United States Army
Fort Monmouth, New Jersey

Remedial Action Work Plan

Wastewater Treatment Lime Pit, CW-1
Charles Wood Area
Fort Monmouth, New Jersey

JUNE 1997

SMITH
TECHNOLOGY CORPORATION

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REMEDIAL ACTION WORK PLAN

WASTEWATER TREATMENT LIME PIT, CW-1

CHARLES WOOD AREA
FORT MONMOUTH, NEW JERSEY

MAY 1997

PREPARED FOR:

UNITED STATES ARMY, FORT MONMOUTH, NEW JERSEY
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CERTIFICATION

For: Remedial Action Work Plan, CW-1 Site, Fort Monmouth, New Jersey

"I certify under penalty of law that the information provided in this document is true, accurate, and complete to the best of my knowledge. I am aware that there are significant civil penalties for knowingly submitting false, inaccurate or incomplete information and that I am committing a crime of the fourth degree if I make a written false statement which I do not believe to be true. I am also aware that if I knowingly direct or authorize the violation of any statute, I am personally liable for the penalties."

Joseph Fallon
Environmental Protection Specialist

Name, Title	Signature	Date
	Joseph Fallon	13 June 97

"I certify under penalty of law that I have personally examined and am familiar with the information submitted herein and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate and complete to the best of my knowledge. I am aware that there are significant civil penalties for knowingly submitting false, inaccurate or incomplete information and that I am committing a crime of the fourth degree if I make a written false statement which I do not believe to be true. I am also aware that if I knowingly direct or authorize the violation of any statute, I am personally liable for the penalties."

William H. McFarland, Jr.
LTC, MI
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This Remedial Action Work Plan has been reviewed and approved.

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EXECUTIVE SUMMARY

In December 1994, the Fort Monmouth Directorate of Public Works (DPW) retained Roy F. Weston, Inc. (Weston) under contract with the Baltimore District of the Army Corp of Engineers to conduct a Site Investigation at Wastewater Treatment Lime Pit CW-1. This investigation involved completion of four soil borings, and the installation and sampling of four shallow groundwater monitoring wells surrounding CW-1. The results of this investigation indicated that the shallow groundwater contained several metals, and the volatile organic compounds (VOCs), tetrachloroethene (PCE), trichloroethene (TCE), and cis-1,2-dichloroethene (1,2-DCE) in excess of the New Jersey Department of Environmental Protection's (NJDEP) February 1994 Groundwater Quality Criteria (GWQC). The metals that were found in concentrations above the NJDEP GWQC were consistent with naturally occurring background levels. VOCs were not detected in any of the soil samples collected around CW-1 above the interim NJDEP Impact to Groundwater Quality Soil Cleanup Criteria (IGW). The results of this investigation were reported by Weston in the November 1995 *Site Investigation Report* (SIR).

In May 1996, Weston conducted further investigation on behalf of the DPW to delineate the horizontal and vertical extent of VOCs in the shallow groundwater. This investigation involved the installation of two additional shallow monitoring wells, and one deep monitoring well downgradient of CW-1. Additional soil samples were collected from these wellbores and analyzed for VOCs. The results of this investigation indicated that the downgradient extent of the VOCs in the groundwater in excess of the GWQC have been delineated. The results of this investigation were reported by Weston in the June 1996 *Supplemental Investigation Report, Sites CW-1 and CW-2*, (SSIR).

Sections 1.1 through 1.4 of this document present a summary of the VOC analytical results that were reported in the SIR and SSIR.

This document presents a proposed Remedial Action Work Plan (RAWP) for addressing dissolved PCE, TCE, and DCE in the shallow groundwater in the vicinity of the Wastewater Treatment Lime Pit, CW-1, located in the courtyard of the Hexagon Building (Building 2700), Charles Wood Area, Fort Monmouth, New Jersey.

The proposed remedial action for VOCs involves injecting clean air into the saturated subsurface via a single air-sparging well, degassing the VOCs dissolved in the groundwater into the subsurface vadose zone, and extracting the degassed VOCs from the vadose zone via a single soil vapor extraction well. Based on the concentrations of PCE, TCE, and DCE dissolved in the groundwater currently, it is estimated that the impacted groundwater in this area will be remediated within approximately six months.

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Once concentrations of PCE, TCE, and DCE levels in the shallow groundwater have achieved compliance with the GWQC, the Fort Monmouth DPW proposes to conduct post-remedial action sampling. This will involve quarterly groundwater monitoring for one year. If the PCE, TCE, and DCE remain below their respective GWQCs during this period, the DPW will discontinue sampling, and will formally request that the NJDEP issue a Letter of No Further Action (NFA) for CW-1.

1.0 REMEDIAL INVESTIGATION REPORT

This document is a Remedial Action Work Plan (RAWP) for volatile organic compounds (VOCs) detected in groundwater in the vicinity of the Hexagon Building Wastewater Treatment Lime Pit CW-1, located in the Charles Wood Area of Fort Monmouth, New Jersey (Figure 1). It has been prepared by Smith Technology Corporation (Smith Technology), on behalf of the Fort Monmouth Directorate of Public Works (DPW), and is based on the data presented in the November 1995 *Site Investigation Report* (SIR) and the June 1996 *Supplemental Investigation Report - Sites CW-1 and CW-2* (SSIR), which were prepared by Roy F. Weston, Inc. (Weston). This RAWP has been prepared in accordance with the New Jersey Department of Environmental Protection's (NJDEP) May 1997 *Technical Requirements for Site Remediation - NJAC 7:26E* (Technical Requirements).

1.1 HISTORICAL INFORMATION

According to the SIR, the Hexagon Building Wastewater Treatment Lime Pit, designated CW-1, was constructed in 1952, with a concrete floor, concrete block and mortar walls, and several internal wooden baffles. From 1952 to the late 80's, liquid laboratory wastes (primarily spent acids) from the north and west wings of the Hexagon Building (Building 2700) were routed to CW-1, where they were neutralized prior to discharge to the sanitary sewer. In the late 80's an internal policy was issued and enforced to prohibit discharge of any hazardous materials into the pit.

In 1992, sludge and limestone chips were removed from CW-1, and disposed at an appropriate offsite facility. New limestone chips were added to CW-1. Sampling conducted in conjunction with the cleanout of CW-1 indicated that in addition to the spent acids, organic contaminants may have also been routed to CW-1. Presently, all laboratory wastes are managed under Fort Monmouth's hazardous waste program, which prohibits the discharge of hazardous materials to the sewer.

1.2 PHYSICAL SETTING

1.2.1 Site Description

The Charles Wood Area is one of three sub-posts of the United States Army installation designated as Fort Monmouth, New Jersey. The Hexagon Building (Building No. 2700) is located in the western portion of the Charles Wood Area (Figure 2). Wastewater treatment lime pit CW-1 is located within the courtyard of Building 2700, approximately 35 feet southeast of a partially underground auditorium (Figure 2). Several above and below ground utilities (including sewer, electric, water, and waste disposal lines) are located within the courtyard.

1.2.2 Regional Geology

Fort Monmouth is located within the New Jersey Section of the Atlantic Coastal Plain physiographic province. In general, New Jersey Coastal Plain formations consist of northeast striking deposits of unconsolidated clay, silt, and gravel. These sediments, predominantly derived from deltaic, shallow marine, and continental shelf environments, date from Cretaceous through the Quaternary Periods. The mineralogy ranges from quartz to glauconite.

Over 20 regional geologic units are present within the sediments of the New Jersey Coastal Plain. Regressive, upward coarsening deposits are usually aquifers, while the transgressive deposits act as confining units. The individual thicknesses for these units vary from several feet to several hundred feet.

1.2.3 Local Geology

The Cretaceous age Red Bank and Tinton Sands outcrop at the Charles Wood Area. The Tinton sand conformably overlies the Red Bank Sand and ranges from a clayey medium to very coarse-grained feldspathic quartz and glauconite sand to a glauconitic coarse sand. The upper part of the Tinton is often highly oxidized and iron oxide encrusted (Minard, 1969).

The Red Bank Sand dips to the southeast at 35 feet per mile. The upper member (Shrewsbury) of the Red Bank sand is a clayey, medium-to-coarse-grained yellowish-gray to reddish brown sand that contains abundant rock fragments, minor mica and glauconite (Jablonski). The lower member (Sandy Hook) is a medium-to-fine grained dark gray to black sand with abundant clay, mica, and glauconite.

Soil borings logs from monitoring wells installed in December 1994 and May 1996 in the Charles Wood Area indicate that the area consists of a thin soil cover (approximately 0.5 feet thick), which is underlain by approximately 17 feet of medium to coarse-grained olive-brown sand with silt. This is underlain by a 2-feet thick layer (17- to 19-feet below grade) of fine-grained light-brown sand with silt. This is in turn underlain by at least 6 feet (19- to 25-feet below grade) of fine to medium-grained organic-rich brown sand with silt and clay, and approximately 16 feet (25- to 41-feet below grade) of fine to medium-grained dark greenish brown sand with silt and clay laminae. A sandy green silt with some clay extends from 41- to at least 50-feet below grade.

Over the last 80 years, the natural topography of Fort Monmouth has been altered by excavation and regrading activities. Topographic elevations for the Charles Wood Area range from 20 feet above mean seal level (MSL) to 71 feet above MSL.

1.2.4 Hydrogeology

The water table aquifer at the Charles Wood Area is identified as part of the "composite confining units" or minor aquifers of the Coastal Plain formations.

According to the well records for monitoring wells MW-1 through MW-4 (completed to approximately 20- to 25-feet below grade), MW-26, MW-27, MW-28, MW-282, MW-29, MW-291 (completed to approximately 15-feet below grade), and MW-281 (completed to 41-feet below grade), the depth to water in the Charles Wood Area averages approximately 7.5 feet below grade.

The groundwater elevation data collected by Weston in March 1995 and May 1996 indicate that the shallow groundwater in the vicinity of the Hexagon Building flows to the northeast.

Shallow groundwater within the Charles Wood Area is assumed to be influenced locally by:

- tidal influence (based on proximity to the Atlantic Ocean, rivers and tributaries)
- topography
- nature of the fill material within the Charles Wood Area
- presence of clay and silt lenses in the natural overburden deposits
- local groundwater recharge areas (i.e., streams, lakes)

1.3 TECHNICAL OVERVIEW

1.3.1 RELIABILITY OF LABORATORY DATA

All data were collected in accordance with Fort Monmouth's December 1994 *Chemical Data Acquisition Plan* (CDAP). The soil and groundwater samples collected in 1995 and 1996 were analyzed within the requisite holding times by Weston's Gulf Coast Laboratory in University Park, Ill., a New Jersey Certified laboratory (New Jersey Certification # 54669). The groundwater samples collected in 1997 were analyzed within the requisite holding times by the U.S. Army Fort Monmouth Environmental Laboratory (New Jersey Certification #13461).

It should be noted that throughout this RAWP the Groundwater Quality Criteria (GWQC) for cis-1,2-dichloroethene (cis-1,2-DCE) is used for evaluation of the analytical results for the 1995 and 1996 sampling events although the sampling results do not differentiate between the 1,2-DCE isomers, cis-1,2-DCE and trans-1,2-DCE. This assumption has been made since there is

preferential production of cis-1,2-DCE over trans-1,2-DCE (Parsons, F., et al., "*Tranformation of Chlorinated Organic Solvents in Groundwater Environments of Southern Florida*". Preprint Extended Abstract, Division of Environmental Chemistry, American Chemical Society, Washington, D.C., Sept. 1983, and Walker, T., "*Fate and Dispostion of Trichloroethylene in Surface Soils*", Doctoral Thesis - Purdue University, August 1984). In addition, the results of the 1997 sampling event indicates that cis-1,2-DCE is the only isomer that was detected above the method detection limit (MDL).

1.3.2 SUMMARY OF CONTAMINATION

Tetrachloroethene (PCE) was detected in one soil sample collected from the saturated zone in the immediate vicinity of CW-1 at a concentration in excess of the NJDEP's Interim Impact to Groundwater Quality Soil Cleanup Criteria (IGW).

PCE, trichloroethene (TCE), and cis-1,2-DCE were detected in excess of the NJDEP's GWQC in four monitoring wells in the Charles Wood Area during groundwater sampling events conducted in February 1995, March 1995, May 1996, and April 1997.

A detailed description of the soil and groundwater contamination in the Charles Wood Area is presented in Section 1.4 of this document.

1.4 FINDINGS AND RECOMMENDATIONS

1.4.1 Work Completed

1.4.1.1 Phase I Soil /Groundwater Investigation

Following the clean-out of CW-1 in 1992, four soil borings (SB-26 through SB-29) that were subsequently completed as monitoring wells, were installed to assess the possibility that organic contaminants had migrated from CW-1 to the adjacent soil and/or groundwater (Figure 3). The soil borings/monitoring wells were installed in Phase I in December 1994, in accordance with the December 1994 CDAP.

Soil Investigation

As outlined in the CDAP, continuous split-spoon samplers were advanced in each pilot boring. Each split-spoon was screened with a photo-ionization detector (PID) or a flame-ionization detector (FID). According to the CDAP, soil samples were to be collected from the 7.0- to 9.0-feet below grade interval if no VOCs were detected by the field instruments. This depth represents the interval immediately above the water table. If VOCs were detected, soil samples were to be collected from the interval with the highest instrument response, and from the interval immediately above the water table. According to the SIR, there was no field instrument evidence of VOCs, accordingly, soil samples were collected only from the 7.0- to 9.0-feet below grade interval. The samples were analyzed for Target Compound List plus 30 parameters (TCL+30) and Target Analyte List (TAL) Metals. The TCL+30 results of the Phase I Soil Investigation are summarized in Section 1.4.2.1 of this document.

