. AIR SPARGE/SOIL VAPOR EXTRACTION SYSTEM COSTS

The Mound OU-1 air sparge/soil vapor extraction system was designed by R.E. Wright Environmental, Inc., constructed by Kelchner Environmental, Inc., and operated by Babcock and Wilcox Technologies of Ohio under a cost-plus-fee management and operations (M&O) contract with the DOE. Several organizations, including Sandia National Labs and several industry participants, played an important role in the design, operation, and monitoring of the remediation system. These services were often in an advisory or consulting role, though some direct support was provided to the project. Where appropriate, direct support costs are included in Table 12, which shows project costs in accordance with the interagency work breakdown structure adopted by the Federal Remediation Technologies Roundtable.

As can be seen from Table 12, 13% of the overall cost of the system operation was related to the extensive monitoring conducted. This level of monitoring was used in an effort to better understand the operation of the system and to track the contaminant removal through time. The monitoring cost data includes summa sampling and onsite GC analysis. From an operational viewpoint, the system removed an estimated 3433 lbs of soil vapor contaminant. The direct treatment cost for contaminant removal, excluding the extensive monitoring costs, during the system operations was therefore approximately $365 per pound of contaminant removed.

Table 12. Air Sparge/Soil Vapor Extraction Project cost by interagency work breakdown structure

Cost element (with interagency WBS Level 2 code)	Description	Costs ($)	Subtotals ($)
Mobilization and preparatory work(331 01)			
	Mobilization	5000	
	Site Preparation	10000	
	Demobilization and Site Restoration	7500	22500
Monitoring ,sampling, testing, and analysis (331 02)			
	Sampling Performance Monitoring	7500	
	Sampling Compliance Monitoring	29750	
	Sampling QA/QC	7500	
	Analysis Performance Monitoring	13000	
	Analysis Compliance Monitoring	38000	
	Analysis QA/QC	8000	
	Analysis Data Reduction	5500	
	Geoprobe Sampling	10467	
	On site automated GC	45000	
	Sampling and Analysis Supplies	20000	184717
Ground water collection and control (331 06)			
	Miscellaneous	5000	5000
Soil vapor collection and control			
	GLCT 4,000 lbs. GAC Replacement (LTD)	55000	55000
Air Sparge Treatment			
	Above Ground Equipment Purchase	15000	
	Below Ground Equipment Purchase	8800	
	Above Ground Installation	36200	
	Below Ground Installation	100500	
	Contractor Operating Costs	64750	225250
Soil Vapor Extraction Treatment			
	Above Ground Equipment Purchase	8000	
	Below Ground Equipment Purchase	4200	
	Above Ground Installation	17800	
	Below Ground Installation	50500	
	Contractor Operating Costs	64750	145250
General requirements (331 22)	Project management and engineering (+O&M)	801322	801322

TOTAL	1439039

7. REGULATORY/INSTITUTIONAL ISSUES

In 1995 DOE, EPA, and EG&G entered into an agreement with the ITRD Program to evaluate innovative technologies to remediate ground water and unsaturated zone contamination at the Mound OU-1 Site effectively and expeditiously.

8. SCHEDULE

Table 13. Tasks and schedule associated with the air sparge/soil vapor extraction project at the Mound OU-1 Site.

Date	Milestone
March 1995	Technical Advisory Group formed
April 1995	Technologies selected for demonstration
April 1996	Pilot scale studies completed
April 1997	Construction of full-scale system begun
November 1997	Construction of full-scale system completed
May 1998	Air Sparge system determined to be unsatisfactory halting sparging
May 2000	>3500 pounds VOC removed from unsaturated zone since startup

9. OBSERVATIONS AND LESSONS LEARNED

Air Sparge Wells

The AS above ground distribution system was constructed of galvanized piping. This could be potentially replaced with schedule 80 PVC with insulation to provide UV degradation protection. This change would result in lower material and labor charges being incurred.

The sparge points recommended for use, with 50-micron bubbles, fouled within seven weeks of use. This occurred during the initial testing period in which the system was operating as designed, switching between two remediation areas. After treatment by traditional well redevelopment method, well performance was restored to initial levels. The restart of the AS system was delayed due to an EPA request that additional

[redacted]

contaminant removal produced by the AS system be quantified. This required the measurement of a stable baseline contaminant level prior to the initiation of the AS. An onsite purge-and-trap GC was required to quantify this VOC baseline concentration and to measure the expected small decrease in contaminant level produced by the AS system. The procurement, testing, and qualification of a purge-and-trap GC added significant cost and time to the project.