Groundwater Investigation

Four overburden monitoring wells (MW-26 through MW-29) were constructed in the pilot borings described above, in Phase I in December 1994 (Figure 4). All wells were installed by a New Jersey-licensed well driller. Monitoring wells MW-26, MW-27, MW-28, and MW-29 are 4-inch polyvinyl chloride (PVC) monitoring wells seated approximately 15 feet below grade. All are constructed with 10 feet of No. 10 slot well screen. The monitoring well/soil boring logs for these monitoring wells were included in the November 1995 SIR.

Two rounds of groundwater sampling were conducted on February 21, 1995 and March 14, 1995. Samples from each well were analyzed for TCL+30 and TAL Metals. The results of the TCL+30 Phase I Groundwater Investigation are summarized in Section 1.4.2.1 of this document.

1.4.1.2 Soil Gas Survey

In order to determine the horizontal extent of VOCs in the shallow groundwater, a passive soil gas survey (SGS) was conducted in the vicinity of CW-1 during March 1996.

A detailed description of the SGS was presented in the SSIR. Twenty-eight (28) Gore-Sorber^{SM} modules (sorbers) were installed in a grid pattern in the unsaturated soils in the vicinity of CW-1. After a two-week residence period, the sorbers were retrieved and submitted to W.L. Gore and Associates, Inc. for analysis. The results of the SGS are summarized in Section 1.4.2.2 of this document.

1.4.1.3 Phase II Soil/Groundwater Investigation

In order to confirm the results of the SGS and provide lateral and vertical delineation of VOCs in the groundwater, a second phase of soil sampling and monitoring well installation was conducted in May 1996.

Soil Investigation

The Phase II soil borings (SB-281, SB-282, and SB-291) were drilled and sampled in May 1996 (Figure 3). As outlined in the CDAP, continuous split-spoon samplers were advanced in each pilot boring. Each split-spoon was screened with a PID or a FID. According to the CDAP, soil samples were to be collected from the 7.0- to 9.0-feet below grade interval if no VOCs were detected by the field instruments, or if VOCs were detected, from the interval with the highest instrument response and from the interval immediately above the water table. Soil samples were analyzed for TCL VOCs only. The results of the Phase II Soil Investigation are summarized in Section 1.4.2.3 of this document.

Groundwater Investigation

The Phase II monitoring well installation and sampling program was conducted in May 1996. Three overburden monitoring wells (MW-281, MW-282, and MW-291) were constructed in the pilot borings described above (Figure 4). All wells were installed by a New Jersey-licensed well driller. Monitoring wells MW-281, MW-282, and MW-291 are 4-inch inside diameter PVC monitoring wells, constructed with 10 feet of No. 20 slot well screen. Monitoring wells MW-282 and MW-291 are seated approximately 15 feet below grade. Monitoring well MW-281 is seated approximately 41 feet below grade. The monitoring well/soil boring logs for these monitoring wells were included in the June 1996 SSIR.

Following the installation of monitoring wells MW-281, MW-282, and MW-291, the third round of groundwater sampling was conducted on May 23 and May 24, 1996. This round included the initial four monitoring wells (MW-26 through MW-29), the newly installed monitoring wells (MW-281, MW-282, and MW-291), and one previously installed monitoring well (MW-1). Groundwater samples were analyzed for TCL VOCs only.

Groundwater sampling of MW-26 through 29, MW-281, MW-282, MW-291, and MW-1 was conducted in April 1997. An additional sample was collected from MW-29 in May 1997. Groundwater samples were analyzed for TCL VOCs only.

The results of the Phase II Groundwater Investigation are summarized in Section 1.4.2.3 of this document.

1.4.2 Analytical Results

1.4.2.1 Phase I Soil/Groundwater Investigation

Soil Investigation

Details of the Phase I Soil Investigation conducted in December 1994 were presented in the SIR, and are summarized in Table 1 and on Figure 3.

Although there were a number of VOCs, and semi-volatile organic compounds (SVOCs) detected above their respective method detection limits, observed concentrations were below the IGW or Residential Direct Contact Soil Cleanup Criteria (RDC), whichever is more stringent.

Groundwater Investigation

Details of the Phase I Groundwater Investigation conducted in February and March 1995 were presented in the SIR, and are summarized in Table 2 and on Figure 4.

Four VOCs, and three SVOCs were detected above their respective method detection limits in one or both sampling rounds. Of these, four VOCs were detected above their respective GWQCs.

TCE was detected above its GWQC in monitoring wells MW-28 and MW-29 in both sampling rounds. PCE was detected at an estimated concentration above its GWQC in monitoring well MW-26 in the second sampling round. The VOC 1,2-DCE was detected at an estimated concentration above its GWQC in MW-29 in both sampling events. The VOC 1,1-dichloroethene (1,1-DCE) was also detected at an estimated concentration above its GWQC in MW-29 in the second sampling round.

1.4.2.2 Soil Gas Survey

Details of the results of the SGS were presented in the SSIR. The SGS indicated that soil gas VOCs extended approximately 75 feet downgradient of CW-1.

1.4.2.3 Phase II Soil Borings/Monitoring Well Installation

Soil Investigation

Details of the Phase II Soil Investigation conducted in May 1996 were presented in the SSIR, and are summarized in Table 3 and on Figure 3.

TCE was detected in soil sample CW01-SB281-A02 at a concentration is in excess of the IGW. It should be noted that this sample was collected from the wellbore of MW-281 at a depth of 18.8- to 19.4-feet below the ground surface, which is below the water table.

Groundwater Investigation

Details of the Phase II Groundwater Investigation conducted in May 1996 were presented in the SSIR, and are summarized in Table 4 and on Figure 4. The results of the April 1997 sampling event are presented in Table 5 and Figure 4.

During the May 1996 sampling event, two VOCs were detected above their respective method detection limits: 1,2-DCE, and TCE. Only TCE was also detected above its GWQC in monitoring wells MW-29 and MW-281.

During the April 1997 sampling event, TCE was detected in excess of its GWQC in MW-281 at a concentration of 17.88 micrograms per liter (ug/l). TCE, PCE, and cis-1,2-DCE were detected above their respective GWQC in MW-29 at concentrations of 3,211.95 ug/l, 1.74 ug/l, and 47.24 ug/l, respectively.

TCE, PCE, and cis-1,2-DCE were detected above their respective GWQC in MW-29 in May 1997 at concentrations of 5,109.18 ug/l, 3.49 ug/l, and 47.46 ug/l, respectively.

1.4.3 Conclusions and Recommendations

Based on the investigation conducted to date by Weston, Smith Technology concludes the following:

- The source of VOCs in the vicinity of CW-1 was removed in 1992.
- The unsaturated soils in the vicinity of CW-1 have not been impacted by VOCs.
- PCE, TCE, and cis-1,2-DCE are the only VOCs of concern in the vicinity of CW-1.
- Elevated concentrations of PCE, TCE and/or cis-1,2-DCE have been detected only in the groundwater and in one saturated soil sample.

Based on the above conclusions, the DPW proposes to implement an air sparging/soil vapor extraction (AS/SVE) system to address the residual PCE, TCE, and cis-1,2-DCE in the vicinity of CW-1 (Section 5.0).

2.0 SAMPLING SUMMARY TABLE

A sampling summary table for sampling to be conducted during the implementation of this Remedial Action Work Plan (RAWP) is included in Table 6.

3.0 STATEMENT OF INTENT TO COMPLETE N.J.A.C. 7:26E

It is the intention of the Fort Monmouth Directorate of Public Works (DPW) that adherence to the remediation program outlined in this Remedial Action Work Plan (RAWP) will result in compliance with the criteria set forth in New Jersey Administrative Code (N.J.A.C.) 7-26E (4/97).

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4.0 APPLICABLE REMEDIATION STANDARDS

The remediation standards for the groundwater in the vicinity of CW-1 will be the Groundwater Quality Criteria (GWQC) defined in New Jersey Administrative Code (N.J.A.C.) 7:9-6. In the event the GWQC for a particular compound is numerically lower than the practical quantitation limit (PQL) for that compound, the PQL will be applied as the groundwater cleanup level.

Compound	Higher of GWQC or PQL (micrograms per liter)
Tetrachloroethene	1
Trichloroethene	1
cis-1,2,-Dichloroethene	10

5.0 PROPOSED REMEDIAL ACTION

The Directorate of Public Works (DPW) proposes to implement an air-sparging/soil vapor extraction system remediation (AS/SVE) program to address the groundwater contamination in the vicinity of CW-1. The following sections describe the configuration and operation of the AS/SVE system, and the classification exception area (CEA) that will be in-place for the duration of the proposed remedial program.

5.1 AIR-SPARGING/SOIL VAPOR EXTRACTION SYSTEM (AS/SVE)

AS/SVE is a method of removing volatile organic compounds (VOCs) from the saturated zone by injecting clean air into an aquifer through sparging wells to volatilize dissolved-phase VOCs. The dissolved-phase VOCs are transferred from the saturated zone into the unsaturated, or vadose zone, and are then extracted from the unsaturated zone through a soil vapor extraction (SVE) system. The extracted vapor is then routed to an appropriate air-treatment system.

A pilot study is typically performed to evaluate effectiveness of a remedial approach prior to full-scale implementation. In this case, due to the limited extent of the contamination, both in the groundwater (dissolved phase VOCs) and in the soil gas (vapor phase VOCs), the DPW proposes a full-scale AS/SVE. If the results of performance monitoring of the AS/SVE system indicate that the AS/SVE system should be modified, the necessary system modifications will be made by the remediation contractor.

5.1.1 Design and Construction

5.1.1.1 Design

The proposed AS/SVE system for CW-1 has been designed by Smith Technology to address conditions specific to the CW-1 area. The air-sparging well will be installed to actively sparge VOCs that are present in groundwater intercepted by monitoring well MW-29 (screened interval 5.0- to 10.-feet below grade). The zone of influence for the air sparging well follows a conservative approach that a minimum of one foot of horizontal influence can be obtained from each foot of depth below the surface of the aquifer. The sparging is to be installed at a depth of 15 feet and will produce an effective radius of influence between 7 and 20 feet based on operating injection pressures.

The soil vapor extraction will be installed to withdraw soil gas vapor generated by the sparge well, and to withdraw soil gas vapor generated by the passive volatilization of VOCs present in the groundwater intercepted by monitoring well MW-281. The soil vapor extraction well radius of influence was calculated through the use of the EPA model "*Hyperventilate*". The well has been designed to operate between 40 and 80 inches of water column vacuum yielding a radius of

influence of approximately 50 feet. This radius contains the extent of the ground water plume as identified from the May 1996 ground water survey results. It also covers the vast majority of the soil gas survey plume as identified in the May 1996 soil gas survey results.

The design basis for the proposed AS/SVE system is included in Appendix A. The system has been designed to

1. Provide for ease of installation
2. Provide for relative ease of operation
3. Provide adequate equipment for the remediation of contaminated groundwater and soil vapor (as identified by the soil gas survey)
4. Avoid operating in situations that may lead to hazardous conditions
5. Be adaptable to possible future modifications
6. Minimize potential for system failure

A simplified process flow diagram of the AS/SVE system is shown in Figure 5. The components of the AS/SVE system have been sized to meet the anticipated conditions at the site. The AS/SVE system includes numerous gages and indicators for monitoring system performance (Table 7).

A single-phase, 230 volt, 100 ampere electrical service will be required for operation of the AS/SVE system.

5.1.1.2 Construction

The major components of the AS/SVE system are:

Air-sparging System	Vapor Extraction System
• Air-sparging well • Blower	• Soil vapor extraction well • Demister vessel • Particulate filter • Pressure relief valve • Blower • Air treatment system

The equipment will be located in a small, temporary structure suitable to serve as a weather proof enclosure to protect the various devices, and to minimize associated noise. For planning purposes, an enclosure of approximately 100 square feet (10 feet by 10 feet) is anticipated. All polyvinyl chloride (PVC) piping leading to the equipment enclosure will be buried. All piping

nominally 2-inch diameter, and less shall be of schedule 80 PVC. Piping greater than 2-inch diameter shall be of schedule 40 construction. Any above ground piping will be of a suitable plastic material for compressed gas service (i.e. Chemaire Piping), or will be constructed of metallic piping material such as galvanized steel.

Air-Sparging System

Air-sparging Well (SPG-1)

A 2-inch PVC well will be installed by a New Jersey-licensed driller installed within 10 feet of monitoring well MW-29 (Figure 6). The well (SPG-1) will be seated at 15 feet bgs and will be screened from 14 feet to 15 feet with No. 20 slot screen. The riser connecting the SPG-1 to the surface piping will be constructed of 2 inch, solid, schedule 40, PVC pipe. SPG-1 will be constructed with a No. 1 Morie Sand pack that will extend two feet above the top of the screen. The remainder of the annular space will be tremie grouted to grade with a bentonite slurry.

Blower

A regenerative, positive displacement, or rotary vane blower, capable of maintaining a flow rate of 5 standard cubic feet per minute (scfm) and operating pressure of 12 feet water column will be utilized to inject the clean air stream into the saturated zone. As stated in Appendix A, the requisite flow rate for the CW-1 area is approximately 1.4 scfm to 3.5 scfm.

The intake side of the blower will be fitted with a particulate filter/silencer. A pressure relief valve (pressure range 40 to 140 inches of water) will be located on the discharge side of the blower. A Bourdon tube pressure gage (maximum pressure range of 10 pounds per square inch) will also be located on the discharge side of the blower.