Soil Vapor Extraction System Components

During the project the large SVE blower (6LP) experienced two failures, the small SVE blower (5LP) experienced one failure, the 50-hp motor required replacement, and the drive belts required replacement twice. The blower failures were attributed to calcium carbonate encrustation of the blower compressor vanes caused by evaporation of moisture contamination. The moisture reached the blowers because the GAC tanks, which acted as water absorption units, were bypassed after the VOC concentrations in the effluent reached deminimus levels and the GAC was no longer required for effluent treatment. Excess moisture should have been removed by the moisture knockout tank, but the system tank was approximately 1/3 the size required to adequately remove moisture from the system.

The heat exchanger core, due to excessive airflow impedance, was changed. The cause was determined to be carbon fouling of the small passages within the core. This was caused by the system not having post carbon vessel filtration and the carbon within the vessels migrating past the 6LP blower and into the heat exchanger. A filter unit was procured and installed in the 6LP blower intake line.

Effluent Treatment System Components

During the period the installation contractor was operating the system and training Mound personnel, carbon saturation was achieved and went undetected until February 4, 1998. On this date, the system was shut down until the carbon was changed out on February 12, 1998. This reinforces the importance of having the contractor provide an approved monitoring plan prior to system startup.

The SVE system was shut down on multiple occasions for spent carbon removal and replenishment. On each of these occasions, the system was offline for approximately six (6) hours. A design change in plumbing and piping is suggested for future systems to enable changing of carbon in a single vessel without necessitating a system shutdown. Furthermore, the use of traditional PVC well screens for air distribution in the lower portion of the GAC vessel should be avoided as this lead to additional down time for multiple cleanings and has resulted in reduced air flow efficiency.

The Grundfos pump, used to transport liquids from the SVE knockout tank to the air stripper, was found inadequate in capacity during rain events exceeding one inch. A pump kit to expand the capacity of the pump was implemented. This only gave marginal relief and did not completely rectify the problem. The major constraint was the one-inch diameter line to the air stripper manifold which limite flow capacity.

10. REFERENCES

1. *2-Phase Extraction Pilot Scale Test Final Report*, Radian International, Rochester, NY, 1996.

[redacted]

2. *Air Sparging and Soil Vapor Extraction Pilot Test and Conceptual Design Report*, Groundwater Technologies, Inc., Cleveland, OH, 1996.

11. VALIDATION

Signatories:

"This analysis accurately reflects the performance and costs of the remediation."

____
_________, ER Program Manager
U.S. Department of Energy

____
Jim Phelan, Technical Coordinator
Innovative Treatment Remediation Demonstration Program
Sandia National Laboratories

____
___________, _______________
____
U.S. Environmental Protection Agency

Attachment G

OU-1 FFA Monthly Report (example)

OU-1 Pump & Treat, Soil Vapor Extraction, Air Sparge and ITRD

The directed Air Sparge study commenced the week of 7/23/01. This is a joint effort between BWXTO and the ITRD. This study was continued through this reporting month.

Operable Unit 1 Performance

Monthly Pump & Treat Totals (Gallons)	Monthly SVE Knockout Tank (Gallons)	Monthly Combined Totals (Gallons)	Cumulative Pump & Treat Totals (Gallons)	Cumulative SVE Knockout Tank (Gallons)	Cumulative Total (Gallons)
3,019,325	693	3,020,018	206,460,885	250,081	206,710,966
Last Calculated SVE Mass Removal (Pounds)	Date of Last Calculated SVE Mass Removal	Last Estimated Cumulative SVE Mass Removal (Pounds)	Date of Last Estimated Cumulative SVE Mass Removal		
3,509	08/28/00	3,898	08/30/01	(BWXTO Calculated)	
Possible Monthly Operating Hours	Air Stripper Down Time (Hours)	Operating Time (%)	Down Time (%)		
720	2.0	99.72	0.28		
Last Calculated Cumulative Air Stripper Mass Removal (Pounds)	Date of Last Calculated Cumulative Air Stripper Mass Removal	Last Estimated Cumulative Air Stripper Mass Removal (Pounds)	Date of Last Estimated Cumulative Air Stripper Mass Removal		
23.2	10/03/00	24.76	08/13/01	(BWXTO Calculated)	
SVE Down Time Hours	SVE Operating Time (%)	SVE Down Time (%)			
2.0	99.72	0.28			

Note: Operating hours based on 07/31/01 am to 08/30/01 am.