Soil Vapor Extraction System

Soil Vapor Extraction Well (SVE-1)

A 4-inch PVC well will be installed by a New Jersey licensed well driller within 10 feet of monitoring well MW-29 . The well (SVE-1) will be seated at 6 feet bgs and will be screened from 4 feet to 6 feet with No. 20 slot screen. The riser connecting the vertical well to the surface piping will be constructed of same diameter, solid, schedule 40, PVC pipe. SVE-1 will be constructed with a No. 1 Morie Sand pack that will extend two feet above the top of the screen. The remainder of the annular space will be tremie grouted to grade with a bentonite slurry.

Blower

A regenerative or rotary vane blower, capable of maintaining a flow rate of 80 scfm and operating vacuum of 100 inches water column will be utilized to extract vapor from the unsaturated zone.

Demister Vessel

In order to remove excess moisture from the extracted air stream, a 30- to 50-gallon demister vessel, capable of withstanding a vacuum of 100 inches of water will be located on the discharged side of the blower.

The discharge side of the blower will be fitted with a particulate filter. A vacuum relief valve (vacuum range 40 to 140 inches of water) and Bourdon tube vacuum gage (maximum vacuum 30 inches of mercury) will also be located on the discharge side of the blower.

Air Treatment System

The extracted soil vapor will be treated by granular activated carbon (GAC). Two in-series canisters will be located on the discharge side of the SVE blower. When break-through of the primary canister occurs, the secondary canister will be moved into the primary canister position, and a new secondary canister will be installed. It is estimated that no more than 200 pounds of GAC will be required over the entire AS/SVE program.

5.1.2 System Operation and Monitoring

5.1.2.1 System Operation

As shown in Appendix A, the AS/SVE system will operate on a continuous basis for an estimated period of six months. A timing device that would allow cyclic operation of the system can be added at a later date should night time noise be of concern, or if there is a need to increase contaminant removal rate. In some cases this cyclic type operation has actually decreased overall contaminant removal time. It is believed that this increased efficiency results from establishing new pathways through the subsurface. In the document, *In Situ Aeration of Groundwater A Technology Overview*, presented at the Conference on Prevention and Treatment of Soil and Groundwater Contamination in the Petroleum Refining and Distribution Industry, Montreal, Quebec, Canada, October 1990, Middleton and Hiller suggest that as the compressed air moves through the screen into the saturated zone it displaces water in the pore space and moves in irregular pathways to the surface of the water table. Cyclic operation provides an opportunity for these established pathways to collapse and permit other pathways to form.

5.1.2.2 System Monitoring

The following information will be collected as part of the system performance monitoring program.

1. Operating pressures and vacuum
2. Operating temperature
3. Vacuum at soil gas extraction well
4. Off-gas air flow
5. Off-gas VOC contaminant concentration prior to GAC treatment
6. Off-gas VOC contaminant concentration between GAC units
7. Off-gas VOC contaminant concentration after GAC treatment
8. Groundwater VOC contaminant concentration

Items 1 through 4 listed above will be recorded daily during the first week of operation, weekly during the second, third and fourth weeks of operation, and monthly during the second through sixth months of operation. The frequency of collection of Items 5 through 8 listed above is presented in Table 6.

In order to maintain system performance, monthly preventative maintenance (i.e. filter cleanout) will be performed.

In order to evaluate system performance, the DPW proposes to conduct groundwater monitoring in all eight of the monitoring wells in the vicinity of and downgradient of CW-1, and the sparging well. For the first month, the groundwater samples will be collected weekly. For the remaining five months, groundwater will be sampled biweekly. Groundwater samples will be analyzed for Priority Pollutant Volatile Organic Compounds plus a library search (PPVOCs+10) by USEPA Method 8240, including cis 1,2-dichloroethene (cis 1,2-DCE). A summary of the proposed system performance monitoring is presented in Table 6.

5.2 FINAL DESIGN SPECIFICATIONS

Following NJDEP approval of the RAWP, final design specifications will be prepared, and contractor bid packages will be distributed by the Chief of Engineering Plans and Services Division, DPW Contracting Office.

All contractor bids will be evaluated by the DPW Contracting Office, and one successful contractor will be selected to implement the proposed remedial action.

6.0 SCALED SITE MAP

A scaled site map is presented in Figure 2.

7.0 QUALITY ASSURANCE PROJECT PLAN

A site-specific Quality Assurance Project Plan (QAPP) will be incorporated by the Department of Public Works (DPW) into the remediation contractor's final Remedial Action Work Plan (RAWP).

8.0 REQUIRED PERMITS

The Department of Public Works' (DPW) remediation contractor will be responsible for obtaining the following:

- Permit to construct/install/alter Air Quality Apparatus/Equipment
- Certification to operate Air Quality Apparatus/Equipment

The DPW's New Jersey certified well drilling contractor will be responsible for obtaining a well drilling permit and completing New Jersey Department of Environmental Protection (NJDEP) Monitoring Well Construction Certification forms (Form A) for each new well. The well drilling contractor will also be responsible for completing NJDEP Well Abandonment Reports for each well, following approval by the NJDEP.

The DPW's New Jersey certified surveying contractor will be responsible for completing NJDEP Monitoring Well Location Certification forms (Form B) for each well.

9.0 EROSION, DUST, AND ODOR CONTROL

Erosion and dust control measures are not deemed necessary due to the limited extent and duration of soil disturbance. Odor control will be maintained by the proposed air pollution control equipment.

10.0 HEALTH AND SAFETY PLAN

Preparation of a site-specific Health and Safety Plan (HASP), encompassing installation and operation of the system will be included in the remediation contractor's final Remedial Action Work Plan (RAWP). The HASP will also address the decommissioning phase of the effort.

11.0 SITE RESTORATION

At the time the Department of Public Works (DPW) submits a Remedial Action Report (RAR) for CW-1, the DPW will propose to seal all air-sparging, monitoring, and soil vapor extraction wells. All wells will be sealed by a New Jersey-licensed well sealer.

All underground air-sparging/soil vapor extraction (AS/SVE) appurtenant piping will be removed and the excavation backfilled to grade with certified clean fill. The above-ground equipment (e.g., blowers, demister, temporary structures etc.) will be dismantled and removed from the site to a location satisfactory to the DPW and/or its agents or representatives. The granular activated carbon (GAC) canisters will be transported to an appropriate offsite recycling/disposal facility.

12.0 POST-REMEDIAL ACTION SAMPLING

Once the Groundwater Quality Criterion (GWQCs) have been achieved for tetrachloroethene (PCE), trichloroethene (TCE), and cis-1,2-dichloroethene (cis-1,2-DCE) in all related monitoring wells for three consecutive performance monitoring periods, the Department of Public Works (DPW) proposes to discontinue active remediation and conduct passive quarterly groundwater monitoring for a period of one year. The monitoring wells MW-1, MW-26 through MW-29, MW-281, MW-282, and MW-291 and the air-sparging well (SPG-1) will be sampled and analyzed for Priority Pollutant Volatile Organic Compounds, plus a library search (PPVOCs+10), including cis 1,2-DCE. A summary of the proposed post-remedial action monitoring, including frequency, is presented in Table 6. If these compounds remain below their respective GWQCs for the one-year sampling period, the DPW will discontinue sampling and will prepare a Remedial Action Report (RAR) that will formally request that the New Jersey Department of Environmental Protection (NJDEP) issue a Letter of No Further Action (NFA) for CW-1.

13.0 ESTIMATED COST OF REMEDIAL ACTION WORK PLAN IMPLEMENTATION

The Opinions of Cost for implementing the proposed remedial action and post-remedial action monitoring are summarized in Table 8.

14.0 PROPOSED SCHEDULE

A schedule for the proposed remedial program is shown in Figure 7. If it becomes necessary to modify the schedule, a revised schedule will be submitted to the New Jersey Department of Environmental Protection (NJDEP).

15.0 CLASSIFICATION EXCEPTION AREA (CEA)

A CEA is a mechanism that has been established by the New Jersey Department of Environmental Protection (NJDEP) to temporarily except a defined area where groundwater does not meet the Groundwater Quality Criteria (GWQC). As required by the *Groundwater Quality Standards* (N.J.A.C 7:9-6 *et seq.*), a CEA must be established whenever constituent standards applicable to a groundwater classification area are not, or will not be met for the term of the remediation program. According to the NJDEP's *Final Guidance on Designation of Classification Exception Areas* (April 17, 1995), a CEA is defined by both physical boundaries, and the amount of time that will be required for the groundwater contaminant(s) to achieve compliance with the GWQCs.

The Fort Monmouth DPW proposes that the CEA apply to PCE, TCE, and cis-1,2-DCE. The proposed CEA will encompass the portion of the Hexagon Building courtyard shown on Figures 4 and 6. The latitude and longitude (taken from the NJDEP Well Location Certification forms) of the monitoring wells that mark the corners of the CEA are as follows:

Well No.	Latitude	Longitude
MW-26	N40°17'44.5"	W74°05'17.7"
MW-27	N40°17'44.6"	W74°05'17.8"
MW-28	N40°17'44.8"	W74°05'17.7"
MW-282	N40°17'45.8"	W74°05'17.0"
MW-291	N40°17'45.1"	W74°05'16.4"

The DPW proposes a maximum CEA duration of six months, based on the assumed duration of operation of the AS/SVE system.

A report on ground water use will be written based upon a well search being conducted pursuant to N.J.A.C. 7:26E-4.4(h)3v. This report will be issued to NJDEP under separate cover upon completion of the well search.

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TABLES

TABLE 1

SOIL SAMPLING RESULTS - DECEMBER 1994

WASTEWATER TREATMENT LIME PIT, CW-1
CHARLES WOOD AREA, FORT MONMOUTH, NEW JERSEY

Sample ID. Sample Depth: Sampling Date:	Units	Criteria[1]	CW01-SB-26-A02 7-9 12/19/94	CW01-SB-27-A02 7-9 12/19/94	CW01-SB-28-A02 7-9 ft, bgs 12/19/94	CW01-SB-29-A02 7-9 ft 12/19/94
VOLATILES						
Acetone	mg/kg	50	ND	ND	0.057 B	0.120 B
SEMI-VOLATILES						
di-n-butyl phthalate	mg/kg	100	0.081	0.086	0.077	0.13 JB
bis(2-ethylhexyl) phthalate	mg/kg	49	0.075	0.09	ND	ND
benzo(a)pyrene	mg/kg	0.66	ND	ND	ND	0.073
benzo(b)fluoranthene	mg/kg	0.9	ND	ND	ND	0.07 J
PESTICIDES/PCBs	mg/kg	ND	ND	ND	ND	ND

Notes:
ns: not specified
ND: not detected
1: IGW or RDC, whichever is more stringent
J: estimated concentration
Source: Roy F. Weston, Inc. *November 1995 Site Investigation Report*

TABLE 2
GROUNDWATER SAMPLING RESULTS - FEBRUARY AND MARCH 1995
WASTEWATER TREATMENT LIME PIT, CW-1
CHARLES WOOD AREA, FORT MONMOUTH, NEW JERSEY

Sample ID:			CW01-MW26-A01	CW01-MW26-A02	CW01-MW27-A01	CW01-MW27-A02	CW01-MW28-A01	CW01-MW28-A02	CW01-MW29-A01	CW01-MW29-A02
Sampling Date:			02/21/95	03/14/95	02/21/95	03/14/95	02/21/95	03/14/95	02/21/95	03/14/95
	Units	Criteria[1]								
VOLATILES										
1,1-dichloroethene	ug/l	2	ND	ND	ND	ND	ND	ND	ND	**4 J**
1,2-dichloroethene (total)	ug/l	10[2]	ND	ND	ND	ND	ND	ND	110	360
Trichloroethene	ug/l	1	ND	ND	ND	ND	**23**	**48**	**780**	**990**
Tetrachloroethene	ug/l	1	ND	**4 J**	ND	ND	ND	ND	ND	ND
SEMI-VOLATILES										
Di-n-butyl phthalate	ug/l	900	ND	ND	ND	5 J	ND	ND	ND	ND
Bis(2-ethylhexyl) phthalate	ug/l	30	2 J	ND	2J	2 J	2 J	1 J	1 J	ND
1,2,4 trichlorobenzene	ug/l	9	ND	ND	ND	ND	ND	ND	3 J	5 J
PESTICIDES/PCBs	ug/l	ns	ND	ND	ND	ND	ND	ND	ND	ND

Notes:
ns: not specified
ND: not detected
NT: not tested
1: Groundwater Quality Criteria (GWQC) or Practical Quantitation Limit, whichever is higher
2: GWQC for cis-1,2-dichloroethene
J: estimated concentration
Concentrations in bold type exceed their respective Groundwater Quality Criteria.
Source: Roy F. Weston, Inc. *November 1995 Site Investigation Report*

TABLE 3

SOIL SAMPLING RESULTS - MAY 1996

WASTEWATER TREATMENT LIME PIT, CW-1
CHARLES WOOD AREA, FORT MONMOUTH, NEW JERSEY

Sample ID:			CW01-SB281-A02	CW01-SB281-A03	CW01-SB282-A02	CW01-SB282-A03	CW01-SB291-A02	CW01-SB291-A03
Sampling Depth:			18.8-19.4	38.0-39.2	6.0-8.0	38.0-40.0	6.0-7.3	32.0-32.4
Sampling Date:			05/01/96	05/01/96	05/02/96	05/02/96	05/03/96	05/03/96
	Units	IGW						
Total Solids	%	ns	73.2	84.9	81.6	84.3	87.7	78.6
VOLATILES								
Acetone	mg/kg	50	2.4	0.012 J	ND	0.051	ND	8.6
Carbon disulfide	mg/kg	ns	50	ND	ND	ND	ND	ND
Chloroform	mg/kg	1	ND	ND	ND	0.015	ND	ND
Trichloroethene	mg/kg	1	**7.8**	ND	ND	ND	ND	ND
Toluene	mg/kg	1	0.020	ND	ND	ND	ND	ND
Tetrachloroethene	mg/kg	1	0.013	ND	ND	ND	ND	ND

otes:
s: not specified
D: not detected
W: Impact to Groundwater Soil Cleanup Criteria
oncentrations in bold type exceed their respective Impact to Groundwater Soil Cleanup Criteria.
ource: Roy F. Weston, Inc. *June 1996 Supplemental Site Investigation Report*

TABLE 4

GROUNDWATER SAMPLING RESULTS - MAY 1996

WASTEWATER TREATMENT LIME PIT, CW-1
CHARLES WOOD AREA, FORT MONMOUTH, NEW JERSEY

Sample ID:			MW-1	MW-26	MW-27	MW-28	MW-29	MW-281	MW-282	MW-291
Sampling Date:			05/23/96	05/23/96	05/23/96	05/23/96	05/23/96	05/23/96	05/23/96	05/23/96
	Units	Criteria[1]								
VOLATILES										
Acetone	ug/l	700	ND	ND	ND	ND	ND	92	ND	ND
1,2-dichloroethene (tot)	ug/l	10^2	ND	ND	ND	ND	7	ND	ND	ND
Trichloroethene	ug/l	1	ND	ND	ND	ND	**170**	**20**	ND	ND
Tetrachloroethene	ug/l	1	ND	ND	ND	ND	ND	ND	ND	ND

Notes:
ns: not specified
ND: not detected
1: Groundwater Quality Criteria or Practical Quantitation Limit, whichever is higher
2: GWQC for cis-1,2-dichloroethene
J: estimated concentration
Concentrations in bold type exceed their respective Impact to Groundwater Soil Cleanup Criteria.
Source: Roy F. Weston, Inc. Report *June 1996 Supplemental Site Investigation Report*

TABLE 5

GROUNDWATER SAMPLING RESULTS - APRIL AND MAY 1997

WASTEWATER TREATMENT LIME PIT, CW-1
CHARLES WOOD AREA, FORT MONMOUTH, NEW JERSEY

Sample ID:			MW-1	MW-26	MW-27	MW-28	MW-29	MW-29	MW-281	MW-282	MW-291
Sampling Date:			04/22/97	04/23/97	04/23/97	04/23/97	04/23/97	05/27/97	042297	04/22/97	04/22/97
	Units	Criteria[1]									
VOLATILES											
cis-1,2-dichloroethene	ug/l	10	ND	ND	ND	ND	**47.24**	**47.46**	ND	ND	ND
Trichloroethene	ug/l	1	ND	ND	ND	ND	**3211.95**	**5109.18**	**17.88**	ND	ND
Tetrachloroethene	ug/l	1	ND	ND	ND	ND	**1.74**	**3.49**	ND	ND	ND

Notes:
ns: not specified
ND: not detected
1: Groundwater Quality Criteria or Practical Quantitation Limit, whichever is higher
J: estimated concentration
Concentrations in bold type exceed their respective Impact to Groundwater Soil Cleanup Criteria.
Source: U.S. Army, Fort Monmouth Environmental Laboratory

TABLE 6

PROPOSED SAMPLING SUMMARY

WASTEWATER LIME TREATMENT PIT, CW-1
CHARLES WOOD AREA, FORT MONMOUTH, NEW JERSEY

Sample No.	Sample Location	Sample Matrix	No. of Samples[1]	EPA Methodology	Analytical Parameters[2]
SYSTEM OPERATION PERFORMANCE MONITORING					
MW-26	upgradient	GW	15	8240	PPVOCs + 10
MW-27	upgradient	GW	15	8240	PPVOCs + 10
MW-28	cross-gradient	GW	15	8240	PPVOCs + 10
MW-29	source	GW	15	8240	PPVOCs + 10
MW-281	source	GW	15	8240	PPVOCs + 10
MW-282	downgradient	GW	15	8240	PPVOCs + 10
MW-291	downgradient	GW	15	8240	PPVOCs + 10
MW-1	downgradient	GW	15	8240	PPVOCs + 10
AIR-1	SVE well headspace	air	15	8240	PPVOCs + 10
AIR-2	pre-carbon treatment	air	15	8240	PPVOCs + 10
AIR-3	post-carbon treatment	air	15	8240	PPVOCs + 10
PROPOSED POST-REMEDIAL SAMPLING					
MW-26	upgradient	GW	4	8240	PPVOCs + 10
MW-27	upgradient	GW	4	8240	PPVOCs + 10
MW-28	cross-gradient	GW	4	8240	PPVOCs + 10
MW-29	source	GW	4	8240	PPVOCs + 10
MW-281	source	GW	4	8240	PPVOCs + 10
MW-282	downgradient	GW	4	8240	PPVOCs + 10
MW-291	downgradient	GW	4	8240	PPVOCs + 10
MW-1	downgradient	GW	4	8240	PPVOCs + 10
SPG-1	source	GW	4	8240	PPVOCs + 10

Notes:
GW: groundwater
1: Assumes weekly sampling for first month and biweekly for remaining 5 months. Total does not include field and laboratory QA/QC samples.
2: Includes cis 1,2-dichloroethene
Source: Smith Technology Corporation (Project No. 09-5004-14)

TABLE 7

AIR-SPARGING/SOIL VAPOR EXTRACTION SYSTEM INSTRUMENTATION

WASTEWATER LIME TREATMENT PIT, CW-1
CHARLES WOOD AREA, FORT MONMOUTH, NEW JERSEY

Instrument Identification	Description	Purpose
Soil Venting System		
L1	Level Indicator	Site glass used to monitor the amount of water vapor (from the soils) accumulated in the demister
P1	Pressure Indicator	Pressure gage on the discharge side of the soil vapor extraction blower. P1 monitors the pressure drop across the activated carbon canisters.
V1	Vacuum Indicator	Vacuum gages located at the soil vapor extraction well head, demister, particulate filter, and blower to measure negative pressures. V1 is used to measure the headloss across the particulate filter.
Air-Sparging System		
FM	Flow Meter	Flow meter located on the discharge side of the blower to measure the flow rate of the clean air injected into the AS well.
P1	Pressure Indicator	P1 is located on the discharge side of the sparging blower to monitor the discharge pressure (indicating wellhead pressure).

Sources: Smith Technology Corporation (Project No. 09-5004-14)

TABLE 8

OPINION OF COSTS FOR PROPOSED REMEDIAL ACTION

WASTEWATER LIME TREATMENT PIT, CW-1
CHARLES WOOD AREA, FORT MONMOUTH, NEW JERSEY

Category	Costs[1]
REMEDIATION COSTS[2]	
Installation	$60,000
Operation and Maintenance	$115,000
Laboratory	$71,000
POST-REMEDIATION COSTS[3]	
Removal	$20,000
Laboratory	$15,500
Restoration	$13,000
TOTAL:	**$294,500**

Notes:

[1]Costs do not include permitting fees, NJDEP review fees, or disposal costs.
[2]Costs assume that system will operate for 6 months
[3]Costs assume that post-remediation monitoring will continue quarterly for 1 year.

Sources: Smith Technology Corporation (Project No. 09-5004-14)

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FIGURES

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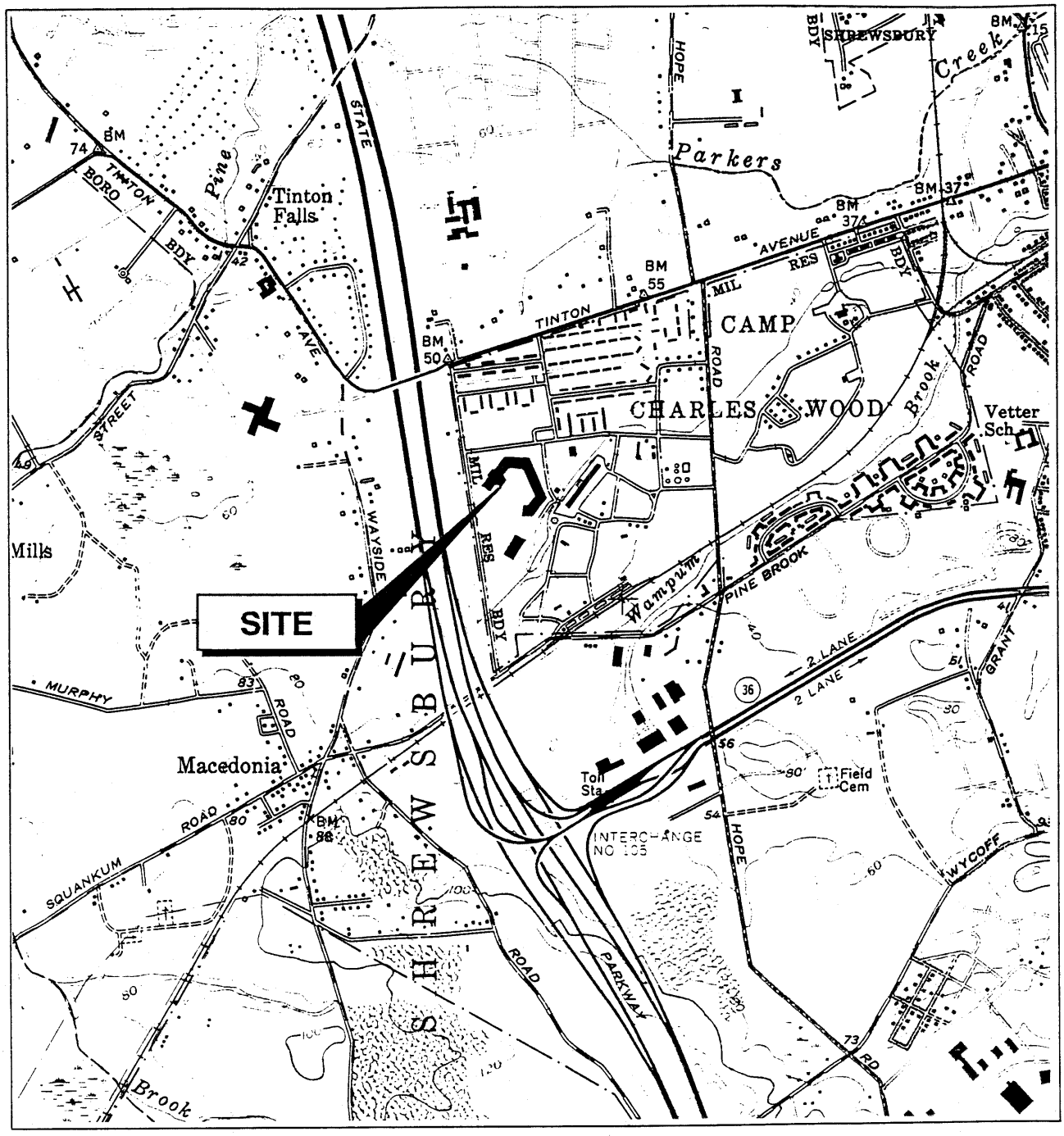
U.S. Army
Department of Public Works
Fort Monmouth, New Jersey



N

SCALE

0 2000 FT.

NEW JERSEY

QUADRANGLE LOCATION

Source: Long Branch, New Jersey Quadrangle

Project No. 09-5004-14

Figure 1
Site Location Map

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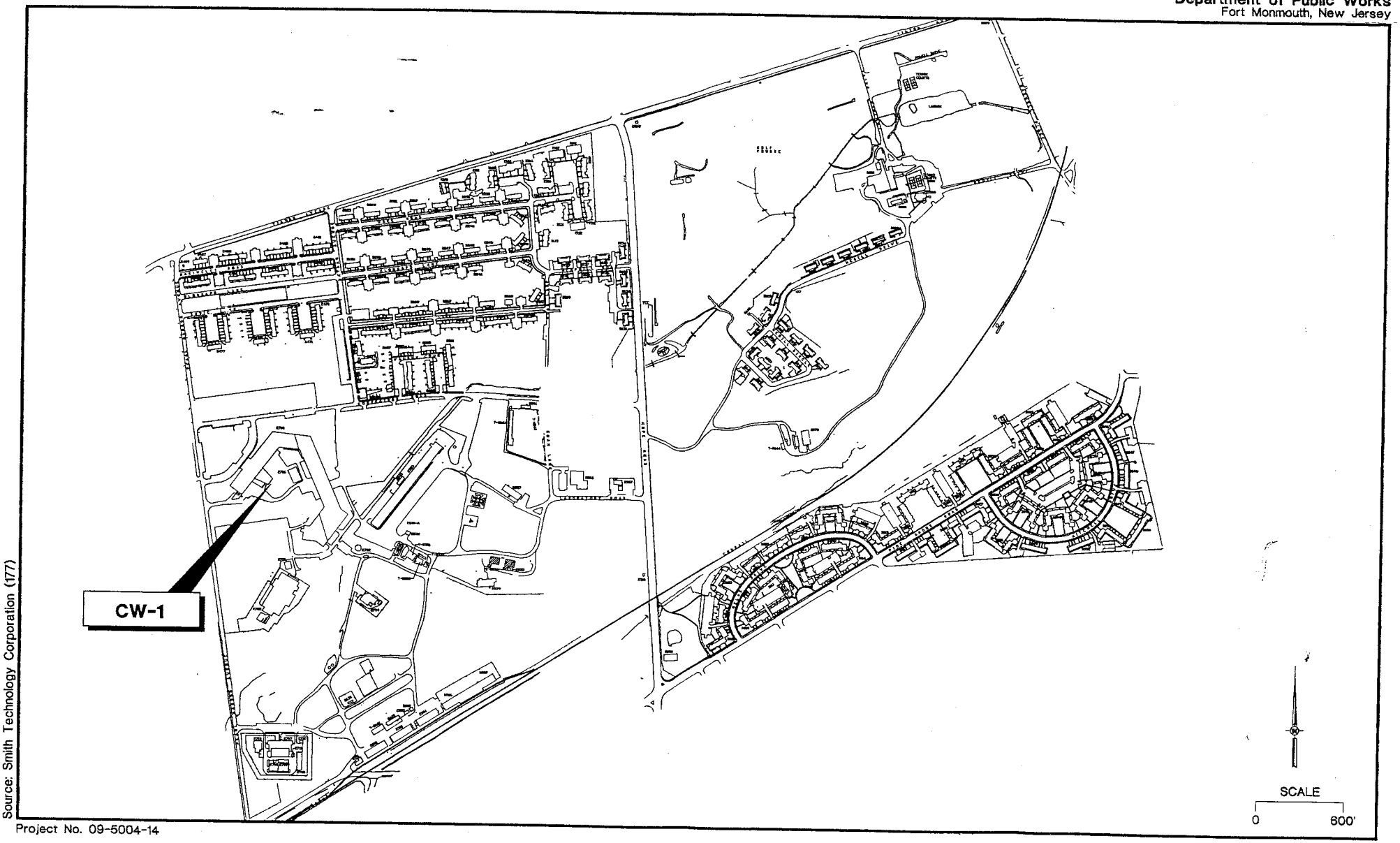
U.S. Army
Department of Public Works
Fort Monmouth, New Jersey



Source: Smith Technology Corporation (177)

Project No. 09-5004-14

Figure 2
SITE PLAN

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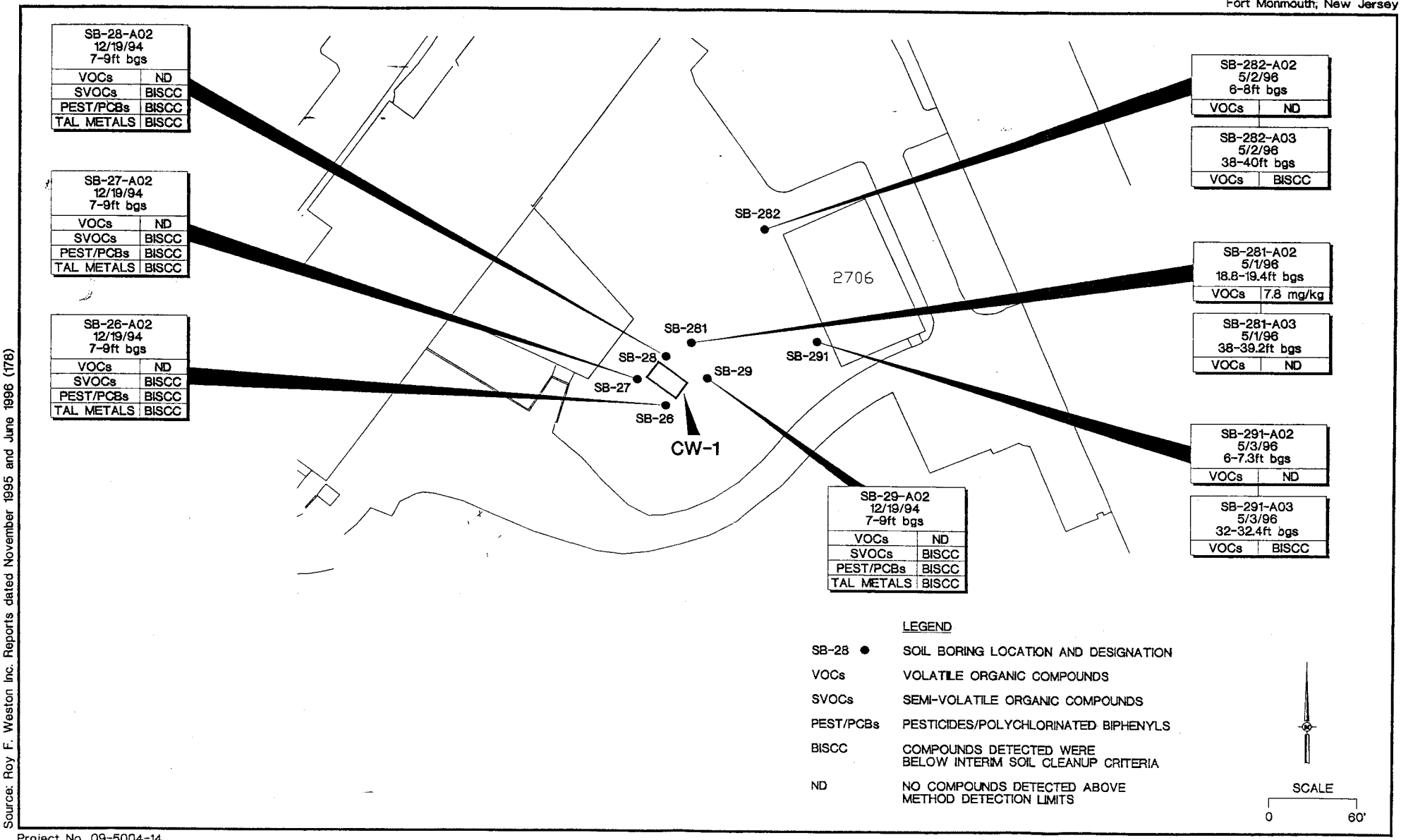
U.S. Army
Department of Public Works
Fort Monmouth, New Jersey



Source: Roy F. Weston Inc. Reports dated November 1995 and June 1996 (178)

Project No..09-5004-14

Figure 3
Soil Sampling Locations and Analytical Results

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U.S. Army
Department of Public Works
Fort Monmouth, New Jersey

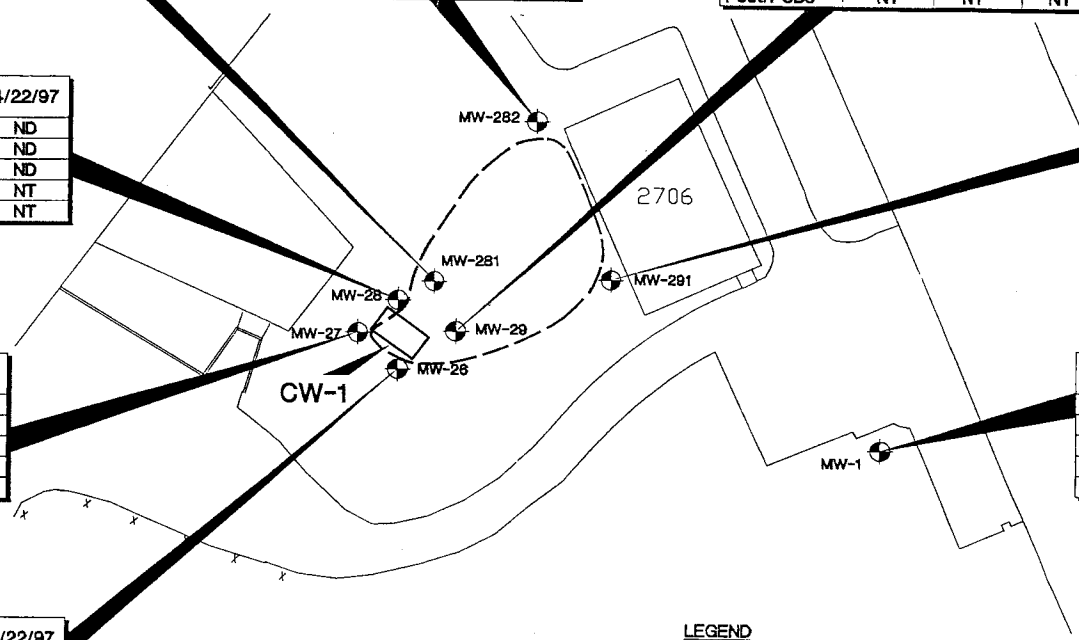
MW-281	5/23/96	4/22/97
1,2-DCE	ND	ND
TCE	20	17.88
PCE	ND	ND
SVOCs	NT	NT
Pest/PCBs	NT	NT

MW-282	5/23/96	4/22/97
1,2-DCE	ND	ND
TCE	ND	ND
PCE	ND	ND
SVOCs	NT	NT
Pest/PCBs	NT	NT

MW-29	2/21/95	3/14/95	5/23/96	4/22/97
1,1-DCE	ND	4 J	ND	ND
Cis-1,2-DCE	110	360	7	47.46
TCE	780	990	170	5109.18
PCE	ND	ND	ND	3.49
SVOCs	NT	NT	NT	NT
Pest/PCBs	NT	NT	NT	NT

MW-28	2/21/95	3/14/95	5/23/96	4/22/97
1,2-DCE	ND	ND	ND	ND
TCE	23	48	ND	ND
PCE	ND	ND	ND	ND
SVOCs	—	—	NT	NT
Pest/PCBs	NT	NT	NT	NT

MW-291	5/23/96	4/22/97
1,2-DCE	ND	ND
TCE	ND	ND
PCE	ND	ND
SVOCs	NT	NT
Pest/PCBs	NT	NT



MW-27	2/21/95	3/14/95	5/23/96	4/22/97
1,2-DCE	ND	ND	ND	ND
TCE	ND	ND	ND	ND
PCE	ND	ND	ND	ND
SVOCs	—	—	NT	NT
Pest/PCBs	ND	ND	NT	NT

MW-1	5/23/96	4/22/97
1,2-DCE	NT	NT
TCE	NT	NT
PCE	ND	NT
SVOCs	NT	NT
Pest/PCBs	ND	NT

MW-26	2/21/95	3/14/95	5/23/96	4/22/97
1,2-DCE	ND	ND	ND	ND
TCE	ND	ND	ND	ND
PCE	ND	4	ND	ND
SVOCs	—	ND	NT	NT
Pest/PCBs	ND	ND	NT	NT

LEGEND

MW-28	MONITORING WELL LOCATION AND DESIGNATION
VOCs	VOLATILE ORGANIC COMPOUNDS
SVOCs	SEMI-VOLATILE ORGANIC COMPOUNDS
PEST/PCBs	PESTICIDES/POLYCHLORINATED BIPHENYLS
—	COMPOUNDS DETECTED WERE BELOW NJDEP GROUNDWATER QUALITY CRITERIA, IF APPLICABLE
ND	NO COMPOUNDS DETECTED ABOVE METHOD DETECTION LIMITS
TCE	TRICHLOROETHENE
PCE	TETRACHLOROETHENE
NT	NOT TESTED
J	ESTIMATED CONCENTRATION
— — —	CLASSIFICATION EXCEPTION AREA BOUNDARY (BASED ON 05/23/96 ANALYTICAL RESULTS)

SCALE
0 60'

NOTE:

ALL CONCENTRATIONS REPORTED IN MICROGRAMS PER LITER (ug/l)

Source: Roy F. Weston Inc. Reports dated November 1995 and June 1996 (179)

Project No. 09-5004-14

Figure 4
Monitoring Well Locations and Analytical Results (Organics)

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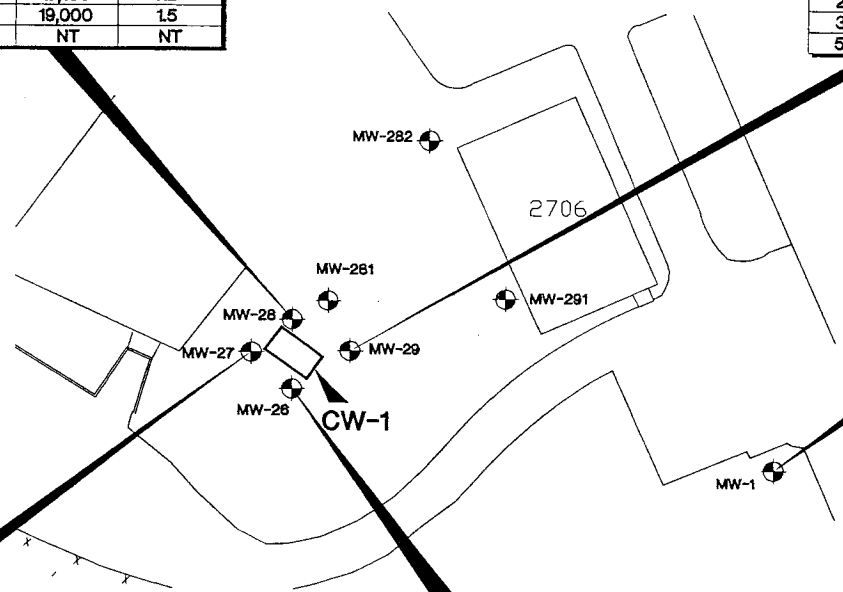
U.S. Army
Department of Public Works
Fort Monmouth, New Jersey

MW-28	Al	Fe	Mn	Na	Pb
UNFILTERED					
2/21/95	3,480	5,760	—	17,000	2.7
3/14/95	4,150	6,610	—	19,200	3.6
5/23/96	NT	NT	NT	NT	NT
FILTERED					
2/21/95	510	8.4	—	17,100	ND
3/14/95	498	28.6	—	19,000	1.5
5/23/96	NT	NT	NT	NT	NT

MW-29	Al	Fe	Mn	Na	Pb
UNFILTERED					
2/21/95	1,980	3,810	65.8	28,000	ND
3/14/95	2,760	5,300	75.3	30,800	ND
5/23/96	NT	NT	NT	NT	NT
FILTERED					
2/21/95	118	134	60.5	27,600	2.3
3/14/95	143	238	70.3	33,500	1.2
5/23/96	NT	NT	NT	NT	NT



MW-1	TAL METALS
2/21/95	NT
3/14/95	NT
5/23/96	NT

MW-27	Al	Fe	Mn	Na	Pb
UNFILTERED					
2/21/95	3,770	7,190	110	64,300	5.6
3/14/95	7,620	15,400	140	79,100	11.0
5/23/96	NT	NT	NT	NT	NT
FILTERED					
2/21/95	653	122	98.4	62,700	ND
3/14/95	885	93.3	114	73,800	2.2
5/23/96	NT	NT	NT	NT	NT

MW-26	Al	Fe	Mn	Na	Pb
UNFILTERED					
2/21/95					
3/14/95					
5/23/96	NT	NT	NT	NT	NT
FILTERED					
2/21/95					
3/14/95					
5/23/96	NT	NT	NT	NT	NT

LEGEND

TAL TARGET ANALYLE LIST

MW-1 MONITORING WELL LOCATION AND DESIGNATION

NT NOT TESTED

ND COMPOUND NOT DETECTED ABOVE METHOD DETECTION LIMIT

— COMPOUNDS DETECTED WERE BELOW NJDEP GROUNDWATER QUALITY CRITERIA, IF APPLICABLE

NOTE:

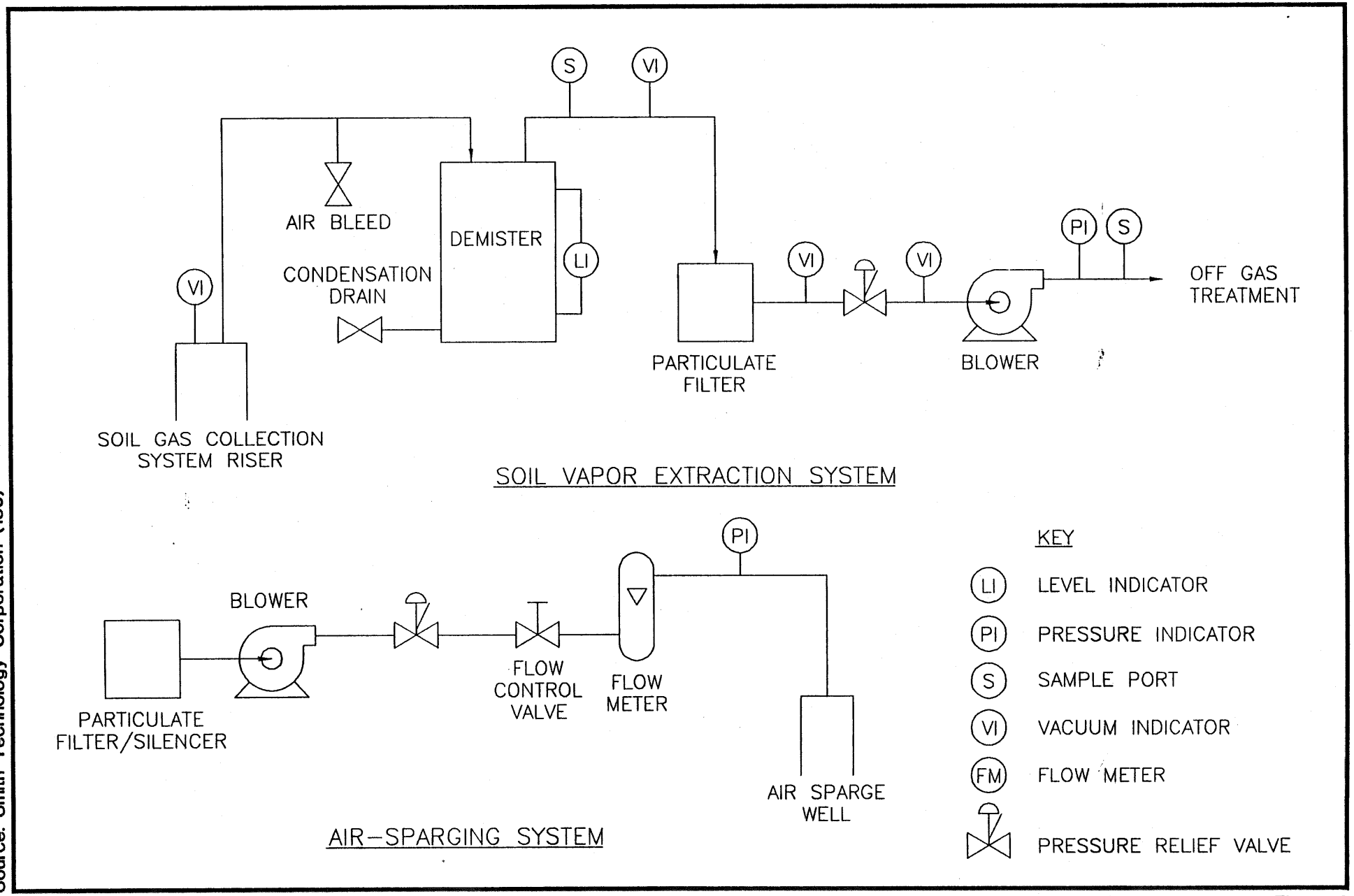
ALL CONCENTRATIONS REPORTED IN MICROGRAMS PER LITER (ug/l)

SCALE
0 60'

Source: Roy F. Weston Inc. Reports dated November 1995 and June 1996 (180)

Project No. 09-5004-14

Figure 5
Monitoring Well Locations and Analytical Results (Inorganics)



Source: Smith Technology Corporation (185)

Project No. 09-5004-14

Figure 6
Air-Sparging/Soil Vapor Extraction System Schematic

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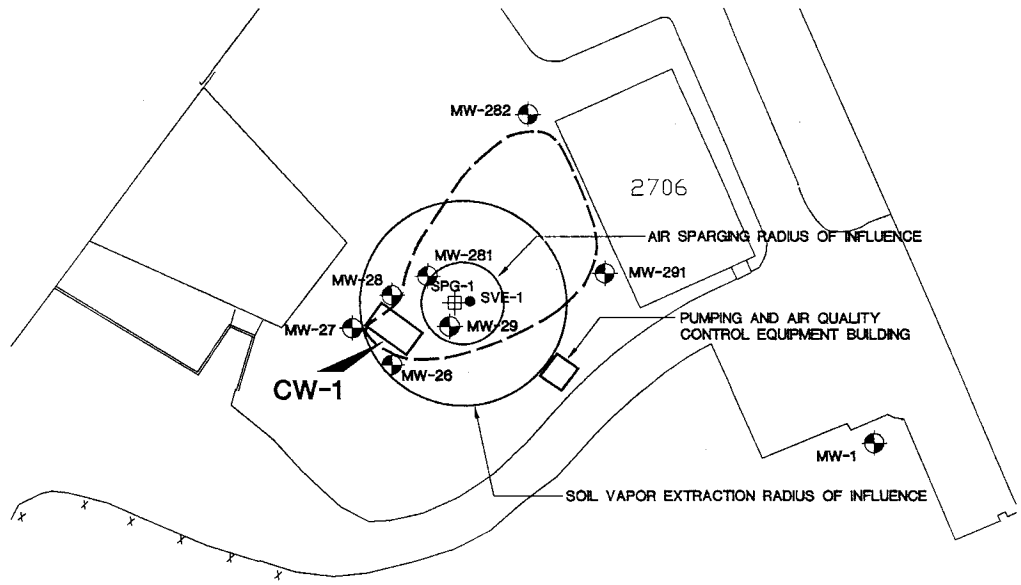
U.S. Army
Department of Public Works
Fort Monmouth, New Jersey



LEGEND

MW-28 MONITORING WELL LOCATION AND DESIGNATION

CLASSIFICATION EXCEPTION AREA BOUNDARY (BASED ON 05/23/96 ANALYTICAL RESULTS)

SVE-1 PROPOSED SOIL VAPOR EXTRACTION WELL WELL LOCATION AND DESIGNATION

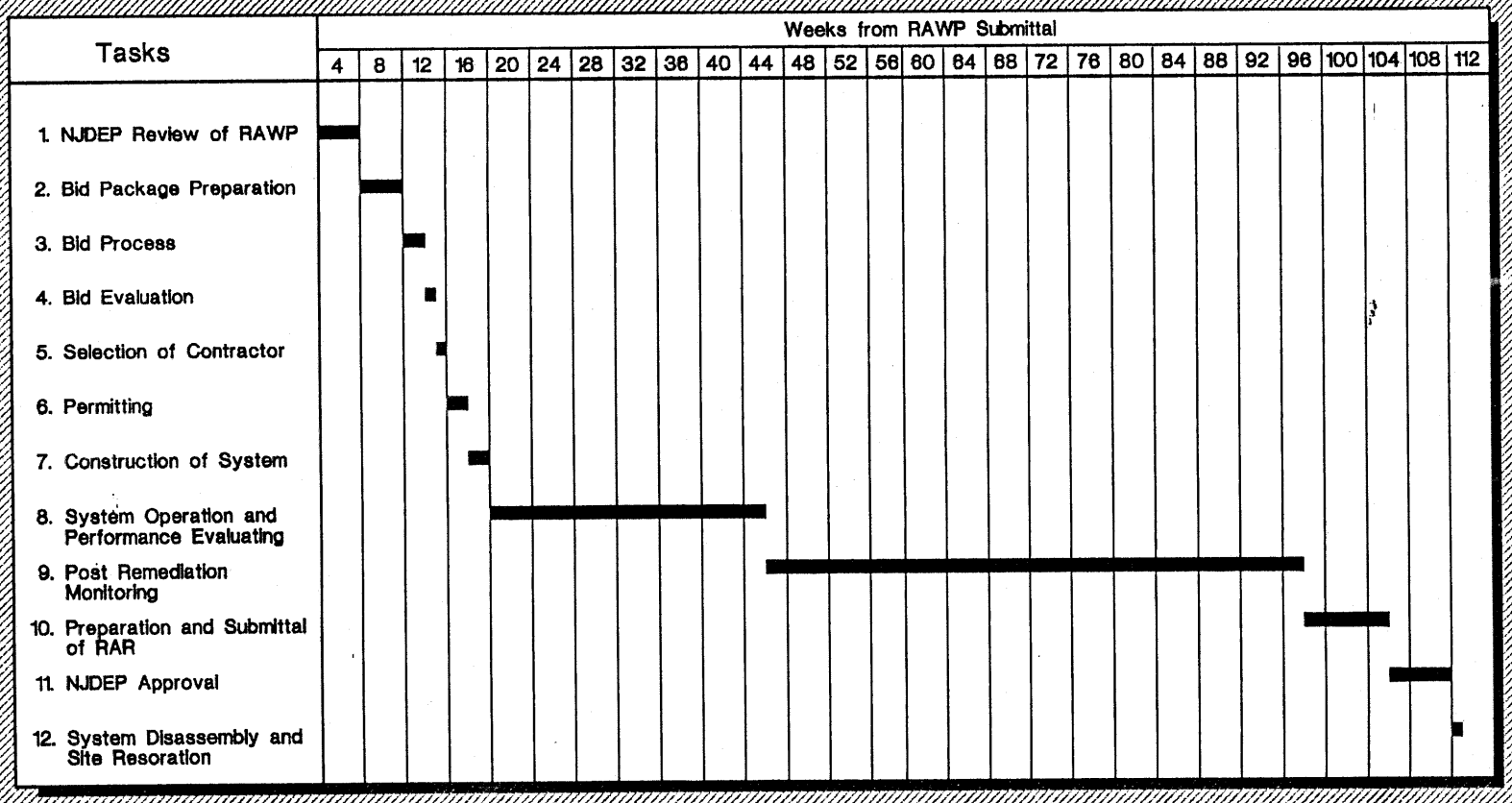
SPG-1 PROPOSED AIR SPARGING WELL LOCATION AND DESIGNATION

SCALE
0 60'

Source: Roy F. Weston Inc. Reports dated November 1995 and June 1996 (184)

Project No. 09-5004-14

Figure 7
Proposed Air Sparging/Soil Vapor Extraction System



Source: Smith Technology Corporation (186)

Project No. 00-5004-14

Figure 8
Project Schedule

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APPENDIX A

SYSTEM DESIGN BASIS

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AS/SVE System Design

Smith Technology used a three dimensional mathematical model developed by Paul C. Johnson, Ph.D. for the EPA to predict the physical zone of influence and performance characteristics for the soil vapor extraction system. This model, entitled *"Hyperventilate"*, is available from the National Technical Information Service as PB93-134880, *Decision-Support Software for Soil Vapor Extraction Technology Application: Hyperventilate*. Guidance documents, technical papers, and text books (attached) were used as sources of design guidance for both the AS and SVE systems. Conservative rules of thumb were evaluated as a confirmation of the developed design.

The following parameters served as the basis for design of the AS/SVE system.

Physical properties included:

- Depth to groundwater = 7 feet
- Height of SVE well screen above ground water = 1 feet
- Length of SVE well screen = 2 feet
- Diameter of SVE well screen = 4 inches
- Soil temperature = 68 °F (20 °C)
- Soil porosity = 0.3 (30%)
- Soil permeability = 40-60 darcy (clean sand with some silt)
- Aerial extent of contamination (as indicated by SGS) = 50 feet radius (assumed)

Chemical properties included:

- Primary chemical of interest is TCE
- Vapor pressure of TCE = 0.0705 ATM (53.62 mm Hg) @ 68 °F (20 °C)
- Molecular weight of TCE = 131.39
- Maximum soil concentration of TCE = 7.8 mg/kg soil, (May 1, 1996)

The results of the modeling efforts and design guidance were optimized to provide an integrated AS/SVE system which permits flexibility, provides for control of sparged vapors, address the aerial extent of the soil vapors, and maximizes the use of existing equipment. The EPA Model was used to determine the operating parameters for the soil vapor extraction system. In the case of this model the radius-of-influence is arbitrarily set, the negative pressure or vacuum is a variable, along with the well configuration. The model was developed around gasoline product but is chemical specific and was, in this case, programmed for trichloroethene. A typical soil vapor extraction system with a companion air sparging system is shown in Figure 6. Although simplified, this diagram depicts the general basis of the system. The sparge air is supplied beneath the water table by a clean air source, typically a compressor or blower capable of delivering the quantity of air at the pressure required; while the soil vapor extraction system provides the mechanism to collect this sparged air along with other soil vapors. Figure 6 depicts a typical process and instrumentation diagram for the soil vapor extraction system. As shown, a system typically consists of a well to collect the vapors, a demister vessel to remove excess moisture, a particulate filter to remove air borne particulate, a pressure relief valve to control wellhead vacuum, a blower to provide the motive force, an off-gas treatment system, and instrumentation to monitor the system's operation and performance. Input parameters and results of the Hyperventilate Model are attached. The model indicates that based on aerial coverage, one (1) 4 inch diameter well operating at between 40-80 inches of water column vacuum should be sufficient to yield a radius-of-influence (ROI) of approximately 50 feet and contain the extents of groundwater plume as identified in May, 1996. Additionally, this ROI aggressively covers the vast majority of the soil gas survey plume as identified in May, 1996. The model indicates that a total vapor extraction rate between 30 to 80 standard cubic feet per minute (scfm) will be achieved, yielding a pore volume turnover of approximately 3 to 7 pore volumes per day in thus area. This corresponds well with the general rule of thumb, taken from operating data for VOC contaminated sites successfully remediated within a six month period; that a pore volume turnover rate of approximately four (4) times per day (typical range 3-5) is sufficient.

In order to estimate the physical zone of influence for the saturated zone air sparging system, two approaches can be taken. The first is a conservative estimate which comes from the rule of thumb that a minimum of one foot of horizontal ROI can be obtained from each foot of depth below the surface of the aquifer. This rule is based on the fact that horizontal permeability typically tends to be greater than vertical permeability (Middleton, 1990). The second approach is to predict the approximate ROI for a single sparge well based on the data presented in the paper *Air Sparging Extending Volatilization to Contaminated Aquifers*, by Brown and Faxedas [Symposium on Soil Venting, EPA 600/R-92/174, September, 1992]. Brown and Faxedas define the relationship between the ROI and the pressure at the air injection point. This relationship is described with the following equation:

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$$R = 5.7\ H\ ((P/P_H) - 1)$$

where:

R = radius of influence (feet)
H = depth of sparge well into saturated zone (feet)
P = air pressure at the injection point (psig)
P_H = hydrostatic pressure at the depth H (psig)

P_H is proportional to the height of the water column above the sparge well and can be determined by:

$$P_H = H * (1\ \text{psig}/2.31\ \text{feet})$$

Using this formula and assuming a maximum injection pressure of 5 psig yields a predicted ROI of 20 feet. Typically, Smith Technology Corporation prefers to hold the injection pressure to just slightly greater than the hydrostatic pressure, and the ratio of P/P_H varies between 1.1 to 1.5.

In this case, if H is 8 feet and the injection pressure is kept at 1.2 times the hydrostatic pressure the calculated ROI for a single point air sparging system is approximately 9 feet. For a depth of 8 feet below the surface of the aquifer using the rule of thumb (1:1 horizontal ROI:vertical depth) yields an approximation very near this calculated value.

Air pressure at the injection site is related to the air flow rate. However, the latter quantity depends on site- and application specific parameters such as the length of the screen interval, the radius of the injection well, and the permeability of the aquifer. This situation is analogous to pumping water through a piping network. The headloss depends on the flow rate and friction losses throughout the network and varies accordingly. However, unlike a piping network, the pressure/flow relationship for an air sparging system in heterogeneous soils cannot be generally predicted in advance. Although we can assume these parameters this relationship is better empirically determined. Therefore, the air sparge system is designed to supply a range of delivery pressures at the wellhead of between 4 psig and 5 psig (approximately 9 to 12 feet of water column). This will yield a potential effective radius of 7 to 20 feet according to the relationship cited above.

Design of the air sparging flow rate is typically back calculated to determine the maximum flow rate of injection. Smith Technology Corporation uses a 2:1 minimum ratio of extracted air to injected air. The design guidance provided in the EPA's document, *"A Technical Assessment of Soil Vapor Extraction and Air Sparging"* states that the volume of extracted air should exceed the volume of injected air to maintain a margin of safety and to prevent subsurface pressure build

ups. It cites that the State of Wisconsin requires at least a 4:1 ratio and that another system maintained a ratio of 5:1. Based on the limited need of air sparging within the vicinity of monitoring well MW-29, Smith Technology recommends a large overall extraction to injection ratio. The actual maximum injection ratio was determined by calculating a pore volume turnover ate of 0.75 to 1.75 pore volumes per day (1/4 of the soil vapor extraction range) for the potential radius of influence of the air sparging well. this calculates to a total injection flow ranging from 1.4 scfm to 3.25 scfm.

Based on the aerial extent of effected groundwater and the predicted air sparging well ROI, a single 2 inch diameter PVC well with a one foot screened interval from 14 to 15 feet bgs located in the vicinity of MW-29 should be adequate to remediate the current groundwater situation.

Air Treatment System Design

The final step in constructing the AS/SVE system is to provide an active means of off-gas control. In this case, soil gas concentration are not expected to be great, therefore, vapor phase granular activated carbon has been selected as the preferred treatment technology. Two approaches can be taken to determine the soil gas concentration from a sparging system. The first is to estimate the equilibrium (saturated) vapor concentration. In this estimation one assumes that the contaminant concentration is great enough (>200 mg/kg) that it is distributed between the vapor, adsorbed, dissolved, and free phases. This being the case, the concentration is determined via "Raoult's Law" corrected for changes in the vapor pressure due to temperature based on the "Clausis-Clapeyron Equation" and is represented by the following equation.

$$C_V = XP_VM_W/RT$$

where:

C_V = total vapor concentration (mg/L)
X = Mole Fraction of Component (1 for single component gas)
P_V = Vapor Pressure of Component (atm)
M_W = Molecular Weight (mg/mole)
R = Universal Gas Constant (atm/K-mole)
T = Absolute Temperature (Kelvin)

The EPA Model calculates this equilibrium concentration and determines that for a trichloroethene stream at 20 °C, the saturation concentration is approximately 300 mg/l.

The second approach is to determine the maximum amount of contaminant present within the soils and assume that it is removed at a steady rate over the entire remediation period. This is the approach that activated carbon suppliers use to determine the carbon usage over the project life.

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A conservative approach is to assume the worst case situation, assuming that all soil within the area of influence is contaminated to the highest level detected (7.8 mg/kg). A total of approximately 50 pounds of TCE is estimated, assuming the range of air flow rates previously determined (30 to 80 scfm). This yields an average air concentration between 1 to 10 ppm_V over the six month remediation period. Based on this concentration level, a theoretical contaminant loading of approximately 20% by weight on carbon can be expected. Calgon Carbon Corporation also performed calculations of the expected concentration and carbon consumption, attached. These estimates concur with their calculations. Both approaches suggest that over the life of the remediation project approximately 400 pounds of granular activated carbon will be utilized. This yields an approximate loading of 12% by weight on the carbon, an even more conservative estimation.

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REMEDIAL ACTION SELECTION REPORT

WASTEWATER TREATMENT LIME PIT, CW-1

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FORT MONMOUTH, NEW JERSEY

JUNE 1997

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1.0 SELECTED REMEDIAL ACTION

The Directorate of Public Works (DPW) proposes to implement an air-sparging/soil vapor extraction system remediation (AS/SVE) program to address the groundwater contamination in the vicinity of CW-1. The following sections describe the configuration and operation of the AS/SVE system that will be in-place for the duration of the proposed remedial program.

1.1 AIR-SPARGING/SOIL VAPOR EXTRACTION SYSTEM (AS/SVE)

AS/SVE is a method of removing volatile organic compounds (VOCs) from the saturated zone by injecting clean air into an aquifer through sparging wells to volatilize dissolved-phase VOCs. The dissolved-phase VOCs are transferred from the saturated zone into the unsaturated, or vadose zone, and are then extracted from the unsaturated zone through a soil vapor extraction (SVE) system. The extracted vapor is then routed to an appropriate air-treatment system.

A pilot study is typically performed to evaluate effectiveness of a remedial approach prior to full-scale implementation. In this case, due to the limited extent of the contamination, both in the groundwater (dissolved phase VOCs) and in the soil gas (vapor phase VOCs), the DPW proposes a full-scale AS/SVE. If the results of performance monitoring of the AS/SVE system indicate that the AS/SVE system should be modified, the necessary system modifications will be made by the remediation contractor.

1.1.1 Design and Construction

1.1.1.1 Design

The proposed AS/SVE system for CW-1 has been designed by Smith Technology to address conditions specific to the CW-1 area. The air-sparging well will be installed to actively sparge VOCs that are present in groundwater intercepted by monitoring well MW-29 (screened interval 5.0- to 10.-feet below grade). The zone of influence for the air sparging well follows a conservative approach that a minimum of one foot of horizontal influence con be obtained from each foot of depth below the surface of the aquifer. The sparging is to be installed at a depth of 15 feet and will produce an effective radius of influence between 7 and 20 feet based on operating injection pressures.

The soil vapor extraction will be installed to withdraw soil gas vapor generated by the sparge well, and to withdraw soil gas vapor generated by the passive volatilization of VOCs present in the groundwater intercepted by monitoring well MW-281. The soil vapor extraction well radius of influence was calculated through the use of the EPA model "*Hyperventilate*". The well has been designed to operate between 40 and 80 inches of water column vacuum yielding a radius of influence of approximately 50 feet. This radius contains the extent of the ground water plume as identified from the May 1996 ground water survey results. It also covers the vast majority of the soil gas survey plume as identified in the May 1996 soil gas survey results.

Smith Technology used a three dimensional mathematical model developed by Paul C. Johnson, Ph.D. for the EPA to predict the physical zone of influence and performance characteristics for the soil vapor extraction system. This model, entitled *"Hyperventilate"*, is available from the National Technical Information Service as PB93-134880, *Decision-Support Software for Soil Vapor Extraction Technology Application: Hyperventilate*. Guidance documents, technical papers, and text books (attached) were used as sources of design guidance for both the AS and SVE systems. Conservative rules of thumb were evaluated as a confirmation of the developed design.

The following parameters served as the basis for design of the AS/SVE system.

Physical properties included:

- Depth to groundwater = 7 feet
- Height of SVE well screen above ground water = 1 feet
- Length of SVE well screen = 2 feet
- Diameter of SVE well screen = 4 inches
- Soil temperature = 68 °F (20 °C)
- Soil porosity = 0.3 (30%)
- Soil permeability = 40-60 darcy (clean sand with some silt)
- Aerial extent of contamination (as indicated by SGS) = 50 feet radius (assumed)

Chemical properties included:

- Primary chemical of interest is TCE
- Vapor pressure of TCE = 0.0705 ATM (53.62 mm Hg) @ 68 °F (20 °C)
- Molecular weight of TCE= 131.39
- Maximum soil concentration of TCE = 7.8 mg/kg soil, (May 1, 1996)

The results of the modeling efforts and design guidance were optimized to provide an integrated AS/SVE system which permits flexibility, provides for control of sparged vapors, address the aerial extent of the soil vapors, and maximizes the use of existing equipment. The EPA Model

was used to determine the operating parameters for the soil vapor extraction system. In the case of this model the radius-of-influence is arbitrarily set, the negative pressure or vacuum is a variable, along with the well configuration. The model was developed around gasoline product but is chemical specific and was, in this case, programmed for trichloroethene.. Although simplified, this diagram depicts the general basis of the system. The sparge air is supplied beneath the water table by a clean air source, typically a compressor or blower capable of delivering the quantity of air at the pressure required; while the soil vapor extraction system provides the mechanism to collect this sparged air along with other soil vapors. As shown, a system typically consists of a well to collect the vapors, a demister vessel to remove excess moisture, a particulate filter to remove air borne particulate, a pressure relief valve to control wellhead vacuum, a blower to provide the motive force, an off-gas treatment system, and instrumentation to monitor the system's operation and performance. Input parameters and results of the Hyperventilate Model are attached. The model indicates that based on aerial coverage, one (1) 4 inch diameter well operating at between 40-80 inches of water column vacuum should be sufficient to yield a radius-of-influence (ROI) of approximately 50 feet and contain the extents of groundwater plume as identified in May, 1996. Additionally, this ROI aggressively covers the vast majority of the soil gas survey plume as identified in May, 1996. The model indicates that a total vapor extraction rate between 30 to 80 standard cubic feet per minute (scfm) will be achieved, yielding a pore volume turnover of approximately 3 to 7 pore volumes per day in thus area. This corresponds well with the general rule of thumb, taken from operating data for VOC contaminated sites successfully remediated within a six month period; that a pore volume turnover rate of approximately four (4) times per day (typical range 3-5) is sufficient.

In order to estimate the physical zone of influence for the saturated zone air sparging system, two approaches can be taken. The first is a conservative estimate which comes from the rule of thumb that a minimum of one foot of horizontal ROI can be obtained from each foot of depth below the surface of the aquifer. This rule is based on the fact that horizontal permeability typically tends to be greater than vertical permeability (Middleton, 1990). The second approach is to predict the approximate ROI for a single sparge well based on the data presented in the paper *Air Sparging Extending Volatilization to Contaminated Aquifers*, by Brown and Faxedas [Symposium on Soil Venting, EPA 600/R-92/174, September, 1992]. Brown and Faxedas define the relationship between the ROI and the pressure at the air injection point. This relationship is described with the following equation:

$$R = 5.7\ H\ ((P/P_H) - 1)$$

where:

R = radius of influence (feet)
H = depth of sparge well into saturated zone (feet)
P = air pressure at the injection point (psig)
P_H = hydrostatic pressure at the depth H (psig)

P_H is proportional to the height of the water column above the sparge well and can be determined by:

$$P_H = H * (1 \text{ psig}/2.31 \text{ feet})$$

Using this formula and assuming a maximum injection pressure of 5 psig yields a predicted ROI of 20 feet. Typically, Smith Technology Corporation prefers to hold the injection pressure to just slightly greater than the hydrostatic pressure, and the ratio of P/P_H varies between 1.1 to 1.5.

In this case, if H is 8 feet and the injection pressure is kept at 1.2 times the hydrostatic pressure the calculated ROI for a single point air sparging system is approximately 9 feet. For a depth of 8 feet below the surface of the aquifer using the rule of thumb (1:1 horizontal ROI:vertical depth) yields an approximation very near this calculated value.

Air pressure at the injection site is related to the air flow rate. However, the latter quantity depends on site- and application specific parameters such as the length of the screen interval, the radius of the injection well, and the permeability of the aquifer. This situation is analogous to pumping water through a piping network. The headloss depends on the flow rate and friction losses throughout the network and varies accordingly. However, unlike a piping network, the pressure/flow relationship for an air sparging system in heterogeneous soils cannot be generally predicted in advance. Although we can assume these parameters this relationship is better empirically determined. Therefore, the air sparge system is designed to supply a range of delivery pressures at the wellhead of between 4 psig and 5 psig (approximately 9 to 12 feet of water column). This will yield a potential effective radius of 7 to 20 feet according to the relationship cited above.

Design of the air sparging flow rate is typically back calculated to determine the maximum flow rate of injection. Smith Technology Corporation uses a 2:1 minimum ratio of extracted air to injected air. The design guidance provided in the EPA's document, *"A Technical Assessment of Soil Vapor Extraction and Air Sparging"* states that the volume of extracted air should exceed the volume of injected air to maintain a margin of safety and to prevent subsurface pressure build ups. It cites that the State of Wisconsin requires at least a 4:1 ratio and that another system maintained a ratio of 5:1. Based on the limited need of air sparging within the vicinity of monitoring well MW-29, Smith Technology recommends a large overall extraction to injection ratio. The actual maximum injection ratio was determined by calculating a pore volume turnover ate of 0.75 to 1.75 pore volumes per day (1/4 of the soil vapor extraction range) for the potential radius of influence of the air sparging well. this calculates to a total injection flow ranging from 1.4 scfm to 3.25 scfm.

Based on the aerial extent of effected groundwater and the predicted air sparging well ROI, a single 2 inch diameter PVC well with a one foot screened interval from 14 to 15 feet bgs located in the vicinity of MW-29 should be adequate to remediate the current groundwater situation.

Air Treatment System Design

The final step in constructing the AS/SVE system is to provide an active means of off-gas control. In this case, soil gas concentration are not expected to be great, therefore, vapor phase granular activated carbon has been selected as the preferred treatment technology. Two approaches can be taken to determine the soil gas concentration from a sparging system. The first is to estimate the equilibrium (saturated) vapor concentration. In this estimation one assumes that the contaminant concentration is great enough (>200 mg/kg) that it is distributed between the vapor, adsorbed, dissolved, and free phases. This being the case, the concentration is determined via "Raoult's Law" corrected for changes in the vapor pressure due to temperature based on the "Clausis-Clapeyron Equation" and is represented by the following equation.

$$C_V = XP_VM_W/RT$$

where:

C_V = total vapor concentration (mg/L)
X = Mole Fraction of Component (1 for single component gas)
P_V = Vapor Pressure of Component (atm)
M_W = Molecular Weight (mg/mole)
R = Universal Gas Constant (atm/K-mole)
T = Absolute Temperature (Kelvin)

The EPA Model calculates this equilibrium concentration and determines that for a trichloroethene stream at 20 °C, the saturation concentration is approximately 300 mg/l.

The second approach is to determine the maximum amount of contaminant present within the soils and assume that it is removed at a steady rate over the entire remediation period. This is the approach that activated carbon suppliers use to determine the carbon usage over the project life. A conservative approach is to assume the worst case situation, assuming that all soil within the area of influence is contaminated to the highest level detected (7.8 mg/kg). A total of approximately 50 pounds of TCE is estimated, assuming the range of air flow rates previously determined (30 to 80 scfm). This yields an average air concentration between 1 to 10 ppm_V over the six month remediation period. Based on this concentration level, a theoretical contaminant loading of approximately 20% by weight on carbon can be expected. Calgon Carbon Corporation also performed calculations of the expected concentration and carbon consumption, attached. These estimates concur with their calculations. Both approaches suggest that over the life of the remediation project approximately 400 pounds of granular activated carbon will be utilized. This yields an approximate loading of 12% by weight on the carbon, an even more conservative estimation.

The system has been designed to

1. Provide for ease of installation
2. Provide for relative ease of operation
3. Provide adequate equipment for the remediation of contaminated groundwater and soil vapor (as identified by the soil gas survey)
4. Avoid operating in situations that may lead to hazardous conditions
5. Be adaptable to possible future modifications
6. Minimize potential for system failure

The components of the AS/SVE system have been sized to meet the anticipated conditions at the site. The AS/SVE system includes numerous gages and indicators for monitoring system performance.

A single-phase, 230 volt, 100 ampere electrical service will be required for operation of the AS/SVE system.

1.1.1.2 Construction

The major components of the AS/SVE system are:

Air-sparging System	Vapor Extraction System
• Air-sparging well • Blower	• Soil vapor extraction well • Demister vessel • Particulate filter • Pressure relief valve • Blower • Air treatment system

The equipment will be located in a small, temporary structure suitable to serve as a weather proof enclosure to protect the various devices, and to minimize associated noise. For planning purposes, an enclosure of approximately 100 square feet (10 feet by 10 feet) is anticipated. All polyvinyl chloride (PVC) piping leading to the equipment enclosure will be buried. All piping nominally 2-inch diameter, and less shall be of schedule 80 PVC. Piping greater than 2-inch diameter shall be of schedule 40 construction. Any above ground piping will be of a suitable plastic material for compressed gas service (i.e. Chemaire Piping), or will be constructed of metallic piping material such as galvanized steel.

Air-Sparging System

Air-sparging Well (SPG-1)

A 2-inch PVC well will be installed by a New Jersey-licensed driller installed within 10 feet of monitoring well MW-29 (Figure 6). The well (SPG-1) will be seated at 15 feet bgs and will be screened from 14 feet to 15 feet with No. 20 slot screen. The riser connecting the SPG-1 to the surface piping will be constructed of 2 inch, solid, schedule 40, PVC pipe. SPG-1 will be constructed with a No. 1 Morie Sand pack that will extend two feet above the top of the screen. The remainder of the annular space will be tremie grouted to grade with a bentonite slurry.

Blower

A regenerative, positive displacement, or rotary vane blower, capable of maintaining a flow rate of 5 standard cubic feet per minute (scfm) and operating pressure of 12 feet water column will be utilized to inject the clean air stream into the saturated zone. As stated in Appendix A, the requisite flow rate for the CW-1 area is approximately 1.4 scfm to 3.5 scfm.

The intake side of the blower will be fitted with a particulate filter/silencer. A pressure relief valve (pressure range 40 to 140 inches of water) will be located on the discharge side of the blower. A Bourdon tube pressure gage (maximum pressure range of 10 pounds per square inch) will also be located on the discharge side of the blower.

Soil Vapor Extraction System

Soil Vapor Extraction Well (SVE-1)

A 4-inch PVC well will be installed by a New Jersey licensed well driller within 10 feet of monitoring well MW-29 . The well (SVE-1) will be seated at 6 feet bgs and will be screened from 4 feet to 6 feet with No. 20 slot screen. The riser connecting the vertical well to the surface piping will be constructed of same diameter, solid, schedule 40, PVC pipe. SVE-1 will be constructed with a No. 1 Morie Sand pack that will extend two feet above the top of the screen. The remainder of the annular space will be tremie grouted to grade with a bentonite slurry.

Blower

A regenerative or rotary vane blower, capable of maintaining a flow rate of 80 scfm and operating vacuum of 100 inches water column will be utilized to extract vapor from the unsaturated zone.

Demister Vessel

In order to remove excess moisture from the extracted air stream, a 30- to 50-gallon demister vessel, capable of withstanding a vacuum of 100 inches of water will be located on the discharged side of the blower.

The discharge side of the blower will be fitted with a particulate filter. A vacuum relief valve (vacuum range 40 to 140 inches of water) and Bourdon tube vacuum gage (maximum vacuum 30 inches of mercury) will also be located on the discharge side of the blower.

Air Treatment System

The extracted soil vapor will be treated by granular activated carbon (GAC). Two in-series canisters will be located on the discharge side of the SVE blower. When break-through of the primary canister occurs, the secondary canister will be moved into the primary canister position, and a new secondary canister will be installed. It is estimated that no more than 200 pounds of GAC will be required over the entire AS/SVE program.

1.1.2 System Operation and Monitoring

1.1.2.1 System Operation

As shown in Appendix A, the AS/SVE system will operate on a continuous basis for an estimated period of six months. A timing device that would allow cyclic operation of the system can be added at a later date should night time noise be of concern, or if there is a need to increase contaminant removal rate. In some cases this cyclic type operation has actually decreased overall contaminant removal time. It is believed that this increased efficiency results from establishing new pathways through the subsurface. In the document, *In Situ Aeration of Groundwater A Technology Overview*, presented at the Conference on Prevention and Treatment of Soil and Groundwater Contamination in the Petroleum Refining and Distribution Industry, Montreal, Quebec, Canada, October 1990, Middleton and Hiller suggest that as the compressed air moves through the screen into the saturated zone it displaces water in the pore space and moves in irregular pathways to the surface of the water table. Cyclic operation provides an opportunity for these established pathways to collapse and permit other pathways to form.

1.1.2.2 System Monitoring

The following information will be collected as part of the system performance monitoring program.

1. Operating pressures and vacuum
2. Operating temperature
3. Vacuum at soil gas extraction well

4. Off-gas air flow

5. Off-gas VOC contaminant concentration prior to GAC treatment

6. Off-gas VOC contaminant concentration between GAC units

7. Off-gas VOC contaminant concentration after GAC treatment

8. Groundwater VOC contaminant concentration

Items 1 through 4 listed above will be recorded daily during the first week of operation, weekly during the second, third and fourth weeks of operation, and monthly during the second through sixth months of operation. In order to maintain system performance, monthly preventative maintenance (i.e. filter cleanout) will be performed.

In order to evaluate system performance, the DPW proposes to conduct groundwater monitoring in all eight of the monitoring wells in the vicinity of and downgradient of CW-1, and the sparging well. For the first month, the groundwater samples will be collected weekly. For the remaining five months, groundwater will be sampled biweekly. Groundwater samples will be analyzed for Priority Pollutant Volatile Organic Compounds plus a library search (PPVOCs+10) by USEPA Method 8240, including cis 1,2-dichloroethene (cis 1,2-DCE).

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2.0 APPLICABLE REMEDIAL STANDARDS

The remediation standards for the groundwater in the vicinity of CW-1 will be the Groundwater Quality Criteria (GWQC) defined in New Jersey Administrative Code (N.J.A.C.) 7:9-6. In the event the GWQC for a particular compound is numerically lower than the practical quantitation limit (PQL) for that compound, the PQL will be applied as the groundwater cleanup level.

Compound	Higher of GWQC or PQL (micrograms per liter)
Tetrachloroethene	1
Trichloroethene	1
cis-1,2,-Dichloroethene	10

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3.0 COST OF REMEDIATION

Opinion of Costs for Proposed Remedial Action

Wastewater Lime Treatment Pit, CW-1
Charles Wood Area, Fort Monmouth, New Jersey

Category	Costs[1]
REMEDIATION COSTS[2]	
Installation	$60,000
Operating and Maintenance	$115,000
Laboratory	$71,000
POST-REMEDIATION COSTS[3]	
Removal	$20,000
Laboratory	$15,500
Restoration	$13,000
TOTAL:	**$294,500**

Notes:

[1]Costs do not include permitting fees, NJDEP review fees, or disposal costs.
[2]Costs assume that system will operate for 6 months
[3]Costs assume that post-remediation monitoring will continue quarterly for 1 year.

Sources: Smith Technology Corporation (Project No. 09-5004-14)

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